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EVK-M91

Evaluation kit

User guide

Abstract

This document describes the structure and use of the EVK-M91 evaluation kit and provides information for evaluating and testing u-blox M9 positioning technology.

u-blox

Document information

Title	**EVK-M91**	
Subtitle	Evaluation kit	
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This document applies to the following products:

Product name	Type number	Firmware version	PCN reference
EVK-M91	EVK-M91-00-01	EXT SPG 4.04, ROM SPG 4.04	N/A

Contents

1 Product description

1.1 Overview

EVK-M91 Evaluation Kit makes evaluating the high performance of u-blox M9 positioning technology simple (see u-blox M9 www.u-blox.com/m9). The built-in USB interface provides both power supply and high-speed data transfer, keeping the possibility to connect through 14 pin connector. EVK-M91 has versatile interfaces and measurement points that enable advanced evaluation needs.

u-blox evaluation kits are compact, and their user-friendly interface and power supply make them ideally suited for use in laboratories or vehicles. Furthermore, they can be used with a PDA or a notebook PC, making them the perfect companion through all stages of design-in projects.

Evaluation kit	Description	Supported products
EVK-M91	u-blox M9 Evaluation kit with TCXO	u-blox UBX-M9140-Kx series chips, NEO-M9N module

Table 1: EVK-M91 supported products

1.2 Kit contents

The delivered package contains:

- Compact 105 x 64 x 26 mm EVK-M91 unit
- USB 2.0 cable (type C)
- Active GNSS antenna with 3 m cable
- EVK Welcome card

☞ For EVK-M91 Quick start guide, see start.u-blox.com.

1.3 System requirements

- PC with USB interface (compatible with USB 2.0)
- Operating system: Microsoft Windows 7 onwards (x86 and x64 versions)
- Internet connection for the first time use

2 Specifications

Parameter	Specification
Serial interfaces	1 USB 2.0 Type C
	1 UART, max baud rate 921600 Bd
	RS-232 +/- 5 V level
	14 pin – 3.0 V logic
	1 I2C max 400 kHz
	1 SPI – max SPI CLK 5.5 MHz, max data rate 1 Mbit/s
Timing interfaces	1 Time pulse output
Dimensions	105 x 64 x 26 mm
Power supply	5 V via USB or powered via external power supply pin 14 (V5_IN) and pin 1 (GND)
Normal operating temperature	-40 °C to +65 °C

Table 2: EVK-M91 specifications

2.1 Safety precautions

EVK-M91 must be supplied by a PS1 class limited power source. See section 6.2.2.4 of IEC 62368-1:2018 [8] for more information on the PS1 class.

In addition to a limited power source, only ES1 class circuits are to be connected to the EVK-M91, including interfaces and antennas. See section 5.2.1.1 of IEC 62368-1:2018 [8] for more information on the ES1 class.

3 Getting started

3.1 u-center installation

u-center, the u-blox interactive evaluation software tool is required for configuration, testing, visualization and data analysis of u-blox GNSS receivers as well as EVKs. The provided user guide together with the evaluation tool provide useful assistance during all phases of a system integration project.

u-center can be downloaded from www.u-blox.com/product/u-center. Once the zipped installer file is downloaded, unzip it and double-click the exe file. The u-center software will be installed on your system and placed under the "u-blox" folder in the "Start > Programs" menu, you can also choose the destination folder for the program installation. After a successful installation, u-center can be started from the **Start** menu (All Programs > u-blox > u-center > u-center). For more information on how to evaluate using u-center, refer to the u-center User guide [7].

The required Microsoft CDC-ACM driver for Windows 10 USB interface is available from the Microsoft Windows Update service. The Windows system driver search mechanism will download and install the USB driver automatically from the Microsoft Windows Update service.

To evaluate with the Windows 7 and 8 operating systems, the u-blox GNSS standard driver (x64bit) is needed which can be found in the u-center package.

3.2 Hardware installation

1. Connect the EVK-M91 to a PC running Microsoft Windows. The available interfaces are listed below. Please refer to section Device description for more information on the interfaces.
    *   USB-C: Connect via USB-C port.
    *   UART: Connect via RS-232. Set interface switch to I2C.
    *   SPI / I2C: Connect corresponding pins. Set interface switch accordingly to SPI or I2C. Refer to Figure 2 to see these interface positions.

    ☞ Press the RST button after changing the switch setting.
2. The device must always have power, either via USB on the back or the V5_IN input on the front.
3. Connect the provided GNSS antenna to the evaluation unit and place the antenna in a location with clear sky view.
4. Start the u-center GNSS evaluation software and select corresponding COM port and baud rate.

    ☞ Refer to the u-center User guide [7] for more information.

3.3 Serial port default configuration

Parameter	Description	Remark
RS-232, Input	UBX and NMEA protocol at 38400 Baud	
RS-232, Output	UBX and NMEA protocol at 38400 Baud	Only NMEA messages are activated by default
USB, Input	UBX and NMEA protocol	
USB, Output	UBX and NMEA protocol	Only NMEA messages are activated by default

Table 3: Default configuration

☞ There are also SPI, I2C and UART interfaces available for debugging and design-in purposes on the digital connector.

4 Approvals

The EVK-M91 complies with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

5 Device description

EVK-M91 evaluation unit contains the GNSS receiver, external TCXO, SAW and an LNA. Option for SPI flash can also be evaluated with the evaluation kit.

5.1 Interface connection

The EVK-M91 supports all three communication interfaces: UART, I2C and SPI. For connecting the EVK to a PC, use a standard SUBD-9 cable or the included USB Type-C cable depending on the interface in use.

The u-blox M9 GNSS receiver has a USB interface which allows direct communication to the receiver by USB.

Additional measurement equipment can be connected to the front connector.
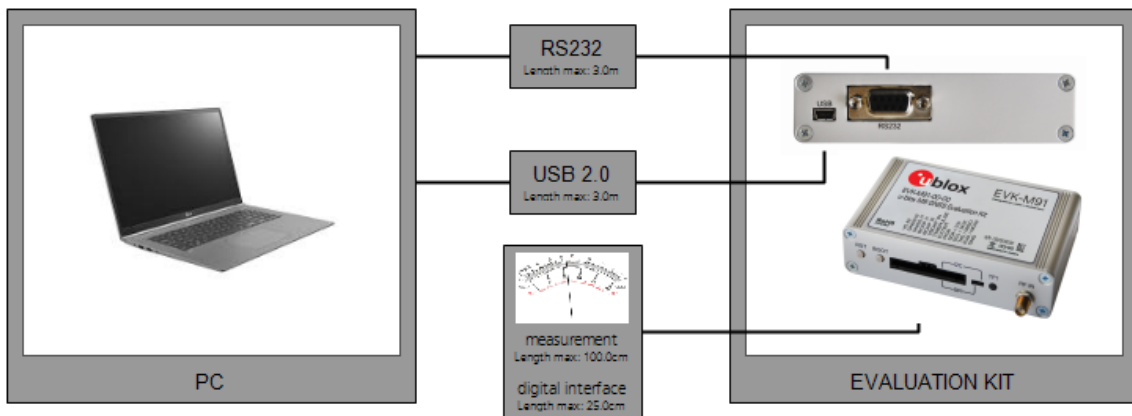
Figure 1: Connecting the unit for power supply and communication

Figure 2 shows the front and the back panel of the EVK-M91 evaluation unit.
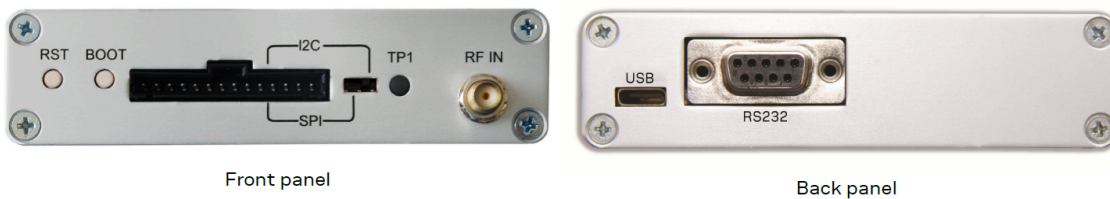
Figure 2: EVK-M91 front and back panels

5.1.1 Interface switch

Use the interface switch on the front panel to choose between I2C/UART and SPI communication ports. You must reset the unit by pressing the RST button after the interface switch setting has been changed.

1. I2C – In this selection the EVK operates with the UART (RS-232 – back panel or the 3.0 V level TXD (MISO), RXD (MOSI) at the front panel). Also the communication via 3.0 V I2C interface is selected.

2. SPI – In this selection the EVK operates only with the SPI interface. RS-232 is switched off.

5.1.2 USB

The USB Type-C connector on the evaluation board can be used for both power supply and communication. The easiest way to evaluate the EVK-M91 operation is to connect the EVK to a PC by the USB-C 2.0 cable and then to use the u-center to configure and monitor the GNSS functions. The USB connector has a direct connection to the u-blox M9 receiver, which enables the USB interface to be used as a communication interface as well.

When the board is connected to the PC, Windows creates a virtual COM port to the PC. This newly created virtual COM port needs then to be selected on the u-center application. The USB communication speed is by default set to 38400 baud. EVK-M91 supports speeds up to 921600 baud.

5.1.3 UART

The evaluation unit includes two options for the UART connection, one is an RS-232 port for serial communication with the PC and the other one is the 14-pin connector.

5.1.3.1 RS-232

Connect using a straight RS-232 serial cable with male and female connectors to the port on your PC. The maximum cable length is < 3.0 meters. To configure the RS-232 port, use the UBX-CFG-VALSET command and select CFG-UART1 Configuration group in the u-center application. The maximum operating baud rate is 921600 Bd. If you are using a USB to RS-232 adaptor cable, you can connect it directly to the evaluation kit RS-232 port.

The 9-pin RS-232 female connector is assigned as listed below:

Pin no.	Assignment
1 & 6	Time pulse
2	TXD/SPI_MISO, GNSS Transmit Data, serial data to external device
3	RXD/SPI_MOSI, GNSS Receive Data, serial data from external device
4	EXTINT
5	GND
7, 8 & 9	not connected

Table 4: EVK-M91 RS-232 connector pin description

5.1.3.2 14-pin connector

There is a 14-pin connector on the EVK-M91. It provides PIO, interfaces and supply options. All these pins are ESD protected. The 14-pin connector can be used for interfacing with UART, SPI, I2C and for evaluating other advanced scenarios.

Pin no.	Pin name	I/O	Level	Description
14	V5 IN	I	4.75-5.25 V	Power input – can be used instead of USB
13	GNSS I2	O	5.0 V	Supply current measurement (total current) node 2. See description for pin 12.
12	GNSS I1	O	5.0 V	Supply current measurement (total current) node 1. Connected to 5 V power supply. Current measured over a 1 Ω 1% resistor between pins 12 (GNSS I1) and 11 (GNSS I2). Pin 12 (GNSS I1) is at higher potential. NOTE: the total current includes also LNA and SPI flash.

Pin no.	Pin name	I/O	Level	Description
11	BCKP I1	O	3.0 V	Backup supply current measurement node 1. Connected to backup supply (super capacitor). Current measured over a 100 Ω 1% resistor between pins 11 (BCKP I1) and 10 (BCKP I2). Pin 11 (BCKP I1) is at higher potential.
10	BCKP I2	O	3.0 V	Backup supply current measurement node 2. See description for pin 11.
9	VBCKP IN	I	3.0 V	Backup power supply input – optional input for testing backup operation
8	TIMEPULSE	O	3.0 V	Time pulse signal
7	EXTINT	I	3.0 V	External interrupt, can be used for time aiding
6	PIO8	I/O	3.0 V	Generic input/output (PIO8)
5	SDA/CS	I/O	3.0 V	If slide the interface switch on I2C, then I2C interface selected; Function: data input / output If slide the interface switch on SPI, then SPI interface selected; chip select input – LOW ACTIVE
4	SCL/SCK	I	3.0 V	Clock input. Can also be used as generic input/output (PIO4).
3	TxD/MISO	O	3.0 V	Serial port transmit or SPI slave transmit, operation selected by interface switch
2	RxD/MOSI	I	3.0 V	Serial port receive or SPI slave receive, operation selected by interface switch
1	GND	I	–	Recommended common ground pin

Table 5: EVK-M91 14 pin connector pin description

Hirschmann
Part Nr.: 934160100
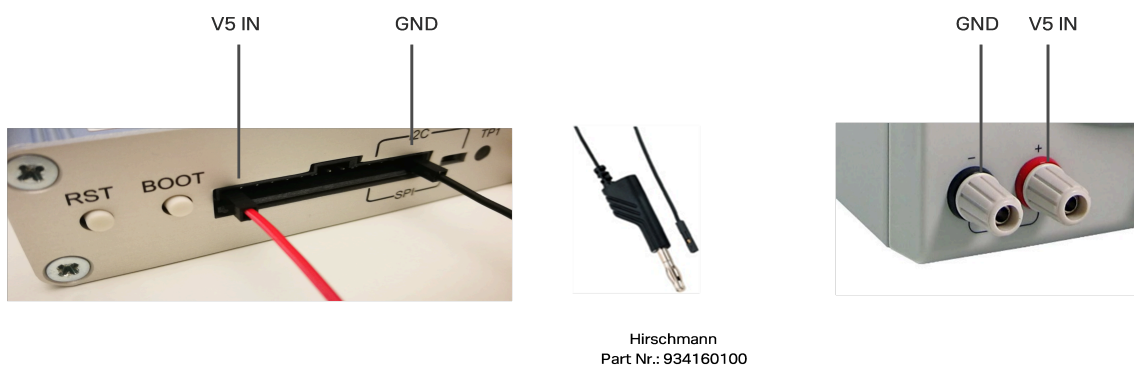
Figure 3: EVK-M91 example 5 V DC power supply

☞ When using the 3.0 V digital interfaces with your application (e.g. SPI or I2C), a cable length less than 25 cm is recommended.

5.1.4 SPI

The SPI interface pins are available on 14-pin connector, see section 14-pin connector for more information.

☞ If using the SPI interface, the Interface switch must be set to "SPI".

5.1.5 I2C

The 14-pin connector contains pins for evaluating I2C bus communication. If using I2C, the Interface switch must be set to "I2C".

By default, the optional I2C pull-up resistors are not populated on the EVK board. The u-blox M9 GNSS receiver already contains internal pull-up resistors for normal use. If fast communication speed with long cable length is needed, the optional pull-up resistors can be placed to the reserved location on the EVK board.

5.2 GNSS input signal

To evaluate the GNSS reception, the GNSS signal must be supplied to the antenna input SMA connector of the evaluation board. EVK-M91 evaluation kit includes a GPS / Galileo / GLONASS / BeiDou antenna with a 3.0 m cable. It is possible to connect various active and passive GNSS antennas with SMA connectors or provide a signal from a recorded or simulated GNSS RF source to the antenna input.

☞ Refer to the NEO-M9N System Integration Manual [5] for more GNSS antenna / signal related information and recommendation.

☞ The characterization and certifications for EVK-M91 are applicable only with the active GNSS antenna included in the evaluation kit (or comparable).

5.2.1 Antenna connector

An SMA female connector is available on the front side (see Figure 2) of the evaluation unit for connecting an active or a passive antenna. The RF path on EVK-M91 contains an LNA and a SAW filter having 3.0 V DC voltage in the RF input. The recommended maximum antenna supply current for active antennas is 40 mA and is limited by the internal antenna short circuit detection feature. Please refer to [3] for more details. In addition to internal short circuit antenna detection feature, a hardware short circuit protection limits the maximum current to 100 mA. This pin is also ESD protected.

5.3 Time pulse

u-blox receivers include a time pulse function providing clock pulses with a configurable pulse period, pulse length and polarity (rising or falling edge). Check the NEO-M9N Data sheet [4] for detailed specifications of configurable values.

The time pulse signal is available at the 14-pin and RS-232 connectors. In addition, time pulse signal is connected to the LED on the front panel of the unit.

5.4 Reset button

The RST button on the front panel resets the unit.

5.5 Safeboot button

This is used to set the unit into safeboot mode. In this mode the receiver executes only the minimal functionality, such as updating new firmware into the SPI flash via UART. In order to set the receiver in safeboot mode please follow these steps:

1. Press the BOOT button and hold it down
2. Press the RST button
3. Release the RST button
4. Release the BOOT button
5. If the UART interface has to be used, a training sequence has to be sent to the receiver though u-center firmware update tool or custom message window. The training sequence is

a transmission of 0x55 0x55 at the baud rate of 9600 Bd. Wait for at least 100 milliseconds before the interface is ready to accept commands.

5.6 LED

On the front panel of the unit, a single blue LED shows the time pulse signal as well as the status that device is supplied. The LED starts flashing one pulse per second during a GNSS fix. If there is no GNSS fix, the LED will only be lit, without flashing.

5.7 Flash

EVK-M91 has an SPI flash that is connected to the u-blox M9 receiver. By default it can be used to:

• Store the current configuration permanently
• Save data logging results
• Hold AssistNow™ Offline and AssistNow™ Autonomous data

EVK-M91 has a 16-Mbit flash. However, only 5 Mbit of this is available for application use. The remainder of the space is reserved for other features.

5.8 Super capacitor

The evaluation board includes a super capacitor to supply the backup power domain of the EVK-M91 and is charged whenever there is a power supply available, either via USB or the 14 pins connector. The super capacitor provides backup power directly to the EVK-M91 V_BCKP power input in case of no other V_BACKUP power supply is provided. When this 1 F capacitor is fully charged to 3.0 V, it can provide backup power for about 10 hours (t=C*U/I=1*(3.0-1.65)/36uA=37,500 seconds -> 10 hours).

The 3.0 V V_BACKUP power supply can be used to provide power for any needed period of time while evaluating for very long backup periods.

5.9 EXTINT

On the EVK-M91, the EXTINT signal is available on 14-pin connector, see sections 14-pin connector and RS-232 for more information.

6 Current measurement

6.1 GNSS current

At startup, the receiver starts in acquisition state to search for available satellites and to download GNSS orbital data, i.e., ephemeris and almanac. Once the data has been downloaded, the receiver enters tracking state. In continuous operation, the receiver typically remains in tracking state once entering it. The current consumption reduces when the receiver enters the tracking state. The time required to enter tracking mode can be reduced by downloading aiding data from the AssistNow™ Online service.

On EVK-M91, the main supply voltage for the u-blox M9 GNSS receiver is 3.0 V. The internal DCDC converter is enabled to reduce power consumption. To measure the total GNSS supply current with EVK-M91, follow these steps:

1. Power up EVK-M91.
2. Connect a true RMS voltmeter across GNSS I1 (pin 12) and GNSS I2 (pin 13) of the 14-pin connector.
3. Read the voltage (and average if necessary) on the voltmeter and convert to current (1 mV equals 1 mA).
4. Perform the test with good signals and clear sky view to ensure that the receiver can acquire the satellite signals.

☞ The total GNSS current includes the internal LNA, SPI flash and TCXO.

6.2 Backup current

To measure the backup current with EVK-M91, follow these steps:

1. Connect a true RMS voltmeter across BCKP I1 (pin 11) and BCKP I2 (pin 10) of the 14-pin connector.
2. Remove power supply (USB cable or other external power supply).
3. Read the voltage (and average if necessary) on the voltmeter and convert to current (1 mV equals 10 µA).

7 Block diagram

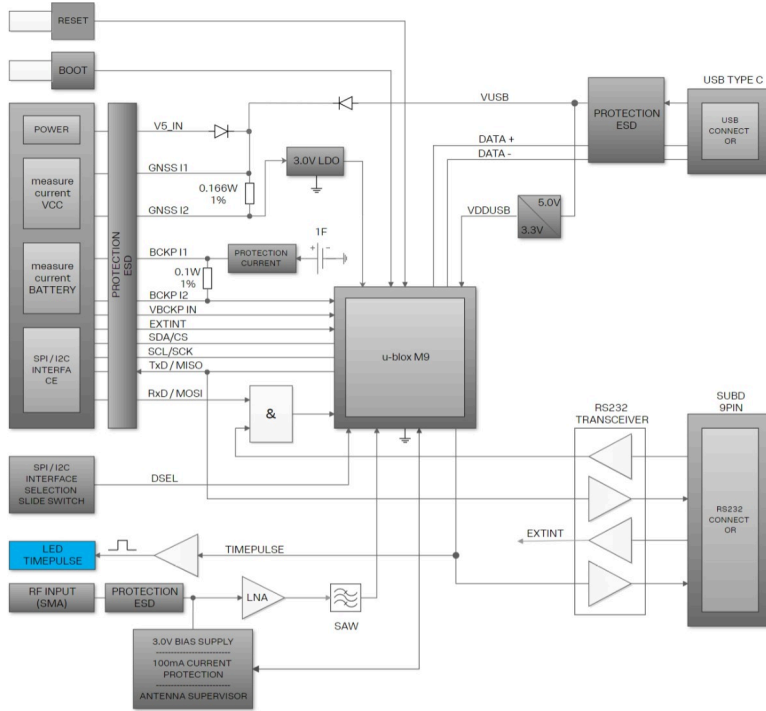EVK-M91 block diagram providing an overview on supply voltages and interfaces is shown in Figure 4.

Figure 4: EVK-M91 block diagram

8 Board layout

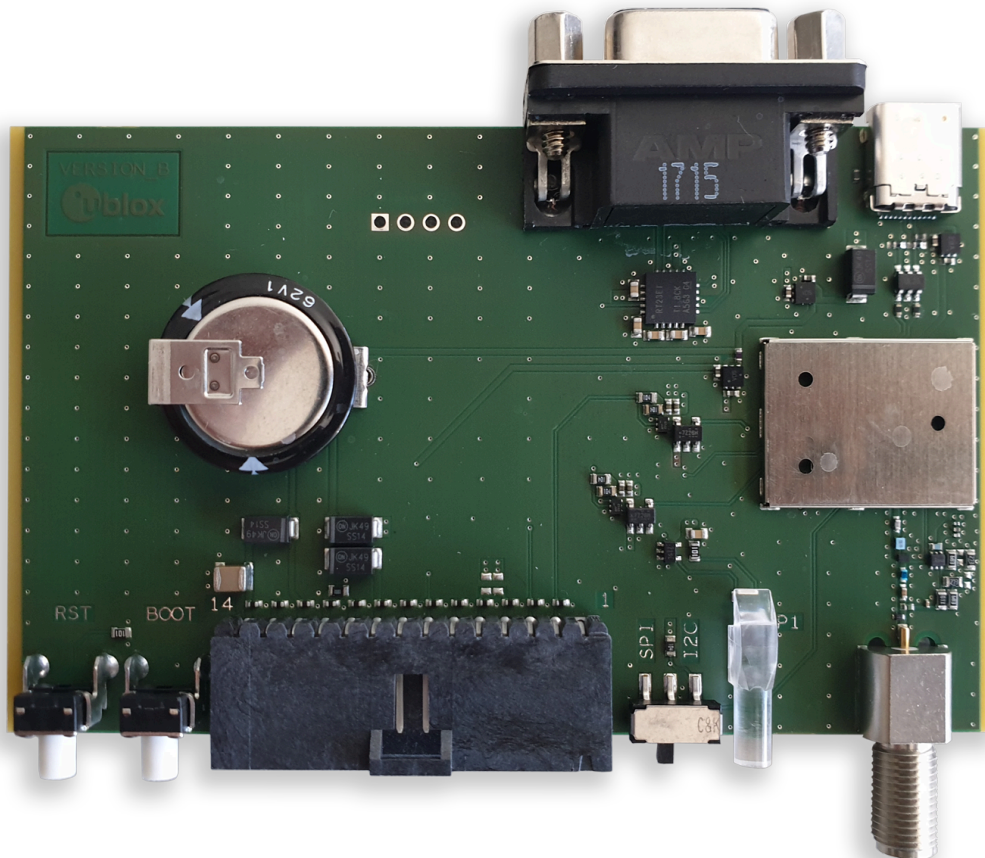## 8.1 PCB version B

The PCB for EVK-M91 is shown in Figure 5.

Figure 5: EVK-M91 PCB

9 External firmware update and ROM firmware evaluation

The EVK-M91 is delivered with the latest version of firmware. By default the EVK will boot from the external flash. It is also possible to boot from the ROM firmware on the EVK-M91. To test the ROM firmware, the flash firmware needs to be erased.

This section describes how to update the external flash firmware if needed. Subsequently, this section also shows how to erase the firmware on the flash of EVK-M91 if required for evaluation and boot the EVK-M91 from the ROM firmware.

To view the currently installed firmware, connect via USB to u-center and poll UBX-MON-VER, as shown in Figure 6.
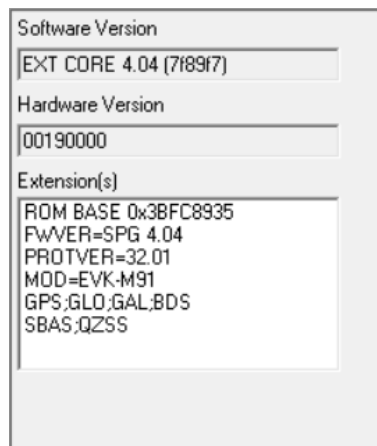
Figure 6: Checking EVK-M91 firmware version from u-center

To update the flash firmware or to revert to booting from external flash firmware from ROM, follow the instructions below

1. Select **Tools > Firmware Update…**. The firmware update window will appear as shown in Figure 7.
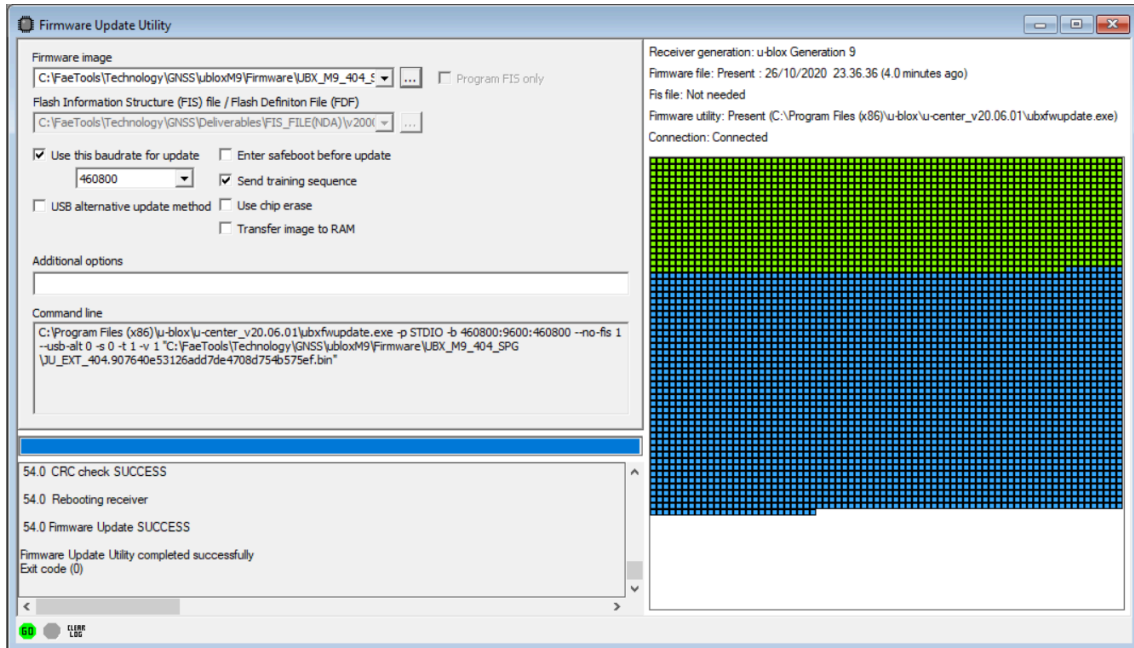
Figure 7: Firmware update tool

2. Select the firmware image by clicking the ellipsis button next to **Firmware image**.
3. Select **Use this baud rate for update** option and choose a higher baud rate, i.e., 460800 to make the firmware update faster.
4. Click **GO**.
5. Poll UBX-MON-VER again to verify the updated firmware.

To erase the flash firmware follow the instructions below:

1. Select **Tools > Firmware Update…**. The firmware update window will appear as shown in Figure 8.
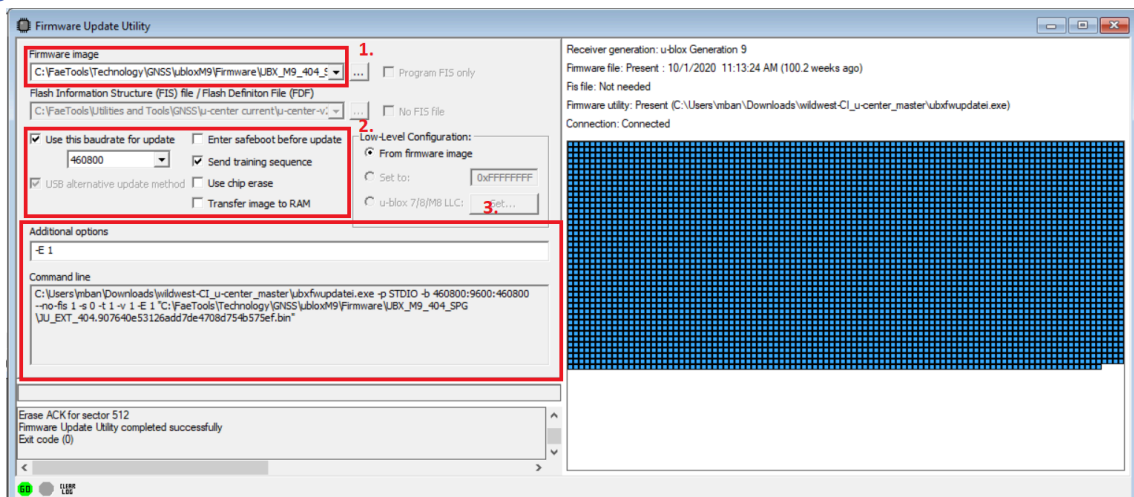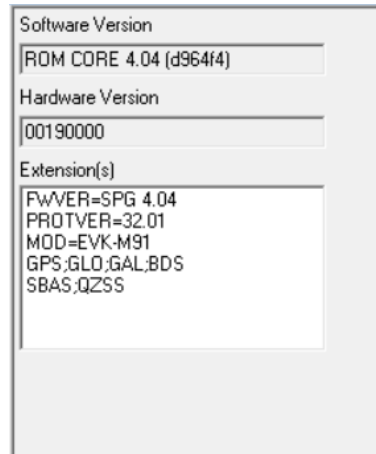

Figure 8: Firmware update tool

2. Select the firmware image by clicking the ellipsis button next to **Firmware image**.
3. Select **Use this baud rate for update** option and choose a higher baud rate, i.e., 460800 to make the firmware update faster.

4. In the **Additional Option** box, enter command **-E 1** which is an erase parameter and can be seen in the **Command line** as well .

5. Click **GO**.

6. Poll UBX-MON-VER again to verify the firmware and see the EVK-M91 booting from the ROM firmware as shown in Figure 9.

Figure 9: Checking EVK-M91 firmware version from u-center

☞ The ROM firmware SPG 4.04 has a default baudrate of 9600 and the flash firmware has a default baud rate of 38400. If UART interface is used for firmware update or ROM firmware evalutation, then the u-center baud rate needs to be in accordance with the default UART baud rate of the respective firmware.

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9 External firmware update
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10 Troubleshooting

My application (e.g. u-center) does not receive all messages

When using UART, make sure the baud rate is sufficient. If the baud rate is insufficient, GNSS receivers based on u-blox M9 GNSS technology will skip excessive messages. Some serial port cards/adapters (e.g. USB to RS-232 converter) frequently generate errors. If a communication error occurs while u-center receives a message, the message will be discarded.

My application (e.g. u-center) loses the connection to the GNSS receiver

u-blox M9 positioning technology and u-center have an autobauding feature. If frequent communication errors occur (e.g. due to problems with the serial port), the connection may be lost. This happens because u-center and the GNSS receiver both autonomously try to adjust the baud rate. Do not enable the u-center autobauding feature if the GNSS receiver has the autobauding flag enabled.

Some COM ports are not shown in the port list of my application (e.g. u-center)

Only the COM ports that are available on your computer will show up in the COM port drop down list. If a COM port is gray, another application running on this computer is using it.

EXTINT signal is not working when connecting the EVK using RS-232 UART-to-USB cable.

Disconnect the RS-232 UART-to-USB cable and use the EXTINT signal from the front panel of the EVK. The USB port on the EVK can also be used for UART communication because of the on-board FTDI USB-to-UART converter.

EVK-M91 does not work properly when connected to a GNSS simulator

When using EVK-M91 together with a GNSS simulator, please pay attention to proper handling of the EVK. A GNSS receiver is designed for real-life use, i.e., time is always moving forward. When using a GNSS simulator scenarios, the scenario time can be in the past resulting in the receiver to jump backwards in time. This can have serious side effects on the performance of GNSS receivers.

The solution is to configure the GPS week rollover value to a week number preceding the date in GNSS simulator scenario. For example, setting the GPS week number to 1200 (corresponding to Jan 2003) allows running simulator scenarios taking place after this date. Please refer to Figure 10 for how to set the GPS week number with u-center GNSS evaluation software. In addition, always issue a Cold start command before every simulator test to avoid receiver confusion due to the time jumps.
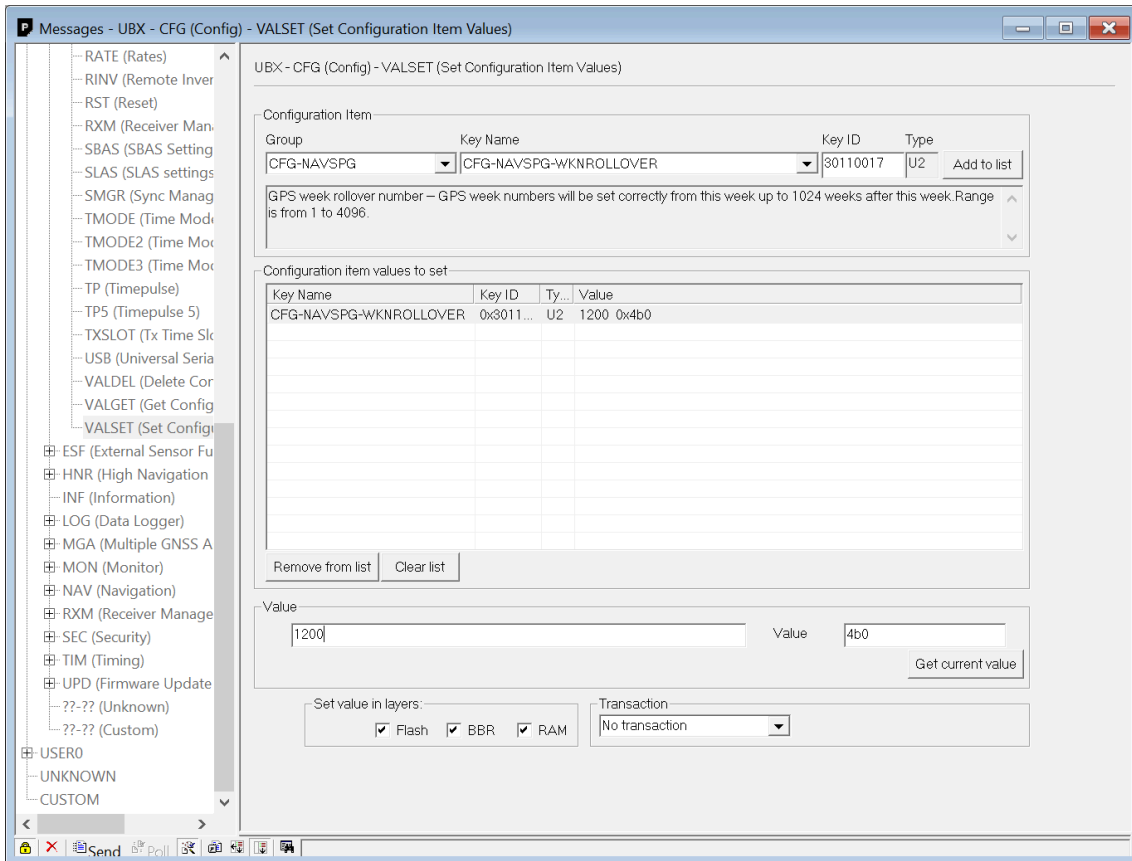
Figure 10: Setting GPS week number with u-center GNSS evaluation software

11 Common evaluation pitfalls

- Parameters may have the same name but a different definition. GNSS receivers may have a similar size, price and power consumption but can still have different functionality (e.g. no support for passive antennas, different temperature range). Also, the definitions of Hot, Warm, and Cold Start times may differ between suppliers.
- Verify design-critical parameters; do not base a decision on unconfirmed numbers from data sheets.
- Try to use identical or at least similar settings when comparing the GNSS performance of different receivers.
- Data, which has not been recorded at the same time and the same place, should not be compared. The satellite constellation, the number of visible satellites and the sky view might have been different.
- Do not compare momentary measurements. GNSS is a non-deterministic system. The satellite constellation changes constantly. Atmospheric effects (i.e. dawn and dusk) have an impact on signal travel time. The position of the GNSS receiver is typically not the same between two tests. Comparative tests should therefore be conducted in parallel by using one antenna and a signal splitter; statistical tests shall be run for 24 hours.
- Monitor the carrier-to-noise-ratio (C/N0). The average C/N0 of the high elevation satellites should be between 40 dBHz and about 50 dBHz. A low C/N0 will result in a prolonged TTFF and more position drift.
- When comparing side-by-side receivers, make sure that all receivers have the same signal levels. The best way to achieve this is by using a signal splitter. Comparing results measured with different antenna types (with different sensitivity) will lead to incorrect conclusions.
- Try to feed the same signal to all receivers in parallel (i.e. through a splitter); the receivers will otherwise not have the same sky view. Even small differences can have an impact on the speed, accuracy, and power consumption. One additional satellite can lead to a lower dilution of precision (DOP), less position drift, and lower power consumption.
- When doing reacquisition tests, cover the antenna in order to block the sky view. Do not unplug the antenna since the u-blox M9 positioning technology continuously performs a noise calibration on idle channels.
- The Interface Switch is used to select "UART/I2C" or "SPI" port. If the receiver is set to "UART/I2C" mode and configuration is saved by sending the CFG-CFG save command, all input and output protocols for SPI are disabled. Powering up the EVK in "SPI" mode will result in the receiver starting with all SPI input and output protocols disabled. Since SPI input has also been disabled, it is impossible to recover using the SPI interface. Powering up in "UART/I2C" mode and sending a CFG-CFG clear command restores the SPI port defaults, which makes SPI usable again.

Appendix

A Glossary

Abbreviation	Definition
BeiDou	Chinese navigation satellite system
EVK	Evaluation Kit
I2C	Inter-Integrated Circuit bus
ESD	Electrostatic Discharge
Galileo	European navigation satellite system
GLONASS	Russian navigation satellite system
GND	Ground
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IEC	International Electrotechnical Commission
PCB	Printed Circuit Board
RF	Radio frequency
UBX	u-blox
QZSS	Quasi-Zenith Satellite System

Related documents

[1] UBX-M9140-KA Data sheet, doc. no. UBX-18021372 (NDA required)

[2] UBX-M9140-KB Data sheet, doc. no. UBX-18020412 (NDA required)

[3] UBX-M9140-Kx Integration manual, doc. no. UBX-21042174 (NDA required)

[4] NEO-M9N Data sheet, doc. no. UBX-19014285

[5] NEO-M9N Integration manual, doc. no. UBX-19014286

[6] u-blox M9 SPG 4.04 Interface description, doc. no. UBX-21022436

[7] u-center User guide, doc. no. UBX-13005250

[8] Information technology equipment – Safety Standard IEC 62368-1:2018

☞ For regular updates to u-blox documentation and to receive product change notifications please register on our homepage https://www.u-blox.com.

Revision history

Revision	Date	Name	Status / comments
R01	23-Dec-2019	msul, rmak	Initial release
R02	03-Apr-2020	msul	Updated FW version to SPG 4.03 in page 2, updated RS-232 output voltage level to +/-5 V in specifications section 2, updated safety precautions in section 2.1, updated short circuit threshold value to 40mA in section 4.2.1, added antenna supervisor part on the block diagram in figure 4, updated figure 5 for PCB version B in section 7. Added firmware update section 8, added glossary in appendix section.
R03	03-Nov-2020	msul	Updated FW version to SPG 4.04 in page 2, added approvals section 4, updated figure in firmware update section 9.
R04	05-Oct-2022	mban	Updated type number, FW (EXT SPG 4.04, ROM SPG 4.04), removed document status on page 2, updated block diagram in section 7 and added section 9 to show ROM firmware evaluation, updated related document section. Added a note about EXTINT limitation in troubleshooting section. Added a note on UART baud rate in section 9.

Contact

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