Navigation Receiver
ML8088s
Evaluation Board

Operating Manual

Version 2.0

St. Petersburg
2013

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General Information

This document is intended for users starting to learn how to operate the multi-channel navigation system GLONASS/GPS/GALILEO receiver device ML8088s (ML8088sE), and it contains a general description of the evaluation board with the specified receiver (hereinafter called "receiver" or "module").

The receiving device of the space navigation system GLONASS/GPS/GALILEO ML8088s (hereinafter called "receiver" or "module"), which is designed to calculate the current coordinates and speed of an object in real time in an autonomous and differential modes, the formation of time stamp in seconds, and the exchange with external equipment via serial ports RS232 and/or USB port. The principle of the receiver operation is based on parallel reception and processing via 32 measurement channels the signals of space navigation system spacecraft GLONASS in the frequency range L1 (PT-code), GPS frequency L1 (C/A code) and GALILEO at the frequency E1.

The navigation receiver ML8088s is designed on the basis of the latest specialized chipset STA8088FG, a part of the family so-called "systems-on-a-chip" STA8088.

The receivers have a high sensitivity, low energy consumption, and a short start time.

Please see Figure 1 for the navigation receiver ML8088s.

Figure 1. The receiver appearance.

The receiver has two capture channels, and 32 channels to track satellite signals, which allows a simultaneous search for satellite signals of GLONASS and GPS groups.

The receiver allows applying specially prepared information for the primary search for satellite signals; this information is stored in the Receiver memory, which allows reducing a cold start time, and, more importantly, make a cold start when receiving weak signals from satellites. The special information can be prepared both by external sources (and transferred to the

Receiver by communication channels), and by the receiver itself. In the latter case, no additional information from external sources is required.

The key (the mark the first output) is a black dot on a white background, and is located in the lower-left corner of the label, next to the serial number.

The Receiver has a built-in interference reduction, that allows it to operate in conditions of high interference.

The Receiver operation is performed with the help of special ST GNSS NMEA commands.

This document describes a new sample evaluation board for the receiver ML8088s. The description of the old model evaluation board is available in the document "Evaluation board ML8088s RE v1_0.pdf".

Please see Figure 2 for the appearance of the evaluation board.

Fig. 2 The appearance of a evaluation board with the installed receiver.

The evaluation board is designed for familiarizing users with the navigation receiver ML8088s. The board allows connecting the receiver to a personal computer to examine information messages sent by the operating receiver. The board allows changing the receiver settings, as well as saving new software to the built-in flash memory.

The new evaluation board (mini) is different from the previous model, because of the lack of connector to install module ML8088s, DIP switches, several LEDs and battery backup. These changes were implemented to simplify the board operation, and to improve its service reliability.

Technical Specifications

Technical specifications of the evaluation board of the ML8088s receiver are shown in table 1.

Table 1.

Specification	**Value**
Navigation receiver	ML8088s or ML8088sE
Type of antenna	Active, passive
Antenna connector	SMA
PC connection interface	USB
Type of interface converters used	FT2232D
USB interface connector	USB-B F
Number of PC communication channels	1
Number of displayed COM ports	2
Primary purpose of COM 1 communication channel	NMEA messages
Primary purpose of COM 2 communication channel	Debug messages, programming
Receiver power on indicator	yes
NMEA signals indication	yes
GNSS status signal indicator	yes
RTC battery power supply	external
Overall dimensions, mm³	60x35x12 - without connectors 75x35x18 - with connectors
Board weight, grams	28

Location of Indicators and Switching on the Board

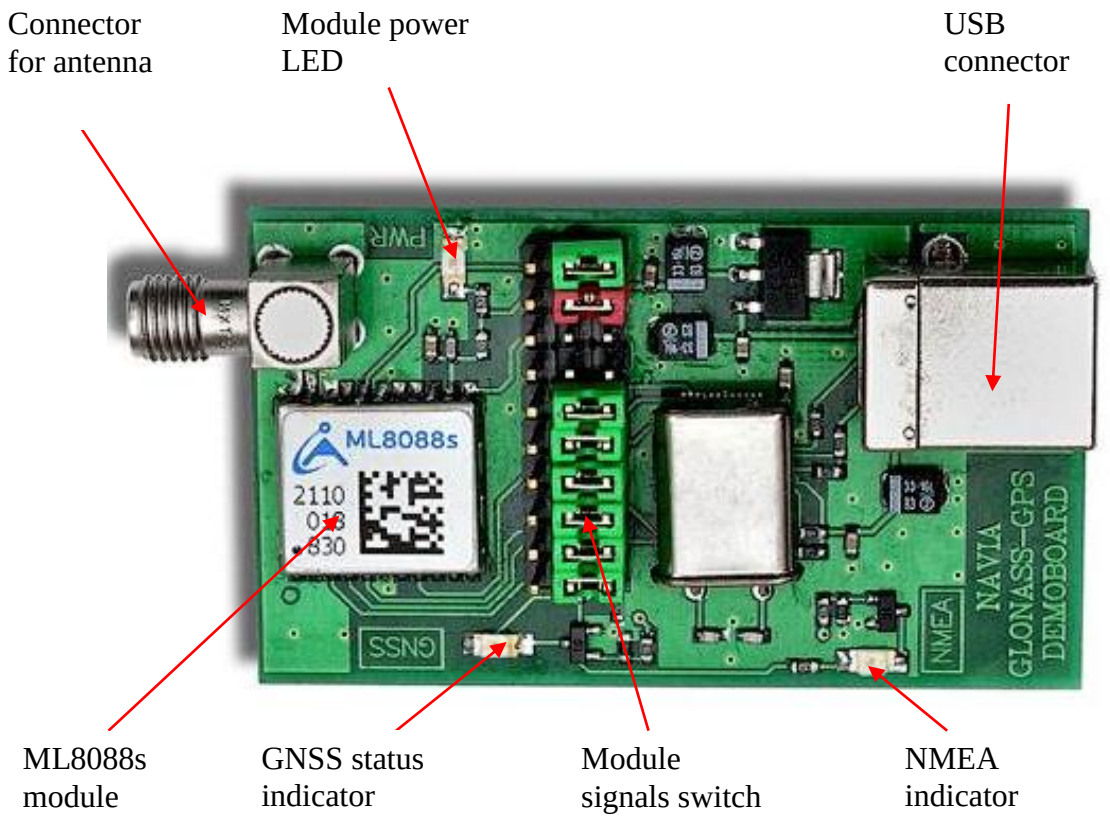

Fig. 3 Location of indicators and switching on the evaluation board

Figure 3 illustrates the location of indication and switching elements on the evaluation board of ML8088s receiver.

The figure shows:

- antenna connector **Antenna**;
- cable connector **USB**;
- signal LED **GNSS**;
- receiver power supply voltage LED **PWR**;
- signal LED **NMEA signals**;
- module signals switch **ML8088s**;
- module (receiver) **ML8088s** .

Signal Switch of ML8088s Module

The switch panel (switch) of the module ML8088s signals is designed to provide users with the opportunity to connect/disconnect any of the major signals of the module ML8088s to electronic nodes of a evaluation board. The signal "disabled" from a evaluation board may be left free (unplugged), or connected to the user's device to accelerate the development of the end product.

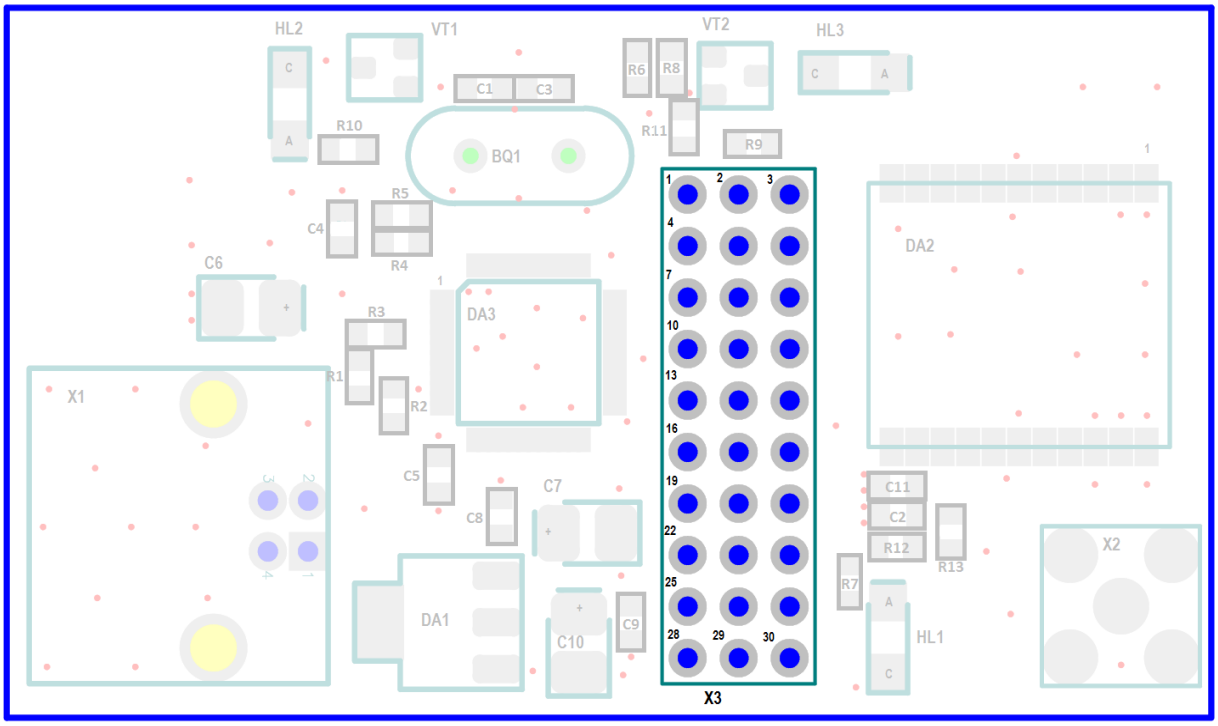

Figure 4. ML8088s module signal switch

X3 signals switch is a set of pins to select connections that attach the module with electronic components of a evaluation board, with external devices, or left unconnected.

The purpose of the switch pins is shown in Table 2.

Table 2.

Signal	Pin	Explanation	Comments
PPS	2	Pulse per second	Timestamp signal
RX1	5	Commands to module	Enter commands into the module
TX1	8	NMEA output	NMEA data output
GNSS status	11	Depended on FW	Indication of a solution
Rx0	14	RTCM-104 input	Enter adjustments
Tx0	17	ST debug output	Output of debug information
GND	20	GND	General
V_BAT	23	RTC battery	Real time clock power
VCC_3.3V	26	Module main power	Module main power supply
/RST	29	Module Reset pin	Module hardware restart input

The positions of the jumpers on the contacts (pins) on the switch in various modes is shown in Table 3.

Table 3.

Signal	Pin	Jumper position for mode				
		Work	**Program via UART0**	**Program via UART0**	**Reset**	**Signal is disabled**
PPS	2	1-2				2-3
RX1	5	4-5		4-5		5-6
TX1	8	7-8	8-9	7-8*		remove
GNSS status	11	10-11				11-12
Rx0	14	13-14	13-14			14-15
TX0	17	16-17	16-17			17-18
GND	20					always connected
V_BAT	23	**	**	**	**	
VCC_3.3V	26	25-26	25-26			26-27
/RST	29	28-29	28-29		29-30***	28-29

Notes:

* - Move a jumper to pins 8-9, turn on the power (connect the USB cable) or momentarily close contacts 29-30, then return the jumper to pins 7-8, after which start programming.

** - is supplied from outside, optional.

*** - closes momentarily.

Components Arrangement on the Evaluation Board

The evaluation board for navigation receiver ML8088s can be supplied either totally assembled or as a pre-form for assembly by the user. In this case the user can assemble the board partially to the extent necessary for the particular use of ML8088s module. For example, the user can install only the receiver ML8088s module, the capacitors in the module power supply circuits and the antenna connector, connect the necessary circuits to the target device being developed and test how the module functions as a part of the target device without material installation of the module. This allows considerable acceleration of the new device development process, as one can develop and test the software without making a hardware prototype product.

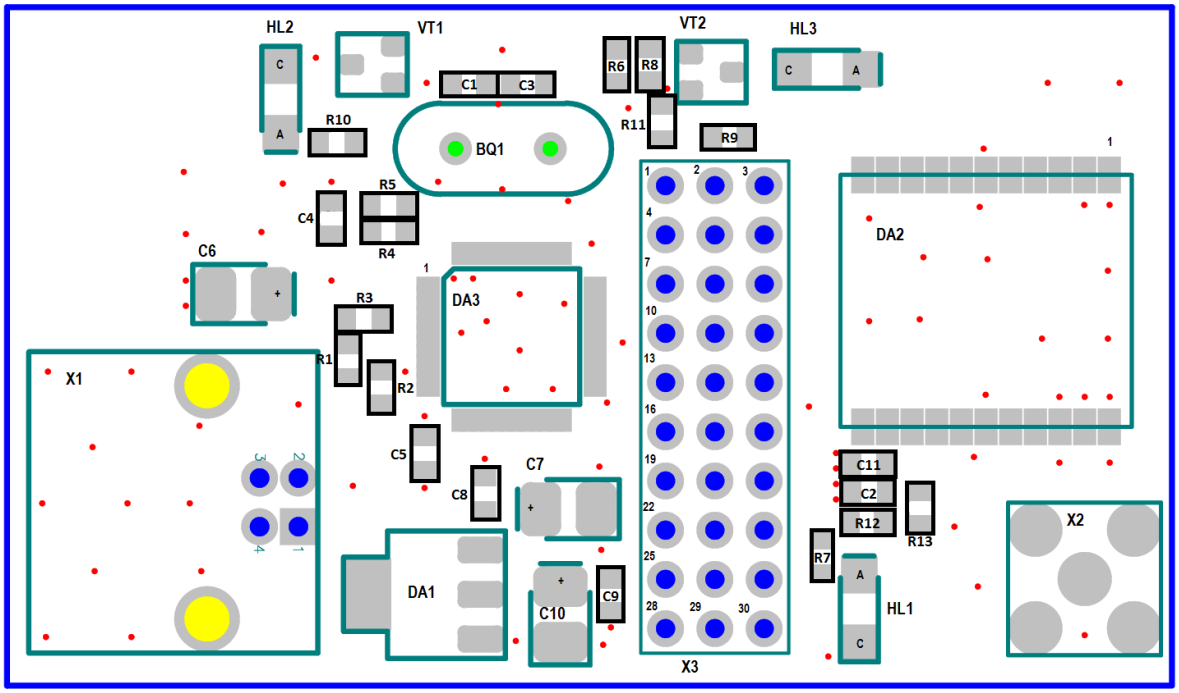

Fig. 5. Components arrangement on the evaluation board

Microcircuits, modules:

DA1	ADP3338AKC-3.3	SOT223
DA2	ML8088s (ML8088sE)	
DA3	FT2232D	LQFP48

Capacitors:

C1	27pF	smd 0603
C2	27pF	smd 0603
C3	27pF	smd 0603
C4	100nF	smd 0603
C5	100nF	smd 0603
C6	47uF	tantal smd TYPE B
C7	47uF	tantal smd TYPE B
C8	100nF	smd 0603
C9	100nF	smd 0603
C10	47uF	tantal smd TYPE B
C11	100nF	smd 0603

Resistors:

R1	27Ω	smd 0603
R2	27 Ω	smd 0603
R3	1.5k Ω	smd 0603
R4	10k Ω	smd 0603

R5	470 Ω	smd 0603
R6	10k Ω	smd 0603
R7	270 Ω	smd 0603
R8	100k Ω	smd 0603
R9	270 Ω	smd 0603
R10	270 Ω	smd 0603
R11	1.5k Ω	smd 0603
R12	0 Ω	smd 0603
R13	NC	smd 0603
Quartz-crystal resonators:		
BQ1	6MHz	HC49US (low profile)
Transistors:		
VT1	MMUN2111LT1G	sot23
VT2	BC 847 C	sot23
LED:		
HL1	KP3216SEC	smd 1206
HL2	KPK3216VGC	smd 1206
HL3	KPK3216VGC	smd 1206
Connectors:		
X1	USBB-1J	Connector USB B
X2	SMA-JR	Connector SMA-JR, RF input, antenna connection
X3	PLT 3x10	A set of pins for selecting connections by jumpers

The Evaluation Board Circuit Diagram

The ML8088s receiver evaluation board circuit diagram is presented in Figure 6.

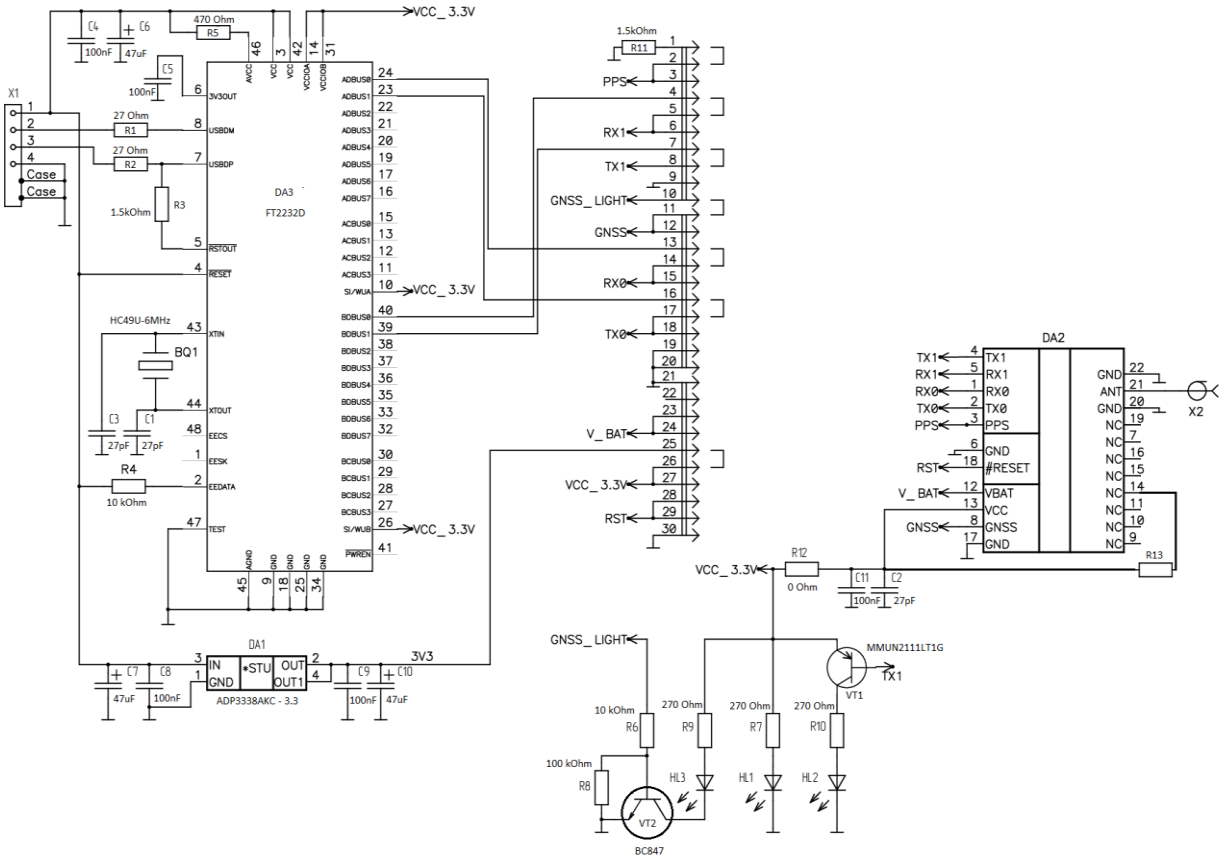

Fig. 6. The evaluation board circuit diagram

Navia GLONASS + GPS Application

Navia GLONASS + GPS Application is intended for working with ML8088s receiver evaluation board (executable file navia_viewer.exe). This application allows getting familiar with the receiver operation, adjusting necessary parameters and testing the receiver performance.

This document describes the application **Navia GLONASS + GPS version 1.10.0.342** (hereinafter Navia viewer). The application main window appearance is presented in Fig. 7.

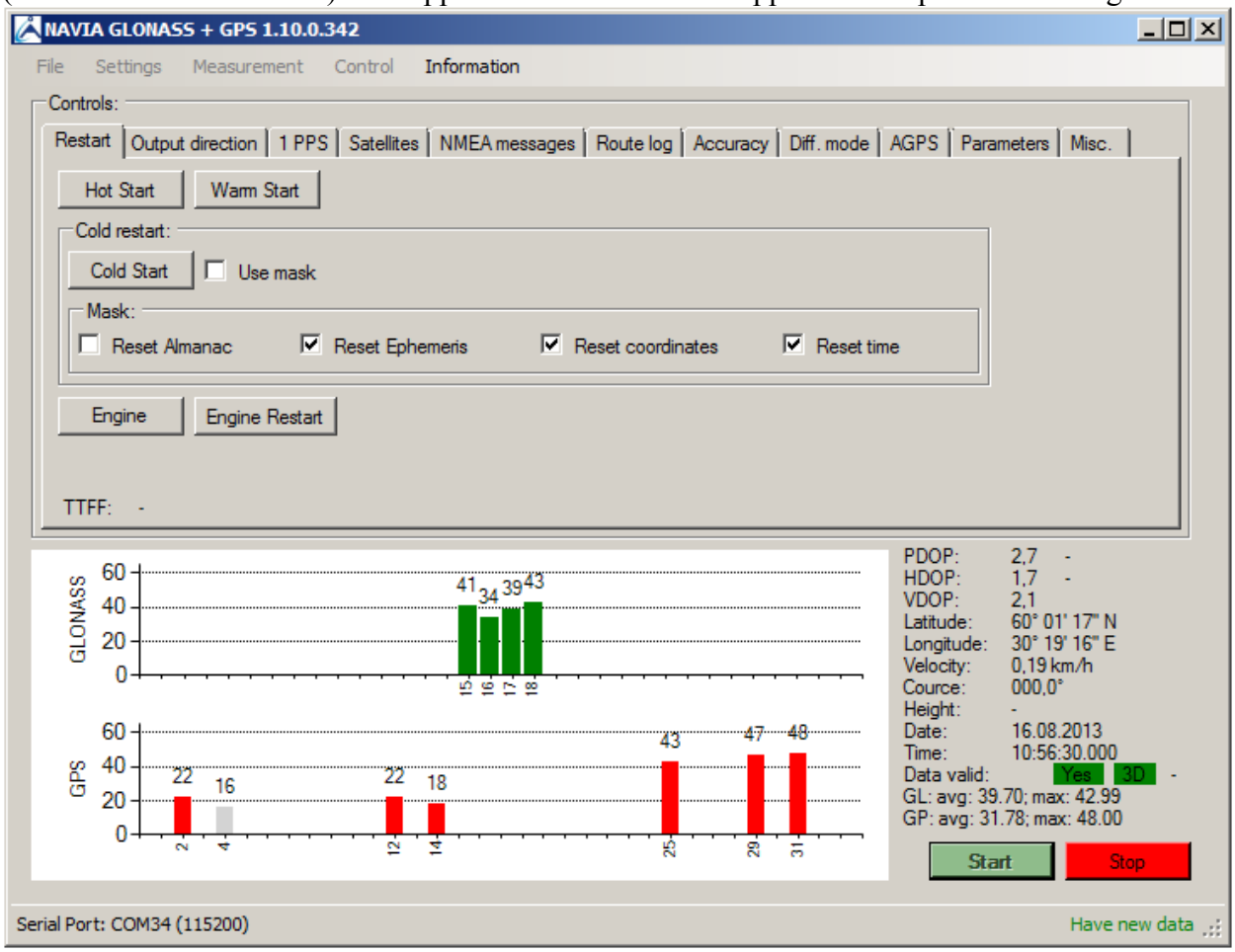

Fig. 7. Navia GLONASS + GPS Application Main Window.

To ensure the application operation you have to install .NET Framework 4.0 Client Profile (or its full version .NET Framework 4.0). This software can be downloaded from Microsoft website www.microsoft.com.

You also have to install USB-COM converter VCP drivers by FTDI. The required drivers can be found at the company's website at the address http://www.ftdichip.com/Drivers/VCP.htm where you have to select the driver matching the operation system of the user's computer.

Further this document describes the interaction of Navia viewer application and the evaluation board in the state "all jumpers are in position **OPERATION** according to Table 3". The receiver embedded software is in standard factory release unless otherwise specified.

The application **Navia GLONASS + GPS** has an embedded system of pop-up prompts and an extensive **Support** section. The prompts are displayed when the cursor is pointed at an area which can be manipulated by the user. It should be noted that a number of functions intended mainly for the application servicing are not supported by prompts.

The document describes the application basic operation modes needed to most users. The application's functionality not described in the manual are intended mainly for investigating the module's operational characteristics. You can inquire the developer on the application functions not described in this manual by email support@naviaglonass.ru.

The Board Activation

To start working with the evaluation board you have to connect the necessary cables.

The GLONASS/GPS antenna jack has to be plugged into the antenna connector X2 (see Fig. 3 and 5). If you use an indirectly excited antenna, then to ensure best results it has to be plugged to connector X2 via a minimal length cable (preferably without a cable at all).

A USB cable has to be plugged into a USB connector. The other cable terminal has to be connected to the computer. Switching on/off the power supply for the evaluation board is done by connecting/disconnecting the USB interface cable to the receiver connector X1.

After the evaluation board power supply is switched on, the LED HL1 (orange-red light) indicating the ML8088s module power supply should light up:

Several seconds later (usually no longer than 3 seconds) after the power is on, the LED HL2 (green light) should start blinking and this induces availability of data out at the receiver ML8088s output TX1, this is a NMEA data output.

If working with a standby power supply from a battery is required, an external supply battery with 3V nominal voltage should be connected to terminals 21 (-) and 24 (+) to the board wiring panel (see Fig. 4).

Application Configuration

The Navia viewer application should be run after the board has been connected to the computer. This is necessary because after the application has been started, it checks all the available serial ports of the user computer.

If the board is connected to the computer through the same interface connector as during the previous session, and no changes have been introduced into the board and application configuration, then you can first run the application and then connect the board. The board can also be disconnected while the application is running, and then reconnected again.

Some Windows operation system versions can misinterpret the NMEA data traffic, which can cause the cursor bounce on the screen or the mouse keys react incorrectly, etc. In this case you have to disconnect the board from the computer and ask the system administrator to configure the Windows.

When the application is run for the first time (in Fig. 8 you can see in the status bar at the screen lower part that the serial port is not specified) after it has been installed on the computer, a message might appear that the data exchange port is not specified (see Fig. 9A). Clicking the OK button will run the NMEA data port quick identification mode (see Fig. 9B). After the Port Search button is clicked, all the available ports will be scanned at all exchange speeds, which can take quite a long time. After NMEA data port has been detected, the port identification message will be displayed (see Fig. 9B). Click the OK button and then save the determined by the application parameters by clicking the Save button. Then the port search window will close automatically,

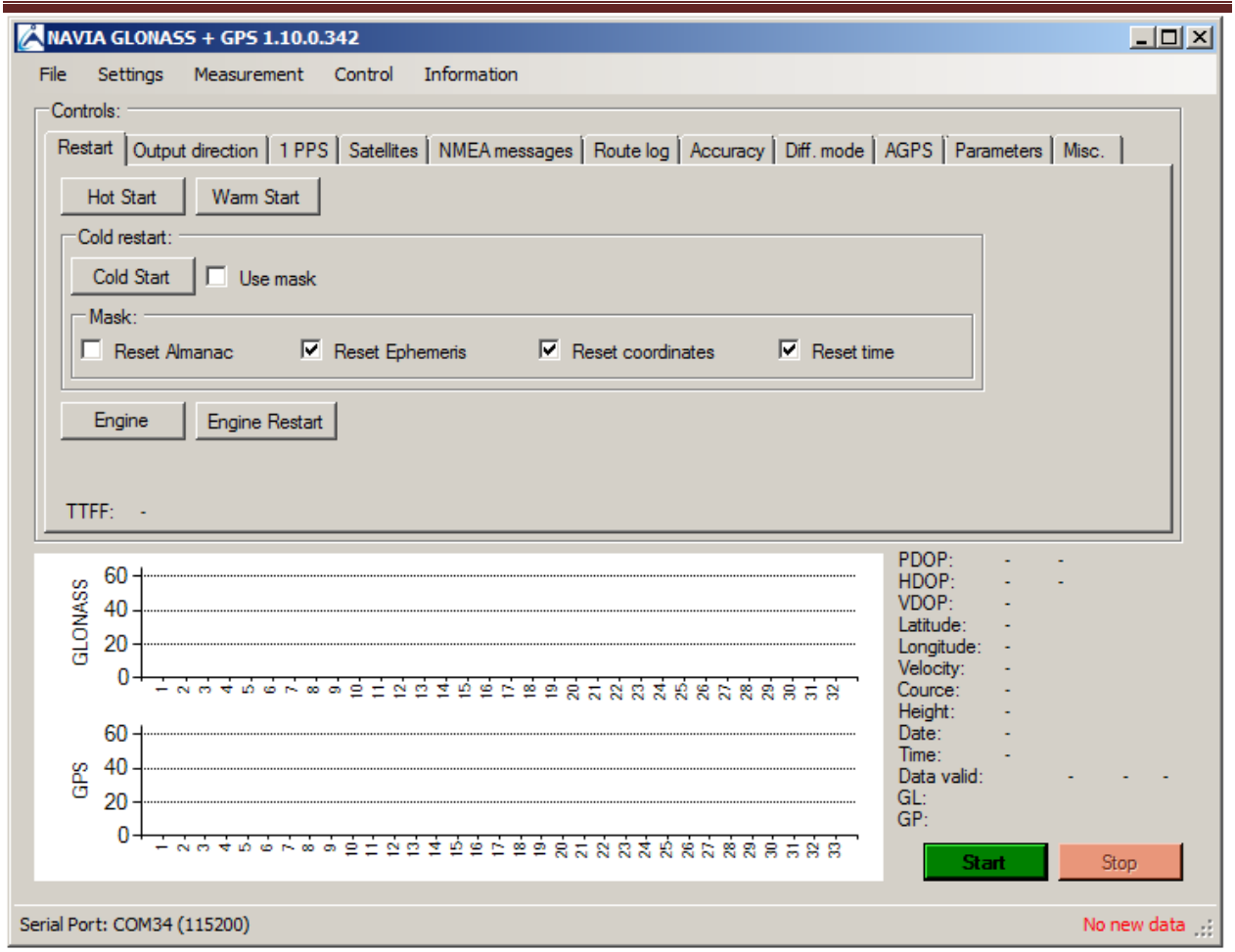

Fig. 8. The application window appearance at first run.

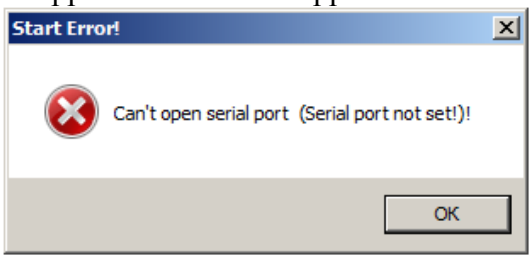

Figure 9A. The message “Data exchange port is not specified".

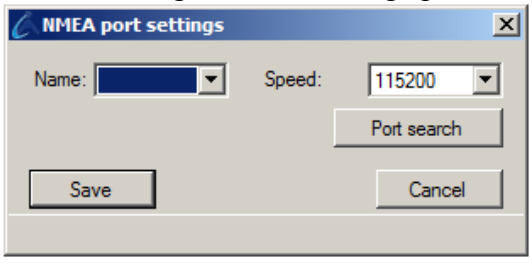

Figure 9B. Data exchange port quick search window.

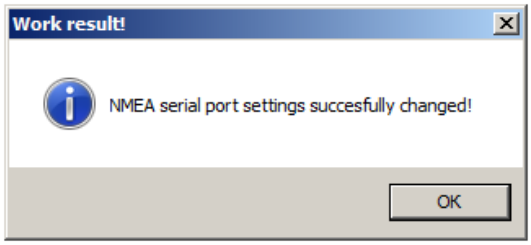

Figure 9C. The message “Data exchange port has been identified”.

The board operation can require changing the port number or the exchange speed, or the interface cable can be connected to another USB connector. All these cases will require changing

the data exchange port configuration. The application has an automatic identification mode for the NMEA channel serial port number. To activate it click the Run button (see Fig. 10, the application with the specified data exchange port). In case the screen will display the message of input data wrong format (see Fig. 11A), open the Settings tab and click the Port Search button in the Data Source field. After the NMEA port search is finished, the message “Search finished successfully" will be displayed. After that you might need to correct the debugging information port number manually (the Data Source port and Debugging Information Port numbers should not coincide) and then click the Save button.

All the configuration can also be done manually. To do this open the Settings menu tab (see (see Fig. 11B) and specify the serial port number and speed in the Serial Port field (the port used for interaction with the NMEA module). After the application has been started, it checks all the available serial ports of the user computer and offers selecting one. The most often required port is the port with the highest number. The factory release setting of the evaluation board port exchange speed is 115200 bit per second, but it can be changed upon the user’s request or by the user independently during the operation.

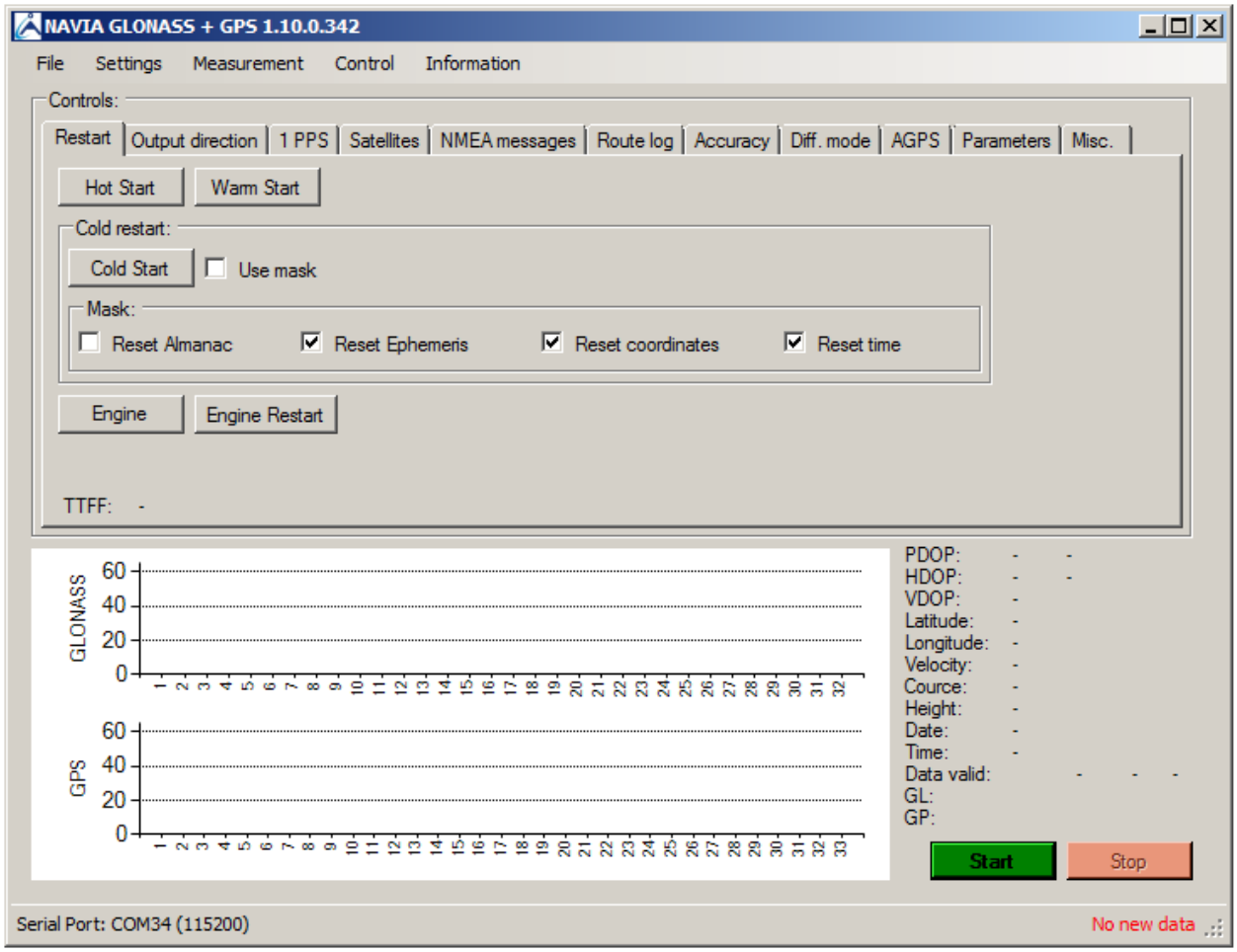

Figure 10. The application main window with the specified data exchange port).

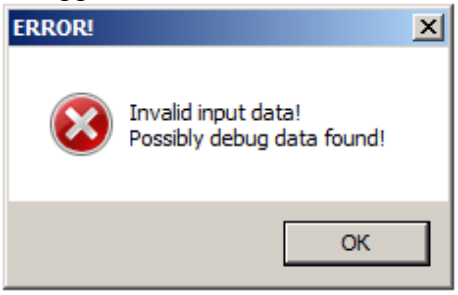

Figure 11A. Message “Input data wrong format”.

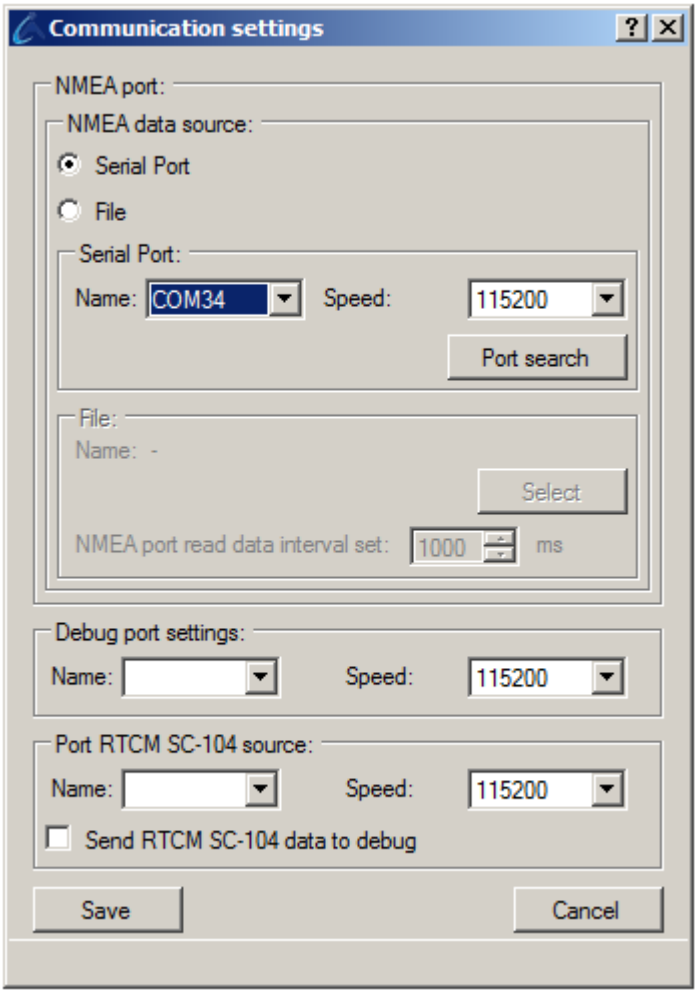

Figure 11B. The data exchange port selection window.

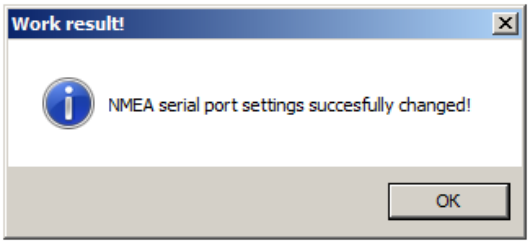

Figure 11C. The message "Data exchange port settings have been successfully updated".

The Application Operation

After the Run button has been clicked, the application reads and analyses the input data, and displays a number of parameters:

- numbers of detected satellites;
- the signal strength of detected satellites;
- numbers of satellites participating in the decision-making (marked by colour: green for GLONASS, red for GPS);
- current location coordinates, speed, heading and altitude;
- time and date;
- dilution of precision factor (PDOP, HDOP, VDOP);
- the message "Data are valid" indicating that the navigation task has been solved successfully;
- 2D/3D positioning mode;

– autonomous/differential operation mode;
– noise level in GLONASS and GPS channels;
– average and maximum GLONASS/GPS signal levels;

The status bar displays the serial port current settings (its number and speed). The parameters controls are placed in several tabs.

Restart

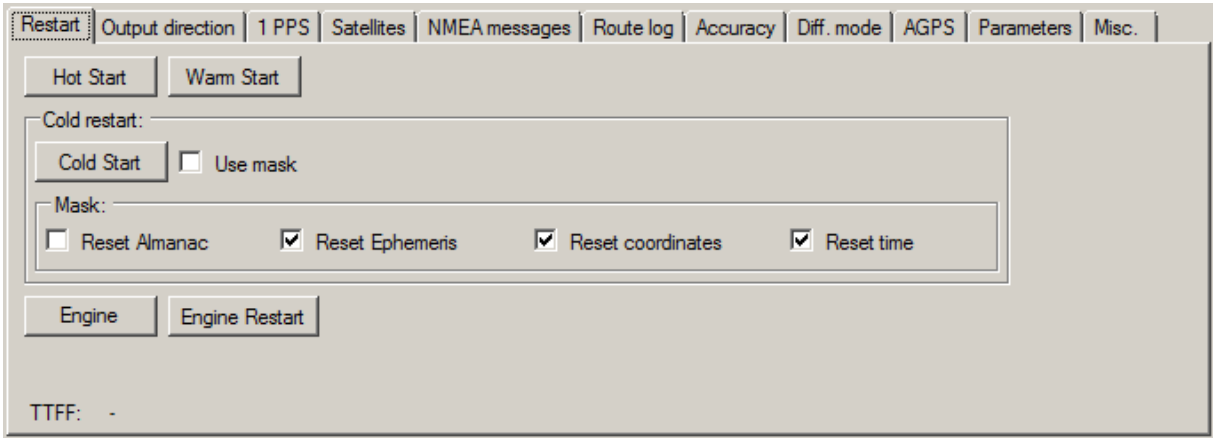

Fig. 12. Navia GLONASS + GPS application restart management window

This tab allows "Hot", "Warm" and "Cold" module restart. For "Cold" restart you can specify the sets of data which have to be cleared by the restart.

Besides, you can reset and restart the module. The TTTF parameter (Time To First Fix) indicates the time elapsed from running the restart command until receiving the correct position coordinates.

Data Output redirection

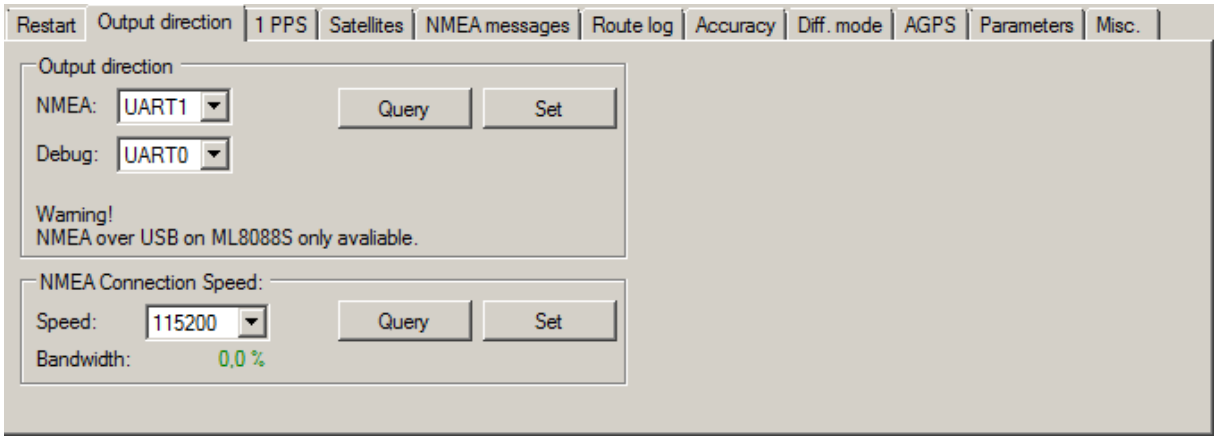

Fig.13. NAVIA GLONASS + GPS application module data output window tab.

This tab provides module set-up by port and output speed selection for positioning system data. For parameter activation additional module restart is required.

This tab also shows NMEA channel estimated load, which depends on exchange rate and message set. Please note, that channel load is estimated approximately on special PSTM signal group basis and the actual load may significantly differ from estimated.

Normal application and channel operation requires less than 70% channel load.

1PPS

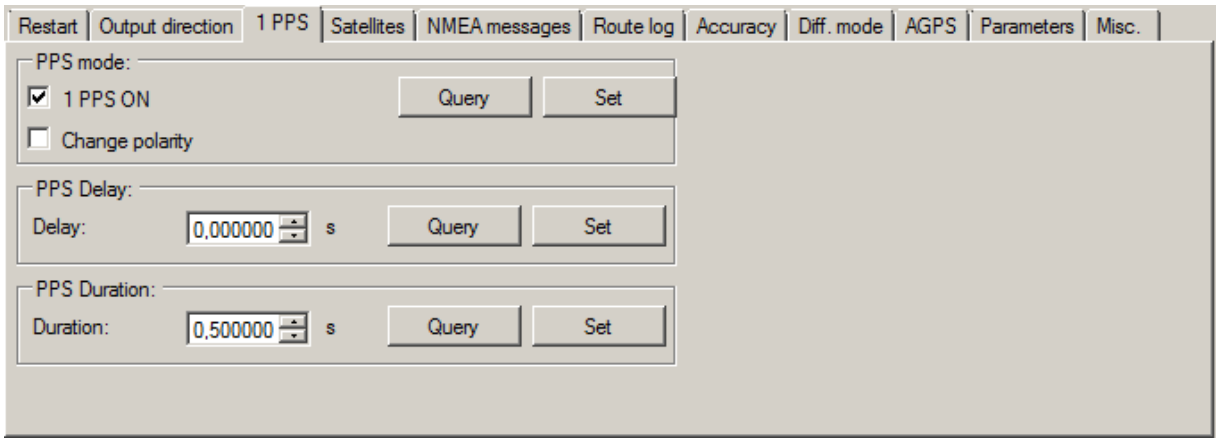

Fig.14. NAVIA GLONASS + GPS application module 1PPS signal window tab.

This tab provides module operation mode, «1PPS» signal latency and duration time setup. For parameter activation additional setup write command («Save» button) and module restart is required.

Module fine tuning for 1PPS signal is achieved by configuration parameters adjustment.

Satellites

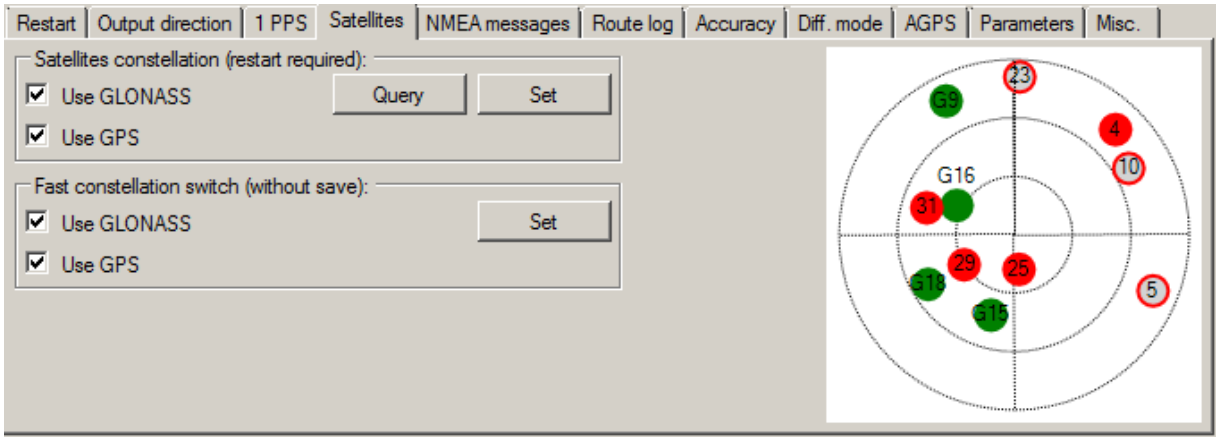

Fig.15. NAVIA GLONASS + GPS application satellite group set window tab.

This tab defines which satellite group is used for positioning solution. Activation requires pressing Set (Установить) button.

Two ways to define used satellite group exist – with parameter save and without parameter save.

Saving parameters allows using previously saved satellite group on furhter application launch. This settings require application restart.

A setting without saving parameters allows switching satellite group on the fly. Made settings not saved. This setting not require application restart.

Celestial hemisphere and satellite location layout is shown on the right side of the window (the North on top). The center of the layout indicates Zenith, the outer circle indicates Horizon. The GPS satellites shown red and GLONASS satellites shown green. Symbol of satellite with solid fill means the satellite is estimated for navigation solution and the satellite shown as colored ring means it is not estimated.

Messages SET

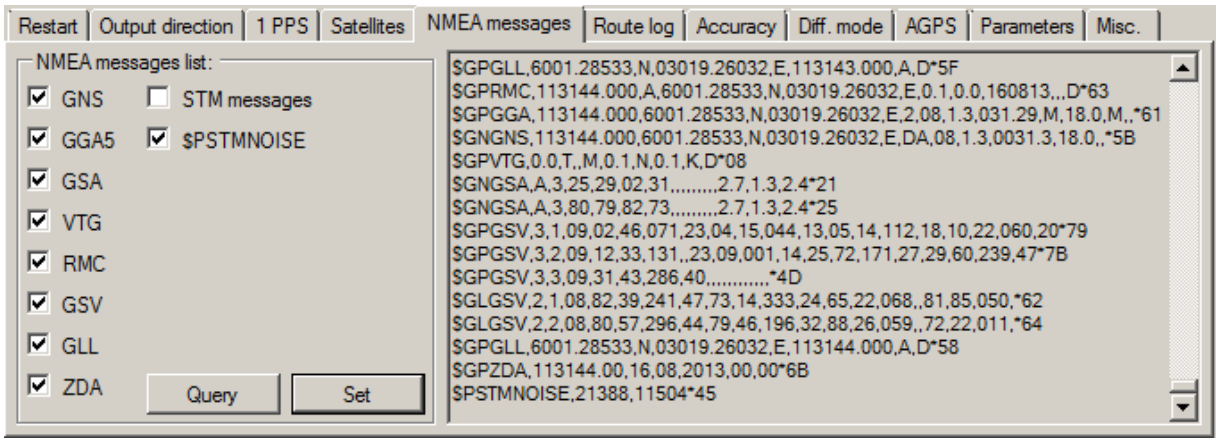

Fig.16. NAVIA GLONASS + GPS application exchange message set window tab.

This tab defines message set, sent by device. Setting activation may require applicatiion restart.

The right area of the window indicates messages, sent by application.

Route log

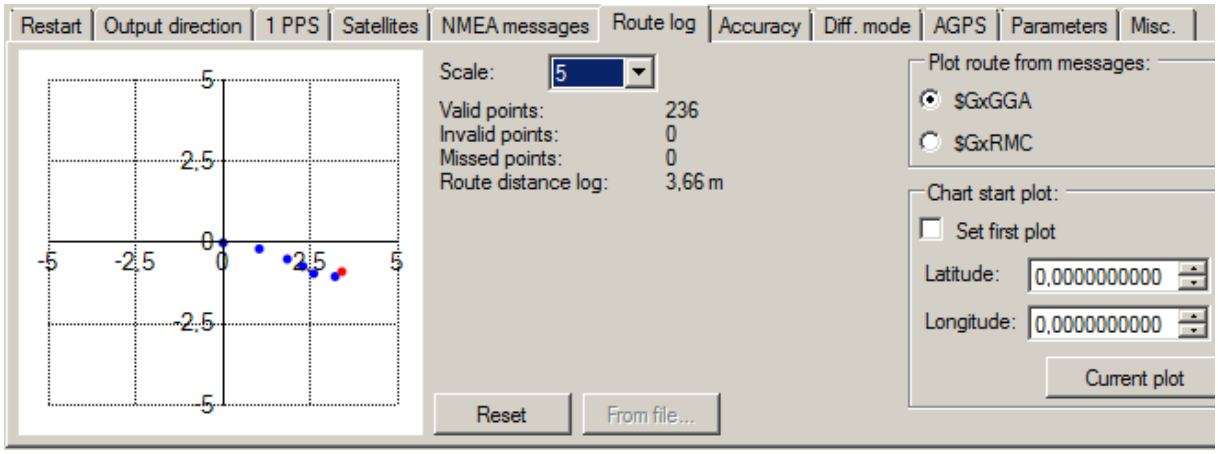

Fig.17. NAVIA GLONASS + GPS application received coordinates point window tab.

This tab shows the layout graph of coordinate's distribution indication. Coordinates are shown as point set. The first point always located in the coordinate origin. The red dot indicates the last correct coordinate, sent by device. The «Scale» parameter defines distance from center in meters. «Reset» button clears point set, following which first correct point is located in the coordinate origin. The «From file…» button allows loading coordinate set from file in the NMEA data format. After loading from file the current coordinates are not shown till «Reset» button is pressed.

DOP level setting (estimated precision)

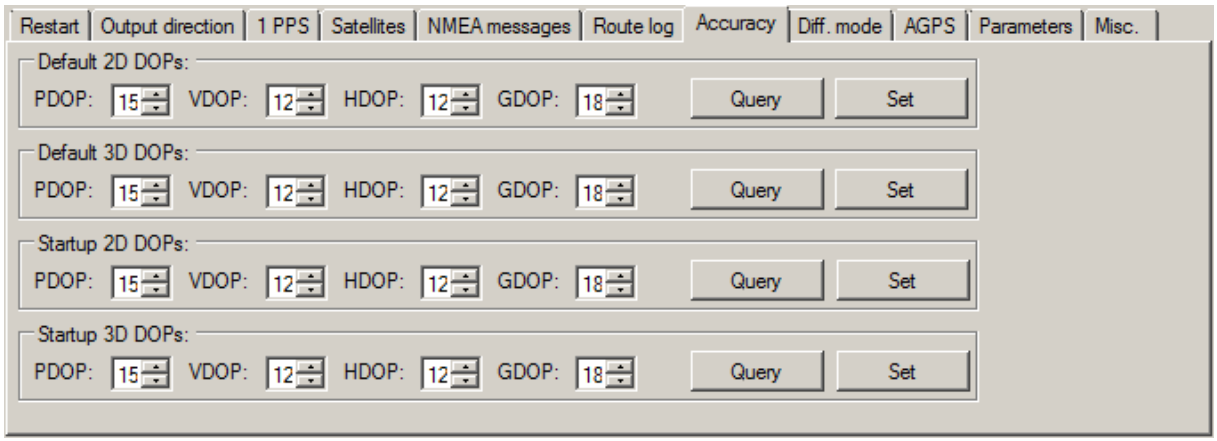

Fig.18. NAVIA GLONASS + GPS application 1PPS signal level window tab.

This tab defines DOP (estimated Dilution of Precision caused by satellite position interference) start and current operation levels threshold.

If the satellite position geometry weakens and the DOP value (PDOP, VDOP, HDOP, GDOP) exceeds the threshold, the navigation solution is treated incorrect (invalid).

ST-AGPS mode

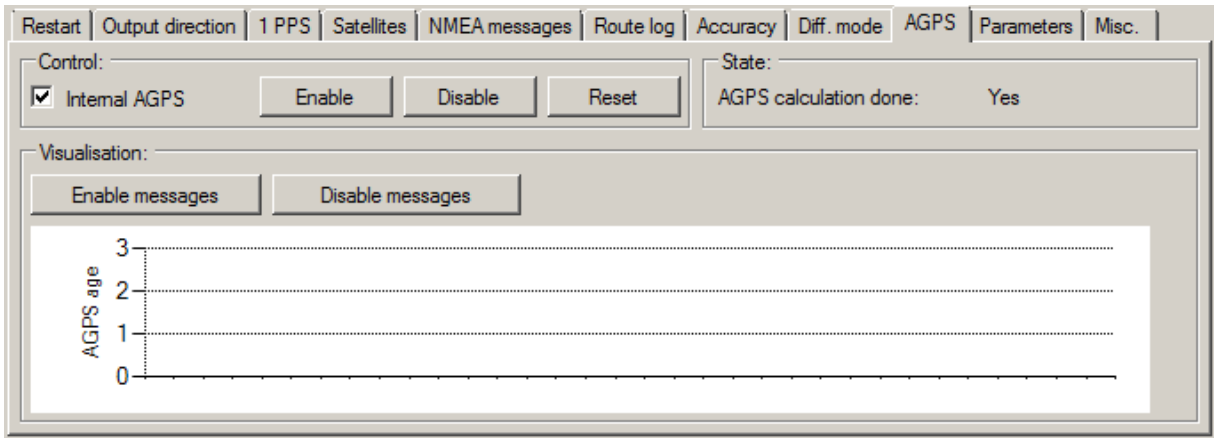

Fig.19. NAVIA GLONASS + GPS application 1PPS signal level window tab.

This tab allows to switch on and off satellite layout prediction functionality (Self Predicted ST-AGPS). This tab also indicates calculations status (either prediction calculation completed or not) and predicted data time for each of the satellites used in estimation. In case of actual current prediction all satellites would have data time equal to 0 days and would not be shown on the graph.

Differential mode

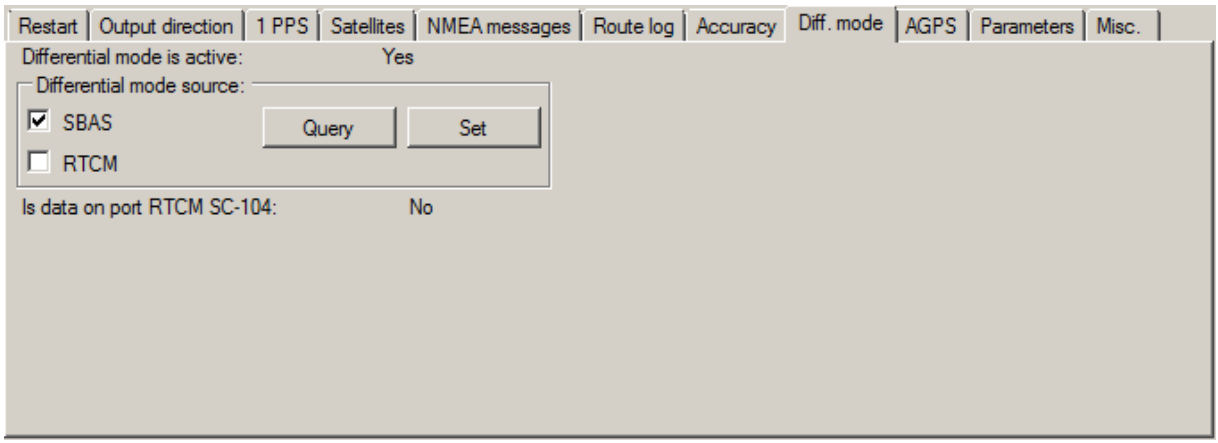

Fig.20. NAVIA GLONASS + GPS application 1PPS signal level window tab.

This tab allows selecting the differential correction source. Should be noted, that the SBAS correction parameter may increase the determination of position precision only in the Western region of Russia, in the other regions its use will be at least useless.

Parameters

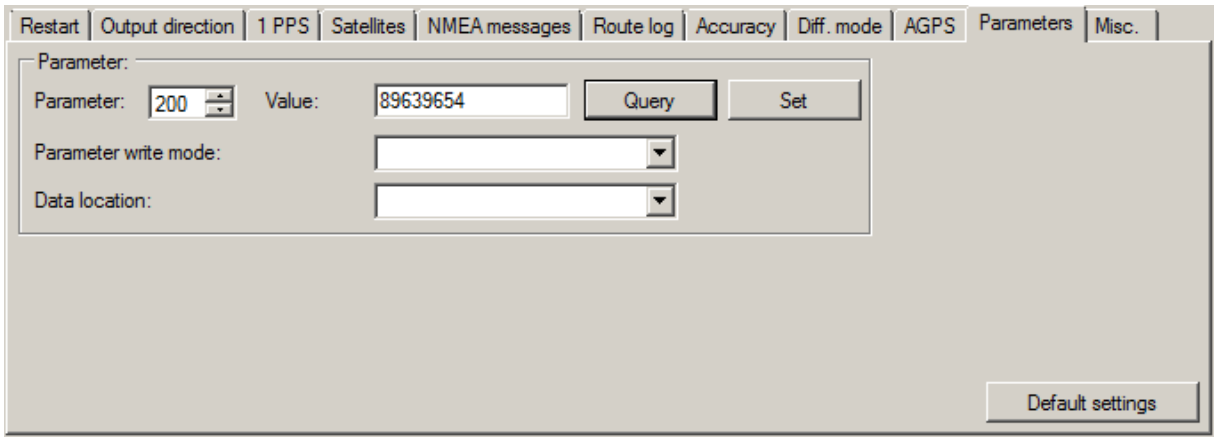

Fig.21. GLONASS + GPS application reciever's read and write parameter window tab.

This tab allows manual request and set of user-defined parameter. The parameter value is set in hexadecimal format (2 HEX digits per byte) for the integer values or in the decimal format for the other formats.

The «Reset settings» button resets all settings to the factory settings.

Miscellaneous

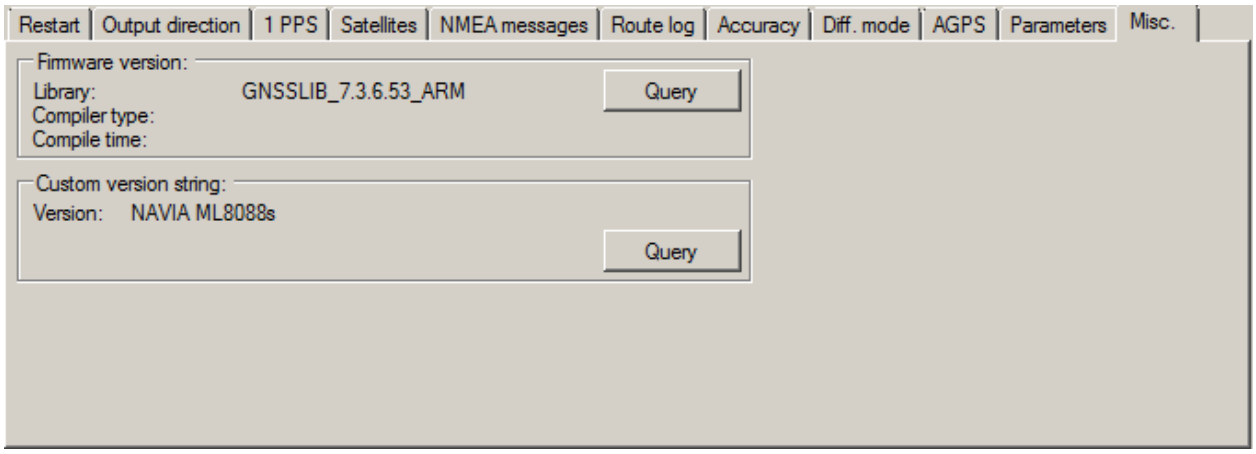

Fig.22. GLONASS + GPS application reciever firmware version window tab.

This tab shows module's navigation library version and the text string for firmware version (parameter 500).

Reciever Pinout

Table 4.

Signal description	Type	Pin №	Marked as
Common for high frequency	Power	20, 22	RF GND
Common for digital	Power	6, 17	GND
Antenna connection jack	Analog	21	IN_RF
DC +3,3V	Power	13	V_IN
Backup battery circuit	Power	12	V_RTC
UART1 OUT (NMEA)	In/**Out**	4	TX1
UART1 IN (NMEA)	**In**/Out	5	RX1
UART0 OUT	In/**Out**	2	TX0
UART0 IN	**In**/Out	1	RX0
USB D+ pin	In/Out	15	USB_DP
USB D- pin	In/Out	16	USB_DM
Timestamp signal	In/**Out**	3	PPS
Reception status	In/**Out**	8	GNSS status
Module hard reset	In	18	/RST
Not Connected	---	7, 9, 10, 11, 14, 19	NC

Practical use of the evaluation board

This evaluation board for the navigation receiver chip ML8088s can help the developer to get acquitted with this chip.

The key features for this board design are the switchable power supply from the USB bus and the option to attach external battery supply at any time, which is not usually allowed in the finished devices. From the other side, these features allow the user to evaluate some restrictions to temporary signal diagram, defined by the receiver.

The receiver multiplexer of ML8088s chip allows to switch off independently separate or all the signal lines from the board. This allows to test the ML8088s chip in the user's devices without soldering the chip to the PCB, resulting in the receiver integration jobs onto devices on very early stage.

The feature to connect and disconnect external battery on the fly allows developer to evaluate battery power impact on the design of the device.

The ML8088s operation method WITHOUT battery connected, is as follows:

1. All the jumpers are set according to the «Work» mode (look Tab.3)
2. Connect the USB cable to the board connector and to PC.
3. PWR LED should lit.
4. NMEA LED should blink.

The ML8088s operation method WITH battery connected, is as follows:

1. Connect external battery to 20 (-) and 23 (+) pins of X3 socket.
2. All the jumpers are set according to the «Work» mode (look Tab.3)
3. Connect the USB cable to the board connector and to PC.
4. PWR LED should lit.
5. Temporally short the 29-30 pins of X3 socket together.
6. NMEA LED should blink.

The receiver board operation mostly matches the description of operation in the typical connection circuit.

Short description of messages and commands of the ML8088s(E) navigation chip is provided in «Command description of ML8088s and GL8088s 1_1.pdf». Full description of messages, commands and configuration parameters is available on demand.

Typical connection circuit

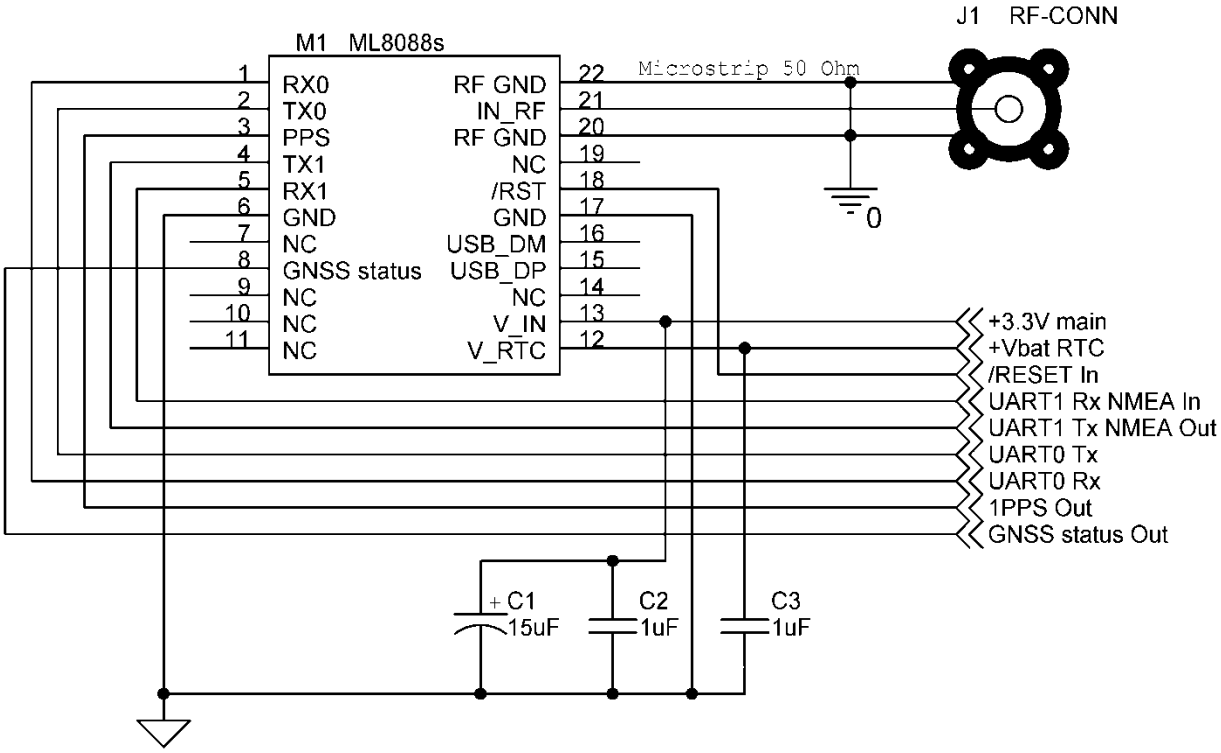

Fig.23. Typical connection circuit for ML8088s chip.

Power supply V_{dd} = 3,0…3,6V is provided to the 13 contact pad, as shown on the curcuit as **+3.3V main. All the voltage values are measured relative to bus GND (common).**

The voltage at any time on any pin of the receiver should not exceed 3,6V.

Voltage from the backup battery of RTC clock in the range V_{bat} = 2,0…3,6 V should be provided to contact pad 12 (V_RTC). This line is shown as the **+V_{bat} RTC** on the connection circuit graph. It is recommended to provide V_{bat} voltage permanently to keep internal clock and memory operational. In addition, backup battery provides power supply for the module firmware activation register memory (module firmware). Not recommended to use backup battery with voltage, exceeding the main power supply voltage level, which results in the current overconsumption from the backup battery during the circuit operation.

During the first activation of the main power supply V_{dd} after the connecting the battery V_{bat} the low logical level pulse should be sent obligatory to the pin 18 (IN/RST). This line is shown as **/RESET In** on the graph. This is necessary for the correct selection of the built-in microcontroller mode operation (operation or the firmware write to build-in flash memory), for the firmware activation and write of its activation status to the register memory. The signal pulse duration should at least 10 ms, the input voltage should not exceed 0,1 V and the load-carrying capacity should be not less than 0.8 mA. During the further power supply connections V_{dd} the pulse signal to the pin IN/RST is not obligatory, due to the fact that this signal pulse erases the current time information, that increases the the satellites search and registration time. The timing chart for states and signal levels on the module pins during the connection of V_{bat} and V_{dd} is given on Fig. 24

Note, that all the states and signals are measured relative to receiver module.

The voltage on the OUT pins at any time should NOT be the power source for the module (so-called «phantom power supply»),, i.e. the voltage on the TxD0 (TX0), RxD0 (RX0), TxD1 (TX1) и RxD1 (RX1) pins should not exceed the main power voltage at any time. Obviously, the voltage on the above mentioned pins should not present during the main power V_{dd} disconnected time, for example these pins are switched to high-impedance state «Z state», input mode or the

«Logical 0», in this situation the «pull up» to the main power supply voltage should not be present. Maximum allowed voltage on the module input pins during the main power V_{dd} switched off should not exceed 0.2 V on all the pins, except of the pin 12 (V_RTC) and 18 (IN /RST).

The pin 18 state (IN /RST) during the main power V_{dd} switched off is not normalized.

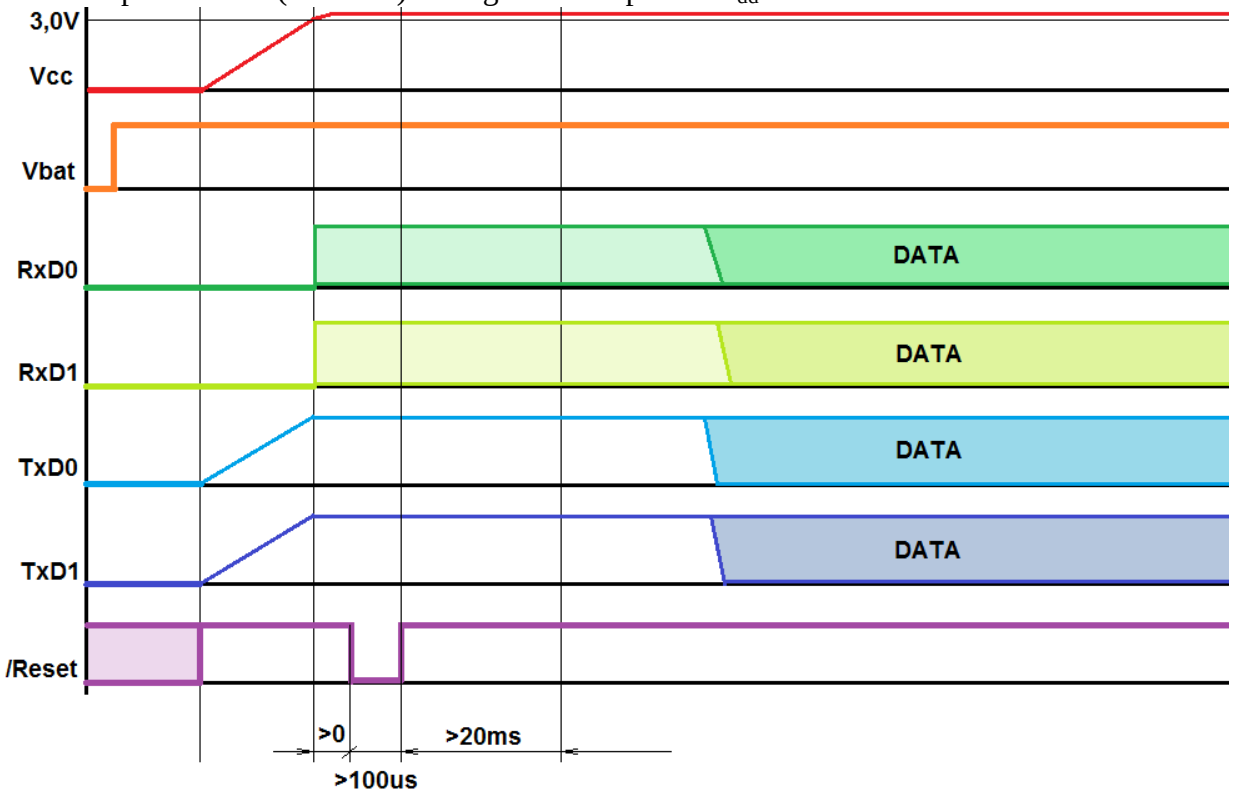

Fig. 24. The timing chart for states and signal levels on the module pins during the connection of Vbat.

At the time of pulse sending to IN /RST pin (or, in cases when this pulse is not formed, but only the main voltage V_{dd} is connected without the voltage $+V_{bat}$), the high-impedance state should be provided (Z-state or «IN» state) on lines, connected to pins TXD0 and TXD1. Note, that the leaks through the lines, connected to the module not allowed. That leaks may include the leaks through the «pull down» resistors or through the overvoltage protections circuits (in case of protection voltage threshold lower , than V_{dd}). Maximum leak current is 2 mkA. The breaking of this rule leads to inability to launch module's firmware. These states should be supported at least 20ms after sending low level to IN/RST or the main power supply V_{dd} connection (in case of V_{bat} not used)

If the backup battery is not used, the pulse send to IN/RST is not obligatory.

Pulse for IN/RST may be send to restart the module firmware. It is strongly recommended to provide forming IN/RST signal in the device. In case of output signals not present on the module during 5…7 seconds, the IN/RST should be send to the module (with timing chart compliance).

Antenna (active or passive) is connected to 21 (RF IN) pin. The line, connecting pin 21 and antenna should be made with 50 Ohm impedance. The contacts 20 and 22 are the (AGND) the part of high-frequency line to pin 21. the power supply to active antenna is provided through the built-in lines.