Release Note

Topic :	**u-blox M8 Flash Firmware 3.01 UDR 1.00**
	UBX-16009439
Author :	ahaz, yste, amil
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1 General Information

This firmware operates with NEO-M8U and EVA-M8E modules.

1.1 Scope

This release note covers features introduced with a new product.

1.2 Released firmware image

The released firmware image contains the UDR feature.

FW ID String: `EXT CORE 3.01 (16559b)`
`UDR 1.00`

Supports ROM base: 2.01, 3.01

Image for in-circuit programming or upgrade with u-blox Flash utility or u-center

Files: `UBX_M8_301_UDR_NEOMU.699d7302daf1c1680ec030781bc8307e.bin`

Image(s) including device driver information for pre-programmed Flash devices

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1.3 Released documentation

Content	Document number
u-blox 8 / M8 Specification	UBX-13003221
Release Notes, GNSS Firmware 3.01 for u-blox 8/M8 Standard Precision Products	UBX-16000319

1.4 Released software tools

1.4.1 u-center

u-center for Windows v8.22 Beta03 or later should be used together with this firmware.

1.4.2 Firmware update tool

The firmware update utility tool v2.01 supports this product.

NOTE: earlier versions of the firmware update tool will not function with this release.

1.5 USB drivers

- u-blox Windows USB CDC-ACM driver v1.2.0.8
- u-blox Windows USB Sensor driver v2.22

The latest drivers are available from the Product Resources section of the u-blox web-site http://www.u-blox.com

1.6 USB identification u-blox M8

Vendor ID: 0x1546
Product ID: 0x01A8
Driver String: `u-blox GNSS receiver`

2 Supported features

The table below shows an overview of the features available in the firmware depending on the GNSS configuration.

	GPS, SBAS, QZSS & GLONASS	**GPS, Galileo & GLONASS**	**GPS, SBAS, QZSS & BeiDou**	**BeiDou & GLONASS**	**GPS**	**GLONASS**	**BeiDou**
Automotive Dead Reckoning (with speed/wheel tick data)	Not Supported						
Untethered Dead Reckoning	Supported						
High Navigation Rate	Supported (minimal extrapolation)						
High Precision	Not Supported						
Time Pulse	Supported						
Timing Modes	Not Supported						
Power Save Modes	Not Supported						
AssistNow Online	Supported for GPS, BeiDou, GLONASS, Galileo and QZSS						
AssistNow Offline	Supported for GPS and GLONASS						
AssistNow Autonomous	Supported for GPS and GLONASS						
Weak Signal Tracking	Supported						
RTCM	Supported for GPS with ADR disabled						
Interference Suppression	Supported						
Logging	Supported						
Raw Data	Not Supported						

3 Protocol message changes

Messages are described in detail in the Protocol Specification identified in 1.3 Released documentation above. Please identify the correct message version table by the description in the Firmware row of each table. **This release uses protocol version 19.**

For a comprehensive list of changes in designs migrating from previous releases of ADR or Standard Precision GNSS products please also see Release Notes, GNSS Firmware 3.01 for u-blox 8/M8 Standard Precision Products identified in 1.3 Released documentation above.

3.1 New messages

Message	Remark
UBX-CFG-HNR	Configure rate of High Navigation Rate output
UBX-ESF-INS	Report vehicle angular rate and acceleration
UBX-ESF-RAW	Raw sensor measurements output
UBX-HNR-PVT	High rate real time positioning output
UBX-NAV-ATT	Report vehicle attitude

3.2 Changed messages

Message	Remark
UBX-CFG-NAVX5	Configuration parameter for reduced antenna performance
UBX-ESF-STATUS	Version 2 message with improved reporting

4 UDR

4.1 Introduction

UDR technology brings the following advantages compared to standalone GNSS positioning:

- Improved navigation performance in GNSS-denied conditions: errors caused by multipath or weak signal conditions are mitigated through the aid brought by the accelerometers and gyroscopes.
- Navigation solution during short GNSS-outages: the newly developed inertial navigation system (INS) bridges short GNSS gaps (typically below 1 minute) which might be caused by tunnels or parking garages.

UDR navigation performance is better than GNSS alone in urban areas but ADR (with speed information from the vehicle) offers the best performance during signal loss. In ADR, absolute distance information from the vehicle is used to bound integrated drift from inertial sensors. However, u-blox UDR firmware implements an automotive dead reckoning positioning mode that helps bound position and velocity errors without speed or distance information during GNSS outages.

4.2 Configuration and operation

Detailed configuration information can be found in the u-blox 8/M8 Specification identified in section 1.3.

4.2.1 Fusion modes

UDR operates in different modes which can be monitored by the `fusionMode` field in the UBX-ESF-STATUS message. The following table summarizes the modes.

Mode	Description	Performed Tasks/Possible Causes	Published Fix Type
Initialization	This phase estimates all unknown parameters required for achieving fusion. Initialization if triggered after first use, a receiver coldstart or an automatic filter reset caused by a failure. Initialization phase requires the vehicle to be subject to some dynamics (left/right turns, stationary periods). `fusionMode=0:INITIALIZING`	• Initialization of IMU sensors (accelerometers and gyroscopes) • Initialization of INS (position, velocity and vehicle attitude)	3D-fix (GNSS)
Fusion	The receiver computes navigation solutions by integrating the IMU sensors with GNSS signals. At the same time, the IMU sensors are permanently calibrated and compensated for errors. `fusionMode=1:FUSION`	• Fine calibration of IMU sensors (accelerometers and gyroscopes) • Fine calibration of INS (position, velocity, attitude errors)	GNSS/DR Fix
Suspended Fusion	Sensor fusion can be temporarily suspended in cases where no fused solution should or can be computed. `fusionMode=2:SUSPENDED`	• IMU error (e.g. missing data) • INS error (e.g. calibration error)	3D-fix (GNSS)
Disabled Fusion	Sensor fusion can be permanently switched-off in cases where recurrent fusion failures happen or user turned-off manually fusion. `fusionMode=3:DISABLED`	• Fatal system failure • Fusion filter turned-off by user (using UBX-CFG-NAVX5 message)	3D-fix (GNSS)

In general the initialization process needs to be performed only once until the parameters are automatically stored and kept in the Battery Backed RAM (BBR).

Once initialized and calibrated, the system delivers optimal integrated navigation solutions together with accuracy estimation. The system is able to bridge short GNSS gaps by integrating the inertial observations over time. The system then outputs "DR" solution types together with accuracy estimation.

The inertial sensors used in UDR technology suffer from bias and scale factor drifts resulting in accumulated errors in positioning. The sensor drift is estimated and compensated continuously in the system but residual uncompensated errors e.g. due to vibrations, bumps in the road and fast temperature changes, inevitably degrade dead reckoning performance with time. In such situations, the system recovers quickly once GNSS signals are reacquired.

4.2.2 Accelerated Initialization and Calibration Procedure

Initialization and calibration of the UDR receiver takes place during normal driving but, for evaluation purposes, an accelerated procedure is described in the Protocol Specification identified in 1.3 Released documentation above.

4.3 Features

4.3.1 High Navigation Rate

This release offers a real time High Navigation Rate feature with minimal extrapolation. This position output uses sensor data to deliver accurate and essentially zero-latency positions, even under significant vehicle dynamics.

4.3.2 Vehicle attitude and dynamics messages

Messages UBX-ESF-INS and UBX-NAV-ATT provide direct reports of vehicle dynamics (compensated angular rate and acceleration) and attitude (vehicle roll, pitch, heading), respectively.

4.3.3 Optimization for reduced antenna performance

This feature improves DR navigation performance in installations suffering consistently attenuated GNSS signals (due for example to an antenna placed within a dashboard). The maximum expected signal to noise density ratio (C/N0) in open-sky conditions should be configured in units of dBHz by the parameter `sigAttenCompMode` in message UBX-CFG-NAVX5. This information will then be used to adjust the overall measurement weighting strategy applied by the receiver.

The value of `sigAttenCompMode` should be reduced from the default (50dBHz) to account for signal loss related to antenna quality and placement. The value should not be reduced below the maximum level observed by the antenna in open-sky conditions. Values below 40dBHz will result in degraded performance and values below 30dBHz should not be used. A value of zero applies the firmware default.

4.3.4 Raw sensor measurement output

`UBX-ESF-RAW` messages deliver un-processed measurement data from the inertial sensor. The measurements are delivered in sets of up to 10 per message to match the measurement rate of the sensor. The nominal message rate is 10 per second. Messages with gyroscope measurements include sensor temperature.

4.3.5 GNSS-only navigation

Sensor fusion can be disabled by setting the `adr` bit and clearing the `useAdr` field of `UBX-CFG-NAVX5`.

4.3.6 Map-matching input

The map matching input feature allows a map-matched position to be fed back to the receiver to aid the next navigation solution and improve positioning performance, as long as the map matching is accurate. The data can be supplied using the UBX-AID-MAPM input message. Details about map-matching input and limitations can be found in the receiver description.

5 Specialties and known limitations

5.1 Untethered Dead Reckoning characteristics

Untethered Dead Reckoning offers better positioning in areas with degraded GNSS signals and in covered areas such as tunnels and car-parks. Compared to conventional Dead Reckoning receivers which make use of speed information from the vehicle the user may observe unfamiliar behavior as the receiver adjusts its estimate of location in response to revised estimates of INS errors. Specifically this process may result in significant instantaneous position corrections along track (backwards or forwards).

The UDR firmware adapts to the following situations intelligently to provide the best overall navigation performance in road transport applications. As a result, the behavior of the Dead Reckoning receiver may differ from that of a standard GNSS-only receiver. For example, if the vehicle moves while the receiver is shut down then the reported position may take a long time to re-converge.

5.2 Heading during reverse driving

UDR outputs the attitude solution as defined in section **Error! Reference source not found.**. Due to the absence of reliable forward/reverse information, the heading published in UBX-NAV-PVT will always be the direction the front of the vehicle faces, even when driving backwards.

5.3 Sensor temperature compensation

u-blox DR products make use of adaptive inertial sensor temperature compensation to improve DR performance. Compensation data are gathered during normal use. Optimum performance in situations relying heavily on the inertial sensors (e.g. in long tunnels) will be achieved once the receiver has been operated in normal use outdoors at similar temperatures.

5.4 Special vehicle types

This release has been optimized and tested for light road vehicles. Performance and behavior has not been characterized for trains, trams, trolley-buses or bicycles.

5.5 Sensor measurement output messages

The raw sensor measurement message outputs follow the characteristics and timing of the sensor rather than the GNSS receiver. As a result, the frequency of the `UBX-ESF-RAW` and `UBX-ESF-MEAS` messages may differ from the GNSS fix rate frequency.

The ESF-RAW message includes a single message time-stamp derived from the GNSS receiver and, where available, individual sample time-stamps from the sensor.

5.6 UBX-ESF-ALG message near vertical pitch

Message UBX-ESF-ALG represents the receiver orientation in terms of Euler pitch, roll and yaw. When pitch is close to +90° or -90°, small changes in orientation are represented by large changes in Euler roll and yaw. Large Euler angle fluctuations under these conditions do not indicate instability in alignment or any degradation in navigation performance.

5.7 No acknowledgement of RESET message

Issuing a UBX-CFG-RST reset message to the receiver causes all or parts of the receiver to re-start immediately. As a result the receiver does not send the usual UBX-ACK-ACK acknowledgement of this message but responds only according to the type of reset requested.