EVK-M8L

Evaluation kit

User guide

Abstract

This document describes the structure and use of the EVK-M8L evaluation kit and provides information for evaluating and testing u-blox M8 ADR positioning technology.

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This document applies to the following products:

Product name	Type number	Hardware version	Firmware version	PCN reference	Product status
EVK-M8L	EVK-M8L-0-12	D	Flash FW 3.01 ADR 4.31 M8L	N/A	Production information

European Union regulatory compliance
EVK-M8L complies with all relevant requirements for RED 2014/53/EU. The EVK-M8L Declaration of Conformity (DoC) is available at www.u-blox.com under Support --> Product Resources --> Conformity Declaration.

Contents

1 Product description

1.1 Overview

The EVK-M8L evaluation kit simplifies the evaluation of the high performance u-blox M8 ADR positioning products. The built-in USB interface provides both power supply and high-speed data transfer, and eliminates the need for an external power supply. The u-blox evaluation kits are compact, and their user-friendly interface and power supply make them ideally suited for use in laboratories, vehicles and outdoor locations. 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	Suitable for
EVK-M8L	u-blox M8 Evaluation Kit 3D ADR with on-board sensors	NEO-M8L

Table 1: List of products supported by the EVK-M8L evaluation kit

1.2 Kit includes

- Evaluation unit
- USB cable
- Active GPS / Galileo / GLONASS / BeiDou antenna with 3 m cable
- Quick Start card

1.3 Evaluation software

The u-center software installation package for the EVK can be downloaded from www.u-blox.com/en/evaluation-software-and-tools.

Once the .zip file is downloaded, extract the file contents in the Tools folder and double-click the extracted .exe file. The software components will be installed in your system and placed under the “u-blox” folder in the “Start > Programs” menu.

The u-center application is an interactive tool for configuration, testing, visualization and data analysis of GNSS receivers. It provides useful assistance during all phases of a system integration project. The latest version of the u-center should be used.

1.4 System requirements

- PC with USB interface
- Operating system: Windows Vista onwards (x86 and x64 versions)
- USB drivers are provided in the evaluation kit installation software

2 Specifications

Parameter	Specification
Serial interfaces	1 USB V2.0
	1 RS232, max. baud rate 921.6 kBd DB9 +/- 12 V level 14 pin – 3.3 V logic
	1 DDC (I2C compatible) max. 400 kHz
	1 SPI – clock signal max 5.5 MHz – SPI DATA max. 1 Mbit/s
Speed Pulse interface	Wheel tick: 3.3 V – 24 V logic Forward / Reverse: 3.3 V – 24 V logic Separate isolated vehicle GND connection for wheel tick and Forward/Reverse signals.
Timing interface	Time-pulse output
Dimensions	105 x 64 x 26 mm
Power supply	5 V via USB or external powered via extra power supply pin 14 (V5_IN) and common supply/interface ground pin 13 (GND)
Normal Operating temperature	-40 °C to +65 °C

Table 2: EVK-M8L specifications

⚠ THE EVK CASE-WORK IS CONNECTED TO THE COMMON SUPPLY/INTERFACE GROUND PIN. Contact u-blox technical support for assistance if required.

2.1 Safety precautions

EVK-M8L must be supplied by an external limited power source in compliance with clause 2.5 of the standard IEC 60950-1. In addition to an external limited power source, only separated or Safety Extra-Low Voltage (SELV) circuits are to be connected to the evaluation kit, including interfaces and antennas.

☞ For more information about SELV circuits see section 2.2 in Safety standard IEC 60950-1 [7].

⚠ CAUTION! IN THE UNLIKELY EVENT OF A FAILURE IN THE INTERNAL PROTECTION CIRCUITRY THERE IS A RISK OF EXPLOSION WHEN CHARGING FULLY OR PARTIALLY DISCHARGED BATTERIES. REPLACE THE BATTERY IF IT NO LONGER HAS SUFFICIENT CHARGE FOR UNIT OPERATION. CHECK THE BATTERY BEFORE USING IF THE DEVICE HAS NOT BEEN OPERATED FOR AN EXTENDED PERIOD OF TIME.

3 Device description

3.1 Interface connection and measurement

To connect the EVK to a PC, use a standard SUBD-9 cable and the included USB cable. The use of RS232 and external power supply is optional. USB provides both power and a communication channel.

Connect the wheel tick and forward/reverse signals as well as vehicle ground (GNDA) to the front connector.

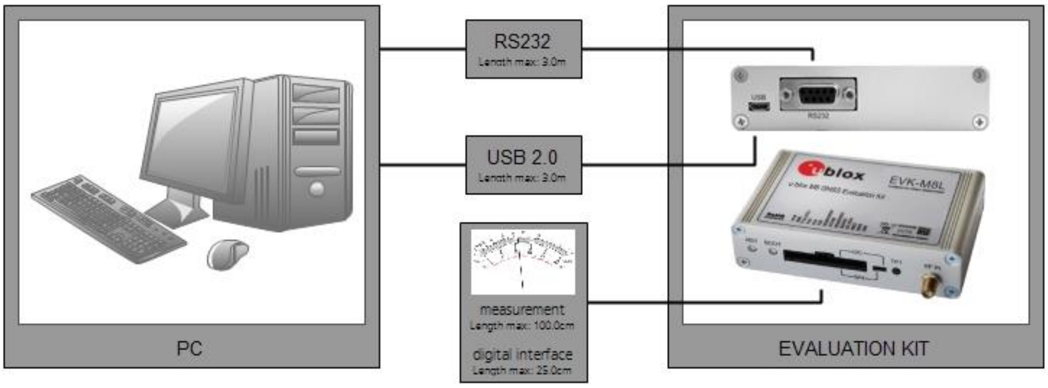


Figure 1: Connecting the unit for power supply and communication

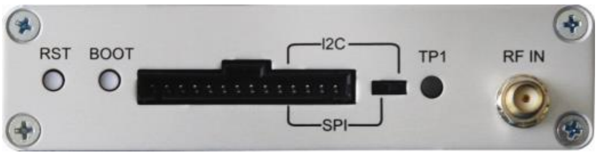
3.2 Active antenna

The EVK-M8L evaluation kit includes a GPS / Galileo / GLONASS / BeiDou antenna with a 3-meter cable. It is possible to connect various active and passive GNSS antennas with SMA connectors to the evaluation unit.

The recommended maximum antenna supply current for active antennas is 30 mA.

3.3 Evaluation unit

Figure 2 shows the front and the rear panel of the EVK-M8L evaluation unit.



Front panel

Rear panel

Figure 2: EVK-M8L evaluation unit – front and rear panels

3.3.1 Antenna connector

An SMA female jack is available on the front side (see Figure 2) of the evaluation unit for connecting an active or passive antenna. The EVK provides a DC supply at the RF input of 3.3 V for active antennas. The maximum supported antenna current is 30 mA; internal protection limits the maximum short circuit current to 60 mA.

To avoid the damage of RF input caused by ESD or Electrical Overstress, and to seek maximum consistency and repeatability of performance independently of the RF component used, the EVK-M8L has an onboard LNA.

⚠ The connector is only to be used with a GNSS antenna or simulator. Do not connect this equipment to cable distribution systems.

3.3.2 USB

A USB V2.0 compatible serial port is featured for data communication and power supply.

3.3.3 UART

The evaluation unit includes an RS232 DCE port for serial communication that is compatible with PC serial ports.

Connect using a straight RS232 serial cable with male and female connectors to the DTE port on your PC. The maximum cable length is 3.0 meters. To configure the RS232 port, use the UBX-CFG-PRT command in the u-center application. The maximum operating baud rate is 921.6 kBd.

If you are using a USB to RS232 adaptor cable, you can connect it directly to the evaluation kit RS232 port.

The 9-pin D-SUB female connector is assigned as listed in Table 3:

Pin no.	Assignment
1	not connected
2	TXD, GNSS Transmit Data, serial data to DTE
3	RXD, GNSS Receive Data, serial data from DTE
4	not connected
5	GND
6	not connected
7-9	not connected

Table 3: SUB-D9 connector pin description for EVK-M8L

3.3.4 RST button

The RST button on the front panel resets the unit. To avoid an inadvertent reset, the button is recessed.

3.3.5 Safe boot button

This is used to set the unit in safe boot mode. In this mode the receiver executes only the minimal functionality, such as updating new firmware into the SQI flash. In order to set the receiver in safeboot mode follow these steps.

- Press the BOOT button and keep holding it down
- Press the RST button
- Release the RST button
- Release the BOOT button
- If the UART interface has to be used, a training sequence has to be sent to the receiver. The training sequence is a transmission of two bytes 0x55 55 at the baud rate of 9600 Bd. Wait for at least 100 milliseconds before the interface is ready to accept commands.

3.3.6 Slide switch

Use the slide switch on the front panel to choose between I2C (and UART) and SPI communication ports. You must reset the unit by pressing the RST button when the slide switch has been changed.

1. I2C: With this selection, the EVK operates with the UART (RS232 DB9 – rear panel or the 3.3 V level TXD (MISO), RXD (MOSI) at the front panel). Also the communication via 3.3 V DDC interface (I2C) is selected.
2. SPI: With this selection, the EVK operates only with the SPI interface. RS232 (DB9) is switched off.

3.3.7 Front connector

This 14-pin connector provides access to additional functionality to the EVK using various interface pins. Most importantly, it provides the interface to the vehicle speed pulse (WHEELTICK) input. The WHEELTICK signal should be adequately de-bounced before application to the EVK input.

The connector also enables measurement of the current used by the EVK. For accurate measurements, it is recommended to use a cable of at most 1 meter in length.

We recommend using the ACE-AM-0 mating connector or equivalent available from our online shop. All pins are ESD-protected.

Pin no.	Pin name	I/O	LEVEL	Description
14	V5_IN	I	4.75 V - 5.25 V	Power input – can be used instead of USB
13	GND	I	-	Common ground pin for case-work, power and serial interface connections
12	P1A (VCC)	O	3.3 V	Power output – max. current supply 100 mA 1 Ω 1% resistor for over-all current measurement to pin 11 (P1B) *NOTE: the current also includes LNA*
11	P1B	O		Second connection for overall current measurement
10	P2A	O	3.0 V	Battery output (unloaded) 100 Ω 1% resistor for battery backup current measurement to pin 9 (P2B) *NOTE: There is a current protection to 3 mA. See the circuit in Figure 16 (D2, D4, R29).*
9	P2B	O		Second junction for battery backup current measurement
8	TIMEPULSE	O	3.3 V	Time pulse (internally buffered output)
7	WHEELTICK	I	3.3 V - 24 V	Wheel tick input
6	FWD	I	3.3 V - 24 V	Forward/reverse input for speed pulse
5	SDA / CS	I/O	3.3 V	If the slide switch is on I2C, the DDC interface is selected; Function: data input / output If the slide switch is on SPI, the SPI interface is selected; chip select input – LOW ACTIVE
4	SCL / SCK	I/O	3.3 V	Clock input / output
3	TxD / MISO	I/O	3.3 V	If the slide switch is on I2C, the DDC interface is selected / UART TxD (3.3 V level) If the slide switch is on SPI, the SPI interface is selected; Master in, Slave out (MISO)
2	RxD / MOSI	I/O	3.3 V	If the slide switch is on I2C, the DDC interface is selected / UART RxD (3.3 V level) If the slide switch is on SPI, the SPI interface is selected; Master out, Slave in (MOSI)
1	GNDA	I	-	Isolated ground pin to be connected with wheel tick and Forward/Reverse signals

Table 4: Connector pin descriptions for EVK-M8L (pins numbered from right to left on the front panel)

⚠ THE EVK CASE-WORK IS CONNECTED TO THE COMMON SUPPLY/INTERFACE GROUND PIN. Contact u-blox technical support for assistance if required.

3.3.8 LED

On the front panel of the unit, a single blue LED may be configured to follow the receiver time pulse signal using the UBX-CFG-TP5 message. The time pulse may be configured so that the LED starts flashing at one pulse per second during a valid GNSS fix. If there is no GNSS fix, the LED will only light up, without flashing. The time pulse is enabled by default in the EVK-M8L.

3.3.9 Backup battery

The evaluation unit includes a backup battery. This is necessary to store calibration and navigation information between operations and to enable immediate startup in DR mode, and fast acquisition of GNSS signals.

Battery	Type	Capacity	Operating temperature range
RENATA 3.0 V Li / MnO^2	CR2450	540 mA	-40 °C to +85 °C

Table 5: Backup battery for EVK-M8L

If the built-in backup battery runs low or is empty after a long storage period, purchase the battery described above for replacement (refer to section 10 for battery replacements guidelines)

⚠ CAUTION! RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE. DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS!

3.3.10 GNSS configuration

The EVK-M8L supports GPS, QZSS, GLONASS, Galileo and BeiDou.
The GNSS to be used can be configured in u-center (View > Messages View > UBX-CFG-GNSS). For more information, refer to the u-center User guide [6], and the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [5]

4 Setting up

4.1 Test vehicle preparation

The test vehicle should allow easy installation. A practical vehicle for testing purposes is a hatchback passenger car. The EVK relies on WHEELTICK and FWD signals from the vehicle as an essential major part of its dead reckoning functionality. The characteristics of the signal inputs are specified in Table 4 (HW interface).

Alternatively, if you have access to the proprietary CAN messages of the vehicle, the same information may be delivered as UBX-ESF-MEAS messages on a communication port (SW interface). Note that EVK-M8L default configuration is set to HW input signals. Should UBX-ESF-MEAS messages be used to input WHEELTICK and FWD information instead of HW signals, a change in the configuration is required using UBX-CFG-ESFWT.

☞ More information on the SW interface can be found in the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [5], or contact u-blox technical support for further SW interfacing solutions.

The next sections focus on use of the HW interface.

The WHEELTICK signal:

- Shall be representative of the distance traveled by the vehicle's reference point. The reference point is the mid-rear axle of the vehicle. Wheel ticks from the front wheels may be used as an alternative with some compromise in performance.
- Shall be a series of (absolute wheel tick) pulses with one pulse corresponding to less than 0.4 meters of distance traveled. For best results one pulse should correspond to about one centimeter of distance traveled.
- Shall be available regardless of the direction of driving.
- Shall be adequately de-bounced before application to the EVK input.

The FWD signal:

- Shall indicate the direction of driving, i.e. forward or reverse.
- May have either polarity. By default the polarity will be detected automatically in normal use, but can also be configured explicitly with UBX-CFG-ESFWT command (see Figure 5).
- May indicate either forward or reverse when the vehicle is stationary.

Most cars since 1980 provide a vehicle speed sensor (VSS) signal, which, for example, may be available on the OBD/OBD-II connector as a signal or CAN message. For evaluation purposes, you can use a device which converts the CAN messages to hardware WHEELTICK signals (see section 4.1). The VSS and forward/reverse signals are also often available directly on standard Head Unit connectors. If necessary, consult the vehicle service manuals, head unit installation manuals for the vehicle, or a certified automotive electrician.

If the vehicle does not provide the signals readily, you can use external sensors as described in section 4.1.3 below.

4.1.1 Wiring harness of the Head Unit

Remove the Head Unit (make sure you know the possible re-activation pass code). Locate the wheel-tick and forward/reverse signals (check voltage and polarity).

4.1.2 OBD-II to VSS converter

Connect a device, such as the BCI-6 from Beijer Automotive BV, to the CAN bus of your vehicle. The location of the CAN interface can be found, for example, from the database maintained by Beijer Automotive BV. Often the CAN bus is available on the OBD-II diagnostics connector. The BCI-6 will read the speed and direction information from the CAN bus, and convert these to wheel tick pulses and direction signals. The wheel tick pulse is available on the SPEED output connector of the BCI-6 and the direction signal is available on the REVERSE connector.

The BCI-6 unit is compatible with a wide range of vehicles using high-speed CAN and low-speed CAN. A full list of supported vehicles can be found from the Beijer Automotive BV website.

4.1.3 Wheel speed sensor

Alternatively you can use a wheel speed sensor connected to the hub of a wheel. We recommend connecting to a rear wheel. Note that the wheel tick from one wheel does not exactly describe the speed of the reference point (mid-read axle) in turns. However, even one wheel provides sufficiently good measurement for most evaluation purposes. Several manufacturers offer these sensors, for example, Peiseler GmbH and PEGASEM Messtechnik GmbH.

Figure 3: WSS2 wheel speed sensor from PEGASEM Messtechnik GmbH. WSS2 provides wheel tick and direction signals.

4.2 EVK-M8L installation

The EVK-M8L ships with an active GPS / GLONASS / BeiDou magnetic mount antenna with a 3-meter cable.

The following sections describe the steps required to complete the EVK-M8L hardware installation.

4.2.1 Mounting the GNSS antenna

Attach the antenna to the car; for the best performance, attach it on the roof as shown in Figure 4. Bring the antenna cable in through the window or door. Be careful not to damage the antenna cable.

4.2.2 Mounting the EVK-M8L

The EVK-M8L should be firmly attached to the car body so as to avoid any movement or vibration with respect to the car body. The EVK should not be attached to any 'live' (unsprung) part of the vehicle's suspension. Often it is enough to use strong double-sided tape or Velcro tape glued to the bottom of the EVK-M8L casing. If necessary, mounting brackets may be attached using the end-plate retaining bolts (M3). The EVK must be secured against any change in position and particularly its orientation with respect to the vehicle frame.

The orientation of the EVK in all three planes must be established accurately either by measurement or by using the automatic calibration process described in section 4.3.2.2. Dead reckoning performance will be seriously impaired by errors or changes in the orientation of the EVK.

⚠ The EVK case-work, antenna and USB connectors are linked internally to the common supply/interface ground (pin 13).

☞ In order to achieve the best possible performance, the GNSS antenna should be positioned on the vehicle roof over the EVK. If GNSS antenna is placed at a significant distance from the EVK, position offsets can be introduced which might affect the accuracy of the navigation solution. In order to compensate for the position offset advanced configurations can be applied. Contact u-blox support for more information on advanced configurations.

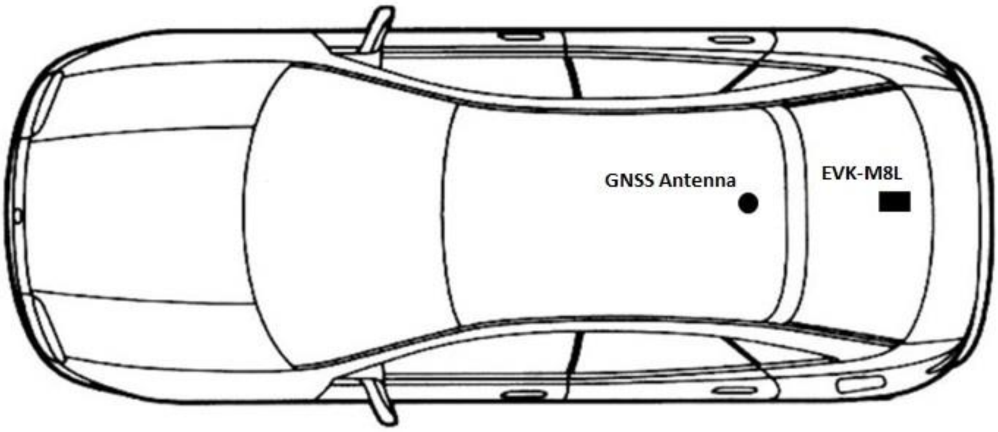


Figure 4: Example installation of the GNSS antenna and the EVK-M8L

4.2.3 Connecting the cables

We recommend using the ACE-AM-0 mating connector (available from the u-blox web shop) because it locks securely to the front connector. You will need to solder the necessary I/O cables to signal sources (e.g. WHEELTICK, FWD and GNDA) and outputs as specified in Table 6.

☞ The WHEELTICK and FWD inputs must be presented to the EVK at 3.3 V - 24 V logic levels. Connect GNDA from your input signals as well.

1. Connect the finalized cable to the front connector of EVK-M8L.
2. Connect the unit to a PC running Microsoft Windows by
    2.1. USB: Connect via USB port or
    2.2. UART: Connect via RS232. Set slide switch to I2C or
    2.3. SPI / I2C compliant DDC: Connect corresponding pins (see Table 4 for pin description). Set slide switch accordingly to SPI or I2C.
3. Press the RST button after changing the switch.
4. The device may be powered either via USB or from a 5 V supply via the V5_IN input on the front.
5. Connect the RF cable of the GNSS antenna to the RF IN connector.
6. Start the u-center GNSS Evaluation Software and select the corresponding COM port and baud rate.
7. Refer to the u-center User guide [6] for more information.

4.3 Recommended configuration

Only NMEA messages have been activated by default. During calibration and test drives we recommend enabling certain UBX messages (see section 4.4 and section 5).

For optimum navigation performance, the recommended navigation rate configuration is as follows:

The default DR/GNSS-fused navigation solution update rate is 1 Hz. You can set the navigation update rate with the message UBX-CFG-RATE. (In this mode, navigation rates up to 30 Hz are also available from the UBX-HNR-PVT message.)

Also, you need to configure the installation-specific ADR configuration parameters discussed in section 4.3.2.

4.3.1 Serial port default configuration

Parameter	Description	Remark
UART port 1, input	UBX and NMEA protocol at 9600 Bd	
UART port 1, output	UBX and NMEA protocol at 9600 Bd	Only NMEA messages are activated
USB, input	UBX and NMEA protocol	
USB, output	UBX and NMEA protocol	Only NMEA messages are activated

Table 6: Default configuration

4.3.2 ADR configuration

The following sections describe how to configure the parameters specific to the installation.

4.3.2.1 WHEELTICK and FWD configuration

By default, the wheel-tick count is based on the rising edge of the wheel-tick pulse signal. To improve performance with lower rate, mechanically derived wheel tick signals, the receiver may be configured to use both the rising and falling edges of the wheel tick signal on the condition that the wheel-tick pulses have approximately 1:1 mark:space ratio regardless of speed.

The wheel tick direction pin polarity is now automatically initialized. The car needs to drive with a minimum speed of 30 km/h for proper initialization.

You can also manually establish the polarity of your FWD signal (e.g. with a multimeter when the gear is set forward). Depending on the setup you may have to drive slowly as well. Set the Direction Pin Polarity (FWD) correctly using message UBX-CFG-ESFWT or in u-center (see Figure 5 below). Usually there is no need to change other parameter values. For more information, refer to the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [5]. Click the **Send** button in u-center if you changed the default values.

WHEELTICK maximum frequency is 20 kHz. Minimum recommended pulse width is 10 us. The wheel tick pulse must have a clean slope transition, the input is Schmidt-triggered. This signal input is single edge triggered. Pulse interval (WT resolution) must be less than 40 cm per tick over distance traveled. The wheel tick pulse output shall change linearly with the change in speed (navigation filter estimates only the linear scale factor).

If the vehicle is standing still, there should be no wheel tick pulses. This is particularly important at system shut down and power up. If there is a dead-band (wheel tick pulse does not change or is not output below a certain speed) performance will be affected.

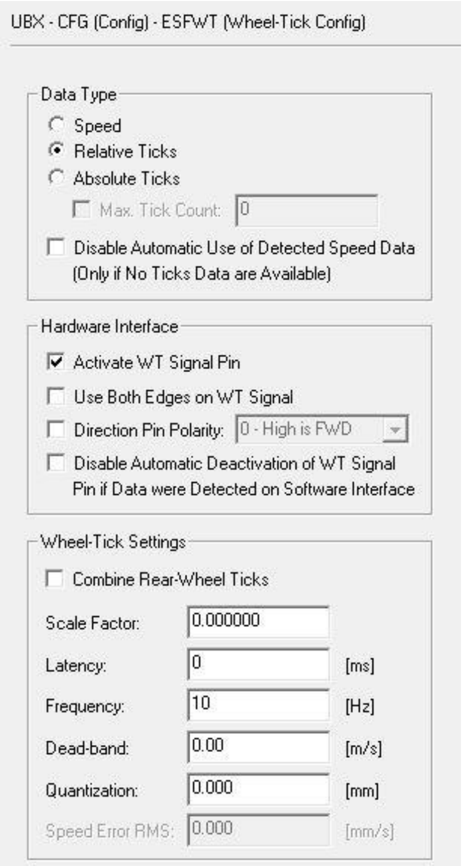


Figure 5: u-center showing the default values of UBX-CFG-ESFWT

By default, it is assumed that the EVK-M8L receives WHEELTICK and FWD signals on its dedicated HW pins. If this is not the case and UBX-ESF-MEAS messages are used, EVK-M8L configuration must be modified using UBX-CFG-ESFWT: set “Use WT Pin for Speed Meas. (L-Modules)” bit to 0 and set all other parameters according to your setup. See the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [5] for details. In such a case, use UBX-CFG-CFG command (see Figure 7) to save the configuration permanently and make sure the EVK will always stay in this particular configuration.

4.3.2.2 Sensor/IMU mount angles configuration

Dead reckoning performance relies on accurate configuration of the sensor mount configuration angles. The angles may be measured and configured manually or established using the Automatic IMU-mount Alignment feature described below. In either case the configuration is made using message UBX-CFG-ESFALG.

If you do not know or are not completely certain how to measure the Sensor-mount Misalignment Angles correctly, enable the Automatic IMU-mount Alignment (see Figure 6 below). Click the **Send** button after selelcting the “Automatic IMU-mount Alignment” box. The correct angles will then be determined automatically in Phase II of the calibration drive (see section 4.4).

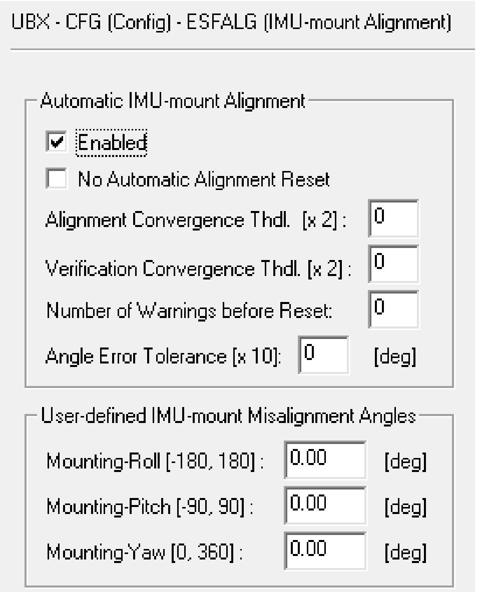


Figure 6: u-center showing how to enable Automatic IMU-mount Alignment with UBX-CFG-ESFALG

If you know the IMU-mount Misalignment Angles, enter those values into the UBX-CFG-ESFALG dialog shown in Figure 6. Make sure the "Automatic IMU-mount Alignment" is unselected. Click the **Send** button. For more information, refer to the u-blox 8 / u-blox M8 Receiver Description including Protocol Specification [5].

☞ Automatically determined IMU-mount Alignment angles do not survive a cold start (either by command or loss of the battery backup supply). If it is important that automatically determined angles continue to be used after the next cold start, follow the procedure in section 4.3.2.3.

☞ If the user reverts to factory defaults with UBX-CFG-CFG command, the UBX-CFG-ESFALG with correct configuration values (yaw, pitch, roll) shall be issued again. For example, in the basic use case when the EVK-M8L is mounted flat (label side up) and X-axis on the label is pointing forward, the user should configure it in UBX-CFG-ESFALG as (yaw, pitch, roll) = (0,0,0).

4.3.2.3 Saving the configuration permanently

If, for example, automatically determined IMU mount angles should be used after the next cold start, they can be saved in the receiver's non-volatile memory and will be re-used until the automatic alignment feature is next enabled. Proceed as follows:

- When configuration is indicated as completed in the UBX-ESF-STATUS and UBX-ESF-ALG windows, copy the angles from UBX-ESF-ALG display to the UBX-CFG-ESFALG dialog. Unselect the "Automatic IMU-mount Alignment" in UBX-CFG-ESFALG dialog and click the **Send** button. Save the configuration as described below.

The entire current configuration of the receiver (including configuration data and all ADR parameters) can be saved to BBR and non-volatile memory (flash) by sending UBX-CFG-CFG command (see Figure 7 below).

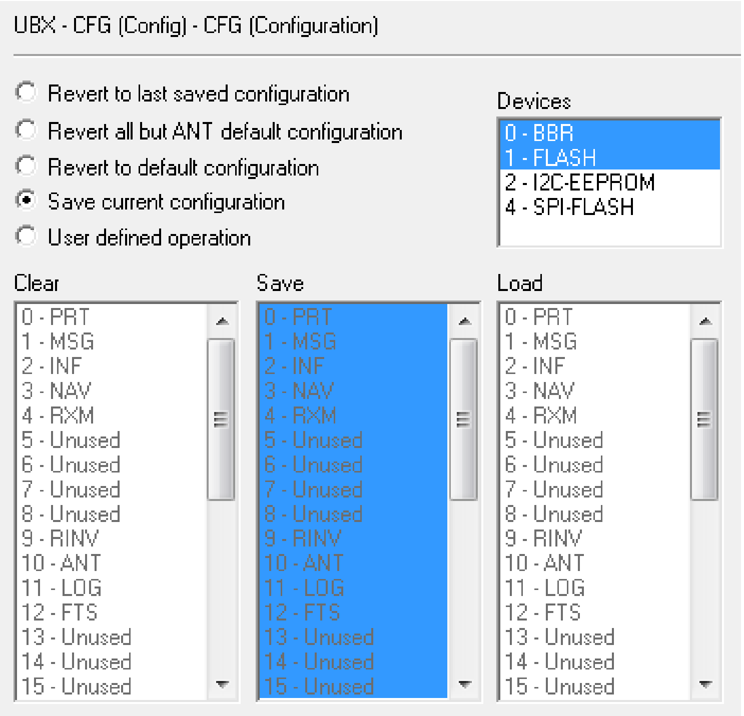


Figure 7: u-center showing how to save current configuration with UBX-CFG-CFG

4.4 Configuration and calibration drive

Before the EVK-M8L can use the vehicle's speed and forward information as well as data from the integrated sensors (gyroscopes and accelerometers), the receiver must gather calibration information from a sufficient number of left and right turns. This information needs to be gathered only once for a particular installation if the ADR configuration parameters are then permanently stored to flash (see section 4.3.2.3). We recommend that a dedicated co-driver observes the progress of the calibration drive using u-center.

☞ Although the initialization and calibration process will complete eventually, the sequence below (illustrated in Figure 8) can be used to achieve more rapid calibration for the purposes of evaluation.

☞ To ensure quick calibration the driving location needs to have very good GNSS visibility. The terrain needs to be flat and speed must be high enough.

The calibration time can be improved if the following procedure is carried out:

Drive the car to an open area. An example of a suitable place is a very large, empty parking area. Use u-center to monitor the process, enable the UBX-ESF-STATUS message.

- **Phase I.** Stop the car, but keep the engine running. Power on the EVK-M8L, for example via USB to PC. The co-driver should open u-center and enable the messages and views shown in Figure 9. Wait for a good GNSS position fix. Stand still for another 3 minutes.
- **Phase II.** Start driving a figure-8 pattern (see Figure 8).
- **Phase III.** Drive straight for 500 meters at least 40 km/h.
- **Phase IV.** Drive curves and straight segments for 5 minutes with good satellite visibility. The segments should include a section where the speed exceeds 60 km/h for at least 10 seconds.
- **Phase V.** This is a continuous fine calibration process running in the background. During this phase, e.g., the gyroscope temperature compensation table gradually fills in.

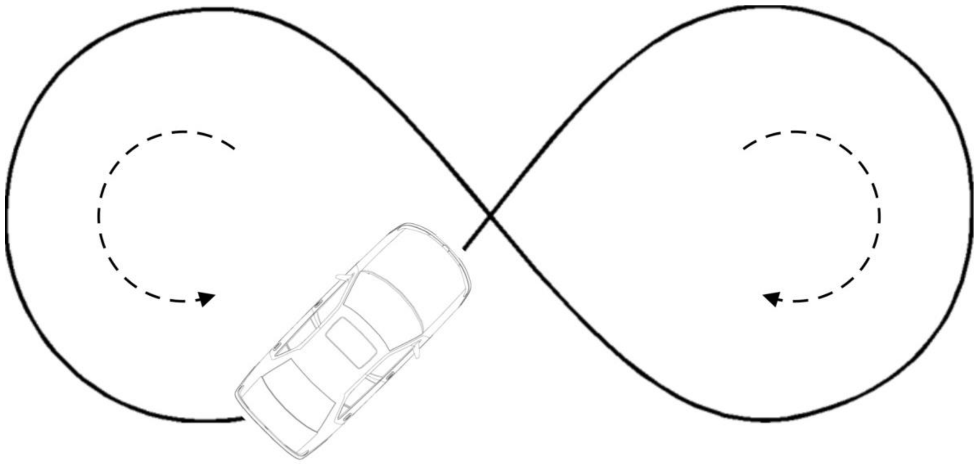


Figure 8: Driving number 8 patterns with fast left and right turns

Figure 9 and Figure 10 show the progress of sensor-mount configuration and calibration drive.

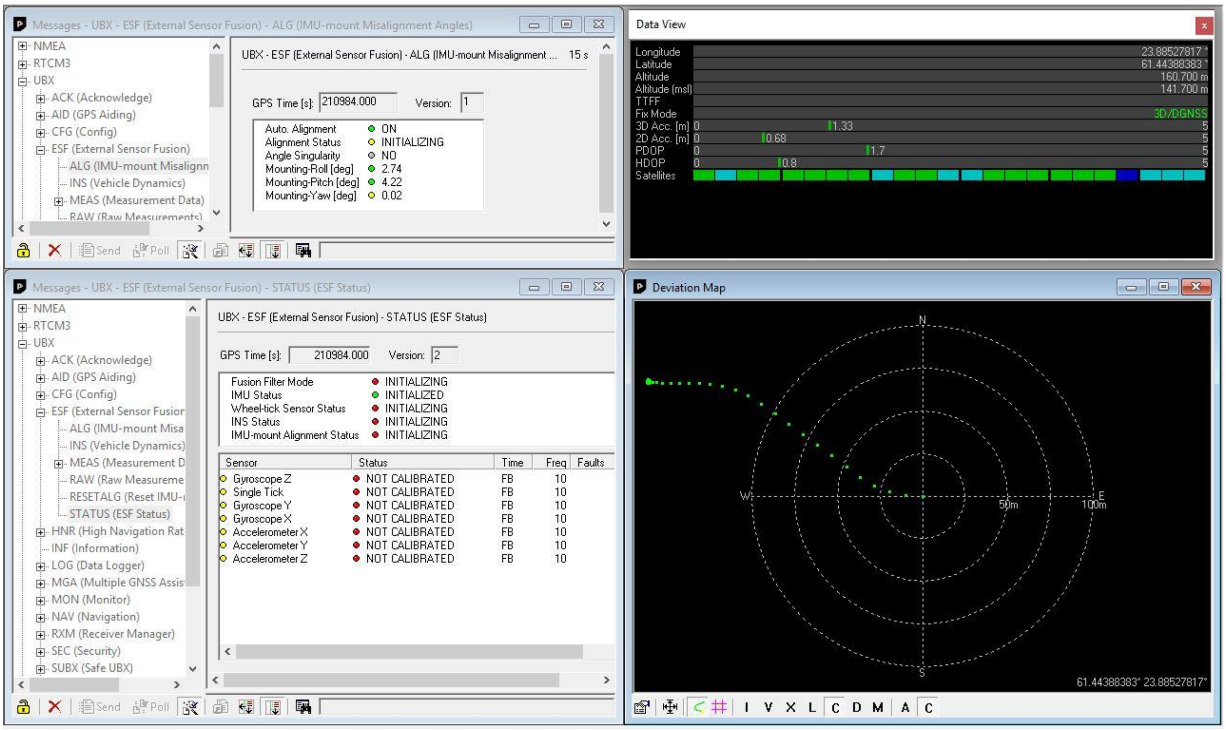


Figure 9: Starting the drive sequence

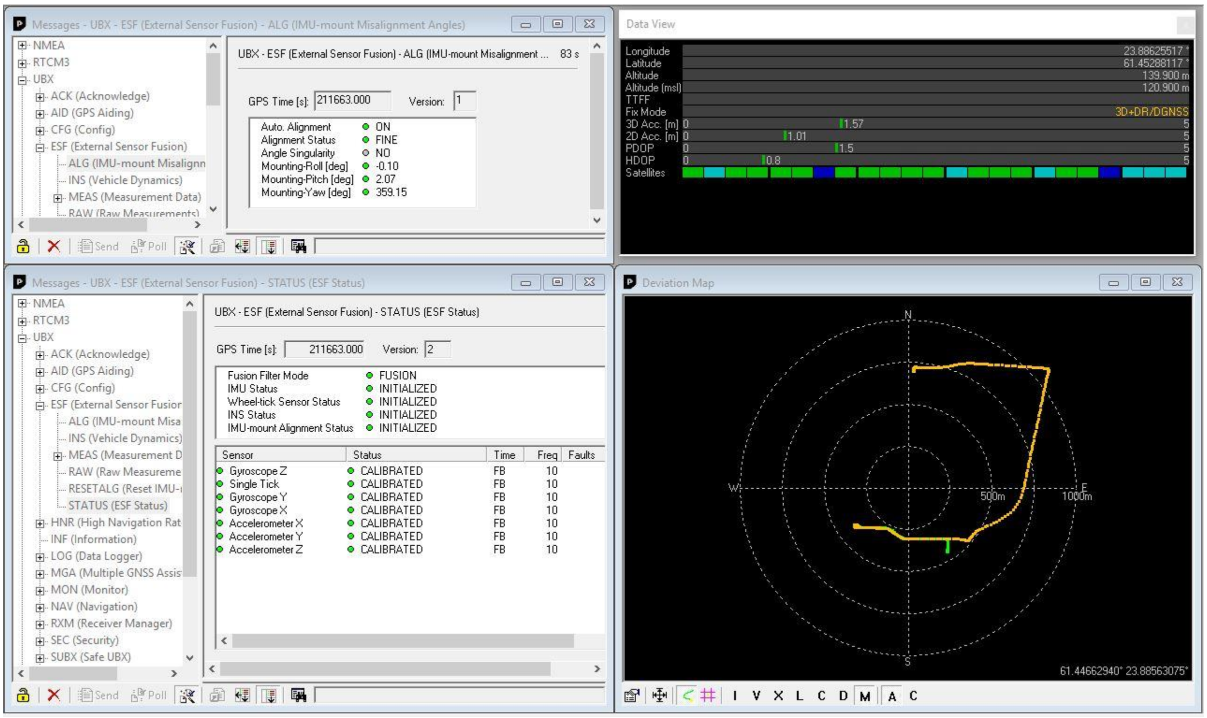


Figure 10: All sensors have reached Calibrated status. The setup is ready for test drives.

5 Test drives

The EVK-M8L is now ready for actual test drives.

We recommend recording and archiving the data of your test drives. You can enable additional debug messages by clicking the **Debug** button, and then clicking the Record button (see Figure 11). When prompted to poll for configuration, click Yes (see Figure 12).

Figure 11: The Debug and Record buttons are used for extra messages and debugging / post-analysis

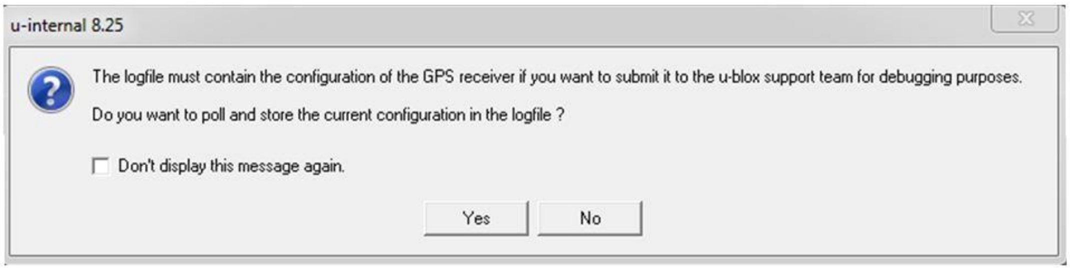


Figure 12: Allow polling and storing of the receiver configuration into log file

6 Measuring tracking current

To measure the tracking current with EVK-M8L, follow these steps:

1. Connect a mean-reading voltmeter across P1A (VCC) and P1B of the front connector (see Figure 13).
2. Wait 12 minutes to download all GNSS orbital data, or download all the Aiding Data via the AssistNow Online service.
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 overall current measurement also includes the internal SQI flash. For ROM-based products the current will be lower.

For more details see the circuit in Figure 16.

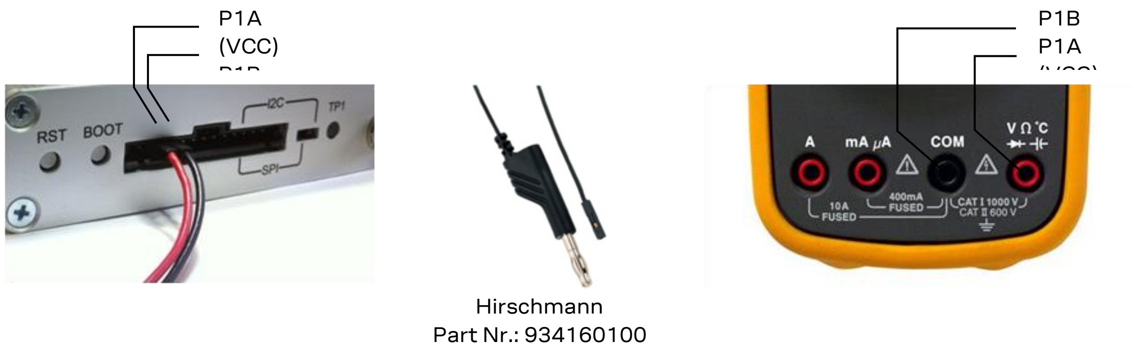


Figure 13: Example – tracking current measurement

7 Block diagram

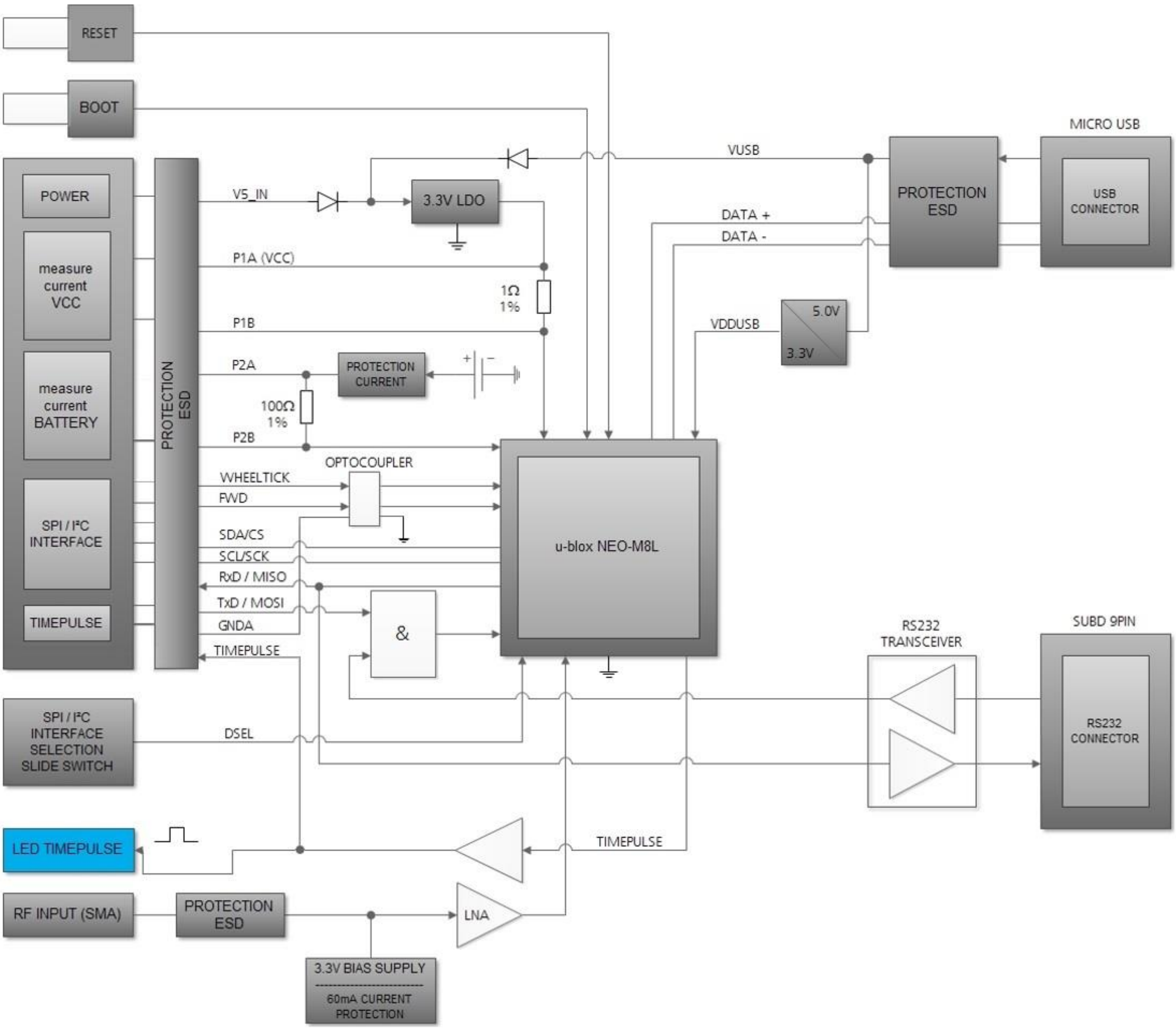


Figure 14: EVK-M8L block diagram

8 Board layout

Figure 15 shows the EVK-M8L board layout (PCB Version D). See Table 7 for the component list of the EVK.

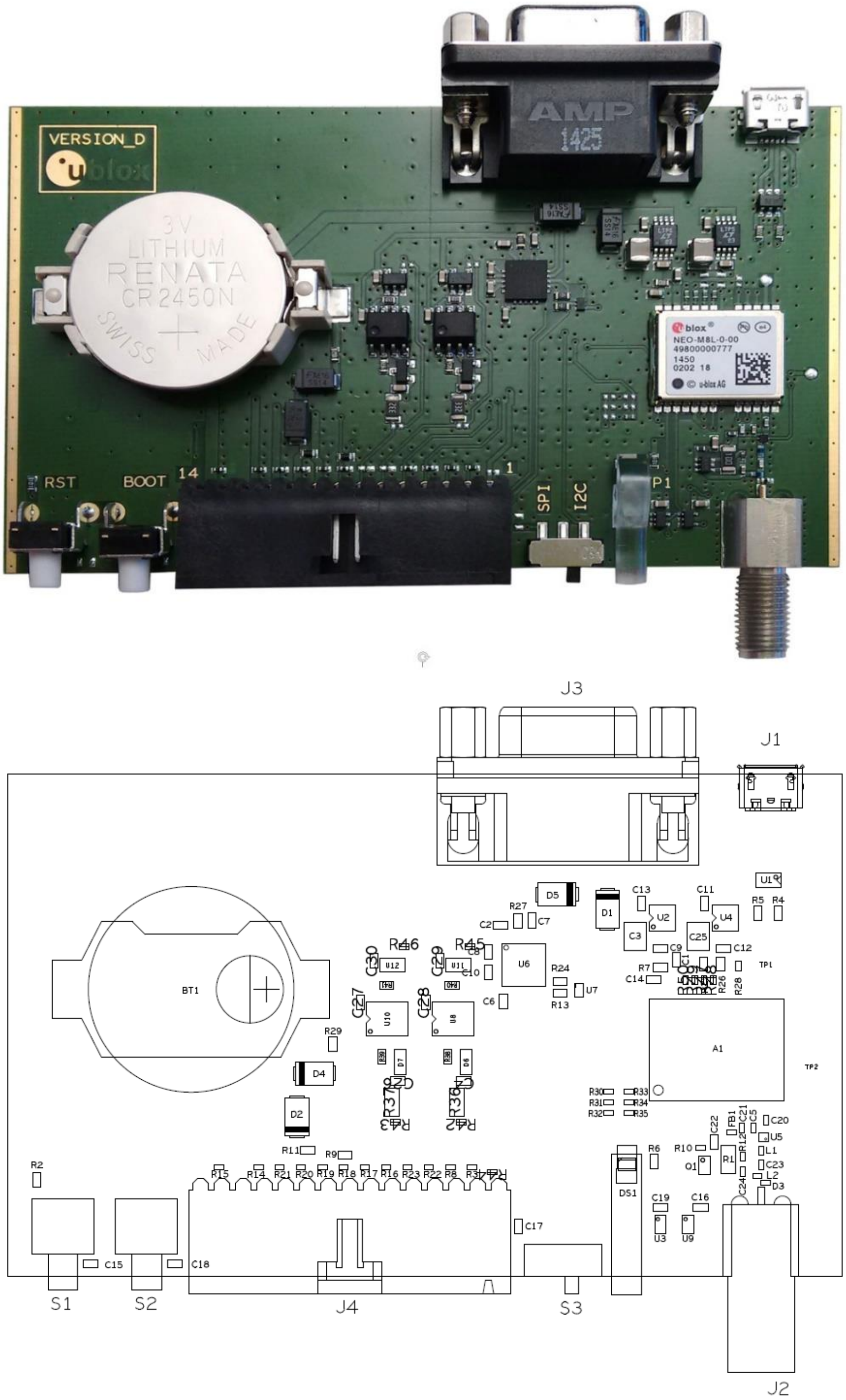


Figure 15: EVK-M8L layout

Part	Description
A1	GNSS RECEIVER -40/+85 °C
BT1	BATTERY HOLDER RENATA CR2450N 3 V
C1, C11, C13, C22	CAP CER X5R 0603 1U0 10% 6.3 V
C10, C14, C16, C19, C2, C6 C7, C8, C27, C28, C29, C30	CAP CER X7R 0603 100N 10% 10 V
C12, C9	CAP CER X7R 0603 10N 10% 25 V
C20	CAP CER COG 0402 1P8 +/-0.1P 25 V
C21	CAP CER COG 0402 22P 5% 25 V
C23	CAP CER COG 0402 47P 5% 25 V
C24	CAP CER X5R 0402 100N 10% 10 V
C25, C3	CAP CER X5R 1210 10U 10% 10 V
C4, C26	CAP CER X7R 0603 1N0 10% 25 V
C5	CAP CER X7R 0402 1N0 10% 16 V
D1, D2, D4, D5	SURFACE MOUNT SCHOTTKY BARRIER RECTIFIER SS14 1A -55/+125 °C
D3, R18, R20, R21, R22, R23	ESD PROTECTION FOR HIGH SPEED LINES, TYCO, 0.25 PF, PESD0402-140 -55/+125 °C
D6, D7	VOLTAGE REGULATOR DIODE FAIRCHILD BZX84 SOT23 6 V 2 0.2 A
DS1	LED OSRAM HYPER MINI TOPLED LB M673-L1N2-35 BLUE 0.02 A
FB1	FERRITE BEAD MURATA BLM15HD 0402 1000R at 100 MHZ
J1	CON USB RECEPTACLE MICRO B TYPE SMD – MOLEX 47346-0001 – TID60001597 30 V 1 A
J2	CON SMA SMD STRAIGHT JACK 11.4 MM HEIGHT WITHOUT WASHER AND NUT
J3	9 POLE SUBD CONNECTOR FEMALE
J4	14-PIN 90° 2.54 MM PITCH DISCONNECTABLE CRIMP CONNECTOR -40/+85 °C
L1	IND MURATA LQW15A 0402 8N7 3% 0.54 A -55/+125 °C
L2	IND MURATA LQW15 A 0402 120N 5% 0.64 A -55/+125 °C
Q1	MBT3906DW1T1G DUAL GENERAL PURPOSE TRANSISTOR 0.2A 0.15W -40/+125 °C
R1	RES THICK FILM CHIP 1206 10R 5% 0.25 W
R10	RES THICK FILM CHIP 0402 220R 5% 0.1 W
R11, R2, R6	RES THICK FILM CHIP 0603 100R 5% 0.1 W
R12	RES THICK FILM CHIP 0402 2K2 5% 0.1 W
R13, R24, R27	RES THICK FILM CHIP 0603 100K 5% 0.1 W
R14, R15, R19, R3, R8	VARISTOR BOURNS MLE SERIES CG0402MLE-18G 18 V
R29	RES THICK FILM CHIP 0603 1K0 5% 0.1 W
R35, R47, R48, R49, R50	RES THICK FILM CHIP 0402 0R 0 0.1 W
R36, R37	RES THICK FILM CHIP 1206 0.25 W 3K3 5% -55/+125 °C
R38, R39	RES THICK FILM CHIP 0603 470R 5% 0.1 W
R40, R41	RES THICK FILM CHIP 0603 910R 5% 0.1 W
R4, R5	RES THICK FILM CHIP 0603 22R 5% 0.1W -55/+125 °C
R7	RES THICK FILM CHIP 0603 1R0 5% 0.1 W
R9	RES THICK FILM CHIP 0603 51R 1% 0.063 W
S1, S2	SWITCH SPST ON 1POL TYCO -40/+85 °C
S3	2 WAY SUB-MINIATURE SLIDE SWITCH SMD JS SERIES – SPDT -40/+85 °C
U1	USB DATA LINE PROTECTION ST USBLC6-2SC6 SOT23-6
U2, U4	LOW DROPOUT REGULATOR LINEAR LT1962 MS8 3.3 V 0.3 A

U3, U9	TINY LOGIC UHS BUFFER OE_N ACTIVE LOW FAIRCHILD NC7SZ125 SC70
U5	LOW NOISE AMPLIFIER GAAS MMIC 1.575 GHZ 1.5 V-3.6 V JRC EPFFP6-A2 3.6 V -40/+85 °C
U6	RS-232 TRANSCEIVER 1MBIT 3-5,5 VOLT TRSF3223 – VQFN20 5.5 V -40/+85 °C
U7	TINY LOGIC ULP-A 2-INPUT AND GATE 1.45 X1.0 6-LEAD MICROPAK -40/+85 °C
U8, U10	OPTOCOUPLER LVTTL/LVCMOS COMPATIBLE AVAGO HCPL-070L-000E SO8
U11, U12	TINY LOGIC UHS INVERTER WITH SCHMITT TRIGGER FAIRCHILD NC7SZ14 SOT23-5

Table 7: EVK-M8L component list

9 Schematic

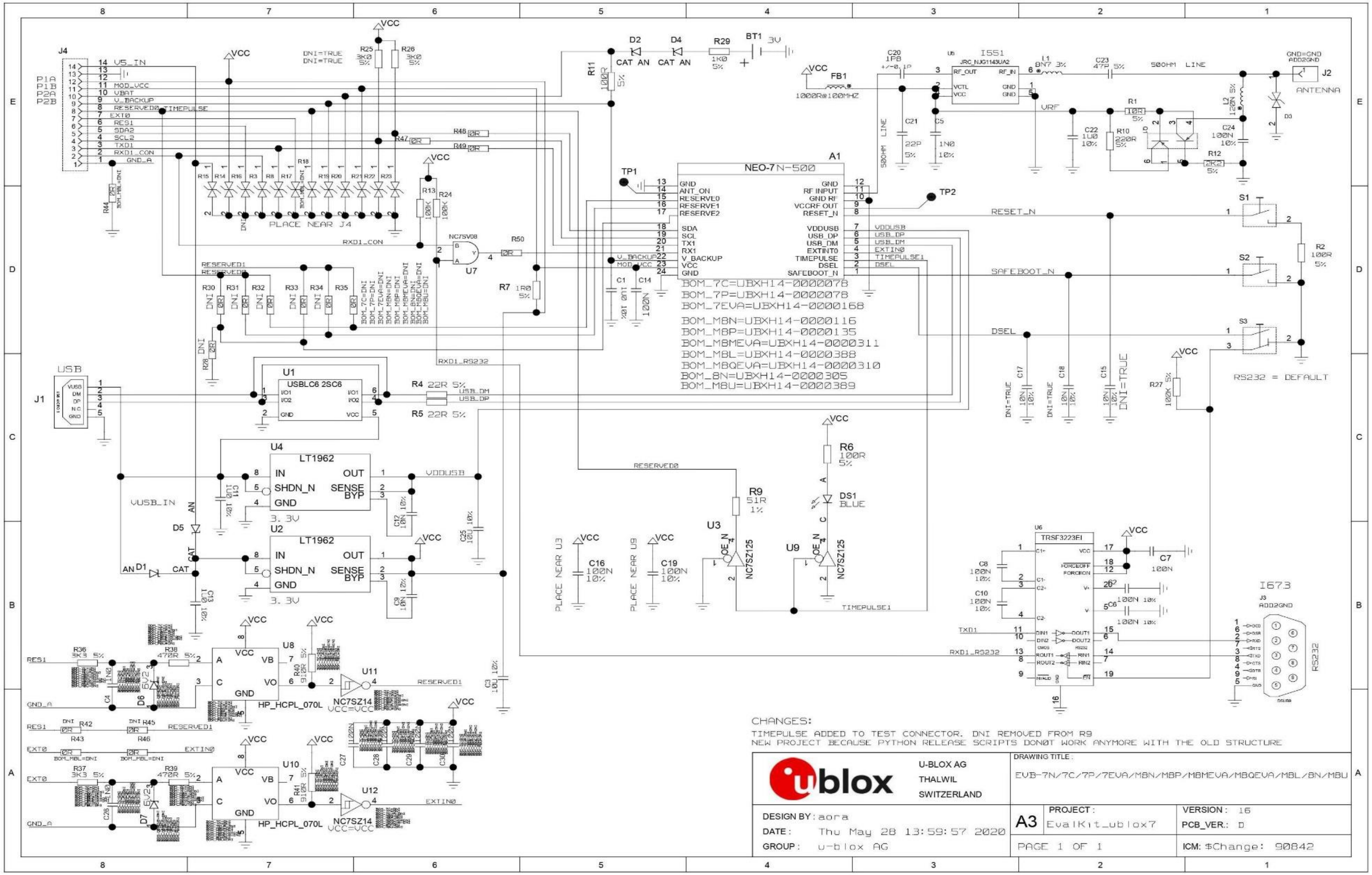
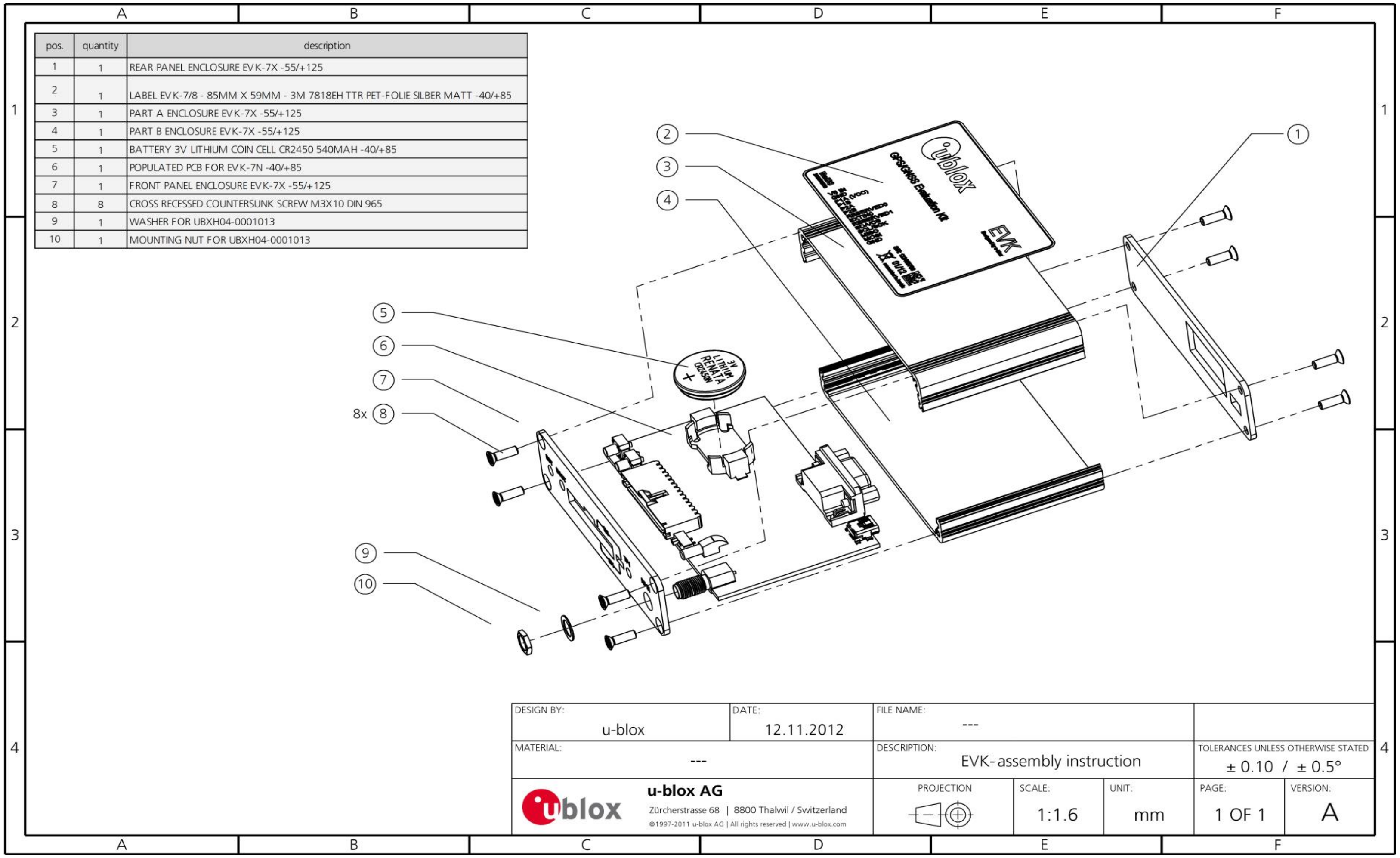


Figure 16: Schematic EVK-M8L: DNI=TRUE in the schematic means: Component not installed

10 Battery replacement

To replace the battery (number 5 in Figure 17), open the unit (unscrew four screws on the front panel).



pos.	quantity	description
1	1	REAR PANEL ENCLOSURE EVK-7X -55/+125
2	1	LABEL EVK-7/8 - 85MM X 59MM - 3M 7818EH TTR PET-FOLIE SILBER MATT -40/+85
3	1	PART A ENCLOSURE EVK-7X -55/+125
4	1	PART B ENCLOSURE EVK-7X -55/+125
5	1	BATTERY 3V LITHIUM COIN CELL CR2450 540MAH -40/+85
6	1	POPULATED PCB FOR EVK-7N -40/+85
7	1	FRONT PANEL ENCLOSURE EVK-7X -55/+125
8	8	CROSS RECESSED COUNTERSUNK SCREW M3X10 DIN 965
9	1	WASHER FOR UBXH04-0001013
10	1	MOUNTING NUT FOR UBXH04-0001013

Figure 17: EVK-M8L battery location

11 Troubleshooting

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

Make sure that the USB cable is properly connected to the evaluation unit and the PC and that USB drivers are installed correctly. By default, the evaluation unit outputs NMEA protocol on Serial Port 1 at 9600 Bd and on the USB.

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 M8 GNSS technology will skip excessive messages. Some serial port cards/adapters (i.e. USB to RS232 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 M8 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.

The COM port does not send any messages

Make sure that the slide switch at the front panel is set to I2C and not SPI. In SPI mode the RS232 pins on the DB9 connector are switched off and the RxD and TxD output at the front panel are used for SPI (MISO, MOSI).

☞ After changing the slide switch, always reset the EVK, otherwise the change will not take place.

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.

The position is inaccurate by a few dozen meters

u-blox M8 GNSS technology starts up with the WGS84 standard GNSS datum. If your application expects a different datum, you will most likely find the positions to be off by a few dozen meters. Do not forget to check the calibration of u-center map files.

The position is inaccurate by hundreds of meters

Position drift may also occur when almanac navigation is enabled. The satellite orbit information retrieved from an almanac is much less accurate than the information retrieved from the ephemeris. With an almanac-only solution, the position will only have an accuracy of a few kilometers but it may start up faster or still navigate in areas with obscured visibility when the ephemeris from one or several satellites have not yet been received. The almanac information is NOT used for calculating a position if valid ephemeris information is present, regardless of the setting of this flag.

In NMEA protocol, position solutions with high deviation (e.g. due to enabling almanac navigation) can be filtered with the Position Accuracy Mask. UBX protocol does not directly support this since it provides a position accuracy estimation, which allows the user to filter the position according to their requirements. However, the “Position within Limits” flag of the UBX-NAV-STATUS message indicates if the configured thresholds (i.e. P Accuracy Mask and PDOP) are exceeded.

TTFF times at startup are much longer than specified

At startup (after the first position fix), the GNSS receiver performs an RTC calibration to have an accurate internal time source. A calibrated RTC is required to achieve minimal start-up time.

Before shutting down the receiver externally, check the status in MON-HW in field “Real Time Clock Status”. Do not shut down the receiver if the RTC is not calibrated.

The EVK-M8L does not meet the TTFF specification

Make sure the antenna has a good sky view. An obstructed view leads to prolonged start-up times. In a well-designed system, the average of the C/No ratio of high elevation satellites should be in the range of 40 dBHz to about 50 dBHz. With a standard off-the-shelf active antenna, 47 dBHz should easily be achieved. Low C/No values lead to a prolonged start-up time.

The EVK-M8L does not preserve the configuration in case of reset

The u-blox M8 GNSS technology uses a slightly different concept than most other GNSS receivers do. Settings are initially stored to volatile memory. In order to save them permanently, sending a second command is required. This allows testing of new settings and reverting to the old settings by resetting the receiver if the new settings are not good. This provides safety, as it is no longer possible to accidentally program a bad configuration (e.g. disabling the main communication port).

Automatic configuration does not work

The automatic configuration does not work reliably when the device is mounted closer to about 7 degrees from pitch angles of +90 or -90 degrees. Do not rely on UBX-ESF-ALG in this case. To solve the issue, measure the angles and use manual configuration OR install the device in an orientation where automatic configuration can be used.

Cannot reach “fine” accelerometer calibration

If the wheel tick resolution is about 25 cm or worse the accelerometer calibration may not reach “fine” as shown in UBX-ESF-STATUS. However, even “coarse” calibration is enough for 3D GAWT fusion solutions.

The EVK-M8L does not work properly when connected with a GNSS simulator

When using an EVK together with a GNSS simulator, pay attention to correct handling of the EVK. A GNSS receiver is designed for real-life use, i.e. time is always moving forward. By using a GNSS simulator, the user can change scenarios, which enables jumping backwards in time. This can have serious side effects on the performance of GNSS receivers.

The solution is to configure the GPS week rollover to 1200 (as indicated in Figure 18), which corresponds to January 2003. Then, issue the Cold Start command before every simulator test to avoid receiver confusion due to time jumps.

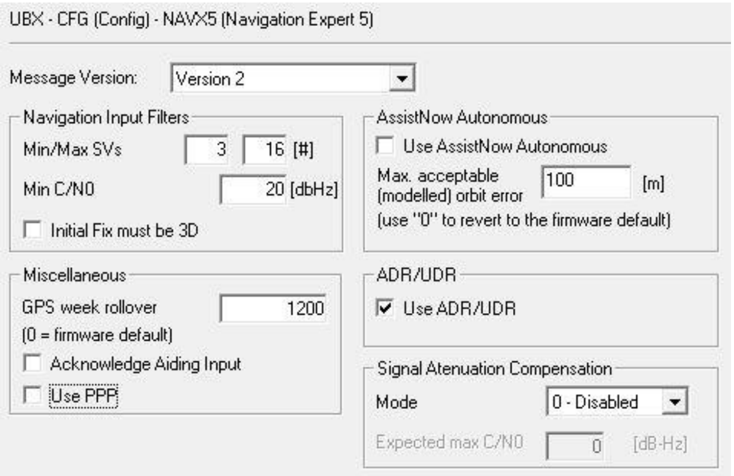


Figure 18: Configuration instructions for using the EVK with a GNSS simulator

Power save mode and USB

For communication in power save mode, use the RS232.

EVK-M8L receives GPS and GLONASS

Use the latest version of the u-center application for the EVK-M8L. Message UBX-CFG-GNSS allows switching the supported GNSS on and off.

12 Common evaluation pitfalls

- A parameter 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 functionalities (e.g. no support for passive antennas, different temperature ranges). 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. The average C/No ratio of the high elevation satellites should be between 40 dBHz and about 50 dBHz. A low C/No ratio will result in a prolonged TTFF and more position drift.
- When comparing receivers side by side, 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 sensitivities) may lead to incorrect conclusions.
- Try to feed the same signal to all receivers in parallel (i.e. through a splitter); the receivers will not otherwise have the same sky view. Even small differences can have an impact on accuracy. One additional satellite can to a lower DOP and less position drift.
- When doing reacquisition tests, cover the antenna in order to block the sky view. Do not unplug the antenna since the u-blox M8 positioning technology continuously performs noise calibration on idle channels.

Related documents

[1] UBX-M8030-ADR (ADR4.31) Data sheet, UBX-18016378 (NDA required)
[2] NEO-M8L (ADR4.31) Data sheet, UBX-20004500 (NDA required)
[3] UBX-M8030-ADR (ADR4) Hardware integration manual, UBX-16005909 (NDA required)
[4] NEO-M8L (ADR4) Hardware integration manual, UBX-16010549 (NDA required)
[5] u-blox 8 / u-blox M8 Receiver Description including Protocol Specification, UBX-13003221
[6] u-center User guide, UBX-13005250
[7] Information technology equipment – Safety Standard IEC 60950-1
webstore.iec.ch/publication/4024

☞ 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	Status / Comments
R01	06-Aug-20	njaf	Updated firmware information to ADR 4.31 Updated Table 4: Connector pin descriptions for EVK-M8L (pins numbered from right to left on the front panel) for time pulse output. Updated Related documents section and reference numbers.

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