RELAY7
Installation and Operation
User Manual

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: novatel.com/products/novatel-warranty-and-return-policies.

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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) / United Kingdom (UK)

NovAtel Inc. declares that the RELAY7 is in compliance with:

1. EU Directive 2014/53/EU
2. UK Regulations S.I. 2017/1206

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

novatel.com/products/novatel-compliance

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 or the United Kingdom, please return it to your dealer or supplier at the end of its life. The objectives of NovAtel'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 ( ).

See novatel.com/products/novatel-compliance/novatel-environmental-compliance for more information.

RoHS

The RELAY7 is in conformity with:

1. Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

2. the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (Amendment) Regulations 2012 (S.I. 2012/3032).

E-Mark

The RELAY7 has been granted EC type approval of an electric/electronic subassembly with respect to electromagnetic compatibility ECE Regulation 10.05. Therefore the equipment is labeled with the following approval marks.

 10 R - 05 10430
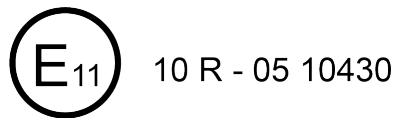
Ethernet Port

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 International Type Approval

Australia and New Zealand

Eurasian Economic Community

Armenia, 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 novatel.com/support. Through the *Support* page you can contact Customer Support, find papers and tutorials or download the latest firmware. To access the latest user documentation, visit docs.novatel.com/OEM7.

Before Contacting Customer Support

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

> If logging data over an RS-232 serial cable, ensure that the configured baud rate can support the data bandwidth (see **SERIALCONFIG** command). NovAtel recommends a minimum suggested baud rate of 230400 bps.

1. Ensure the RELAY7 is connected to the SMART7.
2. Use the information in the *RELAY7 Troubleshooting* on page 28 section to diagnose and troubleshoot your receiver's symptoms.
3. Log the data suggested in the appropriate *Troubleshooting Logs* section to a file on your computer for 15 minutes.
   - *General Troubleshooting Logs* on the next page
   - *Tracking and Interference Troubleshooting Logs* on the next page
   - *PPP Troubleshooting Logs* on page 12

   If using NovAtel Application Suite, log the Troubleshooting message set for 15 minutes.
4. Send the data file to NovAtel Customer Support: support.novatel@hexagon.com
5. 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: novatel.com/support

Log a Case, Search Knowledge and View Your Case History: (login access required)

Web Portal: shop.novatel.com/novatelstore/s/login/

E-mail:

support.novatel@hexagon.com

Telephone:

U.S. and Canada: 1-800-NOVATEL (1-800-668-2835)

International: +1-403-295-4900

General Troubleshooting Logs

```
LOG RXSTATUSB ONCHANGED
LOG RAWEPHEMB ONNEW
LOG GLORAWEPHEMB ONNEW
LOG BESTPOSB ONTIME 1
LOG RANGEB ONTIME 0.5
LOG RXCONFIGA ONCE
LOG VERSIONA ONCE
LOG LOGLISTA ONCE
LOG PORTSTATSA ONTIME 10
LOG PROFILEINFOA ONCE
LOG HWMONITORA ONTIME 10
```

If you have a RELAY7, add the following logs:

```
LOG SATELSTATUSB onchanged
LOG INTERFACEMODEB onchanged
LOG SERIALCONFIGB onchanged
```

Tracking and Interference Troubleshooting Logs

```
LOG VERSIONA ONCE
LOG RXCONFIGA ONCE
LOG CHANCONFIGLISTB ONCE
LOG PASSTHROUGHA ONNEW
LOG RXSTATUSB ONCHANGED
LOG CLOCKSTEERINGB ONCHANGED
LOG RAWEPHEMB ONNEW
LOG GLORAWEPHEMB ONNEW
LOG GALINAVRAWEPHEMERISB ONNEW
LOG BDSEPHEMERISB ONNEW
LOG QZSSEPHEMERISB ONNEW
LOG NAVICEPHEMERISB ONNEW
LOG RAWALMB ONNEW
LOG GLORAWALMB ONNEW
LOG GALALMANACB ONNEW
LOG BDSALMANACB ONNEW
LOG QZSSALMANACB ONNEW
LOG NAVICALMANACB ONNEW
LOG IONUTCB ONNEW
LOG GLOCLOCKB ONNEW
LOG GALCLOCKB ONNEW
LOG BDSCLOCKB ONNEW
LOG TRACKSTATB ONTIME 1
LOG RANGEB ONTIME 0.5
LOG BESTPOSB ONTIME 1
```

```
LOG SATVIS2B ONTIME 30
LOG ITDETECTSTATUSB ONCHANGED
```

For interference issues add this log:

```
LOG ITPSDDETECTB ONNEW
```

For interference issues, when you have enough datalink bandwidth to handle large logs, add this log:

```
LOG ITPSDFINALB ONNEW
```

PPP Troubleshooting Logs

```
LOG RXSTATUSB ONCHANGED
LOG GPSEPHEMB ONNEW
LOG GLOEPHEMERISB ONNEW
LOG QZSSEPHEMERISB ONNEW
LOG BDSEPHEMERISB ONNEW
LOG BDSBCNAV1EPHEMERISB ONNEW (firmware versions 7.08.03 and 7.08.10 and later)
LOG BDSBCNAV2EPHEMERISB ONNEW (firmware versions 7.08.03 and 7.08.10 and later)
LOG BDSBCNAV3EPHEMERISB ONNEW (firmware versions 7.08.03 and 7.08.10 and later)
LOG GALFNAVEPHEMERISB ONNEW
LOG GALINAVEPHEMERISB ONNEW
LOG RANGEB ONTIME 0.5
LOG BESTPOSB ONTIME 1.0
LOG RXCONFIGB ONCE
LOG VERSIONB ONCE
LOG TRACKSTATB ONTIME 10.0
LOG LBANDTRACKSTATB ONTIME 1.0
LOG PPPPOSB ONTIME 1.0
LOG PPPSATSB ONTIME 1.0
LOG TERRASTARINFOB ONCHANGED
LOG TERRASTARSTATUSB ONCHANGED
LOG PSRPOSB ONTIME 1.0
LOG ALMANACB ONNEW
LOG GLOALMANACB ONNEW
LOG GALALMANACB ONNEW
LOG BDSALMANACB ONNEW
LOG QZSSALMANACB ONNEW
LOG IONUTCB ONNEW
LOG GLOCLOCKB ONNEW
LOG LBANDBEAMTABLEB ONCHANGED
```

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 40 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
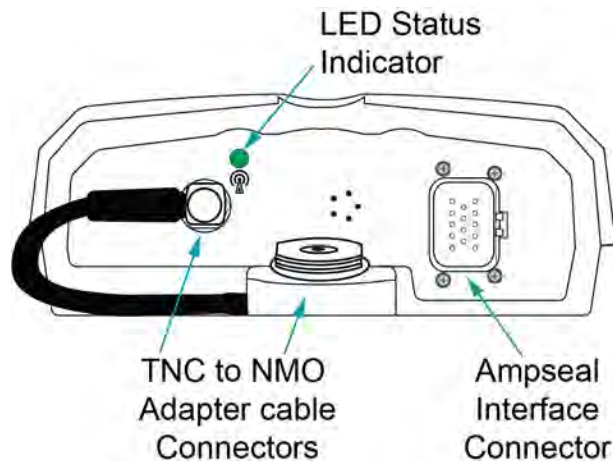
> ℹ The TNC to NMO cable is installed in the factory. It can be removed to install an optional external antenna. Refer to *Connect the RELAY7 to the Radio Antenna Mount* on page 20 for information about disconnecting or reconnecting the TNC to NMO cable.

> ℹ Do not cover the RELAY7 pressure vent. The pressure vent must be allowed to breathe to ensure proper RELAY7 operation.

Figure 2: RELAY7 Back and Front View

Back of RELAY7 for
connecting RTK Radio antenna

Front of RELAY7
for connecting to SMART7
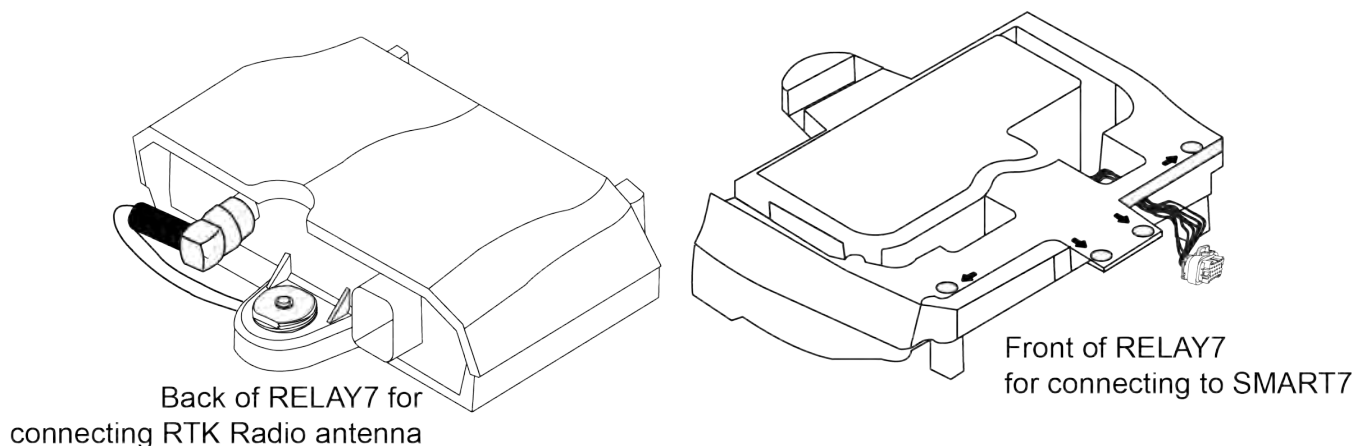
Refer to *RELAY7 Connector Overview* below for information on the Ampseal interface connector.

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 OEM7 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 38 for cable pin outs.

Figure 3: RELAY7 Interface Connector
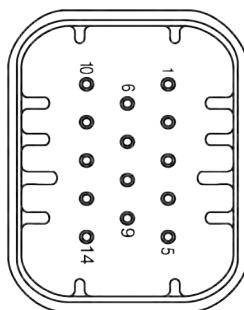
1.4.1   RELAY7 RTK Radio Mount

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 20 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 1: RELAY7 Status LED

Description	LED Status
Power On - Ready - No data transmitting to SMART7	Solid Green
Data is being transmitted between RELAY7 and SMART7	Flashing Green
The radio has encountered an error	Solid Red

Refer to *Figure 1: RELAY7 Back Interface* on page 13 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 39 for cable details.

Figure 4: RELAY7 to SMART7 Cable Routing
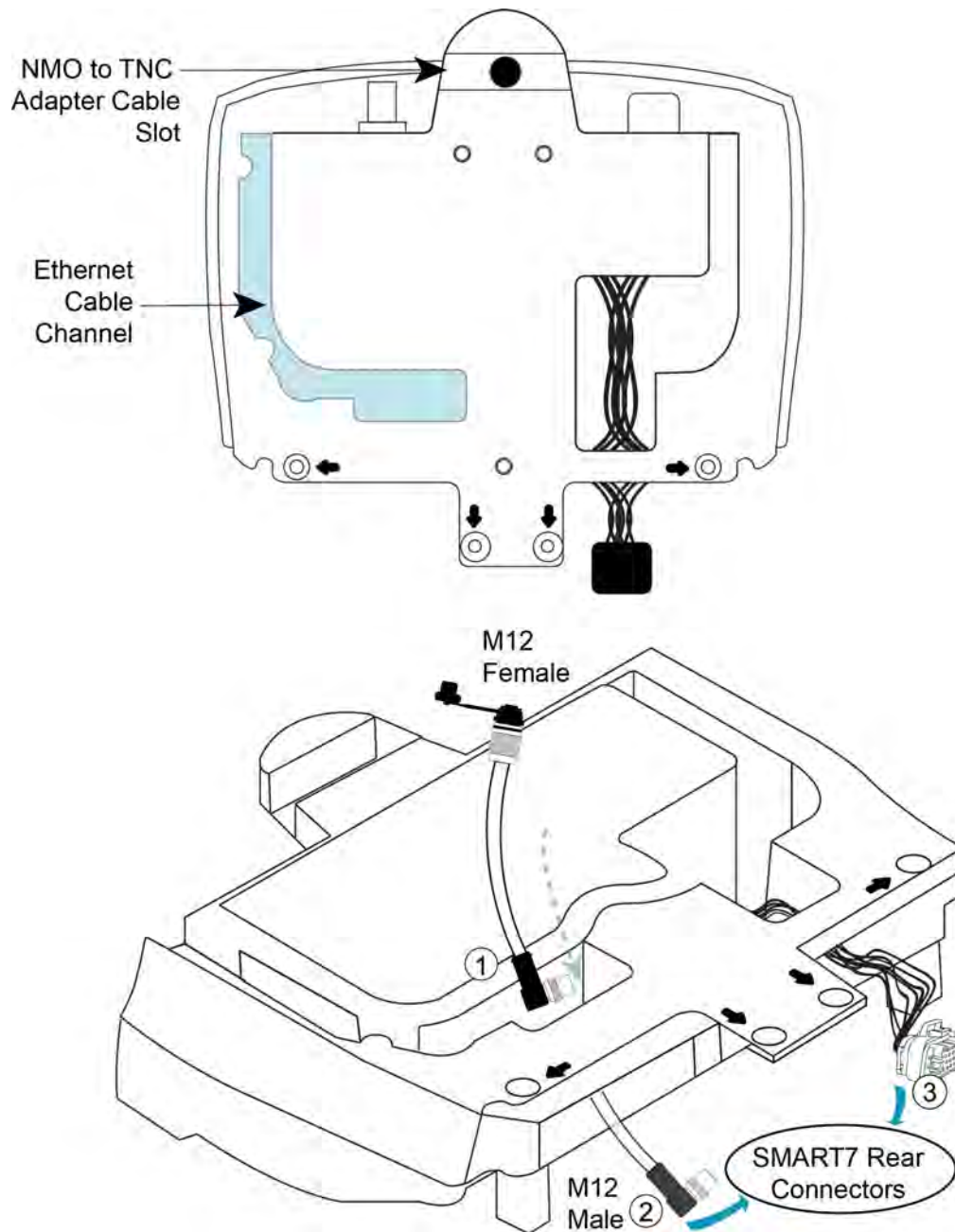
The Ethernet cable is optional (SMART7-I only) and so a cable may not be required. Refer to *Ethernet Cable for SMART7-I (01020095)* on page 39 for cable details.

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.

   > (i) The 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.

Figure 5: Attach RELAY7 to SMART7

Ethernet Cable Channel

Interface Cable Connector

Radio Mounting and Connector

Ethernet Cable (model dependent)
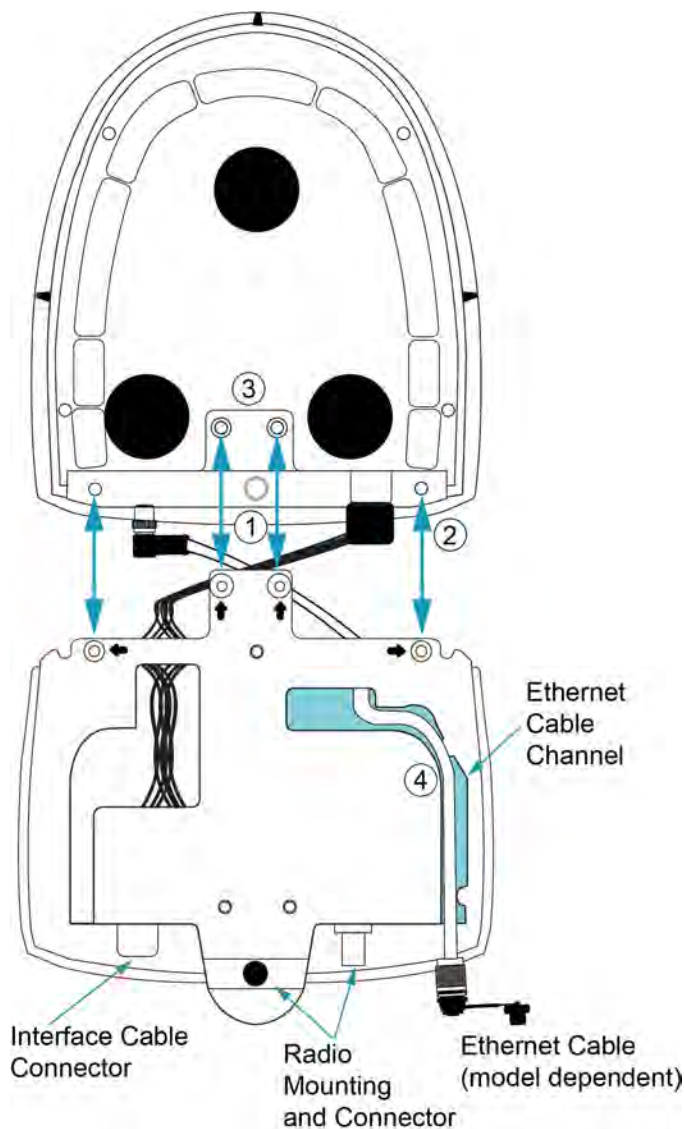
1. Ensure cable connections for the Ampseal interface and Ethernet (model dependent) cables are complete. Refer to *RELAY7 Cable Routing to SMART7* on page 16.

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 40 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
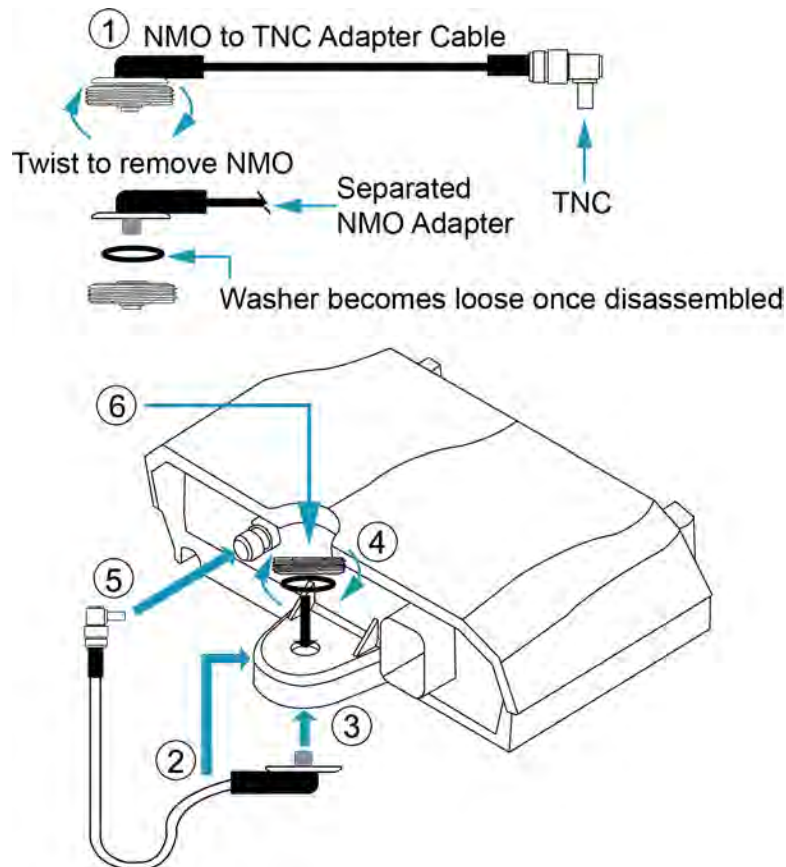
1. Separate the NMO to TNC Adapter cable.
2. From below, slide the now separated NMO end of adapter cable into the slot at the bottom of the RELAY7.
3. Push the NMO end of the adapter cable up and through the hole in the RELAY7.
4. Ensure the white washer is in place before attaching the separated part 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
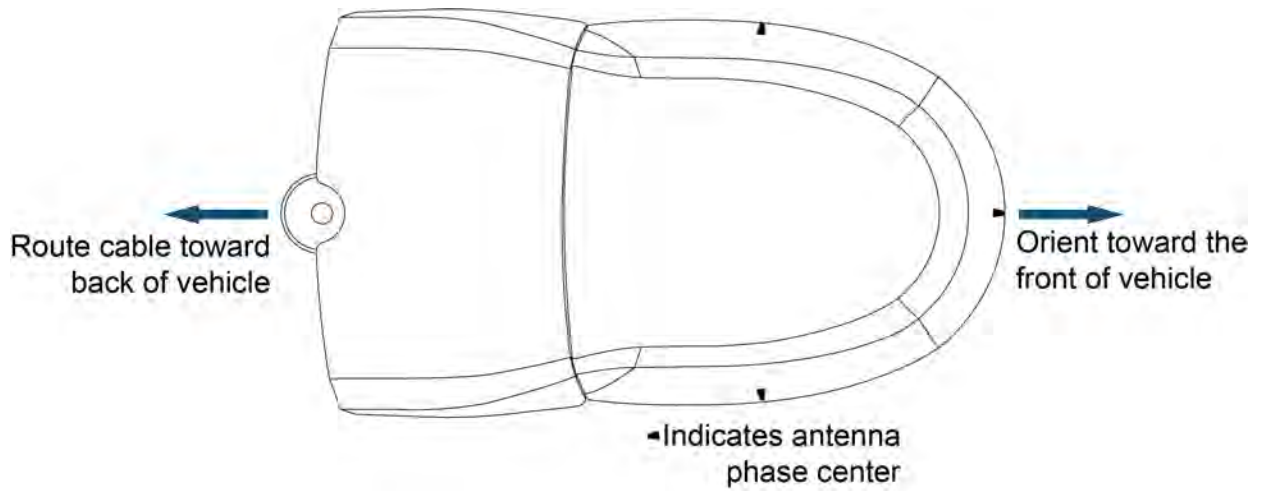
> ▼ The SMART7 and RELAY7 must be rigidly secured to the vehicle to avoid errors caused by vibration and motion.

- 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* available on our website at novatel.com/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.

Figure 8: SMART7 and RELAY7 Mounting Hole Locations
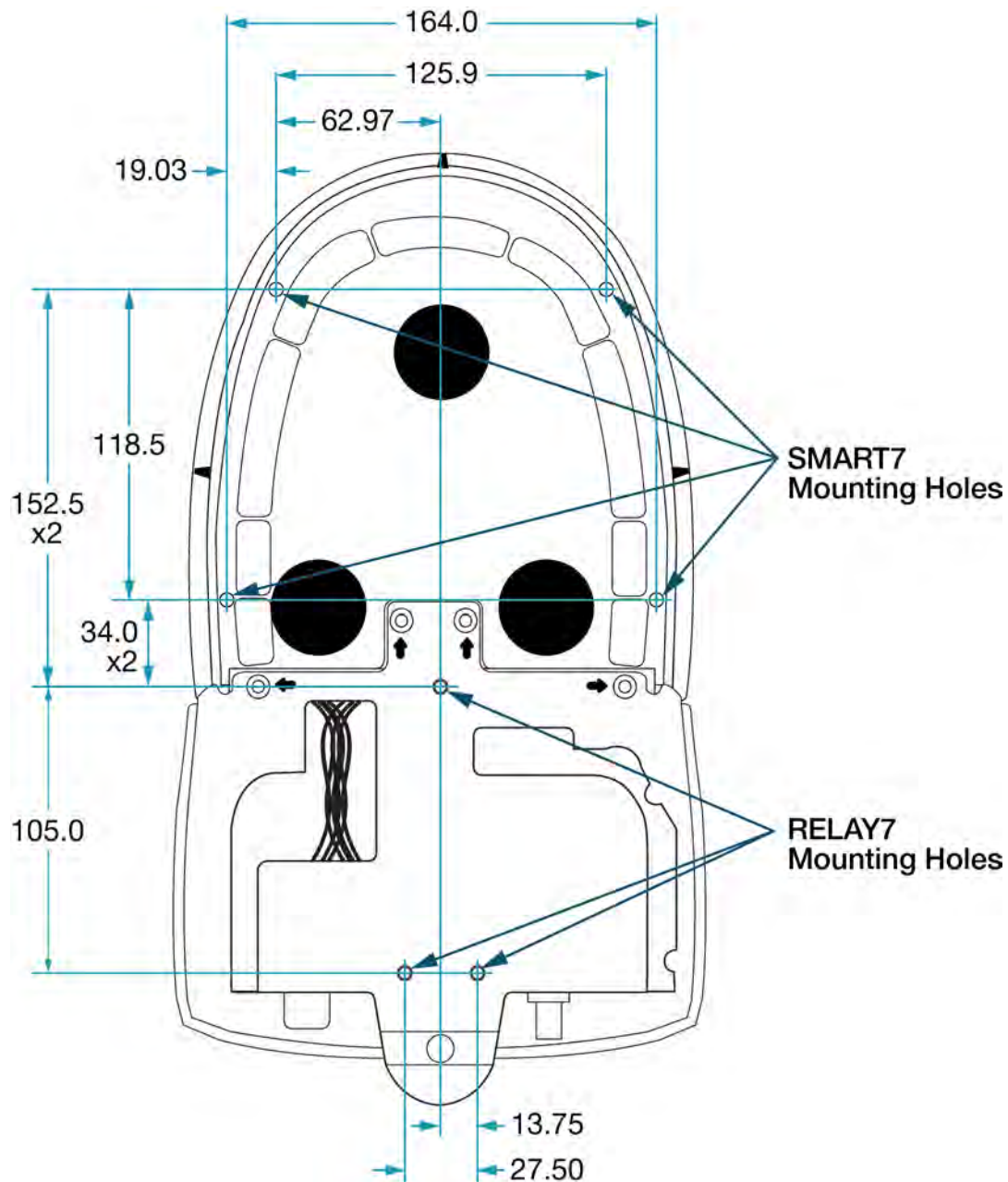
These mounting holes are intended for attachment to a metal plate. When attaching to a 2.5 mm to 3 mm thick metal plate, use four M4X0.7 thread X 12 mm length screws that pass through the plate and into the SMART7 and RELAY7 mounting holes. Torque the screws to 10 - 12 in-lbs.

ⓘ   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 40 for cable details). Apply power and check the front LED on the RELAY7 for status.

> (i) Ensure a 5 A slow blow fuse is incorporated in the power wiring. Refer to Fuse for the Power Supply in the SMART7 Installation and Operation User Manual.

Figure 9: Power the RELAY7 and Check Status

Cable attached to the vehicle's navigation system
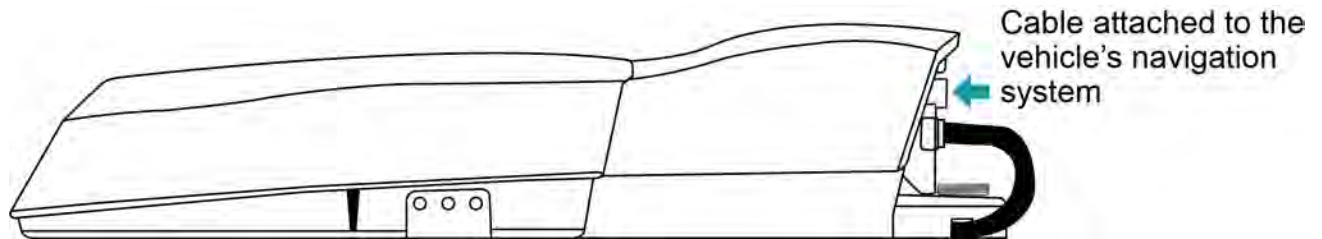
Refer to *Table 1: RELAY7 Status LED* on page 15 for status details.

Refer to *Figure 1: RELAY7 Back Interface* on page 13 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 [OEM7 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 work flow. 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.

> ℹ️ The SMART7 must detect the radio before the radio can be configured or queried. See *Detect the RELAY7 Radio* on page 24 for more information.

> ℹ️ 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 **SATEL9CONFIGN** 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 SATELSTATUS onchanged
```

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:
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
- *SATELSTATUS Log Reports TIMEOUT* on page 30
- *SATELSTATUS Log Reports COMMAND FAILED* on page 30
- *SATELSTATUS reports READY, but RTK corrections are not received* on page 32

4.1 Error Responses to Commands

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

Error Message	Solution
`<ERROR:Radio must be detected before configuration`	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 OEM7 Commands and Logs Reference Manual for more information.
`<ERROR:Radio could not be controlled`	The **SATELCONTROL POWER ON/OFF** command was issued on a product that does not support power control. Refer to the **SATELCONTROL** command in the OEM7 Commands and Logs Reference Manual for more information.
`<ERROR:Invalid combination of parameters (n & m)`	The SMART7 rejected the command to prevent creating an invalid radio configuration. • 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. • When using the **SATEL4CONFIG** command to configure the receive (RX) behavior, use a transmit power of 0 mW. • When using the **SATEL4CONFIG** command to specify the TRIMTALK protocol to use, the base transmitter type (PACCREST or TRIMBLE) must be specified. For information about these commands, refer to the OEM7 Commands and Logs Reference Manual.

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 OEM7 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
    <     BUSY NONE ""
    ```

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

4. Configure the radio to match the settings of the base station. See *Configure the RELAY7 Radio* on page 25.

For information about the commands and logs used in this procedure, refer to the OEM7 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 24.

   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 OEM7 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 317886.722 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:

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 02040000 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 02440009 3681 32768
<          // Other components
<          RADIO "M3-R4" "1719324140" "SPL018" "V07.22.2.3.0.2" "" "" ""
```

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

Radio Type	Allowable Configuration Commands
M3-R4	SATEL4CONFIG SATELCONTROL FRESET

Radio Type	Allowable Configuration Commands
M3-R9	SATEL9CONFIG
	SATEL9CONFIGL
	SATEL9CONFIGN
	SATELCONTROL FRESET

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 10 00 86 00
03
```

> (i) This example assumes a NovAtel receiver is configured as a base station and paired with a 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
```

```
<       COM2 NOVATEL RTCMV3 ON
```

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 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 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
"1111111111111111"
```

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
// Other ports
```

```
<       COM3 38400 N 8 1 N OFF
```

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
<     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 29 or *Factory Reset the Radio Module* on page 29.

> (i) After a factory reset, the radio must be reconfigured.

Appendix A   RELAY7 Technical Specifications

Table 2: RELAY7 Physical Description

Size	186.5 L mm x 199.5 W mm x 76.4 H mm
Weight	<850 grams
Status LED	Daylight viewable (refer to *RELAY7 LED* on page 15 for details)

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 37
- *RELAY7 Connector* on page 38
- *SMART Antenna Interface Cable (Optional Accessory)* on page 40

A.1   RELAY7 Radio Specifications

Two RTK radio models are available.

Table 3: RELAY7 400 MHz Radio Model Description

Frequency Band (receive only)	403 to 473 MHz
Rx Sensitivity	-112 dBm @ 25 kHz -116 dBm @ 12.5 kHz

Table 4: RELAY7 900 MHz Radio Model Description

Frequency Band (receive only)	902 to 928 MHz
Rx Sensitivity	-108 dBm

Refer to *RELAY7 RTK Radio Protocol Compatibility* on page 15 for list of radio protocols.

A.2 RELAY7 Mechanical Specifications

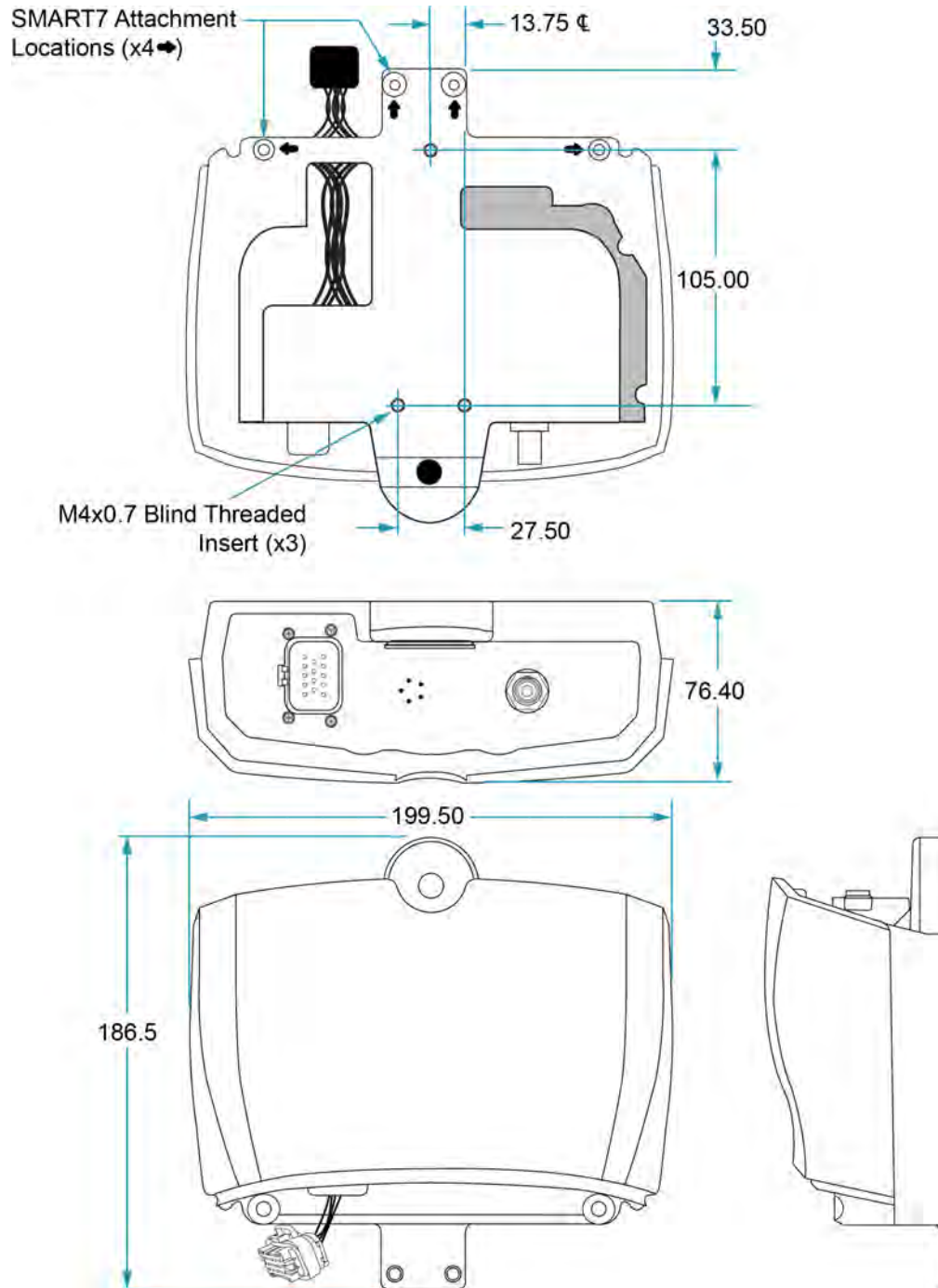> ⓘ In the following diagram, the dimensions are in millimetres.

Figure 10: RELAY7 Dimensions

Table 5: RELAY7 Mounting Description

4 x M4 screw insert to SMART7
Integrated magnetic mount
3 x M4 screws for attachment to mounting plate

ⓘ 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 16 for installation instructions.

A.3   RELAY7 Environmental and Electrical Specifications

Table 6: RELAY7 Environmental Specifications

Operating Temperature	-40°C to +70°C
Storage Temperature	-45°C to +80°C
Humidity	MIL-STD-810G(CH1), Method 507.6
Immersion	MIL-STD-810G(CH1), Method 512.6
Ingress Protection Rating	IP67, IP69 🛑 IP67 and IP69 ratings require that the cable is connected to the RELAY7.
Vibration	MIL-STD-810G(CH1), Method 514.7
Shock	MIL-STD-810G(CH1), Method 516.7
Solar Radiation	MIL-STD-810G(CH1), 505.6
Salt Fog	MIL-STD-810G(CH1), 509.6
Sand and Dust	MIL-STD-810G(CH1), 510.6
Compliance	FCC, ISED, CE Mark, E-Mark

Table 7: RELAY7 Electrical Description

Input Voltage Range	+7 to +30 VDC
Power Consumption	2 W typical

A.4   RELAY7 Connector

Table 8: RELAY7 Connector Description

Interface Connector	14-pin Tyco Ampseal (see the SMART7 manual for details). Also refer to *Table 12: SMART Antenna Interface Cable Connector Pin Out* on page 41
External Radio Antenna Cable	TNC female jack, 50 Ω nominal
Optional Ethernet Cable	M12D (M) to (F) Refer to *Ethernet Cable for SMART7-I (01020095)* on the next page for cable details.

Table 9: Ports Passed Through from SMART7

RS-232 dedicated ports	2
CAN Bus NMEA 2000	1
Ground speed output	1
Optional Ethernet	1

Table 10: RELAY7 Connector Pin Outs

Pin #	RELAY7 Pin Function (Black Ampseal, Male)
1	COM1 TXD Passthrough
2	COM1 RXD Passthrough
3	COM2 TXD Passthrough
4	COM2 RXD Passthrough
5	SIGGND
6	CAN+ Passthrough
7	CAN- Passthrough
8	N/A
9	PWR-
10	Emulated Radar (ER) Passthrough
11	N/A
12	N/A
13	N/A
14	PWR+

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.

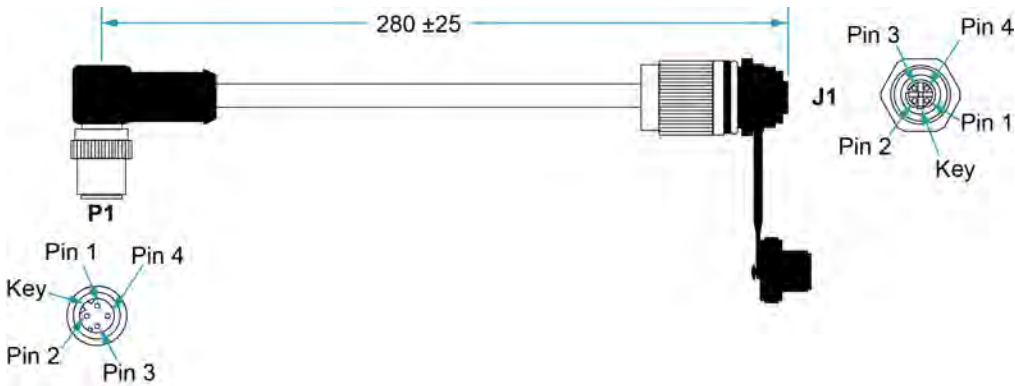**Figure 11: SMART7-I for RELAY7 Ethernet Cable**

Table 11: Ethernet Connector Pin Outs

From P1	To J1	Signal Name
1	1	Tx+
2	2	Rx+
3	3	Tx-
4	4	Rx-
Shell	Shell	Chassis GND

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:
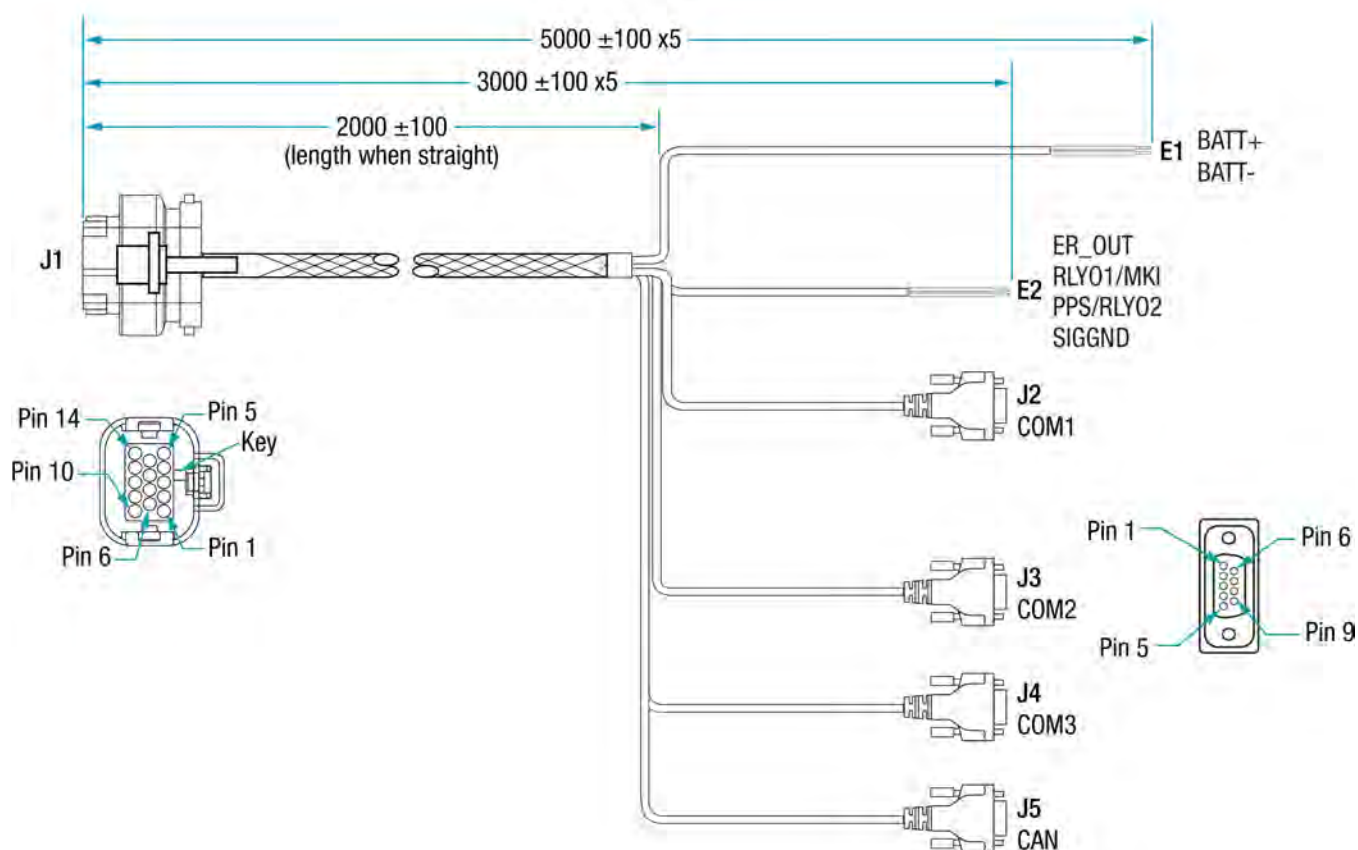
- SMART7
- SMART7 with RELAY7
- SMART2

The SMART Antenna interface cable is also compatible with the Ag-Star, SMART6 and SMART6-L.

In the following diagram, the dimensions are in millimetres.

Figure 12: SMART Antenna Interface Cable

> 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.

Table 12: SMART Antenna Interface Cable Connector Pin Out

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

Table 13: 14-Pin Interface Signal Specfications

Signal Name	Signal Specifications
CAN	SAE J1939/ ISO 11783/ ISO 11898 Compatible
PPS Output	3.3 V CMOS Logic Compatible
Ground Speed Output	High= Supply Voltage Maximum Low= 1.5 V Maximum Load= 3K Ohm Minimum

---

[1]The Mark Input is not available on the SMART7.

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

Connector	Description	Commercial Part Number
J1	AMP Seal 14-pin Plug	776273-1