Navigation device (receiver)
NAVIA GNSS - KL 3333
Operation manual 2.0

GPS navigation device
Of global navigation
Satellite Systems

GLONASS, GPS, GALILEO

NAVIA KL3333

Operation manual

Version 2.0

Saint Petersburg
2015

Table of contents

Summary

This document is intended for users and consumers of global navigation satellite system (GLONASS, GPS, GALILEO) device (thereafter receiver or module) - KL3333 that is multi-channel navigation GLONASS / GPS / GALILEO receiver, and contains a general description, specifications, instructions for use, and rules of operation, transportation and storage.

History of changes

Version Number	Date	Description
1.0	January 201 5	Initial document version
1.1	March 2015	A note of the signal PPS added
2.0	March 2015	The name of the product changed

List of abbreviations

Below is a list of abbreviations:

SS: spacecraft (Space Satellite)
SC Sattelite Constellation
NT: navigation task
PC: Personal Computer
SW: software
SP: standard precision = **TP:** reduced accuracy (obsolete designation)
NMEA: full name **«NMEA 0183** ', text communication protocol sea (usually navigational) equipment between an **(National Marine Electronics Association).**

General information

GPS navigation device consumers of global navigation satellite and a system (GNSS), GLONASS, GPS, GALILEO NAVIA GNSS - KL 3333 (hereinafter - navigation device) is designed to measurement of current navigation parameters and definitions based on these data on the current time and location of the receiver (including geographical coordinates, altitude and velocity).

Navigation equipment of NAVIA GNSS KL3333 is a PCB equipped with navigation receiver KL3333 that is mounted on the board, supplied of matching circuits and connectors for connection to the user equipment.

Exterior of the navigation equipment of NAVIA GNSS KL3333 is shown in Figure 1.

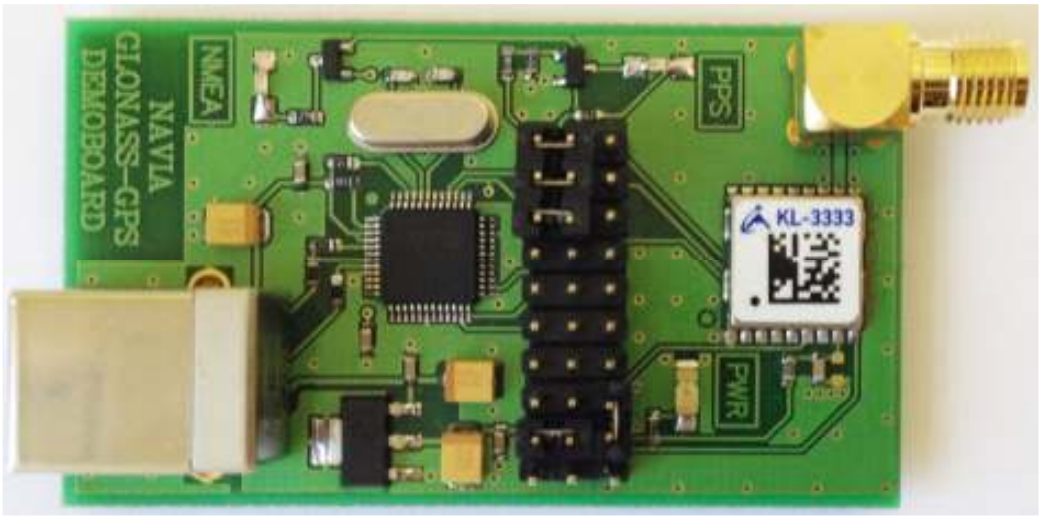

Fig. 1. The exterior of the navigation equipment of NAVIA GNSS KL3333 (not to scale 1:1).

The basis of the navigation equipment is the navigation device of KL3333 (hereinafter - receiver or module) that is designed to calculate the current value of geographical coordinates (position), the time, velocity (speed) in real time in both autonomous and differential modes, forming second timestamp and to communicate with external devices over a serial port (UART). The principle of operation of the receiver is based on a parallel reception and processing of 33 measuring channels of signals from navigation satellites. The receiver uses GLONASS in the frequency range L1 (T-code), GPS on the frequency L1 (C/A code) and GALILEO at a frequency of E1. Results of the solution (NT) are given in the format of NMEA messages.

The sticker shows the abbreviated name of the receiver NAVIA GNSS KL3333 – “KL-3333”, accepted means of identifying are KL -3333, KL 3333.

The user documentation is recommended to use the full name either of the receiver NAVIA GNSS - KL 3333, or in abbreviated form KL 3333.

The rest of this documentation for the receiver NAVIA GNSS - KL3333 applies abbreviation KL3333.

Exterior of the receiver is shown in Fig. 2 and 3.

Fig. 2. The exterior of the navigation receiver NAVIA GNSS - KL 3333 (Not to scale 1:1)

Fig. 3. The exterior of the receiver NAVIA GNSS - KL 3333 top and bottom view (not in scale 1:1).

The receiver of KL3333 is based on a modern specialized chipset of MT 3333, representing the family of so-called "systems on a chip", manufactured by Mediatek of the world leader in the production of chips for navigation and multimedia systems.

Receiver possesses high sensitivity; low power consumption and low start time.

The receiver has 99 channel for acquisition (capture) and 33 channels to track the satellite signals that allows simultaneous search of satellite signals groups of GLONASS and GPS.

The receiver lets you apply for a primary search of satellite signals specially prepared information stored in the receiver's memory that reduces the time of cold start. Moreover, that it is essential to make a cold start in a weak signal from satellites. Specific information can be prepared by external sources (and transferred to the receiver through the communication channels), and independently by the receiver. In the latter case, it is not required to obtain any additional information from external sources.

The receiver has a built-in noise suppression that allows it to operate in a difficult jamming environment.

The operation of the receiver is carried out by means of special NMEA-like commands.

The receiver is equipped with a serial port of the UART.

To learn more about the operation of the receiver of KL3333 may meet the "KL3333 demo board".

KL3333 demo board is a complete analogue of **the GPS navigation equipment of NAVIA GNSS KL 3333** shown in Figure 1. Description of the board is provided in the "demo

board KL 3333 RE v 1 _0. pdf» document. The board can be connected to a PC or other equipment for the analysis of the receiver.

Note. The receivers KL3333 with the data code (the first three digits of the serial number) equal 503 do not guarantee the properly work of the timestamp signal (PPS pulse per second).

Ordering Information

The GPS navigation equipment of consumers of global navigation satellite system (GNSS) GLONASS, GPS, GALILEO NAVIA GNSS – KL3333:

KL3333 - DEMO

The demonstration board of the navigation receiver NAVIA GNSS - KL 3333:

KL3333 - DEMO

The navigation device (receiver) NAVIA GNSS - KL 3333:

KL 3333

Receiver NAVIA GNSS - KL 3333 Specifications

Parameter		Value
The number of tracking channels		33
The number of capture (acquisition) channels		99
GPS frequency band, MHz		1575.42 ± 0.5
GLONASS frequency band, MHz		1597.5 …1605.9
The coordinates tolerance, m (-130 dBm, 24 hour static, 50%)		3 in plan 4 by height
The planned velocity calculation tolerance, not more, m / s		0.05
Tolerance of 1PPS distribution (at the gauss 70% distribution level) to time scales GPS, GLONASS, UTC, UTC (SU), average, ns		± 20
Mean time to the first position measurement (TFPF), at signal level –130 dBm, s		28 cold start 26 warm start 1 hot start 1 re-acquisition
Detection sensitivity, not worse, dBm		-148 cold start -148 warm start -160 hot start
Satellite positioning prediction, days		7, 15, 30 - from an external data source
The tracking sensitivity, NT is not solved, dBm		-165
The tracking sensitivity, NT is solved, dBm		-163 in statics -158 in dynamics
System noise suppression		12-frequency built-in suppressor
Output data updating rate, seconds		0.2 ... 255
Dynamics, no more	acceleration, g the rate of change of acceleration, g / c	3 1
Maximun velocity (speed), m / s		515
Maximum height, m		18000
Microprocessor core		ARM 7
Communication interfaces		UART 2.8 LVCMOS
1 PPS signal	level duration, ms	2.8V LVCMOS 1 by default (configurable)
Main voltage supply, V		2.8 ... 4.2
Backup voltage supply, V		2.3 ... 4.2
The sensitivity level to ESD of IEC 61000-4-2	shield other pins	3 (8 kV air discharge) 1 (2 kV air discharge)
Current consumption from +3.3V, typical, mA		Acquisition 34(GLONASS + GPS) Acquisition 24 (GPS) Tracking 26 (GLONASS + GPS) Tracking 20 (GPS)
Current consumption from the external backup battery,typical, uA		7
Dimensions (length x width x height), mm ³		10.1 x 9.7 x 2.0
Weight, g		1.0
Operating temperature range, ° C		-40 ... + 85

Technical and metrological characteristics

of the GPS navigation equipment

Feature name	Feature Value
	KL3333
Frequency band, MHz	L1 – 1575.42 ± 0.5 (GPS) 1597.5…1605.9 (GLONASS)
Number of Channels	33 tracking 99 capture (acquisition)
Maximum permissible instrumental error of coordinates calculation, in plan, m	± 3
Maximum permissible instrumental error of velocity (at speeds up to 515 m/s), m / s	± 0.05
Supporting differential correction mode, signal sources	SBAS (WAAS, EGNOS)
Coordinate Systems (Geodetic Systems)	WGS-84, TOKYO MEAN, OSGB
The format of the navigation messages	NMEA 0183 v4.1
Message sets	GPGGA, GNGLL, GNGSA, GPGSV, GLGSV, GNRMC, GPVTG, GPZDA
Operating temperature range, ° C	-40 to 85
Peak shock acceleration of multiple mechanical shocks during of 10 ms, m / s ^{2}	150
The amplitude of the vibration acceleration in the range of hours and frequency from 20 Hz to 1000 Hz, m / s ^{2}	100
Voltage supply, V: external interior; basic; backup	5 (USB) 3.3 2.8 to 4.2 2.6 to 4.2
Typical current, consumed by the circuit from an external power supply (5V voltage), mA	50 (capture) 36 (tracking)
Connectors for antenna interface and power supply	 SMA-JR USB-B
Overall dimensions (length x width x height of the one), mm, not more:	60 x 35 x12 - without connectors 75 x 35 x18 - with connectors
Weight, g, max	28

Overall and mounting dimensions of the receiver NAVIA GNSS - KL3333

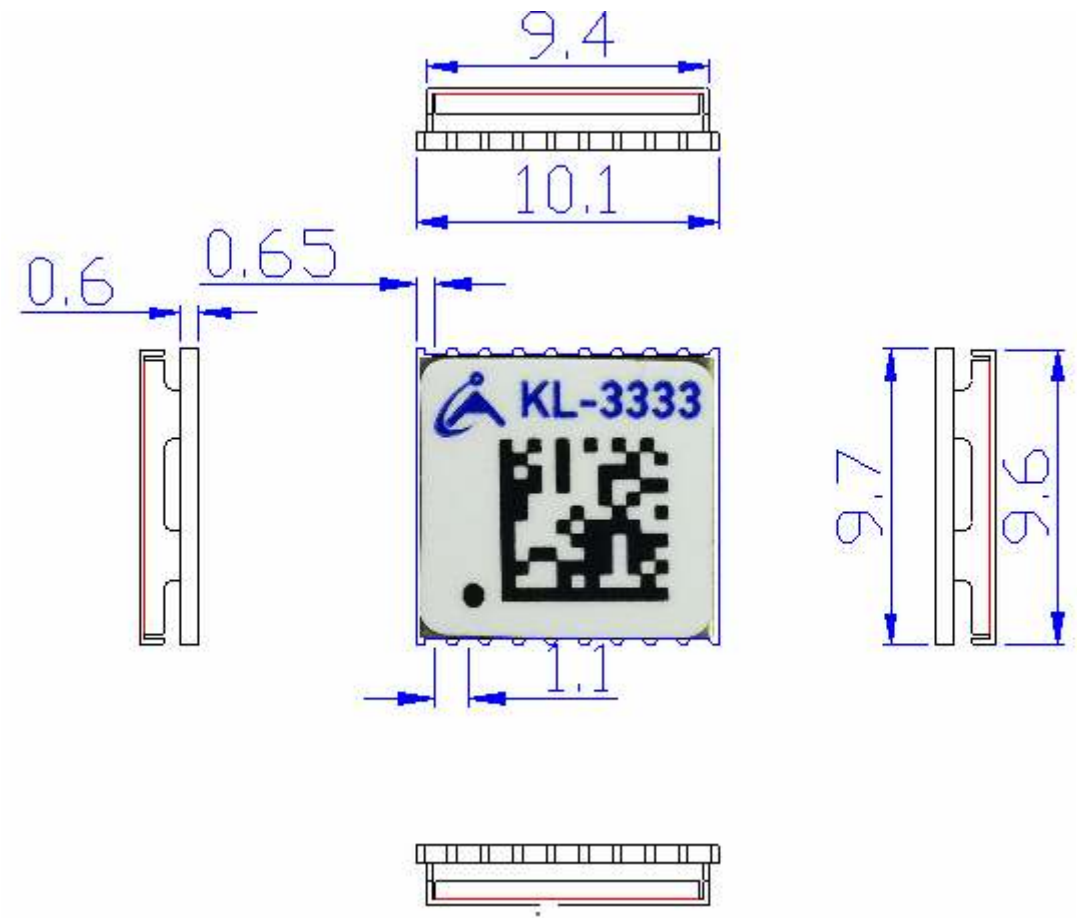

Fig. 4. The overall and mounting dimensions of the receiver KL3333.The first terminal is marked with the black point on the label (bottom left corner).

Recommended footprint for the receiver NAVIA - GNSS KL 3333

The recommended footprint for the KL3333 on the PCB is shown in Fig. 5. All dimensions: in millimeters.

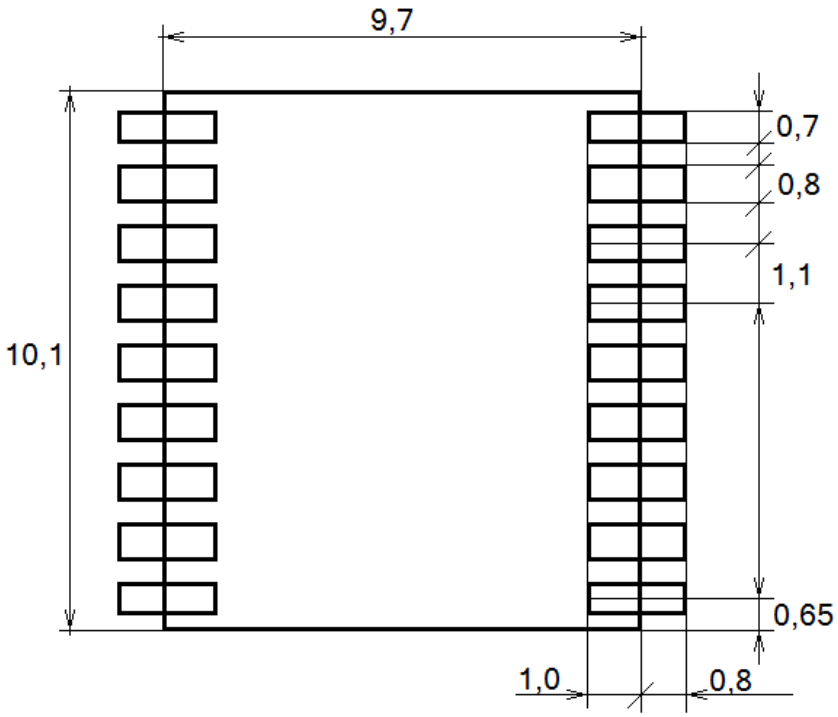

Fig. 5. The recommended footprint for the installation of the receiver KL3333.

Any signal circuits are not accepted under the receiver! Recommended free space below the module to pour by the ground GND.

Pin assignment of the receiver NAVIA GNSS - KL3333

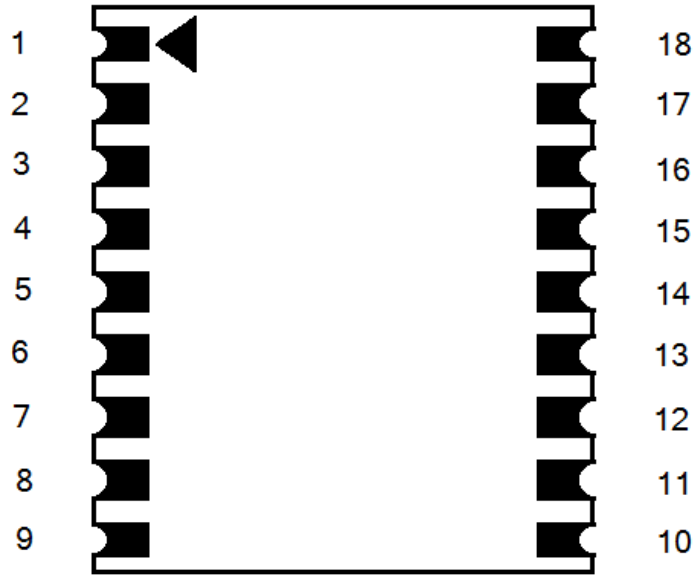

Fig. 6. The location and numbering of terminals (pads pattern) receiver KL3333. Top view. Pin numbers and markings of the first output displays conventional.

Signal Description	Type	Pin Number	Designation
Antenna input	Analog	11	IN _ RF
Ground of high frequency part	Power	10, 12	RF GND
Power supply +3.3V	Power	8	V_IN
Backup battery power supply	Power	6	V_RTC
Total hours of digital and STI	Power	1	GND
UART Output (NMEA)	Out	2	TX
UART Input (NMEA)	In	3	RX
Timestamp signal (1 pulse/sec)	Out	4	PPS
Hard Reset	In	9	/ Reset
Not Connected	---	5, 7, 13, 14, 15, 16, 17, 18	NC

Note. The receivers KL3333 with data code (the first three digits of the serial number) equal 503 do not guarantee the proper work of PPS.

Typical connection of the receiver KL3333

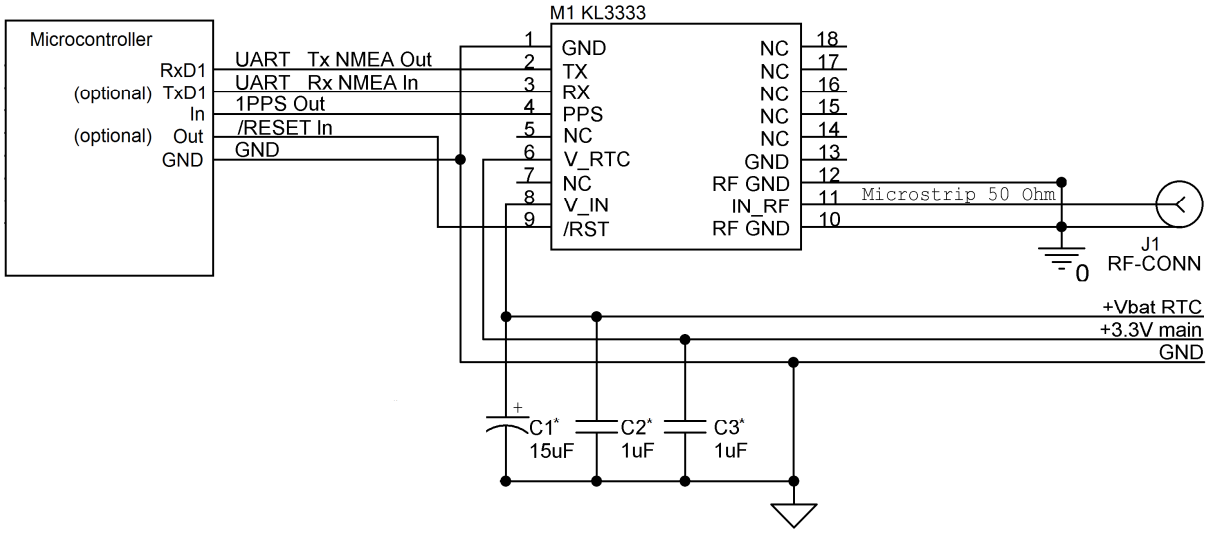

Fig. 7. Typical receiver KL3333 circuit with NMEA data transferring by the UART.

Figure 7 shows a typical circuit of the receiver KL3333 with NMEA data via UART.

The power supply V_{cc} = 2.8...4.2 V connected to pad 8 (V _ IN). The circuit is designated **+3.3V main** on the wiring diagram.

The backup battery voltage in the range of V_{bat} = 2.0…4.2 V should be applied to the contact pad 6 (V_RTC). The circuit is designated + **Vbat RTC** on the wiring diagram. It is recommended to maintain a continuous Vbat for the operation of the internal clock and memory module.

An active or passive antenna is connected to pin 11 (IN _ RF). The antenna connector is designated **J1** on the wiring diagram**.** A conductor connecting the contact 11 and the receiver antenna should be made as a microstrip line with impedance of 50 Ohms. Pins 10 and 12 (RF GND) of the receiver is a high-frequency "ground" circuit concerning pin 11 (in the scheme conventionally indicated by the symbol "hatched" of the earth). The antenna power is suppied through the receiver. In the case of an active antenna the main power supply should provide appropriate load characteristics.

Signal / RST (Pin 9) is to restart (reset) the firmware of the receiver. If the user device does not use this signal, then the output 9 should not be connected to any circuit.

The output signal is provided as a sequence of NMEA with the serial port UART (pad 2 is Tx signal, pad 3 is the Rx signal). NMEA messages are present at this port NMEA messages by the factory default. These signals are designated in the diagram **UART Tx NMEA Out** and **UART Rx NMEA In** respectively.

Setting the baud rate of the serial port UART, choice the satellites groups from GLONASS, GLONASS / GPS or GPS, and other settings are made by the special NMEA-like messages.

The timestamp signal PPS put into contact 4. This signal can be used for consumer equipment for the exact binding instrument time to standard UTC time. This signal is designated the output **1PPS Out** in the wiring diagram.

The general GND circuit (pin 1) must be connected to general GND circuit **GND** of the consumer device that uses the receiver.

GND and RF GND (in the diagram designated "hatched ground") are combined within the receiver and does not need to have communication with each other outside of the receiver.

Moreover, in order to avoid reducing the quality of the signals from the antenna recommended not combining these signals on the PCB.

Warning! The serial decoupling capacitor should be placed in the interruption of the microstrip line when the receiver signal source has a low DC output impedance. Otherwise it's possible current overloading of the signal source and / or overheating of the receiver that can result in a shorter lifespan.

Note. The receivers KL3333 with data code (the first three digits of the serial number) equal 503 do not guarantee the proper work of PPS.

Energy-saving modes

The most important feature of navigation modules assembled on the base of chipset of Mediatek MT3333 is their cost-effectiveness of power consumption. So, at the end of 2014 MT3333 chipset remains the most economical and flexible in terms of power consumption of all commercially produced chipsets. Accordingly, the modules are based on this chipset are leaders in energy-efficiency.

Further in the text **<*CS>** means the message checksum prefixed ***.** This is followed by symbols **<CR><LF>,** command completion.

In the examples, the fragment **<*CS>** not indicated to improve readability.

Standby Mode

Power saving mode with current consumption not exceeding 350 uA. The receiver enters the mode by the command and leaves the mode by the reception of any byte.

$ PMTK161, 0 <* CS>

Entry Standby mode command:

$ PMTK161,0

The answer to the command:

$ PMTK001,161,3

Standby exit command:

Any byte

Backup Mode

Power saving mode with current consumption not exceeding 25 uA. The receiver enters the mode by the command and leaves the mode after a specified time.

$ PMTK 291, 7, 0, RTCWakeup, 1<*CS>

The maximum **RTCWakeup** is 518,400,000 milliseconds (6 days)

Entry Backup mode command:

$ PMTK291,7,0,10000,1

The answer to the command:

$ PMTK001,291,3

Backup exit command:

Not required. Output through 10000 ms (10 s).

Periodic activate mode (Periodic)

Power-saving mode with a current consumption not exceeding 350 uA or 25 uA (depending on settings). This mode is expanded from Standby and Backup modes to auto repeat cycles mode.

PMTK223, SV, SNR, Extension Threshold, Extension Gap

SV = 1. The number of satellites for updating the ephemeris (1 ... 4)

SNR = 30. Value signal - noise ratio for the start of the update ephemeris (25 ... 30)

Extension threshold = 180000 msec. Extension of operation time to update the ephemeris (40000…180000)

Extension gap = 60,000 msec. The time between two consecutive renewals ephemeris (0 ... 3600000)

PMTK225, Type, Run Time, Sleep Time, Second Run Time, Second Sleep Time

Type = 1 (1 for «periodic backup»; 2 for «periodic standby»)

'0': Standard mode
'1': Periodic backup mode
'2': Periodic standby mode
'4': Perpetual backup mode (continuous)
'8': AlwaysLocateTM standby mode
'9': AlwaysLocateTM backup mode

Run time = 3,000 msec. Working time in the presence of the navigation solution (NT).
'0': Disabled
≥1000ms: Enabled
Valid values: 1000 ... 2,047,000ms

Sleep time = 12,000 ms. Sleep time in the presence of the navigation solution (NT).
'0': Disabled
≥1000ms: Enabled
Valid values: 1000 ... 2047 000ms

Second run time = 18,000 ms. Opening hours in the absence of the navigation solution (NT).
'0': Disabled
≥1000ms: Enabled
Valid values: 1000 ... 2047 000ms

Must be greater than **Run time**

Second sleep time = 72,000 ms. Working time in the absence of the navigation solution (NT).
'0': Disabled
≥1000ms: Enabled
Valid values: 1000 ... 2047 000ms

Must be greater than **Sleep time**

If the sleep time is set greater than the 2047 s, the receiver will not be turned into a reduced power state.

Before turning or changing settings is recommended to give a command to reset the periodic mode of "Standard mode".

PMTK225,0

Examples:

Periodic modes

Periodic Backup Mode

PMTK225,0
PMTK223,1,25,180000,60000
PMTK225,1,3000,12000,18000,72000

Periodic Standby Mode

PMTK225,0
PMTK223,1,25,180000,60000
PMTK225,2,3000,12000,18000,72000

AlwaysLocate Standby Mode

PMTK225,0
PMTK225,8

AlwaysLocate Backup Mode

PMTK225,0
PMTK225,9

The receiver works in a differential mode.

Differential mode is for a significant increasing the accuracy of location. This increased accuracy is achieved by corrections transmitted by SBAS satellites (WAAS, EGNOS, MSAS, GAGAN):

- turn on the mode of searching of the differential correction satellites:

$ PMTK313,1 * 2E <CR><LF>

- turn on «SBAS» as a source of correction information in the receiver:

$ PMTK301,1 * 2D <CR><LF>

- ensure that the receiver takes into account the correction signal

When the receiver is in differential mode in the $GPGGA message GPSQual field will have a value of 2.

Management of the receiver

The operation of the receiver is carried out both by means of hardware and by means of special commands to the receiver.

The hardware restart (reset) signal supplied to the special input / RST turns the firmware of the receiver to its original state. At the time of power on, this command is generated automatically by the integrated receiver nodes. However the user may instruct the hardware restart at the right time for him.

There is a special set of NMEA–like commands to manage the program mode and parameters of the receiver. Commands are input to the Rx pin. Description of commands is given in the document "Set NMEA command of KL3333 and SL3333 receiver. pdf» (current version available to developers upon request).

Installation

The receivers NAVIA GNSS - KL 3333 developed as products intended for installation on board the target device (OEM product).

The receiver is designed for installation as components of both the automated assembly lines, and for manual mounting and soldering both leaded and lead-free solder paste and/or solders.

In the manual installation must be carried out using a grounded soldering iron with tip heated to a temperature no higher than 240 °C. The duration of contact of the receiver terminal should not exceed 3 seconds. The interval between adjacent terminals must be at least 2 seconds between repeated rations to the same conclusion - at least 30 seconds.

There is the temperature profile in the case of using lead-free solder pastes during automated installation in Fig. 16. The cooling rate should not exceed 3 ° C per second. Schedule thermoprofile in the case of leaded pastes will be similar in appearance, but to select the temperature and time of each stage should be guided by the documentation of manufacturers for the respective pastes.

With bilateral mounting the receiver board must be installed on the other side, which is mounted and soldered in the final pass through the reflow oven, as otherwise the metal screens mounted on the receiver board can break away from the soldering and fall inside the oven.

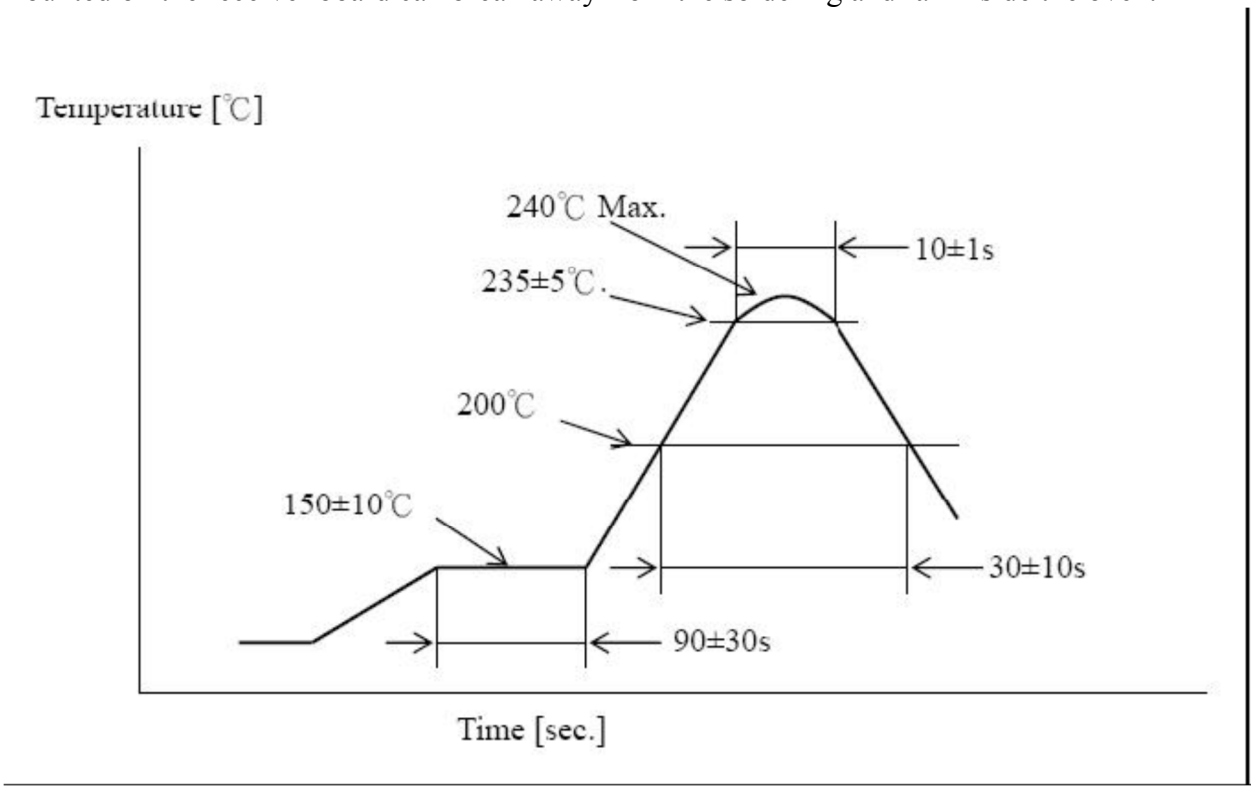

Fig. 16. The temperature profile for soldering the receivers using leaded-free pastes.

When dismantling (desoldering) the receivers from the final product PCB are not allowed to heat them to a temperature exceeding 250 °C. Withal, residence time at temperatures above 230 °C should not exceed 40 seconds. In case of overheating, operation dismantled receivers can be broken.

Products dismantled with clear signs of overheating and/or mechanical damage cannot be repaired or replaced under warranty.

Also, do not be repaired or replaced under warranty dismantled units whose condition does not allow for analysis of their performance (peel of tracks or pads, offset of screen or components, excess solder on the pads and/or terminals do not allow to insert the product in the test equipment).

ESD protection

GPS navigation device - KL3333 in the form of boards, and as a navigational device's reception (receiver) NAVIA GNSS - KL3333 products are sensitive to electrostatic discharge.

Before using the product you should carefully review the requirements for protection against electrostatic discharge!

Navigating equipment and receivers NAVIA GNSS - KL3333 equipped with protection circuits against electrostatic discharges, but non-compliance with the requirements for working with ESD -sensitive products can be generated voltage exceeds the capacity of the protective circuits. It should be borne in mind that the voltage of static electricity depends strongly on the relative humidity (% RH), and materials with which the worker contacts.

Approximate values of static electricity generated

	10-25% RH	65-90% RH
• The voltage	**10-25% RH**	**65-90% RH**
• Stroke the floor covered		
- Vinyl tile	**6,000 V**	100 V
- Carpets or carpeting	**35,000 V**	1,500 V
- Conventional linoleum	**12,000 V**	250 V
- Antistatic linoleum	100 V (max)	20 V (max)
• An employee at the table		
- Standard covers	**6000 V**	100 V
- Antistatic coating	50 V (max)	10 V (max)
• A chair with nylon seat	**18,000 V**	1,500 V
• Plastic bag taken from the table	**20,000 V**	1,200 V

Red marked voltage values exceed the capabilities of ESD protection products on the air breakdown on the screen of the receiver, **brown** - for other conclusions.

If there is no galvanic contact between the local ground (for example, the surface of the desktop, instrumentation, etc.) and circuit ground (GND) of PCB with mounted receiver, the first action in the work with the board to be providing such contact. It is forbidden to use the receivers with ungrounded equipment and/or devices.

Before connecting the antenna to the receiver should ensure that there is the connection of the grounding terminal of the antenna to the board terminal device and/or receiver. That is unacceptable to use interface, which is possible by contacting the first signal terminal (central core) and then through the ground terminal (shield), for example, type connectors F. It is recommended that the use of types of connectors SMA, MMCX, and the like.

Touching antenna input should avoid contact with any charged product (e.g., a ceramic antenna has a capacitance of about 50…100 pF, coaxial cable has a capacitance 50 ... 100 pF/ m, a soldering iron may have a capacity of up to 10nF, etc.). Also you should be careful in contact with materials which can generate and/or store charge. Very good results in the fight against a static electric charge enables the use of a grounded wrist equipment (mats on the desktop, grounding straps, anti-static gloves, anti-static flooring, shoes) and using in the workroom air ionizer, especially in winter.

At any stage of transportation, storage, warehouse for processing, installation, operation, dismantling and other works with the receiver should be taken appropriate measures to protect against electrostatic discharge (ESD protection).

Maintenance

The receiver KL3333 does not require special types of maintenance.

Repairing procedure

The Receiver **KL3333** 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 Receiver **KL3333** must be returned to the manufacturer for subsequent repair. Return the navigation device shall be in proper packaging (protection against ESD, possible damage during transportation and / or treatment is possible ingress of moisture and / or foreign objects on / in the product).

Transportation and storage

Packed Receiver 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 Receiver 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 Receiver 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.

Transport and storage of the receiver **KL3333** must be in a container that provides protection against electrostatic discharge **(ESD protection).**