



HEXAGON



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Application Note

ALIGN Heading and GNSS Relative Positioning for OEM7



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Overview

This application note provides an overview of NovAtel's ALIGN solution, including the ALIGN Heading and ALIGN Relative Positioning options for NovAtel's OEM7 series of receivers. Both receiver software configurations and hardware setup are discussed.

NovAtel's ALIGN technology combines two or more receivers to generate precise positioning and heading for dynamic applications. ALIGN uses GPS, GLONASS, Galileo and BeiDou systems to provide the best solution accuracy and availability for applications such as marine, aviation, land vehicles, etc.

Heading information can be logged at selectable rates¹ up to 20Hz. The Master receiver position accuracy can be enhanced by providing TerraStar, SBAS or RTK corrections.

ALIGN Models

There are two available ALIGN models:

ALIGN Heading

ALIGN Heading provides angular heading and pitch measurements between two receivers for real-time navigation. For ALIGN Heading feature, the fifth character of the ALIGN Rover receiver's model is "Z". The following logs provide outputs for the ALIGN Heading operation:

Table 1: ALIGN heading logs

Log	Description
MASTERPOS	Position of the ALIGN Master receiver
HEADING2	Heading and pitch angles with ROVERID (from Master receiver to Rover receiver)
GPHDT	NMEA heading angle
GPHDTDUALANTENNA	NMEA heading angle (synchronous output)
DUALANTENNAHEADING	Heading information for dual-antenna receivers
ALIGNDOP	DOP of heading computation
HEADINGRATE	Rate of change of the heading parameters
HEADINGSATS	Overview of the numbers of the satellites being used in the heading solution

¹ Options are 1, 2, 4, 5, 10 or 20 Hz.

ALIGN Relative Positioning

ALIGN Relative Positioning ² provides angular heading and pitch measurements, relative positioning measurements and relative baseline information with centimetre level accuracy between two or more receivers for monitoring and automation. For ALIGN Relative Positioning feature, the fifth character of the ALIGN Rover receiver's model is "Y".

The following logs provide outputs for the ALIGN Heading operation:

Table 2: ALIGN relative positioning logs

Log	Description
MASTERPOS	Position of the ALIGN Master receiver
ROVERPOS	Position of ALIGN Rover relative to the ALIGN Master
ALIGNBSLNXYZ	ECEF vector between ALIGN Master and ALIGN Rover
ALIGNBSLNENU	Easting, Northing, Altitude vector between ALIGN Master and ALIGN Rover
HEADING2	Heading and pitch angles with ROVERID (from Master receiver to Rover receiver)
GPHDT	NMEA heading angle
GPHDTDUALANTENNA	NMEA heading angle (synchronous output)
DUALANTENNAHEADING	Heading information for dual-antenna receivers
ALIGNDOP	DOP of heading computation
HEADINGRATE	Rate of change of the heading parameters
HEADINGSATS	Overview of the numbers of the satellites being used in the heading solution

ALIGN Setup

An ALIGN solution typically requires two receivers. One of these receivers operates as an ALIGN Master receiver which sends correction information to the other receiver operating as the ALIGN Rover receiver. The Rover receiver requires either an active ALIGN heading model or relative positioning model. The Master receiver does not need to have an ALIGN capable model, although a minimum of GPS + GLONASS L1 and L2 tracking capability is recommended.

A typical ALIGN setup includes:

- Two NovAtel OEM7 receivers, at least one with an active ALIGN model.
- Two suitable (ideally at minimum GPS+GLONASS, L1 and L2 capable) antennas.
- Data communication link between the two receivers.

It is possible to use a combination of a NovAtel OEM7 receiver and a NovAtel OEM6, or an older NovAtel receiver like OEM-V for an ALIGN setup. For ALIGN configuration of a NovAtel OEM6 or OEM-V receiver, please refer to the [ALIGN Heading and Relative Positioning for OEM6 and OEMV Application Note](#).

² Within this application note, relative positioning refers to GNSS relative positioning and should not be confused with SPAN relative positioning.

For use of ALIGN in SPAN applications, please refer to the [SPAN with ALIGN Application Note](#).

Examples for data communication links are serial, USB, a two-way data radio, Wi-Fi, CAN or Ethernet. For ALIGN operation rates of 10 Hz or higher, the communication data link between the receivers should support at least 230400 bits per second baud rate.

On dual-antenna NovAtel receivers or enclosure products (PwrPak7D), ALIGN functionality needs to be enabled in the dual-antenna receiver model. The primary antenna operates as the ALIGN Master antenna, the secondary antenna operates as the ALIGN Rover. A dual-antenna NovAtel receiver can operate as an ALIGN Master receiver for another receiver operating as an ALIGN Rover, or it can operate as an ALIGN Rover receiver to another receiver operating as the ALIGN Master. Both scenarios are explained in more detail in the following pages.

For every ALIGN setup, the quality of the ALIGN solution depends on the baseline distance between the two antennas and the number of common satellites between the Master and Rover. ALIGN solution can generate the heading angle between two antennas to an accuracy of 0.2 degrees when the antennas are separated by 1 meter. The antennas should be mounted where the view of the satellites is not obstructed by any part of the setup or the operational environment.

Table 3: ALIGN accuracy

	0.5 m Baseline	1 m Baseline	2 m Baseline
Dual Frequency – Fixed Heading Accuracy	0.40 degrees	0.20 degrees	0.10 degrees

Corrections and ALIGN

OEM7 receivers that act as an ALIGN Rover can simultaneously act as a DGNSS, PPP or RTK rover as well. This is an improvement over the previous generations of receivers, where the receiver could be either an ALIGN rover or a DGNSS/PPP/RTK Rover.

An OEM7 receiver acting as both an ALIGN Rover and a DGNSS/PPP/RTK rover will show two independently calculated positions: [ROVERPOS](#) and [BESTPOS](#).

The position reported in the ROVERPOS output log is a highly accurate relative position which uses the position of the ALIGN Master receiver as a reference. This position may not be accurate in the absolute sense, compared to the absolute position of the rover on Earth. The absolute accuracy of the reported ROVERPOS position depends on the accuracy of the absolute position of the ALIGN Master receiver. If the ALIGN Master receiver is using DGNSS, PPP or RTK corrections to calculate its position, the absolute position accuracy of the ALIGN Rover receiver, as reported in the ROVERPOS output log, will be very similar to the accuracy of the position of the ALIGN Master receiver.

The position reported in the BESTPOS log of the ALIGN Rover receiver will have an absolute position accuracy dependent on the quality of the external corrections used, such as DGNSS, PPP or RTK. The ALIGN corrections the ALIGN Rover is receiving from the ALIGN Master define the accuracy of the relative positioning between the ALIGN receivers. ALIGN corrections have no effect on the accuracy of the BESTPOS position of the ALIGN Rover. Positions and position accuracies reported in the ROVERPOS and BESTPOS logs can be similar, however they are separate computations.

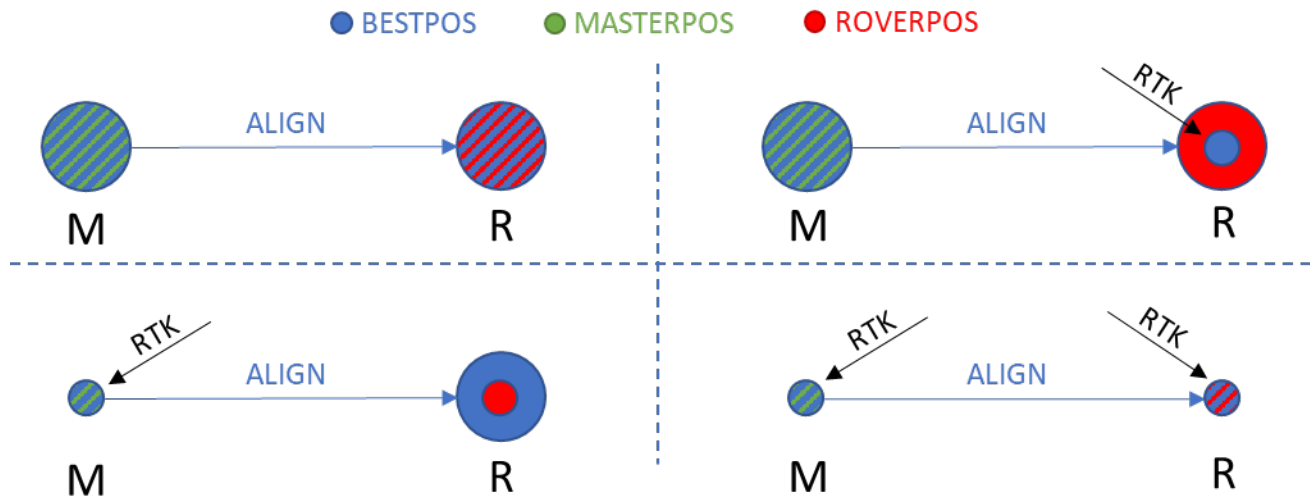


Figure 1: Reported absolute position accuracy for ALIGN Master and Rover in RTK differential correction scenarios










To make sure the ALIGN corrections and the DGNSS/PPP/RTK corrections are processed correctly, the receiver port needs to be configured for the type of correction received at that port. This is achieved by using the [RTKPORTMODE](#) command. A communication port is configured to accept ALIGN corrections by sending the command “RTKPORTMODE [port] ALIGN” to the receiver. When the plug-and-play method is for ALIGN configuration, the RTKPORTMODE of the Rover port being used for ALIGN is configured automatically.

ALIGN plug and play only works over an RS232 connection, all other communication links (Ethernet, Wi-Fi, CAN, USB) require manual ALIGN configuration.

Use Cases

A variety of symbols are used in this application note to depict ALIGN output symbols. The meaning of each symbol is given below:

Table 4: Use case legend

	Master
	Rover (unsolved position)
	Rover (solved position)
	Master and Rover
	North
	Baseline/Vector
	Heading
	Heading angle
	Pitch angle

1: Fixed Antenna Distance Between Master and Rover Receivers on a Single Platform

This use case requires one Master and one Rover receiver. Typically in this setup, the Rover needs the ALIGN Heading model since the baseline between the antennas is fixed. [Figure 2](#) provides an example where the Master and Rover receivers are located on the same vehicle, and the two antennas are located at a fixed distance from one another. The ALIGN solution is computed with respect to the antenna of the Master receiver:

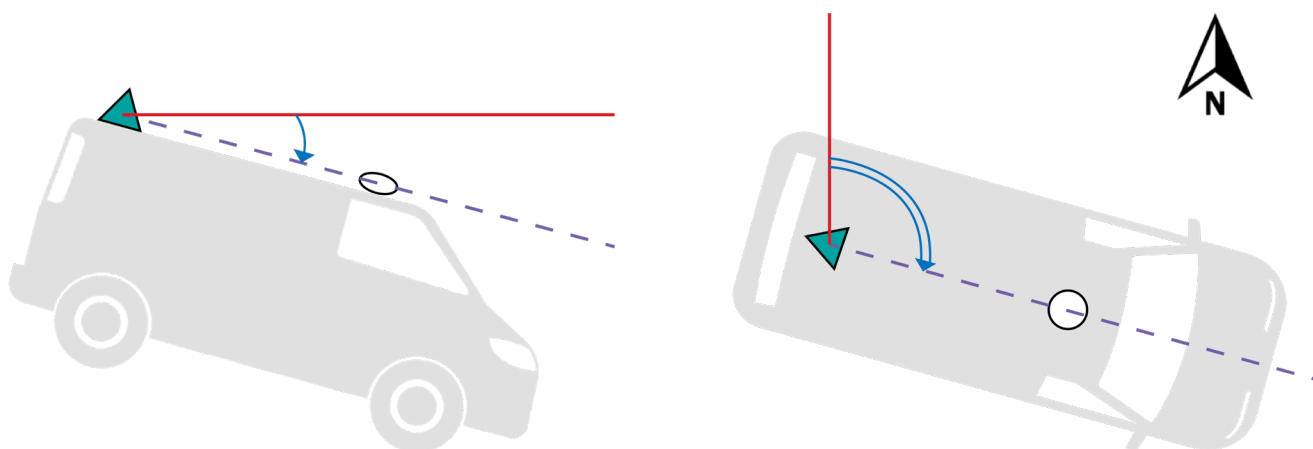


Figure 2: Heading from two receivers on one vehicle

In this setup, Master and Rover are connected over a serial port with a NULL modem. There are two possible ways to set up this use case. One uses ALIGN's plug and play functionality and the other requires manual configuration of the two receivers.



Plug and Play with Cable

For this example, the NULL modem cable connects the COM2 port of the Rover to an available serial port of the Master receiver. ALIGN function is triggered at 10 Hz rate, uses a baudrate of 230400 bps and Rover sends the [HEADINGEXT2](#) log back to the Master:

1. Initiate ALIGN from the Rover receiver by entering the following command:

```
ALIGNAUTOMATION ENABLE COM2 230400 10 ON
```

2. To access heading data, ALIGN heading logs can be logged at either the ALIGN Master or Rover.

Manual Configuration with Cable

For this example, the NULL modem cable is connected to the COM2 port on the Master receiver and the COM3 port on the Rover receiver. ALIGN function is triggered at 10 Hz, uses a baudrate of 230400 bps and Rover sends the [HEADINGEXT2](#) log back to the Master:

1. Issue the following commands to the ALIGN Master:³

```
MOVINGBASESTATION ENABLE  
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
SERIALCONFIG COM2 230400 N 8 1 N OFF  
LOG COM2 NOVATELXOBS ONTIME 0.1  
LOG COM2 NOVATELXREF ONTIME 0.1  
SAVECONFIG (recommended)
```

2. Issue the following commands to the ALIGN Rover:

```
INTERFACEMODE COM3 NOVATEL NOVATEL OFF  
SERIALCONFIG COM3 230400 N 8 1 N OFF  
RTKPORTMODE COM3 ALIGN3  
LOG COM3 HEADINGEXT2B ONNEW  
SAVECONFIG (recommended)
```

3. To access heading data, ALIGN logs can be logged at either the ALIGN Master or Rover.

³ If the Rover receiver has an "L" as the fourth character of the receiver model, the RTKPORTMODE command is not needed and should be omitted.

Manual Configuration over Ethernet

ALIGN can be configured between a Master and Rover that are connected to a local network. In this example, the ALIGN Master is assigned a static IP address 192.168.2.15, the ALIGN Rover is assigned a static IP address 192.168.2.20. ALIGN feature is triggered at 10 Hz and Rover sends the [HEADINGEXT2](#) log back to the Master:

1. Issue the following commands to the ALIGN Master:

```
ETHCONFIG ETHA AUTO AUTO AUTO NORMAL
IPCONFIG ETHA STATIC 192.168.2.15 255.255.255.0 192.168.2.1
MOVINGBASESTATION ENABLE
ICOMCONFIG ICOM1 TCP :3001
INTERFACEMODE ICOM1 NOVATEL NOVATEL OFF
LOG ICOM1 NOVATELXOBS ONTIME 0.1
LOG ICOM1 NOVATELXREF ONTIME 0.1
SAVECONFIG (recommended)
```

2. Issue the following commands to the ALIGN Rover:

```
ETHCONFIG ETHA AUTO AUTO AUTO NORMAL
IPCONFIG ETHA STATIC 192.168.2.20 255.255.255.0 192.168.2.1
ICOMCONFIG ICOM1 TCP 192.168.2.15:3001
INTERFACEMODE ICOM1 NOVATEL NOVATEL OFF
RTKPORTMODE ICOM1 ALIGN3
LOG ICOM1 HEADINGEXT2B ONNEW
SAVECONFIG (recommended)
```

3. To access the heading data, ALIGN logs can be logged at either of the ALIGN Master or Rover.

Some users may prefer to save the Ethernet configuration on their devices with the [SAVEETHERNETDATA](#) command. The configuration saved with this command survives a [RESET](#) or [FRESET](#) on the device.

Manual Configuration via Wi-Fi

When two OEM7 receivers with built-in Wi-Fi module⁴ are used in an ALIGN setup and the distance between the two receivers is less than their Wi-Fi range (approximately 30 meters⁵), the ALIGN connection between the two receivers can be set up over Wi-Fi. This method is similar to the method described previously with two receivers connected to a local Ethernet network, but the Wi-Fi setup requires specific configuration to establish the connection between the two receivers.

For the example here, the ALIGN Master receiver is acting as the Wi-Fi access point and the ALIGN Rover receiver is acting as a Wi-Fi client to the access point of the ALIGN Master receiver. The ALIGN Master receiver uses its default Wi-Fi IP address 192.168.19.1, the ALIGN Rover uses the IP address that is assigned to it via DHCP by the Wi-Fi access point of the ALIGN Master.

Similar to the Ethernet example, ALIGN is configured to 10 Hz rate, and the communication between the two receivers uses the UDP protocol.

⁴ OEM7 receivers with built-in Wi-Fi module: Smart7-W, Smart7-I, Smart7-SI, Smart7-S and all variants of the PwrPak7 and PwrPak7D, except for the PwrPak7M, PwrPak7MD, PwrPak7Q and PwrPak7QD variants.

⁵ The actual Wi-Fi range highly depends on the environmental conditions in which the receivers are being used and may be considerably less than 30 meters under adverse conditions or when other nearby Wi-Fi access points are active in the 2.4 GHz Wi-Fi band.



1. Issue the following commands to the ALIGN Rover:

```
WIFIMODE CLIENT
LOG WIFINETLIST ONCHANGED
```

2. Issue the following command to the ALIGN Master:

```
LOG WIFIAPSETTINGS
```

The first data field in the response shows you the name of the access point of the receiver, the second data field in the response shows the WPA2 access key of the access point.

3. On the ALIGN Rover, when the access point name of the ALIGN Master shows up in the list of access points, send the commands:

```
UNLOG WIFINETLIST
WIFINETCONFIG 1 ENABLE <name of the access
point of the ALIGN Master receiver> <WPA access key
of the ALIGN Master receiver> DHCP
LOG IPSTATUS
```

It may take a bit of time before the Wi-Fi connection is established, monitor the IPSTATUS log until the "WIFI_CLIENT" line shows a valid IP address starting with "192.168.19".

4. Issue the following commands to the ALIGN Master:

```
MOVINGBASESTATION ENABLE
ICOMCONFIG ICOM1 UDP :3001
INTERFACEMODE ICOM1 NOVATEL NOVATEL OFF
LOG ICOM1 NOVATELXOBS ONTIME 0.1
LOG ICOM1 NOVATELXREF ONTIME 0.1
SAVECONFIG (recommended)
```

5. Issue the following commands to the ALIGN Rover:

```
ICOMCONFIG ICOM1 UDP 192.168.19.1:3001
INTERFACEMODE ICOM1 NOVATEL NOVATEL OFF
RTKPORTMODE ICOM1 ALIGN3
LOG ICOM1 HEADINGEXT2B ONNEW
SAVECONFIG (recommended)
```

6. To access heading data, ALIGN logs can be logged at either the ALIGN Master or Rover.

Using a Dual-antenna Receiver

By far the easiest method for a single-platform ALIGN solution is by using a dual-antenna receiver. With a dual-antenna receiver, the ALIGN solution is available from the receiver almost instantly.

The rate at which the ALIGN messages are generated and output on a dual-antenna receiver is controlled by the [DUALANTENNAALIGN](#) command. By default, the internal ALIGN process runs at a rate of 1 Hz, and this can be increased to a maximum of 20 Hz if needed.



2: Master and Rover Receivers on Separate Moving Platforms

This use case requires one Master receiver and one Rover receiver. Typically in this setup, the ALIGN Rover needs the ALIGN Relative Positioning model since the baseline between the Master and Rover changes during operation. [Figure 3](#) illustrates the Master receiver on a vessel and the Rover receiver located in a fighter jet. The ALIGN solution is computed with respect to the Master receiver.

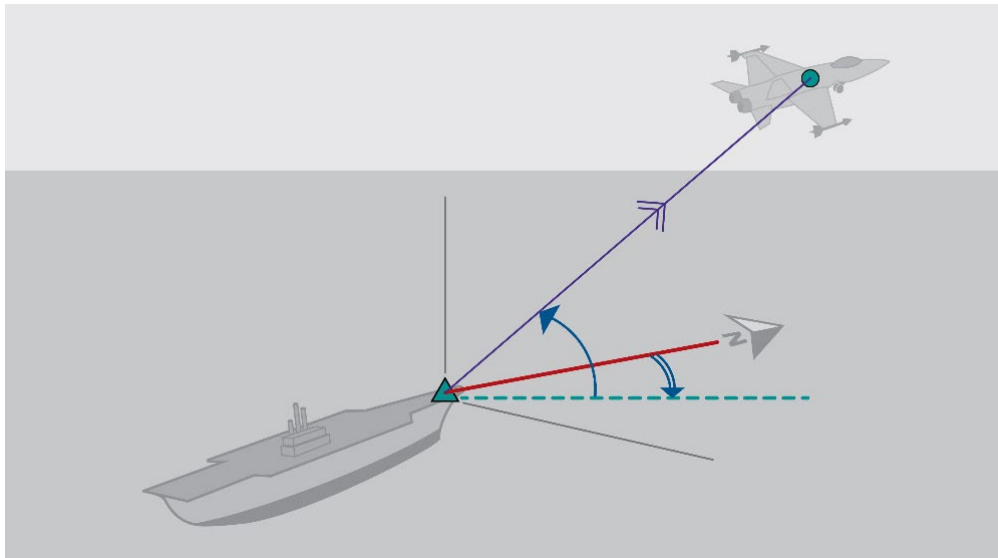


Figure 3: Heading from two receivers on separate platforms

There are two possible ways to set up this use case: the ALIGN plug and play functionality and manual receiver configuration.

Plug and Play with Wireless Data Link

For this example, the ALIGN relative positioning data is output at 10 Hz.

1. Make sure the wireless data link is configured for two-way communication and both transceivers are using the same baud rate (e.g. 230400 bps).
2. Connect one transceiver of the wireless data link to an available COM port on the Master receiver, for example COM2, and configure the Master receiver COM port to communicate at the same baud rate as the wireless transceiver using the [SERIALCONFIG](#) command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

3. Connect the other transceiver of the wireless data link to COM2 of the Rover receiver.
4. Initiate ALIGN from the Rover receiver by entering the following command:

```
ALIGNAUTOMATION ENABLE COM2 230400 10 ON
```

5. To access heading and relative positioning data, ALIGN relative positioning logs can be logged at either of the ALIGN Master or Rover.



Manual Configuration with Wireless Data Link

For this example, the ALIGN relative positioning data is output 10 Hz.

1. Make sure the wireless data link is configured for two-way communication and both transceivers are using the same baud rate (e.g. 230400 bps).
2. Connect one transceiver of the wireless data link to an available COM port on the Master receiver, for example COM2, and configure the Master receiver COM port to communicate at the same baud rate as the wireless transceiver using the [SERIALCONFIG](#) command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

3. Connect the other transceiver of the wireless data link to COM2 of the Rover receiver and configure the Rover receiver COM port to communicate at the same baud rate as the wireless transceiver using the [SERIALCONFIG](#) command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

4. Issue the following commands to the ALIGN Master:

```
MOVINGBASESTATION ENABLE  
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
LOG COM2 NOVATELXOBS ONTIME 0.1  
LOG COM2 NOVATELXREF ONTIME 0.1  
SAVECONFIG (recommended)
```

5. Issue the following commands to the ALIGN Rover:

```
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
RTKPORTMODE COM2 ALIGN3  
LOG COM2 HEADINGEXT2B ONNEW  
SAVECONFIG (recommended)
```

6. To access heading and relative positioning data, ALIGN relative positioning logs can be logged at either the ALIGN Master or Rover.



3: Single Master with Multiple Rovers

This use case demonstrates one ALIGN Master and multiple Rover receivers. There is one main Master receiver set up on one platform as a moving reference, with multiple Rovers set up on other platforms. [Figure 4](#) illustrates the main Master receiver on a seismic research vessel. The Rover receivers are located in a series of buoys. The ALIGN solution is computed with respect to the Master receiver.

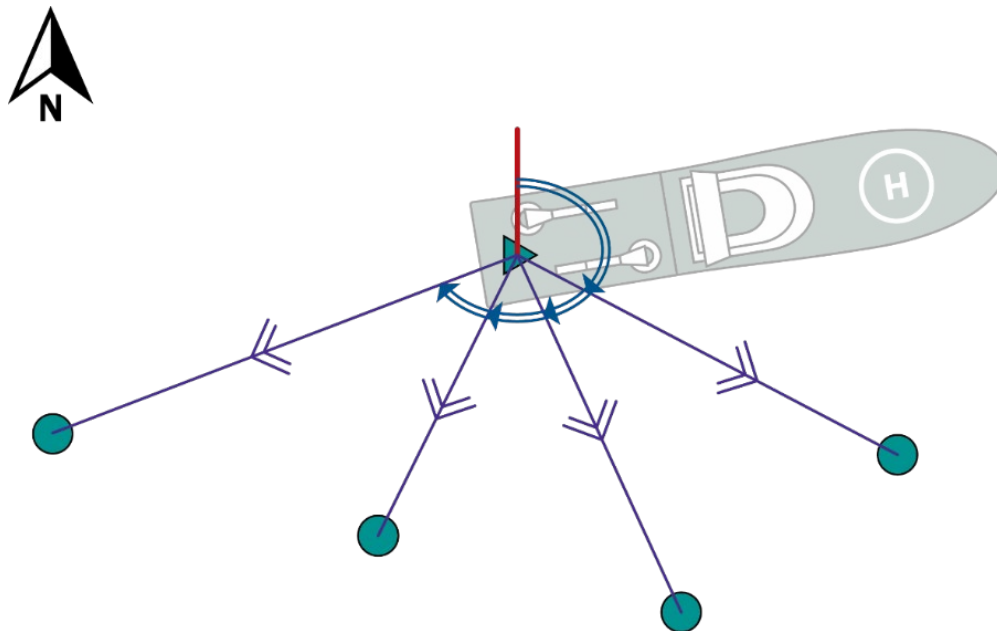


Figure 4: Single Master with multiple rovers ALIGN setup

Manual Configuration with Wireless Data Link

For this example, we will assume the ALIGN relative positioning data should be output 10 times per second. Each connection between the Master and a Rover receiver requires a dedicated data link/transceiver pair. The maximum number of Rover receivers is limited by the amount of available COM ports on the Master receiver.

1. Make sure the wireless data link is configured for two-way communication, both transceivers are using the same baud rate (e.g. 230400 bps) and the frequency at which the transceivers are operating is not being used by any of the other wireless transceiver pairs.
2. Connect one transceiver of the wireless data link to the first available COM port on the Master receiver, for example COM1, and configure the Master receiver COM port to communicate at the same baud rate as the wireless transceiver using the [SERIALCONFIG](#) command:

```
SERIALCONFIG COM1 230400 N 8 1 N OFF
```

3. Issue the following commands to the ALIGN Master:

```
MOVINGBASESTATION ENABLE  
INTERFACEMODE COM1 NOVATEL NOVATEL OFF  
LOG COM1 NOVATELXOBS ONTIME 0.1  
LOG COM1 NOVATELXREF ONTIME 0.1  
SAVECONFIG (optional)
```



4. Connect the other transceiver of the wireless data link to COM2 of the first Rover receiver and configure the Rover receiver COM port to communicate at the same baud rate as the wireless transceiver using the [SERIALCONFIG](#) command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

5. Issue the following commands to the ALIGN Rover:

```
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
RTKPORTMODE COM2 ALIGN3  
LOG COM2 HEADINGEXT2B ONNEW  
SAVECONFIG (optional)
```

6. Connect one transceiver of the wireless data link between the Master receiver and the next Rover receiver to the next available COM port on the Master receiver, for example COM2, and configure the Master receiver COM port to communicate at the same baud rate as the wireless transceiver using the [SERIALCONFIG](#) command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

7. Issue the following commands to the ALIGN Master:

```
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
LOG COM2 NOVATELXOBS ONTIME 0.1  
LOG COM2 NOVATELXREF ONTIME 0.1  
SAVECONFIG (optional)
```

8. Configure COM2 of the next Rover receiver to receive corrections as described in step 4.

9. Issue the following commands to the ALIGN Rover:

```
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
RTKPORTMODE COM2 ALIGN3  
LOG COM2 HEADINGEXT2B ONNEW  
SAVECONFIG (optional)
```

10. Repeat steps 6 through 9 for the remaining COM ports on the Master receiver and/or until all Rover receivers have been configured.
11. To access heading and relative positioning data, ALIGN relative positioning logs can be logged at either the ALIGN Master or each of the Rover receivers.

In a case where one Master receiver is connected to multiple Rover receivers, the 10th data field of the [HEADING2](#) log, which contains the unique Rover ID, can be used to identify and process the data coming from the various Rover receivers.

4: Dual-Antenna Receiver as ALIGN Master for an External ALIGN Rover

When a dual-antenna receiver is used as the Master receiver of an ALIGN pair, the position of its primary antenna will be the reference for both its internal ALIGN calculations and the ALIGN calculations to the external receiver. This is a very similar situation to the “single Master with multiple Rovers” use case described on the previous pages, with the exception that the “internal” baseline of the dual-antenna receiver does not need any setup.

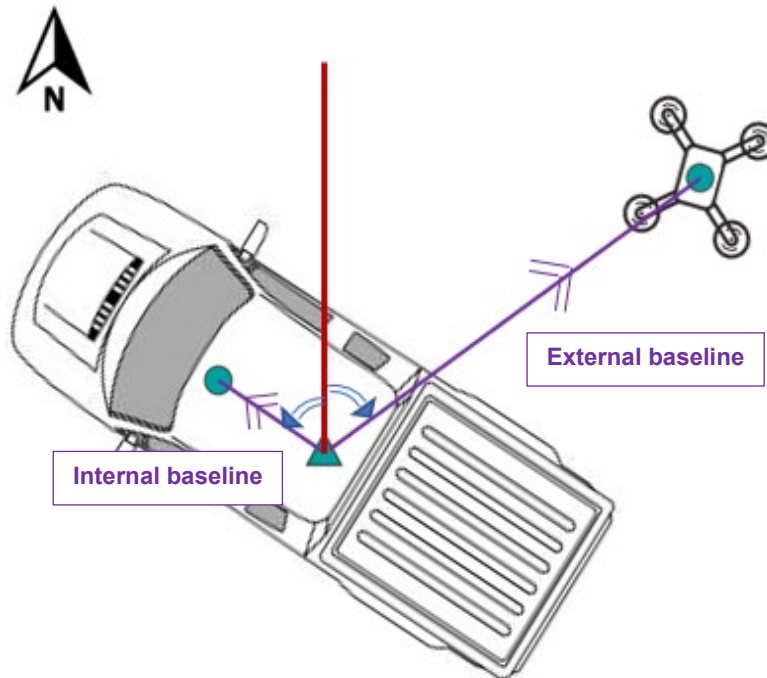


Figure 5: Dual-antenna receiver as ALIGN Master for an external ALIGN Rover

In [Figure 5](#), the heading of the vehicle is calculated using a dual-antenna receiver with antennas on the roof of the vehicle. The primary antenna of the dual-antenna receiver is also the reference point for the heading and baseline calculations between the vehicle and the drone, which only has a single-antenna receiver because of size and weight restrictions.

When the [HEADING2](#) log is requested on the dual-antenna receiver, two different and independent HEADING2 logs are output by the receiver: one for the “internal” heading and baseline (the heading and baseline calculated between the primary and secondary antenna of the dual-antenna receiver) and one for the “external” heading and baseline (the heading and baseline between the primary antenna of the dual-antenna receiver and the (primary) antenna of the external Rover receiver. On the single-antenna receiver, the HEADING2 log only shows the “external” heading and baseline.

On a dual-antenna Master receiver with relative positioning model, when the [ROVERPOS](#) log is requested, the receiver will output two different and independent ROVERPOS logs, one for the position of the secondary antenna of the dual-antenna receiver and one for the position of the (primary) antenna of the external ALIGN Rover receiver. The same holds true for [ALIGNBSLNENU](#), [ALIGNBSLNXYZ](#), [GPHDT](#) and [HEADINGRATE](#). The [ALIGNDOP](#), [DUALANTENNAHEADING](#), [GPHDTDUALANTENNA](#) and [HEADINGSATS](#) logs only provide output regarding the internal baseline and heading of the receiver.

There are two relatively easy ways of telling the different HEADING2 and ROVERPOS messages apart. The first one is looking at fields 10 and 11 of the HEADING2 log, and field 12 of the ROVERPOS log output. When all these fields are identical, the logs contain data about the internal ALIGN solution of the dual-antenna receiver. When one of these fields in the HEADING2 log differs from the others, the log contains data about the external ALIGN solution between the dual-antenna receiver and the external Rover receiver.

Another way of telling whether a HEADING2 log is showing data about the internal ALIGN solution of a dual-antenna receiver or the external ALIGN solution between a dual-antenna receiver and an external Rover receiver, is by looking at field 16 (Solution Source) of the HEADING2 log. For an internal ALIGN solution, this field will report "04", indicating the data in the log were calculated using the secondary antenna of the receiver as the ALIGN Rover. For an external ALIGN solution, this field will report "00", indicating the data in the log was calculated using the primary antenna of an external receiver as the ALIGN Rover.

For ALIGNBSLNENU and ALIGNBSLNXYZ, fields 10 and 11 will show the same information as the fields 10 and 11 of the HEADING2 message. When using a dual-antenna receiver as a Master to an external ALIGN Rover receiver, it is recommended to use the GPHDTDUALANTENNA log instead of GPHDT. The values presented in the "normal" GPHDT log will alternate between the internal and external baseline, but the log itself does not give any indication on which of these two baselines the values in the current log belong to. On a dual-antenna receiver, the GPHDTDUALANTENNA log provides only information about the internal baseline.

When the HEADING2 log and ROVERPOS logs are requested on an external (single antenna) ALIGN Rover receiver, only the information about the external ALIGN solution is reported. Information about the internal ALIGN solution of the dual-antenna ALIGN Master receiver is not transmitted to an external ALIGN Rover receiver. Further details can be looked up in DUALANTENNAHEADING or GPHDTDUALANTENNA logs.



5: Daisy-Chain ALIGN setup

This use case illustrates multiple Master and Rover receivers in a daisy chain type setup. There is one main Master receiver on one platform as a moving reference, with multiple Rovers on other platforms. Each Rover can act as the Master receiver for the next Rover receiver by transmitting ALIGN corrections to the next receiver.

[Figure 6](#) illustrates the main Master receiver on a seismic research vessel. The Rover receivers are located in a series of buoys, with each Rover receiver acting as a Master for the next receiver. Relative heading and pitch are computed with respect to its linking Master receiver. The [HEADING2](#) log is useful in this kind of configuration since it will show you the receiver IDs of both the Master and Rover receiver used to generate the data in the log.

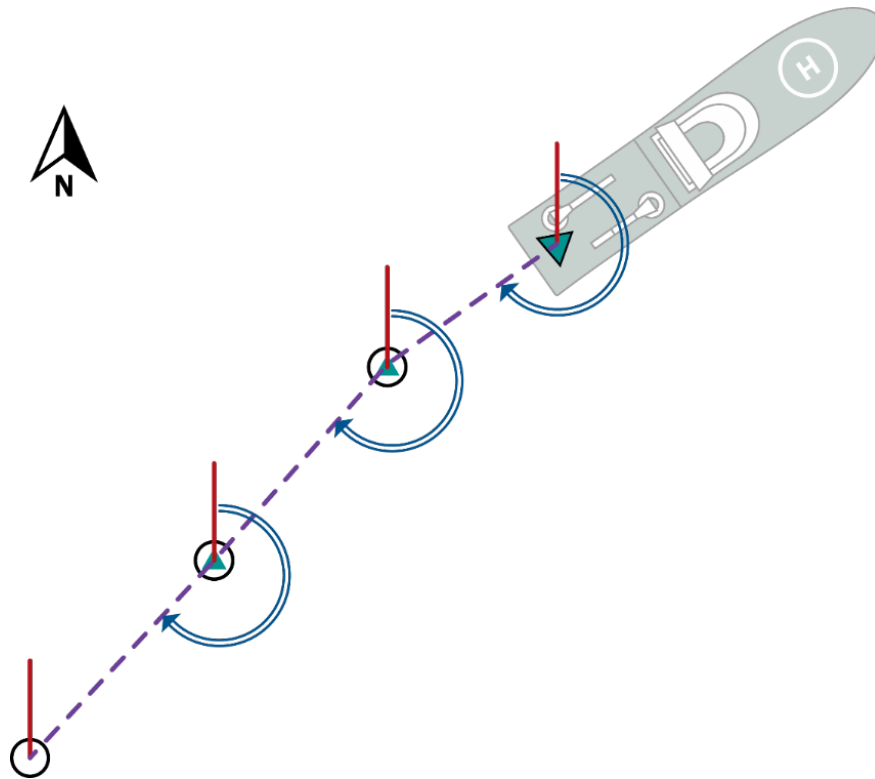


Figure 6: Daisy-Chain ALIGN setup

Plug and Play with Wireless Data Link

For this example, we will assume the ALIGN relative positioning data should be output 10 times per second.

1. Make sure the wireless data link is configured for two-way communication, both transceivers are using the same baud rate (e.g. 230400 bps) and the frequency at which the transceivers are operating is not being used by any of the other wireless transceiver pairs.
2. Connect one transceiver of the wireless data link to an available COM port on the first Master receiver, for example COM2, and configure the Master receiver COM port to communicate at the same baud rate as the wireless transceiver using the SERIALCONFIG command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```



3. Connect the other transceiver of the wireless data link to COM2 of the first Rover receiver and configure the Rover receiver COM port to communicate at the same baud rate as the wireless transceiver using the [SERIALCONFIG](#) command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

4. Initiate ALIGN from the Rover receiver by entering the following command:

```
ALIGNAUTOMATION ENABLE COM2 230400 10 OFF
```

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

If the ALIGN Master receiver is an OEM-V receiver, the command is:

```
ALIGNAUTOMATION ENABLE COM2 230400 10 OFF RTCA
```

5. Configure COM1 of the first Rover receiver to send corrections to the next Rover station. Connect a wireless data link to COM1 and set the Rover's COM1 baud rate to be the same as the baud rate of the wireless transceiver using the SERIALCONFIG command:

```
SERIALCONFIG COM1 230400 N 8 1 N OFF
```

6. Configure COM2 of the next Rover receiver to receive corrections as described in step 3.
7. Initiate ALIGN from the next Rover receiver as described in step 4.
8. Configure COM1 of the next Rover receiver to send corrections to the next Rover station in line as described in step 5.
9. Repeat steps 6, 7 and 8 until all receivers have been configured.
10. To access heading and relative positioning data, ALIGN logs must be logged at each ALIGN Rover.

Manual Configuration with Wireless Data Link

For this example, we will assume the ALIGN relative positioning data should be output 10 times per second.

1. Make sure the wireless data link is configured for two-way communication, both transceivers are using the same baud rate (e.g. 230400 bps) and the frequency at which the transceivers are operating is not being used by any of the other wireless transceiver pairs.
2. Connect one transceiver of the wireless data link to an available COM port on the first Master receiver, for example COM2, and configure the Master receiver COM port to communicate at the same baud rate as the wireless transceiver using the SERIALCONFIG command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

3. Issue the following commands to the ALIGN Master:

```
MOVINGBASESTATION ENABLE  
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
LOG COM2 NOVATELXOBS ONTIME 0.1  
LOG COM2 NOVATELXREF ONTIME 0.1  
SAVECONFIG (optional)
```



4. Connect the other transceiver of the wireless data link to COM2 of the first Rover receiver and configure the Rover receiver COM port to communicate at the same baud rate as the wireless transceiver using the SERIALCONFIG command:

```
SERIALCONFIG COM2 230400 N 8 1 N OFF
```

5. Issue the following commands to the ALIGN Rover:

```
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
RTKPORTMODE COM2 ALIGN3  
SAVECONFIG (optional)
```

6. Configure COM1 of the first Rover receiver to send corrections to the next Rover station. Connect a wireless data link to COM1 and set the Rover's COM1 baud rate to be the same as the baud rate of the wireless transceiver using the SERIALCONFIG command:

```
SERIALCONFIG COM1 230400 N 8 1 N OFF
```

7. Issue the following commands to the first Rover receiver:

```
MOVINGBASESTATION ENABLE  
INTERFACEMODE COM1 NOVATEL NOVATEL OFF  
LOG COM1 NOVATELXOBS ONTIME 0.1  
LOG COM1 NOVATELXREF ONTIME 0.1  
SAVECONFIG (optional)
```

8. Configure COM2 of the next Rover receiver to receive corrections as described in step 4.

9. Issue the following commands to the next Rover receiver:

```
INTERFACEMODE COM2 NOVATEL NOVATEL OFF  
RTKPORTMODE COM2 ALIGN3  
SAVECONFIG (optional)
```

10. Configure COM1 of the next Rover receiver to send corrections to the next Rover station in line as described in step 6.

11. Repeat steps 7 through 10 until all receivers have been configured.

To access heading and relative positioning data, ALIGN logs must be logged at each ALIGN Rover.

In a daisy-chain setup, heading and relative position are only accurate from an ALIGN Master receiver to its connected ALIGN Rover receiver. Since small errors in a part of the chain will propagate to all parts further down the chain, knowing the headings and relative positions from all the links in the chain will not necessarily allow for the accurate calculation of the heading and/or relative position from one node in the chain to another node not directly connected to it as either Master or Rover.



6: Dual-Antenna Receiver as ALIGN Rover to an External ALIGN Master

When a dual-antenna receiver is used as the Rover receiver of an ALIGN pair, the primary antenna will act as the Rover of the external ALIGN pair and as the Master of the internal ALIGN pair. This is a very similar situation to the “daisy-chain” use case described on the previous pages, with the exception that the internal baseline of the dual-antenna receiver does not need any extra setup.

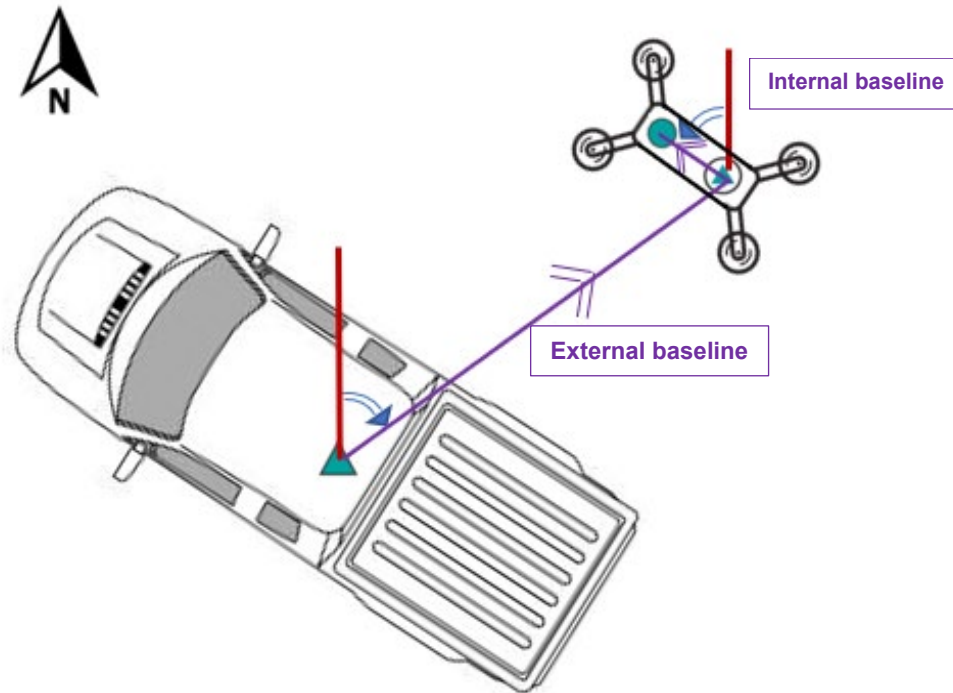


Figure 7: Dual-antenna receiver as ALIGN Rover to an external ALIGN Master

In [Figure 7](#), the heading of the drone is calculated using a dual-antenna receiver. The antenna on the vehicle is the reference point for the heading and baseline calculations between the vehicle and the primary antenna of the drone.

This use case is similar to use case 4, it only differs in which logs are available at which vehicle. In this use case, the receiver on the ground-based vehicle will only get the heading and distance from the ground-based receiver to the drone, so a single [MASTERPOS](#), [ROVERPOS](#) and [HEADING2](#) message. The receiver on the drone will output two completely independent MASTERPOS, ROVERPOS and HEADING2 messages, one set relating to the internal baseline and heading of the drone, and one set relating to the external baseline between the ground vehicle and the drone.

When the autopilot system on the drone requires the NMEA [GPHDT](#) log as an input, it is recommended that the [GPHDTDUALANTENNA](#) log is used instead of GPHDT.



Support

To help answer questions and/or diagnose any technical issues that may occur, the [NovAtel Support website](#) is a first resource.

Remaining questions or issues, including requests for test subscriptions or activation resends, can be directed to [NovAtel Support](#).

Before contacting Support, it is helpful to collect data from the receiver to help investigate and diagnose any performance-related issues. A list of appropriate troubleshooting logs can be found on the [OEM7 Documentation Portal](#) (the LOG command with the recommended trigger and data rate is included with each log).

The data can also be collected using [NovAtel Application Suite](#).

Documentation

For any questions on logs and commands, please visit the [OEM7 Documentation Portal](#).

Contact Hexagon | NovAtel

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For more contact information, please visit novatel.com/contact-us