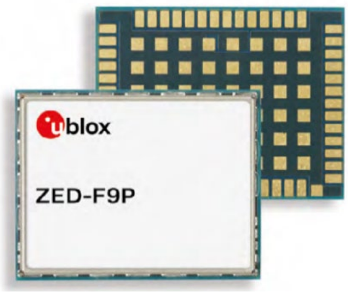
ZED-F9P

Moving base applications

Application note



Abstract

This application note explains how the ZED-F9P multi-band GNSS receiver can be employed in applications that require high precision relative position output or heading and attitude information.

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1 Introduction

The ZED-F9P multi-band GNSS receiver [1] has integrated u-blox multiband RTK technology for centimeter-level accuracy. This application note explains how ZED-F9P can be employed in applications that require high precision relative position output or heading and attitude information. This is enabled by the so-called moving base support in the module firmware.

This first section introduces the basic terminology and essential elements of a moving base setup with two or more GNSS receivers and shows some typical application scenarios. Section 2, which makes up the core of this application note, covers in-depth system-level considerations from antenna placement up to module configuration. Finally, we present how a moving base application can be easily set up with the help of the C099-F9P application board.

1.1 Terminology and fundamentals

RTK technology introduces the concept of a **base** and a **rover**. In such a setup, the base sends a continuous differential correction data stream (complying with the RTCM 3.3 protocol) to one or more rovers via a communication link. This enables the rover to compute its position relative to the base with high accuracy. The vector (or relative position) between base and rover is called the **baseline**.

In the standard RTK mode, the base remains static in a known position, while in the moving base (MB) RTK mode, both base and rover receivers can move. The latter is ideal for applications where the relative position offset between two moving vehicles is required such as, for example, the follow-me feature on a UAV.

The moving base feature also enables derivation of the **vehicle orientation** by mounting two or three GNSS receivers on the same vehicle platform, that is, by fixing the position of the GNSS antennas relative to each other.

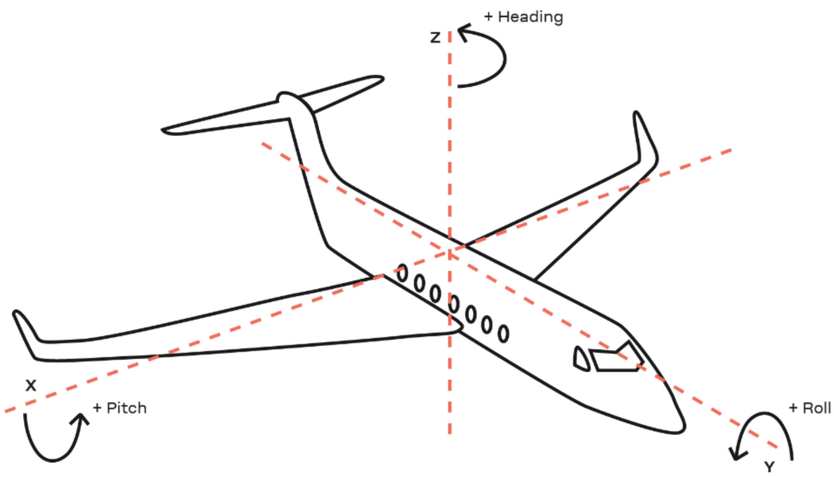

Figure 1: Orientation of a vehicle in space

☞ Mounting two antennas on the X-axis gives heading and roll information.

☞ With three antennas you can derive full attitude; heading, roll and pitch.

The **heading** information and **relative position** is output by the rover. See section 2.4 on the output from ZED-F9P.

Using differential correction data for the base receiver

If the **absolute position** of the rover is required with high precision, the base unit can be provided with correction data as well. See Figure 2 for such a setup. This will allow the base to enter **RTK Fixed mode** with the resultant improvement of absolute position accuracy. Without receiving corrections, the base will have standard 3D Fix position accuracy.

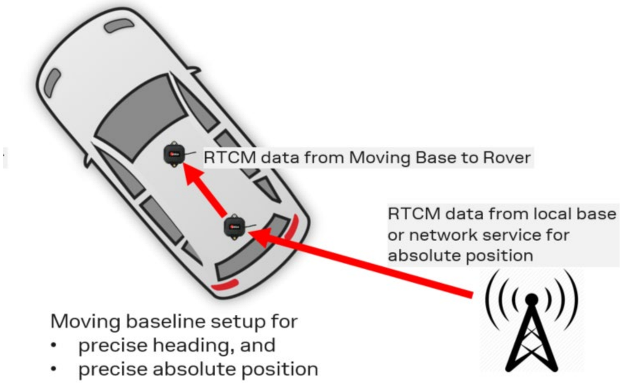

Figure 2: Moving base setup for precise heading and precise absolute position of the rover

In Figure 2, the rear antenna is the base antenna, front antenna is the rover antenna. Heading is from the base to the rover antenna.

1.2 Real-world applications

Moving base support can be used in a wide area of applications, for example:

- Drone attitude and heading determination
- Drone "follow me" sport and filming applications
- Ship heading determination
- Ship portable pilot units
- Vehicle heading determination
- Heavy machinery motion control
- Farming vehicle heading determination and control
- Traditional survey with moving base addition
- Sports data analysis
- Cellular base station antenna alignment

Figure 3: Drone attitude determination – base and rover on drone

Figure 4: Farming application – position and heading, base and rover on vehicle

Figure 5: Drone "follow me" filming – only a rover on the drone typically

Figure 6: Heavy machinery control – blade leveling and heading, base and rover on vehicle

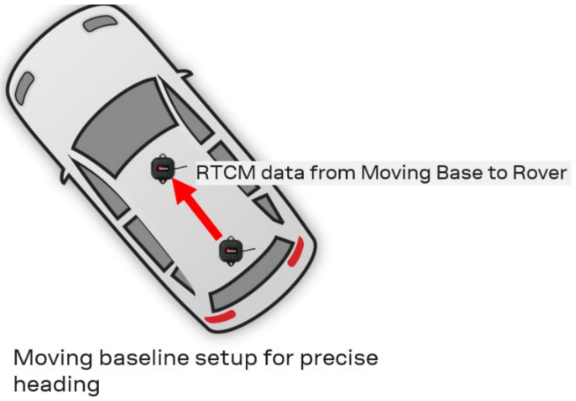

Figure 7: Automotive vehicle heading determination – base and rover on vehicle

Figure 8: Antenna pointing systems – base and rover on single-cell antenna panel

Figure 9: Portable ship pilot systems for entering/exiting harbors - base and rover on ship

Table 1 describes typical parameters of the above mentioned applications.

Application	Key data	Number of GNSS receivers	Baseline length and type
Drone attitude and heading determination	Roll, pitch and yaw	3	Fixed baseline, 20-30 cm
Drone "follow me" sport and filming applications	Heading, relative position	2	Several meters
Precise ship navigation	Heading	2	Fixed baseline, up to 100 m
Automotive vehicle heading determination	Heading	2	Fixed baseline, 1-3 m
Antenna attitude measurement and control	Heading / attitude	2	Fixed baseline, 10-50 cm

Table 1: Typical moving base applications and key characteristics

2 System-level considerations

As outlined in the previous section, two or more GNSS receivers (with separate antennas) are required to determine the relative position between the GNSS receivers. We will now provide recommendations and detailed examples on how to develop high-performance moving base applications with u-blox ZED-F9P receivers.

2.1 GNSS antenna considerations for moving base RTK

☞ The following points only need to be considered if a patch antenna is used and the application has a short baseline and minimal space for ground planes. Typically, these points need to be considered for heading determination in drones and cellular antenna pointing. The use of a helix antenna would be ideal for such applications as they do not require ground planes. Long baselines (meters to kilometers) are not affected.

If used on the same vehicle for heading and precise attitude determination (a drone for example), the antennas should be identical and ideally on an identical ground plane size and shape. In addition the antennas should be orientated in the same plane.

Figure 10: Very short baseline, heading application – patch antenna mounting

2.1.1 Ground plane size and shape

In an application where the base and rover are far removed from each other, such as where the rover is on a drone and the base is on a ship, the ground plane shape will have much less effect as the baseline is very long – kilometers possibly. However there is still a requirement that each antenna has the minimum ground plane size, unless the antenna is a helix that does not require a ground plane for good RTK performance. Helix antennas do not require a ground plane.

A minimum ground plane size and uniform shape is required for best performance if using a patch antenna in a heading application on a moving object such as a drone with a short distance between the antennas. The shorter the distance between the two antennas is, the more critical this becomes. The ground plane shape could distort the antenna phase center offset and could create an error in position. The performance of a patch antenna for good RTK performance is also affected by the size and shape of the ground plane. A helix antenna would prevent such issues.

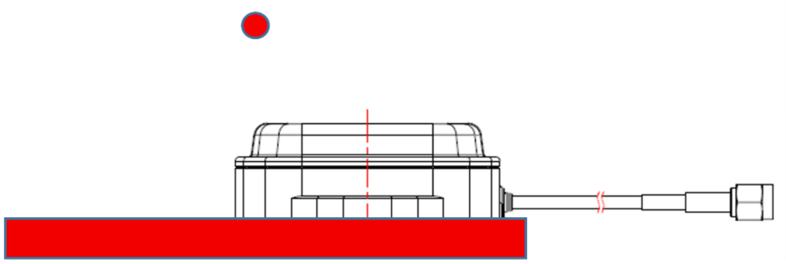

Figure 11: Average antenna phase center offset due to ground plane offset

Figure 12: Non-uniform ground plane shape will offset the phase center (image on the left). Uniform circular ground plane (10 cm) provides best accuracy and performance (image on the right).

2.1.2 Multipath/obscuration from surrounding structures

Any surrounding structures will cause multipath (causing position error) and obscure the satellites. Therefore ensure that the GNSS antennas are above any structures that may cause this issue.

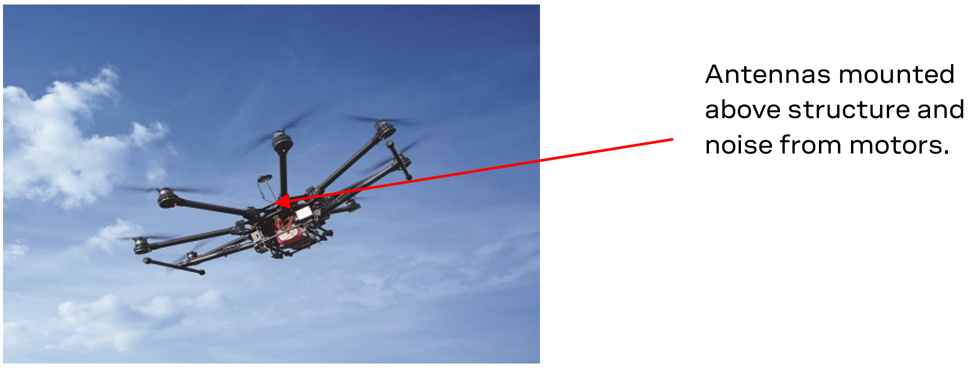

Figure 13: Drone application and recommended position of the GNSS antennas

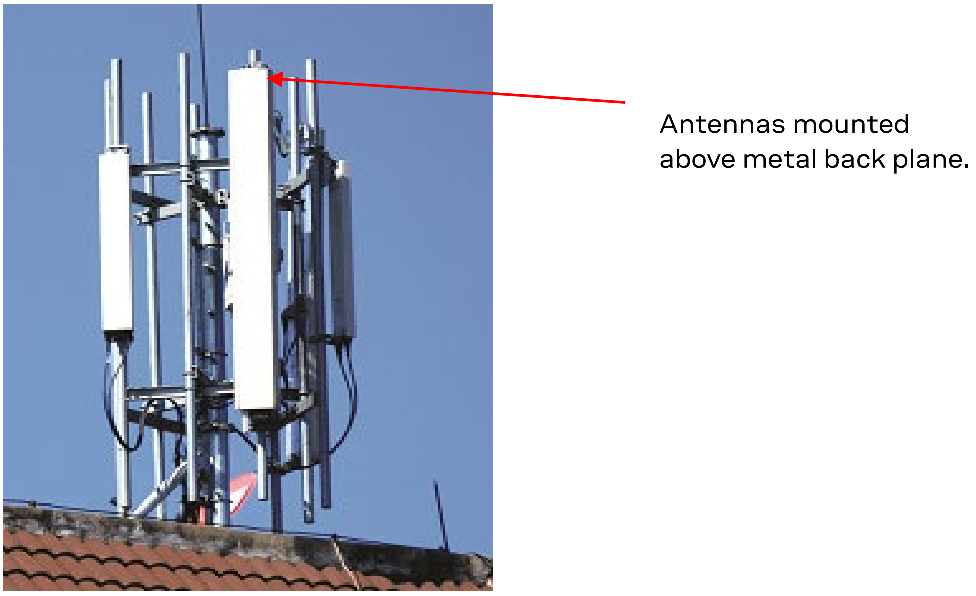

Figure 14: Cellular base station antenna pointing application

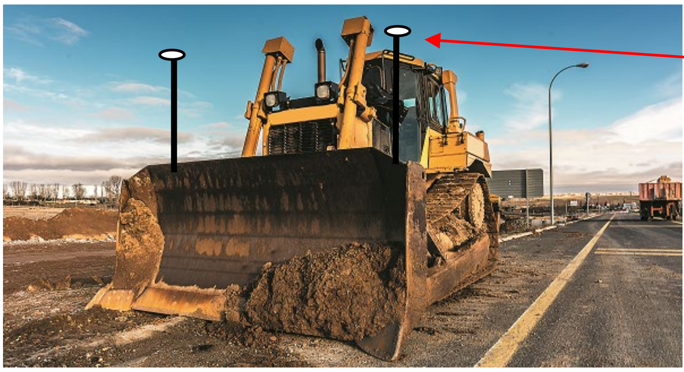

Figure 15: Antenna placement in heavy machinery/machine control application

2.2 Providing corrections between base and rover

The moving base algorithm was optimized for HPG 1.13. As a result, compared to HPG 1.12, RTCM 4072.1 is no longer needed and the RTCM MSM7 messages can be replaced by RTCM MSM4 messages. Both will help reduce serial communication and RF link load.

For each navigation epoch the base will produce a batch of RTCM 3.3 compliant messages. For operation in default GNSS configuration mode, the recommended list of RTCM messages is:

- RTCM 4072.0 Reference station PVT information
- RTCM 1074 GPS MSM4
- RTCM 1084 GLONASS MSM4
- RTCM 1094 Galileo MSM4
- RTCM 1124 BeiDou MSM4
- RTCM 1230 GLONASS code-phase biases

If you are already using MSM7 messages in your settings and are running at 1 Hz navigation rate with no issues with the RF or serial link, you can continue using your previous configuration without the RTCM 4072.1 message:

- RTCM 4072.0 Reference station PVT information
- RTCM 1077 GPS MSM7
- RTCM 1087 GLONASS MSM7
- RTCM 1097 Galileo MSM7
- RTCM 1127 BeiDou MSM7
- RTCM 1230 GLONASS code-phase biases

For detailed configuration instructions, refer to the ZED-F9P Integration manual [2], section "3.1.5.6 Base and rover configuration for moving base RTK operation".

A further benefit of the moving base algorithm optimization done for HPG 1.13 is that, compared to HPG1.12, the hard timeouts threshold are relaxed. This will improve the reliability and stability of the MB RTK solution and allow easier integration of RF links and serial links.

For optimal MB RTK operation, this group of messages should be received at the rover without transmission losses or errors. The size of the messages can vary depending on the number of satellites received and the configured GNSS constellations.

The achievable navigation update rate of the MB RTK solution is limited by the communication link latency. As a rule of thumb, the communication link latency should be less than the desired navigation update period minus 50 ms.

The UART2 interface is recommended as the default RTCM interface. By default the ZED-F9P UART2 is assigned a baud rate of 38400 baud. This will need to be increased for navigation rates above 1 Hz. For the UART interface a speed of 460800 baud is ideal.

2.2.1 Wired connection between base and rover

For a standard moving platform heading determination application the corrections from the moving base are supplied via a serial port to the rover. This can be on any of the available ports:

- UART1
- UART2
- USB (only via a USB "slave – master – slave" implementation)
- I2C (only via an I2C "slave – master – slave" implementation)
- SPI (only via an SPI "slave – master – slave" implementation)

It is important to ensure that ideally only the RTCM correction data is supplied on the communication interface used between the two units.

No other protocols other than RTCM are enabled by default on UART2. No RTCM messages are enabled by default to be output on UART2. This allows the UART2, base TX/rover RX between the two devices to be connected together without issues such as buffer overflowing or the wrong messages being sent into the rover ZED-F9P unit if powered on with default configuration. For example, do not allow NMEA output messages to be fed back into UART2. They are disabled by default. Only enable the required RTCM messages to be output on the base ZED-F9P UART2.

Figure 16 shows a high-level schematics diagram of a design where base and rover are connected via the corresponding UART2 interfaces of the two ZED-F9P modules.

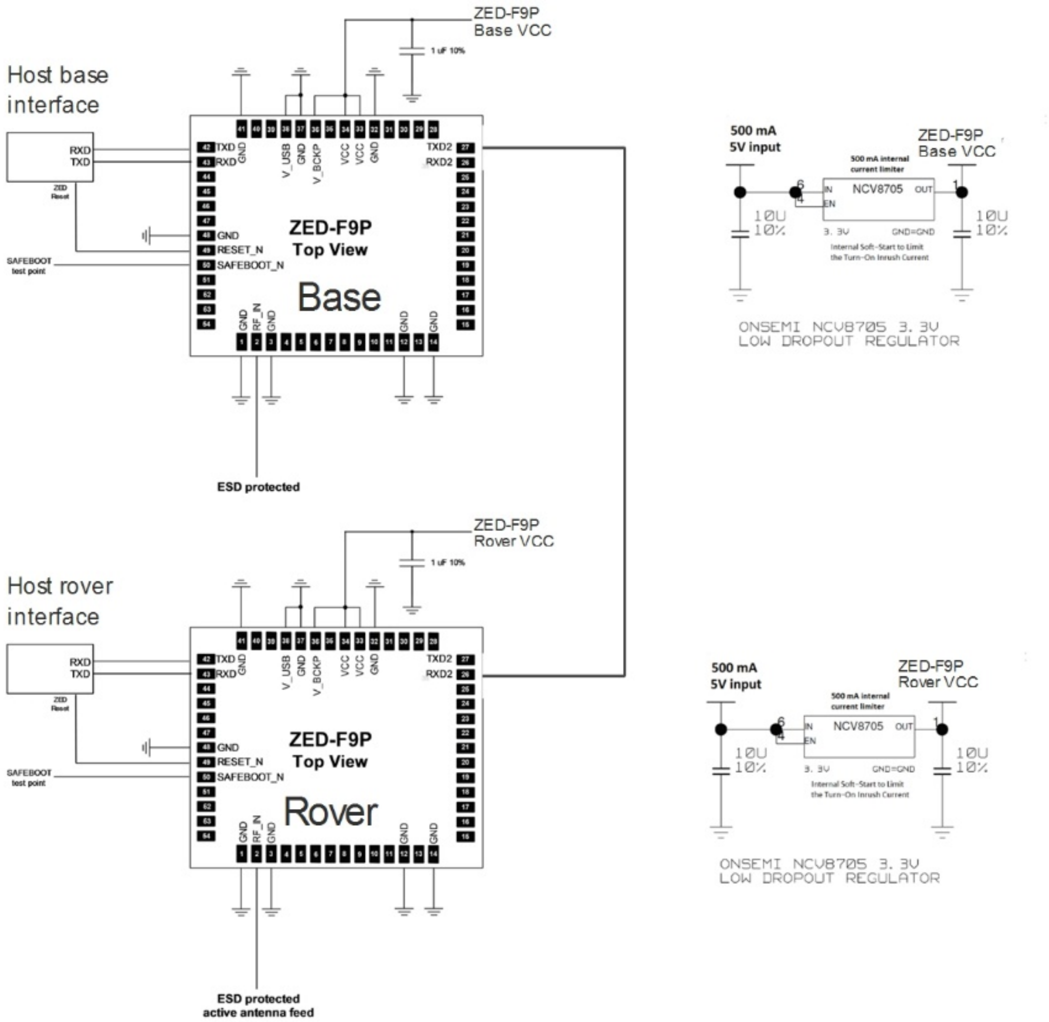

Figure 16: Schematics diagram of base and rover connected via their UART2 interfaces

☞ Level converters and buffers may be required on the ZED-F9P RX/TX lines to the host. These must be supplied by the ZED VCC to ensure the correct ZED I/O states at power up and power off.

2.2.2 Wireless connection between base and rover

In some of the moving base applications illustrated before, for example in a ship-to-drone application, both base and rover are moving independently of each other. They are connected via a wireless link.

Typically this wireless link will have a single RX/TX interface. Therefore we recommend using ZED-F9P UART1, as it supports all NMEA, UBX and RTCM 3.3 protocols.

- RTCM data should be streamed to the drone from the ZED-F9P base
- UBX and NMEA from the drone should be streamed back to the host and not to the ZED-F9P base

The radio system must be capable of supporting the RTCM messages downstream and the UBX/NMEA upstream, ensuring that the RTCM message transmission can be completed fast enough to support the desired rover update rate.

The throughput requirements for the wireless link are stricter if the maximum MB navigation rate of 8 Hz (default GNSS systems) is to be supported. In this case, the communication link must be able to stream RTCM messages to the rover with a latency of roughly 75 ms. This link must also be capable to stream back the NMEA/UBX data back to the host at 8 Hz. The amount of UBX messages and the type of messages (such as UBX debug info) will have a drastic effect on the link capacity and latency. Depending on whether the RF link is also expected to carry a user system protocol and other data this could be more difficult than expected.

2.4 GHz technologies such Classic Bluetooth® and Wi-Fi are good for relatively short range applications[1]. They have the RF throughput and low latency capacity as long as any user data does not load the data link to the detriment of the RTCM stream requirements.

Wi-Fi at 2.4 GHz offers good range with a 2.4 GHz single-band antenna due to better gain than a dual band 2.4/5 GHz Wi-Fi antenna. If the UDP protocol is used over the link, it offers the lowest latency and reduced data flow over the link.

Legacy low-power RF devices are usually not suited due to their limited TX buffer size and real time link data transfer capacity.

Longer ranges will require RF links with greater RF transmit power/ lower frequency, but will need to have the same throughput and latency requirements if running the ZED-F9P at 8 Hz navigation rate. In most countries longer communication ranges will require the use of RF links in licensed bands, however some countries allow much higher TX power on 2.4 GHz and 900 MHz bands than Europe, for example.

Considering that the minimum baud rate is 38400 baud for a 1 Hz navigation rate application and 460800 baud is recommended for a 8 Hz navigation rate application, this will usually limit the radio technology that can be used as the gross data rate will need to be considerably higher to transfer data forwards and backwards.

Bluetooth LE and Bluetooth 5 are not ideal technologies for the RF link between base and rover considering required throughput and range. Consider these very carefully along with practical testing before implementing these as the RF solution.

Figure 17 shows the schema for a ZED-F9P base connected to a ZED-F9P rover via a wireless link.

[1] Bluetooth® is a registered trademark of Bluetooth SIG, Inc.

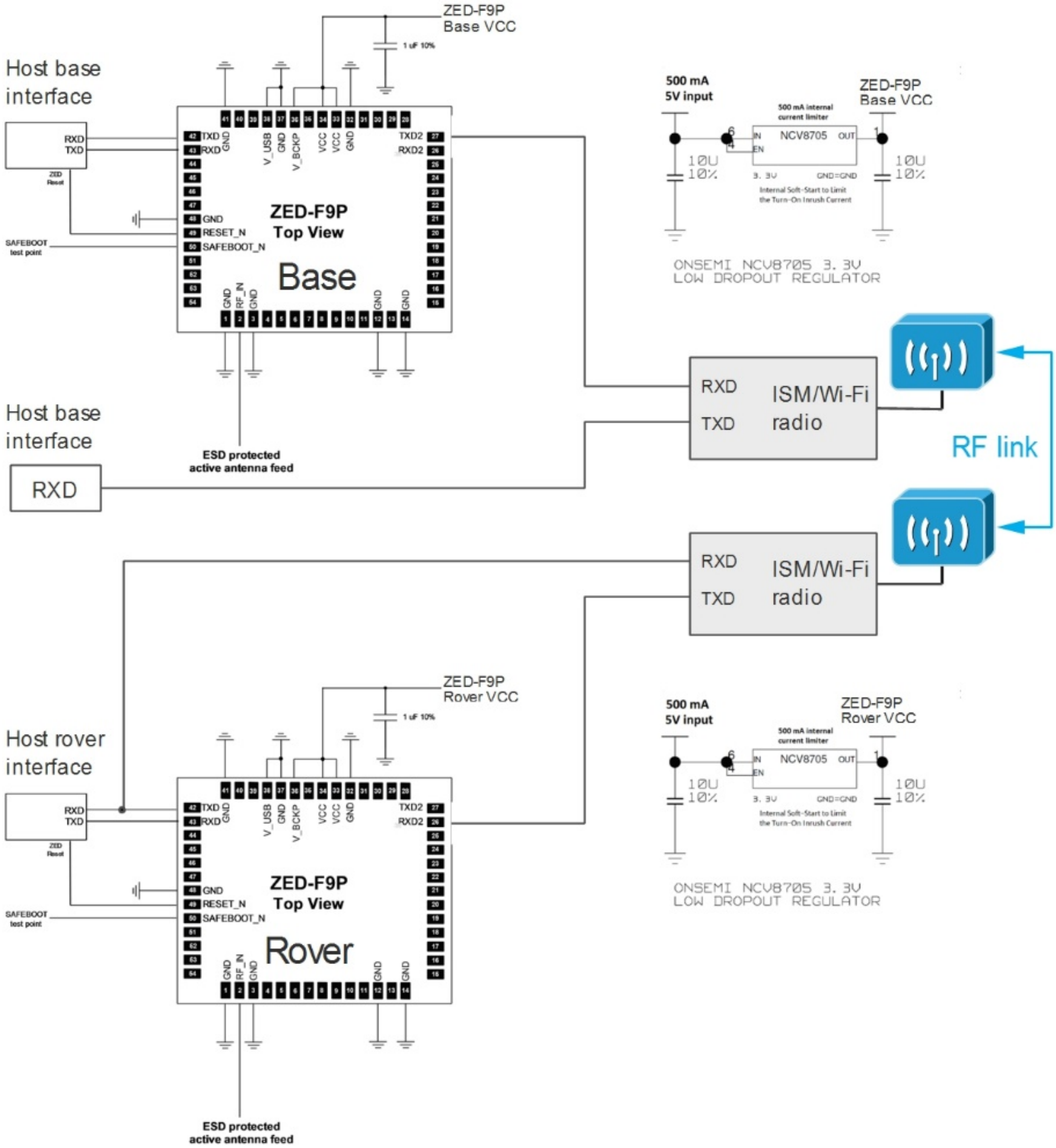

Figure 17: Schematics diagram of base and rover connected via a wireless link

☞ Level converters and buffers may be required on the ZED-F9P RX/TX lines. These must be supplied by the ZED VCC to ensure the correct ZED-F9P I/O states at power up and power off.

☞ This circuit assumes the rover is already configured to provide the required output messages for the remote host. If dynamic message selection during use on the rover is required the base host will need to have a gate to interrupt the RTCM message flow from the base to the rover and insert UBX configuration commands. This will however result in a loss of RTCM messages at the rover during this transfer of commands.

2.2.3 Testing and debugging an RF link application

An RF link by definition and operation will be susceptible to loss of data, fading and limited RF link rate. In addition the TX/RX buffer size and any existing protocol used will have a dramatic effect on actual reception of RTCM messages. Moving baseline applications have more stringent requirements than standard static base RTK applications.

The time-tagged RTCM messages must arrive complete at the rover to be used for an RTK epoch. If running at higher than 1 Hz navigation rate the latency in the rover receiving a group a valid time-tagged messages becomes a factor. This is most evident at 5 Hz navigation rate with default GNSS constellations. The rover RTK solution will effectively slow down its navigation rate if the latency is too high. A UART speed of 460800 baud is ideal for this application. However the effective RF link rate and TX/RX buffer size must be sufficient at this UART speed as the ZED-F9P does not support hardware flow control.

It is quite simple to monitor the effective rover navigation rate and if there are any missing messages:

1. UBX-NAV-RELPOSNED message generated by the rover will indicate if there are any missing messages and their effect.
2. UBX-NAV-PVT or NMEA RMC message can be monitored to see the effective navigation rate achieved. Any other message could be used, but these are good examples as they should be set to be output at the effective navigation rate. UBX-NAV-RELPOSNED can also be used if it is set to be output at the selected navigation rate. In other words at a message rate of “1”.

Ensuring the RF link reliability and throughput is important in achieving high navigation update rates.

Name	Description
`gnssFixOK`	A valid fix (i.e. within DOP and accuracy masks)
`diffSoln`	1 if differential corrections were applied
`relPosValid`	1 if relative position components and accuracies are valid and, in moving base mode only, if baseline is valid
`carrSoln`	Carrier phase range solution status: 0 = no carrier phase range solution 1 = carrier phase range solution with floating ambiguities 2 = carrier phase range solution with fixed ambiguities
`isMoving`	1 if the receiver is operating in moving base mode
`relPosHeadingValid`	1 if relPosHeading is valid

Table 2: UBX-NAV-RELPOSNED bit field flags for monitoring link missing messages and rover moving base RTK status

2.2.4 Improving RF link performance

The following steps can be applied to optimize the performance of a wireless base-rover setup.

1. Start by sending the minimum number of messages back from the rover.
2. Select 1 Hz navigation rate and check UBX-NAV-RELPOSNED message flag fields for missing messages. Slowly increase navigation rate if required. Check UBX-NAV-RELPOSNED flags and the effective navigation rate by monitoring the rate message output. If NMEA RMC or UBX-NAV-PVT output does not match the set navigation rate the link latency and missing messages are having an effect. RF range will have a factor here. If the link cannot work as expected with the base and rover near each other it will not work at real ranges.
3. Test at the expected RF range and environment, monitor as indicated in point 2 above. If your expected range is not achieved, ensure that the antennas on base and rover have the maximum legal gain for the frequency you are transmitting at and are not obscured in any way. If the range you need is higher than the link can support reliably another RF technology could be required.
4. Reducing the GNSS systems being received on the base and rover will reduce the number of messages and message contents that need to be transferred. If in reality only GPS is needed, then the other systems can be disabled. Otherwise decide on the minimum GNSS constellations you may need and disable those you can do without to help reduce RF latency and load.

2.3 Receiver configurations

2.3.1 Default 1 Hz navigation rate application

Running at a default 1 Hz navigation rate is the simplest implementation especially when a wireless link is used between base and rover. The minimum baud rate is 38400 baud if using NMEA only and the required RTCM 3.3 compliant messages.

By default the receivers operate at 1 Hz, therefore no configuration of the navigation rate is required.

- The default UART1/UART2 baud rate of 38400 baud does not need changing.
- Set base ZED-F9P to output the required RTCM messages on UART2.

☞ The binary messages include writing the configuration to flash for each message.

1. Set the base ZED-F9P UART2 to output the required RTCM messages:

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE4072_0_UART2	0x20910300	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 00 03 91 20 01 53 51

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1074_UART2	0x20910360	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 60 03 91 20 01 B3 31

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1084_UART2	0x20910365	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 65 03 91 20 01 B8 4A

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1094_UART2	0x2091036a	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 6A 03 91 20 01 BD 63

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1124_UART2	0x2091036f	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 6F 03 91 20 01 C2 7C

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1230_UART2	0x20910305	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 05 03 91 20 01 58 6A

With both base and rover having their own antenna connected, the base will output all the RTCM messages and the rover will go to RTK Fixed mode if GNSS signal conditions are OK.

The host UART1 interface will have additional messages enabled as per the user's requirement, however the rover must output UBX-NAV-RELPOSNED message to the host for the heading and base line length output.

2. Enable UBX-NAV-RELPOSNED on the rover UART1:

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-UBX_NAV_RELPOSNED_UART1	0x2091008e	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 8E 00 91 20 01 DE 0B

☞ The UART2 interface of ZED-F9P currently does not support UBX messages.

2.3.2 8 Hz navigation rate application

The base and rover UART2 baud rate has to be configured to 460800 baud:

- Set navigation rate on base and rover to 8 Hz (125 ms).
- Set UART1 and UART2 on the base and rover to 460800 baud.
- Enable the required RTCM messages as shown above on the base.

1. Both base and rover navigation rate configuration done first:

   Send this message to each unit.

Key	Key ID	Type	Value	RAM	FLASH
CFG-RATE-MEAS	0x30210001	U2	125 (0x7d)	1	1

Binary message: B5 62 06 8A 0A 00 00 05 00 00 01 00 21 30 7D 00 6E 0F

2. Both base and rover UART1 and UART2 configuration done next:

   Send these messages to base and rover unit.

Key	Key ID	Type	Value	RAM	FLASH
CFG-UART1-BAUDRATE	0x40520001	U4	460800 (0x70800)	1	1

Binary message: B5 62 06 8A 0C 00 00 05 00 00 01 00 52 40 00 08 07 00 43 AF

Key	Key ID	Type	Value	RAM	FLASH
CFG-UART2-BAUDRATE	0x40530001	U4	460800 (0x70800)	1	1

Binary message: B5 62 06 8A 0C 00 00 05 00 00 01 00 53 40 00 08 07 00 44 B5

3. Set the base ZED-F9P UART2 to output the required RTCM messages:

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE4072_0_UART2	0x20910300	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 00 03 91 20 01 53 51

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1074_UART2	0x20910360	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 60 03 91 20 01 B3 31

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1084_UART2	0x20910365	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 65 03 91 20 01 B8 4A

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1094_UART2	0x2091036a	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 6A 03 91 20 01 BD 63

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1124_UART2	0x2091036f	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 6F 03 91 20 01 C2 7C

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-RTCM_3X_TYPE1230_UART2	0x20910305	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 05 03 91 20 01 58 6A

With both base and rover having their own GNSS antenna connected, the base will output all the RTCM messages and the rover will go to RTK Fixed mode if GNSS signal conditions are OK.

The host UART1 interface will have additional messages enabled as per the user's requirement, however the rover must output UBX-NAV-RELPOSNED message to the host for the heading and base line length output.

3. Enable UBX-NAV-RELPOSNED on the rover UART1:

Key	Key ID	Type	Value	RAM	FLASH
CFG-MSGOUT-UBX_NAV_RELPOSNED_UART1	0x2091008e	U1	1 (0x1)	1	1

Binary message: B5 62 06 8A 09 00 00 05 00 00 8E 00 91 20 01 DE 0B

☞ The UART2 interface of ZED-F9P currently does not support UBX messages.

2.4 Using the heading output

The heading output will be provided by the ZED-F9P rover in the UBX-NAV-RELPOSNED message, see the ZED-F9P Interface description [3] for details. This message will provide the actual RTK calculated distance between the two antennas and the resultant RTK heading output.

For an application where two antennas are mounted on the same moving platform, the known precise distance between the two antennas can be used to validate the MB RTK solution, including the heading output. If the RTK calculated distance does not closely match with the known baseline distance, there is a high probability that ambiguities were fixed wrongly and, therefore, that the computed rover relative position and baseline heading are wrong, especially if the distance between the antennas is very short.

The UBX-NAV-RELPOSNED heading output has no additional low pass filtering. This allows the user application to add additional low pass filtering depending on the application-specific operating conditions and required heading output for the end application.

For example, for cellular base station antenna attitude applications there will be a maximum settling time requirement for any large physical antenna heading change. The low pass filtering can be adjusted to match this to prevent short-term effects on the heading output in the application. Known dynamics of the antenna position changes can also be used to filter out any sudden angular rates.

For automotive applications a different filtering strategy could be used due to the dynamics and rapidly changing satellite visibility. However sudden large angular rates should be filtered. Angular rates of automobiles in an urban canyon environment could be surmised. This kind of environment has the most multi-path and satellite obstruction causing position inaccuracy.

3 Using the C099-F9P as a moving base application

The C099-F9P application board can be used in a base and rover pair using the Wi-Fi or wired serial connection for moving base applications.

In addition, the base C099-F9P can receive RTCM 3.3 compliant correction data to improve absolute accuracy.

Further resources are listed here:

1. Using Wi-Fi base and rover pair is covered in the C099-F9P User guides:
    - C099-F9P-AppBoard-ODIN-W2-CSW_UserGuide_(UBX-18055649).pdf https://www.u-blox.com/sites/default/files/C099-F9P-AppBoard-ODIN-W2-CSW_UserGuide_(UBX-18055649).pdf
    - C099-F9P-AppBoard-Mbed-OS3-FW_UserGuide_(UBX-18063024).pdf https://www.u-blox.com/sites/default/files/C099-F9P-AppBoard-Mbed-OS3-FW_UserGuide_(UBX-18063024).pdf
2. Configuration files for moving base are provided in the u-blox GitHub repository:
    - Base ZED-F9P moving base configuration file: https://github.com/u-blox/ublox-C099_F9P-uCS/blob/master/zed-f9p/F9P%20Base%20moving%20base%20config%20C99.txt
    - Rover ZED-F9P configuration file: https://github.com/u-blox/ublox-C099_F9P-uCS/blob/master/zed-f9p/F9P%20Rover%20config%20C99.txt

   These files must be downloaded using the u-center View > Generation 9 Configuration View. They cannot be downloaded using the legacy configuration file download.
3. There is a more detailed quick guide for downloading the moving base configuration files: https://github.com/u-blox/ublox-C099_F9P-uCS/blob/master/zed-f9p/C099-F9P-Quick-configuration-Moving-base_(UBX-19046400).pdf
4. u-center evaluation software: https://www.u-blox.com/en/product/u-center

3.1 Wired UART base and rover

If two units are to be located close together for a heading application, then the boards can be connected using wires and there is no need for a wireless link.

In this case we connect via the UART1 of the two boards. As one board will only transmit and one will only receive, we can achieve the needed communication by connecting the base TX line to the rover RX line. In addition we connect the ground between the two boards.

The connections needed are summarized in the table below and illustrated in Figure 18.

Base	Rover	Remark
J9 pin 2	J9 pin 1	Connects base TX line to rover RX line
J8 pin 7	J8 pin 7	Connects ground between the two boards
-	J18 jumper	Connect a jumper to the jumper header pins marked 4OE_N on the board. This is the second jumper header pin from the top. This jumper is only needed on the rover board, to enable UART1 Rx on the rover ZED-F9P.

Table 3: C099 UART1 wired connection list

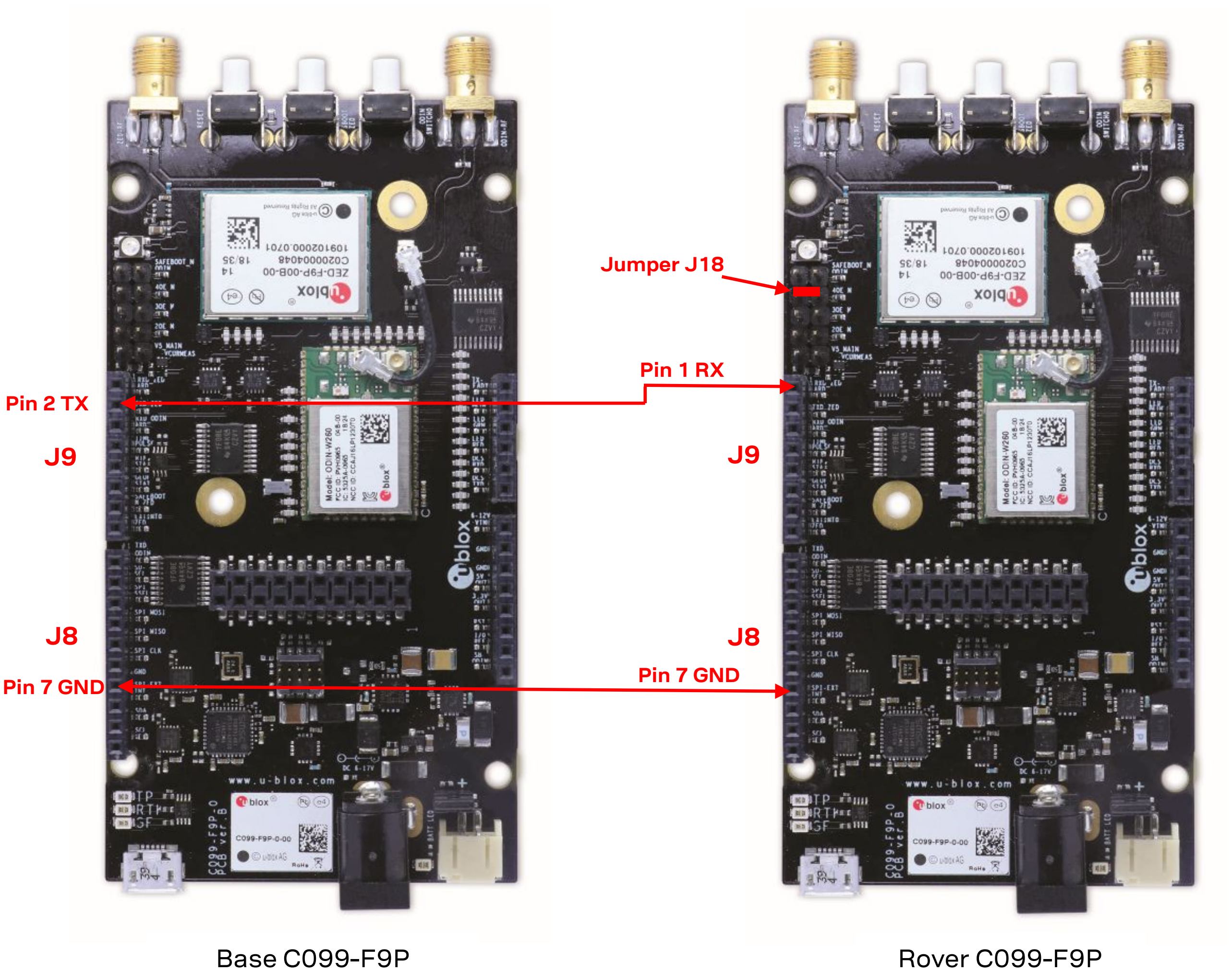

Figure 18: Two C099-F9P application boards connected via UART lines

Use the ZED-F9P native USB ports to monitor and log the ZED-F9P modules output.

Appendix

A Glossary

Abbreviation	Definition
GNSS	Global Navigation Satellite System
ISM	Industrial, scientific and medical (radio band)
NMEA	National Marine Electronics Association
PVT	Position, Velocity and Time
RF	Radio Frequency
RMC	Recommended Minimum Sentence C
RTCM	Radio Technical Commission for Maritime Services
RTK	Real Time Kinematic
RX	Reception
TX	Transmission
UART	Universal Asynchronous Receiver Transmitter
UBX	Proprietary communication protocol for u-blox GNSS receivers. UBX messages have binary format.
USB	Universal Serial Bus
Wi-Fi	Wi-Fi is a technology for wireless local area networking of devices based on the IEEE 802.11 standards. It is a trademark of the Wi-Fi Alliance.

Table 4: Explanations of the abbreviations and terms used

Related documents

[1] ZED-F9P data sheet, UBX-17051259
[2] ZED-F9P integration manual, UBX-18010802
[3] ZED-F9P interface description, UBX-18010854
[4] C099-F9P user guide, UBX-18063024
[5] ANN-MB data sheet, UBX-18049862

☞ For regular updates to u-blox documentation and to receive product change notifications, register on our homepage (www.u-blox.com).

Revision history

Revision	Date	Name	Comments
R01	16-May-2019	ghun	Initial release
R02	05-June-2020	ghun	Early production information Many updates related to the new firmware, FW 1.00 HPG 1.13

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