Navigation Module
ML8088sE

Operations Manual
Version 2.1

Russia

Saint Petersburg

2015

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Summary

This document is designed for users of multi-channel navigation GLONASS/GPS/GALILEO receiving module ML8088s and contains the general description, specifications, application instructions and rules of operation, transportation, and storage.

This document is based on Russian document “Аппаратура навигационная ML8088sE РЭ v3_3.pdf” (Navigation equipment ML8088sE User Manual v3.3). If there is any inconsistency or ambiguity between the Russian version and the English version, the Russian version shall prevail

Revision History

Edition number	Date	Description
1.0	March 2015	Initial English version
1.5	April 2012	Command interface description added
2.0	November 2015	Translation of Russian document “Аппаратура навигационная ML8088sE РЭ v3_3.pdf”
2.1	December 2015	Packing information added

List of Used Abbreviations

The list of adopted abbreviations is set out below:

ESD:	Electrostatic Discharge
SS:	Space Satellite
SC:	Satellite Constellation
NT:	Navigation Task
PC:	Personal Computer
GNSS	Global Navigation Satellite System - Satellite based system to calculate the position of the on the earth surface.
SW:	Software
CT:	Standard Accuracy = ΠΤ-Code: Reduced Accuracy (former designation)
NMEA:	Full name NMEA 0183, ASCII protocol used for marine (normally navigation) equipment intercommunications (National Marine Electronics Association).

Electrostatic discharge warning

This IEC60417 sign shows warning about Electrostatic Discharge sensitive device.

Electrostatic discharge (ESD) is the sudden and momentary electric current that flows between two objects at different electrical potentials caused by direct contact or induced by an electrostatic field. The term is usually used in the electronics and other industries to describe momentary unwanted currents that may cause damage to electronic equipment.

Typical Generated ESD Voltages

Examples of Static Generation Typical Voltage Levels		
Means of Generation	**10-25% RH**	**65-90% RH**
Walking across carpet	**35,000V**	1,500V
Walking across vinyl tile	**12,000V**	250V
Worker at bench	**6,000V**	100V
Poly bag picked up from bench	**20,000V**	1,200V
Chair with urethane foam	**18,000V**	1,500V

Static voltages types marked with RED color, showed in above table, could damage all input pins as well as RF-input pin. Less values of static voltage marked with BROWN color could damage all pins except RF-pin because it is highly ESD protected.

When handling the module, do not touch this RF-pin with any charged capacitors and be careful when contacting materials that can develop or accumulate charges (e.g. patch antenna ~10 pF, coax cable ~50 - 80 pF/m, soldering iron …)

To prevent electrostatic discharge through the RF input pin, do not touch any exposed antenna area. If there is any risk that such exposed antenna area is touched in non-ESD protected work area, implement proper ESD protection measures in the design.

When soldering RF connectors and patch antennas to the ’s RF-pin, make sure to use soldering station with strong ESD protection.

General Information

The exterior view of ML8088s navigation Module showed in figure 1.

Fig. 1. The exterior view of the Module (not on 1:1 scale).

ML8088s is a multi-GNSS device able to track LONASS/GPS/GALILEO Navigation System (hereinafter referred to as module).

Designed for real-time calculation of current geographic coordinates and velocity of the object, generating of a time synchronization pulse called 1PPS and exchange with host-peripherals via RS232 serial ports or USB. The operating principle of the module is based on parallel receiving and processing of signals from navigation GLONASS SC in frequency band L1 (CT or PT code), GPS on L1 frequency (C/A code) and GALILEO on E1 frequency by 32 tracking channels. The GNSS tracking results are available in NMEA messages format.

ML8088s navigation receiver (further - module) is built on a state-of-the-art dedicated engine STA8088F from the family of so-called "systems-on-a-chip" STA8088CFG.

The module has high sensitivity, low power consumption and short cold/warm/hot start time.

The module engine equipped with 2 acquisition (searching, capturing) channels and 32 channels for satellite signals tracking, which ensures simultaneous searching for satellite signals of GLONASS, GPS and GALILEO constellations.

The module makes it possible to use satellites almanac and ephemeris data stored in the module memory for initial search of satellite signals; this ensures to reduce cold start time and, which is more important, makes it possible to perform the cold start when the signals from satellites are weak. The mentioned data can be prepared by external sources (and transferred to the module via data links), as well as by the module itself. In the latter case, no additional information from the external sources is required.

The engine equipped with built-in 3-state jammer barrier feature, which allow the module to operate under high interference signaling environment.

The structure of the module label (sticker) of navigation ML8088sE showed in Picture 2.

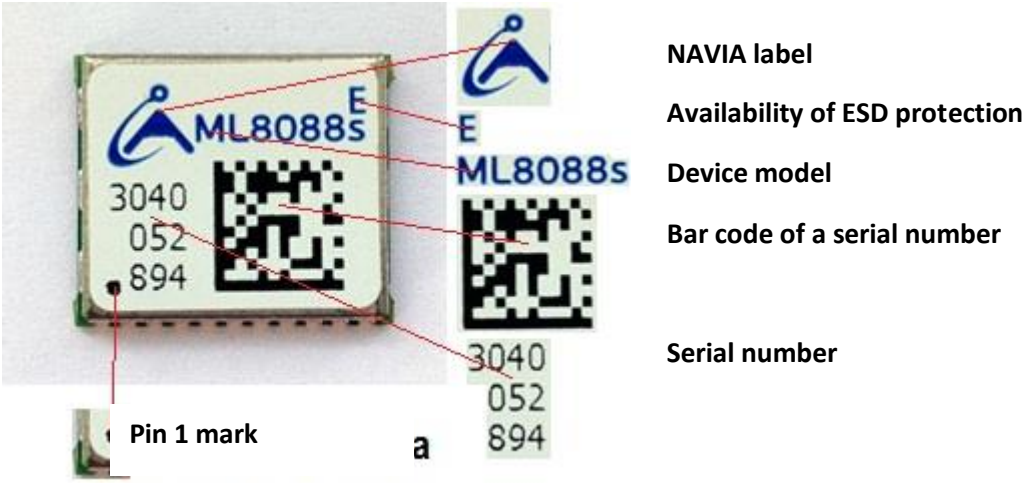

Fig. 2. The module sticker of navigation module ML8088sE, elements.

The first pin key (the mark of the first connection pin) is a black dot against the white background; the key is located in the top left corner of the label beside NAVIA logo.

The module operation command interface is performed with the use of special ST GNSS NMEA commands. Module has on board two UART parts and one USB.

Fig. 3. The Demo Board for the navigation module ML8088sE.

The Demo board is released for user evaluation of the module module operation. The description of the board is provided in document “Demo board ML8088s TD v1_0.pdf”. The board can be connected to PC or other equipment for the module operation analysis.

Specifications

Parameter	Value
Frequency band, MHz GPS GLONASS	 L1 – 1575.42 ± 0,5 L1 – 1597.5 to 1605.9
Number of channels tracking acquisition	 32 2
Horizontal position accuracy, m	± 1,5
Vertical position accuracy, m	4
Velocity accuracy, m/s	± 0,05
Time to first fix (TTFF), s Cold Warm Hot Re-acqusition	 36 36 4 1
Sensitivity. dBm Cold start Warm start Hot start Re-acqusition Navigation Tracking	 -145 -145 -154 -155 -156 -161
Differential correction types	SBAS (WAAS, EGNOS), RTCM SC-104
Dynamics in High Dynamics mode, Acceleration, g Jerk g/s	 4 2
PPS signal Duration Tolerance	 500ms (adjustable) 15ns
RTCM SC-104 support	V2.3, messages 1, 9, 31,34
Datum	WGS-84, TOKYO MEAN, OSGB, Pulkovo42, PZ-90.2, PZ-90.11
Navigation messages format	NMEA 0183 v3.1
NMEA messages set	$GPGGA, $GPGLL, $--GSA, $--GSV, $GPRMC, $GPVTG, $GPZDA
$--GSA и $--GSV preambles	“GA”, “GP”, “GL”, “GN”
Data interface	2*UART, 1*USB
Environment temperature, °C	-50 to +85
Peak mechanical acceleration, m/s^2	150

Parameter	Value
Vibration in frequency range 20 до 1000 Hz, m/s^2	100
Main supply voltage, V	3.0...3.6
Current consumption, mA	110 (acquisition) 60 (navigation) 2 (sleep)
Backup supply voltage, V	2.0...3.6
Backup current consumption, uA	60
Dimensions (length x width x height), mm^3	15x13x2.6
Weight, maximum, g	2

Notes:

1. Position tolerance showed for 50%, 24 hours, static, -130dBm.
2. Velocity tolerance showed for 50%, 1 hour, -130dBm static, circle with speed 10m/s and radius 500m.
3. Tolerance of 1PPS distribution (at the gauss 70% distribution level) to time scales GPS, GLONASS, UTC, UTC (SU), average.
4. Operation in the temperature range -50C°…-30C° allowed but Time-to-First-Fix and sensitivity may be degraded.

Module Outline Dimensions

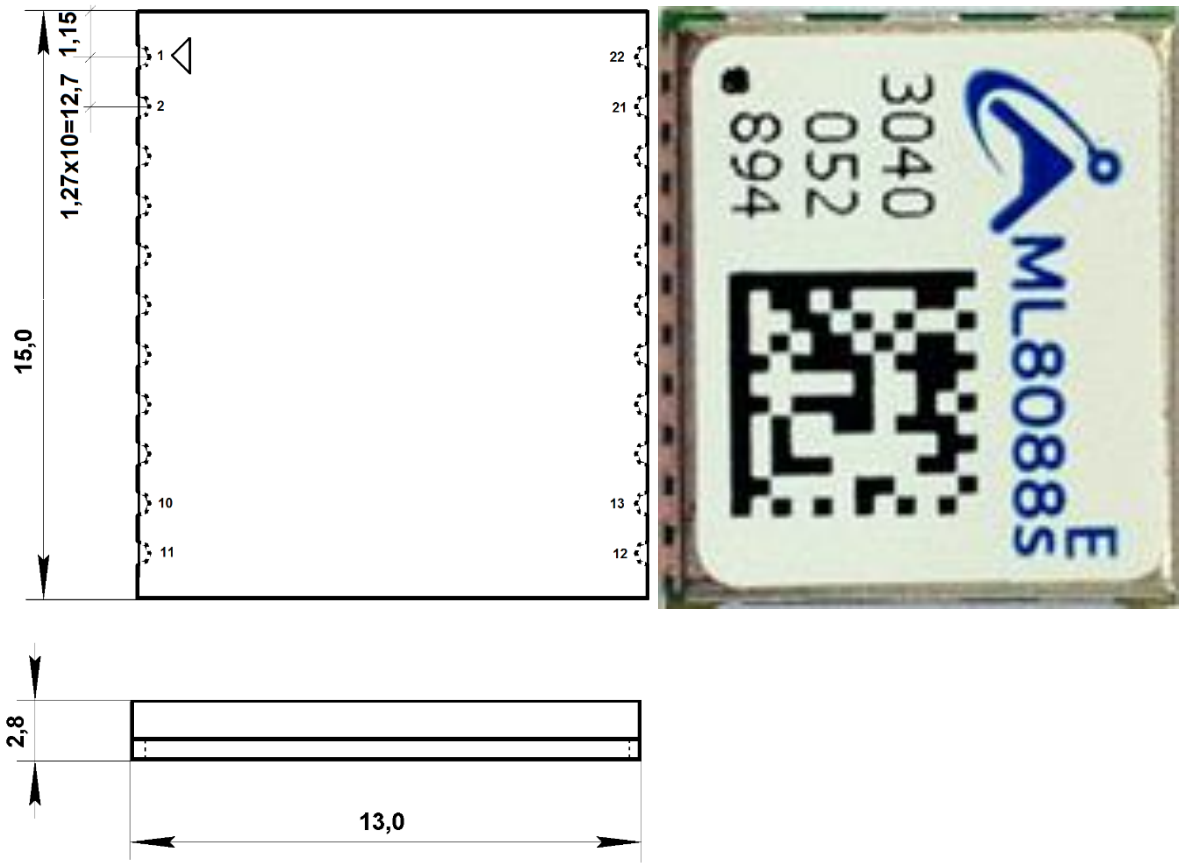

Fig. 4. Overall and Connection Dimensions of ML8088s Module. Pin pins showed in dashed line. Numbers of the pins and the mark of the first connection pin have conventional designations.

Recommended Footprint for the Module

The recommended footprint for ML8088s mounting on the user's PCB showed in figure 3. All dimensions are in millimeters.

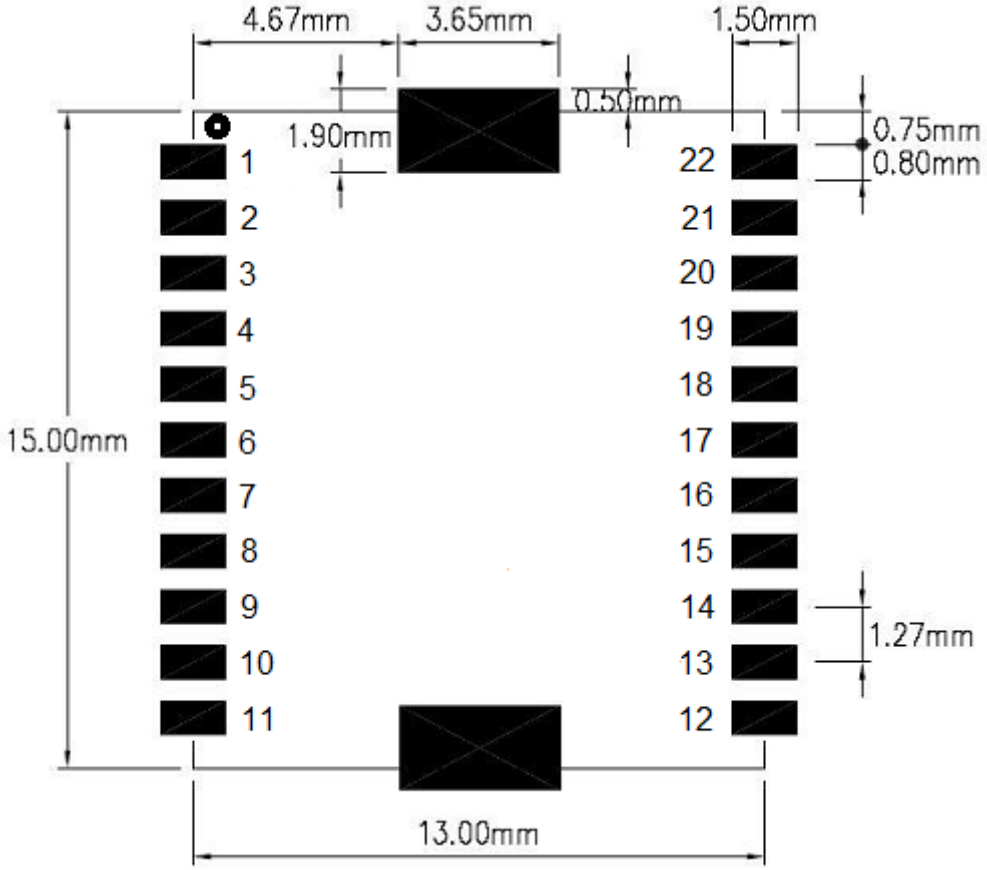

Fig. 5. Recommended footprint for ML8088s Module. Numbers of the connection pins and the mark of the first connection pin have conventional designations.

No signal lines should be placed under the module. It recommended that the free space under the module occupied with GND polygon.

Pins description

Signal description	Type	Pin number	Designation
Ground of the high-frequency part	Power	20, 22	RF GND
Ground of the digital part	Power	6, 17	GND
Antenna input	Analog	21	IN_RF
Power supply +3.3 V	Power	13	V_IN
Backup circuit power supply (battery)	Power	12	V_RTC
Output UART1 (NMEA)	In/**Out**	4	TX1
Input UART1 (NMEA)	**In**/Out	5	RX1
Output UART0	In/**Out**	2	TX0
Input UART0	**In**/Out	1	RX0
Pin USB D+	In/Out	15	USB_DP
Pin USB D-	In/Out	16	USB_DM
1PPS signal	In/**Out**	3	PPS
Reception status	In/**Out**	8	GNSS status
Module hardware reset	In	18	/RST
Not connected	---	7, 9, 10, 11, 14, 19	NC

The states of bidirectional connection pins in working mode of the Module operation showed in **bold** letters.

Typical Application Schematic

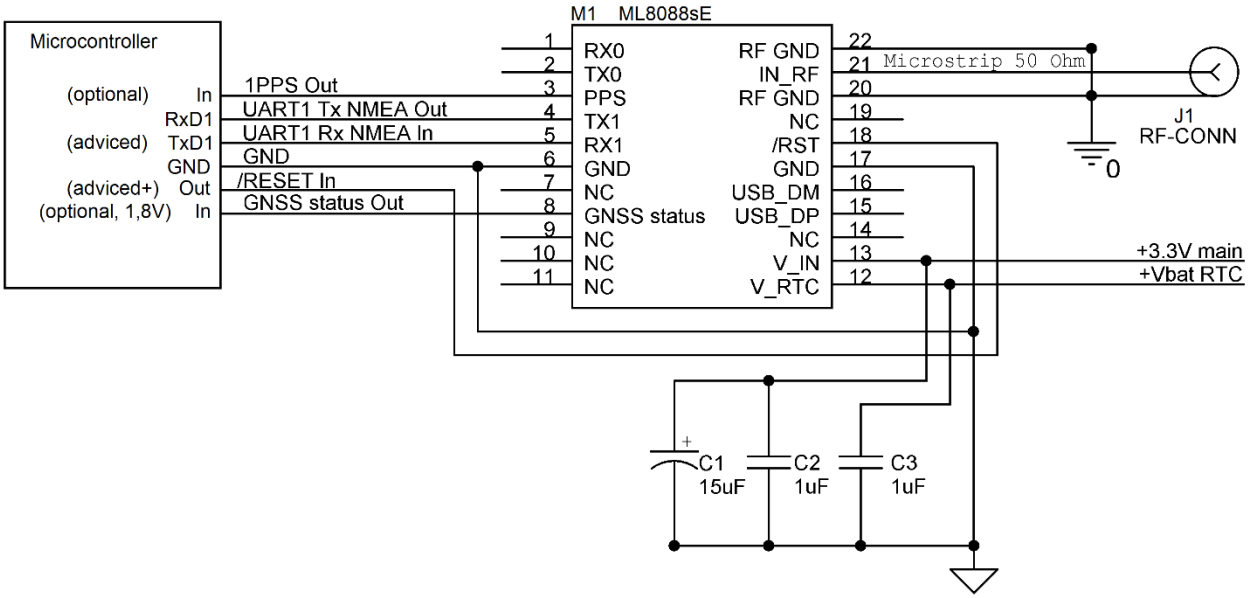

Fig. 6. ML8088s Module standard connecting diagram.

Figure 6 showed standard application schematic diagram for ML8088s Module. The “In” and “Out” label designate the directions of signals interface – input signals of the Module are designated with "In" label, output signals are designated with "Out" label.

The module supply voltage Vdd = 3.0…3.6 V is applied to the pin 13 (V_IN). In the schematic diagram, this pin is designated as **+ 3.3 V main**.

Voltage from the backup battery within the range of Vbat = 2.0…3.6 V must be applied to the pin 12 (V_RTC). In the schematic diagram, this circuit is designated as **+Vbat RTC**. It recommended that Vbat be constantly maintained for assurance of built-in clock and module RAM memory operation. In addition, the backup battery voltage provides power for the module internal Firmware (the module FW) activation attribute storage latch register. Use of a backup battery whose voltage exceeds the module supply voltage is not recommended (Vbat ≤ Vdd).

AT ONLY FIRST TIME when the module supply voltage Vdd is switched “ON”, following Vbat also switched “ON”, be sure to send a low logic level pulse to pin pin18 /Reset in, designation in the diagram **/Reset In** . This is required for selection of operation mode for the internal microcontroller of the module (operation or storing of the program in the built-in flash SQI memory), for activation of the module, internal FW and saving of its activation attribute into the storage latch register. The pulse duration must be at least 10 ms, the input voltage must not exceed 0.1 V, the source output capability must be at least 8 mA. At subsequent switching-on of Vdd supply voltage, sending of the pulse to input is non-mandatory, since

sending of this signal causes erasing of current time information in RTC, which increases the time of satellites searching and capturing. The signal states and levels timing diagram at the module connection pins at Vbat and Vdd switching-on showed in figure 7.

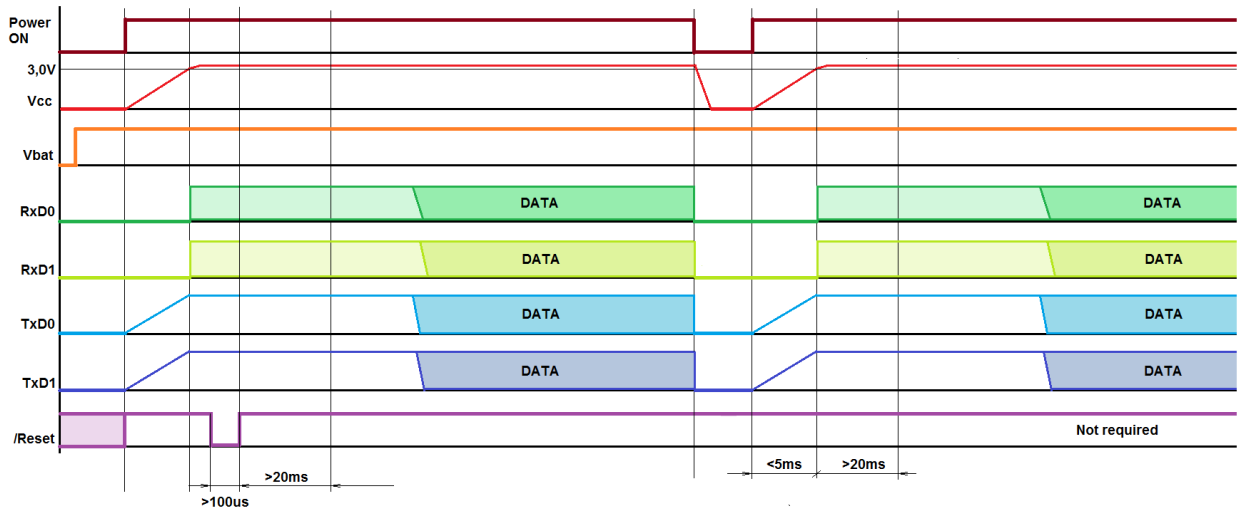

Fig. 7. The signal states and levels timing diagram at the module connection pins at Vbat application. First and subsequent switch on.

High impedance Z state describes the terminal pins of the host system (inputs and outputs) connected to the relevant pins of the module.

The pin-pads used to connect with host-control system must be never a “parasitic voltage sources” for the module (the so-called phantom power source), i.e., voltages at connection pins TX0, RX0, TX1 and RX1 must be never exceed the module supply voltage at any time. Clearly, with Vdd switched-off, there must be no voltage on the other pins; for example, if the host interfcae pins are switched to high-impedance Z state, input mode or into Logical 0 state, there must be no supply voltage "pull-up" on them.

The moment the /Reset pulse is sent to input (or, if this pulse is not generated but instead of the module supply voltage Vdd is applied without applying of +Vbat), be sure to provide for high- impedance state (Z state or Input state) of the circuits connected to TX0 and TX1 pins.

Father, be aware that there should be no leakages through protection circuits of pins connected to host caused by overvoltage up to Vdd value. Violation to meet this requirement will be an incorrect launching of the module internal software. Mentioned states should be maintained for at least 20 ms from the moment of sending low level to the inputs is over or from the moment Vdd supply voltage is switched on (if Vbat is not used).

If the backup battery is not used, sending of the /Reset pulse to input is non-mandatory. The signal states and levels timing diagram at the module Vdd-pin switching-on without Vbat showed in figure 8.

The /Reset pulse can be sent to input for restart of the module internal program.

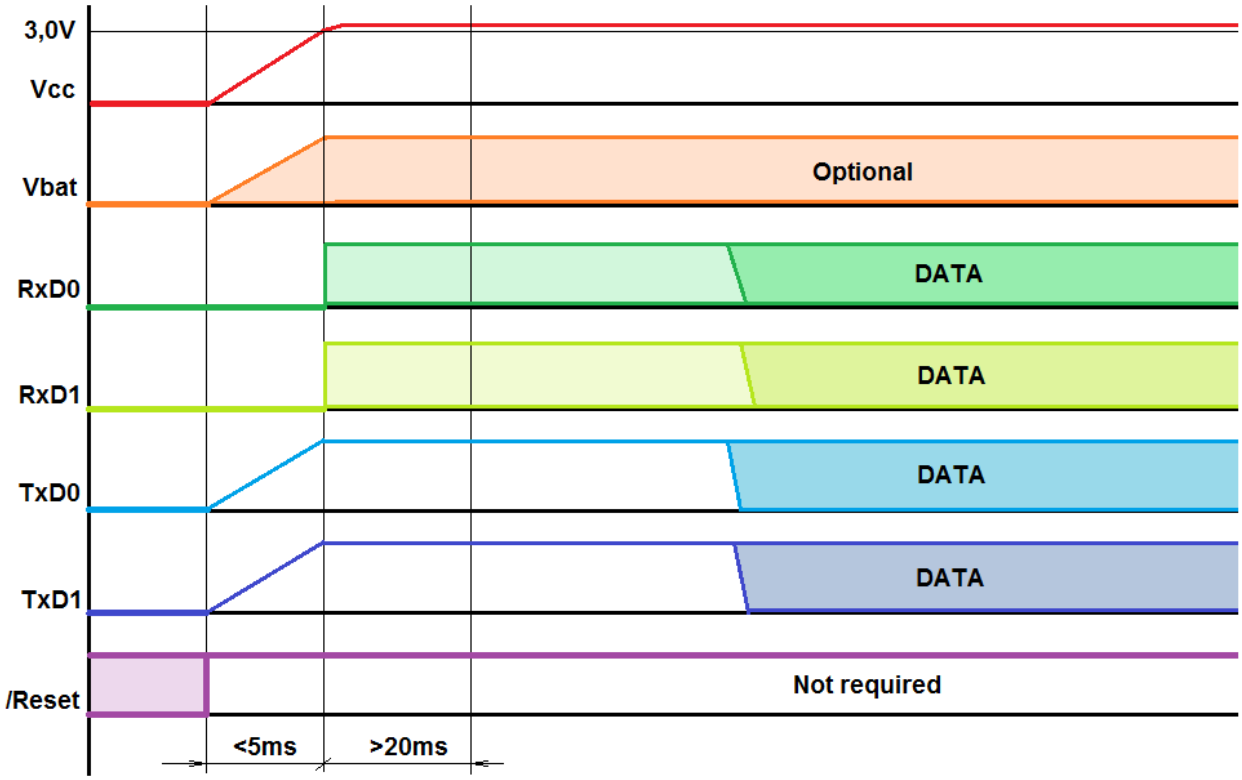

Fig. 8. The signal states and levels timing diagram at the module connection pins when the module is used without Vbat.

The antenna (active or passive) is connected to pin 21 (IN_RF). In the connecting diagram, antenna connector is designated as **J1 RF CONN**. The trace, connecting pin 21 of the Module with the antenna, must be implemented as microwave PCB line with impedance 50 Ohm.

Pins 20 and 22 (RF GND) of the module are the high-frequency ground circuit for pin 21 (designated in the diagram as "shaded" ground). The power to the active antenna for receiving of signals from satellites provided via built-in circuits of the module. The supply circuit of the active antenna protected inside of the module with a resettable fuse with trip current 100 mA. If the active antenna is used, the module power supply has to provide the relevant current.

The output signal as a sequence of NMEA messages generating via UART1 serial port (signal TX1 pin 4, signal RX1 pin 5). NMEA messages are present on this port in as default. These signals are designated in the diagram as **UART1 Tx NMEA Out** and **UART1 Rx NMEA In** respectively. Alternatively, NMEA messages and command can provided via USB in/out.

Setting of the baud rate via UART serial port, selection of GLONASS, GLONASS/GPS or GPS satellite constellations and other setups performed through sending of special NMEA messages to the module.

UART0 port signals have output to pins 1 and 2 of the Module (signal TX0 pin 2 and signal RX0 pin 1). In factory default setting, this port is designed for programming of the Module built-in flash SQI memory. Depending on the program setups of the module, this port can be designed for transferring of information about differential corrections to the Module, receiving of NMEA messages, loading of information about satellite environment, etc. These signals are not showed in the diagram.

1PPS time synchronization signal has output on pin 3. This signal can be used by the consumer's host for precise binding of the device time to UTC standard time. In the connecting diagram this signal is designated as **1PPS Out**.

GND circuit (Ground) (pins 6 and 17) must be connected to GND circuit (Ground) of the peripheral device the module is used in.

Circuits GND and RF GND actually are connected to each other inside of the module but shall be NOT connected outside of the module to avoid possible interference to Antenna signal and the sensitivity degradation. As showed on the application circuit the GND pins 22 and pins 20 connected ONLY to the Antenna connector’s Ground!

ATTENTION! Antenna input pin 21 connected internally to the 3.3 V used to powering active antenna. In case of connection to pin 21 a device with low active impedance (for example GNSS Simulator 50 Ohm matching transformer at the output) a certain Capacitor have to be used to avoid short device overheating.

Using USB as NMEA interface

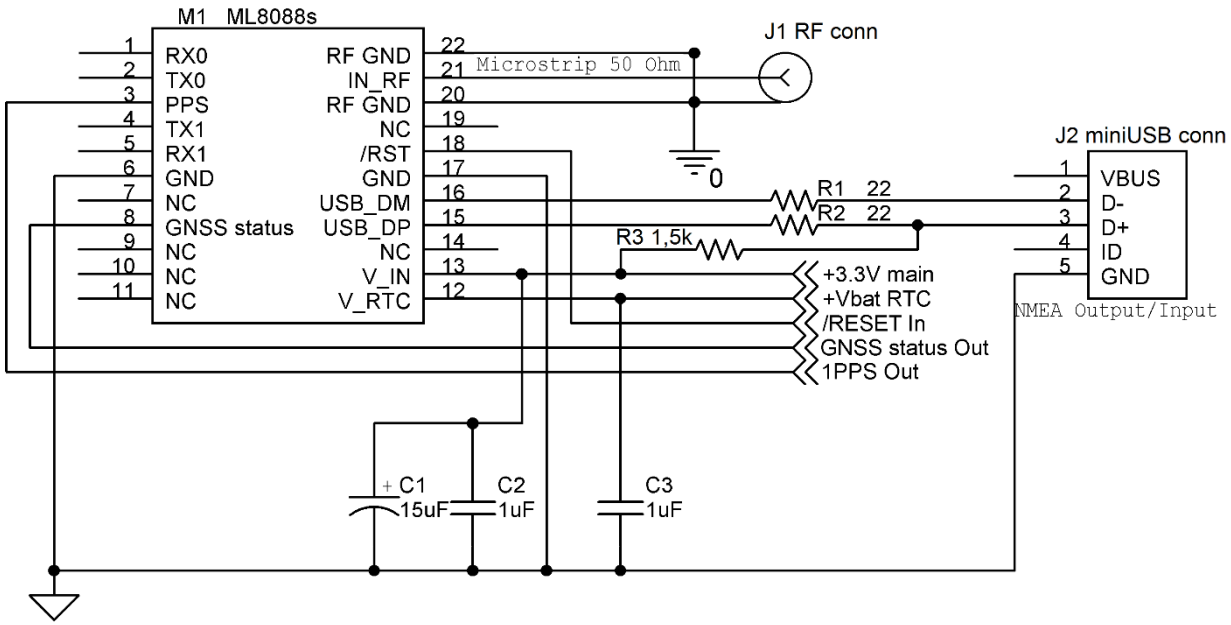

Fig.9 Typical application circuit ML8088sE using USB interface for NMEA transmission.

Figure 9 illustrate possible ML8088sE connection via USB to get NMEA data and control command send. Using this circuit please remind that NMEA data is not come through UART1 when using USB! To switch module in USB mode user must either download corresponded firmware or sending to the module special command using “Navia GLONASS+GPS” software. Connector USB J2 showed on above schematic with mini-USB pinning. Resistors R11 and R12 used to matching pin-outs of module with external USB bus, for most application a 22R can be applied.

GNSS status signal

GNSS status signal (pin 8) is designed for hardware notification of external host about the fact that the navigation task is successfully calculated (coordinates are found). If case there is no calculation of navigation task, this signal is constantly held in "log.0" state. In case of navigation task calculated successfully, the state of the signal pin 8 changes every 2 seconds from "log.0" to "log.1" and back.

GNSS status signal does not support by standard “factory default” ’s firmware. To support this signal the firmware has to be changed. Customer can order the modules with this firmware.

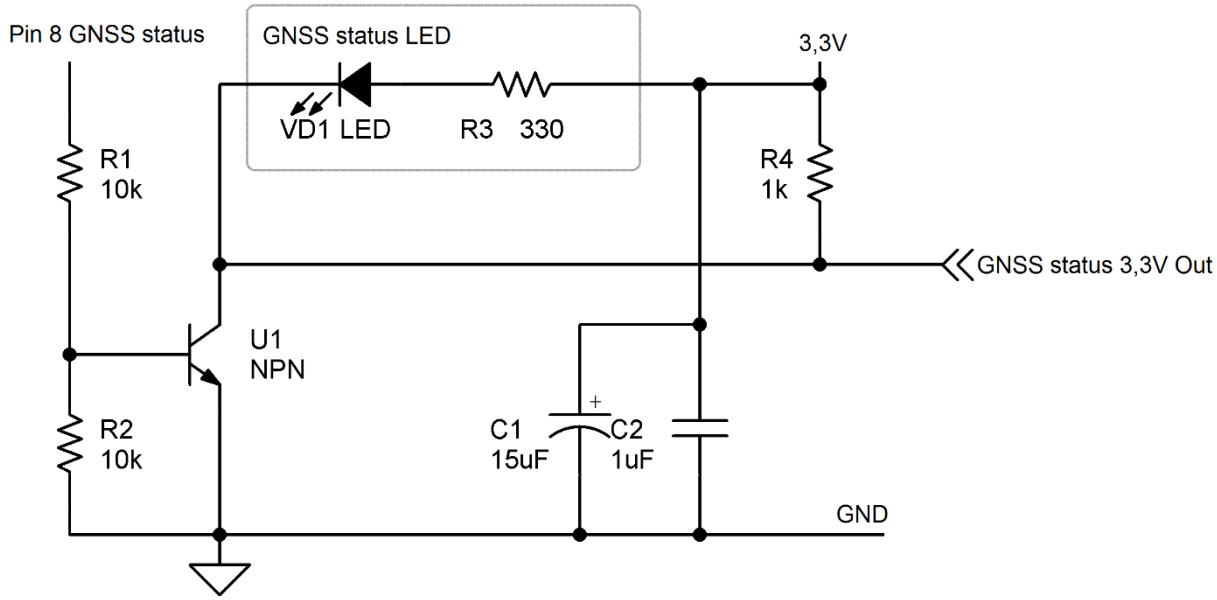

Fig.10 Typical application circuit converting output signal GNSS Status from the module to 3,3V and LED blinking status.

The GNSS status signal has amplitude 1,8V max. To match with 3,3V application a certain circuit showed on Pic. 8 can be used. In case the navigation task successfully calculated, VD1 LED showed in the schematic diagram blinking with a period of 2 seconds (i.e. slowly flashes). In addition, this signal can be sent to other elements of the device the module is used in (e.g., to the host microcontroller)

Module Command Interfaces

The Module operation command interface is performed with the using hardware features, as well as with special commands issued to the Module. The hardware features ensure hardware reset and selection of work/programming mode of functionality. For hardware reset of the Module, a low logic level pulse is sent to /RESET input. The parameters of the pulse explained above on Fig.7. For selection of work/programming mode of functioning, relevant logical levels applied to connection pins TX0 and TX1 at the moment of the Module hardware reset pulse generation. In order to ensure functioning of the Module in working mode, hold connection pins TX0 and TX1 in Input state or high input impedance (Z state) at the moment of the Module hardware reset pulse generation or for at least 20 milliseconds following its completion. In order to switch the Module into programming mode, hold TX0 connection pin in input state or high input impedance (Z state) and TX1 connection pin – in 0 (low logical level) state at the moment of the Module hardware reset pulse generation or for at least 20 milliseconds following its completion.

A set of special commands with NMEA-like format is designed for control of program modes and parameters of the Module. The commands are issued to RX1 input or USB. The description of the commands is provided in document The Set of NMEA Commands of ML8088s Module.pdf (available for developers upon request).

Switching GNSS constellations at run-time

Module can be switched in to 3 modes:

1. Combine GLONASS + GPS reception – give most excellent accuracy and reception stability

2. GLONASS reception only

3. GPS reception only

Switching between modes can be done in two different ways:

1. “on the fly” by using the follow special command:

- $PSTMSETCONSTMASK,2 – for GLONASS only

- $PSTMSETCONSTMASK,1 – for GPS only

- $PSTMSETCONSTMASK,3 – for GLONASS+GPS mode

This type of standard switch is most fast and do not required hardware reset. But after power on the standard type will be reset to default!

2. by sending commands type $PSTMxxx to NMEA port with following hardware RESET by applying low level pulse to pin 18 (/RES) module. Ignore this point can be a cause of incorrect module working or halting module.

Below please find a gropes of certain commands:

1. Combine mode:

$PSTMSETPAR,1200,00630000,1*

$PSTMSAVEPAR

2. GLONASS Only:

$PSTMSETPAR,1200,00410000,2*

$PSTMSETPAR,1200,00220000,1* 16

$PSTMSAVEPAR

3. GPS Only:

$PSTMSETPAR,1200,00220000,2*

$PSTMSETPAR,1200,00410000,1*

$PSTMSAVEPAR

This type of mode switching modify the NVM configuration parameters therefore after power on or Reset stay without change!

Soldering

ML8088sE modules are designed as the products intended for installation (montage) on PCB of the user' device (OEM product).

Modules are designed for installation like the components suitable for both on of the automated assembling (reflow soldering) and for manual mounting and the soldering by both lead and lead-free soldering pastes and/or solders.

At manual assembling it is necessary to make the soldering by the well-grounded soldering station (iron) heated up to temperature 240 °C, duration of a soldering of one pin should not exceed 3 seconds. The interval between soldering of the next pins has to be not less than 2 seconds, between repeated soldering of the same pin – not less than 30 seconds.

Fig. 16 shows the temperature profile of the reflow process of s for the lead-free solder pastes at the automated assembling lines. Speed of cooling should not exceed 3 °C a second. The schedule of a temperature profile in case of use the lead solder pastes will be similar on appearance, but for a choice of values of temperature and time of each of stages it is necessary to be guided by documentation of the corresponding paste' manufacturers.

At double-sided assembling of user PCB' s have to be installed on that side which is mounted and soldered in final pass via the reflow oven**. It is strictly prohibited to put customer's PCB with installed module to the reflow solder oven in a position of "module face down", since the metal shields installed on the module can drop off to the places of the soldering and fall in the oven.** When reading above-mentioned remark is very important to understand the difference between assembling (mount) and reflow soldering process. There is no matter how you mount module on your PCB – face up or face down. It is very important how you put it to the reflow. Reflow must be always "face up"!!!

At an unsoldering process of s from the PCB it is not allowed to heat them to temperature exceeding 250 °C, the time spent at a temperature above 230 °C should not exceed 40 seconds. In case of any overheating the s can be broken.

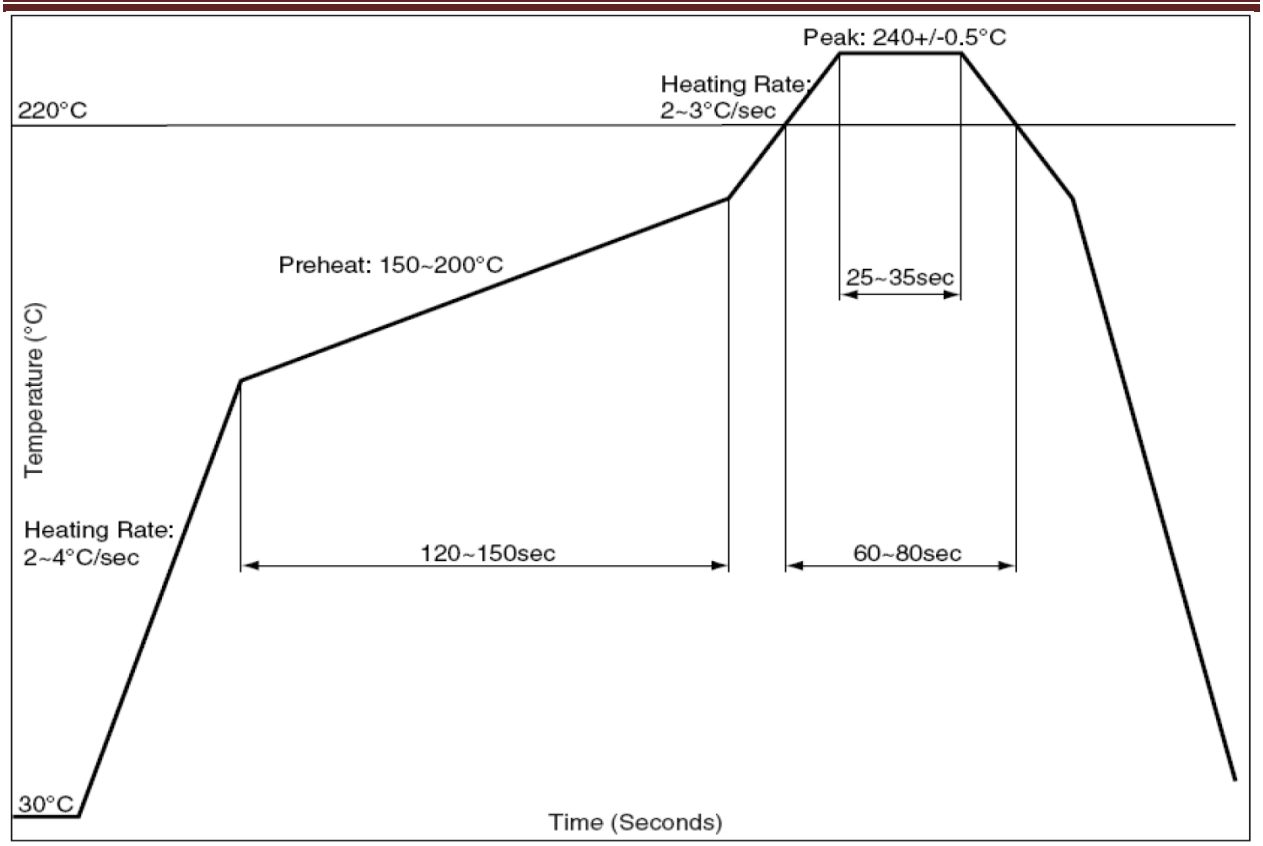

Fig. 11. A temperature profile at the soldering of s lead-free pastes.

The products unmounted with obvious sights of overheat and/or mechanical damages are not subject to repair or replacement within guarantee certificates.

Also the unmounted products which state doesn't allow to make the analysis of their working capacity (traces or contact pins lift-off, shift of components or the metal shield, the surplus of solder on pins and/or pins which aren't allowing to insert a product into the test equipment) aren't subject to repair or replacement within guarantee certificates.

Maintenance

The Module does not require special types of maintenance.

Repairing procedure

The Module does not require any permanent repair, provided that the rules of operation set forth in this Operations Manual, and requirements for operation, storage and transportation conditions are observed. If failures occur, the Module must be returned to the manufacturer for subsequent repair.

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Transportation and Storage

Packed Module units can be transported by all transportation vehicles over distances up to 20,000 km without speed limitation at temperatures from -40°C to +85°C, subject to protection of Module units from direct atmospheric exposure and mechanical damage according to the rules that comply with requirements of GOST 23088. The storage life of a packed Module in heated storage facilities with controlled ambient temperature from + 5 to + 35°C and relative air humidity up to 80% at + 25°C temperature is 10 ears minimum.

Module Packaging Specification

The Module ML8088sE can be packed in two packaging types – tray and tape.

Tray package

Trays for ML8088sE packaging are made from ESD protecting material.

Each tray contains 40pcs of s ML8088sE.

Tray dimensions: 275x181x6.5mm

One small carton contains 440pcs ML8088sE packed into 11 trays and 1 empty tray to close.

The whole packet of trays will be vacuumed and sealed inside the foil bag with

- desiccant bag
- humidity indicator card.

Small carton dimensions: 300x205x60mm

Eight sealed small cartons packed into one big carton. Big carton contains 3520pcs ML8088sE.

Big carton dimensions: 430x340x290mm

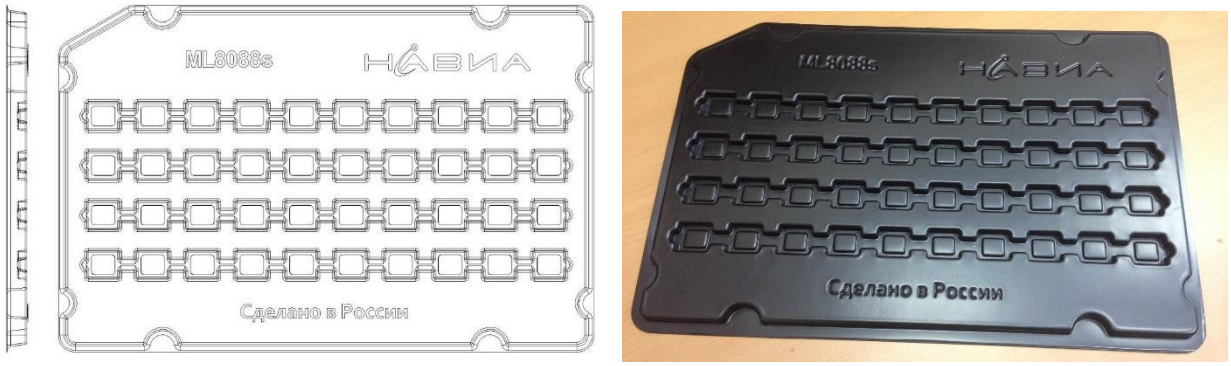


Fig.12 Empty tray.

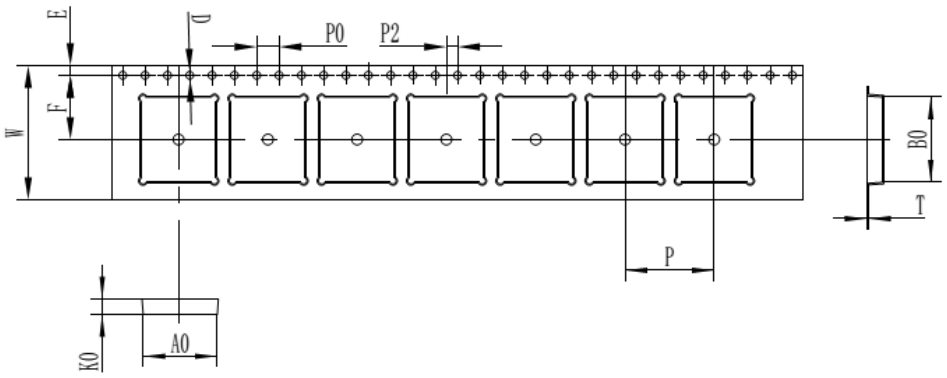
Fig.13 Tray with several s ML8088sE

Fig.14 Whole packet of trays

Fig.15 Packet of trays in small carton

Fig.16 Vacuumed and sealed small carton.

Tape Dimension:



ITEM	W	A0	B0	K0	E	F	P	P0	P2	D	T
DIM	24.0+0.1	13.30±0.1	15.25±0.1	2.79±0.1	1.75±0.1	11.5±0.1	16.00±0.1	4.00±0.1	2.00±0.1	Ø1.5+0.1	0.3±0.05

Fig.17 Tape dimensions

Remarks on the dimensions:

1. Tolerance for even 10 capsules is ±0.2mm
2. Bending of the reel per every 100mm shall not exceed 1mm
3. Tolerance of AO,BO for the internal measurement is ±0.3mm.
4. The dimension is compliant to international standard EIA-418-3
5. All un-specified dimension with tolerance ±0.2mm

Braiding instruction

Orientation:

The module shall follow braiding instruction EIA-481-2-A “the regulations on Embossed Carrier Taping of Surface Mount Components for Automatic Handling”

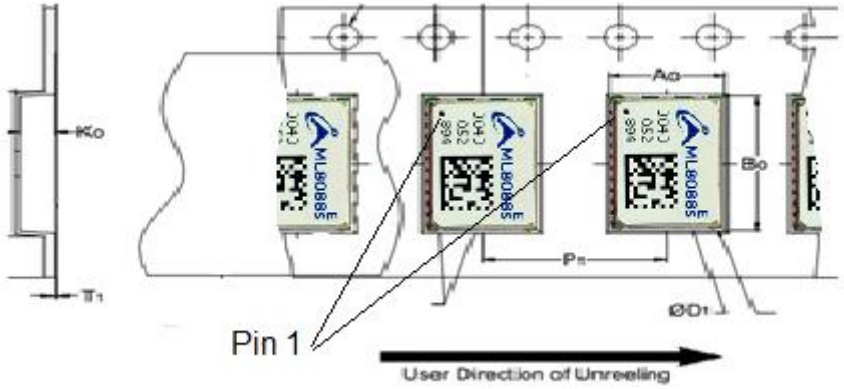


Fig.18 Pin 1 orientation

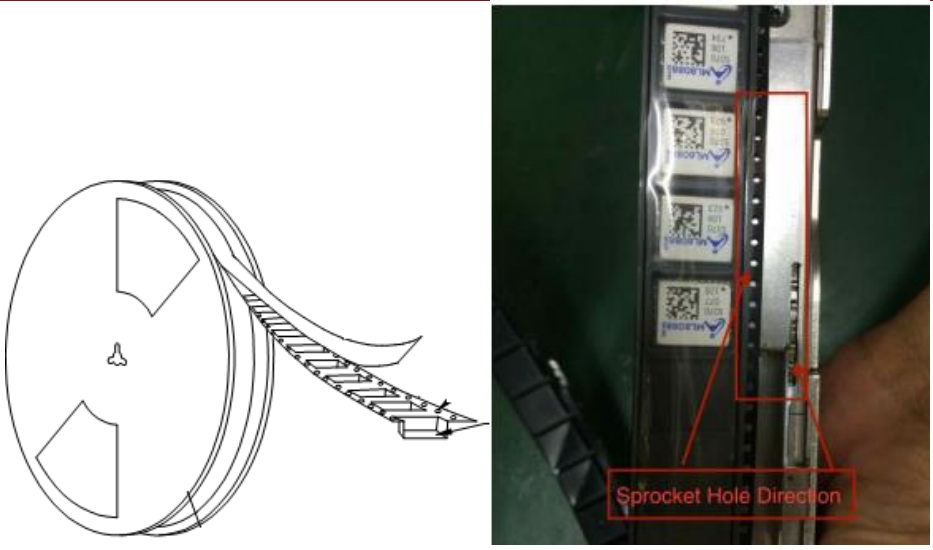


Fig.19 Using of tape

Blank pockets

At the beginning of the tape: 20 empty capsule
At the end of the tape: 20 empty capsule

Package Content

The tape and reel will be vacuumed and sealed inside the foil bag with

- desiccant bag
- humidity indicator card.

Fig.20 Package view

Label on the package

The label has Dimensions: 80mm x 50mm

Fig.21 Label format

Labels shall be stick on the reel as well as on the foil bag.

Fig.22 Label locations

Carton Information

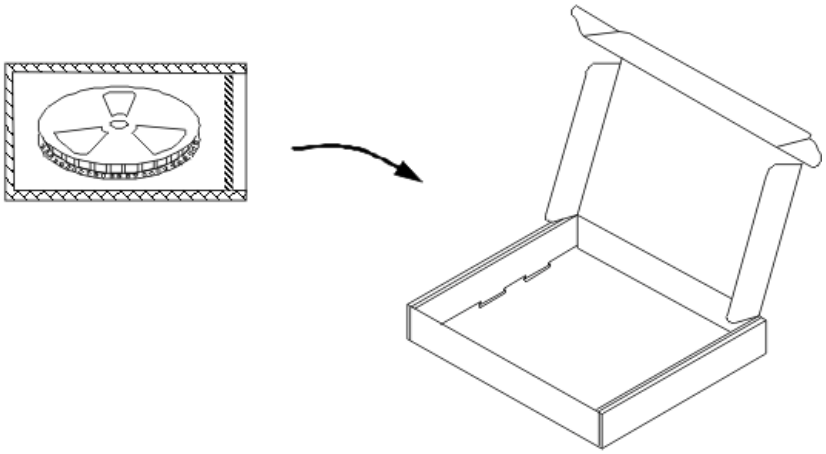


Fig.23 Small carton box

Module per each reel: 1000pcs

Each reel will be placed in a box

Box dimensions: 360x345x60mm 5 boxes (i.e. 5000pcs) will be placed in a big carton

Big carton dimensions: 340x400x360mm

Carton Shipmark:

P/N# ML8088S_E Package：Tape and Reel Delivery date: CTN#1/up