RELAY7 User Manual

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Warranty

NovAtel® Inc. warrants that its GNSS products are free from defects in materials and workmanship, subject to the conditions set forth on our web site: www.novatel.com/products/warranty.

RELAY7 Module One (1) Year
Cables and Accessories Ninety (90) Days

Return Instructions

To return products, refer to the instructions found at: www.novatel.com/warranty-return.

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RELAY7 Notices

The following notices apply to the RELAY7 device.

Changes or modifications to this equipment, not expressly approved by NovAtel Inc., could void the user’s authority to operate this equipment.

FCC

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

RELAY7 has been tested and found to comply with the radiated and conducted emission limits for a Class B digital device. The Class B limits are designed to provide reasonable protection against harmful interference in a residential installation.

The equipment listed generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the RELAY7
- Increase the separation between the equipment and the RELAY7
- Connect the equipment to an outlet on a circuit different from that to which the RELAY7 is connected
- Consult the dealer or an experienced radio/TV technician for help

Innovation, Science and Economic Development (ISED) Canada

RELAY7 Class B digital device complies with Canadian ICES-003.

RELAY7 appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

European Union (EU)

NovAtel Inc. declares that the RELAY7 is in compliance with Directive 2014/53/EU (Radio Equipment).

The full text of the EU Declaration of Conformity may be obtained from the NovAtel web site at:

www.novatel.com/products/compliance/eu-declaration-of-conformity

Radio Information

Description of Service: 400 MHz receiver or 900 MHz receiver

Operational Frequency: 403-470 MHz UHF Licensed band or 902-928 MHz UHF Unlicensed band

WEEE Notice

If you purchased your RELAY7 product in Europe, please return it to your dealer or supplier at the end of its life. The objectives of the European Community’s environment policy are, in particular, to preserve, protect and improve the quality of the environment, protect human health and utilise natural resources prudently and rationally. Sustainable development advocates the reduction of wasteful consumption of natural resources and the prevention of pollution. Waste electrical and electronic equipment (WEEE) is a regulated area. Where the
generation of waste cannot be avoided, it should be reused or recovered for its material or energy. WEEE products may be recognized by their wheeled bin label (\includegraphics{waste-bin-label}). See [www.novatel.com/products/compliance/environmental-compliance](http://www.novatel.com/products/compliance/environmental-compliance) for more information.

**RoHS**


**REACH**


**Ethernet Port**

![Warning]
The Ethernet port is a safety extra-low voltage (SELV) circuit only and is suitable for connection to another SELV circuit. Do not connect to Telecommunications Network Voltage (TNV) circuits.
RELAY7 Notices

RELAY7 International Type Approval

Australia and New Zealand

Eurasian Economic Community
Amenia, Belarus, Kazakhstan, Kyrgyzstan and Russia

Moldova

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Customer Support

NovAtel Knowledge Base

If you have a technical issue, visit the NovAtel Support page at www.novatel.com/support. Through the Support page, you can contact Customer Support, find papers and tutorials or download current manuals and the latest firmware.

Before Contacting Customer Support

Ensure the RELAY7 is connected to the SMART7.

Before contacting NovAtel Customer Support about a software problem, perform the following steps:

1. Log the following data to a file on your computer for 15 minutes:
   - LOG RXSTATUSB onchanged
   - LOG ALMANACB onchanged
   - LOG RAWEPHEMB onchanged
   - LOG GLORAWEPHEMB onchanged
   - LOG TRACKSTATB ontime 1
   - LOG SATVIS2B ontime 60
   - LOG BESTPOSB ontime 1
   - LOG RANGEB ontime 1
   - LOG RXCONFIGA once
   - LOG ITDETECTSTATUSB onchanged
   - LOG VERSIONA once
   - LOG SATELSTATUSB onchanged
   - LOG INTERFACEMODEB onchanged
   - LOG SERIALCONFIGB onchanged
   - LOG PORTSTATSB ontime 10

   For issues with tracking L-Band or TerraStar (PPP) convergence, add the following logs to the above list in the file created on your computer:
   - LOG IONUTCB onchanged
   - LOG GLOCLOCKB onchanged
   - LOG PPPPOSB ontime 1
   - LOG PPPSATSB ontime 1
   - LOG LBANDTRACKSTATB ontime 1
   - LOG TERRASTARINFOA onchanged
   - LOG TERRASTARSTATUSA onchanged
   - LOG LBANDBEAMTABLEA onchanged

2. Send the data file to NovAtel Customer Support: support@novatel.com

3. You can also issue a FRESET command to the receiver to clear any unknown settings.
The **FRESET** command will erase all user settings. You should know your configuration (by requesting the RXCONFIGA log) and be able to reconfigure the receiver before you send the **FRESET** command.

If you are having a hardware problem, send a list of the troubleshooting steps taken and the results.

**Contact Information**

Log a support request with NovAtel Customer Support using one of the following methods:

- **Log a Case and Search Knowledge:**
  - Website: [www.novatel.com/support](http://www.novatel.com/support)

- **Log a Case, Search Knowledge and View Your Case History:** (login access required)
  - Web Portal: [https://novatelsupport.force.com/community/login](https://novatelsupport.force.com/community/login)

- **E-mail:**
  - support@novatel.com

- **Telephone:**
  - U.S. and Canada:  1-800-NOVATEL (1-800-668-2835)
  - International:  +1-403-295-4900
Chapter 1  RELAY7 Overview

The RELAY7 is an RTK rover radio module for NovAtel's SMART7 antennas. The RELAY7 module attaches to the SMART7 to create a single unit for easy system integration. The RELAY7 provides the SMART7 with radio connectivity to support RTK corrections.

When the RELAY7 and SMART7 are connected, the optional SMART7 interface cable can be connected to the RELAY7 to deliver pass-through power, RS-232 ports, CAN Bus and ground speed output from the SMART7. Refer to SMART Antenna Interface Cable (Optional Accessory) on page 39 for cable details.

The SMART7 COM3 RS-232 port is not available when the RELAY7 is connected.

1.1 Features

The main features of the RELAY7 are:

- Satel UHF 400 MHz or 900 MHz radio receiver options to support RTK corrections
- SMART7/RELAY7 combination can be mounted to a vehicle using integrated magnets
- Water and dust tight enclosure
- Integrated NMO radio antenna mount
- Compatible with many RTK Radio Protocols

Figure 1: RELAY7 Back Interface

The TNC to NMO cable is installed in the factory. It can be removed to install an optional external antenna. Refer to Connect the RELAY7 to the Radio Antenna Mount on page 19 for information about disconnecting or reconnecting the TNC to NMO cable.

Do not cover the RELAY7 pressure vent. The pressure vent must be allowed to breathe ensure proper RELAY7 operation.
Chapter 1  RELAY7 Overview

Figure 2: RELAY7 Back and Front View

Back of RELAY7 for connecting RTK Radio antenna

Front of RELAY7 for connecting to SMART7

Refer to RELAY7 Connector Overview below for information on the Ampseal interface connector.

Refer to RELAY7 LED on the next page for LED Status information.

1.2 Available Hardware Models

- RELAY7-400
- RELAY7-900

1.3 RELAY7 Related Documents and Information

After the RELAY7 is set up, the Agriculture Commands and Logs Reference Manual becomes the primary source for command and log information. Also refer to the SMART7 Installation and Operation User Manual for SMART7 functionality.

Refer to our website docs.novatel.com/OEM7 for the latest OEM7 documentation.

This manual does not cover service and repair. Contact a local NovAtel dealer for service or repair inquiries (refer to Customer Support on page 10 for contact details).

1.4 RELAY7 Connector Overview

The RELAY7 uses the same cable for power and communication as the SMART7. Use the Ampseal connector at the front of RELAY7 to connect to the SMART7. Refer to Table 10: RELAY7 Connector Pin Outs on page 37 for cable pin outs.

Figure 3: RELAY7 Interface Connector
1.4.1 RELAY7 RTK Radio Mount

The RELAY7 internal 400 MHz or 900 MHz radio can be used to receive RTK corrections from a compatible base station. An external antenna must be connected to the back of the RELAY7.

Refer to Connect the RELAY7 to the Radio Antenna Mount on page 19 for connection instructions.

1.5 RELAY7 LED

The RELAY7 has a single LED to indicate the radio status. The LED is located above the radio icon (🌐) on the back of the RELAY7.

<table>
<thead>
<tr>
<th>Description</th>
<th>LED Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power On - Ready - No data transmitting to SMART7</td>
<td>Solid Green</td>
</tr>
<tr>
<td>Data is being transmitted between RELAY7 and SMART7</td>
<td>Flashing Green</td>
</tr>
<tr>
<td>The radio has encountered an error</td>
<td>Solid Red</td>
</tr>
</tbody>
</table>

Refer to Figure 1: RELAY7 Back Interface on page 12 for LED location.

1.6 RELAY7 RTK Radio Protocol Compatibility

The RELAY7 RTK radio is compatible with the following protocols:

1.6.1 400 MHz Model

- SATEL 3AS
- PacCrest – 4FSK
- PacCrest – GMSK
- PacCrest – FST
- TrimTalk 450s (P)
- TrimTalk 450s (T)

1.6.2 900 MHz Model

- Freewave MM2-T (900 MHz) point to multipoint
Chapter 2  RELAY7 Installation

Use the following steps to first route the cables, connect the RELAY7 to the SMART7 and power up.

2.1 RELAY7 Cable Routing to SMART7

If using the optional Ethernet cable (SMART7-I NovAtel 01020095), the cable must be inserted through the RELAY7 and then connected to the SMART7 before physically attaching the RELAY7 to the SMART7-I. After the cables are inserted and cables connected, the cable can be routed on the underside of the RELAY7.

The Ampseal interface connector is permanently attached to the RELAY7 and must be connected to the SMART7 by pushing firmly onto the SMART7 Ampseal connector.

Refer to Ethernet Cable for SMART7-I (01020095) on page 38 for cable details.
The Ethernet cable is optional (SMART7-I only) and so a cable may not be required. Refer to Ethernet Cable for SMART7-I (01020095) on page 38 for cable details.
1. Insert the M12 Male end of the Ethernet cable down and through to the back of the RELAY7.
2. Connect the M12 Male end of Ethernet cable to the SMART7. TIP: Tilt the M12 male connector slightly down and then up and forward to insert. NOTE: Cable is keyed so it must be properly aligned to tighten. Ensure cable connection is fully tightened.
3. Connect the RELAY7 Ampseal interface cable to the SMART7. If not using the NovAtel interface cable, connect the cabled attached to the vehicle’s navigation system.

Refer to Attach and Connect RELAY7 to SMART7 below for instructions.

2.2 Attach and Connect RELAY7 to SMART7

NovAtel’s RELAY7 rover radio module attaches to the SMART7 to create a single unit for easy system integration.

**Before attaching the RELAY7 to the SMART7, make note of the SSID and password (passkey) found on the label on the "connector" back side of the SMART7.**
1. Ensure cable connections for the Ampseal interface and Ethernet (model dependent) cables are complete. Refer to RELAY7 Cable Routing to SMART7 on page 15.

2. Tilt the RELAY7 unit slightly up and slide onto the SMART7 unit in the locations marked by the four arrows (▶).

3. Hand fasten the M4 screws (x4). Bit required: M2.5 Hex, torque = 10 to 12 in-lb. Failure to properly install the four screws may cause damage.

4. If using the optional Ethernet cable (NovAtel 01020095), insert the M12 Female end down and into the RELAY7 cable channel. Press cable firmly into the channel to lock in place.

Once complete, flip the combined SMART7/RELAY7 over. The optional NovAtel interface cable or the vehicle’s cable attached to the navigation system can be used to connect to the RELAY7 and power the combined units. Refer to Connect the RELAY7 to the Radio Antenna Mount on the next page for instructions. Also refer to SMART Antenna Interface Cable (Optional Accessory) on page 39 for interface cable details.

⚠️ To prevent damage or cable fatigue, ensure any loose cables are secured.
2.3 Connect the RELAY7 to the Radio Antenna Mount

To receive UHF radio signals, the RELAY7 must be connected to a radio antenna. The NMO to TNC Adapter cable comes factory installed. To use an optional external antenna, the cable can be removed. Use the information below to disconnect or reconnect the cable if required later.

**Figure 6: RELAY7 Antenna Mounting**

1. Separate the NMO to TNC Adapter cable.
2. From below, slide the now separated NMO end of adapter cable into the slot at the bottom of the RELAY7.
3. Push the NMO end of the adapter cable up and through the hole in the RELAY7.
4. Ensure the white washer is in place before attaching the separated part of the NMO cable onto the top of the protruding end of the adapter cable. Hand turn to tighten.
5. Connect the TNC end of the cable to the SMART7. Hand turn to tighten.
6. Attach UHF Radio 400 MHz or 900 MHz antenna as required.

2.4 Mounting the SMART7 and RELAY7

Mount the SMART7 and RELAY7 on a secure, stable structure capable of safe operation in the specific environment. Ensure the SMART7 has a clear view of the sky.
If installing on a vehicle, mount the SMART7 and RELAY7 on the vehicle roof, ideally close to the pivot point of the vehicle. The SMART7 and RELAY7 must be mounted with the connector facing the rear of the vehicle.

**Figure 7: SMART7 and RELAY7 Orientation**

Route cable toward back of vehicle

Orient toward the front of vehicle

- Indicates antenna phase center

The SMART7 and RELAY7 must be rigidly secured to the vehicle to avoid errors caused by vibration and motion.

If installing in a stationary location, mount the SMART7 and RELAY7 in a location that has a clear view of the sky so that each satellite above the horizon can be tracked without obstruction. For more information, refer to An Introduction to GNSS.

### 2.4.1 SMART7 and RELAY7 Mounting Hole Locations

The SMART7 and RELAY7 mounting hole locations are shown in the following diagram.
These mounting holes are intended for attachment to a metal plate. When attaching to a 2.5 mm to 3 mm thick metal plate, use four M4X0.7 thread X 12 mm length screws that pass through the plate and into the SMART7 and RELAY7 mounting holes. Torque the screws to 10 - 12 in-lbs.

If using a thicker mounting surface, select screws that penetrate into the mounting holes 6 mm (±1 mm).

2.5 Power Up the RELAY7

Once internal connections between the SMART7 and RELAY7 are complete and the two modules tightly attached, connect the SMART7 Ampseal interface cable to the back of the RELAY7 (refer to SMART Antenna Interface Cable on page 39 for cable details). Apply power and check the front LED on the RELAY7 for status.
Figure 9: Power the RELAY7 and Check Status

Cable attached to the vehicle's navigation system

Refer to Table 1: RELAY7 Status LED on page 14 for status details.

Refer to Figure 1: RELAY7 Back Interface on page 12 for LED location.

⚠ To prevent damage or cable fatigue, ensure any loose cables are secured.
Chapter 3  RELAY7 Configuration

The RELAY7 must be connected to the SMART7 and powered up before it can be configured.

To configure the RELAY7:
1. The SMART7 must be configured to communicate with the RELAY7. See Configure the SMART7 to Use RELAY7 below.
2. The SMART7 must detect the radio. See Detect the RELAY7 Radio below.
3. The radio in the RELAY7 can be configured or queried. See Configure the RELAY7 Radio on the next page.

Refer to the Agriculture Commands and Logs Reference Manual for command and log details.

3.1 Configure the SMART7 to Use RELAY7

Use the following steps to configure the SMART7 to receive RTK corrections from a RELAY7. This setup allows a pre-configured radio to begin streaming corrections immediately.

1. Use the UNLOGALL command to prevent logs from being sent to the radio module.
   
   UNLOGALL COM3 TRUE

2. Use the INTERFACEMODE command to enable the desired correction type.

   INTERFACEMODE COM3 RTCMV3 NONE OFF

   The command enables the RTCMV3 correction type. To use a different correction type, replace RTCMV3 with the required correction type. See the INTERFACEMODE command for details.

3. Use the SERIALCONFIG command to set COM3 to the correct baud rate for radio operation.

   SERIALCONFIG COM3 38400 N 8 1 N OFF

4. Use the PPSCONTROL command to repurpose the PPS signal pin for use with the RELAY7.

   PPSCONTROL ENABLE NEGATIVE 1.0 100

5. Use the SAVECONFIG command to save the configuration so settings are restored each time the receiver is used.

   SAVECONFIG

3.2 Detect the RELAY7 Radio

The SMART7 must detect the radio before the radio settings can be changed or queried. Radio detection can be done manually or automatically.

| Manual Detection | This is the suggested method if the radio configuration is not changed often. This method allows the SMART7 to start receiving RTK corrections as soon as possible. The radio detection is not maintained when the SMART7 is restarted. A manual radio detection procedure must be run before a radio configuration change is made or the radio status is queried. |
Automatic Detection
This is the suggested method if the radio configuration is changed regularly or if the radio status is required as part of the regular workflow.
A radio detect procedure is automatically run when the SMART7 is restarted, so the SMART7 is ready to configure the radio or query the radio status.
The radio detection procedure must complete before the SMART7 can start receiving RTK corrections.

Before the radio can be detected, manually or automatically, the SMART7 must be configured to use the RELAY7. See Configure the SMART7 to Use RELAY7 on the previous page.

3.2.1 Detect the Radio Manually
In order to configure or query settings, the SMART7 must detect that a radio module is present.
1. Use the SATELSTATUS log to monitor the status of the radio.
   LOG SATELSTATUS ONCHANGED
   <OK
   SATELSTATUS UNDETECTED NONE ""
2. Use the SATELDETECT command to specify COM3.
   SATELDETECT COM3
   The SATELSTATUS log reports DETECTING while the SMART7 is searching for the radio. The log displays READY once the operation is complete.
   SATELSTATUS DETECTING NONE ""
   SATELSTATUS READY NONE ""
   Information such as radio type, hardware version and software version are now available in the VERSION log.

3.2.2 Auto Detect the Radio
To configure the radio to automatically detect the radio at SMART7 power up, automatic radio detection must be configured:
1. Issue the SATELSTARTUPDETECT command to enable auto-detection on the COM3 port.
   SATELSTARTUPDETECT ENABLE COM3
2. Use the SAVECONFIG command to save the configuration.
   SAVECONFIG

3.3 Configure the RELAY7 Radio
Settings for the RELAY7 radio are saved on the radio module. They are not lost when a RESET or FRESET command is sent to the SMART7.
When issuing radio commands, the receiver responds to the command immediately after checking that all parameters of the command contain acceptable values. However, due to radio operations it can take some time to complete the change on the radio. Use the SATELSTATUS log to monitor the status of the radio operations.
Chapter 3  RELAY7 Configuration

The SMART7 must detect the radio before the radio can be configured or queried. See Detect the RELAY7 Radio on page 23 for more information.

During radio programming, the INTERFACEMODE and SERIALCONFIG parameters of the port will be temporarily changed. Care must be taken not to modify these parameters while the SATELSTATUS log displays DETECTING or BUSY. Note that the GENERATERTKCORRECTIONS command will change the INTERFACEMODE settings.

3.3.1 Determine the Type of Radio

The commands required to query or modify the radio settings depends on the type of radio. The type of radio is available in the VERSION log.

1. Request the VERSION log.
   LOG VERSION

2. Check the radio component of the VERSION log.
   If the radio component is M3-R4, the RELAY7 has a 400 MHz radio.

   <VERSION COM1 0 0.0 UNKNOWN 0 11.046 02440009 3681 32768
   <                   // Other components
   <       RADIO "M3-R4" "1719324140" "SPL018" "V07.22.2.3.0.2" "" "" ""

   If the radio component is M3-R9, the RELAY7 has a 900 MHz radio.

   <VERSION COM1 0 0.0 UNKNOWN 0 11.046 02440009 3681 32768
   <                   // Other components
   <       RADIO "M3-R9" "1921487310" "SPL0007" "V07.22.2.3.0.2" "" "" ""

3.3.2 Query the Radio Settings – 400 MHz

To check the current radio settings on a 400 MHz radio:
   LOG SATEL4INFO

Refer to the SATEL4INFO log for information about this log.

3.3.3 Query the Radio Settings – 900 MHz

To check the current radio settings on a 900 MHz radio:
   LOG SATEL9INFO

Refer to the SATEL9INFO log for information about this log.

3.3.4 Configure the Radio Settings – 400 MHz

To configure the radio settings on a 400 MHz radio, use the SATEL4CONFIG command.

3.3.5 Configure the Radio Settings – 900 MHz

The command used to configure the 900 MHz radio depends on the channel identifier used on the radio network.

- To configure the Satel 900 MHz radio network settings using a simplified Leica channel identifier, use the SATEL9CONFIGL command.
- To configure the Satel 900 MHz radio network settings using a simplified Novariant channel identifier, use the
The SATEL9CONFIG command.
- For all other cases, use the SATEL9CONFIG command.

### 3.3.6 Check the Radio Status

To check the status of the radio, use the SATELSTATUS log.

```log
log SATELSTATUS unchanged
```

For details about the information contained on this log, refer to the SATELSTATUS log.
Chapter 4  RELAY7 Troubleshooting

The following procedures are simple ways to diagnose and resolve problems with the RELAY7. In many cases, the issue can be resolved within a few minutes, avoiding the inconvenience and loss of productivity that results from having to return the receiver for repair. This section discusses troubleshooting issues and includes cross-references to other sections of the manual that may help resolve problems.

If the procedures listed below do not resolve the issue, try our Knowledge Base at: www.novatel.com/support/

If you are still not able to resolve the problem, see Customer Support on page 10 for contact information.

- **Error Responses to Commands below**
- **Power Cycle the Radio Module** on the next page
- **Factory Reset the Radio Module** on the next page
- **SETELSTATUS Log Reports TIMEOUT** on page 29
- **SETELSTATUS Log Reports COMMAND FAILED** on page 29
- **SETELSTATUS reports READY, but RTK corrections are not received** on page 31

### 4.1 Error Responses to Commands

The following error responses may occur when sending commands to the RELAY7:

<table>
<thead>
<tr>
<th>Error Message</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;ERROR:Radio must be detected before configuration</td>
<td>The SMART7 must be configured to interact with the radio on the appropriate serial port. Issue the SATELDETECT COM3 command before configuration. Refer to the SATELDETECT command in the Agriculture Commands and Logs Reference Manual for more information.</td>
</tr>
<tr>
<td>&lt;ERROR:Radio could not be controlled</td>
<td>The SATELCONTROL POWER ON/OFF command was issued on a product that does not support power control. Refer to the SATELCONTROL command in the Agriculture Commands and Logs Reference Manual for more information.</td>
</tr>
<tr>
<td>&lt;ERROR:Invalid combination of parameters (n &amp; m)</td>
<td>The SMART7 rejected the command to prevent creating an invalid radio configuration.</td>
</tr>
<tr>
<td></td>
<td>- When using the SATEL9CONFIGL command or SATEL9CONFIGN command to configure the P2MP_SLAVE or P2MP_RX_SLAVE modem modes, use a transmit power of 0 mW.</td>
</tr>
<tr>
<td></td>
<td>- When using the SATEL4CONFIG command to configure the receive (RX) behavior, use a transmit power of 0 mW.</td>
</tr>
<tr>
<td></td>
<td>- When using the SATEL4CONFIG command to specify the TRIMTALK protocol to use, the base transmitter type (PACCREST or TRIMBLE) must be specified.</td>
</tr>
<tr>
<td></td>
<td>For information about these commands, refer to the Agriculture Commands and Logs Reference Manual.</td>
</tr>
</tbody>
</table>
4.2 Power Cycle the Radio Module

The radio settings are saved on the radio module. If the radio module is malfunctioning, a power cycle may recover the unit. A power cycle is suggested as a first step in radio recovery since it does not require the radio to be re-programmed.

1. Start the SATELSTATUS log to monitor the radio status.
   
   LOG SATELSTATUS ONCHANGED

2. Use the SATELCONTROL command to turn the radio off.
   
   SATELCONTROL POWER OFF

3. Wait for the state in the SATELSTATUS log to change to OFF.
   
   <SATELSTATUS COM1 0 79.0 FINESTEERING 2009 317298.899 02000000 aaba 32768
   < OFF NONE ""

4. Use the SATELCONTROL command to turn the radio on.
   
   SATELCONTROL POWER ON

5. Wait for the state in the SATELSTATUS log to change to UNDETECTED.
   
   <SATELSTATUS COM1 0 78.5 FINESTEERING 2009 317415.130 02000000 aaba 32768
   < UNDETECTED NONE ""

6. Use the SATELDETECT command to detect the radio.
   
   SATELDETECT COM3

7. Wait for the state in the SATELSTATUS log to change to READY.
   
   <SATELSTATUS COM1 0 74.5 FINESTEERING 2009 317462.889 02000000 aaba 32768
   < DETECTING NONE ""
   <SATELSTATUS COM1 0 79.0 FINESTEERING 2009 317466.901 02000000 aaba 32768
   < READY NONE ""

For information about the commands and logs used in this procedure, refer to the Agriculture Commands and Logs Reference Manual.

4.3 Factory Reset the Radio Module

If the radio cannot be recovered by a power cycle, it is possible to restore the radio to its factory settings. Note that the radio will need to be re-programmed to match the settings of the base station.

1. Start the SATELSTATUS log to monitor the radio status.
   
   LOG SATELSTATUS ONCHANGED

2. Use the SATELCONTROL command to factory reset the radio.
   
   SATELCONTROL FRESET

3. Wait for the state in the SATELSTATUS log to change to BUSY and then READY.
   
   <SATELSTATUS COM1 0 73.0 FINESTEERING 2009 317587.963 02000000 aaba 32768
4. Configure the radio to match the settings of the base station. See Configure the RELAY7 Radio on page 24. For information about the commands and logs used in this procedure, refer to the Agriculture Commands and Logs Reference Manual.

4.4 SATELSTATUS Log Reports TIMEOUT

The SATELSTATUS log reports **TIMEOUT** when the radio module in the RELAY7 does not respond to the commands that are sent to it.

Use the procedures in Power Cycle the Radio Module on the previous page and Factory Reset the Radio Module on the previous page to attempt to resolve the issue. If those two procedures do not work, use the following recovery process:

1. Ensure all cables are connected properly.
2. Issue the **FRESET** command to set the SMART7 to a known state.

The **FRESET** command will erase all user settings. You should know your configuration (by requesting the RXCONFIG log) and be able to reconfigure the receiver before you send the **FRESET** command.

3. Check the LED on the back of the RELAY7. If the radio module is operating, the LED should display solid green or a blinking green pattern.
4. Reconfigure the SMART7 as described in Configure the SMART7 to Use RELAY7 on page 23.

   If the TIMEOUT issue is resolved, enter the SMART7 user settings that were erased by the **FRESET** command.

For information about the commands and logs used in this procedure, refer to the Agriculture Commands and Logs Reference Manual.

4.5 SATELSTATUS Log Reports COMMAND FAILED

The SATELSTATUS log reports **COMMAND FAILED** if the SMART7 was unable to configure the radio settings.

4.5.1 Unexpected radio response

If the radio module malfunctions, the radio may not respond to the commands issued by the SMART7 in the expected manner. If this happens, the command that was issued will be included in the SATELSTATUS error message. Some examples are:

```
<SATELSTATUS COM1 0 80.0 FINESTEERING 2009 317598.053 02000000 aaba 32768
< ERROR COMMAND_FAILED "SL~E=M1,I23,A99"
```

```
<SATELSTATUS COM1 0 79.3 FINESTEERING 2009 317889.543 02000000 aaba 32768
< ERROR COMMAND_FAILED "SL@S=99"
```

To recover from this type of error:
Chapter 4  RELAY7 Troubleshooting

1. Use the **SATELCONTROL** command to return the radio module to a known state.

   ```
   SATELCONTROL FRESET
   ```

2. Wait for the **SATELSTATUS** log to transition to BUSY and then to READY.

   ```
   <SATELSTATUS COM1 0 73.0 FINESTEERING 2009 317587.963 02000000 aaba 32768
   <   BUSY NONE ""
   <
   <SATELSTATUS COM1 0 80.0 FINESTEERING 2009 317598.053 02000000 aaba 32768
   <   READY NONE ""
   ```

3. Configure the radio to the desired settings.

4. Wait for the **SATELSTATUS** log to transition to BUSY and then to READY.

   ```
   <SATELSTATUS COM1 0 76.5 FINESTEERING 2009 321491.063 02000000 aaba 32768
   <   BUSY NONE ""
   <
   <SATELSTATUS COM1 0 77.5 FINESTEERING 2009 321496.684 02040000 aaba 32768
   <   READY NONE ""
   ```

4.5.2 Wrong Command for Radio Type

If the wrong type radio configuration command (SATEL4CONFIG, SATEL9CONFIG, SATEL9CONFIGL or SATEL9CONFIGN) has been issued to the radio module, the SMART7 will not attempt the configuration. This error will be shown in the **SATELSTATUS** log. For example:

```
SATEL9CONFIGL P2MP_RX_SLAVE 4 10 FF FALSE 0 0
<OK

<SATELSTATUS COM1 0 80.0 FINESTEERING 2009 317886.722 02000000 aaba 32768
<   ERROR COMMAND FAILED "Wrong command for radio type (2)"
```

To recover from this type of error:

1. Use the **VERSION** log to confirm the radio type.

   ```
   LOG VERSION
   <OK
   
   <VERSION COM1 0 0.0 UNKNOWN 0 11.046 02440099 3681 32768
   <   // Other components
   <   RADIO "M3-R4" "1719324140" "SPL018" "V07.22.3.0.2" "" "" 
   ```

2. Use the correct configuration command for the attached radio. See the following table:

<table>
<thead>
<tr>
<th>Radio Type</th>
<th>Allowable Configuration Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>M3-R4</td>
<td>SATEL4CONFIG</td>
</tr>
<tr>
<td></td>
<td>SATELCONTROL FRESET</td>
</tr>
</tbody>
</table>
### 4.5.3 Invalid Radio Operation

Due to regulatory requirements, radios can only be operated by the SMART7 in designated jurisdictions. The radio will not allow configuration if the REGULATORY component of the version log is not recognized. This error is shown in the `SATELSTATUS` log.

```
<SATELSTATUS COM1 0 78.0 FINESTEERING 2009 321583.114 02040000 aaba 32768
< UNDETECTED COMMAND_FAILED "Invalid REGULATORY"
```

### 4.6 SATELSTATUS reports READY, but RTK corrections are not received

Since RTK corrections require both the base station and rover to be operating correctly, both receivers should be examined for possible failures.

1. Check that the base station receiver has a valid fixed position.

   ```
   LOG BESTPOS
   <OK
   
   <BESTPOS COM1 0 85.5 FINESTEERING 2009 322351.000 02100000 b1f6 32768
   < SOL_COMPUTED FIXEDPOS 51.11638764437 -114.03831309695 1047.7300
   0.0000 WGS84 0.0000 0.0000 0.0000 "131" 5.000 0.000 21 10 10 00 86 00 03
   
   This example assumes a NovAtel receiver is configured as a base station and paired with a Satel Radio connected to COM2 and that the Rover has a 900 MHz Satel radio.
   
   2. Check that the base station receiver is outputting corrections to the radio port.

   ```
   LOG LOGLIST
   
   <LOGLIST COM1 0 85.0 FINESTEERING 2009 322424.000 02100000 c00c 32768
   < 44
   ...  
   < COM2 RTCM1006 ONTIME 10.000000 0.000000 NOHOLD
   < COM2 RTCM1008 ONTIME 10.000000 2.000000 NOHOLD
   < COM2 RTCM1033 ONTIME 10.000000 4.000000 NOHOLD
   < COM2 RTCM1004 ONTIME 1.000000 0.000000 NOHOLD
   < COM2 RTCM1012 ONTIME 1.000000 0.000000 NOHOLD
   
   3. Check that the INTERFACEMODE of the base station receiver port is set correctly.

   ```
   LOG INTERFACEMODE
   <OK
   
   <INTERFACEMODE COM1 0 82.5 FINESTEERING 2009 322290.249 02100000 7a68 32768
   ```
4. Check that the base station receiver port settings are set correctly.

    LOG SERIALCONFIG
    <OK

    <SERIALCONFIG COM1 3 86.0 FINESTEERING 2009 322127.084 02100000 6be8 32768
    < COM2 38400 N 8 1 N OFF

5. Use the PORTSTATS log to ensure that the transmitted data is incrementing on the base station receiver radio port.

    log PORTSTATS
    <OK

    [COM1]<PORTSTATS COM1 0 86.0 FINESTEERING 2009 323028.000 02100000 a872 32768
    < 26
    // Other ports
    < COM2 256 280691 256 0 38670 0 0 0

    LOG PORTSTATS
    <OK

    <PORTSTATS COM1 0 87.0 FINESTEERING 2009 323093.000 02100000 a872 32768
    < 26
    // Other ports
    < COM2 256 304848 256 0 41880 0 0 0

6. Ensure rover receivers have compatible radio settings.
   a. On Rover:

    LOG SATEL9INFO
    <OK

    <SATEL9INFO COM1 0 7.5 FINESTEERING 2009 322148.386 02440000 9dd6 32768
    <  P2MP_RX_SLAVE -1 2020 2 235 9 8 10 00 TRUE 1 0 0
    "11111111111111"

7. Ensure Rover Radio port has the correct settings.

    LOG INTERFACEMODE
    <OK

    <INTERFACEMODE COM1 0 78.5 FINESTEERING 2009 321706.983 02040000 7a68 32768
    // Other ports
    < COM3 RTCMV3 NONE OFF

    LOG SERIALCONFIG
    <OK

    <SERIALCONFIG COM1 2 80.0 FINESTEERING 2009 321687.369 02040000 6be8 32768
8. Check that the rover is receiving corrections.
   a. Use the PORTSTATS log to check if received data on the rover radio port is incrementing
      
      ```
      LOG PORTSTATS
      OK
      
      <PORTSTATS COM1 0 80.5 FINESTEERING 2009 322642.000 02000000 a872 32768
      26
      
      // Other ports
      <   COM3 132480 8734 132480 0 41710 0 0 0 0
      
      LOG PORTSTATS
      OK
      
      <PORTSTATS COM1 0 82.0 FINESTEERING 2009 322713.000 02000000 a872 32768
      26
      // Other ports
      <   COM3 159945 8734 159945 0 49842 0 0 0 0
      b. Use the BESTPOS log to see if the rover has achieved a NARROW_INT solution.
      
      ```

      ```
      LOG BESTPOS
      OK
      
      <BESTPOS COM1 0 79.0 FINESTEERING 2009 322880.000 02000000 b1f6 32768
      
      // Other ports
      <   COM3 159945 8734 159945 0 49842 0 0 0 0
      
      SOL_COMPUTED NARROW_INT 51.11638765980 -114.03831308755
      1064.6285 -16.9000 WGS84 0.0075 0.0071 0.0129 "0" 1.000 0.000 18
      18 18 18 00 21 00 33
      ```

9. If all settings are confirmed to be correct but the received data is not incrementing, try the procedures in Power Cycle the Radio Module on page 28 or Factory Reset the Radio Module on page 28.

   ![Informational Note](image)

   After a factory reset, the radio must be reconfigured.
APPENDIX A  RELAY7 Technical Specifications

Table 2: RELAY7 Physical Description

<table>
<thead>
<tr>
<th>Size</th>
<th>186.5 L mm x 199.5 W mm x 76.4 H mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>&lt;850 grams</td>
</tr>
<tr>
<td>Status LED</td>
<td>Daylight viewable (refer to RELAY7 LED on page 14 for details)</td>
</tr>
</tbody>
</table>

See the following sections for more information about the RELAY7:

- RELAY7 Radio Specifications below
- RELAY7 Mechanical Specifications on the next page
- RELAY7 Environmental and Electrical Specifications on page 36
- RELAY7 Connector on page 37
- SMART Antenna Interface Cable (Optional Accessory) on page 39

A.1 RELAY7 Radio Specifications

Two RTK radio models are available.

Table 3: RELAY7 400 MHz Radio Model Description

<table>
<thead>
<tr>
<th>Frequency Band (receive only)</th>
<th>403 to 473 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx Sensitivity</td>
<td>-112 dBm @ 25 kHz</td>
</tr>
<tr>
<td></td>
<td>-116 dBm @ 12.5 kHz</td>
</tr>
</tbody>
</table>

Table 4: RELAY7 900 MHz Radio Model Description

<table>
<thead>
<tr>
<th>Frequency Band (receive only)</th>
<th>902 to 928 MHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx Sensitivity</td>
<td>-108 dBm</td>
</tr>
</tbody>
</table>

Refer to RELAY7 RTK Radio Protocol Compatibility on page 14 for list of radio protocols.
A.2 RELAY7 Mechanical Specifications

Dimensions are in millimeters.

Figure 10: RELAY7 Dimensions

SMART7 Attachment Locations (x4)
M4x0.7 Blind Threaded Insert (x3)

Dimensions:
- 13.75
- 33.50
- 105.00
- 27.50
- 76.40
- 199.50
- 186.5
### Table 5: RELAY7 Mounting Description

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 x M4 screw insert to SMART7</td>
</tr>
<tr>
<td>Integrated magnetic mount</td>
</tr>
<tr>
<td>3 x M4 screws for attachment to mounting plate</td>
</tr>
</tbody>
</table>

Hand fasten the M4 screws (x4). Bit required: M2.5 Hex, torque = 10 to 12 in-lb. Failure to properly install the four screws may cause damage.

Refer to RELAY7 Cable Routing to SMART7 on page 15 for installation instructions.

### A.3 RELAY7 Environmental and Electrical Specifications

#### Table 6: RELAY7 Environmental Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>-40°C to +70°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-45°C to +80°C</td>
</tr>
<tr>
<td>Humidity</td>
<td>MIL-STD-810G(CH1), Method 507.6</td>
</tr>
<tr>
<td>Immersion</td>
<td>MIL-STD-810G(CH1), Method 512.6</td>
</tr>
<tr>
<td>Ingress Protection Rating</td>
<td>IP67, IP69</td>
</tr>
<tr>
<td>Shock</td>
<td>MIL-STD-810G(CH1), Method 516.7</td>
</tr>
<tr>
<td>Solar Radiation</td>
<td>MIL-STC-810G(CH1), 505.6</td>
</tr>
<tr>
<td>Salt Fog</td>
<td>MIL-STD-810G(CH1), 509.6</td>
</tr>
<tr>
<td>Sand and Dust</td>
<td>MIL-STD-810G, 510.6</td>
</tr>
<tr>
<td>UV Protection</td>
<td>MIL-STD-810G, 505.6</td>
</tr>
<tr>
<td>I/O Protection</td>
<td>ISO 15003 and 16750</td>
</tr>
<tr>
<td>Compliance</td>
<td>FCC, ISED, CE Mark, E-Mark</td>
</tr>
</tbody>
</table>

#### Table 7: RELAY7 Electrical Description

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage Range</td>
<td>+7 to +30 VDC</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>2 W typical</td>
</tr>
</tbody>
</table>
A.4 RELAY7 Connector

Table 8: RELAY7 Connector Description

<table>
<thead>
<tr>
<th>Interface Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-pin Tyco Ampseal</td>
<td>See the SMART7 manual for details. Also refer to SMART Antenna Interface Cable (Optional Accessory) on page 39.</td>
</tr>
<tr>
<td>External Radio Antenna Cable</td>
<td>TNC female jack, 50 Ω nominal</td>
</tr>
<tr>
<td>Optional Ethernet Cable</td>
<td>M12D (M) to (F) \nRefer to Ethernet Cable for SMART7-I (01020095) on the next page for cable details.</td>
</tr>
</tbody>
</table>

Table 9: Ports Passed Through from SMART7

<table>
<thead>
<tr>
<th>Ports Passed Through from SMART7</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-232 dedicated ports</td>
<td>2</td>
</tr>
<tr>
<td>CAN Bus NMEA 2000</td>
<td>1</td>
</tr>
<tr>
<td>Ground speed output</td>
<td>1</td>
</tr>
<tr>
<td>Optional Ethernet</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 10: RELAY7 Connector Pin Outs

<table>
<thead>
<tr>
<th>Pin #</th>
<th>RELAY7 Pin Function (Black Ampseal, Male)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>COM1 TXD Passthrough</td>
</tr>
<tr>
<td>2</td>
<td>COM1 RXD Passthrough</td>
</tr>
<tr>
<td>3</td>
<td>COM2 TXD Passthrough</td>
</tr>
<tr>
<td>4</td>
<td>COM2 RXD Passthrough</td>
</tr>
<tr>
<td>5</td>
<td>SIGGND</td>
</tr>
<tr>
<td>6</td>
<td>CAN+ Passthrough</td>
</tr>
<tr>
<td>7</td>
<td>CAN- Passthrough</td>
</tr>
<tr>
<td>8</td>
<td>N/A</td>
</tr>
<tr>
<td>9</td>
<td>PWR-</td>
</tr>
<tr>
<td>10</td>
<td>Emulated Radar (ER) Passthrough</td>
</tr>
<tr>
<td>11</td>
<td>N/A</td>
</tr>
<tr>
<td>12</td>
<td>N/A</td>
</tr>
<tr>
<td>13</td>
<td>N/A</td>
</tr>
<tr>
<td>14</td>
<td>PWR+</td>
</tr>
</tbody>
</table>
A.5 Ethernet Cable for SMART7-I (01020095)

The optional Ethernet cable is used for the SMART7-I 10Base-T/100Base-TX Ethernet for communications with external data communications equipment such as computers and data loggers.

**Figure 11: SMART7-I for RELAY7 Ethernet Cable**

![Ethernet Cable Diagram]

**Table 11: Ethernet Connector Pin Outs**

<table>
<thead>
<tr>
<th>From P1</th>
<th>To J1</th>
<th>Signal Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Tx+</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Rx+</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Tx-</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Rx-</td>
</tr>
<tr>
<td>Shell</td>
<td>Shell</td>
<td>Chassis GND</td>
</tr>
</tbody>
</table>
A.6 SMART Antenna Interface Cable (Optional Accessory)

The NovAtel part number for the SMART Antenna interface cable is 01019944. This cable provides access to all of the signals available on the SMART Antenna 14-pin Tyco Ampseal connector. The exposed wires (BATT+ and BATT-) can then be connected to a vehicular power circuit (or equivalent) protected by a 5 A slow blow fuse (user supplied).

The following SMART Antennas use this cable:

- SMART7
- SMART7 with RELAY7
- SMART2

![Figure 12: SMART Antenna Interface Cable](image)

This cable is also used when the RELAY7 is connected to the SMART7. When the RELAY7 is connected to the SMART7, PPS and COM3 are not available.

Dimensions are in millimeters.
### Table 12: SMART Antenna Interface Cable Connector Pin Out

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>J1</th>
<th>J2</th>
<th>J3</th>
<th>J4</th>
<th>J5</th>
<th>E1</th>
<th>E2</th>
</tr>
</thead>
<tbody>
<tr>
<td>COM1-TXD</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM1-RXD</td>
<td>2</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM2-TXD</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM2-RXD</td>
<td>4</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM3-TXD</td>
<td>8</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>COM3-RXD</td>
<td>13</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN+</td>
<td>6</td>
<td></td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAN-</td>
<td>7</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIGGND</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIGGND</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SIGGND</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIGGND</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIGGND</td>
<td>5</td>
<td></td>
<td>SIGGND</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMD RADAR OUT (E2)</td>
<td>10</td>
<td></td>
<td>ER_OUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RELAYO1/MARK INPUT (E2)</td>
<td>11</td>
<td></td>
<td>MKI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPS/RLYO2 (E2)</td>
<td>12</td>
<td></td>
<td>PPS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWR RET (GND) (E1)</td>
<td>9</td>
<td></td>
<td>BATT-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PWR INPUT (E1)</td>
<td>14</td>
<td></td>
<td>BATT+</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Table 13: 14-Pin Interface Connector

<table>
<thead>
<tr>
<th></th>
<th>CAN</th>
<th>PPS Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAE J1939/ ISO 11783/ ISO 11898 Compatible</td>
<td>3.3 V CMOS Logic Compatible</td>
</tr>
<tr>
<td>Ground Speed Output</td>
<td>High= Supply Voltage Maximum</td>
<td>Low= 1.5 V Maximum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Load= 3K Ohm Minimum</td>
</tr>
</tbody>
</table>

#### A.6.1 SMART Antenna Custom Cable Recommendation

To create a custom cable for a SMART Antenna, a specific connector is required on the end of the cable. See the following table for information about this connector.
Table 14: I/O Connector

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
<th>Commercial Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
<td>AMP Seal 14-pin Plug</td>
<td>776273-1</td>
</tr>
<tr>
<td></td>
<td>14-pin TYCO connector kit</td>
<td>NovAtel 01020132</td>
</tr>
</tbody>
</table>