



CPT7 and CPT7700

QUICK START GUIDE

GM-14915172

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The NovAtel CPT7 and CPT7700 are compact, single enclosure GNSS+INS receivers.

CPT7 The CPT7 combines a dual antenna OEM7720 GNSS receiver and a high performance Honeywell HG4930 IMU in a single enclosure to provide an easy to deploy SPAN GNSS+INS and ALIGN system.

CPT7700 The CPT7700 combines an OEM7700 GNSS receiver and a high performance Honeywell HG4930 IMU in a single enclosure to provide an easy to deploy SPAN GNSS+INS system. In addition to the GNSS signals tracked by the CPT7, the CPT7700 also tracks Galileo E6, BeiDou B3I and QZSS L6.

This guide provides the basic information needed to set up and use a CPT7 or CPT7700.



In this document, the term CPT7 is used to represent both the CPT7 and CPT7700. When a section applies to a specific receiver, the applicable receiver is identified (e.g. *CPT7 only* or *CPT7700 only*).

Box Contents

The following is provided with the CPT7:

- CPT7 I/O1 Cable (01020697)
- CPT7 I/O2 Cable (01020690)

Additional Equipment Required

The additional equipment listed below is required for a typical setup.

- A 9-36 VDC, fuse protected power supply capable of at least 18 W
- A high-quality GNSS antenna, such as NovAtel's VEXXIS GNSS-500 or GNSS-800 series antennas
Two GNSS antennas are needed to use the ALIGN heading feature (*CPT7 only*)
- An antenna cable with an SMA male connector at the receiver end
Two antenna cables are needed to use the ALIGN heading feature (*CPT7 only*)
- Four #6 (M3.5) size screws for mounting
- A computer with a serial RS-232/RS-422, USB or Ethernet port

Optional Accessories

The following optional accessory is available from NovAtel:

- CPT7 Adapter Plate (01020112)

User documentation

For detailed information on the installation, operation, logs and commands for the CPT7, refer to the OEM7 User Documentation (docs.novatel.com/OEM7).

Getting to Know the CPT7

Table 1: CPT7 – Connector Definitions





Connector	Description
 RF1	SMA connector for the primary GNSS antenna
 RF2	SMA connector for the secondary GNSS antenna (<i>CPT7 only</i>)
 IO1	16-pin circular connector <ul style="list-style-type: none">• Power• COM2 (RS-422)• EVENT_IN 1• EVENT_OUT 1• EVENT_IN 3• EVENT_OUT 3 (PPS)
 IO2	16-pin circular connector <ul style="list-style-type: none">• Power• COM1 (RS-232)• USB• Ethernet• CAN bus• Wheel Sensor (DMI) Input• EVENT_IN 2• EVENT_OUT 2

Table 2: Power Status LED Description

LED Label	LED State	Description
PWR	Green solid	Operational mode
	Yellow solid	In the process of booting
	Red solid	Error, for example, invalid receiver AUTH code Firmware/Web UI update in progress

Table 3: Positioning Status LED Description

LED Label	LED State	Description
POS	Green solid	PPP solution User Accuracy Level (UAL) operational (STEADYLINE)
	Green slow blink	RTK integer ambiguity
	Green fast blink	Single point or SBAS position PPP converging or RTK converging Velocity warning or UAL warning
	Yellow solid	No solution
	Yellow slow blink	UAL out of bounds

Table 4: INS Status LED Description

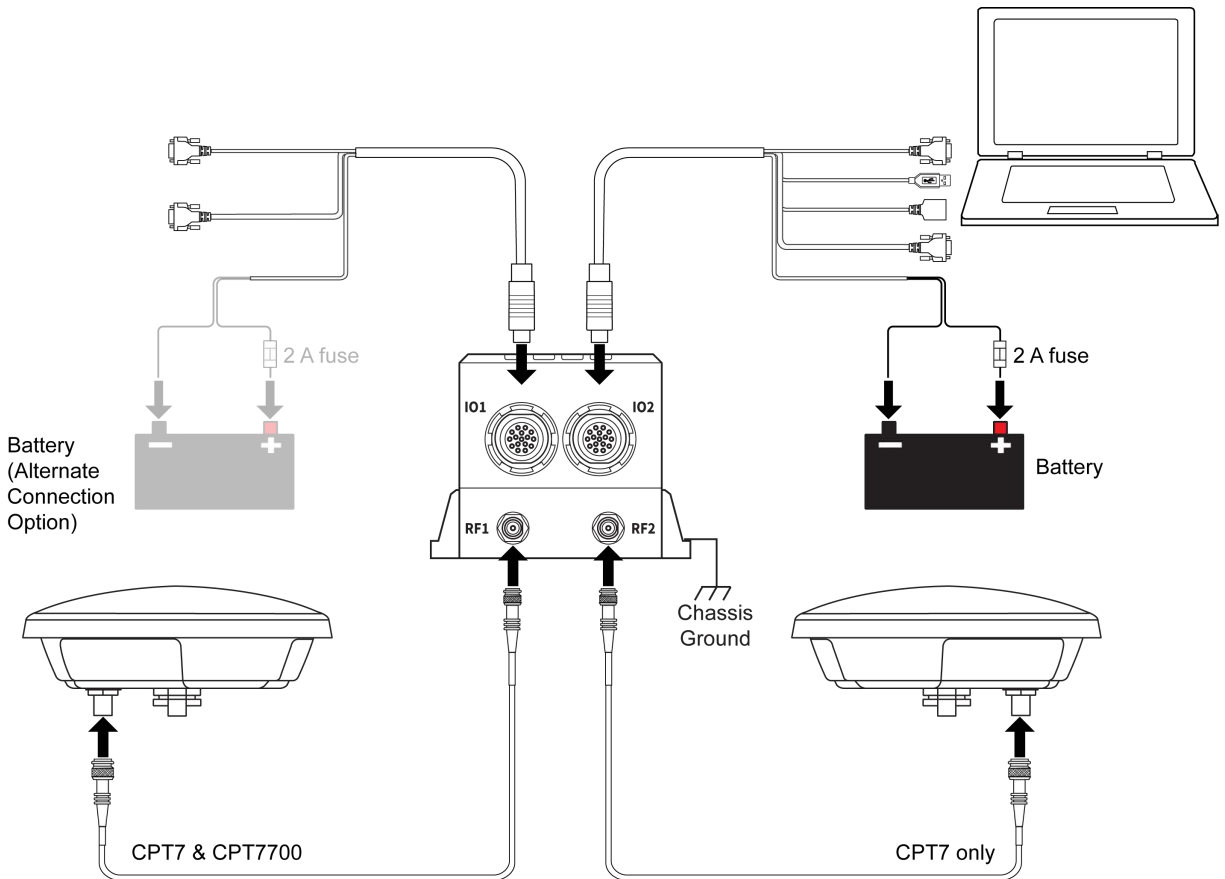
LED Label	LED State	Description
INS	Off	INS inactive
	Green solid	INS solution good
	Green slow blink	INS alignment complete
	Green fast blink	INS solution free
	Green/Yellow alternating blink	INS high variance
	Yellow slow blink	INS aligning/determining orientation
	Red solid	Error

Table 5: Logging Status LED Description

LED Label	LED State	Description
LOG	Green solid	Internal logging stopped (memory available)
	Green slow blink	Logging to internal memory (memory available)
	Green/Yellow alternating blink	Logging to internal memory (low memory)
	Yellow solid	Internal logging stopped (low memory)
	Yellow fast blink	Memory is mounting or unmounting/busy
	Red solid	Internal memory full or corrupt/bad
	Off	The CPT7 is connected to a computer as a mounted device

Setting Up A CPT7

Complete the following steps to connect and power the CPT7.



1. Mount the CPT7. See *CPT7 Mounting* on page 6 for details.



The CPT7 enclosure must be grounded.

To ground the CPT7, mount the enclosure to a grounded metal mounting plate or attach a chassis ground cable under one of the mounting screw heads.

2. Mount the GNSS antennas to a secure, stable structure with an unobstructed view of the sky.



ALIGN heading accuracy is dependent on the antenna baseline length. For best results, mount the GNSS antennas at least one metre apart.

3. Connect the primary GNSS antenna to the RF1 port.
If using a secondary GNSS antenna, connect the second GNSS antenna to the RF2 port (*CPT7 only*).

Use an SMA torque wrench to tighten the connection to 0.9 N.m (8 in-lbs) maximum.

4. Connect the interface cable to the CPT7.
 If RS-422 protocol is used for communication to the other system devices, connect the interface cable (CPT7 I/O1 Cable) to the IO1 port.
 If RS-232 protocol, USB or Ethernet is used for communication to the other system devices, connect the interface cable (CPT7 I/O2 Cable) to the IO2 port.
 If signals from both IO ports are needed, connect both interface cables to the CPT7.
 See *Table 1, CPT7 – Connector Definitions* on page 2.
5. Connect a USB, COM or Ethernet port on the CPT7 to a USB, serial or Ethernet port on a computer.
 If using a USB connection, install the USB drivers (refer to *Connect to the CPT7* on page 7).
 If RS-232 protocol is required, use COM1 which is available on the IO2 port.
 If RS-422 protocol is required, use COM2 which is available on the IO1 port.
6. Connect the power leads on the interface cable to a 9-36 VDC power supply capable of at least 18 W.



Power can be connected to **either** the IO1 or IO2 port.
Do not connect a power supply to both ports.



Ensure the VIN line is connected to the positive pole of the power source and the GND line is connected to the negative pole of the power source.

Install a user supplied 2 A slow blow fuse in the positive line of the connection to the power source to protect the power supply wiring and your warranty.

Table 6: Fuse/Holder Recommendations

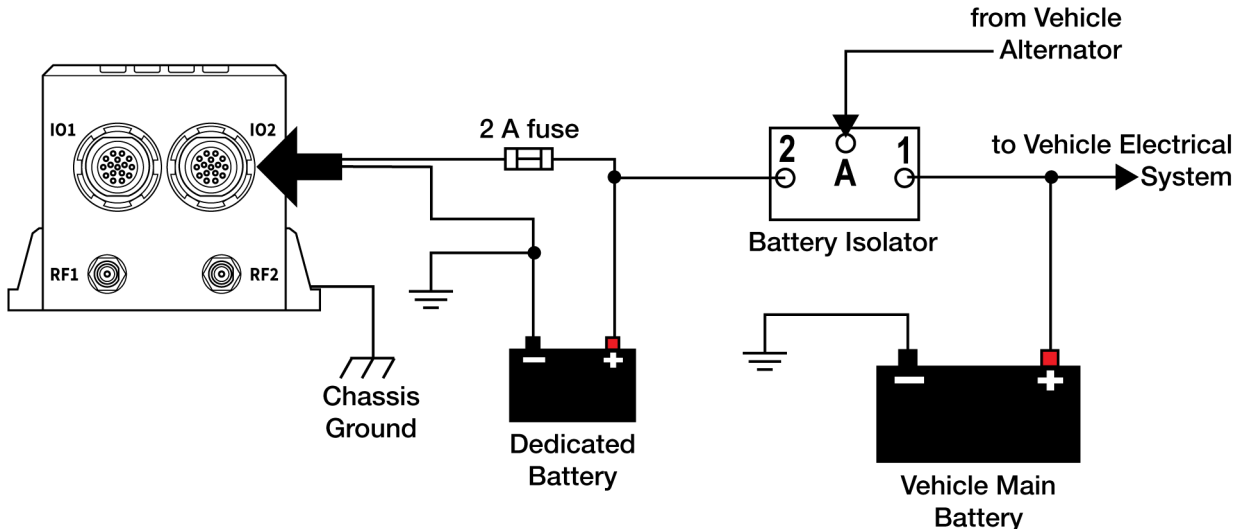
Fuse	Holder
BK/MDA-2-R Fuse (or equivalent) BK/MDL-2-R Fuse (or equivalent)	BK/HFA-R-R Fuse (or equivalent)



The fuse and holder are made by Cooper/Bussmann; available from Digikey.

Vehicle Installation

If the CPT7 is installed in a vehicle, it is recommended that a dedicated battery be provided for the CPT7 that is isolated from the engine starter battery. When a vehicle engine is started, the voltage on the starter battery can dip below the CPT7 minimum voltage or cut-out to ancillary equipment causing the receiver and/or IMU to lose lock and calibration settings.



Power can be connected to **either** the IO1 or IO2 port.

Do not connect a power supply to both ports.



The CPT7 enclosure must be grounded.

To ground the CPT7, mount the enclosure to a grounded metal mounting plate or attach a chassis ground cable under one of the mounting screw heads.

CPT7 Mounting

Mount the CPT7 and GNSS antennas securely to the vehicle. For the simplest operation, align the connectors of the CPT7 with the forward direction of travel of the vehicle and the base facing down. This coincides with X-axis forward and Z-axis down and the default RBV configuration is valid. Any other mounting requires the SETINSROTATION RBV command to be sent. Ensure that the GNSS antennas and CPT7 cannot move relative to each other. The distance and relative direction between them must be fixed.



The X, Y and Z axis are marked on the CPT7 enclosure.

To secure the CPT7 to the mounting surface, use four #6 screws that pass through the mounting holes in the CPT7 and into the mounting surface. The mounting screws should be torqued to 8 to 10 in-lbs (0.9 to 1.1 N·m).

Connect to the CPT7

To configure the CPT7 and access data from the CPT7, establish a communication session with the CPT7 using one of the following methods.

- NovAtel Application Suite
A serial (COM port), USB or Ethernet connection to the CPT7 is needed to use NovAtel Application Suite. To download NovAtel Application Suite, and the USB drivers, go to the NovAtel website: novatel.com/products/firmware-options-pc-software/novatel-application-suite. For information about using NovAtel Application Suite, to go the NovAtel website: docs.novatel.com/Tools.
- Command line interface
Through a terminal emulator, OEM7 commands and logs are used to configure and monitor the CPT7. Refer to the OEM7 User Documentation (docs.novatel.com/OEM7) for more information.

Configure the SPAN System

Follow these steps to enable INS as part of the SPAN system using software commands.

1. Establish a connection to the CPT7.



A GNSS antenna must be connected and tracking satellites for operation.

2. Enter the distance from the CPT7 center of navigation to the phase center of the GNSS antennas using the **SETINSTRANSULATION** command. Use **SETINSTRANSULATION ANT1** for the distance to the primary GNSS antenna. Use **SETINSTRANSULATION ANT2** for the distance to the secondary GNSS antenna (*CPT7 only*).

The offset between the antenna phase center and the CPT7 axes must remain constant and be known accurately. The X, Y and Z directions are clearly marked on the CPT7. The **SETINSTRANSULATION** parameters are (where the standard deviation fields are optional):

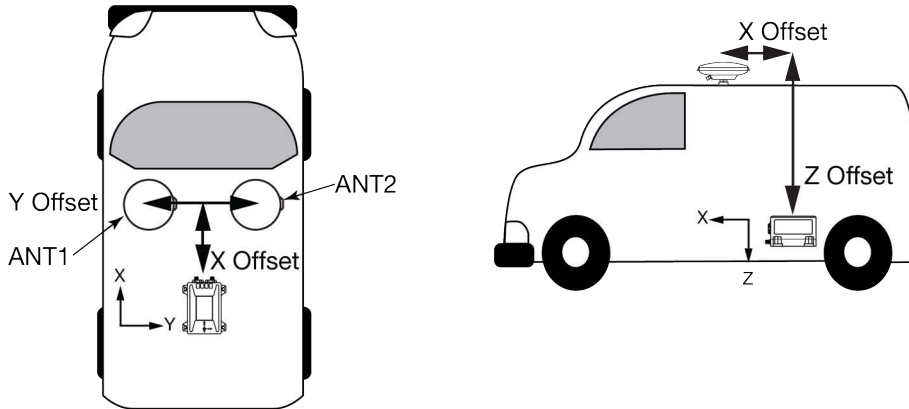
```
SETINSTRANSULATION ANT1 x_offset y_offset z_offset [x_stdev] [y_stdev] [z_stdev]  
SETINSTRANSULATION ANT2 x_offset y_offset z_offset [x_stdev] [y_stdev] [z_stdev]
```

For example, in the following scenario:

- the CPT7 is mounted on the floor in the orientation described in *CPT7 Mounting* on page 6 (positive Z down, positive X forward)
- the primary and secondary GNSS antennas are mounted on the roof of the vehicle
- the distance measured from the CPT7 to the primary GNSS antenna is 2 metres up (Z axis), 0.5 metres right (Y axis) and 1 metre forward (X axis)
the distance measured from the CPT7 to the secondary GNSS antenna is 2 metres up (Z axis), 0.5 metres left (Y axis) and 1 metre forward (X axis)

the **SETINSTRANSALATION** commands would be:

```
SETINSTRANSALATION ANT1 1.0 -0.5 -2.0  
SETINSTRANSALATION ANT2 1.0 0.5 -2.0
```



A typical RTK GNSS solution is accurate to a few centimetres. For the integrated GNSS+INS system to have this level of accuracy, the offset must be measured to within a centimetre. Any offset error between the two systems shows up directly in the output position. For example, a 10 cm error in recording this offset will result in at least a 10 cm error in the output.

If standard deviation values are entered, use non-zero values.

- The CPT7 comes pre-configured with an RBV of 180 0 90. This configuration is valid if mounting is done as described in *CPT7 Mounting* on page 6. If the CPT7 is mounted in an orientation other than the default orientation, the **SETINSROTATION** command must be sent. Using the RBV parameter, enter the Euler Angle rotation from the IMU Body frame to the Vehicle frame.

Accurate knowledge of the rotational offset between the IMU Body frame and the Vehicle frame (the RBV rotation) is critical to correctly computing an attitude solution, and is required before a Kinematic alignment is possible.

For more information about the RBV rotation, refer to *SPAN Configuration for CPT7* in the OEM7 Documentation Portal (docs.novatel.com/OEM7).

Configuration for Alignment

The CPT7 and CPT7700 can use a kinematic alignment routine. The CPT7 can alternately use a dual antenna alignment. The kinematic or moving alignment is performed by estimating the attitude from the GNSS velocity vector and injecting it into the SPAN filter as the initial system attitude. A dual antenna alignment uses the heading information from a NovAtel dual antenna ALIGN solution to rapidly perform an alignment. For information about these alignment techniques, refer to the *System Start-Up and Alignment Techniques* in the OEM7 User Documentation (docs.novatel.com/OEM7).



Regardless of system configuration and IMU orientation, the **SETINSTRANSALATION** command must be sent to the receiver before attempting a kinematic alignment.

Operate the SPAN System

The system is ready to go once it is powered and the GNSS and INS are configured using the previously shown commands.

Observe the status of the system on the *SPAN* status tile in NovAtel Application Suite or in the status field of any of the INS solution logs (for example INSPOS, INSVEL, INSATT and INSPVA).

If performing a kinematic alignment, move the vehicle forward at a speed faster than 5 m/s. The following status stages may be observed:

- The status changes from INS_INACTIVE through DETERMINING_ORIENTATION and WAITING_INITIALPOS as the initial alignment routine starts.
- Once a GNSS position is available, an initial IMU bias estimate is conducted. During this period, the INS Status field reports INITIALIZING_BIASES.
- The system will require an external azimuth input, either from vehicle motion, dual antenna input or command input. While in this state the INS Status field reports WAITING_AZIMUTH.
- The status changes to INS_ALIGNMENT_COMPLETE when the alignment is complete. After some typical vehicle motion (driving around for a few minutes with starts, stops and turns), the attitude solution converges to within specifications and the status changes to INS_SOLUTION_GOOD.
- The status may occasionally change to INS_SOLUTION_FREE. This status indicates that the inertial solution has detected poor quality GNSS positions from the receiver due to limited satellite visibility or high multi-path conditions. The inertial filter may choose to disregard this information and wait for the GNSS quality to improve. The solution is still valid during these times.

Data Logging

An extensive set of logs are available to capture data. Logs can be directed to any of the CPT7 communication ports or internal memory and can be automatically generated at regular intervals or when new or changed data becomes available. Data can also be collected using NovAtel Application Suite.

For example, to view the VERSION and BESTPOS logs on a terminal connected to COM1, enter the following commands:

```
LOG COM1 VERSIONA ONCE
LOG COM1 BESTPOSA ONTIME 1
```

Refer to the *Logging and Retrieving Data Overview* section of the OEM7 User Documentation (docs.novatel.com/OEM7) for details on logging.

Log SPAN Data

Raw GNSS, IMU and navigation data (position, velocity, attitude) are available from the system as ASCII or binary logs.

Data can be collected using the *Logging Configuration* window of NovAtel Application Suite, stored in internal memory or sent out a receiver communication port to user supplied data collection software.

For real-time applications, the GNSS+INS solution is available through the SPAN logs including INSPOS, INSVEL, INSATT and INSPVA. These logs can be collected at rates up to 200 Hz; however, there are some rate restrictions. Refer to the *Data Collection* section in the *SPAN Operation* section of the OEM7 User Documentation (docs.novatel.com/OEM7).

Onboard Memory

The CPT7 contains 16 GB of memory for onboard data storage. Data can be logged to the internal memory of the CPT7 and downloaded for post-processing. Stored data may be downloaded in two ways:

- Transfer to a computer by connecting the computer to the USB port available on IO2 (recommended)
- Transfer using FTP over Ethernet (refer to the OEM7 User Documentation (docs.novatel.com/OEM7) for Ethernet configuration instructions)

When the CPT7 is connected to a computer via the USB port, control of onboard memory can be given to the computer using the **FILEMEDIACONFIG DEFAULT_NO_STORAGE** command. This command causes the CPT7 to relinquish control of its onboard memory and the CPT7 appears as an external drive to the computer. The computer operating system can then be used to copy/move/delete files from the CPT7. To restore control of onboard memory to the CPT7, issue the command **FILEMEDIACONFIG INTERNAL_FLASH**.

To log to internal memory:

1. Set the file media to internal memory (this is the default).

```
FILEMEDIACONFIG INTERNAL_FLASH
```

2. Open a log file on internal memory.

```
FILECONFIG OPEN
```

The LOG LED begins to blink to show that a log file is open on internal memory.

3. Use the LOG command to start collecting logs to the file on internal memory. The logs must use the FILE port. For example:

```
LOG FILE VERSIONA
```

```
LOG FILE BESTPOSA ONTIME 1
```

Enter a LOG command for each log you want to collect.

4. Wait until the desired data has been collected.
5. Enter the following command to stop data collection and close the log file.

```
FILECONFIG CLOSE
```

The LOG LED changes to a solid color to indicate that the CPT7 is no longer logging to internal memory.

CPT7 Post-Processing

Post-mission data processing refers to cases where GNSS data collected by the receiver is processed after the entire data collection session is complete.

CPT7 output is compatible with Inertial Explorer post-processing software. For details, see www.novatel.com/Products/Waypoint Software.

Collecting Data for Post-Processing

Post-processing requires collection of simultaneous data from the base and rover stations. This includes accurate coordinates of the base station and accurate measurement of the IMU to antenna separation.

Collect the following data at a minimum for post-processing:

- From the base station
 - LOG VERSIONB ONCE
 - LOG RXCONFIGB ONCE
 - LOG RXSTATUSB ONCHANGED
 - LOG THISANTENNATYPEB ONCE
 - LOG RANGECMPB ONTIME 1
 - LOG GPSEPHEMB ONNEW
 - LOG GLOEPHEMERISB ONNEW (if using GLONASS)
 - LOG GALINAVEPHEMERISB ONNEW (if using Galileo)
 - LOG GALFNAVEPHEMERISB ONNEW (if using Galileo)
 - LOG BDSEPHEMERISB ONNEW (if using BeiDou)
 - LOG QZSSEPHEMERISB ONNEW (if using QZSS)
- From the rover station(s)
 - LOG VERSIONB ONCE
 - LOG RXCONFIGB ONCE
 - LOG RXSTATUSB ONCHANGED
 - LOG THISANTENNATYPEB ONCE
 - LOG HEADING2B ONNEW
 - LOG INSCONFIGB ONCHANGED
 - LOG RANGECMPB ONTIME 1
 - LOG GPSEPHEMB ONNEW
 - LOG GLOEPHEMERISB ONNEW (if using GLONASS)
 - LOG GALINAVEPHEMERISB ONNEW (if using Galileo)
 - LOG GALFNAVEPHEMERISB ONNEW (if using Galileo)
 - LOG BDSEPHEMERISB ONNEW (if using BeiDou)
 - LOG QZSSEPHEMERISB ONNEW (if using QZSS)
 - LOG RAWIMUSXB ONNEW
 - LOG TIMEB ONTIME 1
 - LOG BESTPOSB ONTIME 1
 - LOG BESTGNSSPOSB ONTIME 1
 - LOG INSPVAXB ONTIME 1
 - LOG INSUPDATESTATUSB ONCHANGED
 - LOG DMICONFIGB ONCHANGED (if using a DMI sensor)
 - LOG RAWDMIB ONNEW (if using a DMI sensor)

Additional Functionality

Additional features, such as RTK, PPP, SBAS and the Interference Toolkit, are available on the CPT7. Refer to the OEM7 User Documentation (docs.novatel.com/OEM7) for set up and installation instructions for other functionality.

Questions or Comments

If you have any questions or comments regarding your CPT7 product, contact NovAtel Customer Service using one of these methods

Log a Case and Search Knowledge:

Website: novatel.com/support

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

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

Email: support.novatel@hexagon.com

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



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