

RAD-Star

BroadR-Reach® (100BASE-T1) / Ethernet Active Tap



User's Guide

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Version History

Version Number	Date	Description / Major Changes
1.0	2015/07/24	Initial release.
1.1	2016/01/20	Added version history page. Added boot time specifications. Added mention of the formal IEEE name of BroadR-Reach (100BASE-T1). Corrected error in description of Figure 15.
1.2	2016/06/01	Corrected length of RAD-Star frame wrapper mentioned in Section 11. Clarified requirement to use Gigabit Ethernet for conventional Ethernet switch in high speed applications. Added note that undersized frames are not captured by the RAD-Star. Added contact information for ICS international offices. General review and minor corrections/edits.

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1 Introduction

Thank you for purchasing a RAD-Star BroadR-Reach (100BASE-T1) active tap from Intrepid Control Systems. The RAD-Star is an inexpensive but powerful tool that facilitates the design, development, analysis and troubleshooting of Automotive Ethernet (AE) networks.

The RAD-Star is primarily used as an *active tap* inserted between a pair of AE devices. The RAD-Star's hardware passes all traffic between these 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 can also be used as a *media converter*, allowing an ECU to be interfaced directly to a PC or other conventional Ethernet device. In both applications, it is also possible to send messages from the PC to the ECU(s) using a tool like Intrepid's Vehicle Spy software, allowing those devices to be directly controlled.

2 Package Contents

Your RAD-Star package includes the following:

- The RAD-Star device.
- A pair of standard 4-wire Ethernet cables.
- A pair of BroadR-Reach cables terminated with Molex Mini50 connectors.

If anything is missing, please contact Intrepid for prompt assistance, using the information at the end of this guide. More information about cabling can be found in Section 6 of the guide.

3 Overview of Operation and Features

We'll now briefly outline the RAD-Star's construction, operation and features. This overview will help you better understand the design of the device and get the most of its capabilities.

Operation as an Active Tap

Due to the high performance and complexity of BroadR-Reach—now also known by its formal IEEE 802.3 Ethernet name, 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 between two Automotive Ethernet devices, typically an ECU and a switch. Instead of connecting the ECU and switch directly, both are attached to the BroadR-Reach ports of the RAD-Star. The 10/100 Ethernet links of the RAD-Star are then connected to a laptop PC or similar conventional Ethernet device.

The RAD-Star is now set up as a “middle man” in the connection, managed by a custom-designed XMOS active tap chip. When a message is sent by the ECU to the switch, the RAD-Star receives it and immediately retransmits it over its other BroadR-Reach port so the

message is received by the switch as usual, with only a minor delay for processing. The RAD-Star also sends a copy of the message over conventional Ethernet to the PC so it can be viewed and analyzed using a software tool such as Intrepid's Vehicle Spy. A similar process occurs for messages sent by the Automotive Ethernet switch: they are received by the RAD-Star, forwarded to the ECU, and a copy also sent to the PC.

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

Figure 1 depicts how the RAD-Star functions when inserted into a network as an active tap.

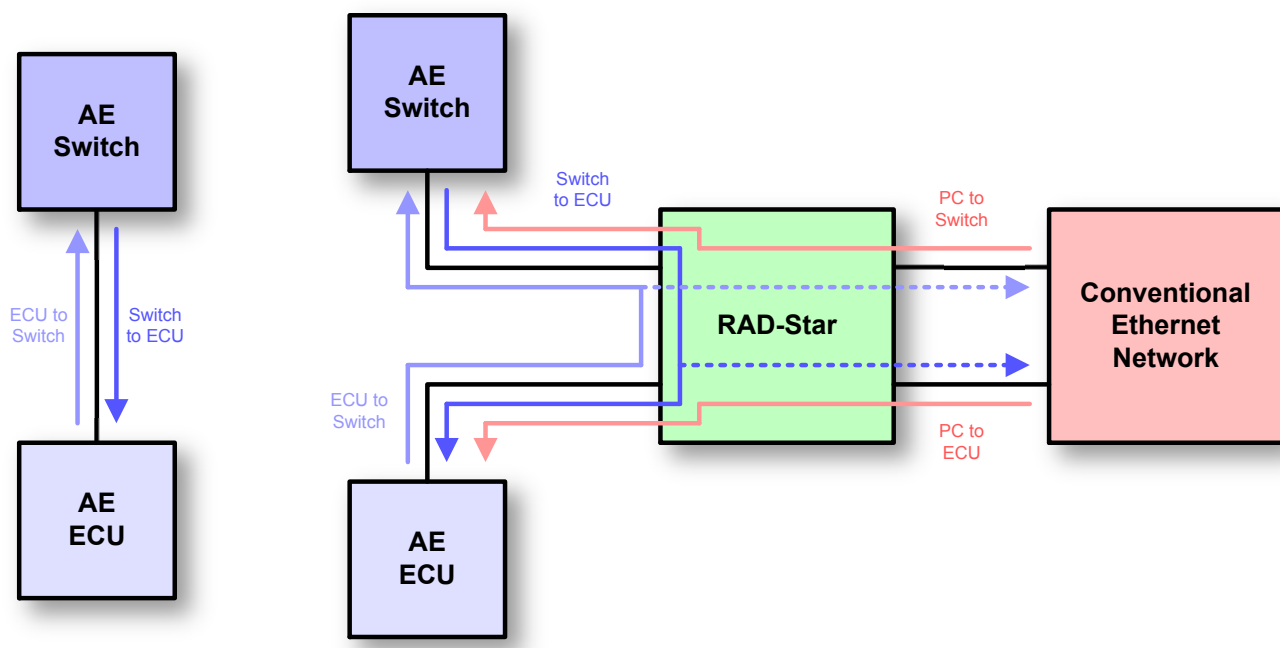


Figure 1: Using the RAD-Star as an Active Tap. On the left, a standard connection between an Automotive Ethernet switch and a single ECU. (Other ECUs connected to the switch are not shown.) On the right, the network that results after inserting the RAD-Star as an active tap. Messages flow from the switch through the RAD-Star to the ECU, and vice-versa, maintaining normal operation of the network. In addition, copies of each message are transmitted by the RAD-Star to the attached conventional Ethernet network. Optionally, messages from a PC or other device on the Ethernet network may also be sent to the switch or ECU.

Operation as a Media Converter

If only one Automotive Ethernet device is connected to the RAD-Star, it will not forward messages received from that device to its other BroadR-Reach port (since the second port will not be connected). However, it will continue to send those messages to the attached conventional Ethernet device, and conversely, will send messages from the conventional Ethernet port to the AE ECU. In this configuration, the RAD-Star is said to be operating as a *media converter*, because it converts messages from the Automotive Ethernet media format to conventional Ethernet and vice-versa. This is depicted in Figure 2.

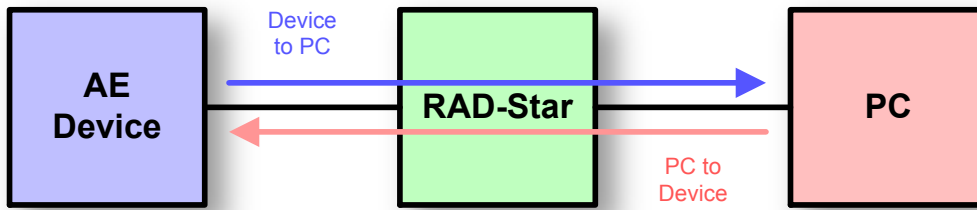


Figure 2: Using the RAD-Star as a Media Converter. Connecting just one Automotive Ethernet device to the RAD-Star creates a simpler network that allows a PC or other standard Ethernet hardware to interact with it.

Timestamping and Frame Wrapping

The RAD-Star records the time that each message is received on one of its BroadR-Reach ports. This hardware-level timestamp is then transmitted in a special *wrapper frame* over its conventional Ethernet links, 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. The wrapper is described further in Section 11.

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's special wrapping mechanism allows it to capture BroadR-Reach frames in their entirety, including the FCS field, and ensures that error frames are preserved so they can be analyzed. (Note, however, that undersized/run frames will not be captured.)

Features

Here are some of the noteworthy features of the RAD-Star:

- Custom XMOS BroadR-Reach active tap
- Support for active tap and media converter operation
- Two SMSC 8710A conventional 10/100 Ethernet PHYs
- Two Broadcom BCM89810 BroadR-Reach (100BASE-T1) PHYs
- Standard RJ-45 jacks for 10/100 Ethernet connections with link and activity LEDs
- Molex Mini50 jacks for Automotive Ethernet connections with combination link/activity LEDs
- DC power input via standard DB-9 CAN connector
- Full-duplex support for simultaneous data transmission and reception across all PHYs
- Compact, portable enclosure
- Fast boot time: forwarding of BroadR-Reach packets on active tap within 120 ms, transmission of tapped packets over standard Ethernet within 2.5 seconds.

Block Diagram

Figure 3 illustrates the main functional elements of the RAD-Star.

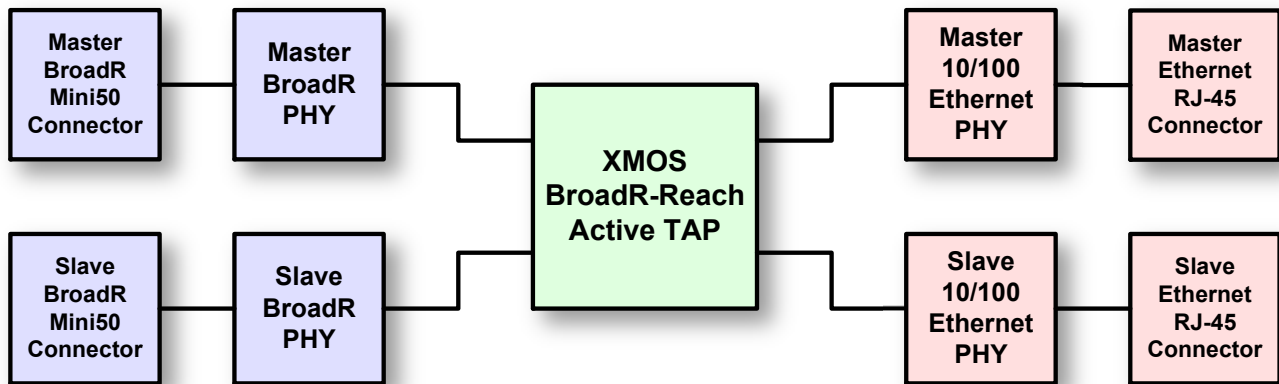


Figure 3: RAD-Star Block Diagram.

4 Description of RAD-Star Interfaces and Indicators

We'll now take a short tour of the RAD-Star, examining the external components of the device and explaining what each does. The RAD-Star is designed so that all of its components are located on its two sides, making the device easier to use in cramped quarters. We'll identify the sides by the type of Ethernet ports each contains, calling one the *Automotive Ethernet Side* and the other the *Conventional Ethernet Side*.

Automotive Ethernet Side


This panel of the RAD-Star (Figure 4) contains a pair of Molex Mini50 jacks. While there is no standardized Automotive Ethernet connector type, the Mini50 is used by many BroadR-Reach / 100BASE-T1 devices, including Broadcom switches and other Intrepid AE hardware.

BroadR-Reach requires that each link have one device serve as the *master*, while the other acts as the *slave*. The two RAD-Star connectors are labeled to illustrate how they are internally configured:

- **BR MSTR:** This port is set as a master device, and is intended to connect to an ECU or switch port configured as a slave.
- **BR SLAVE:** This port acts as a slave device and should be linked to a master ECU or switch port.



Figure 4: RAD-Star Automotive Ethernet Side. The Mini50 BroadR-Reach connector on the left is internally configured as a master device, while the one on the right is configured as slave. Each has a combination link/activity LED.

 **Note:** One of the ways that BroadR-Reach delivers high performance is by coordinating the operation of the two devices on a link: the master device generates a clock signal, while the slave device synchronizes its clock to that of the master. Aside from this low-level timing functionality, there is no difference between the master and the slave on a link. Note in particular that, despite the names used, the master device does not control when or how the slave device transmits; they operate independently.

Each port has a single LED that indicates the status of that port's link as follows:

- **LED Dark:** No link has been established to the port.
- **LED Continually Lit:** Link established to another BroadR-Reach device.
- **LED Flashing:** Link is established and active; flashing rate indicates the level of traffic activity for the port.

During normal operation as an active tap you will see both LEDs lit, and they will flash intermittently or frequently depending on how active the link is. When using the RAD-Star as a media converter, only the LED to which a BroadR-Reach cable is attached will illuminate.

Conventional Ethernet Side

Figure 5 shows the side of the RAD-Star intended to attach to a conventional Ethernet network. The components seen here are the following:

- **RJ-45 Ports:** Two industry-standard conventional Ethernet jacks with indicator LEDs.
- **CAN+PWR Port:** A male DB-9 connector to provide power to the RAD-Star.



Figure 5: RAD-Star Conventional Ethernet Side. The standard Ethernet RJ-45 jacks on this side of the RAD-Star correspond to their equivalently-named jacks on the Automotive Ethernet side. Each has a link LED (above and left of the port) and activity LED (above right). The *CAN+PWR* port provides power to the device using an industry-standard DB-9 CAN connector.

There is no need to configure standard Ethernet ports as master or slave. The labels on the jacks here are instead used to match up the conventional Ethernet ports with their Automotive Ethernet equivalents, as follows:

- **SLAVE:** Carries copies of messages transmitted by the AE device connected to the RAD-Star's *BR SLAVE* port, as well as messages from an attached PC intended for that device.
- **MASTER:** Carries messages coming from the device on the *BR MSTR* port, or going to that device.

Each RJ-45 has a pair of integrated LEDs that provide information about it:

- **Link LED (Above Left):** Indicates that a valid link has been established between the RAD-Star and the conventional Ethernet network.
- **Activity LED (Above Right):** Flashes when traffic passes in either direction over the attached Ethernet cable.

When the RAD-Star is used as an active tap, both ports will have their link LEDs on, and their activity LEDs will flash at a rate proportional to the amount of data being transferred. Using the RAD-Star as a media converter will result in the LEDs being lit on the port with the attached cable, while those on the other port will remain dark.

5 Hardware and Software Requirements

You will need a small amount of support hardware to effectively use the RAD-Star, with the exact equipment requirements depending on the intended application. Note that cabling requirements are described in more detail in the section following this one.

Requirements to Use the RAD-Star as an Active Tap

To use the RAD-Star as an active tap you will need the following equipment:

- One Automotive Ethernet ECU and a free AE switch port, or two ECUs.
- A conventional Ethernet switch with at least two open ports, which should be Gigabit Ethernet capable (see below).
- A PC with a free Ethernet port, preferably Gigabit Ethernet, capable of running analysis software.
- An additional conventional Ethernet cable to connect the Ethernet switch and PC.
- A DB-9 / CAN power cable for the RAD-Star.
- Two BroadR-Reach cables with the correct termination for the Automotive Ethernet devices being tested.

We recommend licensing Intrepid's Vehicle Spy software for the analysis PC. Vehicle Spy is a "Swiss army knife" of vehicle analysis and testing tools, and the RAD-Star was specifically designed to work with it. Please contact Intrepid Control Systems for more information on Vehicle Spy.

Note that the conventional Ethernet switch is necessary for active tap operation because of the RAD-Star's two conventional Ethernet connections. If you are tapping links sending data at high speed, the aggregate throughput of the two Ethernet links may exceed 100 Mb/s, and for this reason we recommend that both the switch and PC Ethernet port support Gigabit Ethernet. For lower-speed applications, slower 100 Mb/s (10/100) hardware may suffice.

You can also use an older Ethernet hub instead of the switch, but this is recommended only for very-low-speed uses.

Requirements to Use the RAD-Star as a Media Converter

If you are using the RAD-Star as a media converter, the following changes apply to the list above:

- Only one Automotive Ethernet device is needed, rather than two.
- Only one BroadR-Reach cable is required, with the correct termination for the ECU being tested.
- No conventional Ethernet switch is necessary, nor an extra standard Ethernet cable.
- There is no need for a Gigabit Ethernet port (10/100 will suffice).

6 Cables and Connectors

The cables and connectors used in automotive networks vary among applications and test benches. Intrepid designed the RAD-Star to work with configurations that are commonly available in the industry, but depending on your setup, it may be necessary to modify the included cables or create new ones.

BroadR-Reach Cables

BroadR-Reach does not specify an industry-standard cable and connector type. However, the Molex Mini50 is used by many BroadR-Reach devices, including Broadcom switches and other Automotive Ethernet hardware made by Intrepid.

The RAD-Star ships with a pair of BroadR-Reach cables terminated in Mini50 plugs. One end of each cable is intended to be attached to the RAD-Star, while the other end can be connected to ECUs or switch ports that have Mini50 jacks.

If your AE hardware does not use Mini50, please snip off the Mini50 plugs on one end of each of the supplied cables. Then simply attach the appropriate plug for the connector type used in your application, or directly connect the bare wires to the devices you want to work with.

The pinout for the RAD-Star's Mini50 jacks can be found in Table 1, with the pin numbers illustrated in Figure 6. Note that this information is also printed on the bottom of the device.

Pin #	Label	Description
1	No Connect	
2	TRD+	Data transmit and receive, positive
3	TRD-	Data transmit and receive, negative
4	No Connect	

Table 1: RAD-Star BroadR-Reach Mini50 Jack Pinout.

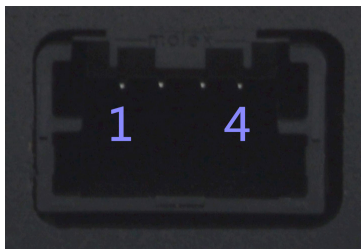


Figure 6: RAD-Star BroadR-Reach Mini50 Jack. Pins are numbered 1 to 4 from left to right looking at the jack, as shown.

Power Cable

The RAD-Star is powered through its DB-9 port (also called a DE-9), which is the standard connector used in the automotive industry for the CAN bus. Most automotive test benches should already have power supply cables using the matching DB-9 female connector. The

RAD-Star operates at a nominal 12V and requires 300 mA of current at that voltage level, but will accept equivalent power input at a range of 4.5V to 36V.

If your test bench does not have a suitable cable to power the RAD-Star, you can make one from a female DB-9 connector and appropriate wiring; the pinout can be found in Table 2, with pin numbers shown in Figure 7. Note that the LIN and CAN interfaces are for internal use by Intrepid; the only end-user function of this cable is to supply DC power, so you only need to connect pin 9 and one of the ground pins.

Pin #	Label	Description
1	LIN	LIN interface (Intrepid use only)
2	HS CAN L	High-speed CAN low (Intrepid use only)
3	GND	Ground
4	No Connect	
5	GND	Ground
6	GND	Ground
7	HS CAN H	High-speed CAN high (Intrepid use only)
8	No Connect	
9	V BATT	DC voltage input

Table 2: RAD-Star CAN+PWR DB-9 Jack Pinout.

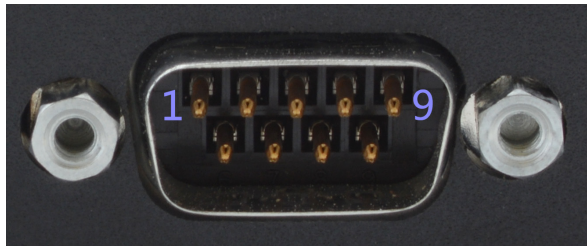


Figure 7: RAD-Star CAN+PWR DB-9 Jack. Pins are numbered 1 to 9 from left to right as shown.

7 Hardware Setup - Active Tap

In this section we explain the process of setting up the RAD-Star step by step. Note that while the directions are listed in a particular order, the exact sequence in which the setup is performed does not affect operation.

The instructions that follow assume that any necessary cables have already been fabricated or modified as described in the previous section.

Figure 8 shows you at a glance how to set up the cables to use the RAD-Star as an active tap.

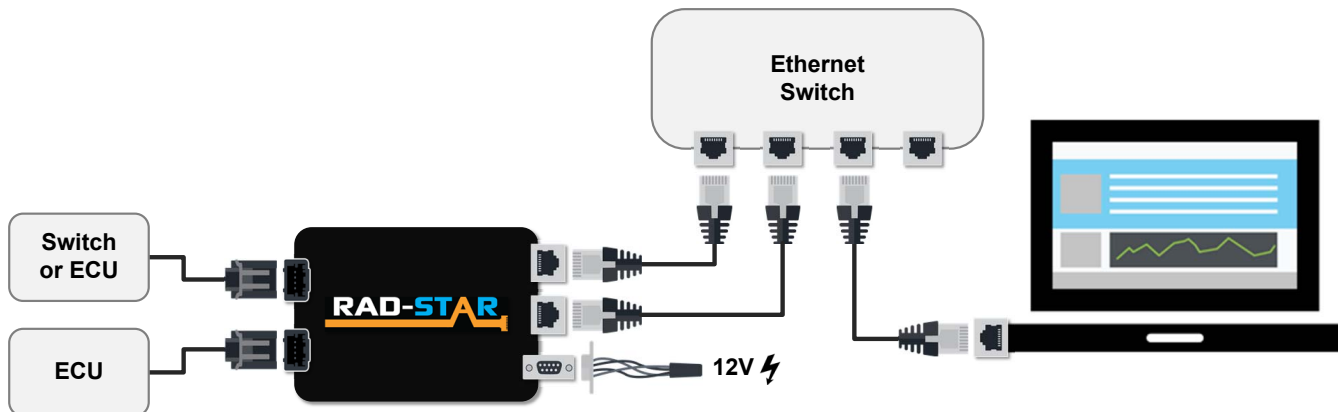


Figure 8: RAD-Star Active Tap Hookup Diagram.

Please follow these steps to complete the necessary connections:

1. **Connect BroadR-Reach Cables to RAD-Star:** Attach the Mini50 connectors on each of the two BroadR-Reach cables to the *BR MSTR* and *BR SLAVE* jacks on the RAD-Star (Figure 9). You should hear an audible click as each plug is seated.



Figure 9: Connecting BroadR-Reach Cables to the RAD-Star.

2. **Connect BroadR-Reach Cables to ECU/Switch Ports:** If you are testing a link between an ECU and switch, attach the other ends of the BroadR-Reach cables to the ECU and switch ports of that link. If testing a link between two ECUs, attach the cables to those ECUs.

When connecting your Automotive Ethernet devices, attach the ECU or switch port configured internally as a master to the *BR SLAVE* port of the RAD-Star, and the device configured as slave to the *BR MSTR* port. Note that some AE devices can operate as master or slave and can thus be connected to either port.

✓ **Note:** If you are unsure which device on a link is the master and which is the slave, just choose either device to connect to *BR SLAVE* and the other to *BR MSTR*. If you guessed incorrectly, the RAD-Star will not function, but you can simply swap the two connectors—you can't damage an ECU or the RAD-Star by connecting two master or two slave devices to each other.

3. **Connect Ethernet Cables to RAD-Star:** Connect one end of each of the supplied conventional Ethernet cables to the *SLAVE* and *MASTER* ports on the RAD-Star (Figure 10). You will again hear a click as the jacks are attached.



Figure 10: Connecting Ethernet Cables to the RAD-Star.

4. **Connect Ethernet Cable to PC:** Connect a third Ethernet cable to the PC that you wish to use to monitor traffic coming from the RAD-Star (Figure 11).



Figure 11: Connecting the Ethernet Cable to a PC.

5. **Connect Ethernet Cables to Ethernet Switch:** Insert the other ends of the cables you just connected to the RAD-Star and PC into open jacks in your Ethernet switch (or hub). (For most devices, the exact choice of ports on the switch/hub does not matter.)

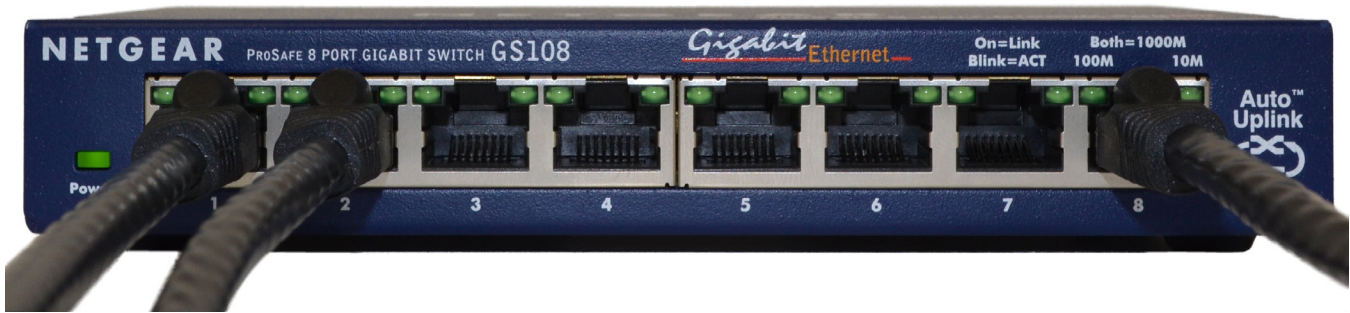


Figure 12: Connecting Ethernet Cables to the Ethernet Switch.

6. **Connect Power Supply to RAD-Star:** Attach the cable coming from your DC power supply to the RAD-Star as shown in Figure 13. Assuming that the power supply is turned on, you should see the link LEDs light up for the RAD-Star's two Ethernet connections.



Figure 13: Connecting Power Cable to the RAD-Star.

Your RAD-Star is now ready to be used as an active tap; Figure 14 shows a complete sample configuration. If you experience any issues setting up the hardware, please refer to the enclosed troubleshooting and support information.

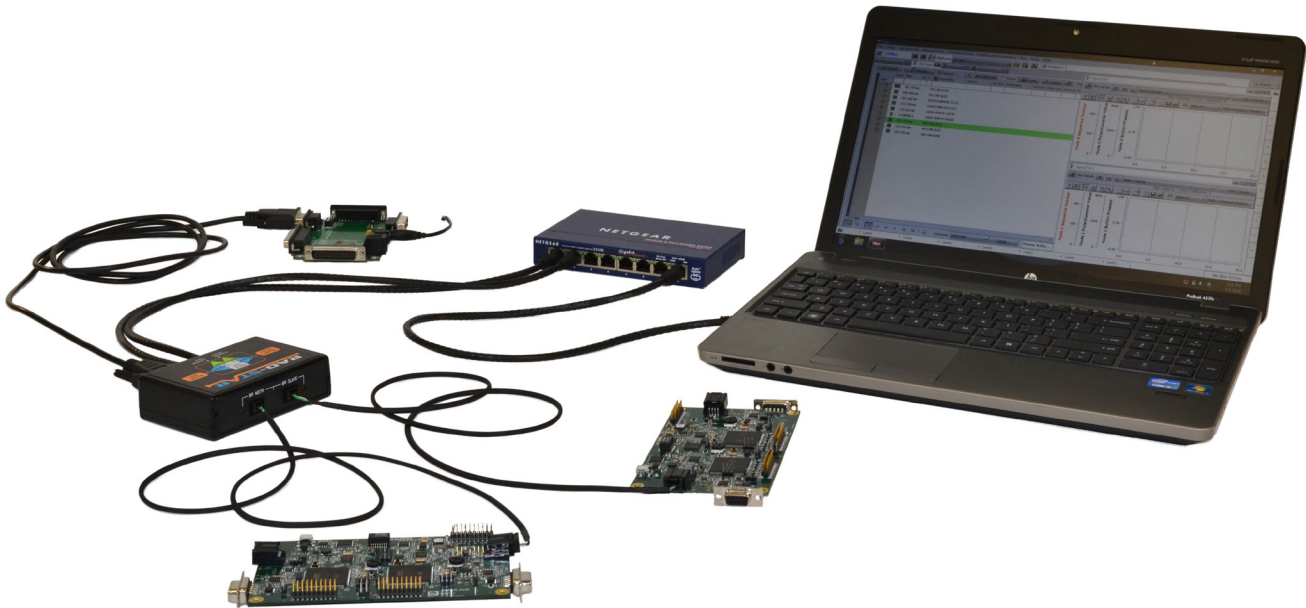


Figure 14: RAD-Star Configured for Active Tap Operation. We have used two Intrepid Ethernet Experimentation and Evaluation Boards (EEVBs) as example ECUs here, for the purpose of illustration; these can be seen in the foreground, attached to the RAD-Star. The component in the background on the left acts as a power supply.

8 Hardware Setup - Media Converter

Configuring the RAD-Star as a media converter involves the same basic process outlined in the active tap description above, but the omission of the Ethernet switch makes this setup considerably simpler. As before, you can make the connections in any order, and we assume that you have already made or modified any necessary cables per the directions in Section 6.

The hookup diagram to use the RAD-Star as a media converter can be found in Figure 15. The “ghosted” connections reflect the fact that the ECU and PC can be connected to either the *MASTER / BR MSTR* pair of ports, or the *SLAVE / BR SLAVE* pair.

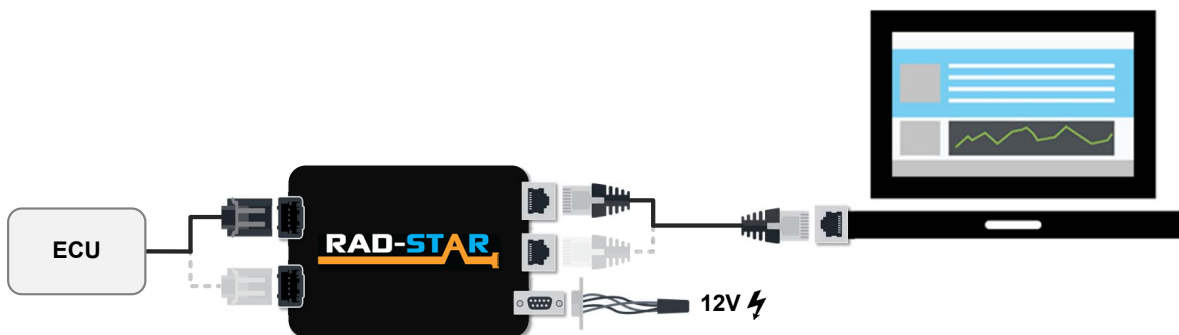


Figure 15: RAD-Star Media Converter Hookup Diagram.

Please complete these steps to use the RAD-Star as a media converter:

1. **Connect BroadR-Reach Cable to RAD-Star:** Attach the Mini50 connector on a BroadR-Reach cable to the *BR MSTR* port if your ECU is configured as a slave device, or *BR SLAVE* if it is configured as a master; Figure 16 shows an example of the former. Note that some devices can operate as master or slave, so you can use either port. You should hear a click when the plug snaps into place.



Figure 16: Connecting a BroadR-Reach Cable to the RAD-Star BR MSTR Port.



Note: If you are unsure of whether the ECU is a master or slave, just choose either *BR SLAVE* or *BR MSTR*. If the RAD-Star doesn't work, you'll know you chose incorrectly; the hardware will not be damaged, and you can simply swap to the other port. If you change which BroadR-Reach port you use, remember to also change the Ethernet port you connect to as well.

2. **Connect BroadR-Reach Cable to ECU:** Attach the other end of the BroadR-Reach cable to the ECU.
3. **Connect Ethernet Cable to RAD-Star:** If you used the *BR MSTR* port in Step 1, connect one end of a standard Ethernet cable to the RAD-Star's *MASTER* conventional Ethernet port. If you used the *BR SLAVE* port in Step 1, instead connect it to the RAD-Star's *SLAVE* Ethernet port. Figure 17 shows the *MASTER* port being used.



Figure 17: Connecting an Ethernet Cable to the RAD-Star. The port chosen must match that chosen for the BroadR-Reach cable. Here we are attaching to the *MASTER* Ethernet port because we used the *BR MSTR* port in Figure 16.

4. **Connect Ethernet Cable to PC:** Connect the other end of the Ethernet cable to the Ethernet port on your PC (as shown earlier in Figure 11).
5. **Connect Power Supply to RAD-Star:** Attach the cable coming from your DC power supply to the RAD-Star. If the power supply is on, the link LED for the connected Ethernet port should now illuminate.

You're done; the RAD-Star can now be used as a media converter (Figure 18 shows a typical configuration). Please refer to the troubleshooting and support information that follows if you encounter any problems with the setup.

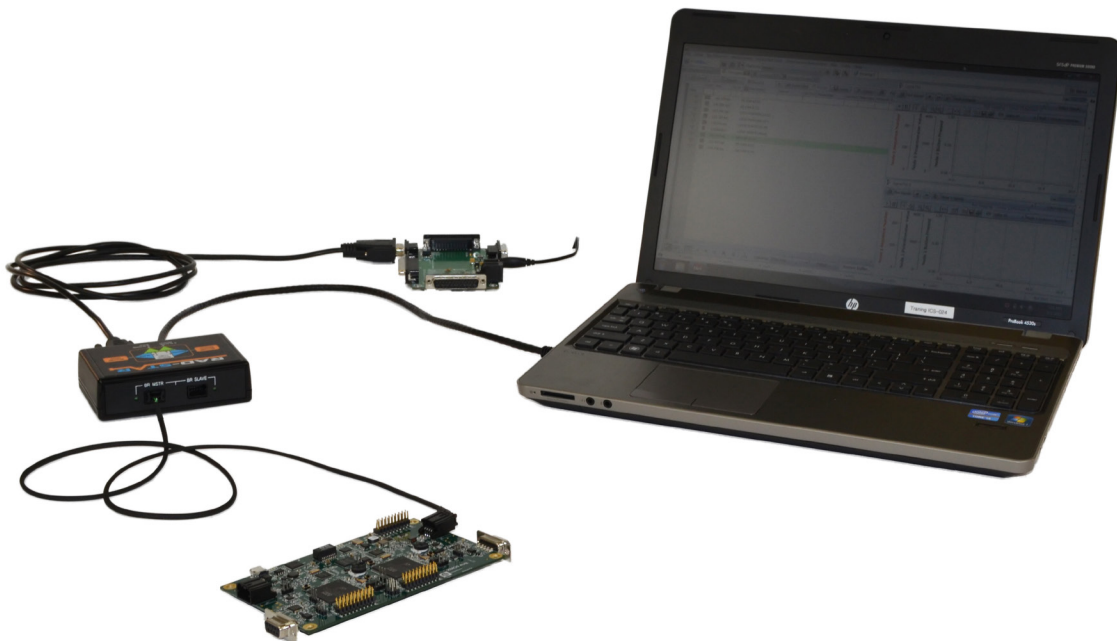


Figure 18: RAD-Star Configured as a Media Converter. This setup uses the *BR MSTR* and *MASTER* ports as described in the connection steps. We have again used an Intrepid Ethernet EVB as an example ECU.

9 Troubleshooting

All Intrepid products, including the RAD-Star, have been designed, manufactured and tested to provide you with years of trouble-free service. However, as with any complex engineered device, problems can occasionally arise, either with the product itself, or with the process of setting up and using it.

If you're experiencing difficulties with your RAD-Star, please try some of the troubleshooting ideas in this section. You may be able to save time by solving the problem yourself!



Note: These troubleshooting instructions are best attempted in the order listed. In particular, make sure the appropriate link LEDs are lit—indicating proper BroadR-Reach or Ethernet links are established—before attempting to diagnose any data transmission issues.

No LEDs Illuminated

This may happen if the RAD-Star has not been connected to any other devices. Check that at least one of its Ethernet ports has been correctly connected to either type of Ethernet device (BroadR-Reach or conventional) and that the device is powered on and operating.

If the RAD-Star is connected to a powered device and still has no LEDs lit, this usually means that the RAD-Star itself is not receiving power. Try the following:

- Check the power connections on the RAD-Star and the power supply.
- Remove and then reconnect the power cable.
- Ensure that the power supply is turned on.
- Try connecting the power supply to a different device.
- Check the voltage setting on the power supply, if applicable.
- Try a different cable, if possible.

If the power supply and cable work with a different device but not the RAD-Star, this suggests a possible hardware fault. Please contact Intrepid for further assistance.

Conventional Ethernet Link LED(s) not Illuminated

The RAD-Star has not established a link to the conventional Ethernet device(s) to which it has been connected. Here are a few things that may help:

- Double-check the Ethernet connections on the RAD-Star and Ethernet device(s).

- Ensure that the Ethernet port on the device is enabled and active.
- Remove and reconnect the Ethernet cable.
- Try a different Ethernet port, if possible.
- Try a different Ethernet cable.
- If a switch or hub is being used, check that it is powered on and correctly configured.
- Disable and then enable the PC Ethernet port, or other conventional Ethernet device, to which the Ethernet cable is attached.

In the unusual case that a supplied Ethernet cable is defective, Intrepid will replace it.

Automotive Ethernet Link LED(s) not Illuminated

The RAD-Star is not linked correctly to its attached BroadR-Reach device(s). Since BroadR-Reach devices and cables vary, this issue may be application-dependent, but please try the following:

- Ensure that a connection from the RAD-Star's *BR MSTR* port goes to an ECU or BroadR-Reach switch port configured as a slave device; similarly, any connection from the *BR SLAVE* port should go to an ECU or switch port configured as a master. If you are unsure, try switching the connections.
- Double-check the connections at both ends of the cable(s).
- Remove the cable from the RAD-Star and reconnect it.
- Check for a loose connection at the Automotive Ethernet device.
- Try a different cable, if possible.



Note: If you are using the RAD-Star as a media converter and switch the BroadR-Reach connection from *BR MSTR* to *BR SLAVE*, or vice-versa, be sure to make the corresponding change to which RAD-Star conventional Ethernet port is attached (*MASTER* to *SLAVE* or vice-versa).

Only One Automotive Ethernet Link LED Illuminated After Swapping Devices

Normally either both link LEDs will light up (correct master/slave configuration) or neither will (incorrect configuration). If only one link LED illuminates, try swapping the devices again:

- If the illuminated link LED changes after swapping devices, the problem is with the device connected to the RAD-Star BroadR-Reach port that is not illuminated.

- If the illuminated link LED does not change after swapping devices, then it is likely that both devices are configured as master or both are set as slaves.

The latter of these two possibilities is atypical; in particular, it should not be possible if the two devices connected to the RAD-Star were originally connected to each other. However, this could happen if two independent ECUs are connected to the RAD-Star's BroadR-Reach ports.

Data Sent by Automotive Ethernet Device(s) Not Received by PC

Check the link/activity LEDs for the BroadR-Reach ports on the RAD-Star. If they are lit solid and not flashing, data is not being received by the RAD-Star. Double-check the attached device(s) to ensure that transmissions are indeed occurring and that the BroadR-Reach cable is functional.

If the link/activity LEDs light up, this means the RAD-Star is receiving data from the BroadR-Reach device. Check the activity LED of the associated conventional Ethernet port (*MASTER* for *BR MSTR*, *SLAVE* for *BR SLAVE*) to see if the RAD-Star is retransmitting copies of the received frames correctly. If the *MASTER* or *SLAVE* conventional Ethernet LED is not flashing, then there is a problem with the link to your PC or Ethernet switch. Try a different cable, switch or Ethernet port.

If the attached devices and cables seem to be correct, the issue may be with the RAD-Star itself; please contact Intrepid for assistance.

Data Sent by PC Not Received by Automotive Ethernet Device(s)

Start by checking the activity LEDs of the PC Ethernet port, the RAD-Star conventional Ethernet port(s), and the switch ports used by all Ethernet cables connected to the Ethernet switch (if used). All of these should flicker as data is transmitted. If any are not flashing:

- Check the relevant cables and cable connections.
- Try different Ethernet cables.
- Try different ports on the Ethernet switch.
- Try a different Ethernet switch.

If any of these fix the problem, you likely have a issue with a cable or other hardware.

If the conventional Ethernet activity LEDs on the RAD-Star are flashing, check to see if their matching BroadR-Reach link/activity LEDs are also flashing: *BR MSTR* if the *MASTER* port is being used, and *BR SLAVE* if the *SLAVE* port is active. If these LEDs aren't flashing, there is a problem with the link to the Automotive Ethernet devices:

- Check the cabling going to the BroadR-Reach devices.
- Ensure that the devices are correctly configured to receive transmissions.

- Verify that the software sending the transmissions on the PC is using the correct hardware address for the device in question. If you are using a switch and enter the wrong address, the switch will not forward the frame, and you will see no activity.

If you are unable to resolve the issue, please contact Intrepid using the information below.

Difficulty Removing BroadR-Reach Cable from Mini50 Jack

Mini50 connectors can be troublesome to use for those not familiar with them. Be sure to press all the way down on the small tab in the middle of the cable connector before attempting to pull it out of the jack. Do not pull the plug out by the wires or you may damage the cable.

10 Support

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

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

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.

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

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

Korea Office

In Korea, use the following contact information:

- **Phone:** +82 31 782 1805.
- **Fax:** +82 31 782 1808.
- **Email:** jchung@intrepidcs.com

China Office

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

- **Phone:** 021-51330254.
- **Fax:** 021-51330271.
- **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

11 Reference: Frame Wrapping and Wrapper Format

In the overview (Section 3) we mentioned that the RAD-Star encloses each message received on its BroadR-Reach ports in a special wrapper frame before it is retransmitted to the conventional Ethernet network. The wrapper allows additional timestamp information to be sent with the message, enables the FCS field of the original frame to be captured, and ensures that error frames are not discarded.

In this section we provide more details on the wrapper and its exact format for those who want to know more about the inner workings of the RAD-Star.

Wrapping Process

The RAD-Star does the following with each frame received on its BroadR-Reach ports:

1. It records the time that the frame was received.
2. It computes a 10-byte RAD-Star header that includes the timestamp and control information.
3. It places the original frame into a buffer, including its header and footer.
4. It constructs a new wrapper frame consisting of the wrapper's Ethernet header, followed by the RAD-Star header, the original frame, and the wrapper's Ethernet footer.

Figure 19 shows graphically the overall format of a wrapped frame.

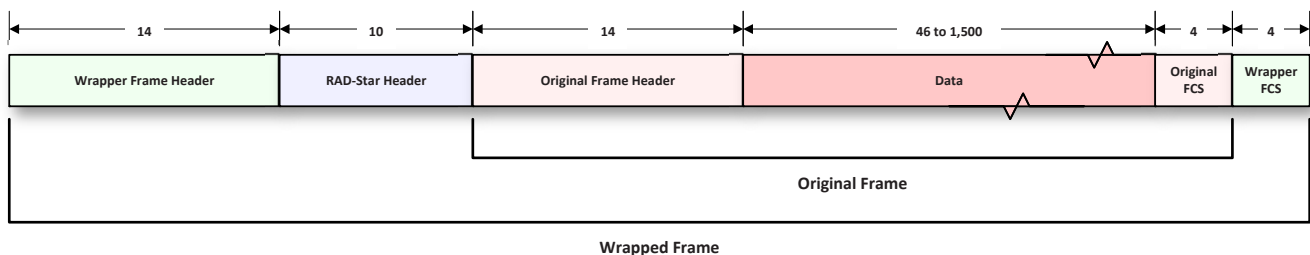


Figure 19: Overall Wrapped Frame Format. The wrapped frame consists of a wrapper header and footer encapsulating the original frame (including its header and footer) prefixed by the special RAD-Star header.

Splitting and Reassembly of Long Frames

The addition of the wrapper frame header, wrapper frame footer and RAD-Star header mean that a wrapped frame is 28 bytes larger than the original. If a frame is received by the RAD-Star that is close to the maximum size allowed on an Ethernet link, the wrapped frame would become too large to transmit.



Note: Jumbo frames (those with lengths exceeding the usual limits) are not supported by the RAD-Star.

The RAD-Star will encapsulate incoming messages in a single wrapped frame if they are up to 1,498 bytes in length. If the incoming message is longer, it is split into two pieces: the first carries the first 760 bytes of the original message (including its header) and the second carries the remaining bytes (including its footer). The receiving device reassembles the original frame, guided by values in special fields in the RAD-Star header.

Wrapper Header and RAD-Star Header Formats

The formats of the wrapper header and RAD-Star header are illustrated in Figure 20.

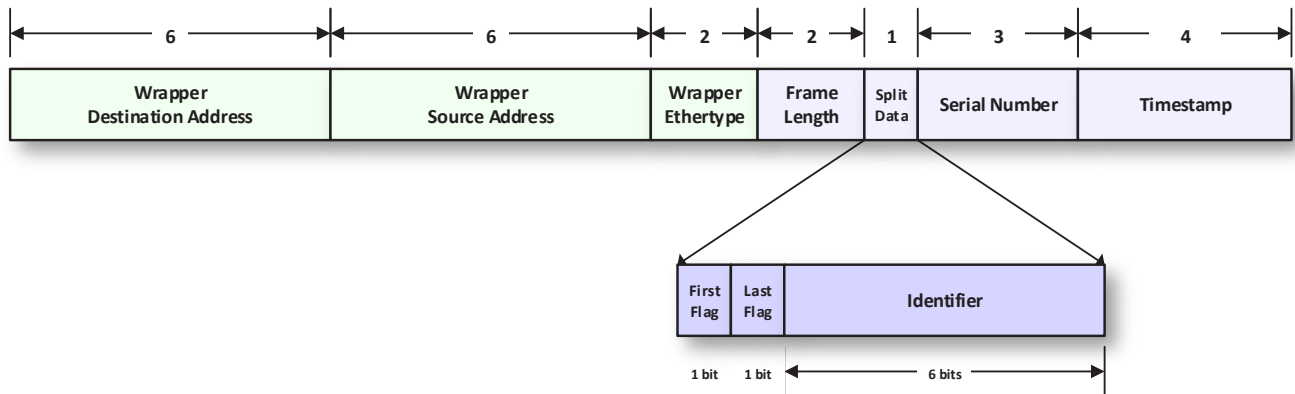


Figure 20: Wrapper Header / RAD-Star Header Format.

The wrapper header has the standard three header fields found in all Ethernet frames, which are assigned the following values:

- **Wrapper Destination Address (6 Bytes):** Always set to the Ethernet broadcast MAC address, FF:FF:FF:FF:FF:FF.
- **Wrapper Source Address (6 Bytes):** Set to the *Source Address* of the original frame.
- **Wrapper Ethertype (2 Bytes):** Set to *0xBEEF*, a special value that indicates to software such as Vehicle Spy that the message is a wrapped frame.

Here are the fields in the RAD-Star header and how their values are used:

- **Frame Length (2 Bytes):** Carries the length of the original frame.
- **Split Data (1 Byte):** Special information used to control splitting and reassembling large frames, when necessary, as described above. This field has three subfields:
 - **First Flag:** Set to 1 for the first (or only) part of a complete message; 0 otherwise.
 - **Last Flag:** Set to 1 for the last (or only) part of a complete message; 0 otherwise.
 - **Identifier:** A number generated by the RAD-Star and placed in both pieces of a split frame to aid in reassembly by the receiving device.
- **Serial Number:** Carries the serial number of the RAD-Star that generated the frame.
- **Timestamp:** The hardware timestamp generated by the RAD-Star when the original frame was received.

The *First Flag* and *Last Flag* fields are interpreted by the receiving device as follows:

- **First Flag = 1 / Last Flag = 0:** First piece of a split message.
- **First Flag = 0 / Last Flag = 1:** Second piece of a split message.
- **First Flag = 1 / Last Flag = 1:** Complete, unsplit message.