

NONLINEAR JUNCTION DETECTOR ST 400 CAYMAN



OPERATING MANUAL

English



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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 400 Cayman is intended to detect and locate

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

ST 400 Cayman 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 400 Cayman comes in a shockproof case that contains the following.

Item	Quantity	No. in Fig. 1
ST 400 ‘Cayman’ NLJD	1	2
Accumulator Battery (type 18650)	2	3
Charger Power Adapter	1	4
Electric Charger	1	5*
Headphones	1	6*
Semiconductor Imitating Dummy (marked red)	1	1
MOM-Structure Imitating Dummy (marked blue)	1	1
Operating Manual	1	not shown in fig.
Case	1	not shown in fig.

*The electric charger and headphones are lodged at the bottom, underneath the device.

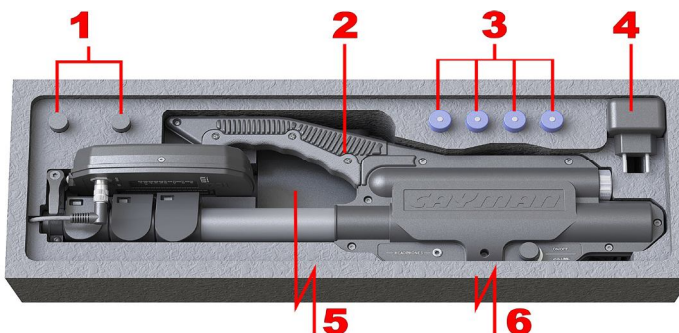


Fig. 1

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 LED gauge bars
– aural	internal speaker or headphones
Power supply	two 3.7V rechargeable Li-ion batteries (type 18650)
Time of operation on one battery charge	3-4 hours, depending on the operation mode
Battery charging time	< 3 hours
Operating conditions	
– working temperature range	+5...+40°C
– relative air humidity	up to 85 percent (at 25°C)
Weight (with batteries)	1,75kg
Dimensions (length×width×height)	
– when folded	510x145x130mm
– with telescopic arm pulled out completely	1500x250x130mm
Weight of full set in case	5,8kg

1.4. Principles of Operation

ST 400 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 400 Cayman 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 400 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 ADAPT service mode 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 400 Cayman NLJD consists of the main unit and antenna module, that are connected with a telescopic arm. The main constituents are shown in Fig. 2.

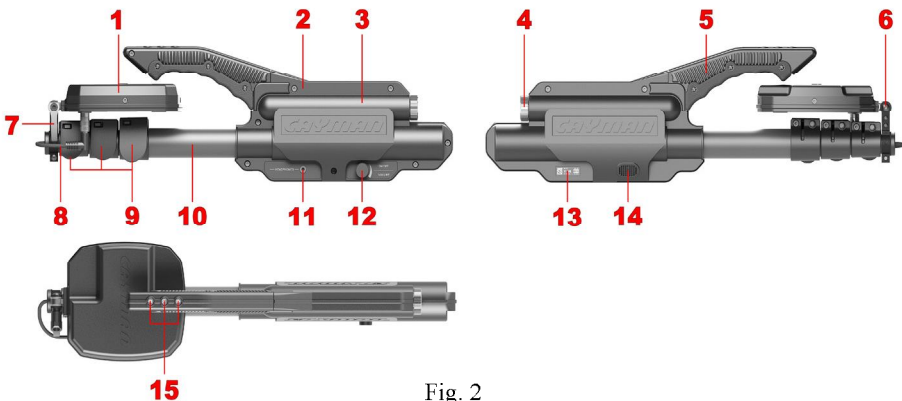


Fig. 2

The numbers in Fig. 2 stand for:

- | | |
|---------------------------------------|----------------------------|
| 1 – antenna module | 11 – headphone socket |
| 2 – main unit | 12 – power and volume knob |
| 3 – battery compartment | 13 – ID plate |
| 4 – battery compartment cap | 14 – inbuilt speaker |
| 5 – handle | 15 – controls |
| 6 – antenna module bracket | |
| 7 – lever handle of the clamp | |
| 8 – power-and-control cable with plug | |
| 9 – cam clamps of the telescopic arm | |
| 10 – telescopic arm | |

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. The antenna is mounted at the end of a telescopic arm by way of a hinge joint that allows adjusting the incline within the vertical plane along the rod's axis, as shown in Fig. 3. To change the incline, unlock the clamp by turning its handle counter-clockwise, as shown in Fig. 3, then adjust and lock by turning the clamp handle in the clockwise direction.

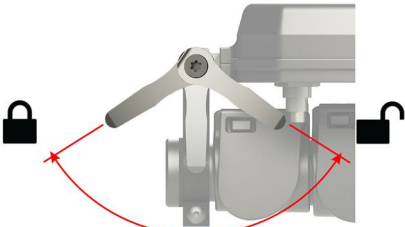


Fig. 3

Do not try to change the antenna incline with the clamp locked: you may break the hinge joint!

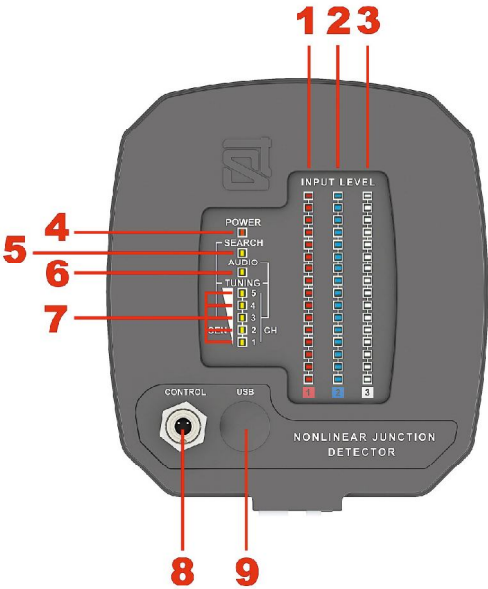


Fig. 4

On the antenna surface facing the 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.

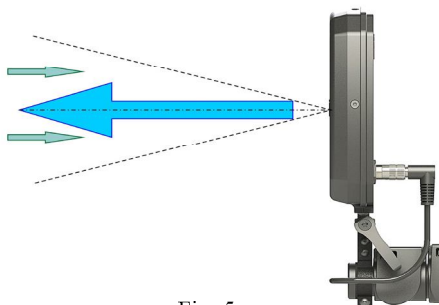


Fig. 5

1.6.2. Main Unit

The main unit of ST 400 Cayman is housed in a durable plastic body (2, Fig. 2) fitted on top with a handle (5, Fig. 2) with three control buttons (15, Fig. 2). It has a battery compartment (3, Fig. 2) for two type 18650 accumulator batteries, closed with a metal cap (4, Fig. 2). On the left side of the main unit are a headphone socket (11, Fig. 2) and a power-and-volume knob (12, Fig.2), and on the right side there is a shield bearing the name of the device, its serial number, and the name of its manufacturer company (13, Fig. 2). Also on the right, a speaker grid can be found (14, Fig. 2).

The main unit's body hosts electronics controlling the device. For durability's sake, all the components of the main unit are assembled on a single bearing structure made of metal, while the plastic body only serves protective and aesthetic purposes.

1.6.3. Telescopic Arm

The four-section telescopic arm is used for bringing the antenna up close to remote objects under inspection. Its length can be adjusted with the aid of cam clamps (9, Fig. 2).

Its base section is anchored inside the main unit. The fore section of the rod is fitted with a bracket mount for the antenna module (6, Fig. 2). A lever handle (7, Fig. 2) is used to fix the antenna in a desired position.

A twisted cable goes through the arm, connecting the antenna with the power and control units housed in the main body. Fig. 6 shows the device with the arm retracted, and fully extended.

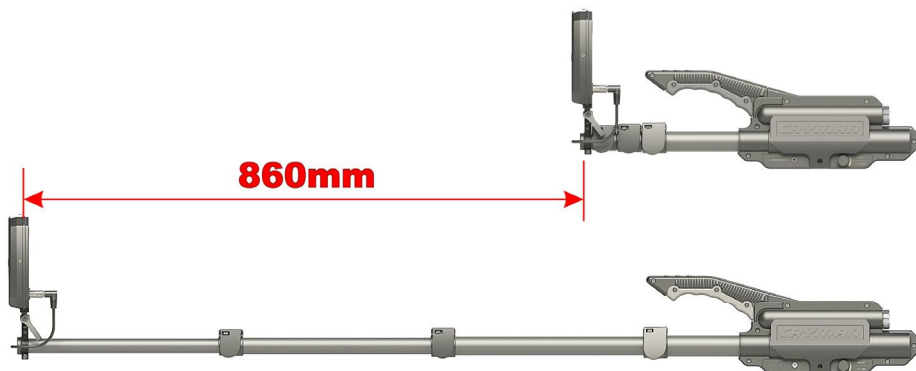





Fig. 6

1.6.4. Controls

Three control buttons are at the front of the handle (Fig. 7).

The mode-setting button (2, Fig. 7) is marked with the symbol . 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  and  (1 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

2. USE

2.1. Preparation

Take the device and rechargeable batteries out of the case. Examine the main unit, antenna, 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.

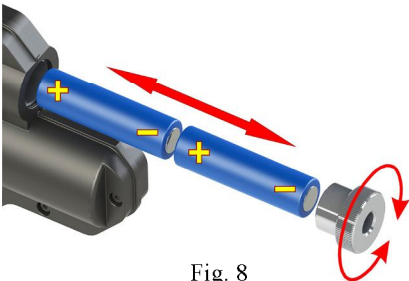


Fig. 8

Make sure the power switch (12, Fig. 2) is in the leftmost position (off). Connect the power-and-control cable plug (8, Fig. 2) to the socket on antenna module (8, Fig. 4). Switch on the device by turning 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 LEDs of the signal level gauge bars (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. Adaptive mode


To activate this mode, press and hold for 3-4 sec the MODE button (2, Fig. 7) on the main unit 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. Meanwhile, 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.



2.3. Operational check with test dummies

Once ST 400 Cayman has been adapted to the environment, its functioning should be checked with the aid of test dummies that imitate nonlinear materials (1, Fig. 1).

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

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. SEARCH Mode

Once ST 400 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 400. 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  (1 and 3, Fig. 7).

Levels of return signals from a target area are shown in the three INPUT LEVEL multi-segment LED gauge bars (Fig. 4: 4–6).

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.

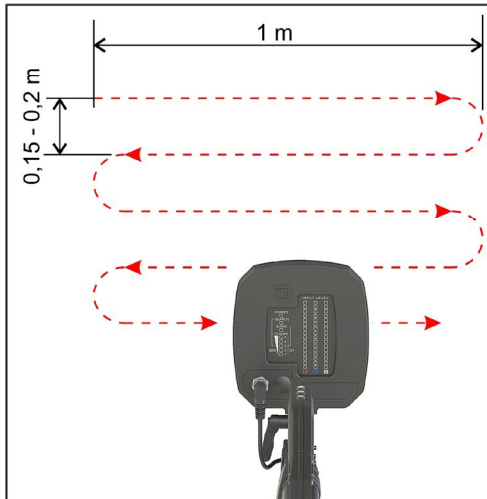


Fig. 9

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 led gauge bar alone, and on both red and blue multi-segment LED 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 off-scaling.

Small-sized objects should be checked at locations where no response is observed on any of the three INPUT LEVEL led 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 . 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 400 Cayman NLJD allows listening 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 (1 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 (12, Fig. 2).

Recommendations

Any response observed on the red bar (or on both the red bar and the 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  to switch from the AUDIO mode to SEARCH.

3. POWER SUPPLY

ST 400 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 are housed in the battery compartment at the back of the main unit. Battery replacement is described in 2.1 above.

ST 400 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 an installed battery.

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.