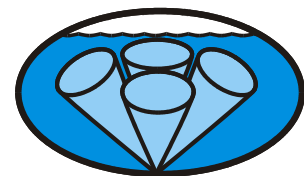


WorkHorse Troubleshooting Guide



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RD Instruments
Acoustic Doppler Solutions

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WorkHorse Troubleshooting Guide

1 Introduction

Considering the complexity of the WorkHorse, we have provided as much information as practical for field repair; *fault location to the component level is beyond the scope of these instructions*. The provided information assumes that faults are isolated with a large degree of certainty to a Least Replaceable Assembly (LRA) level only. The time to repair the system will be minimized if an entire replacement unit is available in the field. If time to repair is of essence, RD Instruments strongly advises the availability of the listed LRAs.



NOTE. When an addition or correction to the manual is needed, an Interim Change Notice (ICN) will be posted to our web site on the Customer Service page (www.rdinstrument.com). Please check our web site often.

Table 1: List of Least Replaceable Assemblies

LRA	Description
ADCP	The entire ADCP; includes the electronics, housing, transducer ceramic assemblies, and end-cap.
Deck Box (Mariner only)	The Deck Box contains all electronics necessary to supply power, provide user communication and gyro interface.
I/O Cable	Connects the ADCP with the Deck Box (Mariner) or Computer.
Serial Cable	Connects the Mariner Deck Box to the computer.
End-Cap	Includes the end-cap, connector, and internal I/O cable.
ADCP electronics	The spare boards kit Includes the PIO, CPU, and DSP boards.
PC Card	Replaceable PC recorder card.

Since these Least Replaceable Assemblies are manufactured in different configurations, please contact RD Instruments (see “[Technical Support](#),”

page 19 for contact information) to obtain the correct part number for your specific system configuration. When contacting RD Instruments about a replacement assembly, please provide the serial numbers of the ADCP and Deck Box. If you want to replace the I/O Cable only, then please provide the cable length.

1.1 Equipment Required

Special test equipment is not needed for trouble shooting and fault isolation. The required equipment is listed in Table 2. Any equipment satisfying the critical specification listed may be used.

Table 2: Required Test Equipment

Required Test Equipment	Critical Specification
DMM	Resolution: 3 ½ digit DC-Voltage Range: 200 mV, 2V, 20 V, 200V DC-Voltage Accuracy: $\pm 1\%$ AC-Voltage Range: 200 V, 450 V AC-Voltage Accuracy: $\pm 2\%$ Resistance Range: 200, 2 k, 20 k, 200 k, 20 MOhm Res.-Accuracy: $\pm 2\%$ @ 200 Ohm to 200 kOhm Res.-Accuracy: $\pm 5\%$ @ 20 Mohm Capacitance Range: 20 nF, 2 uF, 20 uF Capacitance Accuracy: $\pm 5\%$
Serial Data EIA Break-Out Box such as from International Data Sciences, Inc. 475 Jefferson Boulevard Warwick, RI 02886-1317 USA.	Model 60 or similar is recommended as it eases the troubleshooting of RS-232 communication problems significantly. Other manufacturers or models may be substituted.



NOTE. The EIA Break-out Panel is not necessary, but eases RS-232 communication problems troubleshooting significantly.

1.2 Basic Steps in Troubleshooting

The first step in troubleshooting is determining what type of failure is occurring. There are four types of failures:

- Communication failure
- Built-In test failure
- Beam failure
- Sensor failure

Communication failures can be the hardest problem to solve as the problem can be in any part of the system (i.e. the computer, WorkHorse, cable, or power). The symptoms include having the system not respond, or not responding in a recognizable manner (for example “garbled” text).

Built-In test failures will appear when the system diagnostics are run. Use *WinSC* or *BBTalk* to identify the failing test.

Beam failures can be identified when collecting data or during the user-interactive performance tests.

Sensor failures can also be identified when collecting data or during the user-interactive performance tests. The sensor may send incorrect data, or not be identified by the system.

2 Troubleshooting the WorkHorse

Although the WorkHorse is designed for maximum reliability, it is possible for a fault to occur. This section explains how to troubleshoot and fault isolate problems to the Least Replaceable Assembly level (see [Table 1, page 1](#)). Before troubleshooting, review the procedures, figures, and tables in this guide. Also, read the [“System Overview,” page 27](#) to understand how the WorkHorse processes data.



CAUTION. Under all circumstances, follow the safety rules listed in the [“Troubleshooting Safety,” page 4](#).

2.1 Troubleshooting Safety

Follow all safety rules while troubleshooting.



CAUTION. Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so.



CAUTION. Complete the ground path. **The power cord and the outlet used must have functional grounds.** Before power is supplied to the WorkHorse, the protective earth terminal of the instrument must be connected to the protective conductor of the power cord. The power plug must only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.



CAUTION. Any interruption of the earthing (grounding) conductor, inside or outside the instrument, or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.



CAUTION. Only fuses with the required rated current, voltage, and specified type must be used. Do not repair fuses or short circuit fuse-holders. To do so could cause a shock or fire hazard.



CAUTION. Do not install substitute parts or perform any unauthorized modifications to the instrument.



CAUTION. Measurements described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.



CAUTION. Do not attempt to open or service the power supply.



CAUTION. Any maintenance and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazard involved.



CAUTION. Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

2.2 Troubleshooting a Communication Failure

WorkHorse ADCPs communicate by means of two serial communication channels. The user can choose between RS-232 and RS-422 classes of serial interfaces with a switch on the PIO board in the WorkHorse.

To successfully communicate, both the host computer and the WorkHorse must communicate using the same class of serial interface. Standard serial interfaces in IBM compatible computers are also RS-232.



NOTE. If you have just received your WorkHorse from RDI, the standard configuration is RS-232 for Rio Grande and Sentinels and RS-422 for Monitors and Mariners.



NOTE. If you are using a high baud rate and/or a long I/O cable (greater than 50 meters) connected to a Sentinel ADCP, RS-232 may not work. Switch to RS-422 and try to wakeup the WorkHorse again.

There are two types of communication failures; nothing happens at all when attempting to wake up the ADCP, or something happens, but not the correct wake up message is displayed.

Incorrect Wakeup Message

When you send a break and the data is garbled, you may have a baud rate or parity mismatch between the WorkHorse and the computer, or the WorkHorse may be set for RS-422 instead of RS-232. Check the RS-232/422 switch on the PIO card inside the WorkHorse. See [“Incorrect Wakeup Messages,” page 6](#) for symptoms of garbled wakeup messages.



NOTE. Most communication problems are associated with incorrect cabling (i.e. the serial cable is connected to the wrong port) or data protocols (i.e. the wrong baud rate is set between the WorkHorse and computer).

Nothing Happens

If you cannot talk to the WorkHorse (i.e., no wakeup message at all), you need to isolate the problem to a computer fault, power, cable failure, Deck Box (Mariner only), or a WorkHorse problem. Check the following items:

- a. Connect the WorkHorse to a computer according to the appropriate [ADCP User's Guide](#). Check that all cable connections are tight.
- b. Is the Monitor/Sentinel WorkHorse AC power adapter working? Is the input voltage between 100 to 240 VAC? Is the output level 48 VDC?
- c. If the Monitor/Sentinel WorkHorse is running from a battery, check that the battery voltage is above 30 Volts DC. WorkHorse ADCPs will work at 20 volts; however, both lithium and alkaline battery packs with voltages below 30 volts are at or near their end of life, and are approaching uselessness.

For Rio Grande ADCPs, check that the battery voltage is above 10 Volts DC. Rio Grande ADCPs will work at 10 volts; however, batteries with voltages below 11 volts are at or near their end of life and are approaching uselessness.

- d. Is the computer hooked up properly? Does it have power?
- e. Make sure that your computer and the *BBTalk* or *WinSC* programs are set up to use the communication port the serial cable is connected to on the Deck Box (Mariner), or the communication port the I/O cable is connected to on the computer (Monitor and Sentinel).



NOTE. Use *WinSC*'s Auto Detect feature to determine the communications setting (see the [WinSC User's Guide](#) for details on using *WinSC*).

2.2.1 Incorrect Wakeup Messages

The following conditions may indicate a communications mismatch or lost boot code.

- Sending a break causes “garbage” to appear on the screen. The “garbage” text may keep scrolling. This happens when the computer is using RS-232 and the ADCP is set for RS-422 or vice-versa. Check the RS-232/RS-422 switch on the PIO board (see the [maintenance](#) guide).
- Sending a break causes “garbage” to appear on the screen. You can hear the ADCP “beep” when the break is sent. The “garbage” text does not keep scrolling. Check that the ADCP and computer are both using the same baud rate. See the CB-command in the [Command and Output Data Format](#) book.
- If the ADCP gives a steady “beep” when power is applied, the “>” prompt appears on the screen, and a “X” appears when additional breaks are sent, this may indicate that the boot code has been lost (see [“ADCP Checks,” page 8](#)). This can happen if you abort while downloading new firmware. Try downloading the firmware again.

2.2.2 Check the Power

The following test can be done with a voltmeter to check the power.

Monitor/Mariner/Sentinel ADCPs

Check the power going into the ADCP by measuring the voltage on the end of the cable that connects to the WorkHorse at Pins 3 and 7 (GND) (see [“Workhorse Cables,” page 20](#)). The voltage should be +48 VDC (using the standard AC adapter) or +48 VDC if you are using the Deck Box. If not,

check the voltage at the other end of the cable, the AC adapter, and Deck Box (Mariner only).

Rio Grande ADCPs

Check the power going into the system by applying power to the I/O cable and measuring the voltage on Pins 4 and 8 (GND) (see “[Workhorse Cables](#),” page 20). The voltage should be 12 VDC. If not, check the voltage at the other end of the cable and the battery.

2.2.3 Check the I/O Cable

This test will check the communication between the computer and Monitor, Sentinel, or Rio Grande WorkHorse.

- a. Disconnect both ends of the cable and measure the continuity using a DMM (see “[Workhorse Cables](#),” page 20 for the wiring diagram). Correct any problems found.
- a. Reconnect the I/O cable to host computer.
- a. Load *BBTalk* on your computer. Select the proper communications port (see the [RDI Tools User's Guide](#) for help on using *BBTalk*).
- b. For RS-232 communications, short pins 1 and 2 together on the female 7-pin connector that was plugged into the WorkHorse (see “[Workhorse Cables](#),” page 20). If you are using RS-422, connect a jumper between pin 2 to pin 6 and another jumper between pins 1 to pin 5 of the underwater connector at the WorkHorse end of the cable.
- c. Type any characters on the keyboard. The keys you type should be echoed on the screen. If you see characters, but not correctly (garbage), the cable may be too long for the baud rate. Try a lower baud rate. If this works disconnect the jumper on pins 1 and 2 and then push any keys on the keyboard. You should NOT see anything you type.
- d. If the keys are echoed correctly on the screen, the computer and the communication cable are good. Re-connect the I/O cable to the WorkHorse. The above loop-back test does not show if transmit and receive pairs are interchanged. Thus, it is important that you check the wiring diagrams provided in “[Workhorse Cables](#),” page 20.



NOTE. A loop-back test does not show if transmit and receive wires or pairs are interchanged, even though characters may be displayed correctly.

2.2.4 Check the Mariner Cables

This test will check the serial communication cable between the computer and Deck Box (Mariner only).

- a. Disconnect both ends of the cable and measure the continuity using a DMM (see [“Workhorse Cables,” page 20](#) for the wiring diagram). Correct any problems found.
- b. Reconnect the serial cable to host computer. Start the RD Instruments software utility program *BBTalk* on your computer. Make sure to select the proper communications port.
- c. For testing a RS-232 cable, jumper pins 2 and 3 at the far end of the cable. To check a RS-422 cable, connect one jumper between pin 2 to 4, and one jumper between pins 7 to 8.
- d. Type any characters on the keyboard. The keys you type should be echoed on the screen. If you see some characters, but not correctly, the cable may be too long for the baud rate. Try a lower baud rate. If this works disconnect the jumper and then push any keys on the keyboard. You should NOT see anything you type.
- e. If you use cables that are **not** supplied by RD Instruments you must make sure that transmit and receive pairs are not interchanged. The above loop-back test does not show if transmit and receive pairs are interchanged. Thus, it is important that you check the wiring diagrams provided in [“Workhorse Cables,” page 20](#).



NOTE. A loop-back test does not show if transmit and receive wires or pairs are interchanged, even though characters may be displayed correctly.

- f. If the keys are echoed correctly on the screen, the computer and the communication cable are most likely good. Re-connect the serial cable to the Deck Box. If the WorkHorse still does not wakeup, there could still be a problem with the Deck Box or ADCP.

2.2.5 ADCP Checks

Once you have eliminated possible problems with the power, I/O cable, communications settings, and the computer, that leaves the ADCP as the source of the problem. The following checks may help in some situations.

Cold Start the ADCP

- a. Remove the housing to gain access to the PC boards.
- b. Remove *all* power to the ADCP.



CAUTION. Disconnect the power cables P1 and P2 on the PIO board to ensure that NO POWER is applied to the ADCP during the next step.

- c. Short TP3 to TP4 on the PIO board for 10 seconds.
- d. Remove the jumper.

- e. Connect the computer and connect power to the ADCP. Send a break to the ADCP. This should start the ADCP in the “cold start” mode.

Fuse

Check the fuse on the PIO board is not blown (see the [Maintenance](#) Guide for fuse replacement procedures).



CAUTION. Only fuses with the required rated current, voltage, and specified type must be used. Do not repair fuses or short circuit fuse-holders. To do so could cause a shock or fire hazard.

Boot Code Error

If the ADCP gives a steady “beep” when power is applied, the “>” prompt appears on the screen, and a “X” appears when additional breaks are sent, this may indicate that the boot code has been lost. This can happen if you abort while downloading new firmware. Try downloading the firmware again.

2.2.1 Mariner Deck Box Checks

Once you have eliminated possible problems with the WorkHorse power, the serial data communication cable, and the host computer, that may leave the Deck Box as the source of the problem. Check the following conditions.



CAUTION. The Deck Box contains Electro Static Sensitive Devices. You must take accepted ESD prevention measures **before** opening the Deck Box.

- a. One of the interconnecting cables inside the Deck Box may not be fully seated. Turn off power. Remove the top cover of the Deck Box and check that all of the cables are properly seated.
- b. Check the Deck Box fuses are not blown (see the [Maintenance](#) Guide for fuse replacement procedures).
- c. Verify that the **Power Status** LED indicator located at the front panel next to the circuit breaker switch is lit. Make sure power to the Deck Box is connected and that the circuit breaker is in the ON position.
- d. Verify that if you send push the Reset button, the **Channel 1 In** LED on the front panel lights up temporarily. If it does, that means that the serial data receive channel seems to be functioning. If it does not light up then the receive channel is not functioning.
- e. If the **Channel 1 In** LED indicator on the front panel does light up while pushing **Reset**, verify that the **Channel 1 Out** LED next to it responses by lighting up temporarily as well. If the **Channel 1 Out** LED does light up, but there is no Wake-Up message displayed on the computer

screen, then this indicates there is still a problem with the serial data transmit path. A serial data Break-Out box between the Deck Box and the serial communications cable would be helpful for narrowing down the problem.

- f. If the Break-Out box does not indicate any data transmission from the Deck Box to the computer but the **Channel 1 Out** LED front panel indicator does, the problem most likely is with the Deck Box. Switch power to the Deck Box off, and after a few seconds on again. Repeat the Deck Box Checks from the beginning. If the system does not respond normally, it may be malfunctioning and you should contact RD Instruments.
- g. If the Break-Out box does indicate data transmission but there are no characters displayed on the computer screen, then the problem still lies with the communications cable or the computer.

2.3 Troubleshooting a Built-In Test Failure

The built-in diagnostic tests check the major ADCP modules and signal paths. The spare boards kit may be used to repair some failures. This kit includes:

- Spare Boards including PIO board, CPU board, and DSP board. These boards are held together with the standard M4 screw assembly and kept inside a protective anti-static bag.
- A disk containing your original beam cosine matrix table
- Tools for installation

2.3.1 When to use the Spare Boards Kit

Use this Kit whenever you have any of the following problems:

- Cannot communicate to the WorkHorse and you have ensured that the serial port on the computer, WorkHorse Cable, Deck Box (Mariner only), and WorkHorse RS-232 to RS-422 converter (if applicable) are all working properly.
- Your WorkHorse fails any of the following PA tests at any time:

CPU Tests:

- RTC
- RAM
- ROM

DSP Tests:

- Timing RAM
- Demod RAM
- Demod REG
- FIFOs

System Tests:

- XILINK Interrupts
- Receive Loop Back Test
- Your WorkHorse fails any of the following PA tests provided the items indicated by {} have been checked:

Recorder Tests:

Any recorder tests fails {}provided that the PCMCIA card(s) have been checked for proper installation, operation and they are DOS formatted; we STRONGLY recommend checking PCMCIA cards in a computer before replacing the boards}

System Tests:

Transmit {}if the WorkHorse fails when it is in water and air bubbles have been rubbed from the faces}

Sensor Tests:

H/W Operation {}if the WorkHorse fails when it is NOT sitting/resting on its side, or located near a large magnetic field like a motor in a boat}

The spare boards kit will not correct any of the following failures:

- A damaged beam or its urethane surface
- Damage to the transducer beam connections below the copper shield
- If it passes all PA tests and yet the data is all marked as bad
- Fails the following PA test:

System Tests:

Wide Bandwidth {}bandwidth tests may fail due to external interference}

Narrow Bandwidth {}bandwidth tests may fail due to external interference}

RSSI Filter

Transmit

Table 3: Pre-deployment Test (PA) Possible Cause of Failures

PA Test Name	Possible Cause of Failure
Pre-Deployment Tests CPU Tests: RTC RAM ROM	CPU board failed
Recorder Tests: PC Card #0 Card Detect Communication DOS Structure Sector Test (short) PC Card #1 Card Detect Communication DOS Structure Sector Test (short)	PC card not plugged in PC card failed DSP board failed
DSP Tests: Timing RAM Demod RAM Demod REG FIFOs	DSP board failed
System Tests: XILINX Interrupts	DSP or CPU board failed
Receive Loop-Back	DSP or CPU board failed
Wide Bandwidth	Not in water
Narrow Bandwidth	External interference
RSSI Filter	DSP or Receiver board failed
Transmit	Not in water or PIO board failed
Sensor Tests: H/W Operation	PIO board failed Receiver board failed Pressure sensor failed ADCP laying on its' side

2.3.2 Installation of the Spare Board Kit

This Kit has been setup so that you will replace all three of the Workhorse boards at once. This is done so that you do not have to risk damaging the individual boards while swapping in individual boards. The heading, pitch, and roll sensors have all been calibrated (the temperature sensor is an independent calibration and not changed by these new boards). Once you have replaced your original boards place them back in the Spare Board Kit box and contact RD Instruments Customer Service Department so that you can return them for repair.



CAUTION. Before handling either the Spare Board Kit or the original Board Set, always wear an earth-grounding static protection strap. The electronics in the Workhorse are very sensitive to static discharge. Static discharge can cause damage that will not be seen immediately and will result in early failure of electronic components.

We assume that a qualified technician or equivalent will perform all of the following work.

The Spare Boards Set will allow your system to perform to the same velocity specifications as your original set. There is, however, an offset error in the compass that can be as great as ± 1.5 degrees. This error CANNOT be removed by doing the Field Calibration procedure (AF command) even though you MUST do this as part of the installation. The additional ± 1.5 degrees can only be removed by RDI at the factory.

However, in most cases, the total compass error will still be within our original specification of ± 5.0 degrees. The only way to be sure that you have smaller errors than this specification is to perform your own local compass verification and correct any errors you find during your post processing of the data.

2.3.3 Remove the Original Set of Boards

- a. Remove the Transducer assembly from the pressure case. Use the [Maintenance Guide](#) for instructions.
- b. With your earth-ground static protection strap on, use a 3mm Allen wrench, to remove the four bolts that secure the three original Workhorse boards to the Transducer assembly.
- c. Note the orientation of the transmit cable connector as it is plugged into the PIO board and to the Receiver board (see [Figure 1](#)).

This cable must be removed and it has a very tight fit. To remove this cable, lift straight up on the three boards and tilt slightly (no more than 2 cm) toward the cable. This should allow you enough slack to unplug the cable from the PIO board. If this is not possible you may unplug the cable from the Receiver board. Be sure to note its orientation before unplugging.

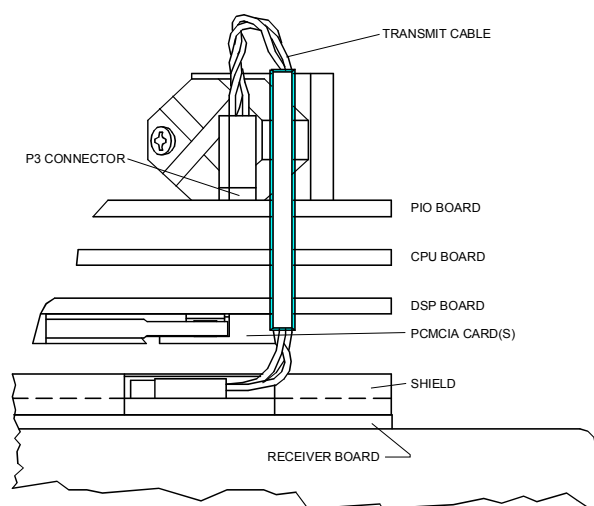


Figure 1. Transmit Cable

- d. Once the transmit cable has been disconnected you may now remove the top three boards as a set by lifting the set straight up.

These top three boards are connected to each other via connectors and will remain as one piece (see [Figure 2](#)). The DSP board connects to the Receiver board through a 26-pin header. The 26-pin header is a series of male pins. The 26-pin header may or may not stay connected to the DSP board when you remove the top three boards. If you see that there are male pins sticking out of the DSP board when you finish removing the board set then the header has remained attached to the DSP board. If this happens remove it and place it into the Receiver board. To remove it, gently rock it back and forth while pulling it away from the DSP board. Once removed, align it with the connector on the Receiver board and press it into place.

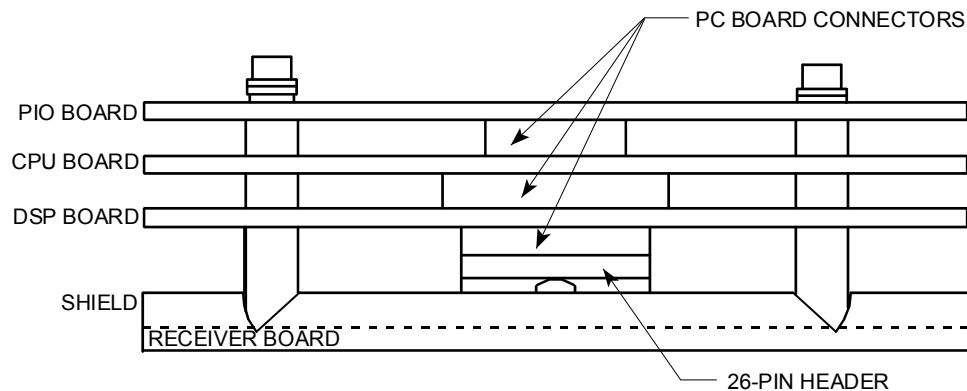


Figure 2. PC Board Connectors

- e. Remove all PCMCIA card(s) from the original set of boards. These PCMCIA cards will be used again once you install your Spare Boards Set. The Spare Board set does NOT contain a PCMCIA card(s). The PCMCIA card(s) are located on the bottom of the DSP board. To remove the PCMCIA card(s) press the button(s) on the side of the PCMCIA card slot. As you press this button the PCMCIA card will slide out. You will have to pull the card(s) out the rest of the way once the button is depressed all the way in.
- f. Set the original board set to the side for now.

2.3.4 Installing the Spare Board Kit

- a. With your earth-ground static protection strap on, remove the Spare Board Kit from the anti-static bag.
- b. Using a 3 mm Allen wrench and a 7mm wrench remove the nuts from the bolts that secure the Spare Boards together. You will be using these bolts to secure the spare set in your system. DO NOT change the posi-

tion of any of the bolts. The bolt containing the felt washers and ground jumper must remain in the same position (see [Figure 3](#)).

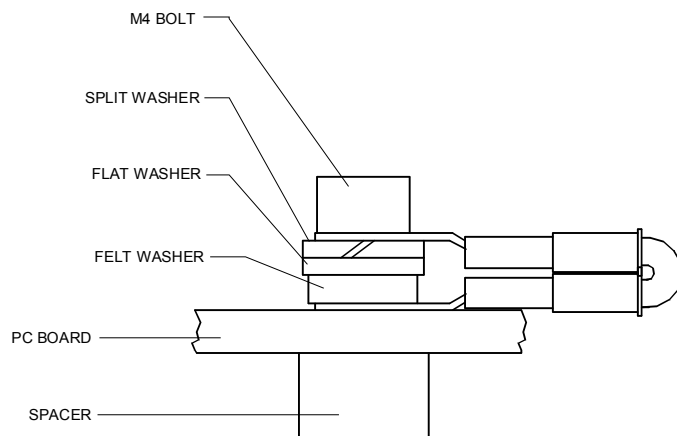


Figure 3. Ground Jumper

- c. Place the nuts (just removed) on the four bolts of your original set of boards and place them into the anti-static bag. You will use the new set of bolts included in the Spare Board kit to secure them to the Transducer assembly.
- d. Install all PCMCIA cards removed in [“Remove the Original Set of Boards,” page 13 step e](#) into the PCMCIA card slots. The PCMCIA card is keyed and will only connect when it has been aligned correctly and slid all the way in. The PCMCIA card is installed with the label side pointing away from the DSP board.
- e. Connect the Spare Board set to the Receiver board. Align the Spare Board set to the 26-pin header connected to the Receiver board. As you connect the Spare Board set, connect the transmit cable you removed in [“Remove the Original Set of Boards,” page 13 step c](#). Be sure to connect the cable in the same orientation as was installed on the original board set.

To test that the transmit cable is connected properly, start *BBTalk* and run the PT4 test. The test failure example shown below is what you would see for a missing or improperly attached transmit cable.

```
[BREAK Wakeup A]
WorkHorse Broadband ADCP Version 16.21
RD Instruments (c) 1996-2002
All Rights Reserved.
>pt4

IXMT    =      0.0 Amps rms  [Data= 0h]
VXMT    =     19.3 Volts rms [Data=4ch]
Z       =     999.9 Ohms
Transmit Test Results = $C0 ... FAIL
>
```

- f. Insert the four new bolts and tighten to 4 Newton-pounds.
- g. Install the Transducer into the Pressure Case. Use the [Maintenance Guide](#) for instructions.

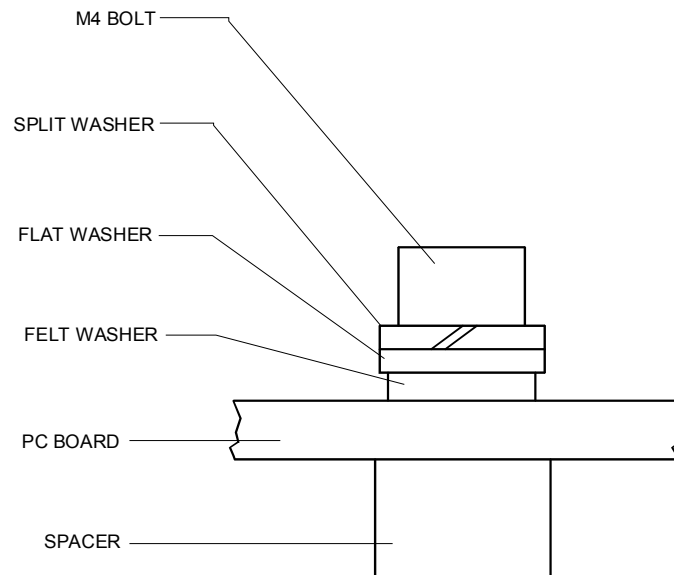


Figure 4. Mounting Hardware

2.3.5 Installing the Beam Cosine Matrix

The beam cosine matrix table corrects small transducer beam misalignment angles that occur during manufacturing.

- a. Connect your Workhorse ADCP as you would normally and apply power.
- b. Start *BBTalk* and confirm that the Workhorse ADCP is communicating normally and which communication port you are using (COM 1 or COM 2).
- c. Place the Beam Cosine Matrix Disk into your computer's disk drive.
- d. If your ADCP is connected to COM 1, press <F2> and run the script file *xxxx_1.scr* (where xxxx is your system serial number).

If your ADCP is connected to COM 2, press <F2> and run the script file *xxxx_2.scr* (where xxxx is your system serial number).

Your Beam Cosine Matrix table will automatically be updated in your ADCP and a file called *SPRBD.LOG* will be created. You can view the contents of this file to confirm that the data entered during the &V portion matches the contents in the PS3 results under the label Q14.

2.3.6 Testing the System

- a. Install the Transducer in the Pressure Case.
- b. Connect the cable and power as you normally do and test as ADCP as shown in the [Test Guide](#). All PA tests should pass when run in water and the PC tests should pass out of water.
- c. **Perform a field calibration of your compass.** Use the [Maintenance Guide](#) for instructions on running the AF command. Remember that there will be up to 1.5 degrees of offset error in the compass measurement. This error is not removed by the field calibration.

You have completed the WorkHorse Spare Board Installation. The original boards can be returned to RDI for repair. Please contact the RD Instruments Customer Service Department for return shipping instructions and repair costs at:

- EMAIL: rdifs@rdinstruments.com
- PHONE: 858-693-1178
- FAX: 858-578-4016

2.4 Troubleshooting a Beam Failure

If the beam continuity test fails, a bad DSP board, Receiver board, PIO board, or a bad beam may cause the failure. If replacing the DSP and PIO board (included with the spare boards kit) does not fix the problem, the ADCP must be returned to RDI for repair.

```
>PC1
```

```
BEAM CONTINUITY TEST
```

```
When prompted to do so, vigorously rub the selected  
beam's face.
```

```
If a beam does not PASS the test, send any character to  
the ADCP to automatically select the next beam.
```

```
Collecting Statistical Data...
```

```
41 46 45 43 41 46 45 43 41 46 45 42 41 46 44 42
```

```
Rub Beam 1 = PASS |   NOTE - Possible cause of failure  
Rub Beam 2 = PASS |           DSP Board  
Rub Beam 3 = PASS |           Receiver Board  
Rub Beam 4 = PASS |           PIO Board  
> |           Beam
```

2.5 Troubleshooting a Sensor Failure

If the PA test fails the sensor test, run PC2 to isolate the problem. The ambient temperature sensor is mounted on the receiver board. This sensor is imbedded in the transducer head, and is used for water temperature reading. The attitude temperature sensor is located on the PIO board under the compass. The ADCP will use the attitude temperature if the ambient temperature sensor fails.

If one of the temperature sensors fails, the PC2 test will show both sensors at the same value.

```
>PC2
Press any key to quit sensor display ...

Heading   Pitch    Roll    Up/Down   Attitude Temp   Ambient Temp   Pressure
301.01°   -7.42°   -0.73°   Up        24.35°C         22.97°C       0.0 kPa
300.87°   -7.60°   -0.95°   Up        24.36°C         22.97°C       0.0 kPa
300.95°   -7.60°   -0.99°   Up        24.37°C         22.97°C       0.0 kPa
300.71°   -7.61°   -0.96°   Up        24.37°C         22.98°C       0.0 kPa
300.69°   -7.61°   -0.96°   Up        24.35°C         22.98°C       0.0 kPa
300.76°   -7.60°   -0.98°   Up        24.38°C         22.97°C       0.0 kPa
>
```



NOTE. If the temperature sensor is bad, the data can still be collected with no effects to accuracy or quality. Contact RDI about scheduling a repair of the temperature sensor at your convenience.



NOTE. For external sensor verification, see the [Installation](#) Guide.

2.5.1 Fault Log

To determine why a sensor failed, view the fault log. To view the fault log, start *BBTalk*. Press the **End** key to wakeup the ADCP. Type the following commands: **CR1**, **FC**, **PA**, **FD**. The fault log will be displayed by the **FD**-command.

```
[BREAK Wakeup A]

WorkHorse Broadband ADCP Version x.xx
RD Instruments (c) 1996-1997
All rights reserved.
>CR1
>FC
>PA
|           (PA test results (not shown))
|
>FD
Total Unique Faults   =      2
Overflow Count        =      0
Time of first fault:   97/11/05,11:01:57.70
Time of last fault:    97/11/05,11:01:57.70

Fault Log:
Entry #  0 Code=0a08h Count=    1 Delta=    0 Time=97/11/05,11:01:57.70
Parameter = 00000000h
Tilt axis X over range.
```

```
Entry # 1 Code=0a16h Count= 1 Delta= 0 Time=97/11/05,11:01:57.70
Parameter = 00000000h
Tilt Y axis ADC under range.
End of fault log.
```

2.6 Technical Support

If you have technical problems with your instrument, contact our field service group in any of the following ways:

RD Instruments

9855 Businesspark Ave.
San Diego, California 92131
(858) 693-1178
FAX (858) 695-1459
rdifs@rdinstruments.com

RD Instruments Europe

5 Avenue Hector Pintus
06610 La Gaude, France
+33(0) 492-110-930
+33(0) 492-110-931
rdifs@rdieurope.com

Web: <http://www.rdinstruments.com>

If your instrument works and you have questions involving a specific application, you may call either the field service group (above) or our sales/marketing staff.

3 Workhorse Cables

This section has information on Workhorse cabling. Special user-requests may cause changes to the basic wiring system and may not be shown here. We provide these drawings only as a guide in troubleshooting the ADCP. If you feel there is a conflict, contact RDI for specific information about your system. The following figures show various Workhorse cable locations, connectors, and pin-outs.



NOTE. Where shown, the color code is for reference only; your cable may be different.

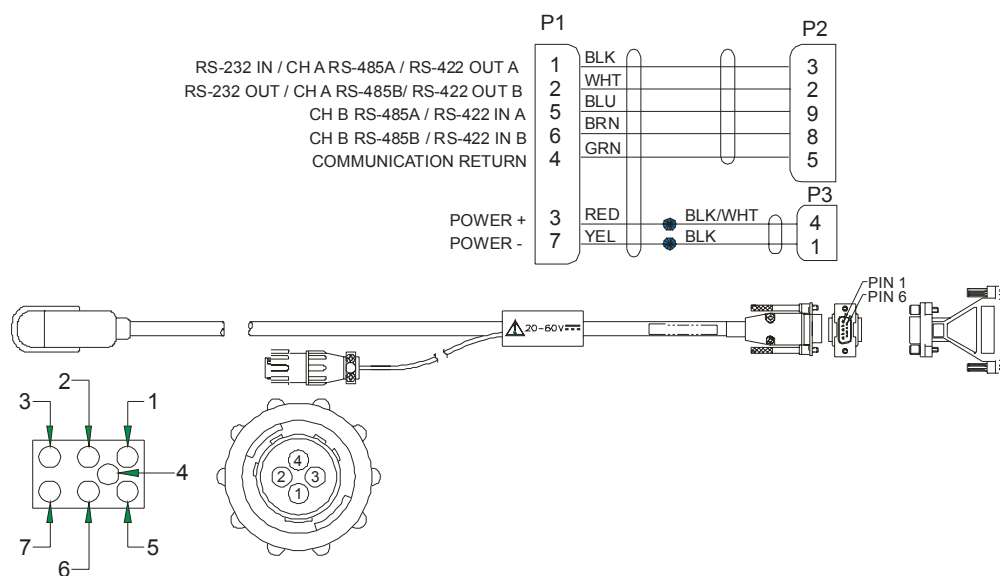


Figure 5. Monitor and Sentinel I/O Cable Wiring



NOTE. Where shown, IN refers to signals going into the ADCP and OUT refers to signals coming out of the ADCP.

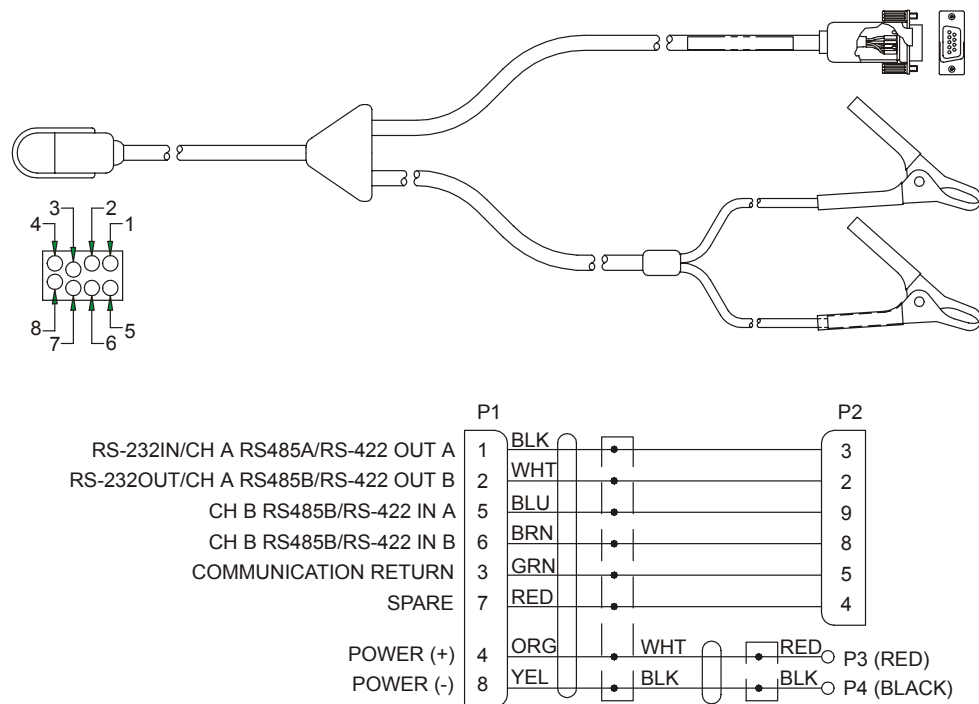


Figure 6. Rio Grande I/O Cable Wiring

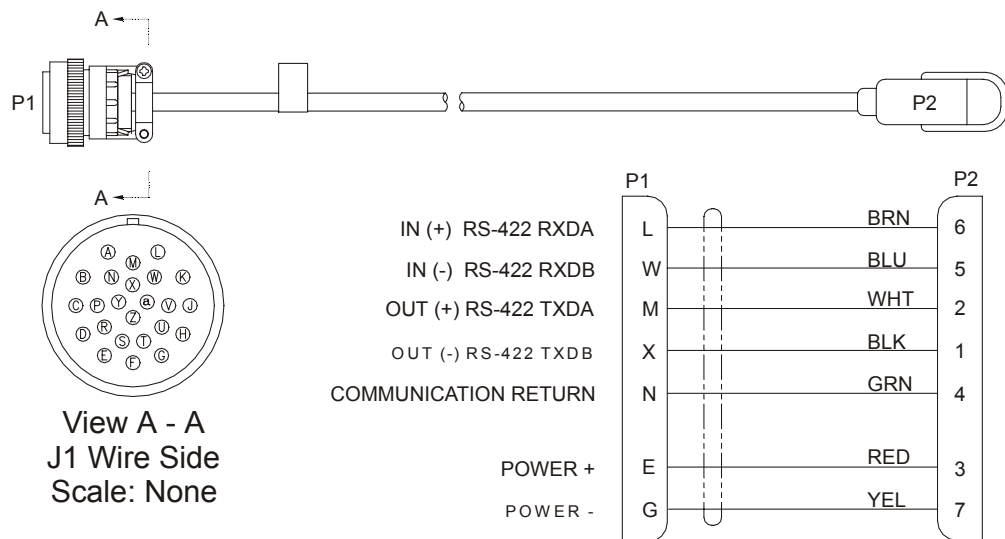
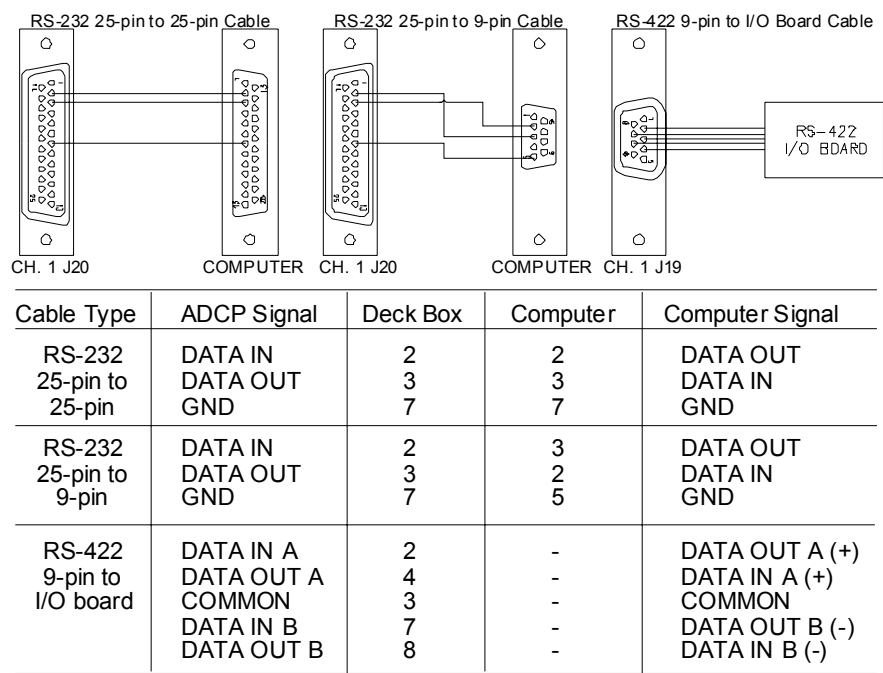
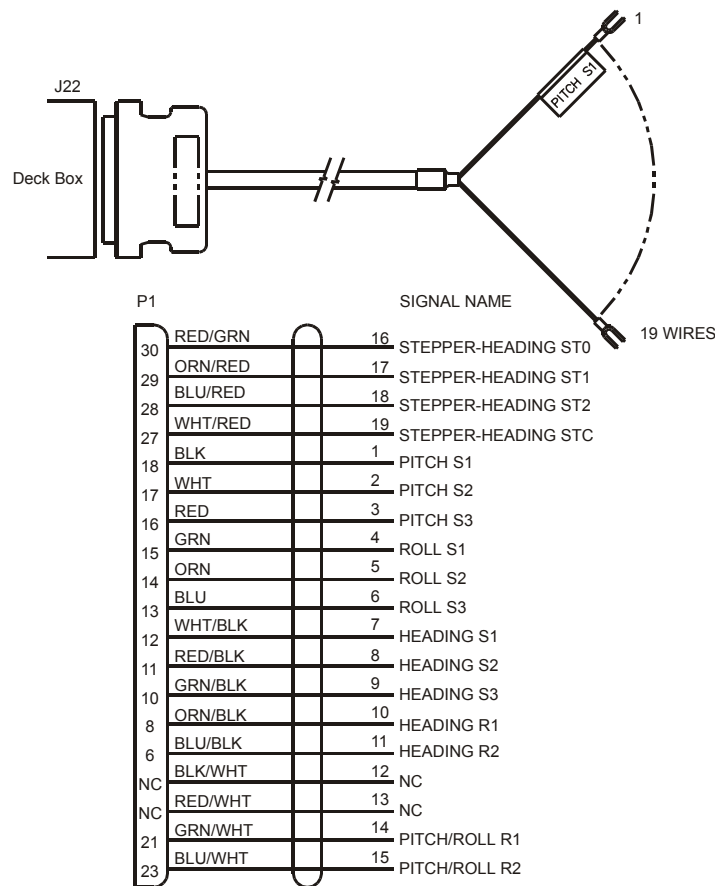


Figure 7. Mariner I/O Cable Wiring



NOTE: These cables provides RS-232 or RS-422 communications. Two cables are provided with the instrument: (1) 25-pin to 25-pin RS-232 cable, and (1) 25-pin to 9-pin RS-232 cable. Each cable is about 2-meters long and has a diameter of 8 mm (0.31 in.). For cable lengths longer than 25 meters, we recommend you use RS-422 communications. The cable for RS-422 communication is not provided with the equipment.

Figure 8. Mariner Deck Box to Computer Serial Cable



NOTE: This cable provides synchro/stepped heading signals and/or synchro tilt from an external gyrocompass to the deck box. This cable is provided with the instrument (length specified by user). Cable specifications: 26 conductors, cable OD = 8 mm (0.31 in.), terminated at one end with a 37-pin connector (deck box side), terminated at the other end (gyro side) with 19 spade (or forked) lugs for connecting to the gyro's terminal strip.

Figure 9. Mariner Gyro Cable

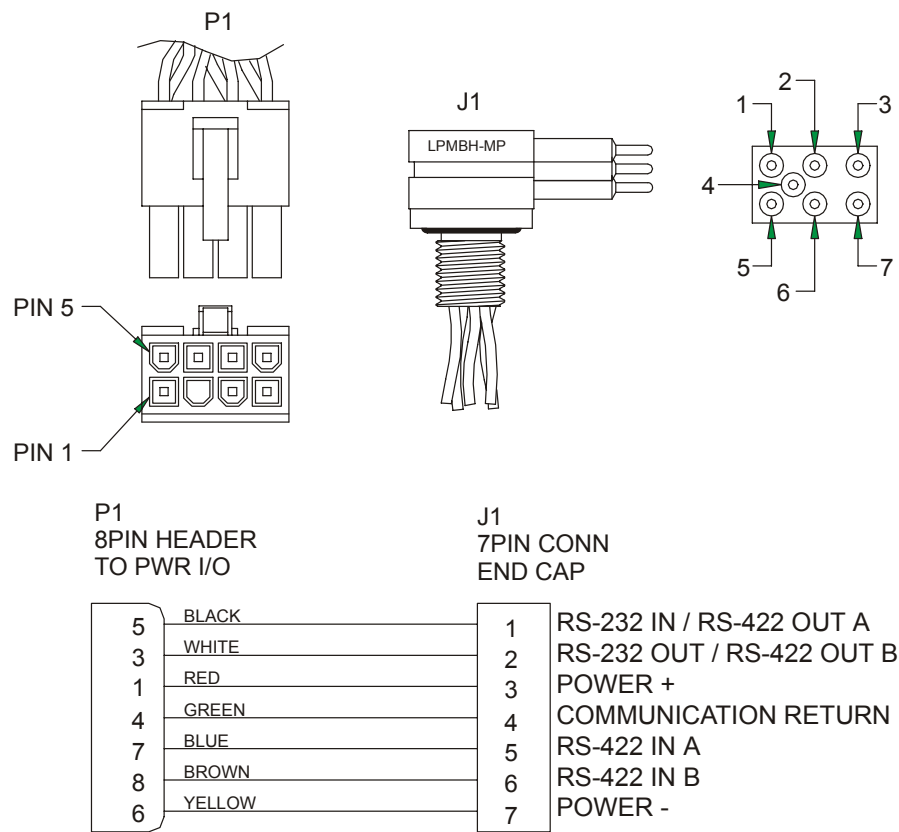


Figure 10. Mariner/Monitor/Sentinel Internal I/O Cable (End-Cap to PIO Board) Wiring

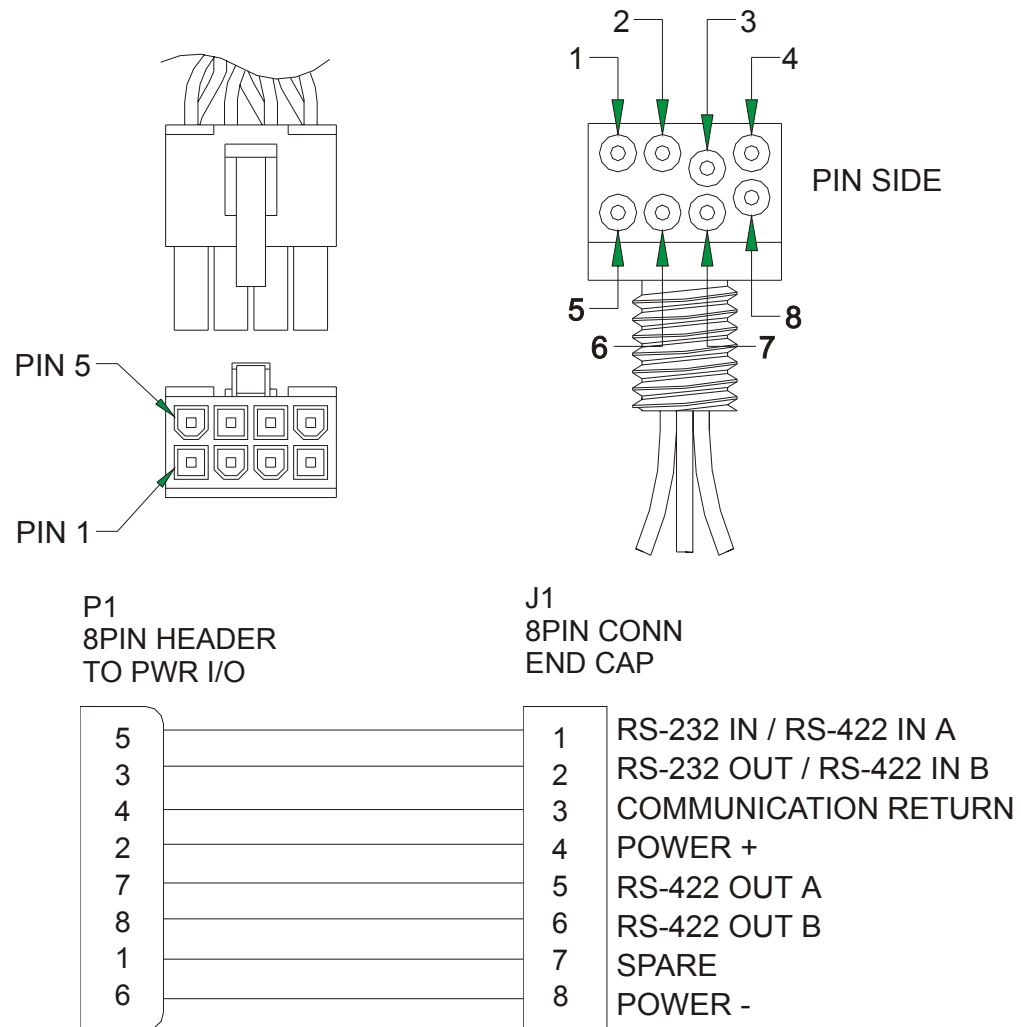


Figure 11. Rio Grande Internal I/O Cable (End-Cap to PIO Board) Wiring

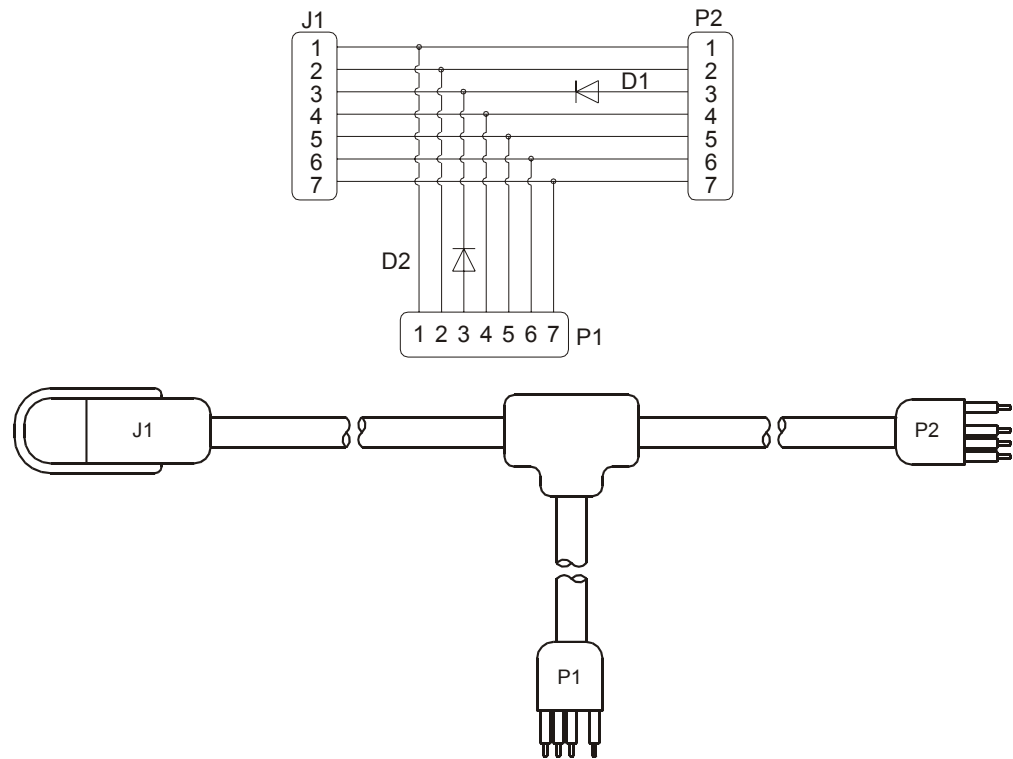


Figure 12. External Battery Pack “Y” Cable

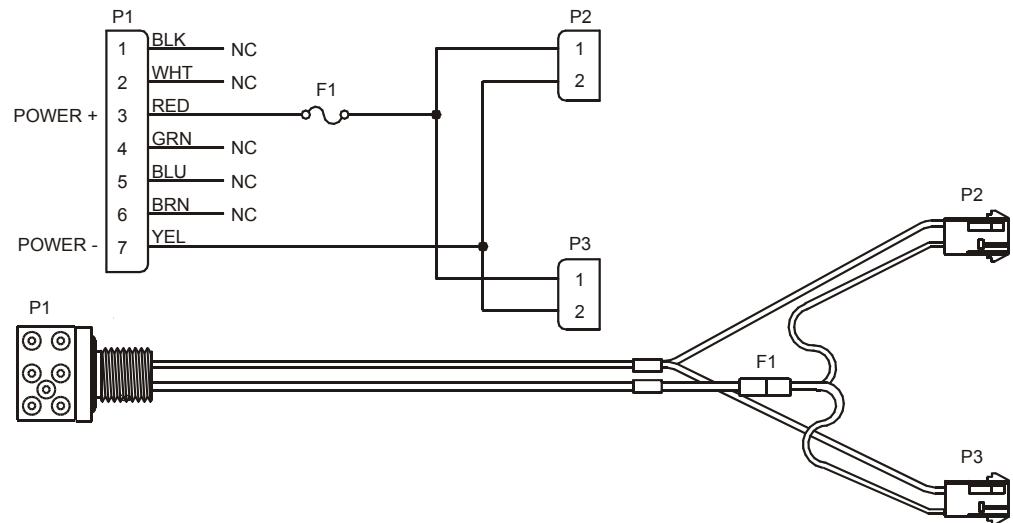


Figure 13. External Battery Case Internal Wiring

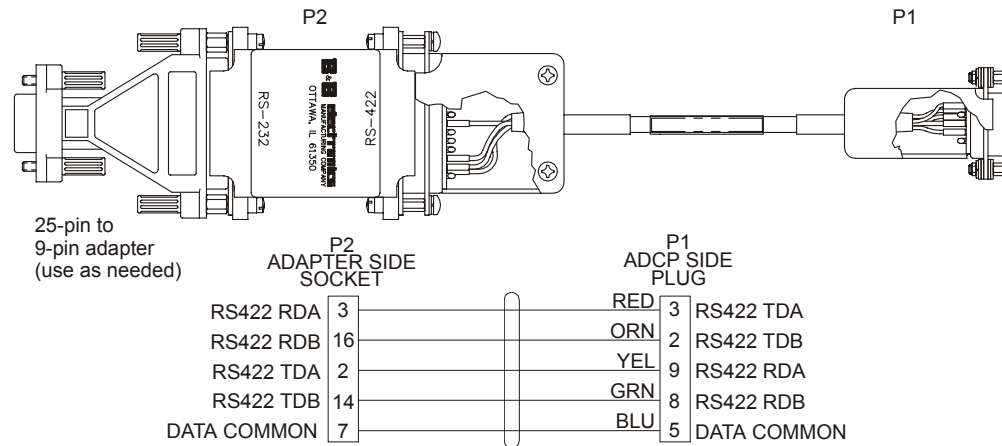


Figure 14. RS232-to-RS422 Converter Wiring (25-Pin to 9-Pin)

4 System Overview

This section presents a functional description of WorkHorse operation using block diagrams.

4.1 Operating Modes

The WorkHorse has two modes of operation: *command mode*, and *ping mode* (also referred to as “Deployment Saver” Mode). Depending on what mode the ADCP is in; it will go either to sleep, or to resume pinging.

4.1.1 Command Mode

Whenever you wake up your WorkHorse, power dissipation increases from less than 1 mW to around 2.2 W. If you leave the WorkHorse in command mode without sending a command for more than 5 minutes, the WorkHorse automatically goes to sleep. This protects you from inadvertently depleting batteries.

- If the ADCP receives a BREAK, it will go to the command prompt and wait for a command. The ADCP will wait at the command prompt for five minutes. If no commands have been sent, it will go to sleep (also called “Battery Saver” mode).
- If you press the reset switch (located on the CPU board), the ADCP will go to sleep.
- If the ADCP receives a CS-command, it will go into the ping mode and begin pinging. If a TF-command (Time of First Ping) was sent prior to the CS-command, then the ADCP will go to sleep until the TF time occurs.

- If the ADCP does a COLD wakeup (i.e. an unknown state), it will go to the command prompt.
- If the ADCP is asleep for approximately nine hours, it wakes up to charge the capacitor used to maintain RAM. Once the capacitor is charged (this only takes a few seconds), the ADCP goes back to sleep.

4.1.2 Ping Mode

After you send commands to the WorkHorse that tells it to start collecting data, the WorkHorse goes into deployment saver mode. If power is somehow removed and later restored, the WorkHorse simply picks up where it left off and continues to collect data using the same setup.

- If the ADCP receives a BREAK, it will go to the command prompt, but stays in the ping mode. If a valid command is received, the ADCP will switch to the command mode. If no valid command is received, a warning will be displayed after four minutes, indicating that the system will self-deploy. After a total of five minutes with no input, the ADCP will resume pinging.
- If you press the reset switch, and an alarm is currently set for the next ping, the ADCP will go to sleep. If no alarm is set, the system will start a new deployment and starts pinging immediately unless a TF-command had been set after the last BREAK. In this case, the ADCP will go to sleep until the TF time occurs.
- If the ADCP does a COLD wakeup, the system will start a new deployment and starts pinging immediately unless a TF-command had been set after the last BREAK. In this case, the ADCP will go to sleep until the TF time occurs if the TF time is valid (i.e., not in the past).
- If the ADCP is asleep for approximately nine hours, it wakes up to charge the capacitor used to maintain RAM. Once the capacitor is charged, if a valid alarm is set for the next ping time, the ADCP goes back to sleep and waits for the alarm. If no alarm is set, the ADCP will resume pinging immediately, or wait for the TF time (if valid), and then start pinging.

4.2 Overview of Normal WorkHorse Operation

Refer to [Figure 15, page 33](#) through [Figure 19, page 37](#). The following events occur during a typical data collection cycle.

- a. The user or a controlling software program sends data collection parameters to the WorkHorse. The user/program then sends a CS-command to start the data collection cycle. The firmware program stored in the CPU microprocessor takes control of WorkHorse operation based on the commands received through the serial I/O cable.

[Figure 15, page 33](#) shows a flow chart of the wake-up logic used by the WorkHorse. The WorkHorse determines what to do based on where the wake-up came from (a Break, CS-command, battery saver timer, or watchdog timer was detected).

- b. On the PIO Board, the POWER REGULATOR circuit sends a transmit command to the POWER AMPLIFIER circuit. This tells the WorkHorse to start acoustic transmissions (pinging) on all TRANSDUCERS.
- c. The TRANSDUCERS receive echoes from the backscatter. The RECEIVER board amplifies and translates the echoes into a base-band frequency.
- d. The CPU board processes the received echoes.
- e. After echo reception, the WorkHorse injects a self-test signal into the RECEIVER board and processes the signal as normal data for test purposes.
- f. The THERMISTOR measures water temperature at the transducer head and sends it to the CPU via the DSP Board.
- g. The PIO Board sends pitch and roll from the TILT SENSOR and WorkHorse heading from the COMPASS to the DSP Board. The DSP Board digitizes this information and sends it to the CPU for processing.
- h. The CPU repeats steps “b” through “g” for a user-defined number of pings. The CPU averages the data from each ping to produce an ensemble data set.
- i. At the end of the ensemble (sampling) interval, the CPU sends the collected data to the serial I/O connector or PCMCIA recorder.

4.3 Functional Description of Operation

The following paragraphs describe how the WorkHorse operates and interacts with its modules. Refer to [Figure 15, page 33](#) through [Figure 19, page 37](#) throughout this description.

4.3.1 Input Power

The Workhorse Monitor/Sentinel requires a DC supply between 20 volts and 60 volts. The WorkHorse Rio Grande requires a DC supply between 10.5 volts and 18 volts. Either an external DC power supply or internal battery packs can provide this power. [Figure 16, page 34](#) shows the DC voltage power distribution path.

Monitor External DC Power Supply – With an external supply, power is applied to pins 3 (positive) and 7 (negative) on the external connector (see [Figure 18, page 36](#)). The power then goes through an electromagnetic interference (EMI) filter on the PIO Board. This filter reduces the chance that external noise sources associated with the external power source can disrupt Workhorse operation.

Sentinel Internal Battery Packs – Each internal battery pack uses 28 alkaline “D” cells. Each pack supplies a nominal output voltage of 42 volts open circuit when fresh. The diode-isolated battery packs can only power the Workhorse; they cannot “charge” each other.

Rio Grande External DC Power Supply – The Rio Grande requires a DC supply between 10.5 volts and 18 volts. Either an external DC power supply or battery can provide this power. If you are using a battery, use the largest rated amp-hour battery as possible. A car battery should last one to two days powering a 600-kHz ADCP. [Figure 17, page 35](#) shows the DC voltage power distribution path.

Power is applied to pins 4 (positive) and 8 (negative) on the external connector. The power then goes through an electromagnetic interference (EMI) filter on the PIO Board. This filter reduces the chance that external noise sources associated with the external power source can disrupt Rio Grande operation.

Mariner Deck Box – The deck box automatically scales the input voltage to the proper level. No special jumpers or switch settings are required to select the input voltage. If more than one power source is connected to the deck box, the highest voltage source will be used. Although this is not recommended, it will not damage the deck box.

AC Power. The deck box accepts input voltages of 98 to 264 VAC, 50 to 60Hz (J27). This input voltage will be converted to 48 VDC. This is the voltage supplied to the ADCP.

12 VDC Car Battery. Use a 12 VDC car battery (J26) when AC power is not available. The deck box converts the voltage to 48 VDC. This is the voltage supplied to the ADCP. Use the largest rated amp-hour battery as possible. A car battery should last one to two days powering a 1200-kHz River ADCP.

DC Power Supply. If you are using an external DC power supply connected to the deck box on J25 (20-60 VDC, 3.0 A), the voltage from the external power supply is sent *directly* to the ADCP. This is useful if you want to increase (higher voltage level) or decrease (lower voltage level) the range of the ADCP. The current requirement for the power supply is listed as a reference. Using a lesser-rated power supply can cause the voltage level to drop. The ADCP will draw only the current it needs.

4.3.2 Board Descriptions

PIO Board.

- Receives the filtered/internal power.
- Uses a diode “OR” gate to determine which power source to use (external or internal). With both sources connected, the OR gate selects the “higher” voltage for Workhorse use.
- Limits the in-rush of current to the WorkHorse and provides over- and negative-voltage protection. Either condition will blow a protective fuse. However, damage could occur to other circuits before the fuse blows. Please ensure you apply only voltages within the specified range (+20 to +60 VDC for Mariner/Monitor/Sentinel and +10.5 to 18 VDC for Rio Grande).
- Converts the operating power supply (filtered/isolated 20 to 60 VDC or 5 to 18 VDC) in a DC-to-DC converter to the +5 VDC (Vcc) used to power all other WorkHorse circuits.
- Uses the Power Amplifier circuit on the PIO board to generate the high-amplitude pulse AC signal that drives the sonar transducers. The Power Amplifier sends the drive signal to the Receiver Board.
- RS-232/RS-422 switch.



CAUTION. Do not swap the PIO board between a Rio Grande and a Mariner/Monitor/Sentinel ADCP. The power requirements are different.

CPU Board.

- Real time clock.
- Generates most of the timing and logic signals used by the WorkHorse.

DSP Board.

- Contains the PCMCIA recorder slots.
- Analog to Digital converter.
- Digitizes information from sensors and sends sensor information to the CPU.

Receiver Board.

- Tuning functions
- Receiver functions
- Temperature sensor
- Interface for pressure sensor

4.3.3 Sensors

This section describes the standard WorkHorse sensors. The PIO and DSP boards control the environmental sensors and contain unit-specific data. Sensors include:

Temperature Sensor (Thermistor) - Used to measure the water temperature. The system uses this data to calculate the speed of sound. This sensor is embedded in the transducer head and is not field replaceable.

Up/Down Sensor - Determines whether the transducer head is facing up or down. This sensor is located on the PIO board.

Compass - Determines the Beam 3 heading angle of the WorkHorse using a flux-gate compass. This sensor is located on the PIO board. The flux-gate measured earth magnetic field vector together with the tilt sensor pitch and roll information is used to determine the heading. Since the tilt sensor data is only valid when the ADCP is $\pm 20^\circ$ from vertical, the heading information is also limited to this range.

Attitude Sensor - Determines the tilt angles of the WorkHorse. This sensor is located on the PIO board. The attitude sensor uses a pitch and roll liquid-filled sensor. This sensor is functional to an angle of $\pm 20^\circ$ from vertical.

Pressure Sensor (optional) - Measures pressure at the WorkHorse transducer. This sensor is embedded in the transducer head and is not field replaceable.

The CPU microprocessor controls a multiplexed analog-to-digital converter to accept analog data from the sensors. Digital data are taken in directly. The pressure sensor incorporates a Wheatstone Bridge strain gage to measure the water pressure at the transducer faces. Depth is calculated from pressure, with water density adjusted by the salinity (ES) setting.

Calibration data for the sensors, a beam-angle correction matrix, and unit identification parameters (frequency, serial number, firmware version, etc.) are stored in ROM.

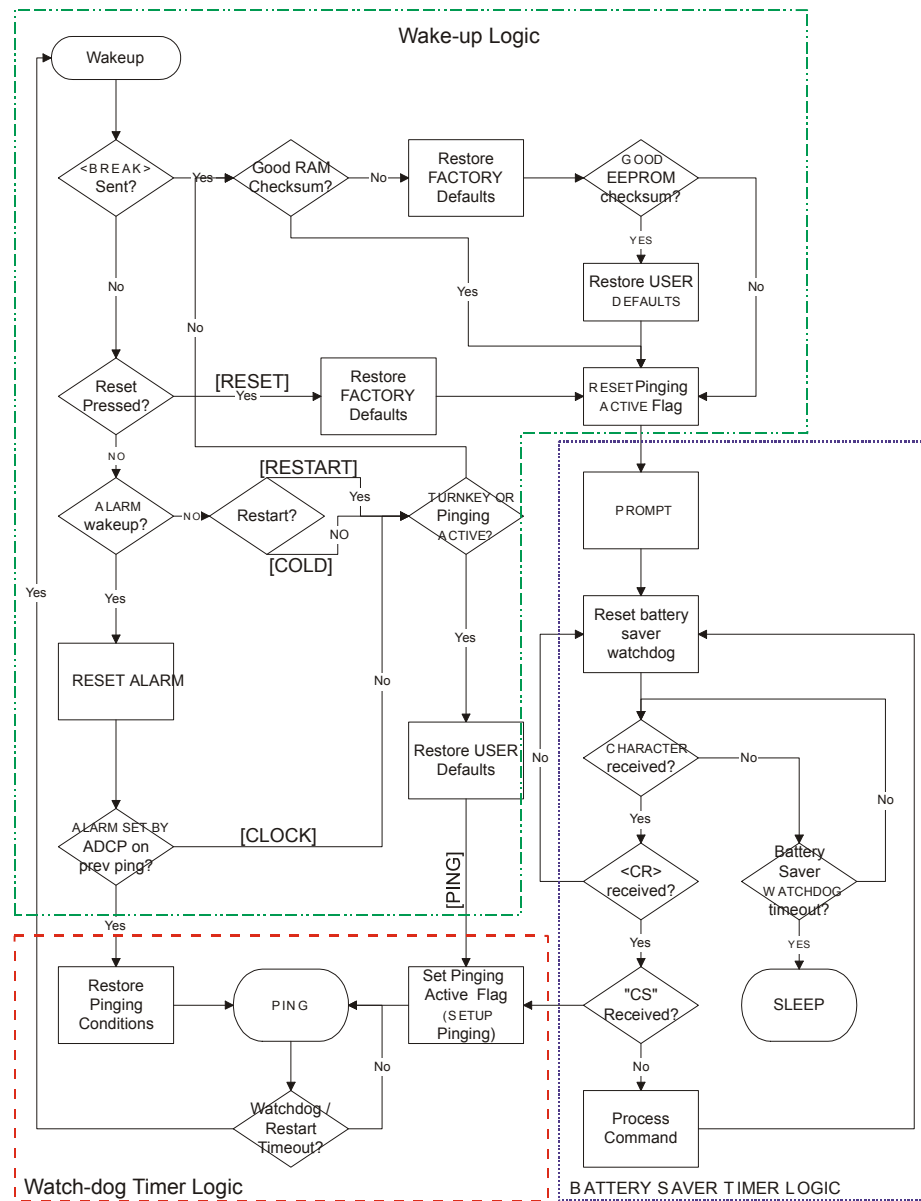


Figure 15. WorkHorse Wake-up and Timer Logic

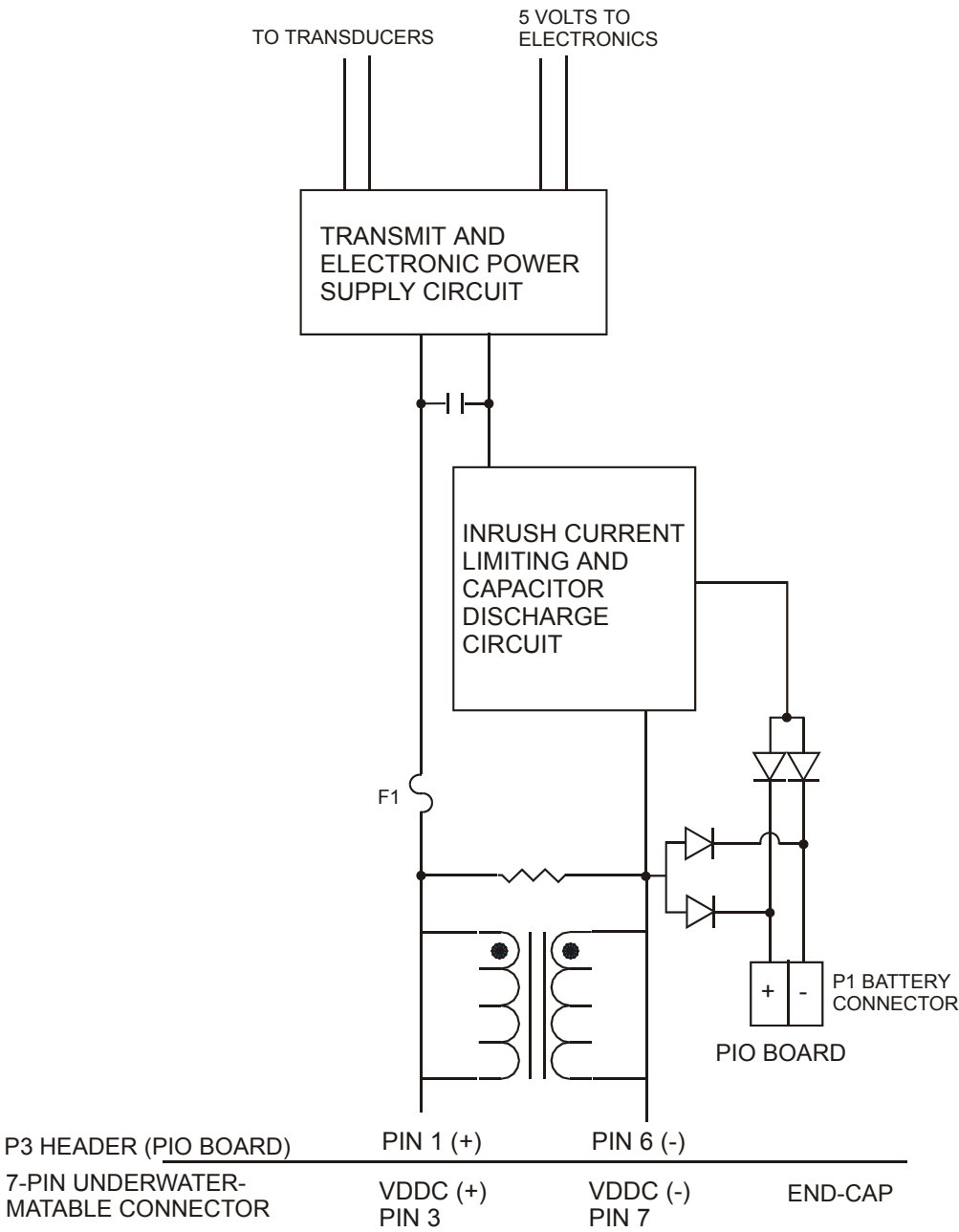


Figure 16. Mariner/Monitor/Sentinel DC Power Path

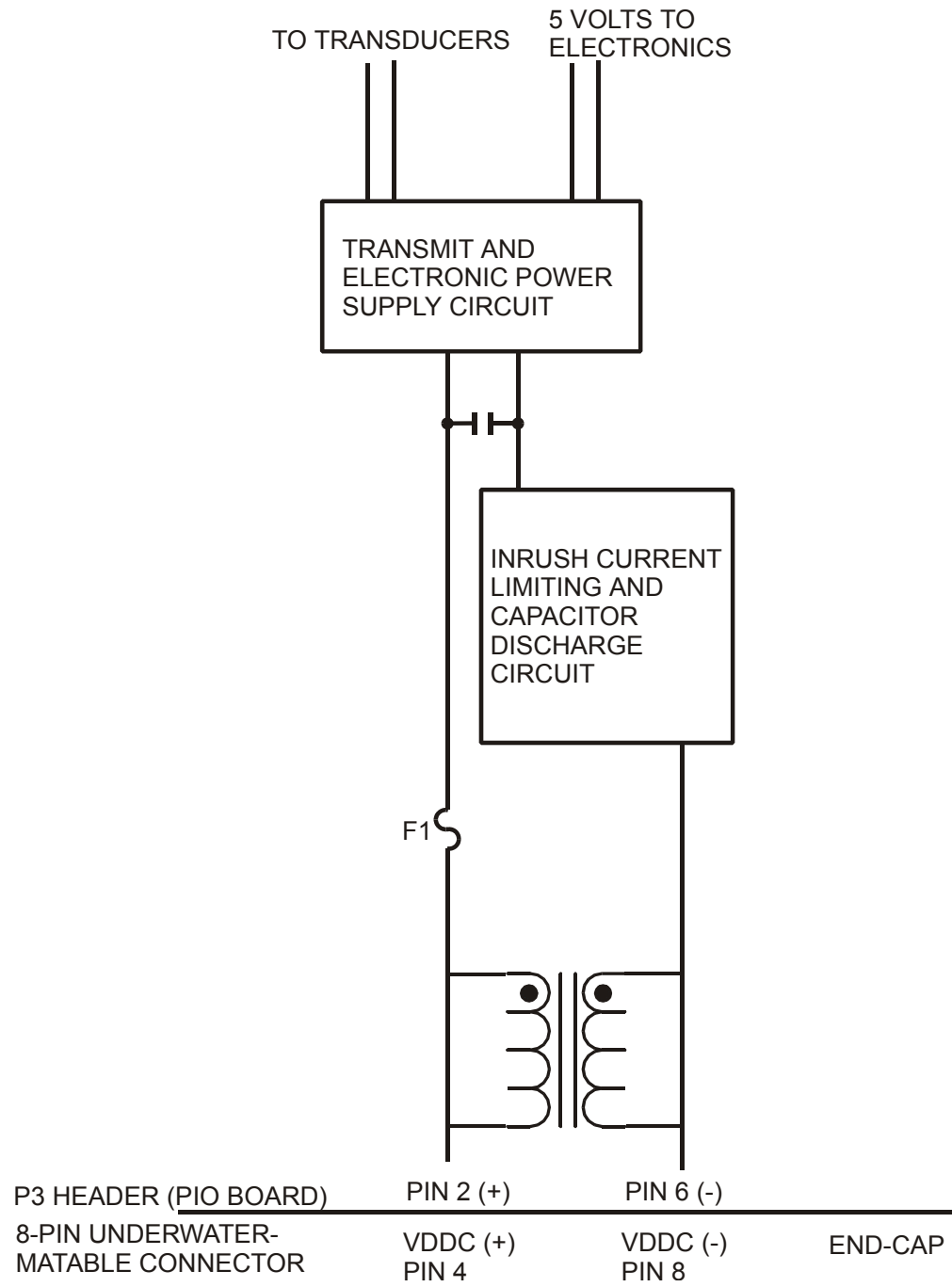


Figure 17. Rio Grande DC Power Path

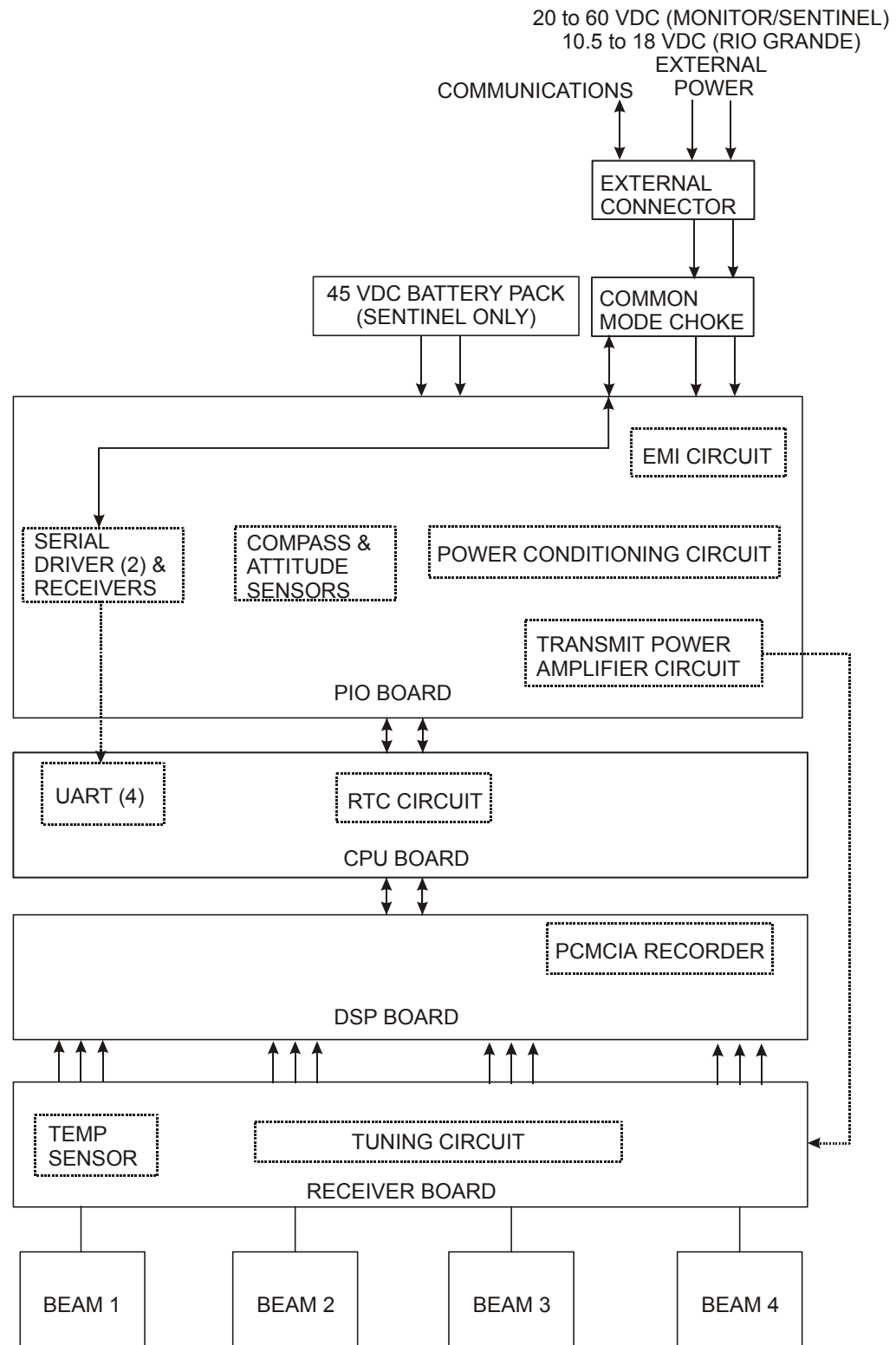


Figure 18. WorkHorse Block Diagram

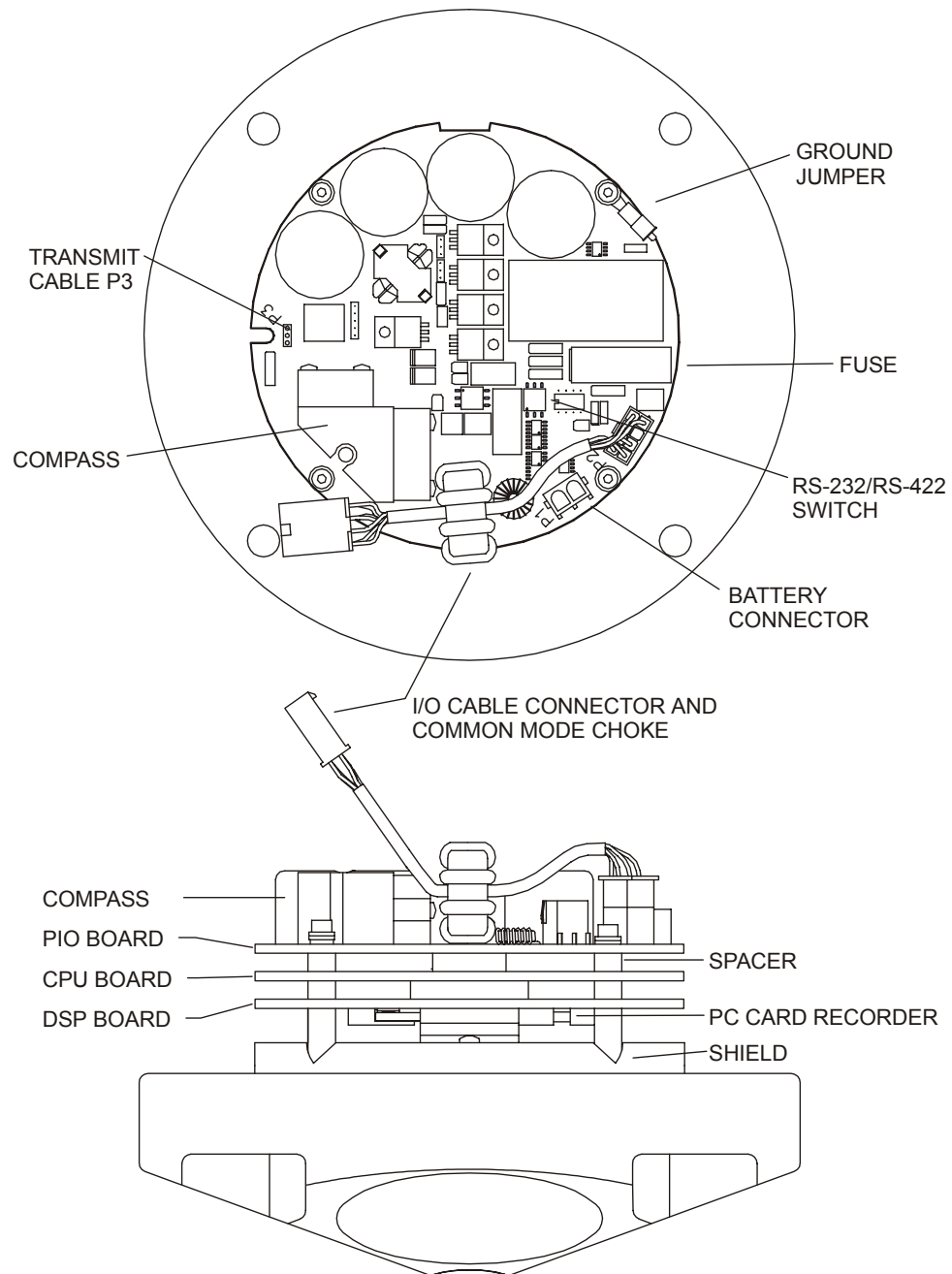


Figure 19. WorkHorse PC Board Locations

NOTES