PORTABLE
NONLINEAR JUNCTION DETECTOR
ST 401 CAYMAN

OPERATING MANUAL

CONTENTS

This operating manual contains important technical information and guidance on proper use of the product. Please read the manual before using ST 400 Cayman.

1. Description

1.1. Purpose

ST 401 CAYMAN is intended to detect and locate

- eavesdropping electronics
- mobile phones and SIM cards
- any other devices utilising semiconductor technology

ST 401 allows detecting electronic devices, whether active or not, as well as finding their exact location. It also enables one to distinguish between return signals from real semiconductors and other kinds of responses, such as those given by corrosion or metal-oxide-metal structures.

1.2. Delivery package

ST 401 comes in a shockproof case NANUK-915, The delivery package includes the following.

Item	Quantity	No. in Fig.1
ST 401 'Cayman' NLJD	1	1
Accumulator Battery (type 18650)	4	2
Electric Charger	1	3
Charger Power Adapter	1	4
Headphones	1	5
Semiconductor Imitating Dummy (marked red)	1	6
MOM-Structure Imitating Dummy (marked blue)	1	7
Case	1	8
Operating Manual	1	not shown in figure

Fig. 1

1.3. Main Technical Specifications

Range of radiated frequencies	2–3GHz
Max. peak radiated power	< 2W
Antenna polarisation	elliptic
Operation modes	SEARCH
	AUDIO
	ADAPT
Sensitivity range in manual mode	40dB (5 values with 8dB increment)
Response indication	
– visual	three 16-segment gauges
– aural	internal speaker or headphones
Power supply	two 3.7V Li-ion batteries (type 18650)
Time of operation on one battery charge	3–4 hours, depending on operation mode
Battery charging time	< 3 hrs
Operating conditions	
– working temperature range	+5...+40°C
– relative air humidity	up to 85 percent (at 25°C)
Weight (with batteries)	0,85kg
Dimensions (length×width×height)	340x130x160mm
Weight of full set in case	3,7kg

1.4. Principles of Operation

ST 401 ‘Cayman’ is a nonlinear junction detector, or NLJD. Instruments of this type employ active detection, i.e. they emit probing signals and analyse the return. Their primary search targets are electronic devices, and those typically consist of circuit plates with conductive elements and various semiconductor parts connected to them, such as diodes, transistors, and microchips. The probing electromagnetic radiation induces variable electromotive forces in these loops, and electronic components with a non-linear current-voltage curve transform the initial signal into its higher frequency harmonics, which come back to the NLJD’s receiver.

Higher harmonics can also be re-radiated by corroded metal or the so-called MOM-diodes, metal-oxide-metal structures brought about by contacting metal surfaces. However, these formations return somewhat different spectra than semiconductors.

With ST 401 one can distinguish with high probability between responses given by real semiconductors, and those ‘faked’ by MOM-structures or corrosion. Another important advantage is a confident detection of search targets behind partially shielding obstacles, which is achieved by simultaneously radiating several frequencies within the 2-3GHz band and analysing the composite picture of the reflection spectrum.

1.5. Operation Modes

The NLJD ST 401 ‘Cayman’ has the following modes of operation:

Primary operation mode: SEARCH

Secondary operation mode: AUDIO

Service mode: ADAPT

The main operation mode named SEARCH is meant for detecting nonlinear targets and identifying them, based on the response levels as indicated by 16-segment bars.

The auxiliary operation mode named AUDIO allows demodulating the response and listening to it through the built-in speaker or headphones. Use this mode upon detecting a response in the SEARCH mode.

The service mode named ADAPT is used to optimise the parameters in a given electromagnetic environment and thus maximise the effectiveness of search. Engaging this mode is necessary every time the device is switched on. It is advisable to pause during searches from time to time, to repeat this procedure. During adaptation, the antenna must be pointed away from electronics and large metal objects.

1.6. Structure

Structurally, the ST 401 ‘Cayman’ NLJD consists of the antenna module and the main unit connected by way of a hinge joint. The general appearance of ST401 is shown in Fig. 2, the numbers standing for:

1 – antenna module

2 – main unit

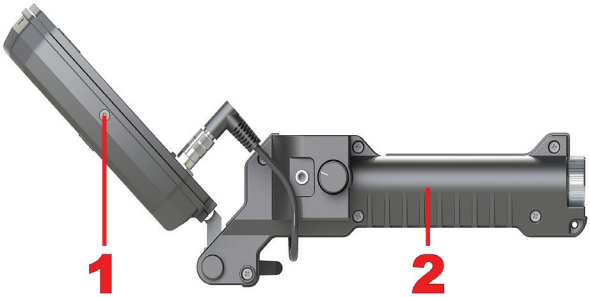

Fig. 2

1.6.1. Antenna module

The antenna module comprises a receiver-transmitter unit, a control-display unit, and an aerial, all of which are assembled on a single platform and incorporated in a single body.

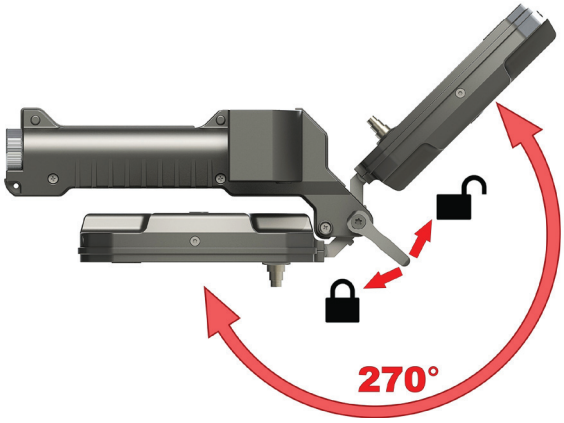

Fig. 3

The antenna module is connected with the handle through a hinge joint that allows adjusting the incline within the vertical plane, as shown in Fig. 3. Loosen the hinge screw (2, Fig. 6) to change the incline, then tighten the screw again.

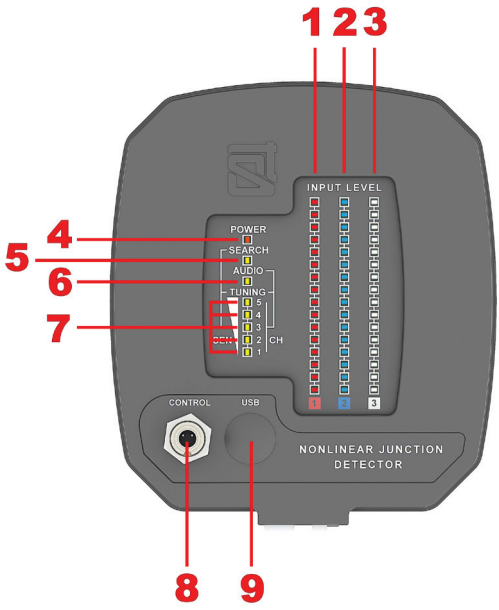

Fig. 4

On the surface of antenna facing operator, there are an indicator panel, a socket for the power-and-control cable, and a USB port for computer connection (Fig. 4). The numbers in Fig. 4 stand for the following:

# in Fig. 4	description	colour	subscript on indicator panel
1	16-segment led gauge of threat-type response levels	red	1
2	16-segment led gauge of MOM-type response levels	blue	2
3	16-segment led gauge of reflection levels	white	3
4	Power-on led indicator	red	POWER
5	SEARCH mode indicator	yellow	SEARCH
6	AUDIO mode indicator	yellow	AUDIO
7	5-segment tuning bar*	yellow	TUNING
8	socket for power-and-control cable		CONTROL
9	USB port		USB

* the TUNING segment bar has two functions:
– in the SEARCH mode, it shows the selected sensitivity of the receiver (SEN)
– in the AUDIO mode, it shows the selected frequency combination (CH 1..5)

The boresight directions of the receiving and transmitting antennas are shown in Fig. 5.

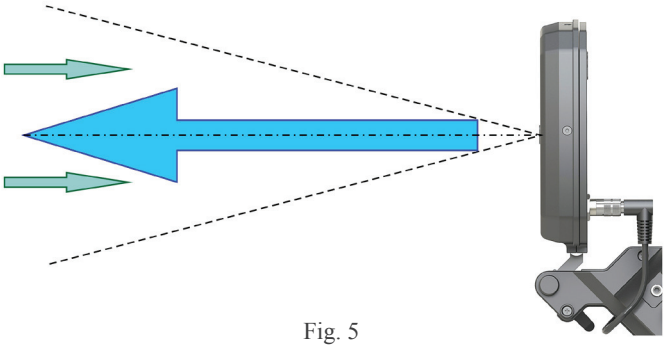

Fig. 5

1.6.2. Main Unit

The main unit of ST 401 ‘Cayman’ consists of a battery compartment, a control panel, and mechanical parts that form the bearing structure. The appearance of the main unit and the location of its components are shown in Fig. 6.

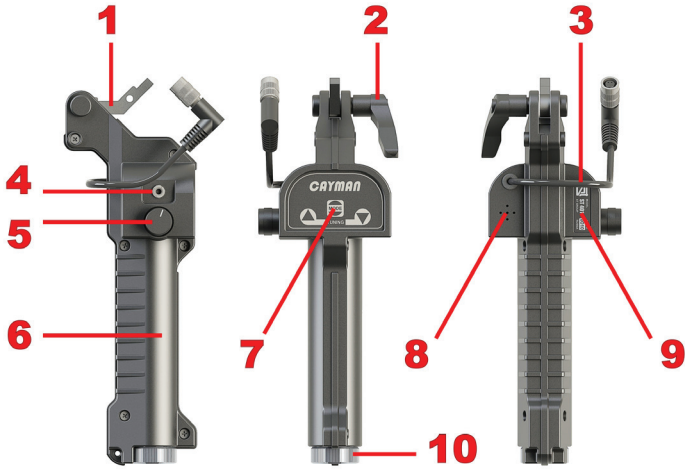

Fig. 6

The numbers in Fig. 6 stand for:

1 – bracket mount for the antenna module
2 – lever handle of the clamp
3 – power-and-control cable with plug
4 – headphone socket
5 – power and volume knob
6 – battery compartment
7 – control panel
8 – grid of the built-in speaker
9 – ID plate
10 – battery compartment cap

A three-button control panel is located in the upper part (Fig. 7).

The MODE button (1, Fig. 7) is used to set the operation mode of the device. A short press of this button alternates between SEARCH and AUDIO; holding it down for a few seconds will set the device to the ADAPT mode.

The other two buttons marked with arrows ▲ and ▼ (2 and 3, Fig. 7) are for tuning the device. Depending on the mode, they allow:

– in the SEARCH mode, increasing and decreasing the receiver sensitivity, respectively.

– in the AUDIO mode, setting the desired frequency combination.

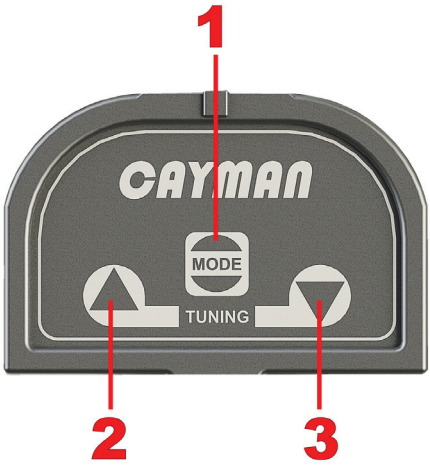

Fig. 7

The main unit has a battery compartment for 2 type 18650 accumulator batteries. Those are enclosed with a screw cap (10, Fig. 6) that also serves as the negative contact.

Fore of the handle are the headphone socket (4, Fig. 6) and the power and volume knob (5, Fig. 6). In the lower part there are a speaker grid (8, Fig. 6) and an ID plate (9, Fig. 6) that indicates:

– product name

– serial number

– logo, and name of the manufacturer company.

2. USE

2.1. Preparation

Take the device and 2 batteries out of the case. Examine the antenna module, handle, cable and socket for mechanical damage. Examine the batteries for mechanical damage and electrode corrosion. Do not use the device if any such defects are found! To replace the batteries, do the following:

- unscrew the battery compartment cap;
- insert two accumulator batteries as shown in Fig. 8, making sure you observe the polarity;
- screw the cap back in place.

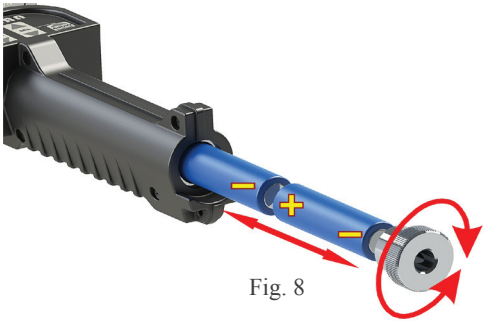

Fig. 8

Make sure the power switch (5, Fig. 6) is in its leftmost position (OFF). Insert the power-and-control cord plug (3, Fig. 6) into the socket (8, Fig. 4) on the antenna module. Activate the device by rotating the knob clockwise. The device status will be displayed on the antenna module as shown in Table 1 below.

Table 1

legend	colour	light indication	interpretation
POWER	red	continuous	The antenna module is powered properly.
		blinking	The battery is discharged and needs to be replaced.
TUNING SEN	yellow	continuous	This displays receiver gain. At startup the gain is automatically set to maximum, which is signalled by all the 5 indicator segments being lit.
SEARCH	yellow	continuous	This displays the operating mode. The SEARCH mode is selected automatically at startup.

Upon activation of the device one or more segments of the signal level gauges (1..3, Fig. 4) may light and go out spontaneously. This would mean that the device should need to be adjusted to the electromagnetic environment using the adaptive mode.

2.2. Adaptation mode

To activate this mode, press and hold for 3-4 sec the MODE button (1, Fig. 7) on the control panel. The antenna must be directed away from large metal objects and anything that is presumed to contain nonlinear elements (it is often best to point the antenna at either the floor or ceiling).

The adaptation takes 10–15 seconds, with all the indicators but TUNING lit in the meantime on the antenna module. The TUNING indicator will be showing a consecutive lighting of segments. The user can check if any of the indicator LEDs are dead.

Upon adaptation the device status will be displayed in accordance with Table 1.

Upon activation of the device one or more segments of the signal level gauges (1..3, Fig. 4) may light and go out spontaneously. This would mean that the device should need to be adjusted to the electromagnetic environment using the adaptive mode.

2.3. Operational check with test dummies

For that purpose select an area free of responses from nonlinear elements or reflecting surfaces, and place the dummy that is marked red.

Press button ▼ (3, Fig. 7) repeatedly to set the receiver gain at 3 lit segments of the TUNING indicator, which corresponds to medium sensitivity.

Point the antenna at the test dummy and find the distance at which all the 16 segments of the INPUT LEVEL Gauge bar 1 light up. For a device that is in proper working order and has self-tuned properly, this distance should be no less than 0.8 m.

Repeat the procedure using the dummy with the blue marking. In doing so, find the distance at which all the segments of the INPUT LEVEL gauge bar 2 will be lit. For a properly working device that has been adjusted to the environment, this distance should be no less than 0.3m.

If either distance is found to be smaller than the respective value above, it is advisable to engage the self-tuning routine anew (see 2.2) and repeat the checks as described above.

If both distances exceed the required minimums, the device is functional and operation-ready.

2.4. Manual Gain Control

Once ST 401` Cayman has been prepared and proven functional as described above in 2.1 – 2.3, it can be put to use. When activated, the device starts up in SEARCH mode, and the receiver gain is by default set to maximum, which is displayed by 5 lit segments of the TUNING indicator.

The SEARCH mode is the primary operation mode for ST 401. The operator can change the receiver gain at his discretion, thus increasing or decreasing the detection range.

The gain can be varied discretely with an 8dB increment, over 5 values in a 40dB range; each increment corresponds to one LED segment of the TUNING indicator. Thus, if all five are lit, the gain is equal to 40dB, providing maximum detection range. If all are dimmed, the gain is 0dB, with minimum detection range. The gain can be brought a step up or down by a single pressing of the TUNING buttons ▲ or ▼ (2 and 3, Fig. 7).

Levels of return signals from a target area are shown in the three INPUT LEVEL multi-segment LED gauge bars (1-3, Fig. 4).

INPUT LEVEL led gauge bar 1 (16 red LEDs) displays the levels of return signals from semiconductor material. The indication is accompanied with an alternating sound alarm.

INPUT LEVEL led gauge bar 2 (16 blue LEDs) displays the levels of return signals from MOM (metal/oxide/metal) structures.

INPUT LEVEL led gauge bar 3 (16 white LEDs) displays the levels of return signals from reflecting surfaces (most likely, metal).

The greater the response of a certain type, the more LEDs will light up in the corresponding INPUT LEVEL gauge bar.

Recommendations

With an NLJD one typically probes

- enclosing structures (walls, ceilings, floors)
- different parts of the interior
- various objects that are not supposed to contain semiconductor material

Items known to contain semiconductor components (electronic instruments, office and home equipment, communication devices, etc.) are checked by other means.

When running checks on enclosing structures, it is important to set a suitable receiver gain. If excessive, it may well cause detection of objects behind the walls, which may be a problem when there is no access into the adjoining spaces. On the other hand, if the gain is too small, targets of interest with a weak response may remain undiscovered in the structure under scrutiny.

While scanning walls and other large vertical structures, it is recommendable to move the antenna from top to bottom in a serpentine fashion, as is shown in Fig. 9.

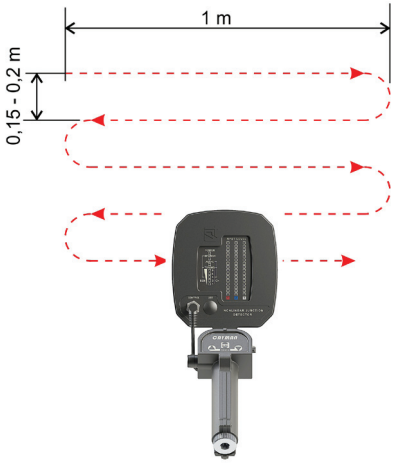

Fig. 9

The antenna head should be held at a distance of 5-15 cm from the surface.

If a potent response is registered (all LEDs in an multi-segment LED gauge bar light up), the gain should be decreased in order to establish the exact location of the responding target.

The primary task for an NLJD is the discovery of eavesdropping devices, whose giveaways are the signals returned by semiconductor-containing electronic components and by MOM-structures on casings, at junctures, etc. Therefore, particular attention should be paid to scanned areas where responses have been observed on the red multi-segment LED gauge bar alone, and on both red and blue INPUT LEVEL gauge bars. The nature of each such response should be determined and its source identified.

A strong, off-scale response on one of the multi-segment LED gauge bars may be accompanied by a much weaker one on another. As a rule, the former is a true response and the latter a false one; it is advisable to decrease the gain or move away from the target until there is no scaling-off.

Small-sized objects should be checked at locations where no response is observed on any of the three INPUT LEVEL multi-segment gauge bars, preferably away from large metal structures, pillars, cabinets, safes, etc.

2.5. Listening (AUDIO mode)

The AUDIO mode is primarily intended for analysing target responses by listening to the demodulated signal output. This should give the operator ample information to identify the response type.

To switch from SEARCH to AUDIO, press MODE. The SEARCH led (5, Fig. 4) on the antenna head will then go off, and AUDIO led will light up (6, Fig. 4).

When the AUDIO mode is on, the device status will be displayed on the antenna module as described in Table 2 below.

Table 2

legend	colour	light indication	meaning
POWER	red	continuous	The antenna module is powered properly.
		blinking	The battery is discharged and needs to be replaced.
TUNING	yellow	continuous*	The 5-segment bar displays the selected probing frequency combination.
AUDIO	yellow	continuous	AUDIO mode on.
INPUT LEVEL 3	white	varying numbers of lit LEDs	The 16-segment bar displays the levels of returned signals. Note: in the AUDIO mode this gauge bar shows a sum total of responses, regardless of their type.

*Upon switching to AUDIO, none of the TUNING bar segments are lit, which corresponds to #0 frequency combination.

The ST 401 ‘Cayman’ NLJD makes it possible to listen to demodulated signals while probing with six different frequency combinations. Each combination, indicated by LEDs on the TUNING bar, is suited to deal with a particular category of nonlinear objects. Upon activation of the AUDIO mode, frequency combination #0 is set by default; it is meant for probing semiconductor content and, as a rule, gives good results in identifying active radio-transmitting and sound-recording devices.

Frequency combination #1 is used to analyse return signals from MOM (metal/oxide/metal) structures.

The remaining four combinations are auxiliary. Their use is advised when responses have been observed in the SEARCH mode on the red INPUT LEVEL bar, yet probing with combination #0 has rendered no definitive findings.

Table 3 shows correspondence between frequency combinations and responses observed in the SEARCH mode.

Table 3

	indication on TUNING bar					
						
freq. combination #	**0**	**1**	**2**	**3**	**4**	**5**
gauge bar # in SEARCH mode	**1**	**2**	**1**	**1**	**1**	**1**

Use buttons ▲ and ▼ to change probing frequency combinations (2 and 3, Fig. 7).

Table 4 shows typical results of analysing targets with nonlinear properties.

Table 4

Type of probed target	**Optimum frequency combination**	**Sounds when subjected to mechanical impact or test sound**	**Sounds in the absence of mechanical impact or test sound**
MOM-structure	1	crackling, creaking	none
active electronic devices (unencoded transmission channel)	0 (2–5)	audible response to tapping or test sound	sounds of the environment
active electronic devices (encoded transmission channel)	0 (2–5)	peculiar signals caused by the operation of the device and independent of sounds in the environment	peculiar signals caused by the operation of the device and independent of sounds in the environment
inactive electronic devices	0 (2–5)	none	none
active electro-mechanic or mechanic appliances	0-5	crackling, creaking	peculiar signals caused by the operation of the device and independent of sounds in the environment

When listening to demodulated signals, it is recommended to use headphones. Sound volume is adjustable with a variable resistor (5, Fig. 6).

Recommendations

Any response observed on the red bar (or on both red and blue bar simultaneously) should be analysed in the audio mode with the use of a test sound source. If a response has been observed on the blue bar, it is advisable to perform audio analysis with the frequency combination #1, subjecting the target area to mechanical impact (tapping). While probing, it is advisable to change gradually the distance between the antenna and target within 5–100 cm range.

Push the MODE button to switch from the AUDIO mode to SEARCH.

2.7. Program Updates

ST401 Cayman has a processor that operates in accordance with the program firmware that is pre-installed by the manufacturer company. Over time the firmware gets refined and newer versions get released, that can be installed through the USB port.

'What is my firmware version?'

In order to find out what firmware version is currently installed on your ST401, set it to SEARCH, then press ▲ and hold it for 3 seconds. The three INPUT LEVEL bars (4, 5 and 6, Fig. 4) will light up, with the number of lit LEDs indicating the current version in the format 'R.B.W' (red, blue, and white). For example, if 1 red, 2 blue, and 5 white LEDs are lit up, then the current version is 1.2.5.

Press any button to exit this mode.

Firmware update procedure

The newest firmware version, with issues sorted out or features added, can be downloaded from http://spymarket.com/ ('ST 401 CAYMAN' section) and installed through the USB port with the installer enclosed with the update files.

In order to update the ST 401 Cayman firmware, do the following:

– turn off the device (if activated)

– using a thin object, open the USB socket cover on the antenna panel (9, Fig. 4)

– connect ST401 Cayman to the computer using a USB cable

– turn on the device

– when the POWER led (4, Fig. 4) lights up, within 5 seconds briefly press ▲ ; after 5 seconds the power-on LED will go dim to indicate that the device is now in the updating mode

– turn off the device

– follow instructions in the README file that comes with the update.

WARNING! Once the updating process has started, ST 401 Cayman can only be switched into operation again upon completion of the update installation.

3. POWER SUPPLY

ST 401 Cayman is powered by two Li-ion rechargeable batteries (type 18650). 4 batteries are included in the delivery package. The total run time on one battery charge is from 3 to 4 hours, depending on the modes employed; the most demanding in terms of power consumption is the AUDIO mode.

The batteries is housed in the battery compartment at the back of the main unit. Battery replacement is described in 2.1 above.

ST 401 Cayman monitors its battery charge status. A continuously lit power-on led (4, Fig.4) on the antenna head means that the battery charge is sufficient. A low battery charge will be signalled by blinking of the power-on LED and a warning sound. If the charge goes below the critical threshold, the device will switch off automatically.

Accumulator batteries can be charged with the charger included in the delivery package. The charging time of a fully discharged battery is 3 hours. As these batteries are free of memory effect, incomplete charging is acceptable, but the running time will then be shorter.

The following is not allowed:

– long-term storage of discharged batteries
– long-term storage of batteries at low temperatures
– short-circuiting battery contacts
– subjecting batteries to strong shock
– transportation of the device with installed batteries.

4. OPERATING RESTRICTIONS

Use of the device is subject to safety regulations for equipment incorporating UHF transmitters. The following must be observed at all times:

• Avoid long exposure of people to the antenna beam (the main lobe of the polar diagram) at distances less than 1m.

• Do not point the antenna at people's eyes at distances less than 1m.

If the device has been transported at temperatures well outside the service temperature range, make sure to keep the device indoors at service temperature for 2 hours before use.

5. STORAGE AND TRANSPORTATION

The device must be stored in heated storage facilities pursuant to GOST V9.003–80 (ГОСТ В9.003–80). The following conditions must be maintained:

1) ambient temperatures from + 0 to 50°C;
2) relative air humidity 80 percent at 30°C;
3) atmospheric pressure from 630 to 820 mmHg;
4) absence of acidic, alkaline, or other aggressive vapours.

The device can be transported in standard packaging by any suitable means of conveyance (in a pressurised module, if transported by plane) as long as it is protected from atmospheric moisture. While transporting the device, avoid dropping or otherwise subjecting it to strong impacts. During transportation, the mechanical conditions must comply with medium level requirements per GOST B20.57.310–76, while the ambient conditions must correspond to those specified by GOST B9.003–80 for open-air storage.

6. WARRANTY

The manufacturer guarantees compliance of every manufactured item with all the requirements as per technical specifications, within 12 months of the date of purchase.

During the warranty period, the manufacturer guarantees free of charge repairs of the device, its auxiliary components and accessories, up to full replacement.

Free repairs or replacement can only be claimed if the user has observed all the rules of operation, transportation, and storage of the device, and on condition that the device itself and its ancillary parts are free from mechanical damage, and upon submission of a properly filled out warranty coupon.

Upon expiry of the warranty period, post-warranty servicing is available from the manufacturer.

The warranty does not cover batteries.