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NEO-D9S and ZED-F9 configuration

SPARTN L-band correction data reception

Application Note

Abstract

This document explains how to configure the NEO-D9S correction data receiver together with ZED-F9 high precision modules in order to receive and use SPARTN L-band correction data.

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Document information

Title	**NEO-D9S and ZED-F9 configuration**	
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☞ Check if the ZED-F9 product that you are using supports the SPARTN protocol and the related configurations.

Contents

1 Introduction

The ZED-F9 high precision modules have integrated multiband PPP-RTK technology for centimeter-level accuracy using SPARTN [8] State Space Representation (SSR) type of correction.

SSR services rely on a GNSS reference station network to model key errors (such as satellite or atmospheric errors) over large geographical regions and provide corrections to the rover via broadcast link such as internet or satellite L-band, all receivers receive the same data over a large area.

☞ Check if the ZED-F9 product that you are using supports the SPARTN L-band stream formatted as UBX-RXM-PMP messages, and the related configurations.

Figure 1 represents how NEO-D9S and ZED-F9 work together:

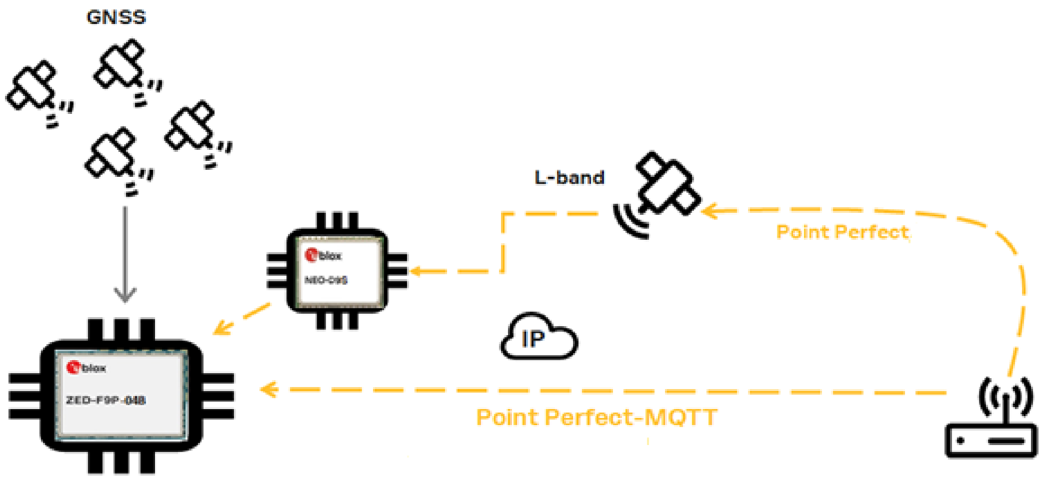


Figure 1: NEO-D9S and ZED-F9 scenario

NEO-D9S is a satellite data receiver for L-band correction broadcasts, which can be configured to work with a variety of correction services. This document provides instructions on how to configure NEO-D9S for this purpose and provides configuration examples for the PointPerfect service, SPARTN L-band correction, and ZED-F9 receivers. Figure 2 represents the NEO-D9S and ZED-F9 connection:

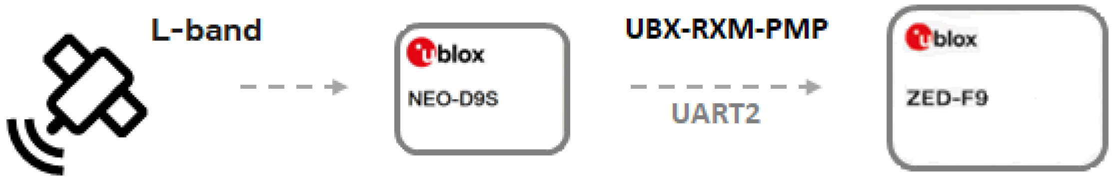


Figure 2: NEO-D9S and ZED-F9 connection

The NEO-D9S and ZED-F9 receivers follow the u-blox configuration concept. The UBX-CFG-VALSET, UBX-CFG-VALGET, and UBX-CFG-VALDEL messages can be used to configure the SPARTN L-band correction data reception. See the D9 PMP 1.04 Interface description [4] and the F9 HPG 1.32 Interface description [5] for further details.

For the correction data, NEO-D9S and ZED-F9 can be connected via their respective UART2 interfaces, as shown in Figure 2. The UART2 connection is commonly used and recommended for customer designs, while The UART1 can be used as the main host interface for configuration, monitoring, and control. The USB interface is provided for host communication purposes and can be used for monitoring or logfiles collection.

Figure 3 shows the series of actions to be done:

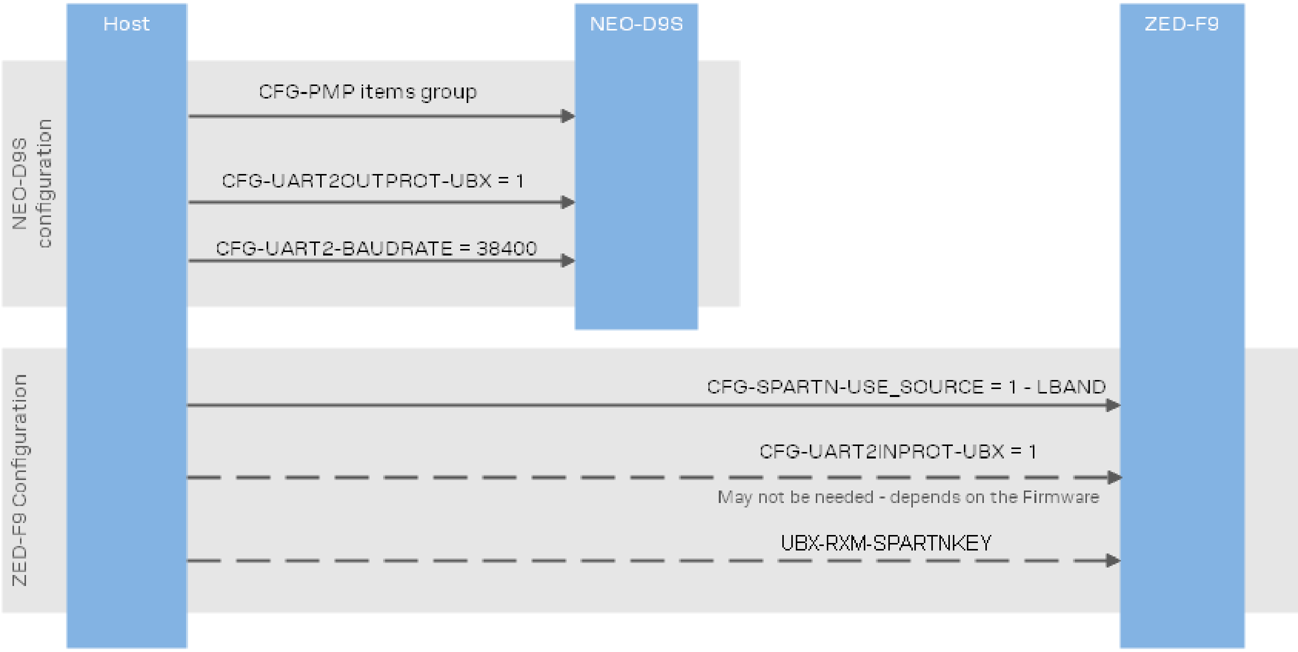


Figure 3: ZED-F9 and NEO-D9S configuration sequence diagram

Configuration strings are provided in the following sections of the document for each configuration item. If you are using u-center, the strings can be sent via a custom message:

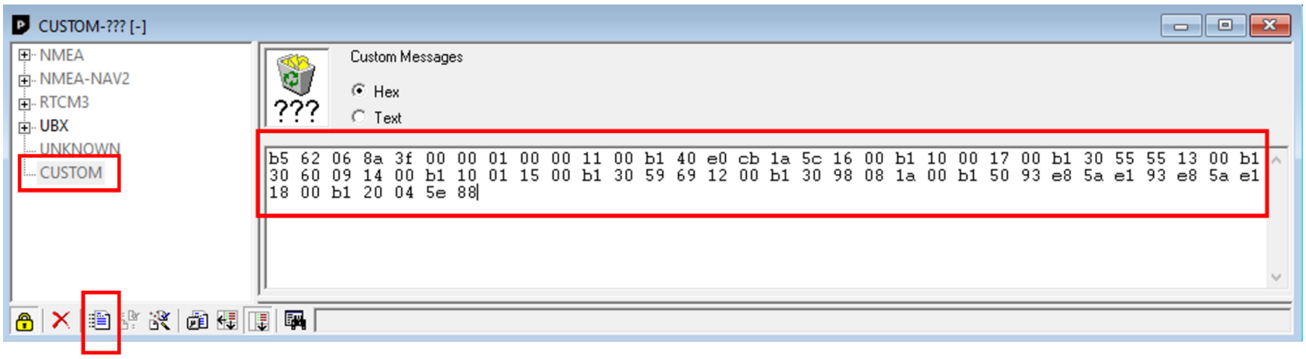


Figure 4: Send Custom message with u-center

For more details, see the u-center user guide [3].

The easiest way to test how to configure the NEO-D9S and ZED-F9 receivers is to make use of the C099-F9P and C101-D9S application boards. See the related user guides [6] and [7], and in particular Chapter 4 of the C101-D9S User Guide.

2 NEO-D9S configuration

NEO-D9S needs to be configured to receive SPARTN L-band correction data and forward these, encapsulated in UBX-RXM-PMP messages, to the ZED-F9 receiver via UART2.

2.1 L-band point to multipoint (PMP) configuration

Table 1 lists the NEO-D9S L-band default configuration values, which will vary depending on the service provider. Once the related values have been obtained from the service provider, they can be set accordingly with the UBX-CFG-VALSET configuration messages (see the interface description [4] for further details).

Configuration item	Value
CFG-PMP-CENTER_FREQUENCY	1539812500 Hz
CFG-PMP-SEARCH_WINDOW	2200 Hz
CFG-PMP-USE_SERVICE_ID	1 (true)
CFG-PMP-SERVICE_ID	50821
CFG-PMP-DATA_RATE	2400 (B2400) bps
CFG-PMP-USE_DESCRAMBLER	1 (true)
CFG-PMP-DESCRAMBLER_INIT	23560
CFG-PMP-USE_PRESCRAMBLING	0 (false)
CFG-PMP-UNIQUE_WORD	0xe15ae893e15ae893

Table 1: NEO-D9S L-band default configuration values

Section 4 outlines how to obtain the L-band configuration values for the PointPerfect service.

2.2 Interface configuration

Table 2 shows the configuration items needed to configure the UART2 interface of NEO-D9S so that it can communicate with the ZED-F9.

Configuration item	Value
CFG-UART2OUTPROT-UBX	1 (true)
CFG-UART2-BAUDRATE	38400

Table 2: NEO-D9S UART2 configuration items

To facilitate the configuration, examples of the configuration strings for **RAM** and **Flash** layers are shown here:

RAM layer configuration string:

b5 62 06 8a 11 00 00 01 00 00 01 00 53 40 00 96 00 00 01 00 76 10 01 54 ef

Flash layer configuration string:

b5 62 06 8a 11 00 00 04 00 00 01 00 53 40 00 96 00 00 01 00 76 10 01 57 1f

When sending Flash layer configuration strings, the receiver needs to be restarted to apply them in RAM.

The UBX-RXM-PMP message is enabled by default in the output to the NEO-D9S UART2 interface.

2.3 Functional check

Firstly, some initial functional checks are required to verify that NEO-D9S is operating correctly:

- NEO-D9S communication has been established (e.g., via u-center) through UART1 or USB
- The L-band antenna is plugged in
- The L-band and interface configurations have been sent
- The UBX-RXM-PMP message can be used to check the received correction data (Figure 5)
- The UBX-MON-TXBUF message can be used to check the data sent via UART2 (Figure 6)

Figure 5 and Figure 6 show the messages as they appear in u-center.

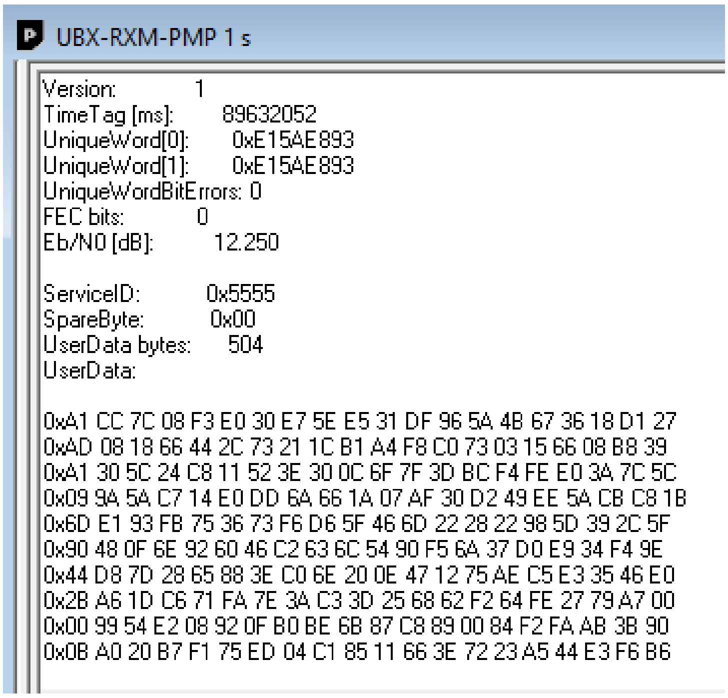


Figure 5: UBX-RXM-PMP message in u-center

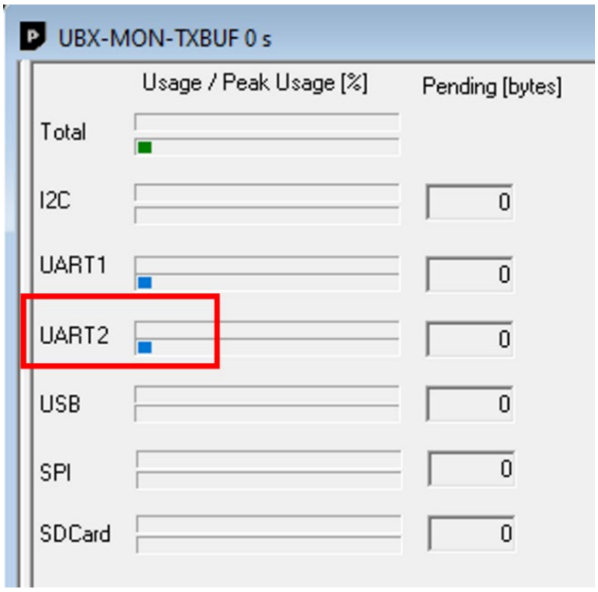


Figure 6: UBX-MON-TXBUF message in u-center

3 ZED-F9 configurations

ZED-F9 needs to be configured to receive and use the SPARTN L-band correction stream, in the form of UBX-RXM-PMP messages from NEO-D9S.

3.1 L-band configuration

The CFG-SPARTN-USE_SOURCE configuration key needs be set to LBAND:

Configuration item	Value
CFG-SPARTN-USE_SOURCE	1 - LBAND

Table 3: ZED-F9 configurations for SPARTN L-band data reception

The configuration strings for **RAM** and **Flash** layers are:

RAM layer configuration string:

b5 62 06 8a 09 00 00 01 00 00 01 00 a7 20 01 63 6c

Flash layer configuration string:

b5 62 06 8a 09 00 00 04 00 00 01 00 a7 20 01 66 84

When sending Flash layer configuration strings, the receiver needs to be restarted to apply them in RAM.

3.2 Interface configuration

The UBX protocol needs to be enabled on the ZED-F9 UART2 input:

Configuration item	Value
CFG-UART2INPROT-UBX	1 (true)

Table 4: ZED-F9 UART2 configuration item

☞ For some ZED-F9 receivers, the UBX input protocol is already enabled by default on UART2. For example, it is enabled by default on ZED-F9P with firmware HPG 1.32. Check the default interface configuration for your ZED-F9 receiver in the related interface description.

The configuration strings for **RAM** and **Flash** layers are:

RAM layer configuration string:

b5 62 06 8a 09 00 00 01 00 00 01 00 75 10 01 21 b6

Flash layer configuration string:

b5 62 06 8a 09 00 00 04 00 00 01 00 75 10 01 24 ce

When sending Flash layer configuration strings, the receiver needs to be restarted to apply them in RAM.

3.3 Dynamic keys

ZED-F9 may require proper keys to decrypt a SPARTN data stream. Once the key or keys are obtained from the correction service provider, the UBX-RXM-SPARTNKEY message needs to be formatted and sent to the ZED-F9 receiver. The following is an example of a UBX-RXM-SPARTNKEY construction for the PointPerfect service. For more details, read about UBX-RXM-SPARTNKEY in the interface description [5].

The following shows a UBX-RXM-SPARTNKEY construction example for PointPerfect:

b5 62 02 36 00 2c 01 02 00 00 00 10 88 08 4d 82 04 00 00 10 88 08 ce 29 05 00 XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX
XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX de 77

Cyan is the UBX header bytes
Red is field “version”
Yellow is “numKeys”, so we have 2 keys loaded
Purple is padding bytes
Dark blue is “encryptAlgorithm”, this should be zero

Grey is “keyLengthBytes”, so our keys are both 16 bytes long
Dark red is “validFromWno” in little endian format
Dark green is “validFromTow” in little endian format
Black is “key”
Green is the CRC

☞ The keys are not stored in non-volatile memory and will be deleted on every module reset or restart. In such cases, the keys need to be re-entered.

3.4 Functional check

Firstly, some initial functional checks are required to verify that ZED-F9 is operating correctly:

- ZED-F9 communication has been established (e.g., via u-center) through UART1 or USB
- The GNSS antenna is plugged in
- The L-band and interface configurations have been sent, as well as the dynamic keys
- The ZED-F9 UART2 has been connected to the NEO-D9S UART2

Then, the UBX-MON-COMMS message can be enabled to verify that UBX messages are received on the ZED-F9 UART2, including UBX-RXM-PMP:

UBX-MON-COMMS 0 s

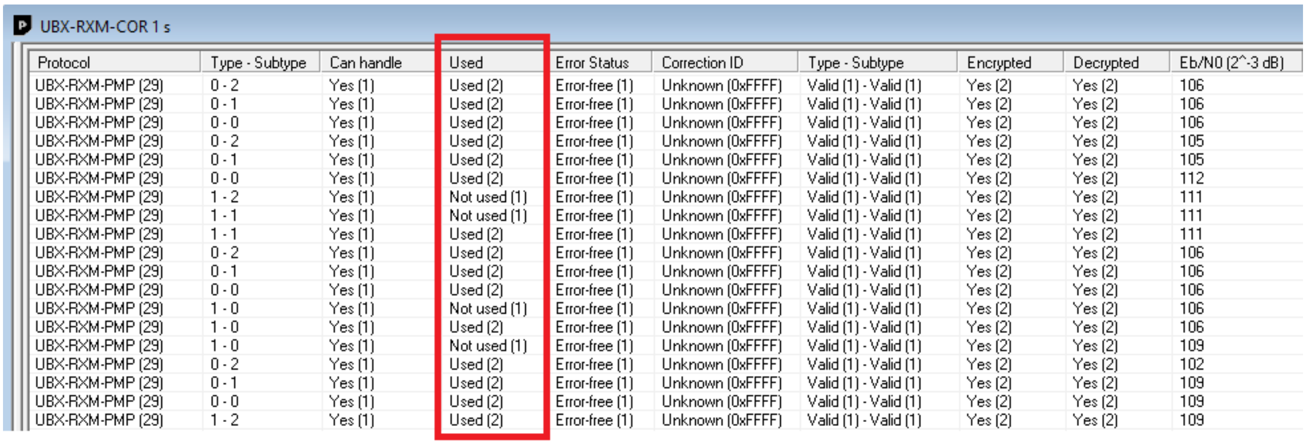
memAllocError	No
txBufFullError	No

Port (PortId)		Total (B)	Pending (B)	Usage	PeakUsage	OverrunErrs
UART1 (0x01)	Tx	1456080	0	15%	16%	-
USB (0x03)	Tx	0	0	0%	19%	-
UART2 (0x12)	Tx	0	0	0%	0%	-
UART1 (0x01)	Rx	371	0	0%	1%	0
USB (0x03)	Rx	0	0	0%	0%	0
UART2 (0x12)	Rx	177416	0	0%	8%	0

Port (PortId)		0-UBX	1-NMEA	5-RTCM3	6-SPARTN	skipped (B)
UART1 (0x01)	Rx	23	0	0	0	0
USB (0x03)	Rx	0	0	0	0	0
UART2 (0x12)	Rx	331	0	0	0	0

Figure 7: UBX-MON-COMMS message in u-center

The UBX-RXM-COR message can be enabled to check if SPARTN corrections, encapsulated in UBX-RXM-PMP messages, are being received, decrypted, and used (in the red square) by the ZED-F9 receiver:



UBX-RXM-COR 1 s

Protocol	Type - Subtype	Can handle	Used	Error Status	Correction ID	Type - Subtype	Encrypted	Decrypted	Eb/N0 (2^-3 dB)
UBX-RXM-PMP (29)	0 - 2	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	0 - 1	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	0 - 0	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	0 - 2	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	105
UBX-RXM-PMP (29)	0 - 1	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	105
UBX-RXM-PMP (29)	0 - 0	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	112
UBX-RXM-PMP (29)	1 - 2	Yes (1)	Not used (1)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	111
UBX-RXM-PMP (29)	1 - 1	Yes (1)	Not used (1)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	111
UBX-RXM-PMP (29)	1 - 1	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	111
UBX-RXM-PMP (29)	0 - 2	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	0 - 1	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	0 - 0	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	1 - 0	Yes (1)	Not used (1)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	1 - 0	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	106
UBX-RXM-PMP (29)	1 - 0	Yes (1)	Not used (1)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	109
UBX-RXM-PMP (29)	0 - 2	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	102
UBX-RXM-PMP (29)	0 - 1	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	109
UBX-RXM-PMP (29)	0 - 0	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	109
UBX-RXM-PMP (29)	1 - 2	Yes (1)	Used (2)	Error-free (1)	Unknown (0xFFFF)	Valid (1) - Valid (1)	Yes (2)	Yes (2)	109

Figure 8: UBX-RXM-COR message in u-center

If all these checks pass, the ZED-F9 receiver should go into an RTK fix or float solution depending on the satellite visibility and environmental condition:

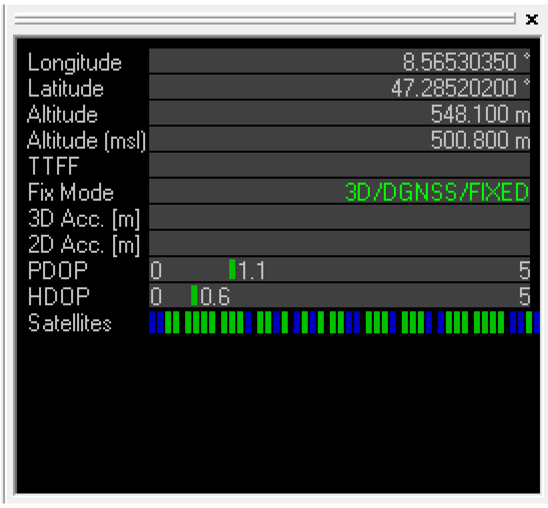


Figure 9: Position and status visualization windows in u-center

4 Example configuration for PointPerfect

To create a Thingstream account and a PointPerfect Thing, use the following link:

https://developer.thingstream.io/guides/location-services/pointperfect-getting-started

PointPerfect L-band SPARTN service is only available to qualified customers. The service is not available for consumer customers.

4.1 NEO-D9S L-band configuration

Contact the Thingstream support at support@thingstream.io to obtain the NEO-D9S PointPerfect L-band configuration keys value for your region.

The configuration should be applied as mentioned at section 2.1.

4.2 Setting ZED-F9 keys

The keys should be in the following format:

Figure 10: PointPerfect SPARTN Keys

Once the keys have been obtained from the PointPerfect account, the UBX-RXM-SPARTNKEY message needs to be formatted and sent to the ZED-F9 receiver, as shown in section 3.

ZED-F9 will first use the “Current key”, and when it expires the “Next key” will be used. Users should take care to download new keys periodically and update accordingly.

Setting the keys via the u-center MQTT client

From your Thingstream account and after the PointPerfect Thing has been created for the L-band service, it will be possible to download the u-center config file (JSON file) and save it in your u-center working folder:

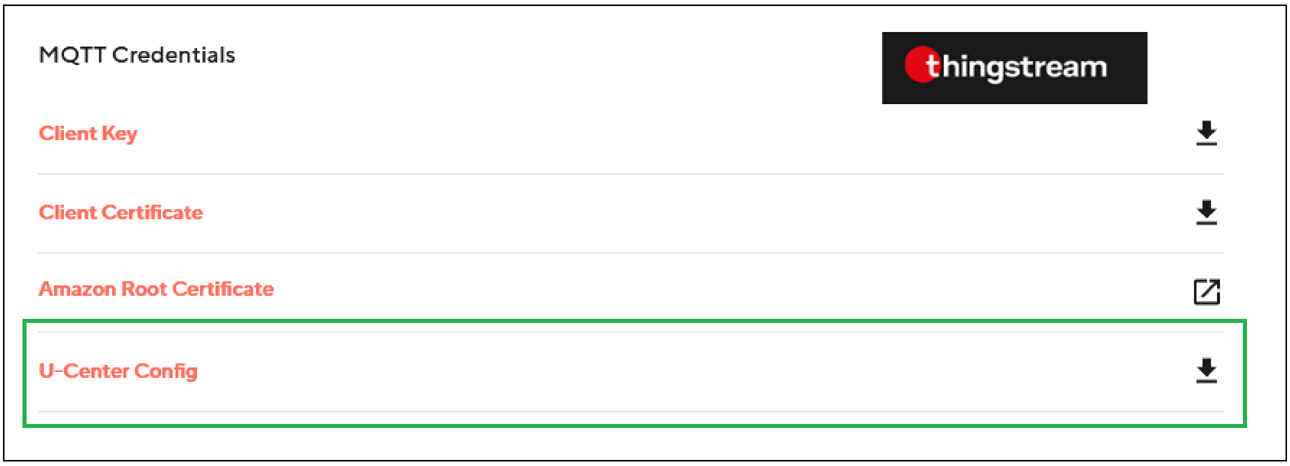


Figure 11: PointPerfect MQTT credentials and u-center configuration file

Connect u-center, version 22.05 or newer, to the F9 receiver and open the MQTT client dialog box from the Receiver menu. Browse for the JSON file from the u-center working folder, tick the key topic box, and select the OK button. Then the keys will be loaded in the F9 receiver.

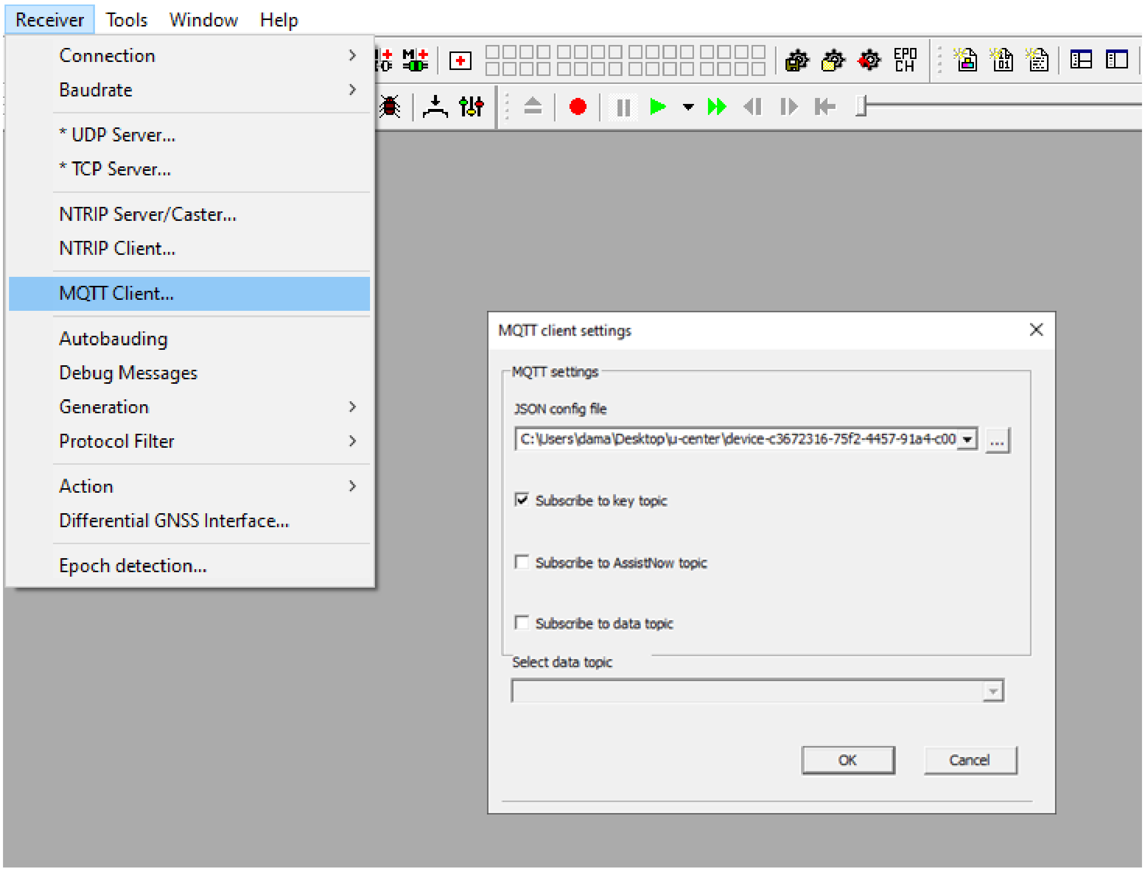


Figure 12: u-center MQTT client and key topic

The MQTT client dialog windows also include topics for providing data to the receiver via an IP connection – AssistNow for GNSS assistance and the SPARTN correction data.

Settings the keys manually via u-center

The UBX-RXM-SPARTNKEY message can be formatted, for example, using u-center [3]. Figure 14 shows the UBX-RXM-SPARTNKEY message view in u-center:

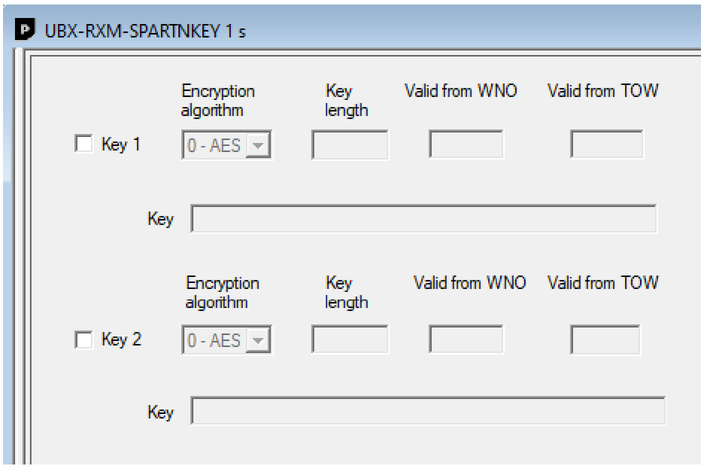


Figure 13: UBX-RXM-SPARTNKEY message view in u-center

"Key 1" in the message view represents the Current Key received form the PointPerfect Thing as shown in Figure 11, and "Key 2" represents the Next Key.

For each key, the related fields should be filled in as follows:

- Encryption algorithm = 0 – AES
- Key length = 16 (Bytes)

For Key 1, the fields "Valid from WNO" and "Valid from TOW" can be filled in with the current date expressed in GNSS data format, while for Key 2 these fields can be filled in using the Key 1 expiration date.

As an example, consider 22 March 2022 as the current date (you could use a GNSS online data translator, e.g., http://navigationservices.agi.com/GNSSWeb) and fill in the fields as shown below:

Row	Example	Definition
First	1	Calendar day of the month
Second	1485:2	Full GPS week since 1st epoch : day of week number
Third	462:172800	GPS Week since latest epoch : seconds of week at midnight for that day
Fourth	183	Julian Day Number

March | 2022 | Go To Month | Today

February			March 2022			April
Sun	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
		1 2199:2 151:172800 60	2 2199:3 151:259200 61	3 2199:4 151:345600 62	4 2199:5 151:432000 63	5 2199:6 151:518400 64
6 2200:0 152:0 65	7 2200:1 152:86400 66	8 2200:2 152:172800 67	9 2200:3 152:259200 68	10 2200:4 152:345600 69	11 2200:5 152:432000 70	12 2200:6 152:518400 71
13 2201:0 153:0 72	14 2201:1 153:86400 73	15 2201:2 153:172800 74	16 2201:3 153:259200 75	17 2201:4 153:345600 76	18 2201:5 153:432000 77	19 2201:6 153:518400 78
20 2202:0 154:0 79	154:86400 80	22 2202:2 154:172800 81	23 2202:3	24 2202:4	25 2202:5 154:432000 84	26 2202:6 154:518400 85
27 2203:0 155:0 86	28 2203:1 155:86400 87	29 2203:2 155:172800 88	30 2203:3 155:259200 89	31 2203:4 155:345600 90		

Week number

Time (second) of week

Figure 14: Example of current date in GNSS data format

WNO and TOW can be used to fill the related fields in the UBX-RXM-SPARTNKEY message, as shown in Figure 16.

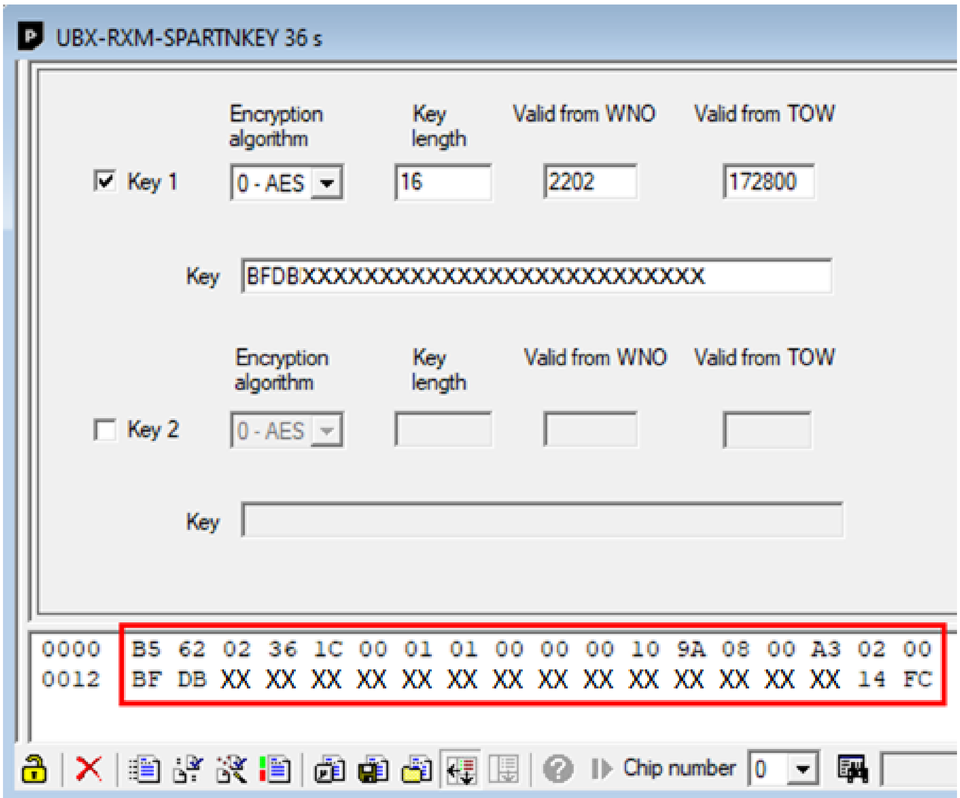


Figure 15: UBX-RXM-SPARTNKEY with Current Key entered

The UBX-RXM-SPARTANKEY message is shown within the red outline in Figure 16. This can be sent to the connected receiver by clicking Send, or it can be copied and sent separately (e.g., from the customer host processor).

The Next Key can also be updated, and it will automatically be used instead of the Current key when the latter expires.

From the example in Figure 11, the Current Key expiration date is 01:59 Apr 09, 2022. As previously stated, you can use the GNSS data translator to convert it to the appropriate GNSS data format:

Figure 16: Example of expiration date in GNSS data format

518400 is the TOW at 00:00 Apr 09, 2022.

In the current example (Current Key expiration date: 01:59 Apr 09, 2022):

TOW = 518400 + 7200 (2 hours) = 525600

The figure below shows the related UBX-RXM-SPARTNKEY message:

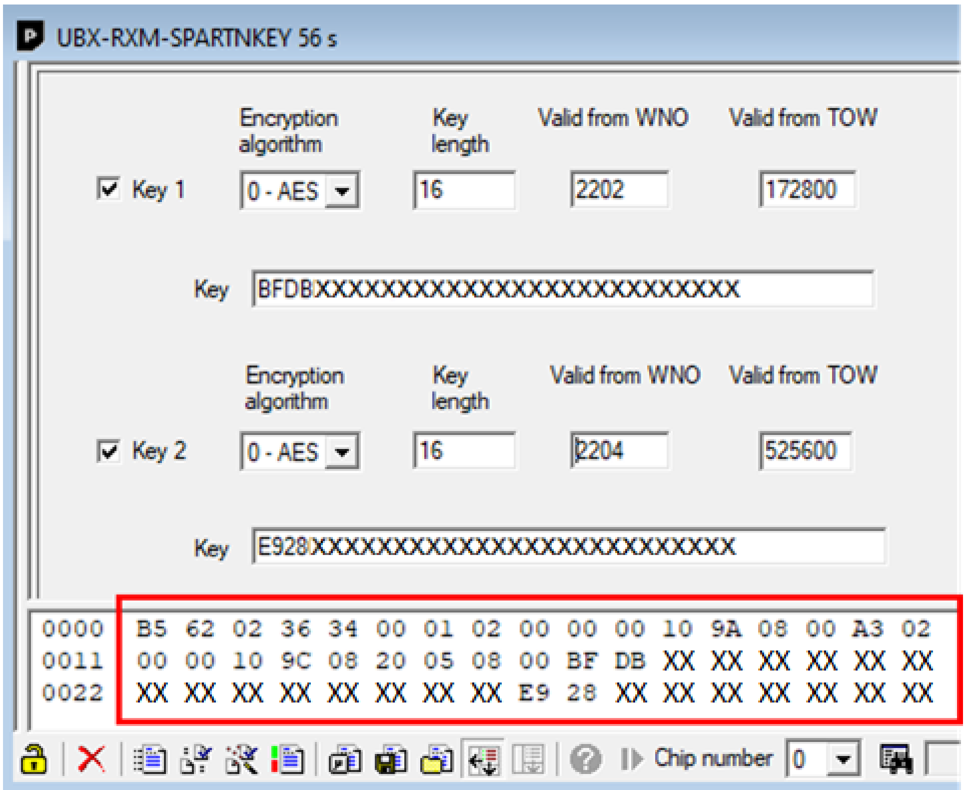


Figure 17: UBX-RXM-SPARTNKEY with Current and Next Keys entered

As mentioned previously, this can be sent to the receiver by clicking Send, or it can be copied and sent separately (e.g., from the customer host processor).

Appendix

A Glossary

Abbreviation	Definition
GNSS	Global Navigation Satellite System
HPG	High Precision
RAM	Random Access Memory
SPARTN	Secure Position Augmentation for Real Time Navigation
RTK	Real Time Kinematic
SSR	State Space Representation
TOW	Time Of Week
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
WNO	Week Number

Table 5: Explanation of the abbreviations and terms used

Related documentation

[1] NEO-D9S Integration manual, UBX-19026111
[2] ZED-F9P Integration manual, UBX-18010802
[3] u-center User guide, UBX-13005250
[4] u-blox D9 PMP 1.04 Interface description, UBX- 21040023
[5] u-blox F9 HPG 1.32 Interface description, UBX-22008968
[6] C099-F9P application board User guide, UBX- 18063024
[7] C101-D9S application board User guide, UBX-20031865
[8] Secure Position Augmentation for Real-Time Navigation (SPARTN) Interface Control Document, Version 2.0.1, September 2021.

☞ For product change notifications and regular updates of u-blox documentation, register on our website, www.u-blox.com.

Revision history

Revision	Date	Name	Comments
R01	13-Jun-2022	dama	Initial release
R02	27-Jul-2022	dama	Section 2.3 updated

Contact

For further support and contact information, visit us at www.u-blox.com/support.