

# RAD-Star 2

Active Tap, Media Converter and  
Network Interface for Automotive Ethernet and CAN FD



## User's Guide

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## Version History

Version Number	Date	Description / Major Changes
1.0	2017/09/01	Initial release.

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# 1 Introduction and Overview

## 1.1 Introduction

Thank you for purchasing an Intrepid Control Systems RAD-Star 2 active tap and media converter for Automotive Ethernet (AE). The RAD-Star 2 allows you to monitor all traffic on a BroadR-Reach (100BASE-T1 compatible) link between two AE devices. Once inserted in the link, the RAD-Star 2 passes all traffic between the devices with virtually no added latency, while sending a timestamped copy of each message to a standard Ethernet device (such as a laptop PC) for monitoring. The RAD-Star 2 can also be used as a *media converter*, allowing up to two ECUs to be interfaced directly to a PC or other conventional Ethernet device. In both applications, it is also possible to transmit messages from the PC to the ECU(s) using a tool like Intrepid's Vehicle Spy software, allowing those devices to be directly controlled.

As its name suggests, the RAD-Star 2 is Intrepid's second generation single active tap tool and includes numerous improvements over the original RAD-Star. These include improved performance, a Gigabit Ethernet port, the ability to interface two devices in media converter mode instead of one, raw media converter mode, a membrane LED display and keypad, the ability to interface over USB, ruggedized packaging, and much more. The RAD-Star 2 also adds support for two CAN FD channels in addition to its Automotive Ethernet capabilities, allowing you to work with conventional CAN devices and to gateway between CAN and AE.

 **Note:** *BroadR-Reach* (sometimes abbreviated as *BroadR* or just *BR*) is sometimes also called *One Pair Ethernet* (*OPEN* or *OP*). In 2015, BroadR-Reach was published as a formal Ethernet standard in IEEE 802.3bw and given the designation *100BASE-T1*. While not 100% identical, the two are nearly the same; the RAD-Star uses BroadR-Reach transceivers, but is compatible with 100BASE-T1.

## 1.2 Package Contents

Your RAD-Star 2 package includes both hardware and software.

### **Hardware**

Upon opening the RAD-Star 2 box, you should find a RAD-Star 2 Quick Start Guide on top with the device itself secured under transparent plastic film in a cardboard holder. Remove the guide, the device and the cardboard, and you'll see the following additional items:

- A standard four-pair 3' (~1m) Ethernet cable.
- An Intrepid 12V power supply.
- A small plastic bag containing a TE Connectivity 8-position Nano MQS female plug housing and 8 Nano MQS crimp contacts. These are used to create a cable to connect to your Automotive Ethernet network.

Please remove, unwrap and inspect all of the contents of the box. If anything is missing or damaged, please contact Intrepid for prompt assistance, using the information at the end of this guide. Later in the document you will find more information on the Nano MQS components and detailed instructions for creating Automotive Ethernet cables to connect the RAD-Star 2 to your vehicle networks.

## **Software**

In addition to the hardware items described above, you will find in the box a software/driver CD containing:

- A copy of Intrepid's Vehicle Spy vehicle network software.
- Drivers for the RAD-Star 2.
- An API install kit containing the neoVI Explorer utility for configuring the device.
- Documentation materials.

Intrepid's Vehicle Spy (often abbreviated as *VSpy*) is the "Swiss army knife" of automotive networking tools. It allows you to easily monitor and transmit on vehicle networks, and includes capabilities for ECU simulation, data acquisition, scripting, diagnostics, data analysis and much more.

The RAD-Star 2 and Vehicle Spy are designed to work together hand in hand, and we recommend purchasing a *VSpy* license to go along with your new hardware. If you did so, then a full copy of the software will be included on the software/driver CD. If you did not purchase Vehicle Spy, a trial version of the program will be provided instead, which allows access to *VSpy*'s basic features and also lets you configure your hardware.

It is also possible to control the RAD-Star 2 from within other software using one of the APIs that the device supports.

## **1.3 Operational Overview**

The RAD-Star 2 is both a powerful and flexible device that allows you to handle a number of different challenges associated with Automotive Ethernet. The device can function as an active tap or media converter, and also includes a special "raw media converter" mode. At the same time it can also act as an interface to conventional vehicle networks such as CAN and CAN FD, with support for LIN coming in the future.

## Active Tap Mode

Due to the high performance and complexity of BroadR-Reach (and 100BASE-T1), typical approaches for interfacing to a network—such as attaching a probe to the bus—do not work. This problem is resolved by interposing the RAD-Star 2 between two Automotive Ethernet devices, typically an ECU and a switch, but possibly also two ECUs. Instead of connecting the two devices directly, both are attached to the BroadR-Reach ports of the RAD-Star 2. The Gigabit Ethernet link of the RAD-Star 2 is then connected to a laptop PC or similar conventional Ethernet device (USB can also be used).

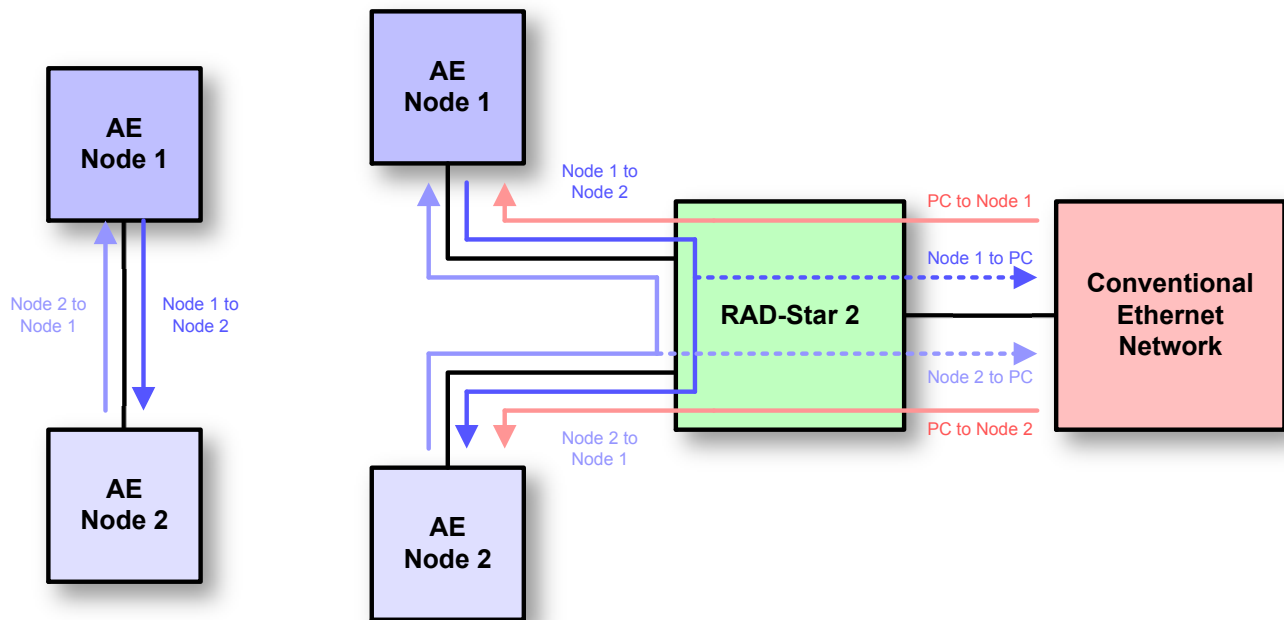


**Note:** The term “tap” has a dual meaning: it refers to the act of tapping into a network (such as used in the phrase “wire tap”). It also is sometimes considered an acronym for “test access point,” since a tap does indeed act as an access point for testing, though you can do much more than that with the RAD-Star 2. For simplicity, in this document we will just use the word “tap”.

Once configuration is complete, the RAD-Star 2 is set up as a “middleman” in the network, managed by a custom-designed processor within the unit. When either AE device transmits, the RAD-Star 2 receives the message and retransmits it to the other device with only a minor delay for processing. The RAD-Star 2 also sends a copy of the message over its Gigabit Ethernet or USB connection to the PC, so it can be viewed and analyzed within software like Vehicle Spy. These frames are encapsulated in a custom wrapper (the details of which can be found later in this section).

The interface provided by the RAD-Star 2 is full-duplex and bidirectional. This means that in addition to using the PC to monitor messages sent by the Automotive Ethernet nodes attached to it, you can create and send custom messages from the PC to the nodes as well. This allows you to query, test, configure and manage these nodes using Vehicle Spy.

Figure 1 depicts how the RAD-Star 2 functions when inserted into a typical Automotive Ethernet network as a tap. Note that operation is the same whether tapping a link between an ECU and a switch or between two ECUs.

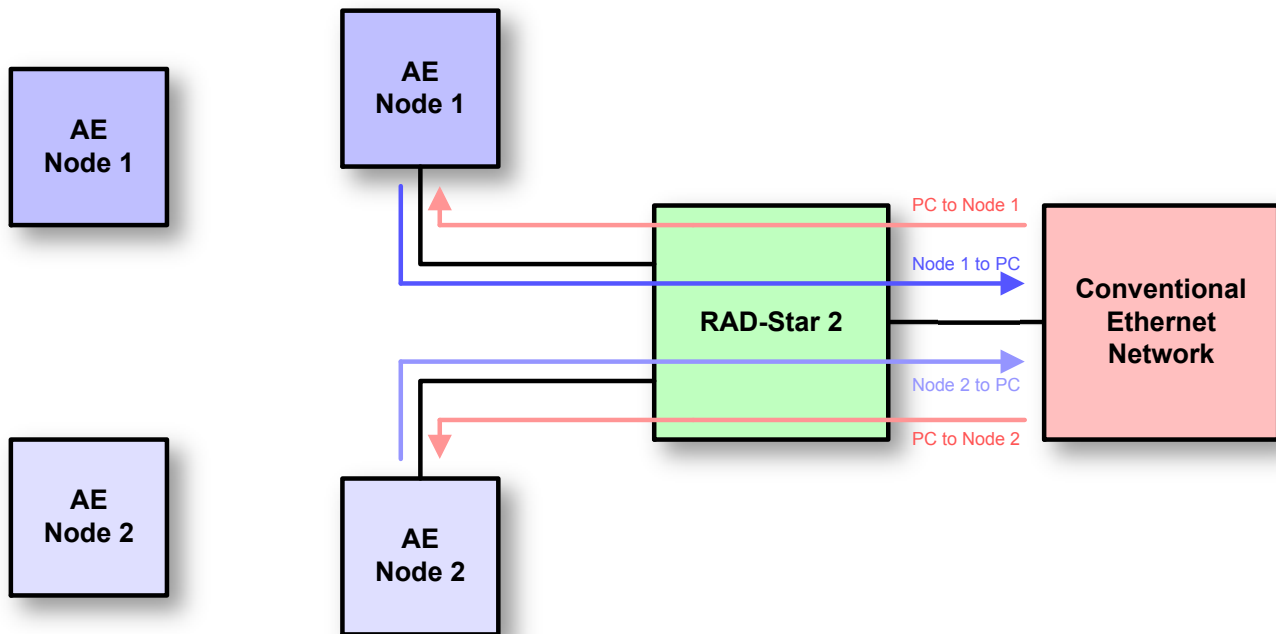


**Figure 1: Using the RAD-Star 2 as an Active Tap.** On the left, a standard connection between two Automotive Ethernet nodes, which could be a switch port and an ECU or two ECUs. On the right, the network that results after inserting the RAD-Star 2 as an active tap. Messages flow from Node 1 through the RAD-Star 2 to Node 2, and vice-versa, maintaining normal operation of the network (solid blue arrows). In addition, copies of each message are transmitted by the RAD-Star 2 to the attached conventional Ethernet network (dashed blue arrows). Optionally, messages from a PC or other device on the Ethernet network may also be sent to both nodes (red arrows).

### Media Converter Mode

Instead of being interposed in a link between two Automotive Ethernet nodes, the RAD-Star 2 can be configured to interface to two nodes independently. Any traffic received by a node will be converted from Automotive Ethernet to standard Ethernet (or USB) and sent to the PC. Conversely, traffic from the PC will be converted to BroadR-Reach and sent to the appropriate node. Since in this operating mode the RAD-Star 2 is converting between two media—Automotive Ethernet and either Gigabit Ethernet or USB—it is said to be acting as a *media converter*. Again here, frames are encapsulated in a proprietary wrapper, which will be explained shortly.

Figure 2 depicts the logical operation of the RAD-Star 2 when used in this manner. Note the difference between tap and media converter mode: traffic is not copied between the AE nodes, so they behave independently.



**Figure 2: Using the RAD-Star 2 as a Media Converter.** On the left, two independent (unconnected) Automotive Ethernet nodes. On the right, the two nodes connected to the RAD-Star 2 and a PC in media converter mode. Each node can send to the PC, and vice-versa, simultaneously and independently.

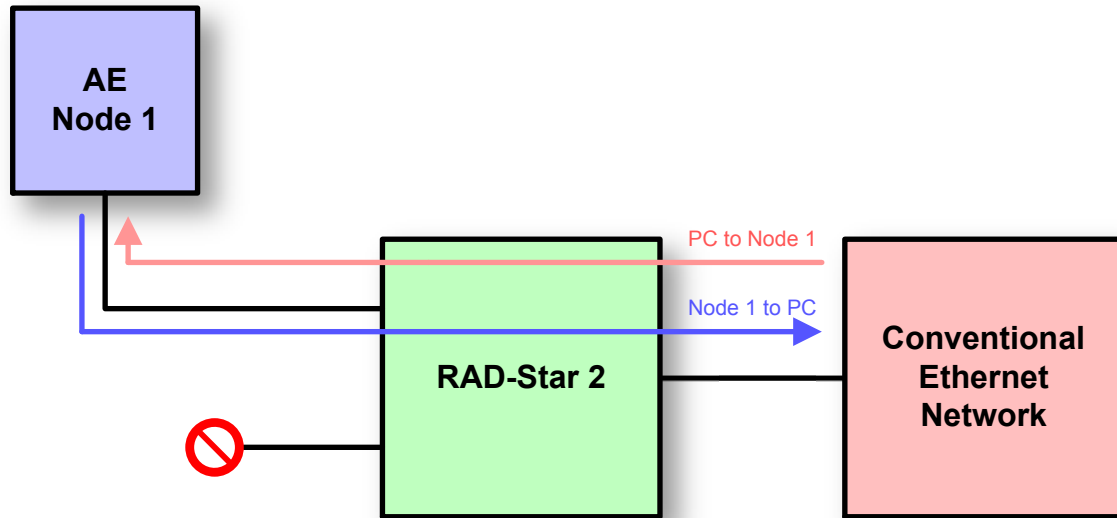
### ***Raw Media Converter Mode***

In addition to its “normal” media converter mode, the RAD-Star 2 supports a special “raw” media converter mode that is intended for special applications. In this mode, one of its BroadR-Reach ports is configured to act as a “pure” media converter at the physical layer level, while the other is disabled. Communication is always through Gigabit Ethernet (not USB) and no wrapper is used on frames.

In this mode the RAD-Star 2 effectively operates the same way as Intrepid’s RAD-Moon media converter device. One difference, however, is that frame buffering is supported in the RAD-Star 2 in this mode, allowing a BroadR-Reach device to be connected to a conventional Ethernet network running at 10 Mb/s, if needed.

This mode of operation is illustrated in Figure 3.





**Figure 3: Using the RAD-Star 2 as a Raw Media Converter.** In this configuration the first BroadR-Reach channel is configured to act as a pure physical layer media converter, attaching the PC to a single AE node; the other channel is disabled. Traffic is passed between devices without the use of a frame wrapper.

### ***Timestamping and Frame Wrapping***

The RAD-Star 2 records the time that each message is received on any of its Automotive Ethernet ports. This hardware-level timestamp is then transmitted in a special *wrapper frame* over its Gigabit Ethernet or USB link, encapsulating the original message. The wrapper frame contains its own Ethernet header and *Frame Check Sequence (FCS)* field, along with an extra header containing information specific to the RAD-Star 2. As mentioned above, this wrapper is used in the two “normal” modes (active tap and media converter) but not in raw media converter mode.

Ethernet controllers normally discard any frames received for which an error has been detected, and strip the FCS error-detection field even on valid frames. The RAD-Star 2’s special wrapping mechanism allows it to capture BroadR-Reach frames in their entirety, including the FCS field, ensuring that error frames are preserved so they can be analyzed.

### ***Conventional Vehicle Network Interfacing***

In addition to its Automotive Ethernet capabilities, the RAD-Star 2 can act as an interface to conventional vehicle networks. It includes hardware for 2 CAN channels with CAN FD support. Both channels are captured simultaneously, and are hardware time-stamped with great accuracy. Non-Ethernet messages are encapsulated into Ethernet frames and transmitted to the PC over the same connection used for BroadR-Reach data, where they are decoded and displayed by Vehicle Spy. The RAD-Star 2 also has hardware support for one LIN channel, which will be enabled in a future firmware update.

## 1.4 Block Diagram

Figure 4 shows a simple block diagram of the RAD-Star 2. All operations are controlled by the central processor, which is implemented as a custom system-on-a-chip (SoC) integrated circuit. This design provides powerful flexibility and also allows the implementation of new features in existing hardware through firmware flash updates. The various physical layer chips and network-specific controllers connect to the appropriate connectors on the device for attachment to vehicle networks.

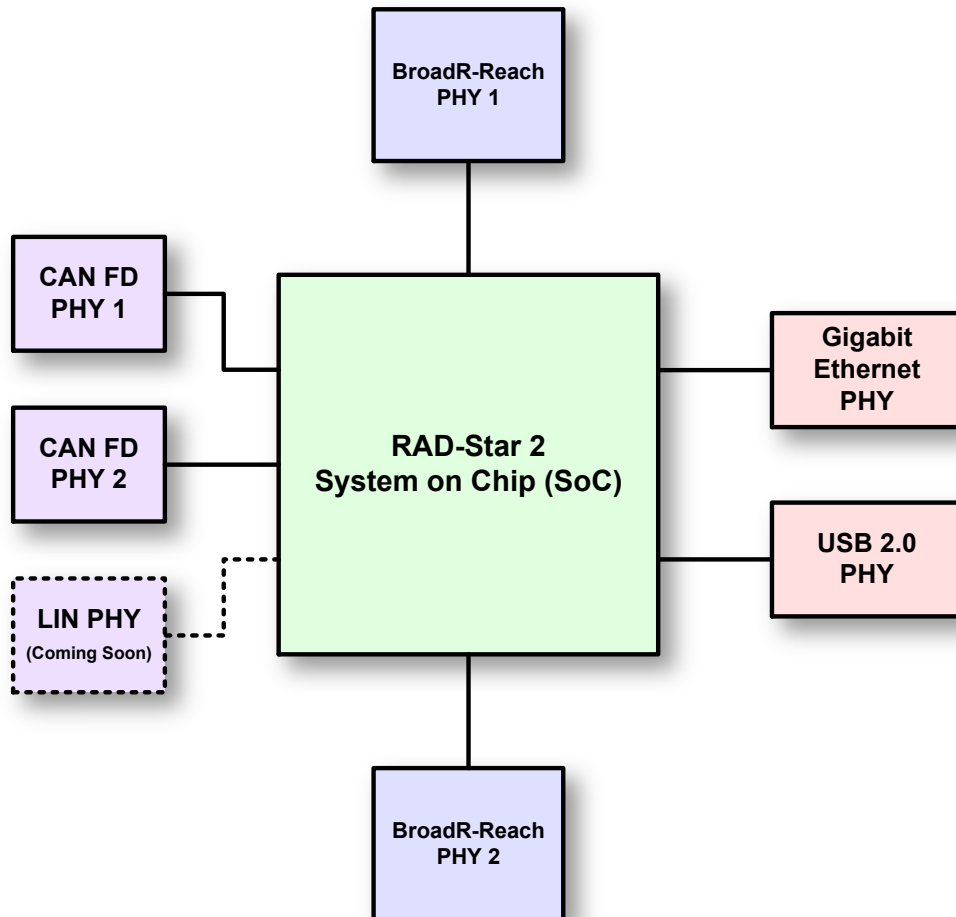


Figure 4: RAD-Star 2 Block Diagram.

## 1.5 Summary of Key Features

The RAD-Star 2 is one of the most powerful vehicle networking tools ever developed, providing extensive analysis and simulation options for both conventional and Automotive Ethernet networks. To give you an idea of how much you can do with the RAD-Star 2, here's a summary of the device's most important design, construction, operational and performance features.

***Construction, Controls and Cabling***

- Compact design: 5.4" x 3.4" x 1.5" (14 x 9 x 4 cm).
- Light weight: about 11 oz (315 g).
- Solid anodized aluminum case.
- Thick rubber end boots for shock protection.
- Ruggedized metal connectors.
- Cable interfaces on sides for easier connections.
- Multiple LEDs for status output.
- Included cables and connector contacts for vehicle network interfacing.
- Included 12V power supply.

***Power and Performance***

- Powerful SoC design.
- Field-upgradeable firmware.
- Support for 4.5V to 36V input power.
- Low power consumption (0.5A @ 12V).
- 64-bit timestamping with 10 ns accuracy on all networks.

***Automotive Ethernet Interfaces and Features***

- Two BroadR-Reach (100BASE-T1 compatible) Broadcom Automotive Ethernet PHYs.
- One Gigabit Ethernet PHY with industry standard RJ-45 jack.
- One USB Type B connector.
- One DB-9 connector for interfacing to CAN / CAN FD (and future LIN) networks.
- Switchable between one active tap, two media converter ports and one raw media converter using surface touchpad.
- Full-duplex support for simultaneous data transmission and reception across all PHYs.
- AVB/TSN support.
- Ethernet frame preemption support.

## ***Conventional Network Interfaces and Features***

- Two dedicated Dual Wire (DW) CAN channels (ISO 11898-2).
- CAN FD support with software selection of ISO and non-ISO CAN FD versions.
- 1 LIN channel (coming soon).

## **1.6 Hardware and Software Requirements**

You will need only a small amount of support hardware to make use of your RAD-Star 2:

- A vehicle network, either within an actual vehicle or in a test bench environment.
- A standard electrical plug to use the included DC power adapter. You also have the option of providing power via a custom cable on your network bench.
- A PC or other device with an available Gigabit Ethernet or USB 2.0 (or higher) port.
- Cables and/or connectors to connect to the BroadR-Reach nodes in your Automotive Ethernet network.
- A crimping tool to attach wires to the provided crimp contacts and secure them within the Nano MQS plug housings. See Section 2.5 for more details.

Additional cables may also be needed, depending on the nature of the network to which the RAD-Star 2 is being connected.

Intrepid's Vehicle Spy Professional is recommended for use with the RAD-Star 2, and provides everything you need to set up your hardware and use all of its capabilities. The setup program for VSpy will also install the necessary drivers for your RAD-Star 2. If you do not have a VSpy license, you can use the included Vehicle Spy trial version for basic network interfacing and driver setup.

It is also possible to use Vehicle Spy with third-party or custom software, via the Intrepid API. The necessary drivers can also be set up using the API kit installer. All of this software comes with the RAD-Star 2, or if necessary, can be downloaded from the Intrepid web site at <http://www.intrepidcs.com>. Installation instructions can be found later in this guide.


Please refer to the Vehicle Spy documentation for its more specific PC hardware and operating system requirements and recommendations. Note, however, that Vehicle Spy will run on most modern Windows-based PCs.

## 2 A Tour of RAD-Star 2 Hardware

Let's now take a quick tour of the RAD-Star 2. We'll examine the device from all sides, showing its external components and explaining what each does. This will help you become more familiar with the unit so you can more easily set up, configure and use it.

We'll start with a look at the unit as a whole, then describe the operation of the membrane LED display and keypad on top, and show you the connectors on the unit's sides. We'll conclude with a discussion of cables used with the RAD-Star 2.

Like many Intrepid products, the RAD-Star 2 is designed so that all of its connectors are located on its sides, making the device easier to use in cramped quarters. When facing the unit with the top label text readable, the left side of the unit contains its vehicle network ports (plus its power jack) while the right side bears its PC connection interfaces. We'll refer to these from here on as the *vehicle network interface side* and *PC interface side*, respectively.

 **Warning:** The RAD-Star 2 is a complex device that does not contain any user-serviceable parts. Do not attempt to open the case of the RAD-Star 2 unless specifically instructed to do so by an Intrepid Control Systems technician, or you risk possible injury or damage to the unit.

### 2.1 Case and Overall Design

The RAD-Star 2 is enclosed in a sturdy black-anodized metal case. The device has been designed and tested for in-vehicle use, and is operational in a temperature range from -40°C to +85°C. An overall view of the RAD-Star 2 can be seen in Figure 5.

Connectors and ports are often a point of failure with hardware devices. To ensure that the RAD-Star 2 provides you with years of reliable service, Intrepid has ruggedized the physical interfaces on the device by using reinforced metal connectors.

To further protect the device against bumps and drops, it has blue rubber bumpers on both ends. These bumpers are removable, but there is no need to do this under normal circumstances, and we recommend that you leave them in place.



Figure 5: Overview of the RAD-Star 2.

The bottom of the RAD-Star 2 contains useful reference information, including the device serial number, pinouts of its Nano MQL BroadR-Reach and CAN/LIN connectors, and Intrepid's contact information (Figure 6). Pinouts for all RAD-Star 2 connectors can be found in Chapter 5.



**Note:** The names of the channels may differ from one place to another in your hardware and software. "HS CAN" and "CAN 1" both refer to the first CAN channel, while "MS CAN" and "CAN 2" mean the second CAN channel.





Figure 6: RAD-Star 2 Bottom View Showing Connector Pinouts.

## 2.2 Membrane LED Display and Keypad

One of the RAD-Star 2's many improvements over the original RAD-Star is the addition of a membrane LED display and keypad on top of the unit (Figure 7). The membrane contains 10 LEDs that provide immediate visual feedback about the status of the device, and two keypad buttons that can be used to toggle the meaning of the status indicators and change the device's operating mode and connection method.



Figure 7: RAD-Star 2 Membrane LED Display and Keypad.

### Keypad Buttons and LEDs

There are two keypad buttons on the RAD-Star 2's top membrane: one with "BR" written in blue near the top left, and one with white "CAN LIN" text near the bottom right. Pressing either button toggles the meaning of the 8 LEDs outside the buttons as follows:

- **Blue Button (Top Left):** When pressed, activates the "blue set" of LED interpretations above the LEDs, which are associated with the RAD-Star 2's BroadR-Reach channels.
- **White Button (Bottom Right):** When pressed, activates the "white set" of LED meanings below the LEDs, which show the status of the device's conventional vehicle networks (CAN, and in the future, LIN).

The buttons also both indicate the device's operating mode by the color of the flashing LED in the button most recently selected, and allow you to change the mode as well. The colors correspond to the three modes of the device as follows:

- **Flashing Green:** Device is operating in normal mode as either an active tap or media converter, with communication over Ethernet. Selection of active tap or media converter is made via a software setting (see Section 4.6).
- **Flashing Blue:** Same as above, but with communication over USB.
- **Flashing White:** Device is in raw media converter mode.

To rotate among these three modes, hold down both the "BR" and "CAN LIN" buttons at the same time for around two seconds until the color changes.



Note that the speed that the LED flashes will change depending on whether the unit is currently online or offline.

### **“Blue Set” LED Status Indicators**

The blue labels consist of two sets of four indicators for the two BroadR-Reach channels in the device. The meanings of the LEDs when the blue set is selected are as follows:

- **LINK 1 / LINK 2:** Illuminate green when a link is established on BroadR-Reach channel 1 or 2 respectively.
- **ACT 1 / ACT 2:** Blink green to indicate activity on BR1 or BR2 respectively.
- **MODE 1 / MODE 2:** Illuminate green when the corresponding channel is configured or operating as the master device on the link, and blue when operating as slave.
- **SIG 1 / SIG 2:** A signal quality indicator communicated from the BroadR-Reach PHY for channel 1 or 2. Blinking green means normal operation, while red indicates poor signal quality on the link.

### **“White Set” LED Status Indicators**

The white labels provide information on the status of the RAD-Star 2's conventional vehicle network channels. The LEDs for CAN 1, CAN 2 and LIN (future) glow green to show activity on the associated channel.

The LEDs labeled “A” through “E” are reserved for future use.

## **2.3 Vehicle Network Interface Side Connectors**

The left side of the RAD-Star 2 contains the two main connectors for interfacing to your vehicle networks, as well as the device's 12V power jack, all of which are clearly labeled (Figure 8). We'll describe them further, going left to right as you look at the side of the device.



Figure 8: RAD-Star 2 Vehicle Network Interface Side View.

### ***12V Barrel Connector (“12V”)***

This standard 12V socket is the power input to the RAD-Star 2 and matches the male connector on the included power supply.

### ***DB-9 Conventional Network Interface Connector (“CAN/LIN”)***

This industry standard DB-9 male connector carries two CAN channels, plus power and ground. One line is reserved for a LIN channel for future implementation.

### ***BroadR-Reach Nano MQS Connector Socket (“BR”)***

After creating an interface cable for your Automotive Ethernet networks from the included Nano MQS socket plug and crimp contacts, you attach it here. There are two BroadR-Reach (100BASE-T1 compatible) channels, which use pins 3/4 and 7/8 respectively of the 8-position connector.

## **2.4 PC Interface Side Connectors**

This side of the RAD-Star 2 contains the Ethernet and USB connectors used to interface the device to a PC or other monitoring hardware (Figure 9).

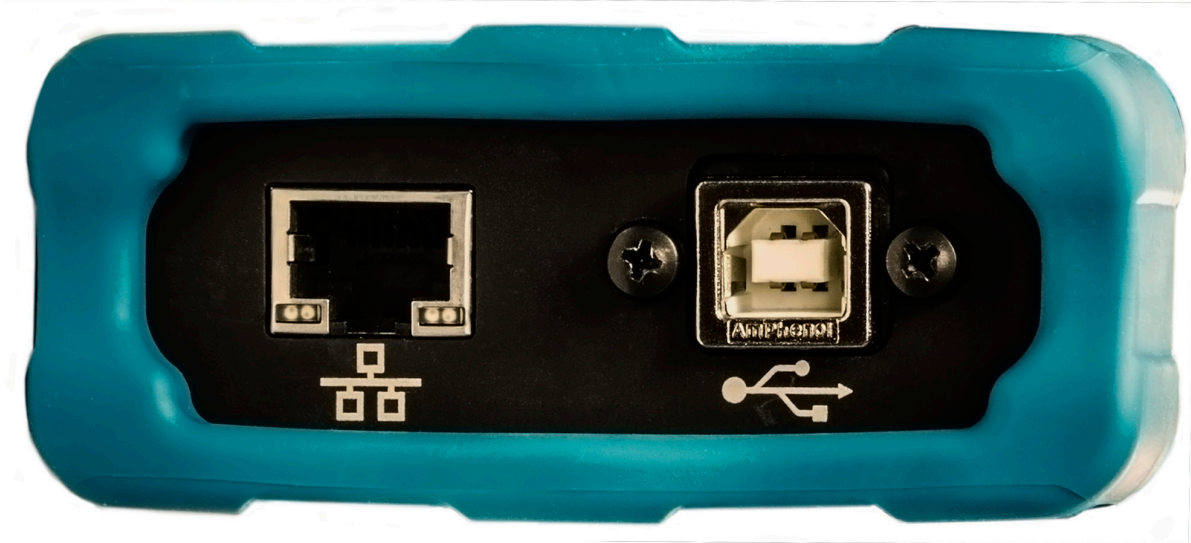


Figure 9: RAD-Star 2 PC Interface Side View.

### ***RJ-45 Ethernet Jack***

An industry standard 8-pin Gigabit Ethernet jack. It includes link and activity LEDs that will light up to show that a connection has been established and to indicate that messages are being sent between the RAD-Star 2 and the attached device.

### ***USB Jack***

This is an industry standard USB 2.0 “Type B” jack that is an alternative method of connecting the RAD-Star to a PC or similar unit.

## **2.5 Included Cables and Cable Assembly**

The RAD-Star 2 is a relatively simple device that ships with just one standard Ethernet cable and the special components necessary to make the cable assembly for Automotive Ethernet networks. Depending on your vehicle network configuration, you may need to supplement or modify the included hardware to suit your needs.

This section briefly describes RAD-Star 2 cables and how they are used. More detailed instructions for hooking up the RAD-Star 2, including these cables, are provided in Chapter 3. Full pinouts for all RAD-Star 2 connectors can be found in Chapter 5.

### ***Standard Ethernet Cable***

The RAD-Star 2 is usually connected to a PC or other conventional Ethernet device using its RJ-45 jack and an industry standard Ethernet cable. The supplied cable is 3’ (about 1 m) in length, which should be sufficient for most bench applications. If you need a longer cable,

any standard Ethernet cable suitable for Gigabit Ethernet will work; these can be obtained inexpensively at electronics and office stores, or ordered online.

### ***USB Cable***

In lieu of an Ethernet connection, the RAD-Star 2 can be linked to a PC using a standard USB cable. The cable needed is sometimes called an “A/B” cable since it links the “Type A” USB port found on PCs with the “Type B” found on electronic devices such as the RAD-Star 2. Since most users will employ Ethernet, a USB cable is not included with the device. However, these too can be obtained easily at retail or online stores. You can also order one directly from Intrepid.

### ***Automotive Ethernet (BroadR-Reach) Cable Assembly***

Specific cables for Automotive Ethernet are not included with the RAD-Star 2 for two reasons. First, Automotive Ethernet does not specify an industry-standard cable and connector type. Second, termination and connector requirements vary from one application to another, so it makes sense for each company to create the cables/harnesses needed for its own networks.

To support its two BroadR-Reach (100BASE-T1 compatible) connections, the RAD-Star 2 uses an 8-pin Nano MQS style connector made by TE Connectivity, which is designed for vehicle use. The part number of the male connector within the RAD-Star 2 is 2177372-3, while the matching female plug supplied is TE Connectivity part number 2177586-1. The crimp contacts that fit into the plugs are TE part number 2-2112449-1; 8 of these are provided with the RAD-Star 2 (the 4 required for its 2 channels, plus 4 spares).

You will need to create a cable assembly for the BroadR-Reach connection using the supplied plugs and contacts. To secure the wires of your cable to the contacts, you will need a special Nano MQS crimping tool, TE Connectivity part number 4-1579014-0. This device can be purchased from various electronic component suppliers or directly from Intrepid Control Systems. The contacts must then be inserted into the female plug following the pinout on the bottom of the RAD-Star 2. Pinout information is provided for your convenience in Chapter 5.

The other ends of the 4 wires coming from the Nano MQS plug should be terminated according to the needs of your vehicle network or bench application.

Be sure to label each of the wires and/or termination connectors with the appropriate RAD-Star 2 channel number. This will allow you to easily link the connectors to the correct devices in your network.

### ***Conventional Vehicle Network Cables***

The RAD-Star 2 supports two CAN / CAN FD channels, with support for LIN planned in the future. If you plan to use these conventional channels, you will need to supply the appropriate cable terminated in a standard female DB-9 connector. If you are unsure of exactly what you need, please contact Intrepid for assistance using the information at the end of this document.

### 3 Hardware and Software Setup

In this chapter we will explain the steps necessary to set up your RAD-Star 2 to work with vehicle networks. This will include showing you how to install the required software and drivers, connect cables between the RAD-Star 2 and your vehicle networks, and link the unit to a PC.

Note that because vehicle and test bench setups will vary, we can only show a typical case here. You may need to alter these instructions to suit your particular needs.

#### 3.1 Vehicle Spy and Driver Installation and Setup

It is possible to install your hardware and software in either order. However, the RAD-Star 2 requires drivers to function properly, which are installed automatically by the included software setup programs. If you connect the hardware before the drivers are installed, it will not work correctly. For this reason, we recommend installing the software first.

As mentioned earlier, a full licensed version of Vehicle Spy is recommended in order to allow you to get the most from your RAD-Star 2. If you purchase Vehicle Spy, its installer will be included on the software disc that comes with the device; if not, a more limited trial version will be provided instead.



**Note:** A separate driver installer is provided for those who will be interfacing to the RAD-Star 2 using its API, rather than using Vehicle Spy. Please see Section 3.2 for details.

##### *Installing Vehicle Spy (Professional or Trial)*

The installation process is very similar for both the full and trial versions, though there may be some slight differences between the figures in this document and what you see on your screen. Vehicle Spy 3 uses an automated installer, which will do most of the work for you. Simply follow the instructions below to set up the program on your computer.

1. **Load the Software and Documentation Disc:** Put the disc that came with your RAD-Star 2 into the optical drive of your computer. A few seconds later, the ICS software installation menu should appear on your computer screen, as shown in Figure 10.



**Note:** On some computers this window may not appear automatically. If this occurs, start Windows Explorer, navigate to the disc's letter under *Computer*, and then double-click the file *icsAutoPlay.exe* to open the menu.



Figure 10: RAD-Star 2 Software Install Dialog Box.

From this menu you can start installing Vehicle Spy 3, install the API support files, and access videos, documentation and online support materials.

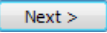

2. **Start Vehicle Spy 3 Installation:** Click *Vehicle Spy 3 Install*.
3. **Select Language:** Select your preferred language, and then click  to proceed. (For the remainder of these directions, we will assume that English has been used.)

The Vehicle Spy 3 setup wizard will now start, displaying a welcome screen as shown in Figure 11 (though the exact version number is likely to differ from the one seen here).



Figure 11: Vehicle Spy 3 Setup Wizard Welcome Screen.



4. **Start Vehicle Spy 3 Setup Wizard:** Click  to start the setup wizard.
5. **Review and Accept License Agreement:** Review the license agreement, and assuming its terms are acceptable, select *I accept the agreement*, then click  (Figure 12).

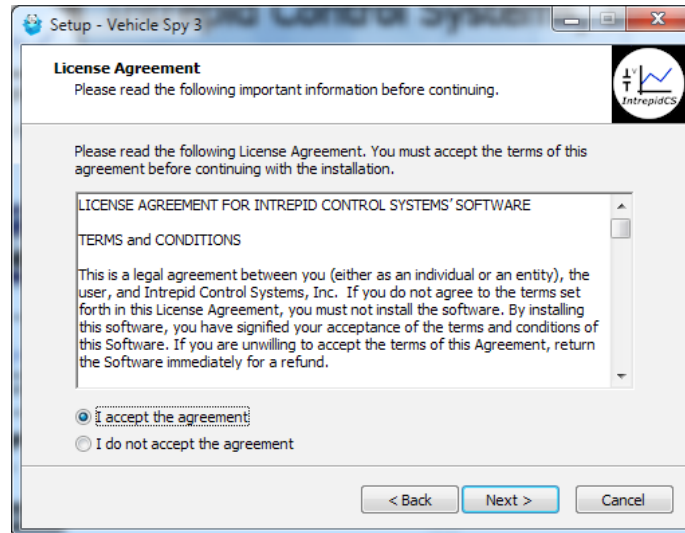




Figure 12: Vehicle Spy 3 License Agreement.

6. **Select Installation Type:** We are doing a new installation so simply click  to continue.
7. **Select Destination Location:** Choose where you want to install Vehicle Spy 3 (Figure 13). We normally recommend using the default location. Click .

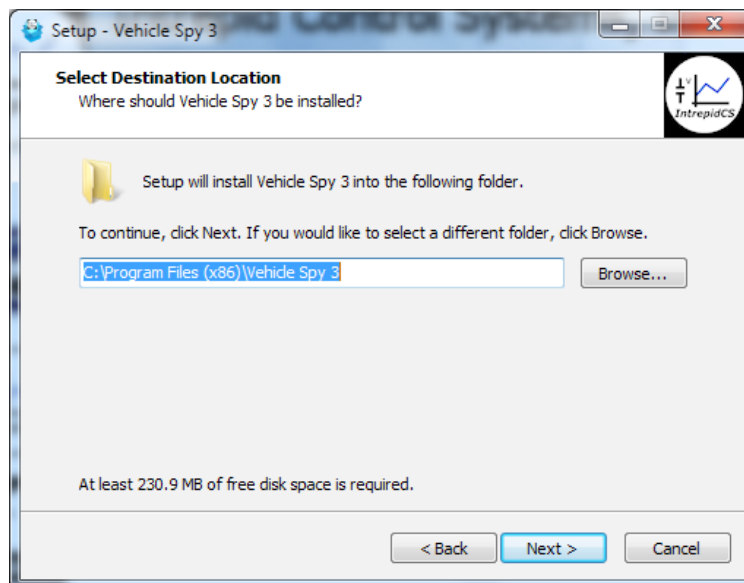


Figure 13: Choosing the Destination Location.

8. **Select Data Directory Location:** Next, choose where you want Vehicle Spy 3 to store its data files. We recommend sticking with the provided default, *C:\IntrepidCS\Vehicle Spy 3* (Figure 14). Click **Next >** to continue.

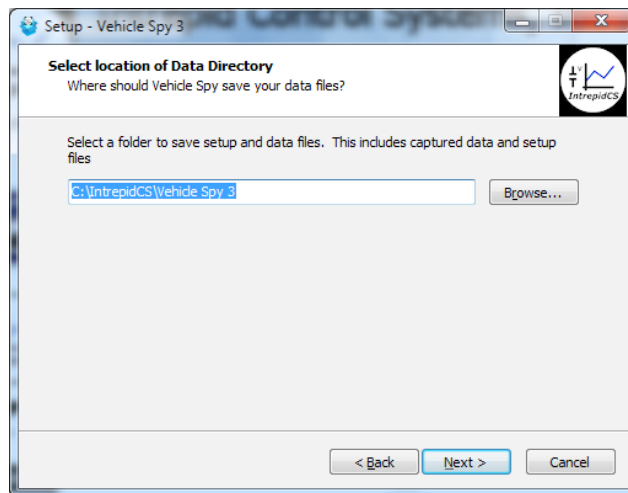


Figure 14: Selecting the Vehicle Spy 3 Data Directory Location.

9. **Select Start Menu Folder:** Choose where you want your Windows shortcuts for Vehicle Spy 3 to reside. Again, the defaults are generally fine here, though you can change them if you wish. Click **Next >** to proceed.
10. **Select Additional Tasks:** The one option here is to create a desktop icon for Vehicle Spy 3, which is selected by default. Uncheck the box if you do not wish to have this icon created, then click **Next >**.

You have now provided all of the information the wizard needs to install Vehicle Spy 3. Your selected options will be displayed in a review box, as shown in Figure 15.

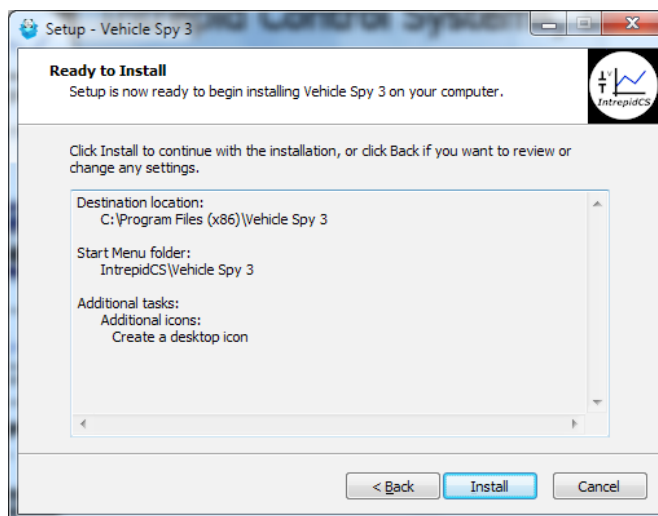


Figure 15: Installation Options Review.



- 11. Review Installation Options and Begin Installation:** Ensure that the options you have chosen are correct, and then click .

The wizard will now begin installing Vehicle Spy 3. A window will appear showing you the progress of the installation (Figure 16).

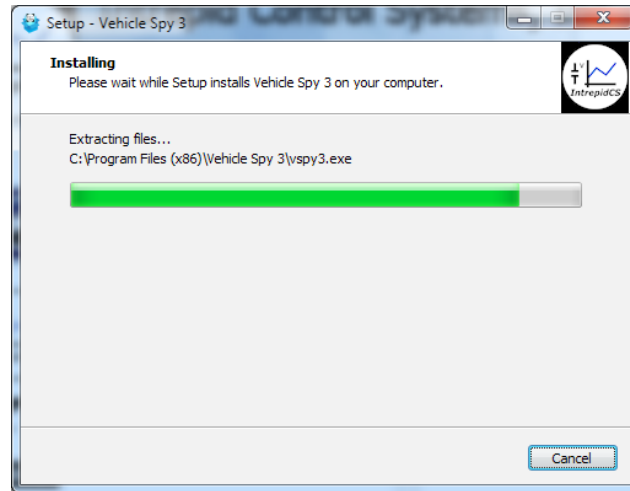


Figure 16: Installing Vehicle Spy 3.

After completing installation of the software itself, the wizard will automatically install various drivers required by Vehicle Spy 3 and the RAD-Star 2. The first install will be guided by the VCP Driver Installer.

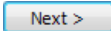

- 12. Install VCP Drivers:** Click  to begin installing the first set of drivers. This will usually take only a few seconds, and when completed, a message will appear like the one in Figure 17. Click  to complete this initial driver installation process.



Figure 17: VCP Driver Installation Complete.

Next, support files for Microsoft Visual C++ 2010 and 2005 will be installed, if they are not already on the computer. This happens automatically, and you may briefly see a dialog box like the one in Figure 18. Many systems already have these files, however; if that is the case, a message may appear telling you that they are already present; just hit **OK** to continue.

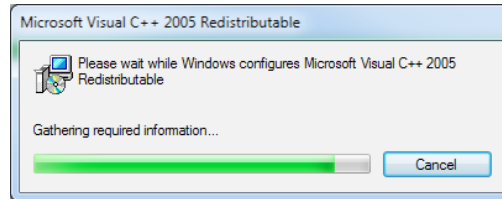


Figure 18: Installing Support Files for Microsoft Visual C++ 2005.

The WinPcap installer will start next. This is a special support program that allows Ethernet traffic on a PC to be captured and displayed by Vehicle Spy 3. You will see a window similar to the one shown in Figure 19.

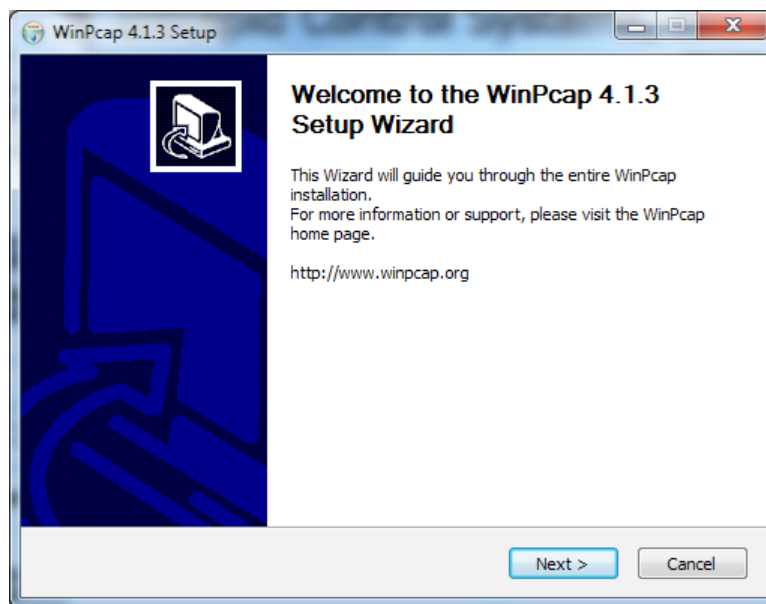


Figure 19: WinPcap setup wizard.

13. **Install WinPcap:** Click **Next >** to start the installation process. Review the WinPcap license agreement and click **I Agree** if you are willing to abide by its terms. Leave the box on the next screen checked so that WinPcap starts automatically, and click **Install**. After a few seconds a message will appear saying that the installation is complete; click **Finish** to exit this installer.

The setup wizard will now install SMSC LAN9500 device drivers. This only takes a few seconds and requires no user intervention; you may see a dialog box on the screen like the one in Figure 20.

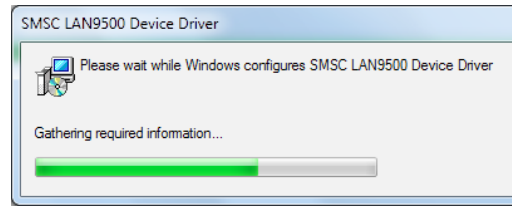


Figure 20: SMSC LAN9500 device driver installation.

Another ICS driver installer dialog box will now appear, similar to the first one.

**14. Install ICS Port Drivers:** Click **Next >** to begin installing the ICS port drivers.

At this point you may receive a prompt from Windows like the one shown in Figure 21. Please click **Install** to authorize driver installation.

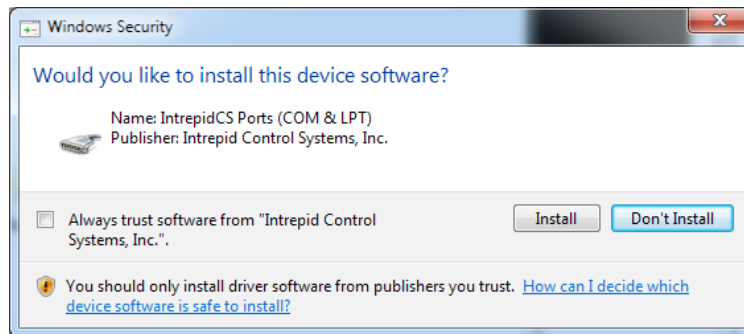


Figure 21: Windows Security Dialog Box.

Once installation begins, it will take only a few moments, and when completed, a message will appear like the one in Figure 22.

**15. Complete Port Driver Installation:** Click **Finish** to exit this part of the install.



Figure 22: Port Driver Installation Complete.

You will now see a window similar to Figure 23, indicating that the setup process is complete.

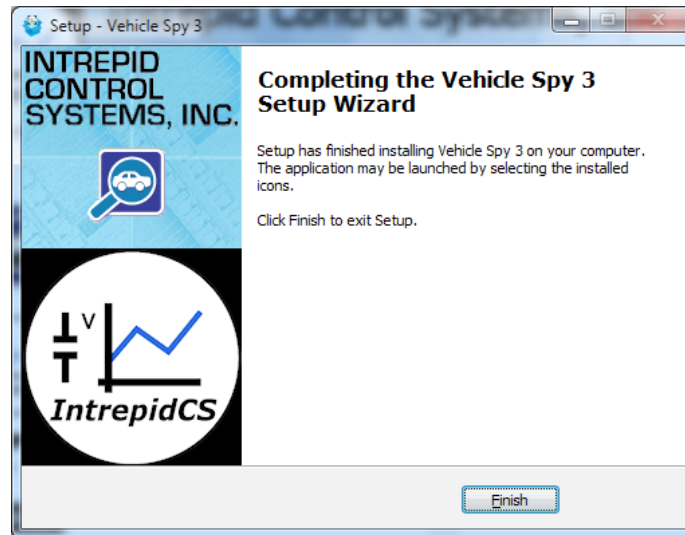


Figure 23: Vehicle Spy 3 Setup Complete.

16. **Exit the Setup Wizard:** Click .

Congratulations, you're done!

### 3.2 Driver and API Support File Installation and Setup

If you plan to use the RAD-Star 2 without Vehicle Spy 3, you will need to install drivers and support files to allow the hardware to be accessed via its API. Please follow the steps below.

All of these files are installed automatically with Vehicle Spy 3, so if you followed the instructions in Section 3.1, you can skip the directions here.

1. **Load the Software and Documentation Disc:** Insert the disc that came with your RAD-Star 2 into the optical drive of your computer. A few seconds later, the ICS software installation menu should automatically appear on your computer screen, as shown in Figure 24.


 **Note:** On some computers this window may not appear automatically. If this occurs, start Windows Explorer, navigate to the disc's letter under *Computer*, and then double-click the file *icsAutoPlay.exe* to open the menu.



Figure 24: RAD-Star 2 Software Install Dialog Box.

2. **Start Support File Installation:** Click *RP1210 J2534 Intrepid API Install*.
3. **Select Language:** Select your preferred language, and then click  to proceed. (We will assume that English has been used.)

The setup wizard for the ICS API and driver kit will now start, displaying a welcome screen as shown in Figure 25. (The version number you see may be different from the one shown here.)

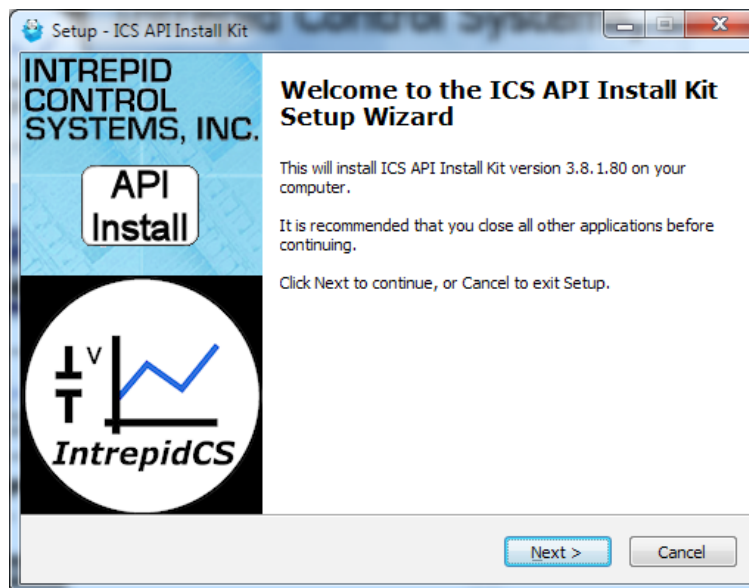
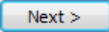
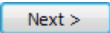


Figure 25: API and Driver Setup Wizard Welcome Screen.

4. **Start API and Driver Setup Wizard:** Click  to start the setup wizard.
5. **Review and Accept License Agreement:** Review the license agreement, and assuming its terms are acceptable, select *I accept the agreement*, then click  (Figure 26).

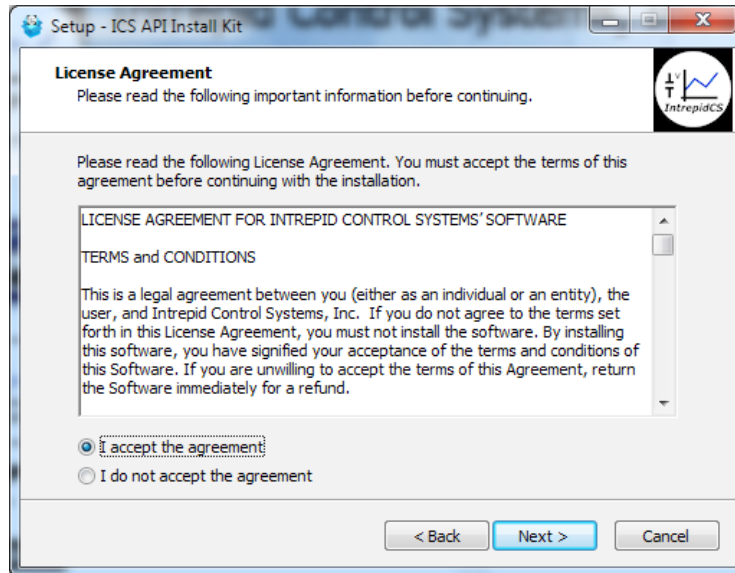
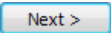
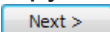


Figure 26: API and Driver File License Agreement.

6. **Select Installation Type:** We are doing a new installation so simply click  to continue.
7. **Select Destination Location:** Choose where you want to install Vehicle Spy 3 (Figure 27). We normally recommend keeping the default location. Click .

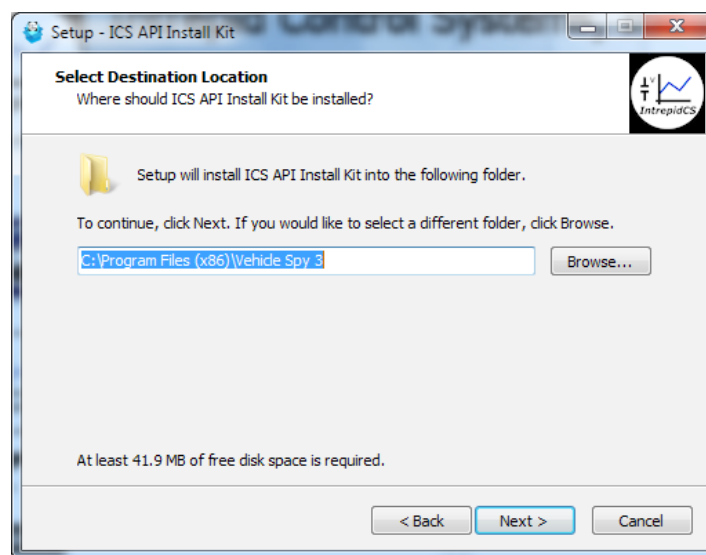


Figure 27: Choosing the API Kit Destination Location.

You have now provided all of the information the wizard needs, and it will display a summary as shown in Figure 28.

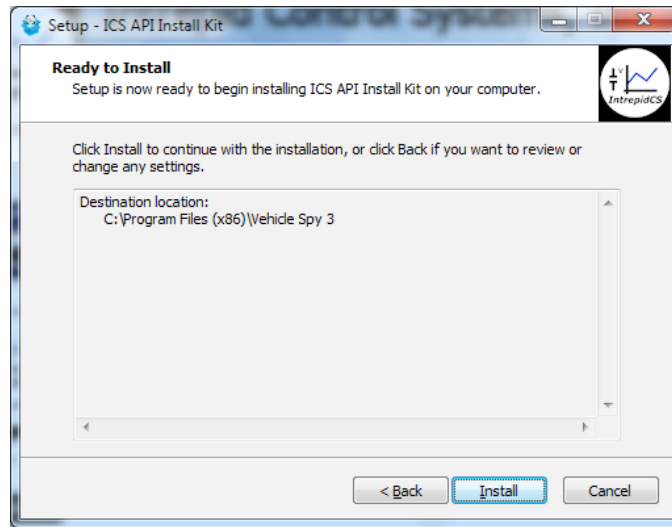


Figure 28: API Installation Options Review.

8. **Review Installation Options and Begin Installation:** Ensure that the options you have chosen are correct, and then click .

The wizard will now begin installing Vehicle Spy 3. A window will appear showing you the progress of the installation (Figure 29).

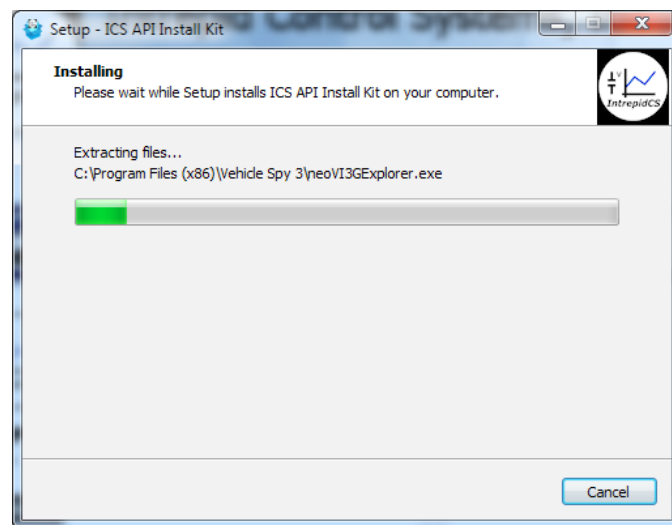


Figure 29: Installing API and Drivers.

After completing the basic setup, the wizard will automatically install various drivers required by the RAD-Star 2. The first install will be done by the VCP Driver Installer.

9. **Install VCP Drivers:** Click **Next >** to begin installing the first set of drivers. When completed, a message will appear like the one in Figure 30. Click **Finish**.

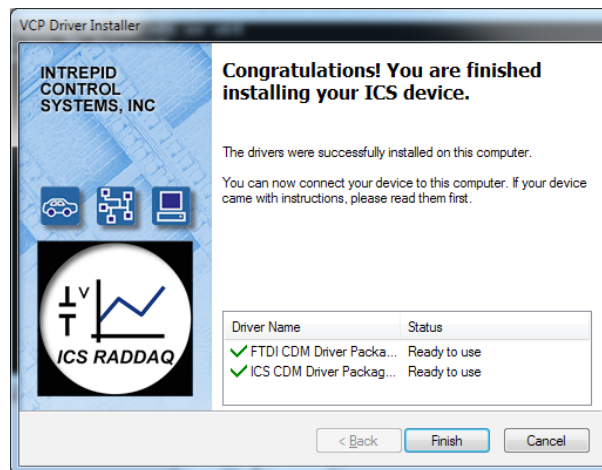


Figure 30: VCP Driver Installation Complete.

Next, support files for Microsoft Visual C++ 2010 and 2005 will be automatically installed, if they are not already on the computer. You may briefly see a dialog box like the one in Figure 31. If a prompt appears saying the files are already installed, hit **OK** to continue.

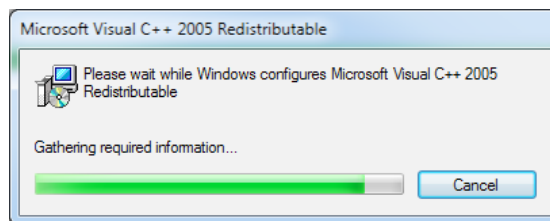


Figure 31: Installing Support Files for Microsoft Visual C++ 2005.

Another ICS driver installer dialog box will appear now.

10. **Install ICS Port Drivers:** Click **Next >** to begin installing the ICS port drivers. If you see a Windows dialog like the one in Figure 32, click **Install** to authorize installation.

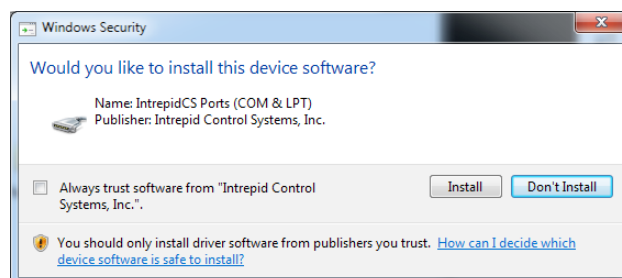


Figure 32: Windows Security Dialog Box.



Once installation begins, it will take only a few seconds, and when completed, a message will appear like the one in Figure 33.


- 11. Complete Port Driver Installation:** Click  to exit this part of the install.



Figure 33: Port Driver Installation Complete.

You will now see a dialog box like the one shown in Figure 34, indicating that the setup process is complete.



Figure 34: Vehicle Spy 3 Setup Complete.

- 12. Exit the Setup Wizard:** Click .

Congratulations, you're done!

### 3.3 Hardware Hookup Diagrams

The hookup diagrams below show you at a glance how to physically connect your RAD-Star 2 to your vehicle networks and PC. The exact configuration depends on how you are using the device, but since its operation is relatively straightforward, hardware hookup is quite easy.

#### ***Standard Active Tap and Media Converter Hardware Hookup Diagram***

Figure 35 shows the basic hookup of components for the RAD-Star 2 when used in its normal active tap or media converter modes. In active tap mode, naturally, both AE nodes must be connected; when using the device as a media converter, you can connect one or two nodes. Either the Ethernet or USB connection to the PC can be used, but not both at the same time.

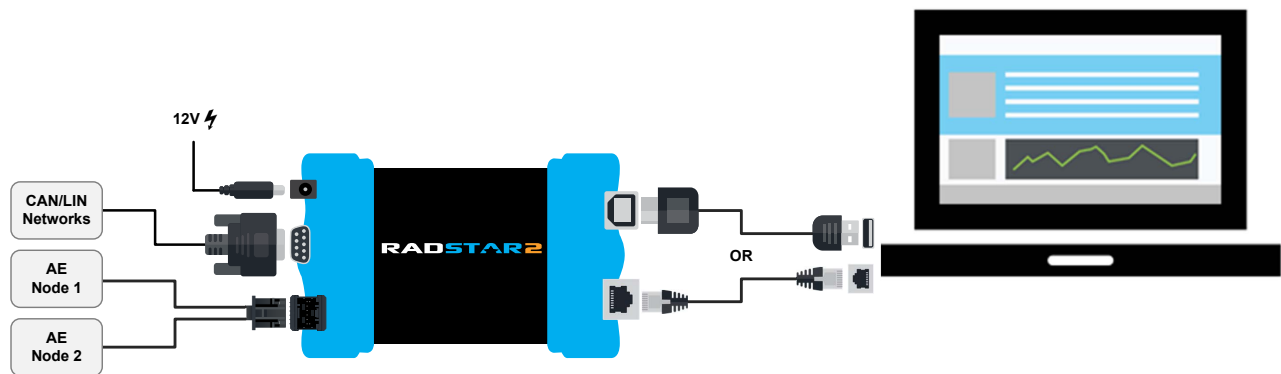


Figure 35: RAD-Star 2 Standard Active Tap and Media Converter Hookup Diagram.

#### ***Raw Media Converter Hardware Hookup Diagram***

Figure 36 is the same as Figure 35 but modified slightly to show the relevant connections in raw converter mode. As described earlier, in this mode only one Automotive Ethernet channel (BR1) is enabled in the RAD-Star 2, and only the Ethernet link to the PC may be used.

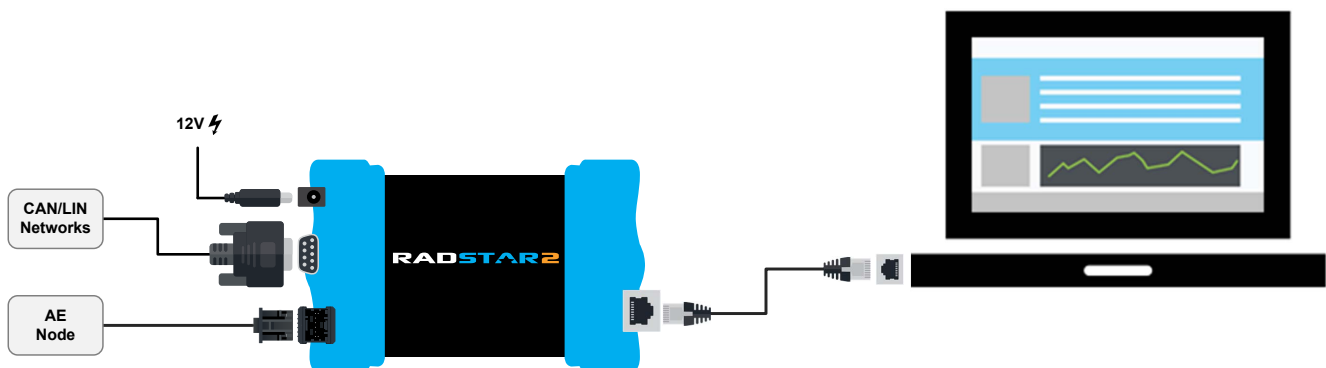


Figure 36: RAD-Star 2 Raw Media Converter Hookup Diagram.

### 3.4 Vehicle Network and Power Connections

Let's start our hardware connections by attaching the RAD-Star 2 to its power supply and the vehicle networks it will monitor. Please follow these steps.

1. **Connect the Power Supply:** Plug the included power supply into a standard wall outlet, then attach the barrel connector to the mating connector on the left side of the RAD-Star 2. You should immediately see an LED begin blinking on the top surface of the device.

If you are using a different means of providing DC power to the RAD-Star 2, then make the appropriate connections instead.

2. **Attach BroadR-Reach Cable Nano MQS Connector to RAD-Star 2:** Carefully slide the Nano MQS plug of the cable assembly you created for BroadR-Reach into the matching socket on the RAD-Star 2. The connectors are keyed, and you should hear a slight click when the plug is correctly seated. Notice the release tab, which you will use if you want to remove the connector later on.
3. **Connect BroadR-Reach Cable to Automotive Ethernet Nodes:** Attach the terminated ends of the Nano MQS cable assembly to the appropriate ECUs and/or switch ports. The exact means of doing this will depend on how the wires are terminated, and whether you are using the device as an active tap or a media converter. Remember that in raw media converter mode, only the BR1 channel is operational.
4. **(Optional) Connect Conventional Vehicle Networks:** If using the RAD-Star 2's CAN (and in the future, LIN) channels, attach the appropriate cable to your network and to the RAD-Star 2's DB-9 connector.

The RAD-Star 2 should now be fully connected to your vehicle or bench network.

### 3.5 PC Connection

Now we are ready to connect the RAD-Star 2 to the PC. Since all data is conveyed over a single link, this is quite straightforward:

- **Ethernet Link:** If using Ethernet to connect to your PC, connect one end of the included Ethernet cable to the RAD-Star 2 and the other to the Ethernet port of your PC.



**Note:** The RAD-Star 2 was designed to be connected directly to a PC Ethernet port. Intrepid does not support using a conventional Ethernet switch between the RAD-Star 2 and the PC.

If the supplied Ethernet cables are too short for your application, you can use a longer one, as long as it is certified for Gigabit Ethernet operation.

Since the RAD-Star 2 is capable of transmitting up to 200 Mb/s of data bidirectionally, we strongly recommend using a PC with a Gigabit Ethernet controller. A 100 Mb/s Ethernet connection may be sufficient, however, for low-bandwidth applications.

- **USB Link:** If using USB to connect to your PC, attach one end of a standard USB 2.0 “A/B” cable to the RAD-Star 2 and the other to a USB port on your PC.

Again, remember that USB cannot be used for raw media converter mode.

## 4 Device Configuration

Your RAD-Star 2 ships from the factory ready to use with its default settings. Note that since its primary function is to serve as an active tap, it is configured by default to run in that mode. However, its operation can also be customized to your exact needs by adjusting many parameters that control its internal hardware and firmware. In this chapter, we'll show you how to manage and fine-tune your RAD-Star 2, including switching between active tap and media converter modes and turning on or off specific features.


### 4.1 Starting and Using neoVI Explorer

The *neoVI Explorer* utility allows you to connect to, manage and configure all of your Intrepid Control Systems hardware, including the RAD-Star 2. It is supplied both as an integrated feature of Vehicle Spy, and as a standalone program.

This section will describe general features and the basics of using neoVI Explorer, so you will understand the utility when we get into settings specific to the RAD-Star 2.

#### *Starting neoVI Explorer from within Vehicle Spy*

There are several ways to open neoVI Explorer from within VSpy. These are probably the two easiest, since they are accessible at all times:

- **Menu Item:** Click the *Setup* menu and then select *Hardware*.
- **Hardware Setup Button:** Click the  button located in the main Vehicle Spy toolbar just under its menu (Figure 37).

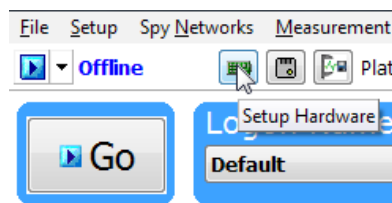


Figure 37: Starting neoVI Explorer from within Vehicle Spy.

Note that you cannot start neoVI Explorer when Vehicle Spy is online (even if in simulation mode). If you attempt to do so, VSpy will prompt you to either go offline and launch neoVI Explorer, or remain online and return to Vehicle Spy.

#### *Starting neoVI Explorer as a Standalone Program*

If you want to work with your RAD-Star 2 without opening Vehicle Spy, you can launch neoVI Explorer directly. Open the Start Menu, navigate to the *IntrepidCS* folder, then under the *Vehicle Spy 3* subfolder, select *neoVI Explorer* (Figure 38).

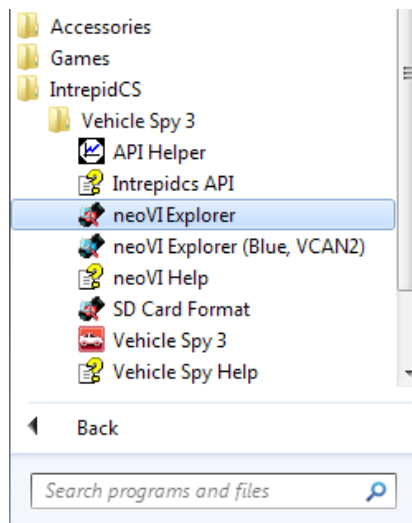


Figure 38: Starting neoVI Explorer Directly.

### ***Starting neoVI Explorer as a Standalone Program (API Kit Installed)***

If you installed the API kit and support files instead of Vehicle Spy, you can run neoVI Explorer from the Start Menu using the same basic process as described above. The only difference is the name of the subfolder, so you will navigate to the *IntrepidCS* folder, then open the *ICS API Install Kit* subfolder, and finally select *neoVI Explorer* (Figure 39).

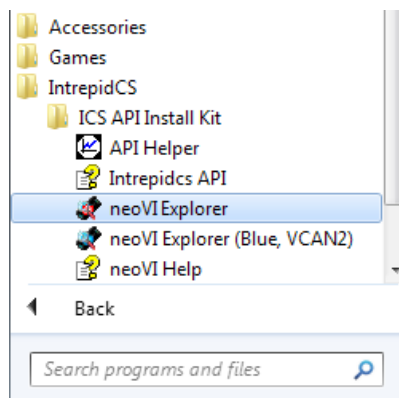


Figure 39: Starting neoVI Explorer as a Standalone Program from the API Kit.

### ***Connecting to the RAD-Star 2***

When neoVI Explorer loads, it will start up with the first hardware device it can find selected in the menu pane on the left. You should see your RAD-Star 2 listed here, along with its serial number, which begins with “RS”. If you don’t see the RAD-Star 2, but do see other Intrepid devices, be sure to scroll down to look for it. If it is still not visible, this means its drivers have not been installed correctly, it is not powered properly, or it is not connected to the PC’s Ethernet or USB port. Please contact Intrepid for assistance, if needed.

To manage your RAD-Star 2, click on its entry in the navigation pane (if it is not already highlighted) and then press the *Connect* button. After successfully connecting to the device, you will see a “thumbs up” icon next to the device’s name, and checkmarks will appear next to currently-enabled networks in the explorer area on the left. You should also see a message in the message box on the right saying “RADStar2 RSxxxx settings have been read”. This tells you that neoVI Explorer has loaded the current settings from the unit. The information in the upper right-hand part of the window is device-specific and described in Section 4.2. The screen as a whole should appear similar to that shown in Figure 40 (but note that the version number shown at the bottom may be different).

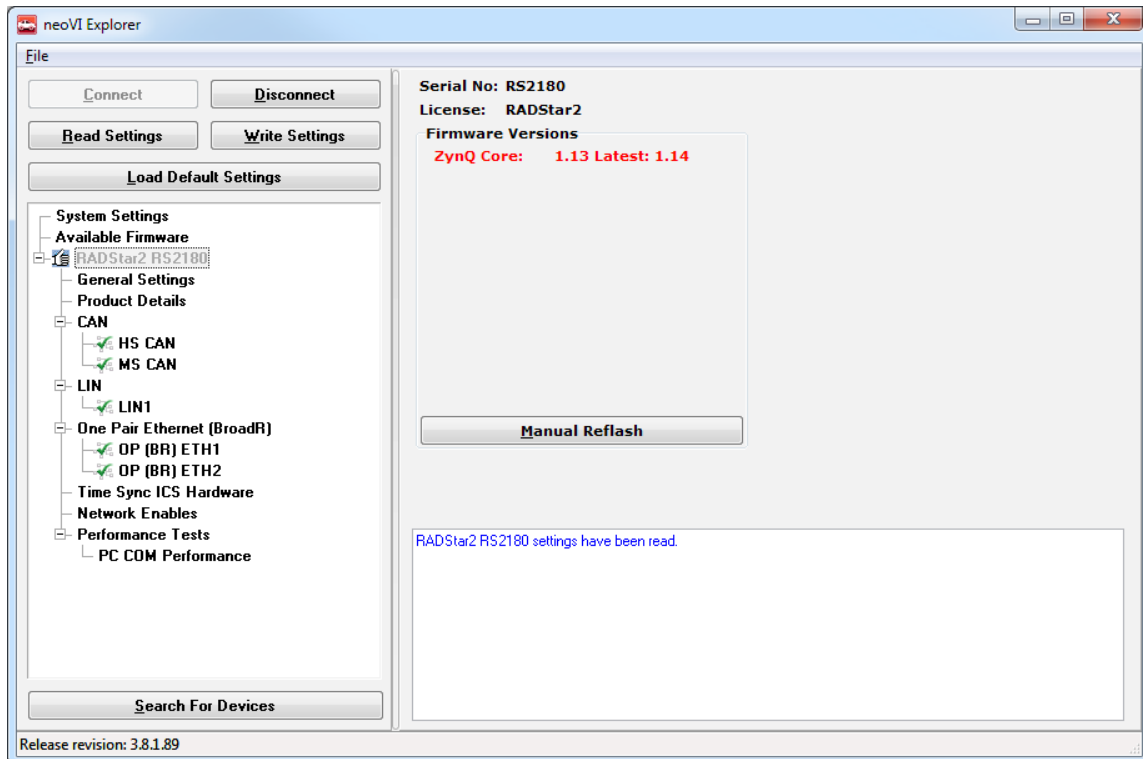


Figure 40: Typical neoVI Explorer Window After Initial Connection to the RAD-Star 2.

## Writing and Reloading Settings

To avoid potential problems, neoVI Explorer will not save any changes to device parameters until you instruct it to do so. This is done by pressing the *Write Settings* button, which will update the parameters within the firmware in your RAD-Star 2. If you make changes you do not want to keep, pressing the *Read Settings* button will reload the settings stored in the device, wiping out any modifications made in neoVI Explorer that had not yet been saved.

## Reloading Device Defaults

To return all settings to factory defaults, press the *Load Default Settings* button. This is convenient if many changes have been made and written to the firmware in the past, and you want to start over with a clean slate.

Note that pressing this button actually writes the defaults to the device first, and then reloads them automatically, so you do not need to also press *Write Settings*. You will see messages in the message area telling you that defaults have been sent to the device and then read from it.

### ***Disconnecting from the RAD-Star 2***

Press the *Disconnect* button to tell neoVI Explorer that you are done working with the RAD-Star 2. This step is not required if you are simply done with neoVI Explorer and want to exit, but is necessary before connecting to another device.

### ***Searching for Devices***

If you attach new hardware to your PC after starting neoVI Explorer, press the *Search For Devices* button at the bottom left of the dialog box to prompt the program to scan for new hardware you can manage.

### ***Exiting neoVI Explorer***

Like any Windows program, you can close neoVI Explorer by clicking the “X” in the top right corner, or pressing the Alt+F4 key combination.

## **4.2 System Settings and Firmware Updates**

The top two entries in the explorer window on the left side of neoVI Explorer contain system-wide settings that apply to all hardware devices, and information related to firmware updates.

### ***System Settings***

Click here, and in the right-hand pane you will see three settings that you can enable or disable (Figure 41):

- **Enable Server:** Turns on the neoVI Server feature, a background program that allows your hardware to be used by multiple applications at the same time.
- **Enable Low Latency:** This is an advanced setting for applications where fast response is needed after transmission.
- **Enable Auto Update:** When enabled, both neoVI Explorer and Vehicle Spy will automatically update firmware. If this box is not checked, firmware must be updated manually. (See below for details.)



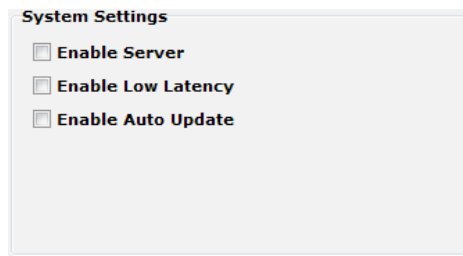


Figure 41: neoVI Explorer System Settings Pane

## Available Firmware

This is an informational page that shows which firmware versions are available in this version of neoVI Explorer for various Intrepid products. Some devices have multiple firmware programs that control different aspects of their operation; in the case of the RAD-Star 2, there is only one, called *ZynQ Core*.

You normally won't need to look in this area, because as seen in Figure 40, neoVI Explorer shows you the current and available firmware versions for your RAD-Star 2 when you connect to it.

## Automatic and Manual Firmware Updates

Firmware is essentially software that runs hardware, and is required to enable the many capabilities of your RAD-Star 2. New versions of firmware are created regularly by Intrepid's engineers to implement new features and correct problems that have been identified.

If you have *Enable Auto Update* on—which is the default, and is recommended—then you don't really need to worry about firmware updates. Each time you connect to your RAD-Star 2 in neoVI Explorer or go online with it in Vehicle Spy, the firmware will be checked, and if a newer version is available, the device will immediately be updated.

If you do not have automatic updates enabled, you control when your firmware is updated. When new firmware is available, you will be notified on the initial connection screen, as shown in Figure 42. Simply press the *Manual Reflash* button to update the firmware.



**Note:** Firmware updates are not supported over USB at this time. If you normally use USB to connect to the RAD-Star 2, you will need to temporarily connect using Ethernet to perform firmware upgrades. This limitation should be removed in a future firmware version of the RAD-Star 2 (which will itself, of course, require a firmware upgrade!)

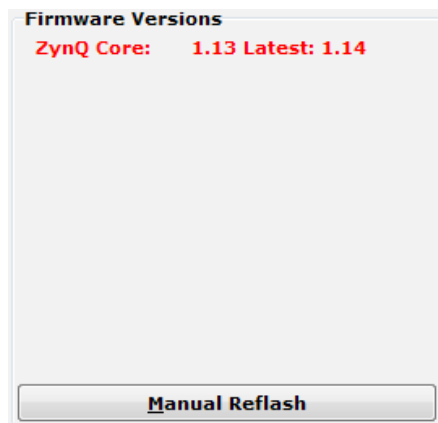


Figure 42: neoVI Explorer Firmware Message Box and Manual Reflash Button.

### The Firmware Update Process

During the firmware update process, the RAD-Star 2 will be placed into *bootloader mode*, indicated by all of its LEDs flashing blue synchronously. (The device's normal LED flash patterns will resume when the update is complete and the device reboots.)

You will see a dialog box on the screen showing you the progress of the firmware update operation, which takes about a minute; an example is shown in Figure 43. You will also see messages in the message box on the right side of neoVI Explorer as the ZynQ Core firmware program is sent to the device. When the process is complete the dialog box will disappear and another message will appear in neoVI Explorer to confirm that the update has finished.

If you receive any error messages or experience any other problems updating your RAD-Star 2's firmware, please contact Intrepid for assistance (see Chapter 6).

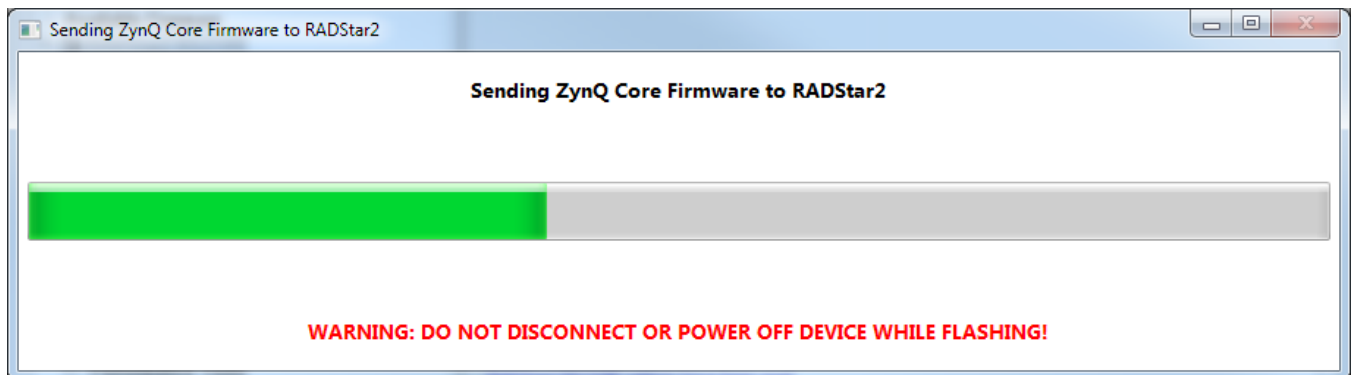



Figure 43: RAD-Star 2 Firmware Update Message Box.

 **Warning:** Please take heed of the warning on the firmware update dialog box: leave the RAD-Star 2 connected and powered on for the entire firmware update process to avoid possible problems with the device.

## 4.3 General Settings and Product Details

These two areas of the RAD-Star 2's parameter setup provide information about the device and allow you to perform a few basic maintenance tasks.

### ***General Settings***

After connecting to the device you will see basic information about it in the right-hand pane of the window:

- The device's serial number.
- The firmware versions currently in the device, and an indication if new firmware is available.
- A message showing that the hardware license for the device was recognized.

This information can be displayed again at any time by clicking the RAD-Star 2's name in the explorer navigation window, or the *General Settings* entry immediately below it.

The version of the ZynQ Core firmware for the RAD-Star 2 will be shown in black if it matches the firmware version within neoVI Explorer. If not, the current version and the newest available version will be shown in red to help you notice that an update is available, as seen in Figure 42. Section 4.2 provides more information on firmware updates.

### ***Product Details***

This is an informational area that provides technical data on the RAD-Star 2's hardware and internal setup. You will generally only need this if requested by Intrepid in order to facilitate support or troubleshooting. You can use the *Copy To Clipboard* button to copy all of the information to the Windows Clipboard, so you can then paste it into an email or file.

## 4.4 Standard CAN Networks (HS CAN and MS CAN)

This area of neoVI Explorer is used to enable, disable and configure the two standard dual wire CAN networks in the RAD-Star 2: the High Speed CAN channel (HS CAN) and the Medium Speed CAN channel (MS CAN). Each channel has an entry under the "CAN" group (which

cannot be clicked itself). The current status of each channel is shown next to its name; a green checkmark indicates that the channel is enabled, while a red X means it is disabled. Figure 44 shows an example of the CAN channels area, with both channels enabled.

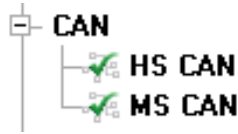



Figure 44: neoVI Explorer CAN Group.

 **Note:** The names of the channels may differ from one place to another in your hardware and software. “HS CAN” and “CAN 1” both refer to the first CAN channel, while “MS CAN” and “CAN 2” mean the second CAN channel.

Both of these channels have the same parameters, which can be configured using the controls in the right-hand pane; the default settings are shown in Figure 45.

Figure 45: neoVI Explorer Standard CAN Parameters with Default Settings.

## Enabled

Place a checkmark in this box to enable the channel, or clear the checkmark to disable it. When disabled, all of the other parameter controls are disabled (grayed out).

## HS CAN / MS CAN Settings

The settings on the left side of the parameter area are for normal (non-FD) CAN operation.

## Specify by Baud

This is a master control that determines whether the operation of the channel is controlled by a numeric baud rate, or is calculated from lower-level timing parameters. When checked, the *Baud Rate* drop-down boxes for both CAN and CAN FD are enabled and the relevant *TQ*, *Sync* and *BRP-1* entries are disabled. When unchecked, this is reversed.

Specifying by baud rate is the default, and is recommended except for advanced users with special requirements.

## Baud Rate

When *Specify by Baud* is selected, choose a baud rate for the channel from the drop-down box below. The default value is 500000.

## CAN Timing Settings

When *Specify by Baud* is deselected, the operation of the CAN channel is based on these five settings: *TQ SEG1*, *TQ SEG2*, *TQ Prop*, *Sync*, *BRP-1*. These settings are for advanced users and normally should be left at their default values.

## Bit Rate Calculator

Press this button to launch the Intrepid Bit Timing Calculator.

## CAN FD Settings

The settings on the right side of the parameter area control CAN FD operation.

## CAN FD Baud Rate

When *Specify by Baud* is selected, choose a baud rate for the data phase of CAN FD messages. The default value is 2000000.

## CAN FD Timing Settings

When *Specify by Baud* is deselected, use these settings (*TQ SEG1*, *TQ SEG2*, *TQ Prop*, *Sync*, *BRP-1*) for the data phase of CAN FD messages. These parameters are for advanced users and normally should be left at their default values.

## ISO

Check this box to enable ISO-compliant CAN FD operation.

## 4.5 LIN Network (LIN)

This section will be detailed in a future version of the manual, once the LIN channel on the RAD-Star 2 is functional.

## 4.6 One Pair Ethernet (BroadR) Automotive Ethernet Networks

This is the section of neoVI Explorer that is arguably the most important for the RAD-Star 2, since it controls the operation of the device's BroadR-Reach (100BASE-T1 compatible) Automotive Ethernet channels. Overall control parameters are found within the parent *One Pair Ethernet (BroadR)* entry, while those for the individual channels are located in the subordinate *OP (BR) ETH1* and *OP (BR) ETH2* entries, as shown in Figure 46.



Figure 46: neoVI Explorer Automotive Ethernet Parameter Group.

### *One Pair Ethernet (BroadR)*

This area contains a small number of parameters that affect the overall operation of the RAD-Star 2's Ethernet channels (see Figure 47).

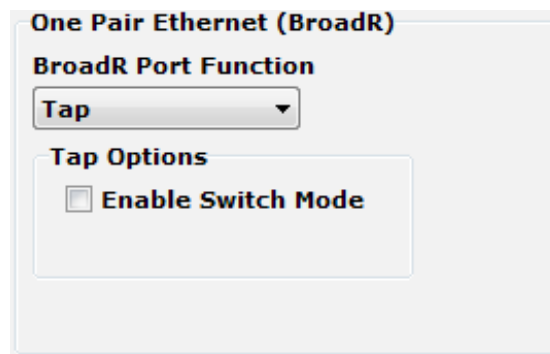


Figure 47: neoVI Explorer One Pair Ethernet (BroadR) General Parameters.

### BroadR Port Function

Use this dropdown box to select the primary mode of operation of the RAD-Star 2 (please refer back to Section 1.3 for more detailed explanations of these modes). This box only controls the operation of the device when it is set to normal mode operation, indicated by flashing green or blue LEDs in the “BR” or “CAN LIN” buttons on top of the device. If the LED is flashing white, the device is in raw media converter mode, and this setting is ignored; please see Section 2.2 for more information.

The three settings here are:

- **Tap:** The RAD-Star 2 behaves as an active tap.
- **Media Converter:** The RAD-Star 2 is configured as a “normal” media converter (support for two connected devices).
- **Tap - Low Latency:** The RAD-Star 2 behaves as an active tap but with “cut-through” operation.

The standard operating mode of the RAD-Star 2 is called “store and forward,” which means that each packet is received by the device and then retransmitted where it needs to go. In contrast, “cut-through” means that the frame starts being retransmitted as soon as possible, before it has been fully received.

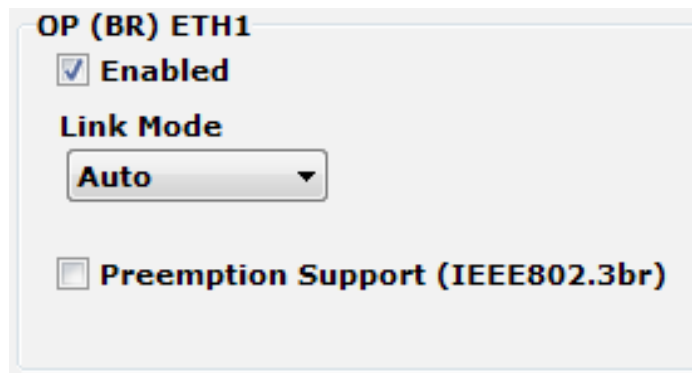
Cut-through operation provides lower latency operation, since frames are retransmitted more quickly. However, there are some limitations: there’s no buffering of frames and you cannot transmit from the PC to attached devices in this mode.

### Tap Options - Enable Switch Mode

This is present only when the parameter above is set to *Tap*. It is reserved for future functionality and currently does not affect the operation of the device. (Note specifically that this does not cause the RAD-Star 2 to behave as an Ethernet switch.)

### OP (BR) ETH1 and OP (BR) ETH2

Each of these entries contains the same parameters and controls the corresponding BroadR-Reach channel on the RAD-Star 2 (Figure 48).



The screenshot shows a configuration window titled "OP (BR) ETH1". It contains three settings: a checked checkbox labeled "Enabled", a "Link Mode" dropdown menu currently set to "Auto", and an unchecked checkbox labeled "Preemption Support (IEEE802.3br)".

Figure 48: neoVI Explorer OP (BR) Automotive Ethernet Channel Parameters.

### Enabled

Placing a checkmark in this box enables the channel, while clearing the checkmark disables it. When disabled, the *Link Mode* parameter is disabled (grayed out).

## Link Mode

Provides control over link negotiation for the channel. Automotive Ethernet requires each link to have one device configured as master and the other as slave: the PHY of the master device generates a shared clock signal for the channel, and the slave device's PHY synchronizes to it.

By default, the RAD-Star 2 will automatically adjust to complement the settings of the devices connected to its channels. However, if necessary, you can use these settings to manually override this behavior:

- **Auto:** The RAD-Star 2 will automatically configure itself as master or slave as required to establish a link to the other device on this channel.
- **Master:** This channel will always act as a master device.
- **Slave:** This channel will always act as a slave device.

Automatic configuration is accomplished by alternating the internal configuration of the PHY between master and slave and continuously attempting to establish a connection with the linked device using both settings. In this manner, the RAD-Star 2 will link with the other device whether it is set to master or slave. (The autonegotiation feature in conventional Ethernet that allows PHYs to communicate their master/slave settings does not exist in BroadR-Reach.)

Note that the designation of a device as master or slave only matters for low-level clock synchronization as described above. Aside from this, the devices are peers on the network; in particular, the master does not control operation of the slave.

## Preemption Support (IEEE802.3br)

Click this checkbox to enable frame preemption support for the associated channel, as described in IEEE standard 802.3br.

## 4.7 Time Sync ICS Hardware

These settings are used to enable time synchronization between multiple Intrepid hardware devices. This section will be described in more detail in a future version of this manual.

## 4.8 Network Enables

This area provides more options for enabling and disabling individual networks within the RAD-Star 2 (Figure 49). The main display contains a scrollable list with checkboxes that can be set or unset to enable or disable each network. These are equivalent to the Enable checkboxes found in the parameter areas for the corresponding networks.

This list contains all of the networks supported by all Intrepid devices. By default, networks not present on the RAD-Star 2 are disabled.



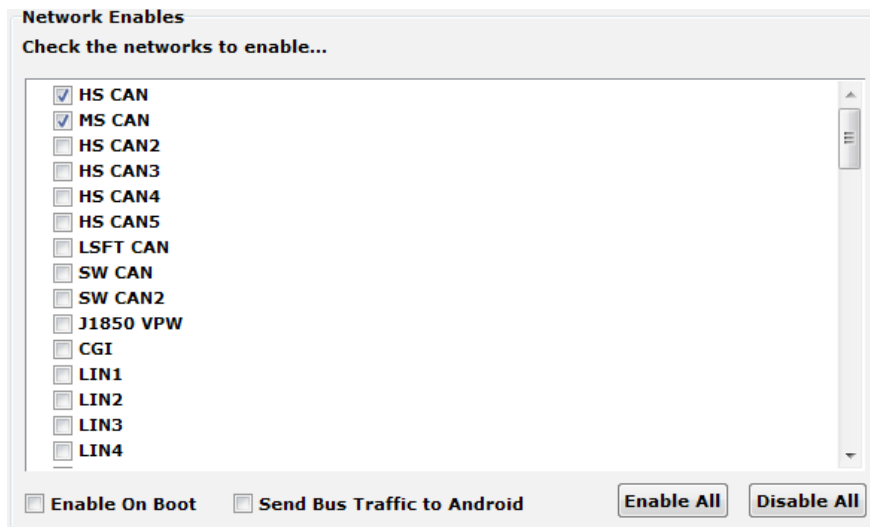


Figure 49: neoVI Explorer Network Enable/Disable Parameters.

### Enable On Boot

Normally, the RAD-Star 2 will not acknowledge messages on a network unless it is online with that network. When this option is enabled, the device always acknowledges frames on all enabled networks.

### Send Bus Traffic to Android

This setting is not applicable to the RAD-Star 2 and can be ignored.

### Enable All

Enables all networks. Pressing this button will attempt to set checkmarks for all networks; if you use it, be sure to disable networks that should be off, so the device remains in a valid configuration.

### Disable All

Disables all networks.

## 5 Reference: Connector Pinouts

This chapter contains pinout information for the vehicle interface connectors on the RAD-Star 2. For your convenience, this information is also printed on the bottom of the device.

Note that the connectors for linking the RAD-Star 2 to the PC are not described here since they are industry standard (Gigabit Ethernet and USB).

### 5.1 BroadR-Reach Nano MQS Connector Pinout

The pinout of the RAD-Star 2's BroadR-Reach ("BR") connector can be found in Table 1. A close-up of the connector is shown in Figure 50.

Pin #	Label	Description
1	DNC	Do not connect
2	DNC	Do not connect
3	BR1-	BroadR-Reach channel 1, negative
4	BR1+	BroadR-Reach channel 1, positive
5	DNC	Do not connect
6	DNC	Do not connect
7	BR2-	BroadR-Reach channel 2, negative
8	BR2+	BroadR-Reach channel 2, positive

Table 1: BroadR-Reach Nano MQS Pinout Details.

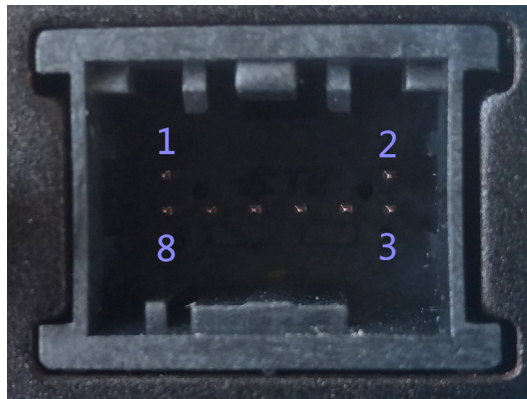


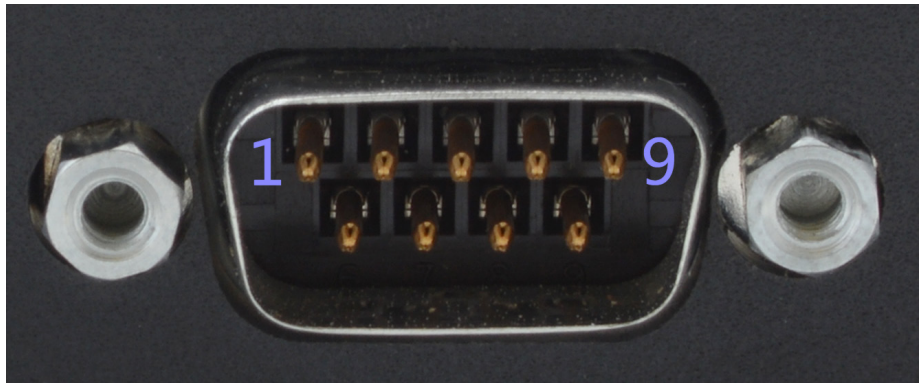
Figure 50: BroadR-Reach Nano MQS Connector with Pin Assignments.

### 5.2 DB-9 Conventional Network Interface Connector Pinout

See Table 2 for the details on the RAD-Star 2's conventional network ("CAN/LIN") DB-9 connector, and refer to Figure 51 for a close-up of the connector and its pin assignments.

Pin #	Label	Description
1	LIN 1	LIN channel (future)
2	CAN 1 L	High Speed CAN channel, low
3	GND	Ground
4	CAN 2 L	Medium Speed CAN channel, low
5	GND	Ground
6	GND	Ground
7	CAN 1 H	High Speed CAN channel, high
8	CAN 2 H	Medium Speed CAN channel, low
9	VBATT	DC power input

**Table 2: Conventional Network (CAN/LIN) DB-9 Connector Pinout Details.**



**Figure 51: Conventional Network (CAN/LIN) DB-9 Connector with Pin Assignments.**

## 6 Support Contact Information

If you have a problem you cannot resolve on your own, feel free to contact ICS for assistance at one of our offices.

Note that problems with the device can sometimes be resolved through firmware updates, which are covered in Section 4.2.

### 6.1 ICS United States Headquarters

Our primary support personnel can be reached at our American headquarters in the Detroit area, using the following contact information:

- **Phone:** (800) 859-6265 or (586) 731-7950, extension 1.
- **Fax:** (586) 731-2274.
- **Email:** [icssupport@intrepidcs.com](mailto:icssupport@intrepidcs.com)

Intrepid's normal support hours are from 8 am to 5 pm, Monday to Friday, United States Eastern time. If you require assistance outside standard business hours, feel free to contact us and a member of our support team will get back to you as soon as possible.

### 6.2 ICS International Offices

#### *European Union Office*

For support in the EU, please contact Intrepid's Germany office:

- **Phone:** +49 721 6633703 -4.
- **Fax:** +49 721 6633703 -9.
- **Email:** [icsgermany@intrepidcs.com](mailto:icsgermany@intrepidcs.com)

#### *Japan Office*

Intrepid's office in Yokohama can be reached as follows:

- **Phone:** +81-(0)45- 263-9294.
- **Mobile Phone:** 080-8884-0111.
- **Fax:** 045-263-9296.
- **Email:** [kharukawa@intrepidcs.com](mailto:kharukawa@intrepidcs.com)

***Korea Office***

In Korea, use the following contact information:

- **Phone:** +82 31 698 3460.
- **Fax:** +82 31 698 3461.
- **Email:** icskorea@intrepidcs.com

***China Office***

Intrepid's Shanghai office can also be reached by phone, fax or email:

- **Phone:** +86 4006151011.
- **Fax:** +86 021-51330271-601.
- **Email:** icschina@intrepidcs.com

We can also be contacted in Shenzhen:

- **Phone:** +86 0755-82723212.
- **Email:** icschina@intrepidcs.com

***India Office***

In India, please use this contact information:

- **Phone:** +91 +97 66 44 55 33.
- **Email:** sbhagwat@intrepidcs.com

***Australia Office***

Our Australian office can be reached as follows:

- **Phone:** 03 9466 4948 (international callers: +61 3 9466 4948).
- **Email:** icsaustralia@intrepidcs.com