

WAYFINDER

DOPPLER VELOCITY LOG (DVL)



**TELEDYNE
MARINE**
Everywhere you look™

P/N 95P-6001-00 (September 2023)

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REVISION HISTORY

September 2023

- Updated software and manuals download links

July 2023

- Updated website address.
- Update outline installation drawing 96P-9000.

February 2023

- Added 96P-9001 outline installation drawing.
- Updated EAR statement.

February 2021

- Added RTC battery charging information to Power Overview section.
- Added “The power source needs to be able to supply at least 2A” to page 3.

October 2020

- Initial Release.

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Wayfinder Product Website:

teledynemarine.com/en-us/products/Pages/Wayfinder.aspx



Chapter 1 - Overview

The Wayfinder assembly contains the ceramics and electronics with a molded one-meter serial cable. The standard acoustic frequency is 600 kHz. See Figure 5 and Figure 6 for dimensions and weights.

Note that the urethane face covers the ceramics and provides a robust, flexible waterproof seal. Avoid setting the Wayfinder on bumpy surfaces that may leave an indentation in the urethane or damage the urethane face or anodized finish.

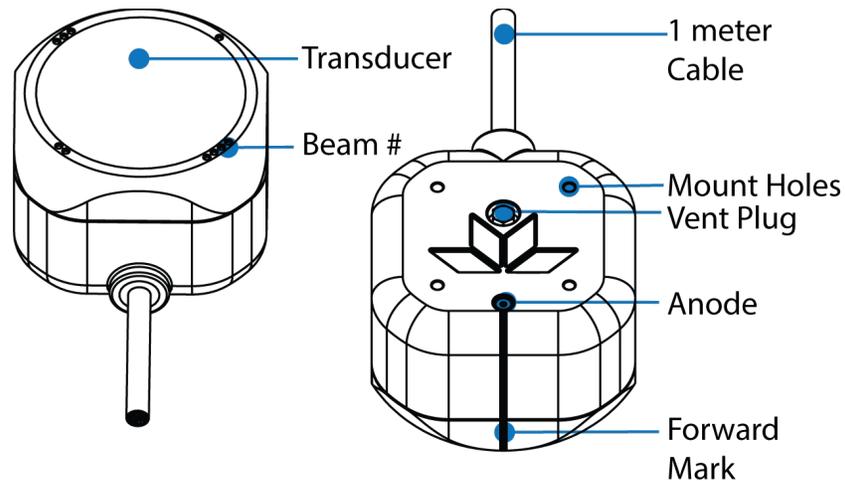


Figure 1. Wayfinder Overview

Setting up the Wayfinder System

Use this section to connect the Wayfinder to a computer and establish communications. Install the *Wayfinder Tools* software to communicate with the Wayfinder.

Where do I download the Wayfinder software and manual?

<https://www.teledynemarine.com/support/RDI/technical-manuals>

Software Installation

The customer application for all core Wayfinder functionality is the *Wayfinder Tools* app. This software runs on Windows and Linux.

To install the Wayfinder software:

1. Use the Wayfinder Product Website and download the Wayfinder Tools app.
2. Double-click on the *Wayfinder Tools xx.xx setup.exe* file (where xx.xx is the version number) to install.
3. Use the desktop icon to start the app or click **Start, Teledyne RD Instruments, Wayfinder_Tools**.

Power Overview

The Wayfinder requires a DC supply between 11.4 to 36.7 VDC (24 VDC typical). Either an external DC power supply or battery can provide this power. The power supply should be able to source at least two Amps.

Input Voltage Range	Transmit Power	Average Power	Idle Power
11.4 to 36.7VDC	25 W	3.0 W	1.5 W

There is a constant background power consumption of 1.5 watt (idle power) anytime the Wayfinder is powered and not pinging. The average power consumption depends upon the transmit duty cycle. As soon as you connect to the system using Wayfinder Tools, the system begins pinging.

Leave the Wayfinder powered on for approximately 24 hours to fully charge the Real Time Clock (RTC) battery after unpacking the system. You can use the Wayfinder while the RTC battery is being charged, but it will be necessary to set the date and time each time after powering up the system. With a fully charged RTC battery, the RTC keeps the date and time for more than nine months.

Cable Wiring Diagram

The following table shows the Wayfinder Power/Comm cable connections. Where shown, RX is the incoming signal; TX is the outgoing signal.

Table 1. Wayfinder Power/Comm Cable Pigtail Wiring

Wire Color	Signal	Wire Gauge
Red	Power (+)	22AWG
Black	Power Return (-)	22AWG
Brown	COM_GND	22AWG
Orange	RS-232_TX	22AWG
Yellow	RS-232_RX	22AWG
Green	Not Used	N/A



Pigtail cable is one meter.

Cable bend radius is 10x cable diameter

Nominal cable O.D. is 0.247" to 0.263" Max. (6.2mm to 6.7mm Max.)

Jacket wall Nom. is 0.032" (0.81mm)

Cable bundle diameter is 0.228" (5.79mm)

The cable has foil shielding. It is not terminated inside the Wayfinder and can be grounded at the cable end if needed.

Bench Test Setup

Several parts and tools are needed to setup the Wayfinder DVL for a bench test.

- **USB to RS232 adapter** (recommended). Source for purchase [here](#).



or

- **DB9 female socket, solder cup**. Source for purchase [here](#).

- **Laptop/tablet**

TRDI recommends a medium to high-end model or Windows Surface tablet with Windows 10 or Linux operating systems.

- **Battery or power supply**

Either an external DC power supply or battery can provide the 11.4 to 36.7 VDC (24 VDC typical) power. Source for purchase [here](#). The power source needs to be able to supply at least 2A.

- **Tools**

Soldering iron, wire stripper (22AWG capable), heat shrink.

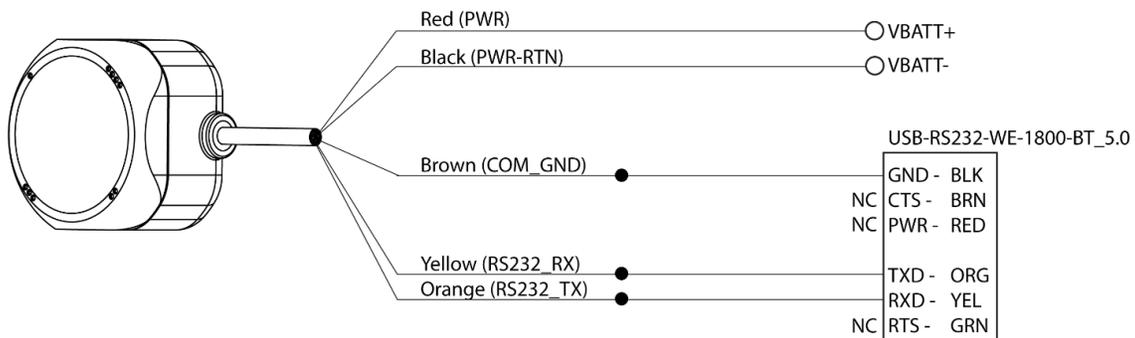


Figure 2. Wiring Diagram Using the Recommended USB to Serial Adapter



RS-232 RX and TX are from the perspective of the Wayfinder. Serial adapters or other terminations may follow the opposite convention so the RX and TX connections may need to be swapped.

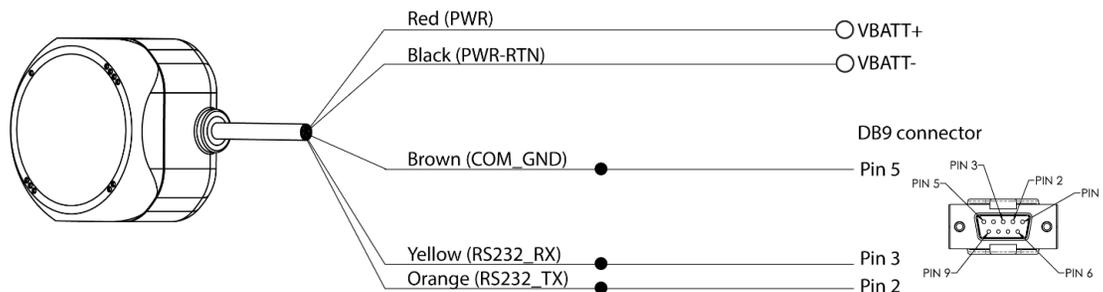


Figure 3. Wiring Diagram Using a DB9 Serial Connector

Connecting to the Wayfinder

To establish communications with the Wayfinder using the Wayfinder Tools app:

1. Connect the Wayfinder cable to the computer's serial port.
2. Apply +12 to 36VDC power (24 VDC typical) power to the system.
3. Start the Wayfinder Tools app using the desktop shortcut.
4. Select the **Port** the cable is connected to and set the **Baud rate** to 115200 (default setting).
5. Click the **Connect** button. As soon as you connect to the system using Wayfinder Tools, the system begins pinging.



Testing the Wayfinder System

You should test the Wayfinder DVL:

- When you first receive the system.
- Before each deployment or every six months.
- When you suspect instrument problems.
- After each deployment.

To test the Wayfinder:

1. Connect the Wayfinder cable to the computer's serial port.
2. Apply +12 to 36VDC power (24 VDC typical) power to the system.
3. Start the *Wayfinder Tools* app.
4. Click on the Diagnostics tab.
5. Click the **Run tests** button.
6. If all the tests pass, the Wayfinder is functioning normally.
7. If any of the result shows fail, contact TRDI Field Service for more information.

Caring for the Wayfinder System

This section contains a list of items to be aware of every time handling, using, or deploying the Wayfinder. *Please refer to this list often.*

- Never set the Wayfinder on a hard or rough surface. This may leave an indentation in the urethane, damage the urethane face, or scratch the anodized finish.
- Do not expose the Wayfinder to prolonged sunlight (24 hours or more). The urethane face may develop cracks. Cover the Wayfinder if it will be exposed to sunlight.
- Do not store the Wayfinder in temperatures over 60 degrees C or under -25 degrees C. The internal components and/or urethane face may be damaged.
- Do not connect other metal to the Wayfinder. Other metals may cause corrosion damage. Isolating bushings must be used when mounting the Wayfinder to a metal structure.

Chapter 2 – System Integration

This chapter is intended to provide the necessary and often critical implementation and integration considerations for the use of Wayfinder systems on various platform types. In addition, the procedures described provide a step-by-step guide that will enable the client to configure the Wayfinder DVL sonar for optimum utilization.

Mechanical Integration Considerations

Before choosing a mounting location, keep in mind the following mounting requirements.

Table 2. Wayfinder Mounting Checklist

Mounting Criteria	Critical Requirement	Vehicle Dependent	Notes
Location on centerline			Mechanically mount the center of the Wayfinder as close as possible to the vehicle's fore-to-aft centerline.
Level pitch/roll			Mount the Wayfinder as level as possible using the vehicle's roll and pitch references.
Beam clearance			Clear the Wayfinder beams of any acoustic obstacles. A 90-degree cone around the face of the Wayfinder should be observed to account for each beam acoustic spread.
Bottom strike protection			Ensure there is a section on the hull/platform that is lower than the Wayfinder location to protect from bottom strikes.
X Y axis alignment			Typical alignment is Beam 3 (instrument Y-axis) rotated 45° relative to the vehicle forward axis or Beam 3 facing forward.
Cable routing			Tight mounting spaces next to bulkheads may require rotating the Wayfinder to prevent sharp bends in the cable.
Flow noise/cavitation			May need a fairing to reduce flow noise and/or cavitation.
Isolation Hardware			Use M5 isolating bushings and washers when mounting the Wayfinder to a metal structure.

Location on Centerline

The mechanical alignment of the Wayfinder is important to data accuracy. Mechanically mount the center of the Wayfinder as close as possible to the vehicle's fore-to-aft centerline. Although it is preferable to mount the Wayfinder on the centerline, other components or structural items may make this impossible. Balance this requirement with the other critical requirements when choosing a mounting location. As distance from the centerline increases, accelerations caused by vessel rotation also increase. These accelerations can cause additional uncertainties in Wayfinder velocity measurements.

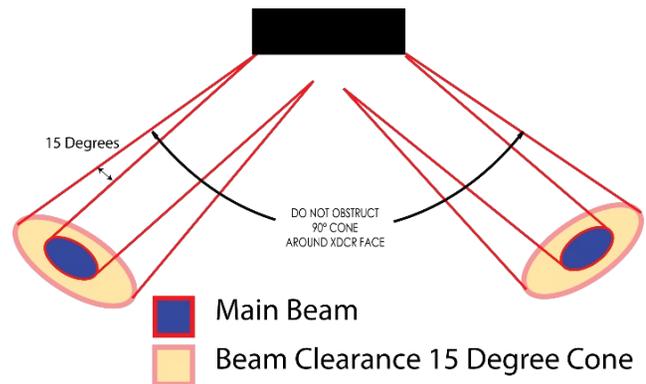
Level Pitch & Roll

Mount the Wayfinder as aligned as possible with the vehicle's frame of reference. Bottom Track only performs up to around 15-degree tilt or slope (angle of incidence). To assure the best performance over sloping bottom topography or system tilt, the system should be mounted as close to level as possible.

Significant misalignment in mounting may require post-processing to re-align the reference frames.

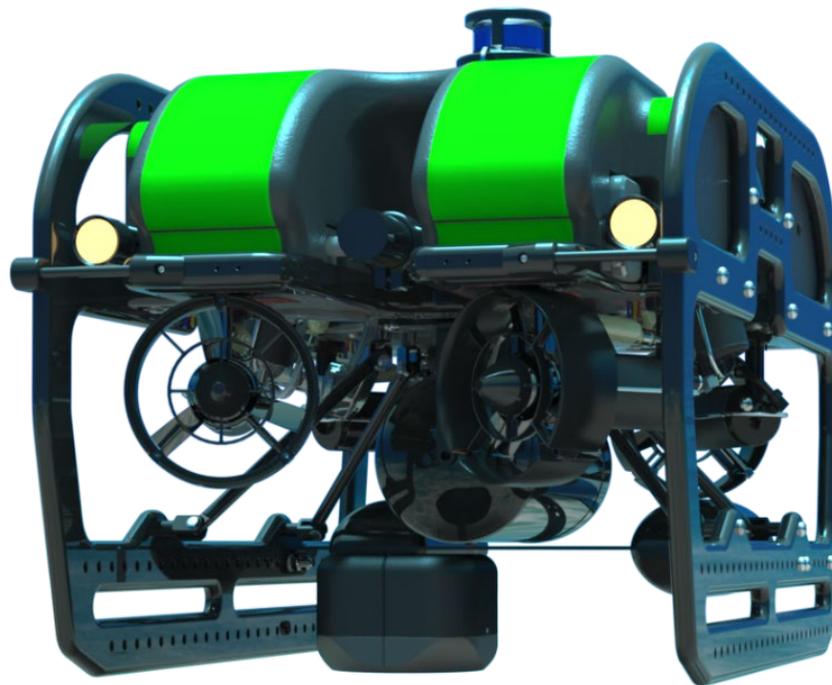
Beam Clearance

Acoustic obstacles such as cables, hull, other instruments, etc. are numerous on undersea vehicles. Special care should be observed in clearing the Wayfinder beams of any acoustic obstacles. A 90-degree cone around the face of the Wayfinder should be observed to account for each beam acoustic spread. Any acoustic obstacle in the Main Beam and acoustic spread will interfere with the Wayfinder measurement or worse prevent the measurement altogether. If the Wayfinder is used near a quay wall for instance, then a quick rule of thumb is that for every meter of vertical separation between the Wayfinder face and the seabed the same separation is necessary between the Wayfinder and the Quay wall. The Wayfinder also has side lobes, which could collect energy backscattered by acoustic obstacles in the beam clearance cone as shown in the outline installation drawing (Figure 5 and Figure 6).



Bottom Strike Protection

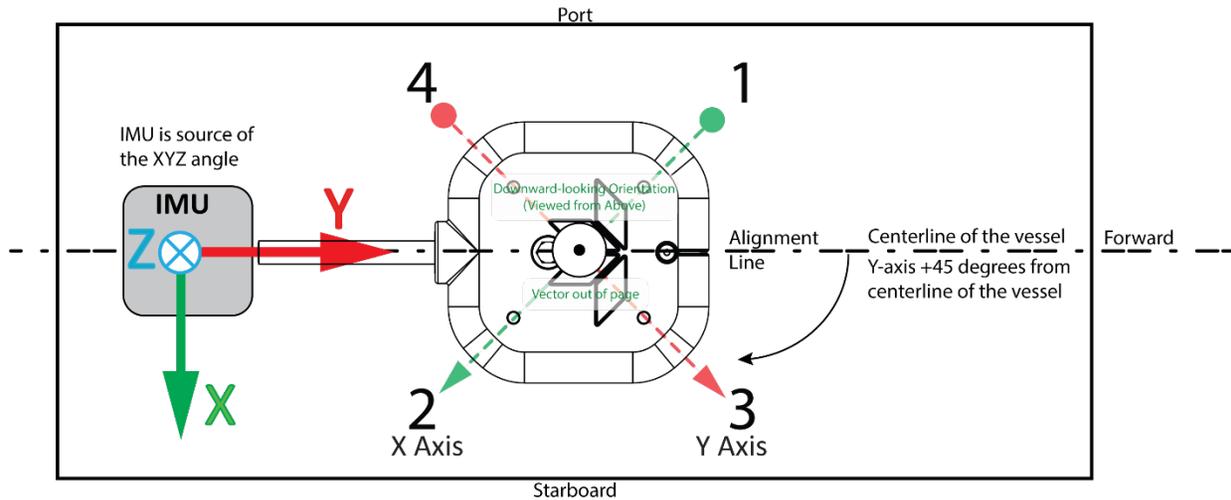
When mounting the Wayfinder, ensure there is always a section on the hull/platform that is lower than the Wayfinder location. This will reduce the risk of damage to the Wayfinder should you run aground or collide with any submerged obstacle.



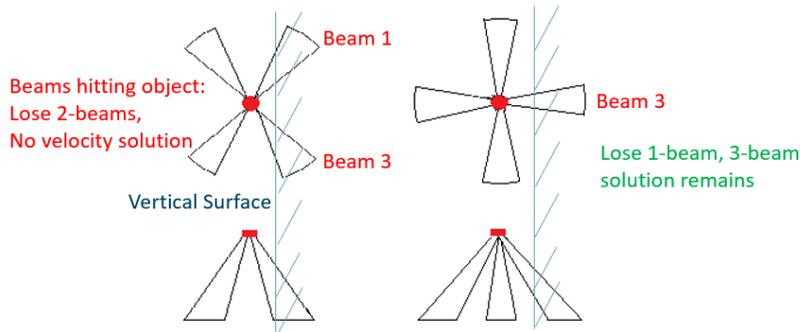
Good mounting location – on centerline, level pitch/roll. Wayfinder has good beam clearance and is protected from the bottom and most submerged obstacles.

X Y Axis Alignment

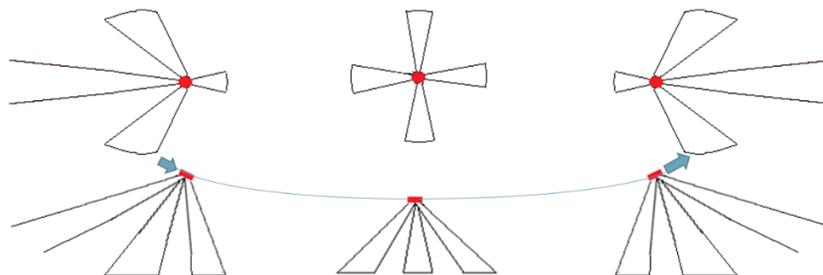
TRDI recommends mounting the Wayfinder with the alignment line facing forward on the vessel. This makes Beam 3 (instrument Y-axis) rotated 45° relative to the vehicle forward axis. This causes the magnitude of the signal in each beam to be about the same. This improves error rejection and increases the Wayfinder’s effective velocity range by a factor of 1.4. Any significant misalignment in mounting may require post-processing to align the reference frames.



However, on some vehicles that operate at regular times close to vertical surfaces, it is desirable to mount the Wayfinder with Beam 3 in-line to the vehicle axis. See [Three-Beam Solution](#) for more information.



For vehicles that routinely dive and raise in the water-column, it again may be desirable to mount the Wayfinder with Beam 3 in-line to the vehicle axis so that as the vehicle pitches down and up, 15 to 20 degrees, at least 3 beams are tracking the bottom.



Note that tight mounting requirements next to bulkheads may require rotating the Wayfinder to prevent sharp bends in the cable. See [Routing the Cable](#) for more information.

Wayfinder Instrument (X, Y, Z) Coordinates

The Wayfinder uses Instrument Coordinates (X, Y, Z). Instrument Coordinate axis are always oriented the same relative to the Wayfinder. Looking at the end view of the Wayfinder, the beams are labeled clockwise in the order 3-2-4-1. When you look at the face of the Wayfinder, the beams are labeled clockwise in the order, 3-1-4-2. The X-axis lies in the direction from Beam 1 towards Beam 2 and the Y-axis lies in the direction from Beam 4 towards Beam 3. The Z-axis lies along the axes of symmetry of the four beams, pointing away from the water towards the housing.

The Wayfinder data format assumes the bottom is stationary and that the Wayfinder/vessel is moving.

- If Beam 3 is going forward, then the Y velocity is positive.
- If Beam 2 is going forward, then the X velocity is positive.
- If the bottom is going towards the face of a down facing Wayfinder, then Z is negative.

To compute the DVL physical forward and lateral velocity, rotate the XYZ Instrument Velocities by 45°.

Instrument to Ship Rotation Matrix:

Transposition Matrix	Values to Transpose (Rotate)	Matrix Results
$\begin{Bmatrix} 0.7071 & 0.7071 & 0.0000 \\ -0.7071 & 0.7071 & 0.0000 \\ 0.0000 & 0.0000 & 1.0000 \end{Bmatrix}$	$\begin{matrix} \text{(Transverse)} X = \\ \text{(Longitudinal)} Y = \\ \text{(Vertical)} Z = \end{matrix} \begin{Bmatrix} -1.4142 \\ 1.4142 \\ 0.0000 \end{Bmatrix}$	$\begin{matrix} \text{(Transverse)} S = \\ \text{(Longitudinal)} F = \\ \text{(Vertical)} M = \end{matrix} \begin{Bmatrix} 0.00 \\ 2.00 \\ 0.00 \end{Bmatrix}$

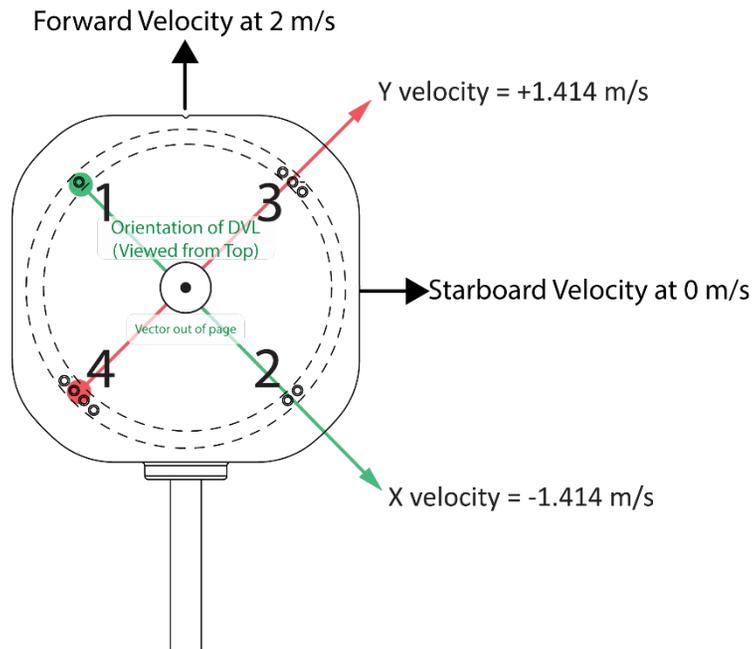


Figure 4. XYZ Instrument Velocities

Routing the Cable

Use care when routing the Power/Comm cable through bulkheads, deck plates, cable runs, and watertight spaces. Make allowances in cable length and engineering design plans for cable routing. When necessary, use strain reliefs on the cables.

Route the cable so:

- Cable does not have kinks or sharp bends (see [Cable Wiring Diagram](#) for specifications). Tight mounting requirements next to bulkheads may require rotating the Wayfinder to prevent sharp bends in the cable.
- The Wayfinder cable (or junction box, if one is used) must **NOT** be exposed or installed next to high voltage lines or circuits, motors or engines. See [Identifying EMI](#) for more information.
- If a junction box is used, make sure that all the cable conductors are connected properly and avoid ground loop effects. Make sure that the conductors are electrically isolated from each other.

Flow Noise/Cavitation

Water flowing over the Wayfinder face increases the acoustic noise level, which in turn decreases the operational range of the Wayfinder. Flow noise can be reduced by mounting the Wayfinder behind a fairing. Flow noise can also be reduced by optimizing the design to conform to the platform hull form being used.

Avoid mounting the Wayfinder DVL in the input or output area of a thruster as this will reduce the Wayfinder operating range AND thruster performance. 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 Wayfinder or surrounding area near the Wayfinder 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 design to the platform hull form being used.

Isolation Hardware

Once you have chosen a mounting location, use the four M5 mounting holes on the housing. See Figure 5 and Figure 6 for dimensions and weights. The Wayfinder housing is made of aluminum that is protected by a sacrificial anode and a hard anodize coat. Do not connect other metal to the Wayfinder as this may cause corrosion damage. Isolation hardware is not required for use in freshwater environments; it is strongly recommended to use M5 isolating bushings and washers for saltwater environments. Keep this in mind when fabricating a fixture, which materials to use, or deciding how to place it on the vehicle.

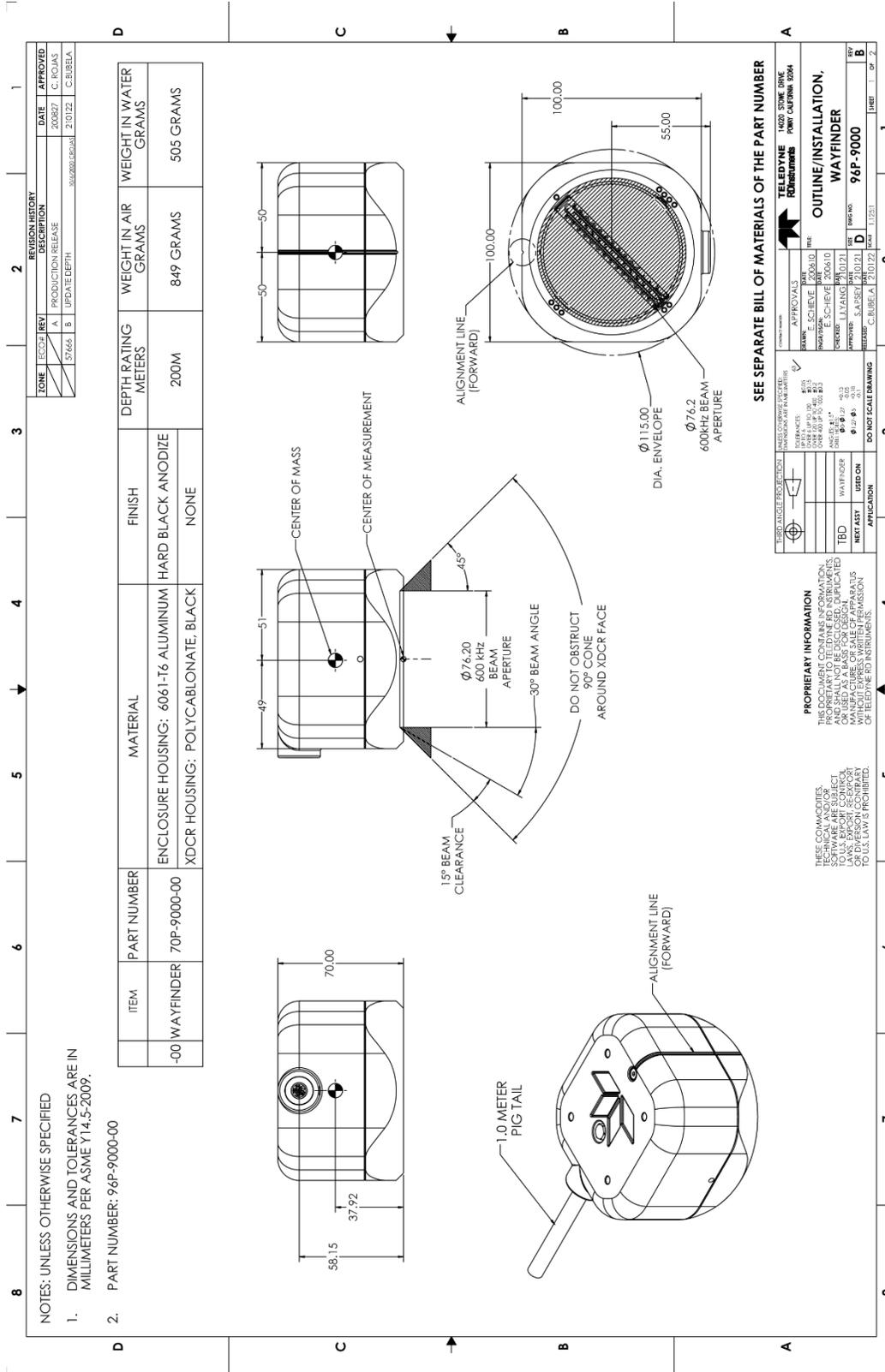


Figure 5. Outline Installation Drawing –Wayfinder 600 kHz Sheet 1

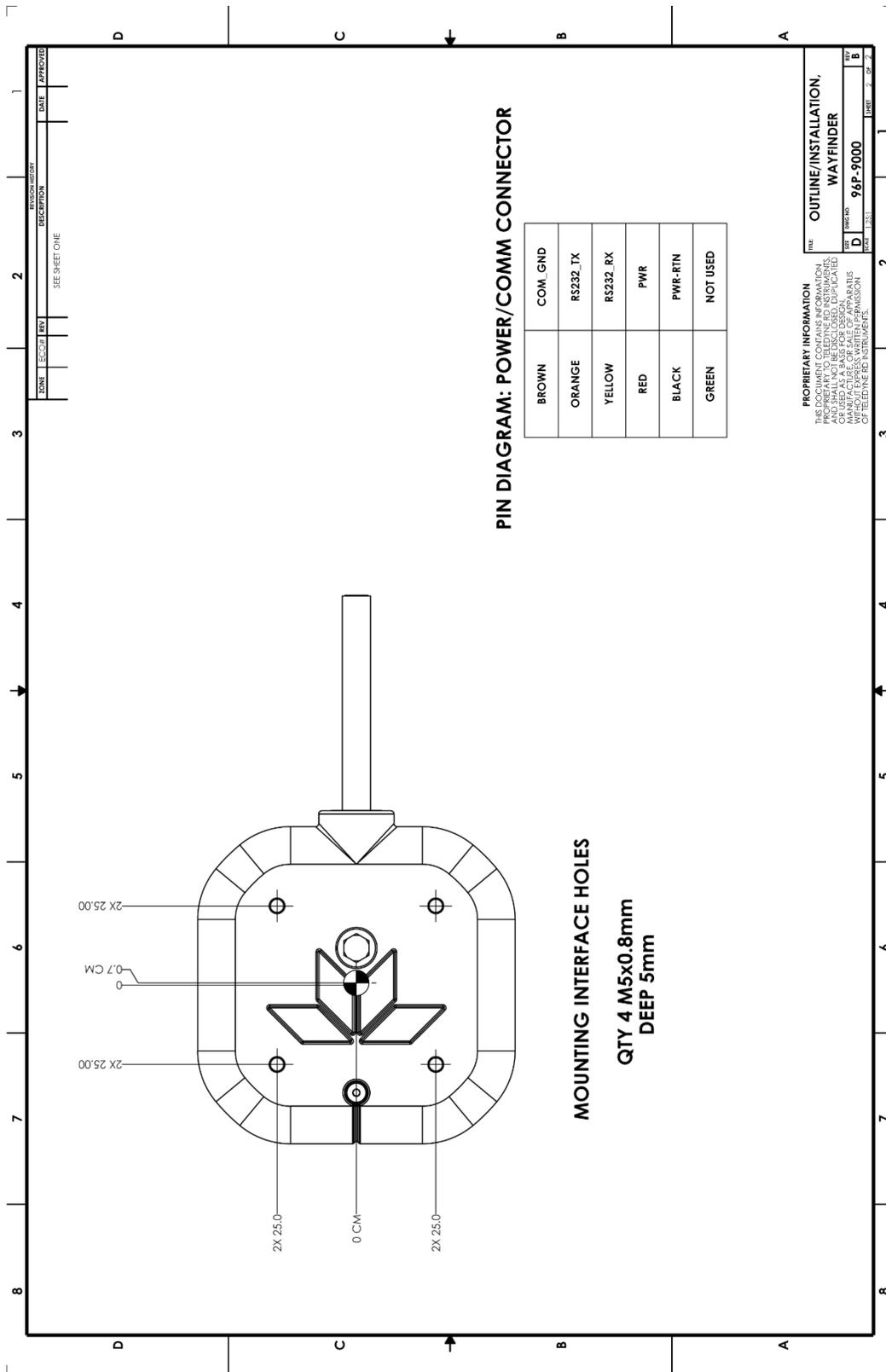


Figure 6. Outline Installation Drawing –Wayfinder 600 kHz Sheet 2

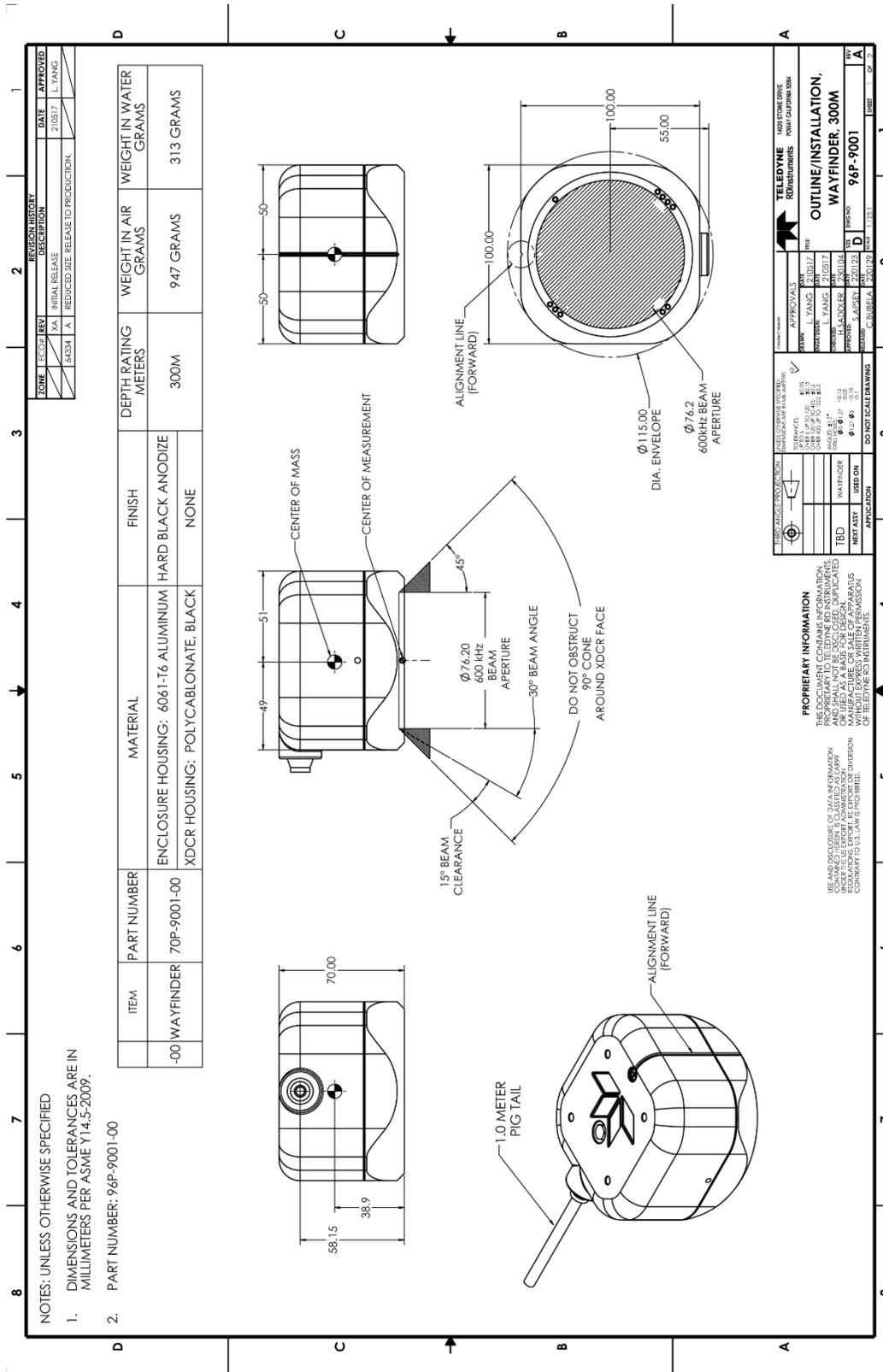


Figure 7. Outline Installation Drawing –Wayfinder 600 kHz, 300 meters

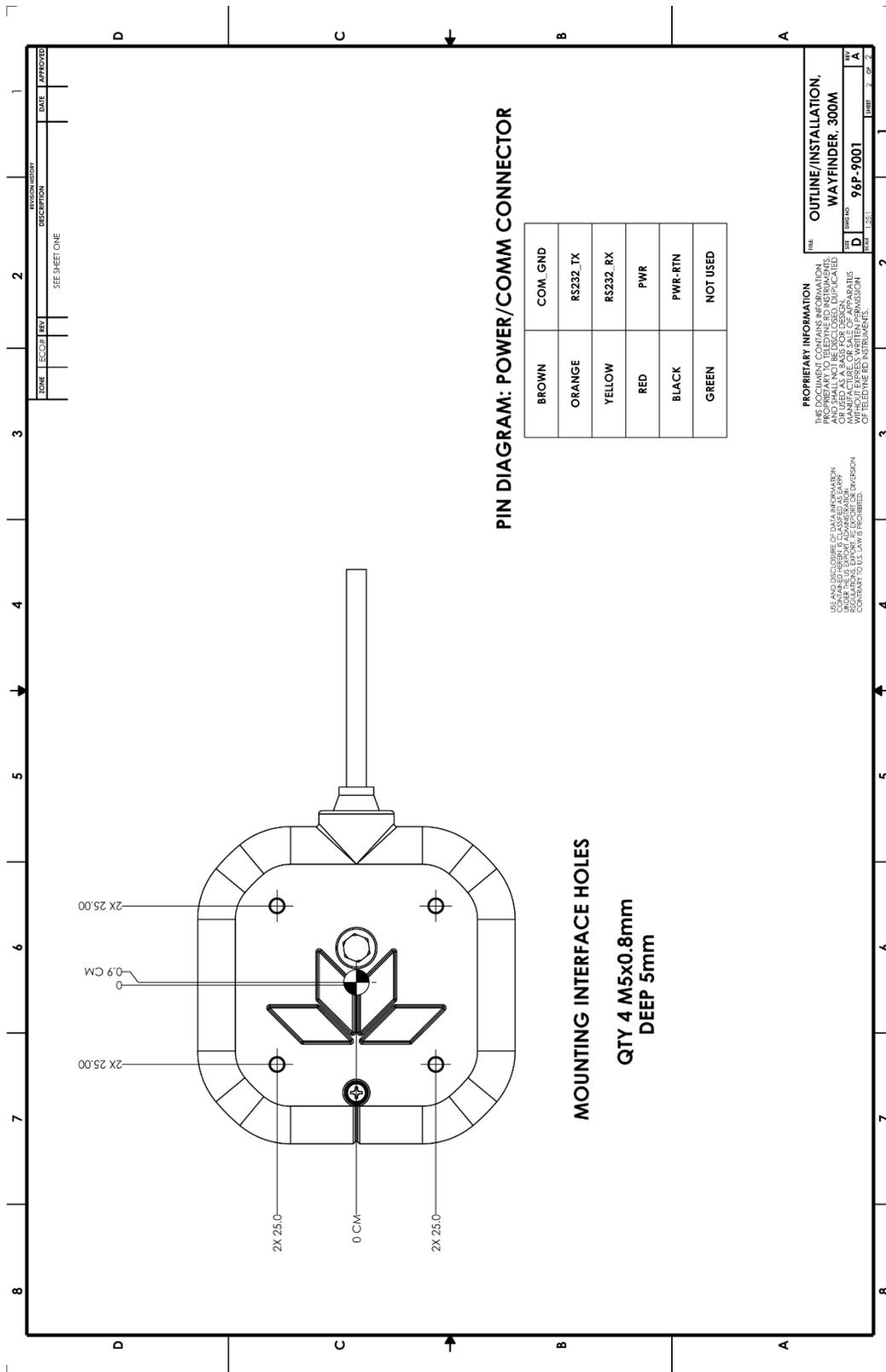


Figure 8. Outline Installation Drawing –Wayfinder 600 kHz, 300 meters, Sheet 2

Electrical Integration Considerations

Grounding Recommendations

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

- Communication ground
- Power ground
- Chassis ground

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 grounded systems noted above are isolated from each other. The Power Ground is isolated from the Chassis Ground by an isolation / ground noise filter circuit. This 'link' between these two grounds is susceptible to EMI from outside sources if the isolation is not properly maintained outside the Wayfinder. If the Wayfinder's isolation / ground noise filter circuit is shorted, the Wayfinder may experience an increased noise floor, ultimately propagating into the signal receivers.

This same isolation circuit will be shorted if the chassis (DVL GND) is in direct contact with the vehicle chassis (vehicle GND) and the Power supply ground connected to the Wayfinder is also connected to the vehicle chassis (vehicle GND).

The Wayfinder chassis is anodized, thereby providing electrical insulation when the instrument is mounted into what are usually metal hulls. The anodized coating is required to maintain chassis ground isolation.

Another potential electrical path bypassing the isolation/ground filter can occur through seawater. The current generated can pass via the Wayfinder anode, (or scratches in the Wayfinder anodized coating), through the seawater, and then back to the hull (or frame) to the vehicle. The likelihood of this ground path occurring is increased if the hull of the vehicle is connected to the Power ground of the Wayfinder through the vehicle's grounding circuitry. Typically, this resistance is very high resulting in only a few microamperes of current and is limited by the size of the Wayfinder anode and the distance between the Anode and the grounded hull of the vehicle (the greater the separation the greater the resistance).

For the condition described, if the exposed surface resistance is great, the Wayfinder will not be adversely affected, as is usually the case. For conditions where the surface resistance of the Wayfinder chassis and vehicle are low, undesired interferences will occur.

Another way that you can have undesired grounding of the Wayfinder to the frame or hull of a vehicle is that mounting holes can lose their anodized coating by scraping of the anodized inner wall with the mounting screws. The use of an isolation plate and plastic bushings and washers are good practices to avoid this grounding path.

In summary, bypassing or shorting the Wayfinder isolation / ground noise filter circuit will increase the sensitivity of the Wayfinder 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 Wayfinder isolation/ground filter can lead to accelerated corrosion.

Acoustic Integration Considerations

Interference from other acoustic and electromagnetic devices can cause velocity and direction bias. In extreme cases, interference may prevent the Wayfinder from operating. It is possible to avoid interference by using a suitable triggering scheme. This is particularly recommended if the other device is operating within the bandwidth of the Wayfinder receiver (in some cases up to 40% of the carrier frequency of the Wayfinder) or if the other device has a harmonic component that is within the Wayfinder frequency receive bandwidth. Initiating a well-conceived triggering scheme (triggering the interfering device, the Wayfinder, or both) will keep the interfering device from operating during the Wayfinder's transmit and receive period. It is important to note that the TRDI receivers have 90 to 110 dB of gain, which for the sake of clarity is greater than 100,000 times of voltage amplification.

Table 3. Transmit and Receive for the Wayfinder DVL

Wayfinder System	Carrier Frequency	Transmit & Receive Bandwidth
600 kHz	614400 Hz	38.4 kHz (6.25%)

Data and Timing Considerations

Data Screening

Wayfinder measurements suffer from occasional data outliers which, although rare, can still be far more frequent than would be expected from a normal (Gaussian) probability function. To prevent the navigation system from giving undue weight to data outliers, it is important to screen the Wayfinder data to detect and reject them.

Data outliers are often the result of ambient data environmental factors. The Wayfinder DVLs have several internal routines to detect and account for the false data described. Unless the bottom is detectable, and the correlation value is above a threshold criterion, bottom track velocity will be marked Not a Number (NaN). The presence of fish in one or more beams will also cause data outliers. The Wayfinder also screens for fish using the information in the intensity data for all four beams.

If all four beams pass these screening tests, the Error Velocity (representing the redundant information among the four beam velocities) is calculated and its magnitude compared to a threshold as an additional screen. Measurements exceeding this Error Velocity threshold will be rejected.

To keep the Wayfinder errors as independent as possible from ping to ping, the Wayfinder does not screen for unreasonably abrupt changes in altitude or velocity. These kinds of screens are most appropriately performed at the front end of a navigation system. An isolated abrupt change in altitude is most likely an outlier (fish or other false target) that should be rejected, whereas a step function with a persistent final altitude might be real (a cliff or a transition from a vehicle hull to the real bottom, for example). A robust algorithm will reject the isolated data outlier while quickly recovering from a persistent step. Similar screening can be done on velocities.

Three-Beam Solution

The Wayfinder screens the velocity data by comparing the magnitude of the Error Velocity to a threshold. The Error Velocity has redundant information among the four beam velocities. A three-beam solution is produced if, on a particular ping, only three beams have good data, and in that case only, error velocity screening cannot be performed. The Wayfinder still computes a four-beam solution with error velocity screening on all pings where all four beams have good data. There are operating circumstances where due to the bottom slope and/or pitch only three beams can have adequate reflection from the bottom, while the fourth beam is not. The three-beam solution makes it possible to operate in such severe environments.

Ping Timing

It is usually desirable to minimize the time it takes a Wayfinder to complete a ping cycle because this enables faster data update rates. When the maximum operating altitude is known, the **Max Range** setting on the [System tab](#) can be used to limit the maximum ping time in Bottom Track mode, since time to receive data from the bottom is proportional to the distance to the bottom.

For example, if you know the maximum depth in the deployment area is 40 meters, set the value slightly larger than 40 m, say 45 m, instead of default 60 meters. Now if the Wayfinder loses track of the bottom, it will stop searching for the bottom at 45 m rather than spend time searching down to 60 m.

Table 4 shows the approximate Bottom Track ping times for a Wayfinder DVL as a function of altitude above the bottom.

Table 4. Approximate Bottom Track Ping Times (in milliseconds)

Altitude in meters	Ping Time in ms
5	55

The following equation provides an estimate for the time between pings for ranges greater than 3.8m for the Wayfinder:

$$\text{Ping time (seconds)} = \text{RTB(m)} * .42\text{e-}3 + 30\text{e-}3$$

Where RTB is the Range to Bottom in meters.

System Synchronization

Typically, data from the Wayfinder is fed into a larger user supplied acquisition and control system, which collects data from other sources as well. In such situations, it is important to have all the data accurately referenced to a common time base.

The Wayfinder data ensembles contain a time stamp with a 10 ms resolution from a reading of the real-time clock before the ping, but the resolution in setting the time is limited to 1 second. If higher accuracy is required, it is recommended to send the time set command using binary command or the python driver at or near the full second.

Software Integration

The Wayfinder Tools software provides a graphical user interface for use with a Wayfinder DVL. It is a Python-based application, so it runs on a variety of operating systems including Windows and Linux and can be executed directly on the platform.

To facilitate vehicle integration, there is an interface driver also in Python. This driver integrates directly with many vehicles or top-side computer systems and provides the tools to configure and extract data from the Wayfinder DVL.

Integration Steps:

1. Ensure remote access to host computer and internet access.
2. Install Python 3.6 (or later) on the host computer.
3. Install pyserial and numpy via pip for Python 3 on the host computer.
4. Use the WayFinder Python API to access the streamed data or send commands.

Notes:

- Confidence value for Wayfinder data is not available from the Python API
- Data timestamp can be up to 1 second off (see [Setting the Wayfinder's Real-Time Clock](#))

Troubleshooting

The purpose of this section is to provide a list of critical tests to perform when the system is not operating to either specifications or expectations.

Communications Issues

The Wayfinder is connected to the data collection computer via a standard RS-232 serial port. If you have problems communicating with the Wayfinder, check to make sure that you are selecting the correct serial port or correct serial device. USB-serial adapters may be used if the computer does not have a serial port. Be aware that some USB-serial adapters are not fully compatible with Wayfinder data collection. If you experience communications issues with the USB-serial adapter, first try a different device. TRDI has had good experience with the Edgeport® line of multi-port USB-serial adapters and single-port adapters using the FTDI chipset and drivers.

Identifying EMI

The main sources of EMI are induced voltages from signal and power lines that are 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.

It is critical to route the Wayfinder cable such that it is not in proximity to interfering signal sources, such as clocks, CPU's, DC-DC converters, engine controls, and hydroelectric power units, power lines, acoustic devices and their power electronic. In the case of radiated EMI to the cable, then the EMI can be rapidly reduced as the power reduction goes by square of the separation distance between the source and the Wayfinder cable.

To avoid problems when the Wayfinder is installed in the final system, it is helpful to perform a bench test prior to installation. In the bench test, the Wayfinder should be exercised along with all the other components that will be installed in the final system. By performing this initial bench test, EMI and acoustic interference issues can be identified and remedied while all the system components are easily accessible.

The recommended types of systems that should be bench tested:

- If possible, select components and systems that are acoustically, and RF wise “out of band”, based on the specifications from the manufacturer of that equipment.
- It is important to test for all EMI interference that may be occurring in the system. Bench test all the equipment in air and see if there are interfering sources.
- Spread out the various systems and components that you intend to use on the bench in a pattern similar to how they will work.
- Try varying bench test temperatures, so it can be determined if there are tank circuits in your system that “tunes into” Wayfinder’s band, or visa-versa.

Observation of the FFT acoustic interference plots will provide information about interference to the Wayfinder DVL. The *Wayfinder Tools* app provides the user with a frequency domain plot (~100% bandwidth) of the Wayfinder’s four receiver channels during a sampling interval.

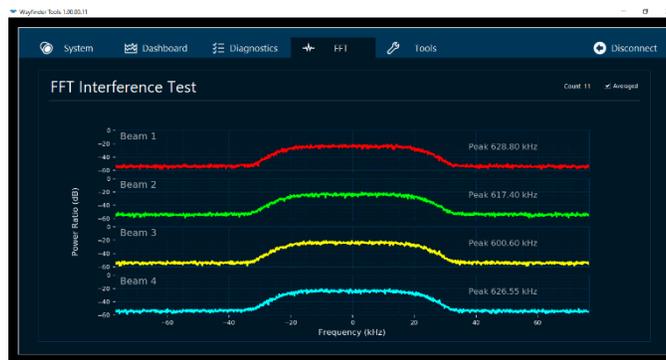
To view the FFT data:

1. Start *Wayfinder Tools* and connect to the Wayfinder DVL.
2. Click on the **FFT** tab.
3. While observing the FFT use the Wayfinder as a “probe” and touch it against components or systems to check their acoustic signature. Identify any unacceptable interference. Observe changes in the plots. Interference will show as large spikes.

For example, separating devices or shielding may be help. Note that the Wayfinder face (where the urethane is on the Wayfinder) will always be submerged in water during real operation. You can simulate this in water performance by placing the Wayfinder at the bottom of a small bucket, with just enough water to wet the urethane faces. Often what appears to be interference when the Wayfinder is in air may be completely gone when the Wayfinder is submerged in water. The inverse may be true as well. If there are other sonars or mechanical devices such as hydraulic power units that create acoustic signals, these may interfere with the Wayfinder system and the interference may only be detected when both the Wayfinder and the other device are submerged in a larger bucket or tank of water or somehow acoustically coupled through a hull or structural framework.

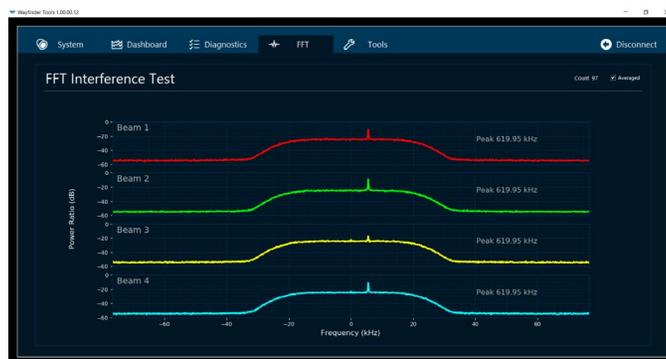
Examples of Clean FFT Plots, No Interference

The following is a screen shot of a typical “clean” FFT.



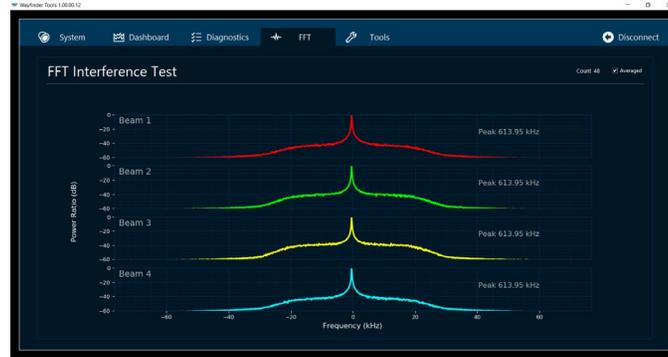
Examples of Interference

The following image shows an interference term on all channels at 619.95 kHz just to the right of center frequency.



Although not ideal, the previous interfering terms is small, and the Wayfinder will still bottom track accurately if the bottom echo return amplitude is stronger than this very weak interfering term.

The following types of interference will have significant effects on the accuracy of bottom track.



Unfavorable Environments

There are certain environmental conditions where the Wayfinder'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 Wayfinder from detecting the true bottom. If the Wayfinder 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 Wayfinder. The transmitted acoustic pulse from a Wayfinder is attenuated as a function of range due to a phenomenon called absorption. Absorption is caused by the conversion of some of the transmitted acoustic energy being converted to heat while traveling through the water. This lowers the available energy for the detection and processing of the reflected pulse from the bottom and affects the Wayfinder's altitude capability. This absorption loss is influenced through complex physics by the frequency and the average temperature and salinity of the water column. The Wayfinder system is minimally affected by temperature and salinity changes. Operation in fresh water enhances the Wayfinder's altitude capability; in general, low-salinity waters will increase the operating range of the unit.

Chapter 3 – Using Wayfinder Tools

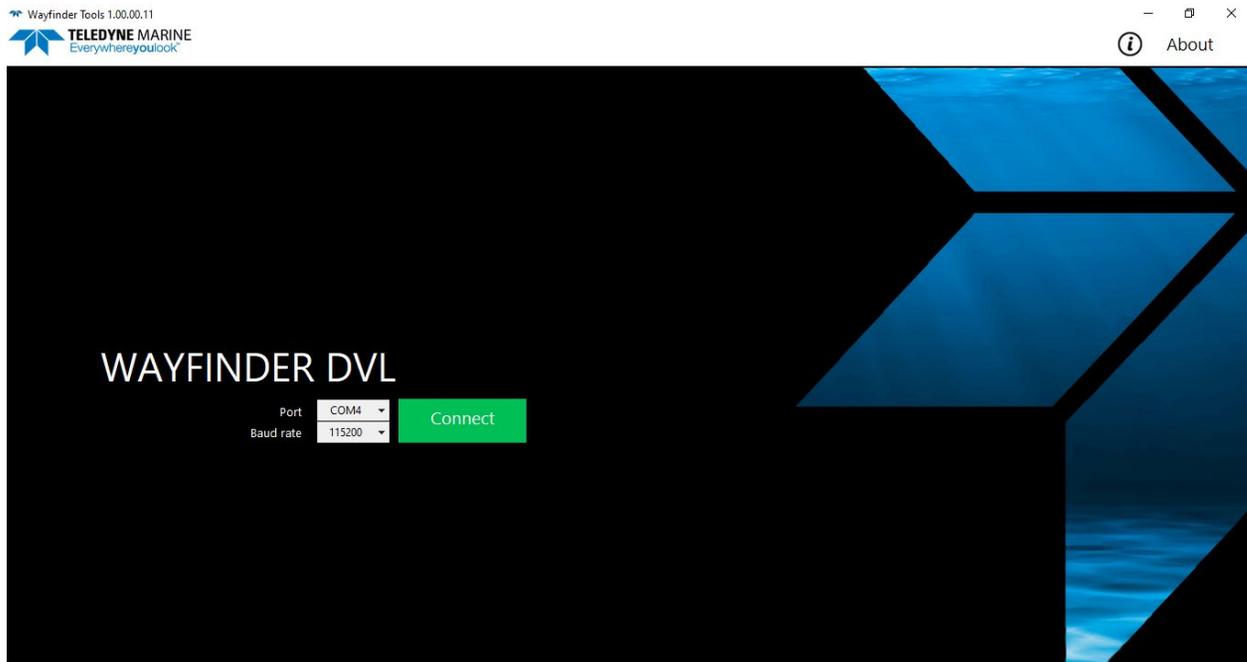
Using the Wayfinder Tools app

Wayfinder Tools is the customer app for configuring, testing, and viewing data for the Wayfinder system.

Communication Settings

To connect to the Wayfinder:

1. Start the *Wayfinder Tools* app using the desktop shortcut.
2. Apply +12 to 36VDC power (24 VDC typical) power to the system.
3. Select the **Port** the serial cable is connected to and set the **Baud rate** from the drop-down list to 115200 (default setting).
4. Click the **Connect** button. Once connected, the Dashboard tab will display.

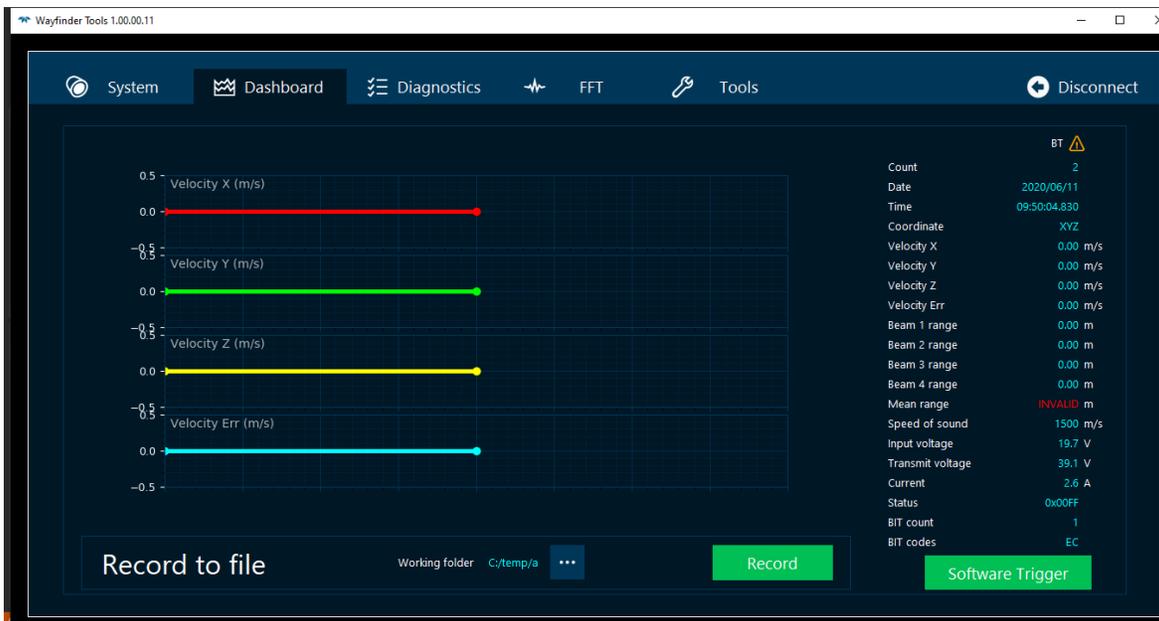


Dashboard Tab

Once you have connected to the Wayfinder, data collection starts.

To record data:

1. Press the ... button next to the Working folder.
2. Select the folder to record data into.
3. Press the **Record** button.
4. Press the **Stop** button to stop recording data.
5. If the Software Trigger is Enabled on the [System tab](#), pressing the **Software Trigger** button will cause the Wayfinder to ping once. Use this to test the trigger function. For normal operation, the trigger signal is sent via a binary command.



System Tab

To change the system setting:

1. Select the **System** tab.
2. Change the settings as needed.
3. Click on the **Update** button to set the new values.

Speed of sound - Sets the speed of sound value used for Wayfinder data processing. The default setting of 1500 m/s is recommended for most applications. Set the range to 1400 to 1600 meters per second.

Max range - If the Wayfinder loses lock on the bottom, it goes into search mode, which iteratively searches increasing ranges until either the bottom is found or the maximum range is reached, and then the process starts over at the minimum range. The **Max range** setting will prevent the Wayfinder from searching to ranges beyond the maximum range value and can result in shorter search cycles and allowing a faster ping

For example, if you know the maximum depth in the deployment area is 40 meters, set the value slightly larger than 40 m, say 45 m, instead of default 60 meters. Now if the Wayfinder loses track of the bottom, it will stop searching for the bottom at 45 m rather than spend time searching down to 60 m.



Use caution in setting this command to less than the expected maximum depth as the Wayfinder will be less likely to hold a lock on the bottom if there is any slope beyond the maximum range setting.

Software trigger - The Wayfinder is intended to operate in some applications where it will need to be coordinated with other acoustic sensors. The Wayfinder may use triggering to orchestrate many acoustic sensors to avoid acoustic interference. When the trigger is Enabled, a **Software Trigger** button is available on the Dashboard tab. Each time the **Software Trigger** button is pushed, the Wayfinder pings. This function may be automated by a binary command to send the trigger.

The screenshot shows the 'System' tab interface for the Wayfinder. The top navigation bar includes 'System', 'Dashboard', 'Diagnostics', 'FFT', 'Tools', and 'Disconnect'. The main content area is titled 'WAYFINDER' and shows 'DVL' with serial number '345678'. The 'System' section displays: Frequency (614 kHz), Firmware version (1.00.00.39), and FPGA version (0x1008). The 'Settings' section includes: Speed of sound (1500 m/s), Max range (60 m), and Software trigger (DISABLED). An 'Update' button is present in the Settings section.

Diagnostics Tab

The Diagnostics tab runs the Wayfinder Built-In tests (BIT).

To run the Built-In tests:

1. Select the Diagnostics tab.
2. Click the **Run tests** button.
3. The test results will change from NOT RUN to PASSED or FAILED.
4. If a test fails, please contact TRDI support for advice.

SDRAM Test - Fill the memory section with random values along with a checksum of those values. Then read the memory back and verify using the checksum.

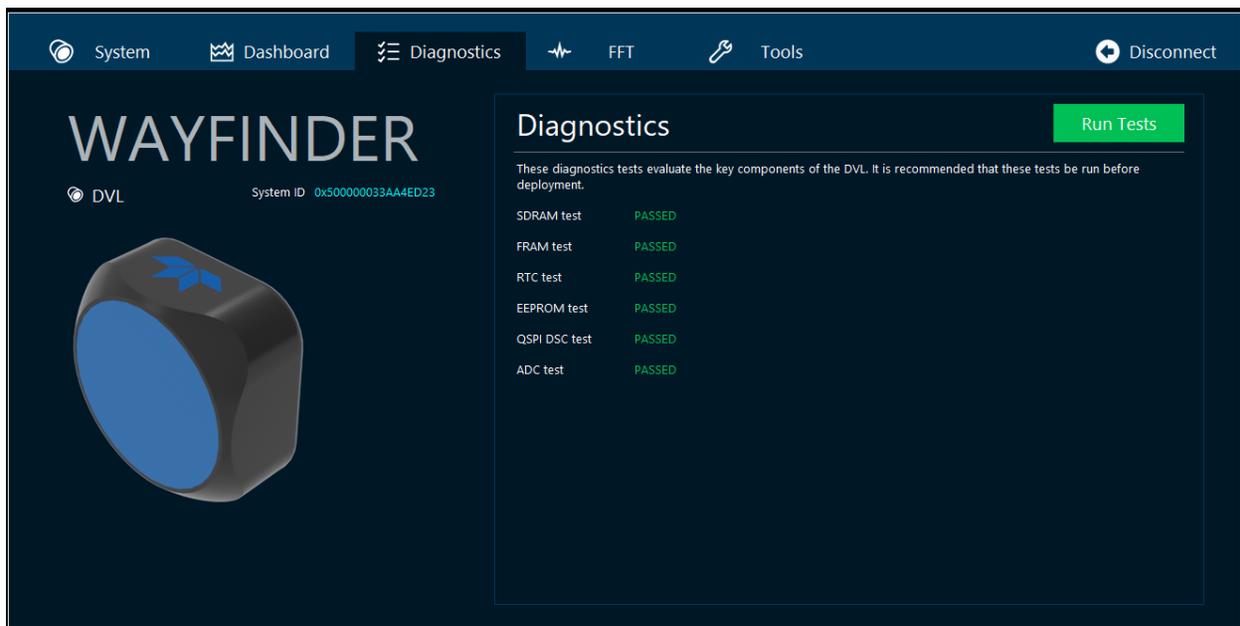
FRAM - Read the FRAM header and verify that the header value matches the expected value

RTC Test - Read the current time from the Real-Time Clock (RTC)

EEPROM Test - Read the DP device ID and verify the read is successful

QSPI/DSC Test - Write a pattern to the registers, read back and verify

ADC Test - Write to the ADC registers, read back and verify



The screenshot displays the Wayfinder software interface. At the top, there is a navigation bar with icons for System, Dashboard, Diagnostics (selected), FFT, and Tools, along with a Disconnect button. The main area features the 'WAYFINDER' logo and a 3D model of a DVL sensor. To the right, the 'Diagnostics' section is active, showing a list of tests and their results:

Test Name	Result
SDRAM test	PASSED
FRAM test	PASSED
RTC test	PASSED
EEPROM test	PASSED
QSPI DSC test	PASSED
ADC test	PASSED

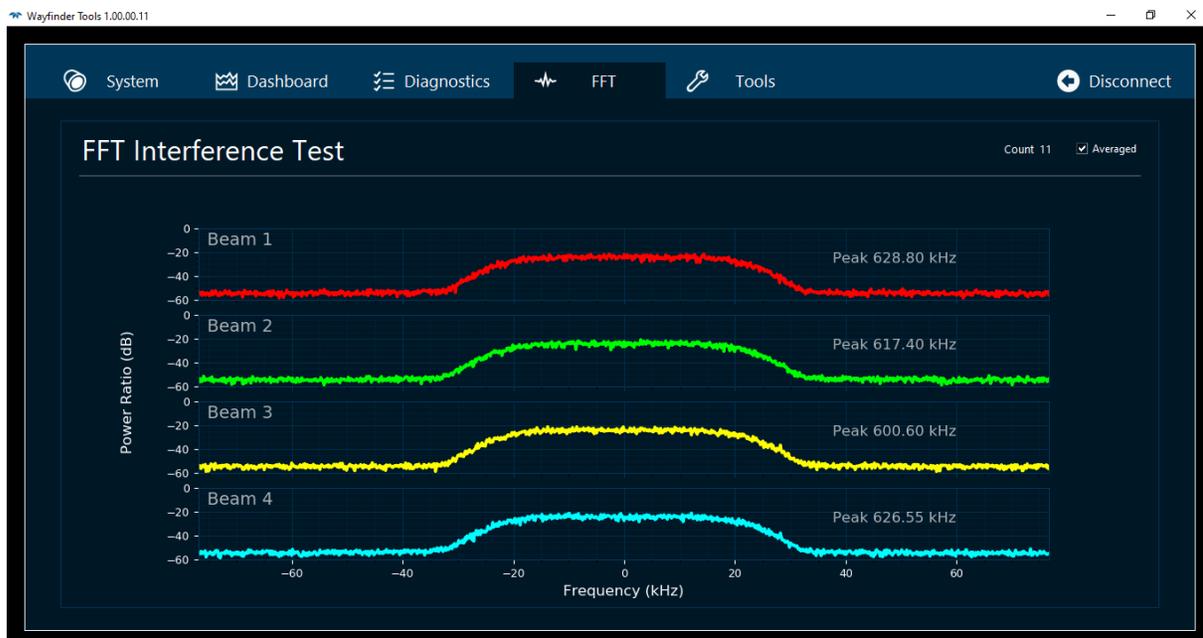
A green 'Run Tests' button is visible in the top right corner of the Diagnostics panel. Below the test list, a note states: 'These diagnostics tests evaluate the key components of the DVL. It is recommended that these tests be run before deployment.'

FFT Tab

Observation of the FFT acoustic interference plots will provide information about interference to the Wayfinder DVL. The *Wayfinder Tools* software provides the user with a frequency domain plot (~100% bandwidth) of the Wayfinder's four receiver channels during a sampling interval.

To view the FFT data:

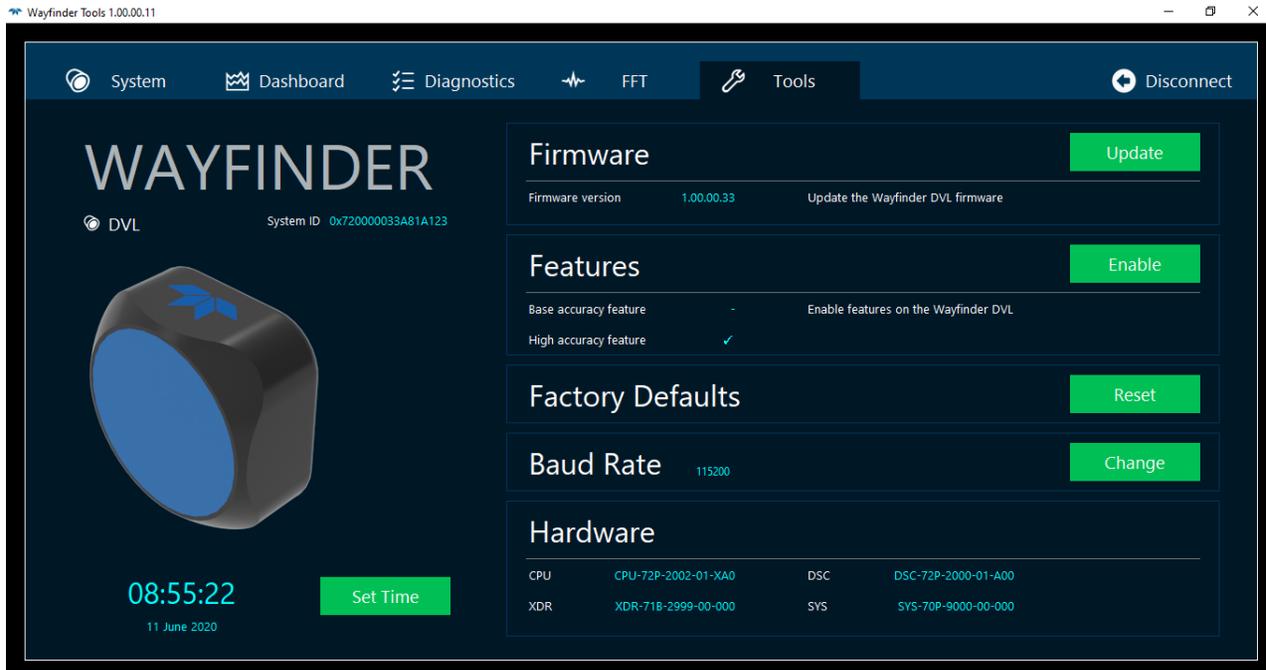
1. Start *Wayfinder Tools* and connect to the Wayfinder DVL.
2. Click on the **FFT** tab. It takes a few seconds for the FFT plots to display.
3. Select the **Averaged** button to view a moving average of the last 30 FFTs.
4. Move devices that may cause interference closer to the Wayfinder. Observe changes in the plots. Interference will show as spikes (see [Identifying EMI](#) for more information).
5. If any of the results show interference, contact TRDI Field Service for more information.



Tools Tab

Use the Tools tab to:

- Set the system time
- Update the firmware
- Enable features
- Set the Wayfinder to the factory defaults
- Set the communication Baud rate

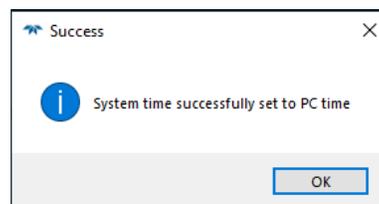


Setting the Wayfinder's Real-Time Clock

The Wayfinder system includes an internal Real-Time Clock (RTC) with a one second precision. The clock should be set before each deployment.

To set the RTC:

1. Start *Wayfinder Tools* and connect to the Wayfinder DVL.
2. Click on the **Tools** tab.
3. Click the **Set Time** button.
4. Click **OK** at the *System time successfully set to PC time* message.

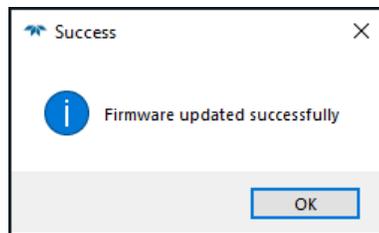


Updating the Wayfinder's Firmware

Wayfinder firmware updates can be requested from TRDI field service. Contact Field Service at rdifs@teledyne.com or by phone 858-842 2700. Save the file to the computer and unzip the file. The file will be named *WF_xx.xx.bin* (where *xx.xx* is the firmware version).

To update the firmware:

1. Start *Wayfinder Tools* and connect to the Wayfinder DVL.
2. Click on the **Tools** tab.
3. Click the **Update** button.
4. Navigate to the **.bin* file provided by TRDI and select **Open**.
5. Click **OK** at the *Firmware updated successfully* message. If the new firmware does not install, contact Customer Service for advice.



Enabling Wayfinder Features

Wayfinder feature updates can be purchased from TRDI sales. Save the file to the computer and unzip the file. The file will be named *WF_xx.xx.feature* (where *xx.xx* is the system serial number).



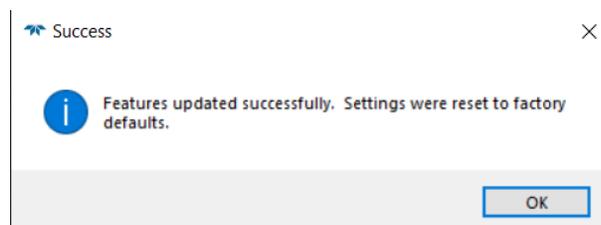
Contact your local sales representative if you are interested in upgrading your system.

The upgrade file is specific to the System ID for which it was ordered. DO NOT attempt to install this feature for any other unit.

Many feature upgrades require the latest firmware version to be installed in your Wayfinder. If you need to update the firmware, do this before installing the feature upgrade.

To install a feature:

1. Start *Wayfinder Tools* and connect to the Wayfinder DVL.
2. Click on the **Tools** tab.
3. Click the **Enable** button.
4. Navigate to the **.feature* file provided by TRDI and select **Open**.
5. Click **OK** at the *Feature updated successfully* message. Note that the [System tab](#) settings will be reset to the factory defaults. Verify the new features installed show a check mark. If the new feature does not install, contact Customer Service for advice.

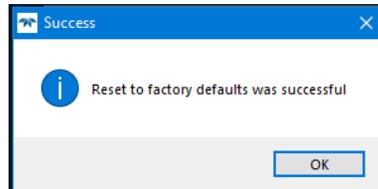


Setting the Wayfinder to the Factory Defaults

Use the Factory Defaults to ensure all settings on the **Settings** tab are at the default setting.

To set the factory defaults:

1. Start *Wayfinder Tools* and connect to the Wayfinder DVL.
2. Click the **Reset** button.
3. Click **OK**.

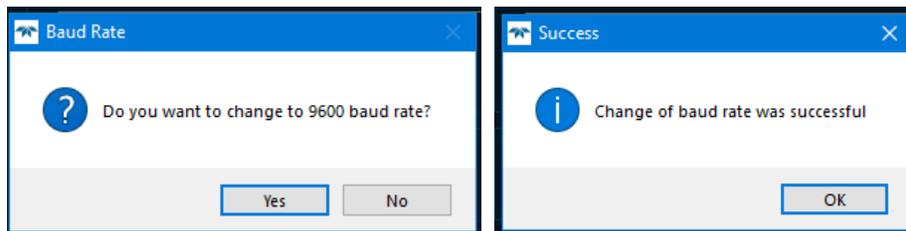


Changing the Wayfinder's Baud Rate

The Wayfinder default baud rate is 115200. Using 115200 baud will allow for faster pinging. However, high baud rates are more susceptible to noise and may result in poor communications. The alternative baud rate is 9600. Using it caps the maximum ping rate at 4 to 6Hz.

To change the Baud rate:

1. Start *Wayfinder Tools* and connect to the Wayfinder DVL.
2. Click the **Change** button.
3. Depending on what Baud rate is in use, select **Yes** to change to the new Baud rate and click **OK**.



The sample-rate may decrease some operations such as FFT and firmware upload. They will run slower when using 9600 baud.

Chapter 4 - Maintenance

Replaceable Parts

Use the following table to order replacement parts:

Table 5. Wayfinder Replacement Parts

Description	Part number	Where used
Anode	810-4106-00	Anode for Housing
M3 Anode Screw	93395A198	

Six anodes and the anode screws are included in the Spare Parts kit.

Periodic Maintenance Items

These maintenance items should be done prior to deploying the Wayfinder.

Wayfinder Inspection

The urethane coating on the Wayfinder is important to watertight integrity. Mishandling, chemicals, abrasive cleaners, and excessive depth pressures can damage the Wayfinder ceramics or urethane coating. Never set the Wayfinder on a rough surface; always use a soft pad to protect the Wayfinder. Inspect the urethane for dents, chipping, peeling, urethane shrinkage, hairline cracks, and damage that may affect watertight integrity or Wayfinder operation. Please contact the TRDI Support Team for advice if there is any damage.

The vent plug is used by TRDI for a helium leak test and nitrogen purge during manufacturing or repair. Other than checking that the plug is not loose, there is no need to remove it.

Zinc Anode Inspection and Replacement

The Wayfinder has one zinc anode on the housing. If the Wayfinder does not have exposed bare metal, a properly installed anode helps protect the Wayfinder from corrosion while deployed.

Inspect the anode for corrosion and pitting. If most of an anode still exists, it may not need to be replaced. If there are doubts about the condition of the anode, remove and replace the anode.

To remove and replace the zinc anode:

1. Remove the screw.
2. Clean the bonding area under the anode. Remove all foreign matter.
3. Set the new anode in place and tighten the M3 screw to 0.5 Nm (4.4 In-Lb).

Removing Biofouling

To remove foreign matter and biofouling:

1. Remove soft-bodied marine growth or foreign matter with soapy water. Waterless hand cleaners remove most petroleum-based fouling. Do NOT use a brush stiffer than a hand cleaning brush on the Wayfinder urethane face.
2. Rinse with fresh water to remove soap residue.
3. Dry the Wayfinder with low-pressure compressed air or soft lint-free towels. Always dry the Wayfinder before placing it in storage to avoid fungus or mold growth. Do not store the Wayfinder in wet or damp locations.

Protective Coating Inspection

For more protection, the Wayfinder assembly has a hard anodize coat. Do not damage the surface coatings when handling the Wayfinder.

Inspect the Wayfinder assembly for scratches, cracks, abrasions, and exposed metal (silver-colored aluminum). Be critical in your judgment; the useful life of the Wayfinder depends on it. If there is any damage to the anodizing, **DO NOT** deploy the Wayfinder. Please contact the TRDI Support Team for advice.

Appendix A

Notice of Compliance

Date of Manufacture

China RoHS requires that all Electrical and Electronic Products are marked with a Date of Manufacture. This is the starting point for the Environmental Friendly Use Period, described below.

Environmental Friendly Use Period (EFUP)

Per SJ/T 11364-2006 – Product Marking, the EFUP is defined as the time in years in which hazardous/toxic substances within Electrical and Electronic Products (EIP) will not, under normal operating conditions, leak out of the Product, or the Product will not change in such a way as to cause severe environmental pollution, injury to health, or great damage to property. TRDI has determined the Environmental Friendly Use Period is Ten (10) years.

The purpose of the marking is to assist in determining the restricted substance content, recyclability, and environmental protection use period of our covered products, as required in Chinese law, and does not reflect in any way the safety, quality, or warranty associated with these TRDI products.



Some homogenous substance within the EIP contains toxic or hazardous substances or elements above the requirements listed in SJ/T 11363-2006. These substances are identified in Table 6.

WEEE



The mark shown to the left is in compliance with the Waste Electrical and Electronic Equipment Directive 2002/96/EC (WEEE).

This symbol indicates the requirement NOT to dispose the equipment as unsorted municipal waste, but use the return and collection systems according to local law or return the unit to one of the TRDI facilities below.

Teledyne RD Instruments USA
14020 Stowe Drive
Poway, California 92064

Teledyne RD Instruments Europe
2A Les Nertieres
5 Avenue Hector Pintus
06610 La Gaude, France

Teledyne RD Technologies
1206 Holiday Inn Business
Building
899 Dongfang Road, Pu Dong
Shanghai 20122 China

CE



This product complies with the Electromagnetic Compatibility Directive 89/336/EEC, 92/31/EEC. The following Standards were used to verify compliance with the directives: EN 61326(1997), A1(1998), A2(2001) – Class “A” Radiated Emissions.

Material Disclosure Table

In accordance with SJ/T 11364-2006, the following table disclosing toxic or hazardous substances contained in the product is provided.

Table 6. Toxic or Hazardous Substances and Elements Contained in Product

零件项目(名称) Component Name	有毒有害物质或元素 Toxic or Hazardous Substances and Elements					
	铅 Lead (Pb)	汞 Mercury (Hg)	镉 Cadmium (Cd)	六价铬 Hexavalent Chromium (Cr ⁶⁺)	多溴联苯 Polybrominated Biphenyls (PBB)	多溴二苯醚 Polybrominated Diphenyl Ethers (PBDE)
换能器配件 Wayfinder Assy.	X	○	○	○	○	○
换能器接口电路板 Wayfinder PCBs	○	○	○	○	○	○
外接电缆 External Cable	○	○	○	○	○	○
专用装箱和泡沫塑料垫 Shipping Case w/Foam	○	○	○	○	○	○

○: 表示该有毒或有害物质在该部件所有均质材料中的含量均在 SJ/T 11363-2006 标准规定的限量要求以下。
○: Indicates that the toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit required in SJ/T 11363-2006.
X: 表示该有毒或有害物质至少在该部件的某一均质材料中的含量超出 SJ/T 11363-2006 标准规定的限量要求。
X: Indicates that the toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T 11363-2006.

NOTES