GeoSIG
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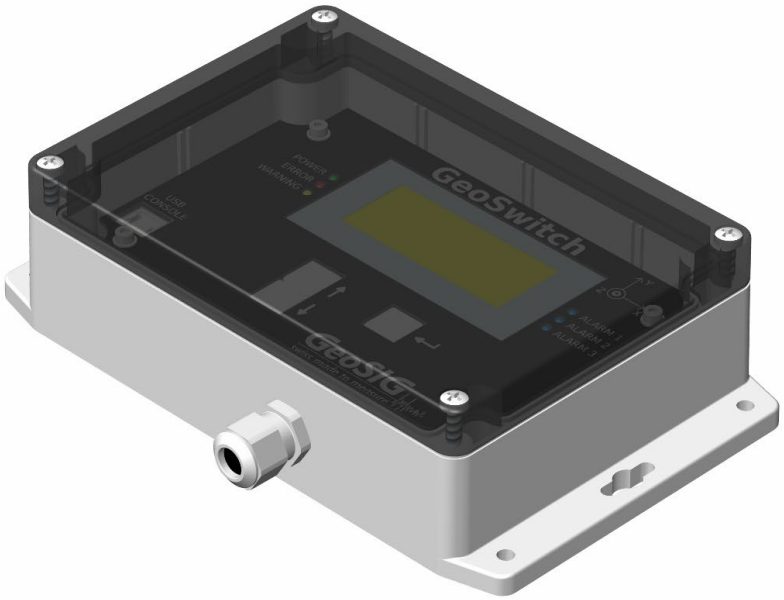
GeoSwitch
User Manual



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Document Revision

Version	Date	Modification	Prepared	Checked	Released
1	03.11.2014	Document created	IGP		
2	13.03.2015	Various corrections in text and figures. Added information about configuration of GeoSwitch, GeoSwitch Configurator software, Console Commands, LCD display and push buttons, MODBUS registers.	IGP		
3	16.03.2015	Added symbols explanation. Minor corrections. Updated address.	JON		
4	20.03.2015	The “power” usage of relay was corrected.	IGP		
5	2.04.2015	MODBUS registers adjusted to correspond recent FW.	IGP		
6	22.04.2015	MODBUS baud-rate register changed. Now it holds index of baud-rate.	IGP		
7	12.05.2015	Various updates of “Configuration of the Instrument” and “Console Commands” chapters. The “LCD Display and Push-buttons” chapter updated. Error and Warning codes added into appendix. Corrected addressing of MODBUS registers in the appendix.	IGP	JON	JON
8	20.05.2015	Update warnings and safety.	JON	TAB	TAB
9	26.10.2015	Corrected and improved description of “Relay Hold Time” and “Time of RTC” chapters. The Heartbeat relay usage was changed. The “Security of LCD Menus” subchapter added. The “Logging of Alarm Events” chapter added. The “MODBUS Registers” Appendix extended by “menu.lock_code” and “menu.unlocked” holding registers. The “Error codes” and “Warning Codes” chapters improved to have comments.	IGP	JON	JON
10	17.11.2015	The “Redundant Quadruplet Matrix” and “System Test” chapters added. “System Test” item added into LCD menus and “systest” into console commands. Some error codes changed.	IGP	JON	JON
11	30.11.2015	Console commands updated.	IGP	JON	JON
12	14.09.2016	Addition of “GeoSIG Cybersecurity Recommendations” section	KEC	VAG	VAG
13	23.05.2017	Adding Appendix D: Cable Drawing	JOG	PAT	JOG
14	27.03.2018	Applicability section added. Updates for GS_SIMPLE_SSW_V2. Updated Firmware programming section with STM32CubeProgrammer. ERR_V_DIODES_IS_LOW level changed. Appendix E added.	PAT	WES	VAG
15	20.04.2018	Appendix D updated	PAT	WES	VAG
16	08.04.2022	Added information about STA/LTA features into the Configuration of the Instrument, Changing Configuration from Terminal by Console Commands, Changing Configuration through MODBUS Interface,	IGP		

		LCD Display and Push Buttons chapters. Corrected chapters Firmware Programming or Upgrade, Security of LCD Menus, "Appendix A. MODBUS Registers". Removed 115200 from list of baud-rates of MODBUS interface. Notes added about MODBUS address and baud-rate change application. Error Codes and Warning Codes updated.			
17	09.05.2022	Cosmetic improvements.	IGP		
18	02.08.2022	Added notes about PCB versions equipped by super-capacitor or Li-Po battery. Improved chapter Configuration of the Instrument in regard of STA/LTA feature. Removed Bluetooth option. Added note about non-operational STA/LTA and threshold triggering functions for short period after power on or reset.	IGP	ALM	ALB
19	31.05.2023	Removed Bluetooth option from figure 10 "GeoSwitch Interfaces". Corrected description for the full-scale MODBUS holding register. Improved description of input MODBUS registers and "struct event".	IGP	KEC	TAB

Disclaimer
GeoSIG Ltd reserves the right to change the information contained in this document without notice. While the information contained herein is assumed to be accurate, GeoSIG Ltd assumes no responsibility for any errors or omissions.

GeoSIG Ltd Switzerland

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Table of Appendices

Applicability of This Manual

GeoSIG instruments are constantly being improved. Although the manual you receive along with your instrument corresponds to the actual software versions, **you are advised to check the GeoSIG web page periodically for the most recent version of this document**, and especially after performing any software upgrades. This manual is based on the following product serial numbers and firmware versions:

Component	Description	Serial number / Firmware version or higher
GeoSwitch S/N	Serial number of GeoSwitch product	102600
GeoSwitch FW	Firmware version of GeoSwitch	1.1.0

Warnings and Safety

☞ STATIC ELECTRICITY

The instrument contains CMOS devices and when serviced, care must be taken to prevent damage due to static electricity. This is very important to ensure long-term reliability of the unit. Such risk exists when both the instrument cover and the front panel are removed.

☞ INSIDE THE INSTRUMENT (MAINTENANCE)

Under normal circumstances, there is no need to remove the front panel of the instrument.

In any case, only trained person should remove the front panel. Moreover, untrained access may lead to serious damage to the instrument, as well as may void the warranty.

Before removing the front panel:

1. Turn the unit off
2. Wait for 10 minutes till all the LED indicators are OFF
3. Disconnect all cables connected to the unit

The housing provides no protection against explosive atmosphere. It must not be directly operated in area where explosive gases could be present.

☞ DO NOT USE IN LIFE SUPPORT OR LIFE CRITICAL APPLICATIONS

The GeoSIG GeoSwitch is not to be used for Life Support or Life-Critical Systems.

This product is not designed for operating life critical support systems and should not be used in applications where failure to perform can reasonably be expected to cause a risk of harm to property or persons (including the risk of bodily injury and death).

☞ INSTALLATION SITE

This instrument is designed for highly specialized applications. If installed in publicly accessible areas it is the responsibility of the instrument owner to ensure that the device is installed in a safe and secure manner.

The instrument should be installed in a well-ventilated place and when possible be protected from direct sunlight and heat.

The housing provides no protection against explosive atmosphere. The instrument must not be operated without necessary protective measures (e.g. EX-proof housing) in an area where explosive gases could be present.

BATTERY (MAINTENANCE) AND SAFETY

The instrument is usually shipped with an internal rechargeable battery (main battery), which is an optional accessory.

NEVER use any battery other than the ones supplied or approved in writing by GeoSIG.

An external power module, which is an optional accessory, is also usually shipped with the instrument.

NEVER use any other power module than the one supplied or approved in writing by GeoSIG.

Do not forget to connect the internal battery when installing the instrument. The main battery is provided with a short cable that has a polarised connector to avoid any wrong connections. Please ensure that this connector is fully inserted and secured on the mating connector inside the instrument.

CAREFULLY observe the polarity,

when replacing the main battery:

RED cable = ***(+) plus terminal of the battery***

BLACK cable = ***(–) minus terminal of the battery***

Any battery MUST be replaced by following its manufacturer's instructions regarding actual operating conditions AND latest by the end of below mentioned replacement intervals to prevent data loss and to avoid safety related issues:

Battery	Battery model	Replacement interval
Main Battery (Internal)	GS Internal Battery	3 years from date of production[1]

[1] assuming operation at a steady 20°C or below.

The expected lifetime of a battery can change drastically depending on operating conditions. Strong discharge of the battery and extreme temperatures must be avoided as per specific battery manufacturer's recommendations and guidelines.

Lifetime and replacement intervals mentioned in this manual are based on a constant ambient temperature of 20°C or below. If this condition cannot be met the user must check with the documentation of the battery manufacturer for information about the battery lifetime at elevated temperatures.

When replacing the battery only newly manufactured batteries may be installed. The replacement interval specified above starts from the manufacturing date of the battery, which is typically found printed on the battery itself. When replacing the battery, it is the users' responsibility to record the "battery installation dates". This parameter is required to ensure battery changes are performed in a timely manner.

For safety reasons the battery and operating conditions have to be annually checked to ensure that it is still within the manufacturer's recommended operational criterion.

It is important that all necessary precautions about operating a battery, such as the ones installed in the instrument, are taken into consideration and the safety instructions are followed accordingly.

The internal main battery (if installed) is a Lithium-Polymer type battery and is classified as "dangerous waste". The user is obliged to follow local laws and manufacturer's guidelines for safe use and correct disposal of any battery.

Lack of care or misuse of the battery as per battery manufacturer's recommendations can be hazardous, may damage your instrument and may even cause explosions. Please consult the battery manufacturer's website for the latest operating, maintenance and safety guidelines. Please contact GeoSIG in writing if the specific safety, operating, maintenance and disposal information for your battery type can't be found.

GeoSIG Cybersecurity Recommendations

GeoSIG instruments, as described in their documentation, have built-in security and safety features against unauthorised access or use. However, ultimately it is the user's responsibility to ensure the safe and secure usage of our instruments based on their actual implementation. No factory delivered solution can fit each and every possible scenario. The user is advised herein that once you connect a device to a network, you are also connecting that network to that device. It is the responsibility of the user to take appropriate precautions so that all devices should be adequately hardened, such as with individual strong passwords, and should have their traffic monitored and managed via appropriate security features, such as firewalls. Also, non-critical devices should be segmented away from networks that contain sensitive information.

Compliance with a well-defined security procedure helps protect not only an individual device, but also other devices connected through the network. Such procedure would be intended to prevent exploitation of an individual device's resources by unauthorized individuals, including the use of such device to attack other systems on the network or the Internet.

The following recommendations can be considered in establishing such a security procedure:

1. Physical access restriction

All devices must be restricted from unauthorised physical access and a well-defined physical access procedure shall be utilised.

2. No Unattended Console Sessions

Except for the devices which are physically secured, no unattended console sessions shall be left running.

3. No Unattended Network Sessions

No unattended user interface sessions shall be left running towards any device accessed through its network interface.

4. Use of a Firewall

For a network that has any connection to the outside world, a hardware firewall must be running and configured to block all inbound traffic that is not explicitly required for the intended use of the network and the connected devices. The user can also consider limiting outbound traffic.

Any communication ports that are required for the operation must be protected.

5. No Unnecessary Services or Ports

If a service or port is not necessary for the intended purpose or operation of the device, that service must not be running and the port must be closed. (E.g. if seedlink server is running, but not used, turn it off)

6. Use of authentication

Network and console device access must require authentication by means of strong and individualised passwords per device (no passe-partout passwords).

Wireless access must require strong encryption to associate (such as WPA2), or some other strong mechanism to keep casual users near the access point from using it to get full access to the network. WEP or MAC address restrictions do not meet this requirement.

7. Password complexity and security

When passwords are used, they must meet the specifications similar to below:

All default passwords must be changed at time of initial access or latest at deployment into service.

Passwords MUST:

contain eight characters or more

contain characters from AT LEAST two of the following three character classes:

```
Alphabetic (e.g., a-z, A-Z)
Numeric (i.e. 0-9)
Punctuation and other characters (e.g., !@#$%^&*()_+|~-=\`{}[]:";'<>?,./)
```

8. Privileged Accounts

Privileged and super-user accounts (Administrator, root, etc.) must not be used for non-administrator activities. A secure mechanism to escalate privileges with a standard account is acceptable to meet this requirement. Network services must run under accounts assigned the minimum necessary privileges.

9. No Unencrypted Authentication

All network-based authentication must be strongly encrypted. In particular, insecure services such as Telnet, FTP, SNMP, POP, and IMAP must not be used or must be replaced by their encrypted equivalents.

10. Software / Firmware updates

Networked devices must only run software/firmware that are updated according to supplier's guidelines. A periodical check of any available updates from the supplier must be sought.

Please contact GeoSIG Ltd if you require any further advice or clarification.

Symbols and Abbreviations

Bootloader	First program executed when unit starts.
CLI	Command Line Interface.
CPU	Central Processing Unit.
FIFO	First Input, First Output.
Flash	Program storage memory device. It contains main program and configuration data.
FW	Firmware. Low level program for microcontroller.
LiPo	Lithium Polymer
MCU	Microcontroller unit.
NC	Normally Closed.
NO	Normally Opened.
PC	Personal Computer.
RAM	Random Access Memory.
ROM	Read-Only Memory.
RTC	Real Time Clock.
RQM	Redundant Quadruple Matrix.
SPS	Samples Per Second.
SSW	Seismic Switch or GeoSwitch.
SW	Software. High level program for CPU.
UI	User Interface.
USB	Universal Serial Bus.

Direct current. This symbol indicates a direct current (DC) power line derive from an alternating current (AC) power source.

Earth terminal.

CE. This symbol indicates that the device conforms to all legal requirements needed to achieve free movement and sale of the product through the European Economic Area (EEA).

1. Introduction

Dear Valued GeoSIG Customer, thank you for purchasing this product.

These Instruments have been optimised to meet the requirements of the majority of customers out of the box and may have even be delivered tailored to your needs. In any case, to be able to get the most out of our product, please carefully study this manual, its appendices and referenced manuals, as well as any other documents delivered with it.

This is a reliable and easy to use device, and at the same time a sophisticated product, which requires care, attention and know-how in configuring, installing, operating and maintenance.

The GeoSwitch should never be used to switch main AC power. It should always be used in conjunction with appropriate high-power relays.
Solid state relays of GeoSwitch can switch maximum 60 VAC/VDC at 500 mA.

The GeoSwitch must be supplied with power from a 9-28 VDC power supply that is safely grounded and meets all applicable local regulations. The GeoSwitch will be damaged if the power is connected with the wrong polarity.

If you supply your own power system, be sure that the system provides the correct voltage and current required by the GeoSwitch under all operating conditions. You are responsible for the safety of your power system. Be sure you have supplied adequate grounding for all the equipment.

The GeoSwitch can be referred as SSW (Seismic Switch) in this document. The GeoSwitch is a device name for GeoSIG Seismic Switch.

2. Incoming Inspection

All instruments are carefully inspected both electrically and mechanically before they leave the factory. Please check if all received items correspond with the packing list and your order confirmation. In case of discrepancy please contact GeoSIG or your local representative immediately.

2.1. Damage during shipment

If requested at the time of order, all instruments can be insured prior to shipment. If you receive a damaged shipment and shipping insurance was previously arranged you should:

- Report the damage to your shipper immediately
- Inform GeoSIG or your local representative immediately
- Keep all packaging and shipping documents

Insurance claims may be void if the above procedure is not followed.

2.2. Warranty

GeoSIG Ltd (hereafter GeoSIG) warrants hardware and software products against defects in materials, workmanship and design for the defined period in the relevant contract or offer, starting from date of shipment and 5 years parts and maintenance support commitment. If GeoSIG receives notice of such defects during the warranty period, GeoSIG shall at its option either repair (at factory) or replace free of charge hardware and software products that prove to be defective. If GeoSIG is unable, within a reasonable time to repair or replace any cabinet to a condition as warranted, buyer shall be entitled to a refund of the purchase price upon return of the cabinet to GeoSIG. 50% of freight charges on shipments of warranty repairs or replacements will be borne by GeoSIG (normally one way freight).

2.2.1. Limitation of Warranty

The foregoing guarantee shall not apply to defects resulting from:

- Improper or inadequate maintenance by buyer
- Buyer supplied software or interfacing
- Unauthorised modification or misuse
- Operation and storage outside of the environmental specifications of the instrument
- Related to consumables or batteries
- Improper preparation and installation at site.

3. Description

3.1. Housing

The instrument comes with an UV stabilized Polycarbonate housing with UL94-HB flammability rating and mounting flanges on both sides. These mounting flanges allow easy fixation of the instrument on the ground, wall or any other surface. For the detailed installation see chapter 4.

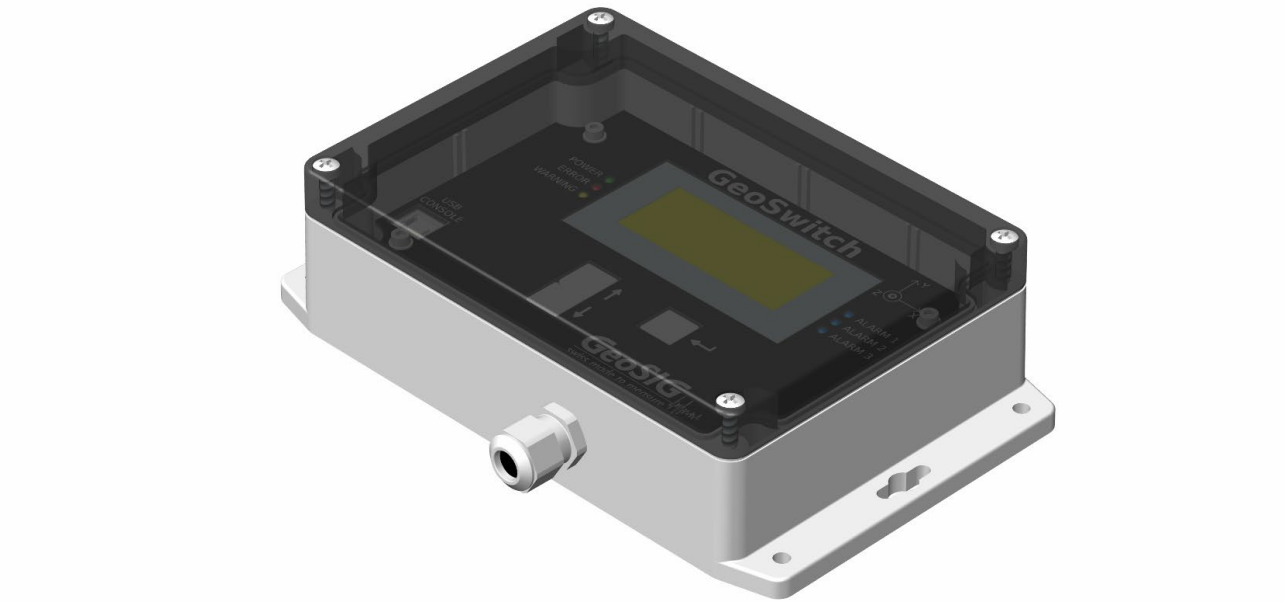


Figure 1. Instrument Housing.

3.2. Connectors

The GeoSwitch instrument has three connectors – *Main connector*, *USB Console connector and the LiPo Backup Battery connector.*.

The *Main Connector* must be only accessed during the first installation of the instrument. To access this connector the transparent cover and the internal black cover must be removed.

The *USB Console* connector can be accessed during normal operation when the transparent cover is removed.

The *Backup Battery* connector can only be accessed when both the transparent and the internal black cover are removed.

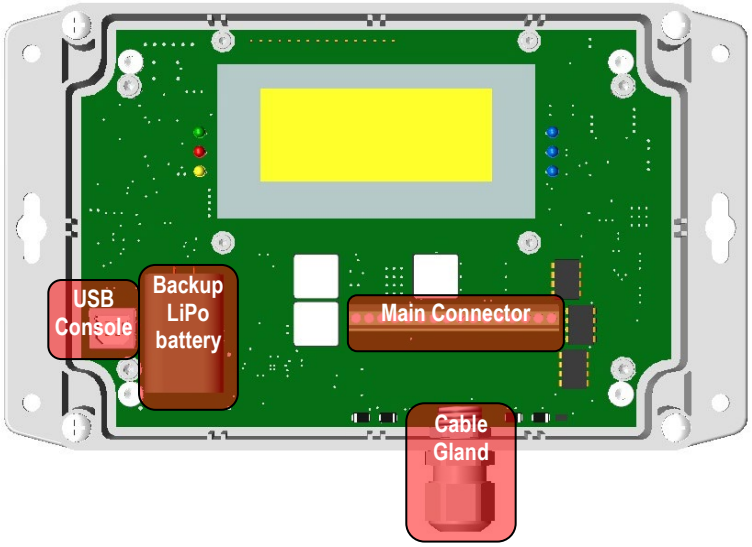


Figure 2. Location of Connectors on the Instrument,
shown with the transparent cover and internal black cover removed.

3.2.1. Main Connector

The *Main Connector* (J201) allows to connect the instrument with an external power supply, RS232/RS485 MODBUS control interface, Clear Switch and circuits controlled by the instrument's alarm relays.

The cable for *the Main Connector* shall come in through the cable gland to protect the unit from humidity leakage.

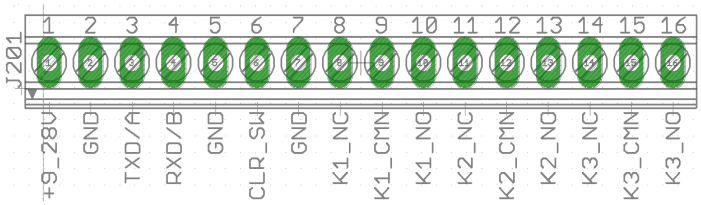


Figure 3 Main Connector pinout

Connector	Pin	Name	Comment
J201	1	+9-28 VDC	Power line for external power supply
	2	GND	Ground line for external power supply
	3	TXD/A	TXD line of RS232 interface or A line of RS485 interface (MODBUS)
	4	RXD/B	RXD line of RS232 interface or B line of RS485 interface (MODBUS)
	5	GND	Ground line for RS232 or RS485 interface (MODBUS)
	6	CLR_SW	Clear Switch input
	7	GND	Ground line for Clear Switch input
	8	K1_NC	Normally closed contact of relay 1
	9	K1_CMN	Common contact of relay 1
	10	K1_NO	Normally opened contact of relay 1
	11	K2_NC	Normally closed contact of relay 2
	12	K2_CMN	Common contact of relay 2
	13	K2_NO	Normally opened contact of relay 2
	14	K3_NC	Normally closed contact of relay 3
	15	K3_CMN	Common contact of relay 3
	16	K3_NO	Normally opened contact of relay 3

Each of three alarm relays of the GeoSwitch has 3 contacts, where one Common (Kx_CMN) contact will be connected to Normally Closed (Kx_NC) in case the instrument is not powered.

Figure 4. Schematic of Relay Contacts.

The pins RXD/B and TXD/A allow to interconnect the GeoSwitch with a master MODBUS device. Type of the physical interface (RS232 or RS485) can be configured by the following jumpers, located right above the *Main Connector*:

Interface	JP302	JP304	JP305	JP306
RS232	1-2	1-2	1-2	1-2
RS485	2-3	2-3	2-3	2-3

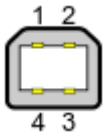
If the physical interface configured to RS485 and GeoSwitch is last MODBUS device at bus, then enable termination resistor (120 Ohm) by closing of JP213 jumper.

The GeoSwitch indicate activity at MODBUS interface by blinking of LED501 (visible from right side of "Up" button, when top cover detached only).

3.2.2. GeoSwitch Cable

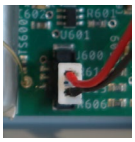
Please refer to Appendix D for cable drawing with pin colour code

3.2.3. USB Console Socket



This is a standard USB type B socket, which can be interconnected with computer to configure the GeoSwitch.

3.2.4. Battery Connector



The internal battery is provided with a short cable that has a polarised connector to avoid any wrong connections.
Please ensure that this connector is fully inserted and secured on the mating connector inside the instrument.

3.3. Visual Indicators

Several visual indicators (LCD and LEDs) show the status of the instrument.

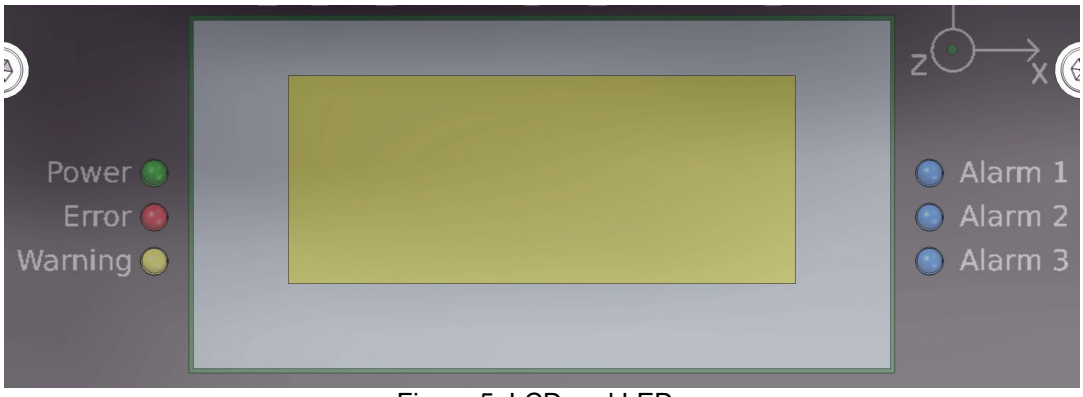


Figure 5. LCD and LEDs

3.3.1. LEDs

Colour	Indication	States
GREEN	**POWER**	Blinks once per second when external power supply is operating or when internal backup power source has enough charge.
RED	**ERROR**	**ON:** Error detected during operation. **OFF:** No errors detected.
YELLOW	**WARNING**	**ON:** Warning detected during operation. **OFF:** No warnings detected.
BLUE	**ALARM**	**ON:** Alarm activated. **OFF:** No alarm.

3.3.2. LCD

The LCD has 4 lines, 16 symbols each.
It shows information about current time, number of registered events for each relay and other information depending from display mode selected by push buttons.

3.4. Push Buttons

The UP, DOWN and SELECT push buttons allow to navigate between menus of the LCD.

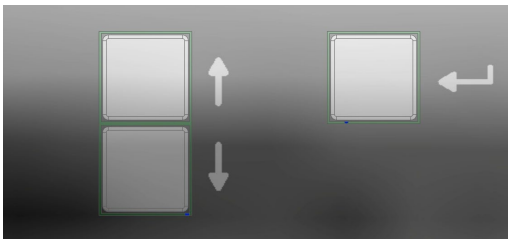


Figure 6. Push Buttons.

3.5. Power Supply and Internal Backup Power

The power can be fed to the instrument from any power supply, which provide at least 9 VDC at 0.8 A. Maximal voltage is 28 VDC.

Average power consumption of the GeoSwitch is around 0.3 W.

HW of GeoSwitch prior to version 3 has supercap as main backup power source. HW version 3 has Li-Po battery as main backup power source.

RTC has small supercap too, and it is used as a backup power source to keep time counting during power outage. RTC's supercap provides backup power for up to 10 days. Its charge time is around 2 minutes.

3.5.1. Supercap as Main Backup Power Source

Note: chapter applies only to GeoSwitch board versions ≤ 2.

After power ON GeoSwitch can consume up to 6.5 W for about 10-20 seconds during supercap charging.

The first supercap provides backup power for instrument for up to 400 seconds. Its charge time is around 1 minute after startup. The ERROR LED shows an error if the external power supply is switched OFF and the instrument is running from its internal supercap.

So, for maximal endurance it is required to provide external power to the instrument for at least during 2 minutes after power ON.

3.5.2. Li-Po Battery as Main Backup Power Source

Note: chapter applies only to GeoSwitch board versions ≥ 3.

After power ON GeoSwitch can consume up to 2.5 W for about 3-4 hours during LiPo battery charging.

The first LiPo battery provides backup power for instrument for up to 36 hours. The ERROR LED shows an error if the external power supply is switched OFF and the instrument is running from its internal battery.

After start up, it is recommended to fully charge the LiPo battery to extend the GeoSwitch autonomy in case of power loss.

3.6. Supplied Accessories

The following parts will be included in a shipment additional to the instrument:

- **USB type A – USB type B cable** used for the configuration through console or by means of GeoSwitch Configurator software.

Optional accessories:

- External **AC/DC power supply** module, 100 to 230 VAC / 50-60 Hz, CE and UL approved.

AC Power cable, depending on the shipping address with European, US or Swiss power plug.

4. Installation

This section lists the procedures involved in installation of the Instrument. The procedures will be outlined as steps to be performed in the field or in house prior to deploying the instrument in the field.

4.1. Site Selection

4.1.1. Environmental Considerations

Although the instrument is housed in a solid, weatherproof case, it should be installed in a place free from direct sunlight, precipitation, the danger of falling materials in the event of a severe earthquake and the risk of tampering or vandalism if the unit is to be left unattended.

You should make note at this point of any cultural or environmental sources of noise and vibration around the selected site, which may cause false triggers of the instrument. These will have to be considered when setting the alarm parameters.

It is important to select a site with an environmental noise as low as possible to avoid unwanted false alarms, e.g. from vibration from machinery, highway traffic, aircraft, waves, etc. It is wise to check the instrument frequently during the first several days of operation after each set-up, to see if there are previously unsuspected sources of noise which are triggering the instrument.

4.1.2. Power Supply Considerations

The Instrument may be powered from a 115 / 230 VAC supply through the external AC/DC converter or from a 9…28 VDC external power supply such as an automotive battery or solar panels.

- If the instrument will be powered in the field from a 115 / 230 VAC supply, an external AC/DC power supply is required. The GeoSwitch cannot be connected directly to 115 / 230 VAC. The VAC supply must consist of Phase, Neutral and Protection Earth.
- If the instrument is running from an external battery, the battery can be connected to the instrument directly. The external battery must be charged with an external battery charger or solar panels.

4.1.3. Communication Considerations

For setup of the instrument the USB Console port can be used. An intuitive graphical user interface allows easy configuration of the GeoSwitch by any computer or laptop.

The GeoSwitch can be integrated into a MODBUS network. The instrument acts as slave and information of its status and detected events can be polled by any MODBUS master device. The slave address of the seismic switch and all its parameters can also be configured using the LCD menus, console or MODBUS interface.

The MODBUS interface can be configured to have RS232 or RS485 electrical levels by jumpers on the board.

4.1.4. Configuration Considerations

It is highly recommended, to check and configure the Instrument for the correct time, trigger and other relevant settings in the lab, prior to the installation. It may then be carried to the remote site and then connected to the VAC power through the external AC/DC converter or directly to the VDC power source or battery. After turning the Instrument *ON*, the instrument runs with the pre-configured parameters. This reduces the amount of time needed to configure in the field; an important consideration in the case of an adverse condition. The internal real time clock continues to run for 10 days if the instrument is switched off. If the instrument is installed later, then the time must be set again in the field. All configuration parameters are stored permanently.

4.2. Physical Installation

Many times the locations of seismic equipment are highly exposed to electrical disturbances caused by lightning or by the industrial environment. Although the instrument contains over voltage protection, it may be necessary to use additional surge protectors for the equipment. Contact GeoSIG or your local representative for more information.

4.2.1. Requirements for the Instrument Foundation

- Minimum surface area requirements are 25 x 20 cm.

Foundation has to be very well anchored or adhered to a controlled surface. In case of a need for a foundation on soil, a concrete cube of 1 m^3 has to be cast in the ground to serve as a base.

4.2.2. Mounting the Instrument

The unit must be fixed rigidly on the foundation. For that purpose, the housing has mounting flanges for fixation, where two or four M4 screws with washers should be used. The GeoSwitch contains an internal offset correction. Therefore the instrument can be installed on the floor, wall or any other oriented surface without any limitations.

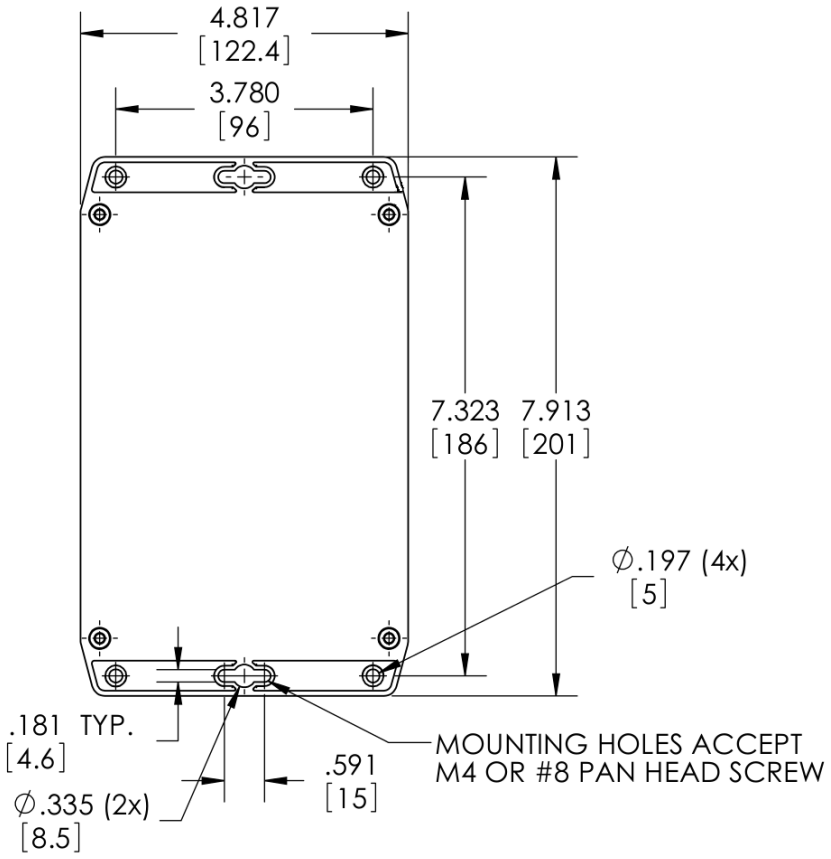


Figure 7. Dimensions of Housing for Fixation.

Prepare the installation surface:

- Place the housing at the selected location. Verify that the surface is sufficiently flat. Be sure to leave enough space at the bottom and front and side of the Instrument for the cable inlet and for opening the cover. The sides of the instrument should typically not be closer than 20 mm from a wall. Mark on the surface the location of the fixation holes and remove the housing again.
- Check that the M4 threads for the instrument fixation are free from dust.
- Drill appropriate holes in the surface.
- Clean up dust at area of holes.
- Mount the housing in place and fix it by screws.

☞ *Do not overtighten the screws.*

4.2.3. Connection of Cable to Main Connector

Cable diameter should be 6.5 – 8.0 mm to nicely fit and be tightened in the cable gland. This will ensure protection from humidity. Cross section of cable wires should be up to 1.5 mm^2 to provide good fixation and contact inside of the terminal blocks.

To access the Main Connector the internal black cover must be removed. Make sure the instrument is switched off and all LEDs on the front are off before removing the black cover by its four screws in the corner. Pinout of the Main Connector can be seen in chapter 3.2.1.

☞ ***It is required to connect relays to controlled equipment in such a way, so that in case of power outage for GeoSwitch, its relays should block operation or activate brakes of controlled equipment for safety reasons.***
Additionally, it is required to configure triggering of GeoSwitch to block operation or activate brakes of controlled equipment in case of alarm or errors.

4.2.4. Connection of the internal LiPo backup battery

The *Backup Battery* and its connector can only be accessed when both the transparent and the internal black cover are removed.

The covers are secured using a total of 8 screws, 4 per panel as shown in the figure below.

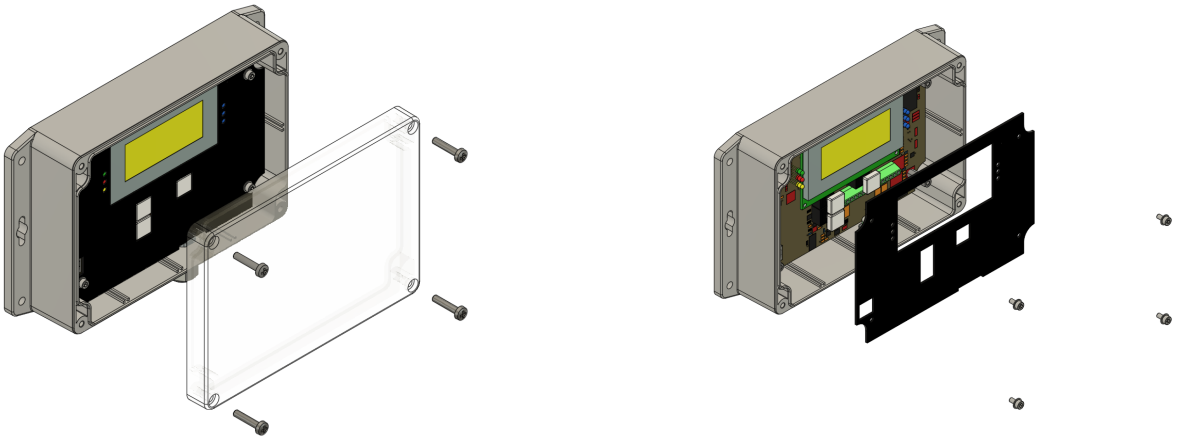


Figure 8 - Removal of protective covers

Once the protective panels have been removed, the GeoSwitch internal electronic boards and battery will be visible as shown in the figure below.

For ease of installation and to avoid wrong connections, the internal battery is provided with a short cable that has a polarised connector. To connect the battery, simply insert the connector into the dedicated slot.

Please ensure that this connector is fully inserted and secured on the mating connector inside the instrument.

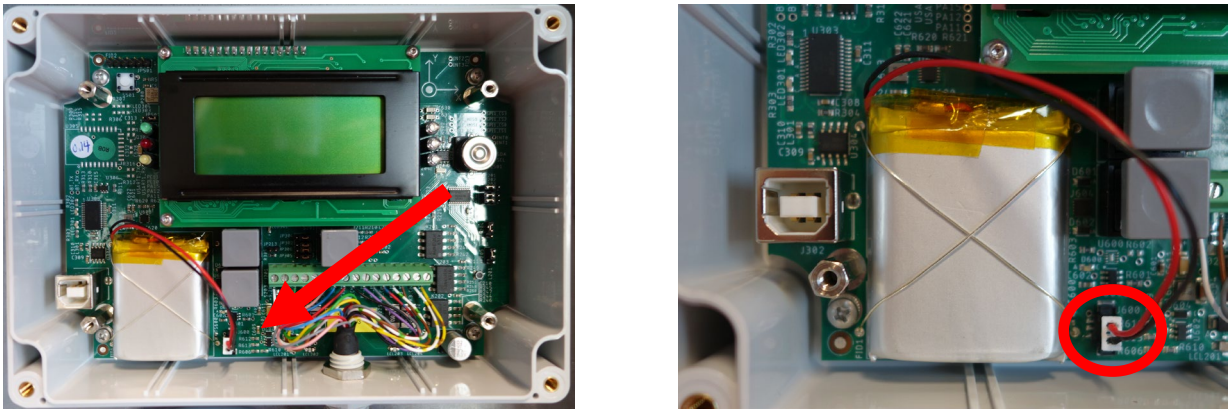


Figure 9 - Internal Battery Connector

☞ ***If installed, the optional LiPo backup battery must be connected before first use of instrument.***

☞ **STATIC ELECTRICITY**

The instrument contains CMOS devices and when serviced, care must be taken to prevent damage due to static electricity. This is very important to ensure long-term reliability of the unit. Such risk exists when both the instrument cover and the front panel are removed.

5. Principle of Operation of the Instrument

This chapter gives an overview about the normal operation the instrument in a network or as a standalone unit.

5.1. Interfaces of the GeoSwitch

Generally, GeoSwitch has LCD display, LEDs, push buttons, Main Connector and Console Interface (USB).

Main Connector allows connecting:

- External power source.
- MODBUS master to configure the GeoSwitch and fetch data from it.
- Equipment to be controlled from its alarm relays.
- Clear Switch to reset the GeoSwitch or reset detected alarm events.

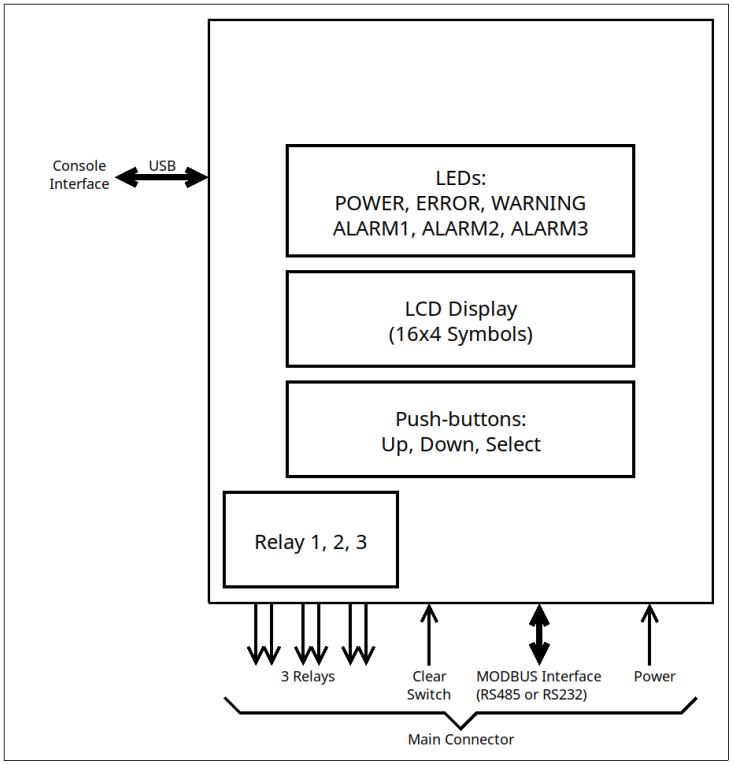


Figure 10. GeoSwitch Interfaces.

5.2. Normal Operation

During normal operation the instruments are installed on sites and connected to controlled devices. Optionally, the instrument can be connected to a Clear Switch, MODBUS master and/or to a Console interface.

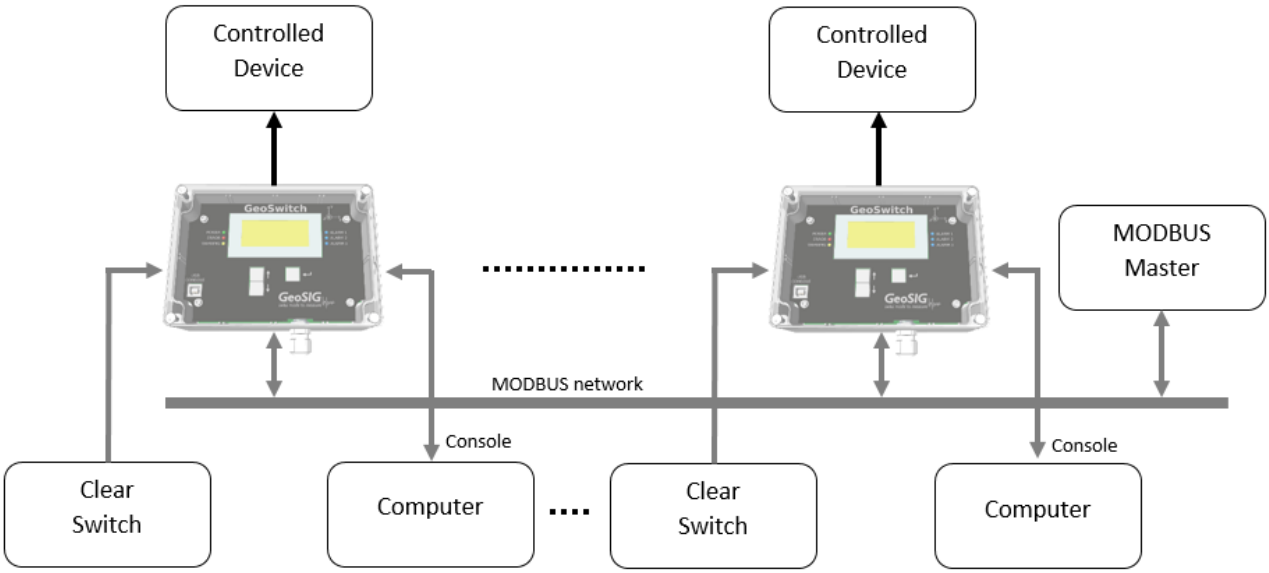


Figure 11. Connections of GeoSwitch.

The instrument detects vibrations and activates alarms in case of thresholds exceeding and/or errors (depends from configuration).

Alarms activation will directly influence on controlled devices through the alarm relays. Optionally (if configured), internal buzzer of the GeoSwitch will beep periodically during active alarm.

5.3. Switch ON and OFF the Instrument

The GeoSwitch does not have any main power switch, so its power should be switched off externally. Because of its internal backup power source it is required to wait up to 400 seconds until GeoSwitch will completely switch off. Alternatively GeoSwitch can be reset and powered off through the Clear Switch input if it is configured to reset the device and external power is off. The last possibility to switch off GeoSwitch is by pushing the RESET push button S501 on the main board, while external power is off.

5.4. Redundant Quadruplet Matrix

The GeoSwitch contain four identical accelerometers, 3-axis each.

To determine which MEMS sensors are trustable and which are not, they are tested for following criteria:

1. MEMS identifiers correspond to expected value. This is checked only during GeoSwitch startup. Error code is ERR_ACCEL_NOT_DETECTED.
2. Static vector of the g-force is equal to 1 g ± 1%. This is checked continuously, for each of MEMS, during normal GeoSwitch operation. Error code is ERR_G_FORCE_VECTOR_IS_BAD.
3. Feedback on self-test is within predefined limits. This is checked continuously and sequentially, for each of MEMS, during normal GeoSwitch operation. Error code is ERR_TEST_PULSE_BAD.

If any of the accelerometers produce false data during any of above tests, then it is marked as bad and excluded from data acquisition. The GeoSwitch will continue to react on threshold or vector exceeding if at least one of sensors is valid.

If all sensors are bad, then error flag ERR_TOO_MUCH_OF_BAD_MEMS will be asserted.

Note: It is important for safety to have at least one of relays to be used as alarm for Fault condition. This will allow to stop device which is under control of the GeoSwitch.

5.5. System Test

Main functionality of the GeoSwitch can be tested by means of the “System Test” LCD menu or by the “systest” console command.

System Test will sequentially make following actions:

- Configuration data checked for correctness. Error code is ERR_WRONG_CONFIG.
- All LEDs are switched OFF and then sequentially switched ON by pairs for 1 second and then OFF. Should be checked visually.
- Voltage of external power should be >= 8.95 VDC. Error code is ERR_V_IN_IS_LOW.
- Voltage of main supercap should be >= 2.0 VDC. Error code is ERR_V_SUPERCAP_IS_LOW.
- Voltage of main DC-DC converter should be >= 3.20 VDC. Error code is ERR_V_DIODES_IS_LOW.
- Voltage of RTC’s supercap should be >= 2.5 VDC. Error code is ERR_V_RTC_IS_LOW.
- All relays and alarm LEDs are switched OFF, then they are sequentially switched ON for 2 seconds and then OFF. Should be checked visually and by ohmmeter at relay contacts on the main connector.
- Beeper shortly beeps for 0.1 second. This is indication of test end.

If any test encounters an error, then corresponding error code will be set and can be seen from “Errors” LCD menu or by means of “errors” console command. The “Error” LED will show presence of any error.

Notes:

- *During the system test, monitoring of predefined relay events temporary disabled. It is forbidden to use system test if GeoSwitch control real elevator or another device in operation. This is dangerous!*
- *Acceleration sensors excluded from system test, because they are tested continuously in an operation process. See chapter about RQM.*

6. Configuration of the Instrument

6.1. General

STA/LTA feature added from version 1.1.0 of GeoSwitch FW.

At first start or after a restart (reboot), the GeoSwitch needs to stabilize its signal filters based on actual ambient conditions and vibrations, to achieve higher accuracy. This may take up to 1-2 minutes during which STA/LTA and Threshold triggering functions disabled.

STA/LTA feature must be used with care, because it is possible thoughtlessly set up such combination of sensor gain and STA/LTA ratio, so GeoSwitch will be physically unable to trigger in case of seismic event. As safety countermeasure, it is recommended to use two relays in parallel, where the first is configured to use the STA/LTA ratio and the second is configured to use the acceleration threshold. This will provide a logical "or" function for triggering.

All the configuration changes can be made through interface:

- USB Console port with help of
  - Terminal software and console commands,
  - GeoSwitch Configurator software for PC.
- MODBUS interface with appropriate software.

The USB Console port represented as virtual serial port (COMn port for MS Windows or /dev/ttyUSBn for GNU Linux OS). It is based on the FT232R USB UART integrated circuit. Most recent OS have a built-in device driver for the FT232R.

The MODBUS interface of GeoSwitch is a MODBUS over Serial Line with RTU transmission mode.

The GeoSwitch have various configuration features.

6.1.1. STA Duration

STA duration is a common parameter for all relays.

Must be specified in range from 0.2 to 50.0 seconds.

STA duration limited to be less than LTA duration.

Measured in 0.1 second counts.

STA duration has effect on "sta_lta", "sta_lta_vector", "sta_lta_fault", "sta_lta_vector_fault" usage of relay. See chapter Relay Usage.

Default is 2 (0.2 seconds).

6.1.2. LTA Duration

LTA duration is a common parameter for all relays.

Must be specified in range from 1.0 to 250.0 seconds.

LTA duration limited to be greater than STA duration.

Measured in 0.1 second counts.

LTA duration has effect on "sta_lta", "sta_lta_vector", "sta_lta_fault", "sta_lta_vector_fault" usage of relay. See chapter Relay Usage.

Default is 10 (1.0 seconds).

6.1.3. Relay Usage

Relays can be configured to activate contacts on following event types:

- threshold – when acceleration at corresponding axis exceeds threshold value.
- vector – when vector sum of accelerations (acceleration at any direction) exceeds threshold value.
- fault – when internal error state is registered.
- thresholdfault – when threshold or fault event happen.
- vectorfault – when vector or fault event happen.
- power – when input power is present and corresponds to requirements.
- heartbeat – when alarm state alternate between set and unset state periodically until fault will happen.
- sta_lta – when STA/LTA at corresponding axis exceeds threshold value of STA/LTA.
- sta_lta_vector – when vector sum of STA/LTA exceeds threshold value of STA/LTA.
- sta_lta_fault – when STA/LTA at corresponding axis exceeds threshold value of STA/LTA or when internal error state is registered.
- sta_lta_vector_fault – when vector sum of STA/LTA exceeds threshold value of STA/LTA or when threshold or fault event happen.

Default is Threshold usage for relays 1 and 2, and Fault usage for relay 3.

The Heartbeat is a special usage, which increase counter of events by Heartbeat start event and Fault event.

Vector sum is calculated as $V = SQRT(X^2 + Y^2 + Z^2)$.

6.1.4. Relay Threshold Values of Acceleration

Relays configured to be used on acceleration threshold exceeding, need to have configured threshold values of acceleration for X, Y and Z axes of GeoSwitch.

Relays configured to be used on vector sum exceeding, need to have configured one threshold value of acceleration.

Threshold values must be specified in mg (Milli g).

Applicable only for Threshold and Vector usage of relay.

Default is 1000 milli g.

6.1.5. Relay Threshold Values of STA/LTA

Relays configured to be used on STA/LTA exceeding, need to have configured threshold values of STA/LTA for X, Y and Z axes of GeoSwitch.

Relays configured to be used on vector sum exceeding, need to have configured one threshold value of STA/LTA.

Threshold values of STA/LTA has multiplication coefficient 10.

Applicable only for "sta_lta" and "sta_lta_vector" parts of relay usage.

Default is 10 (means 1.0).

6.1.6. Relay Hold Time

This is the time during which the relay will be active after disappearing of an alarm event.

Must be specified in range from 0 to 6553.5 seconds.

Measured in 0.1 second counts.

To set infinite hold time select 0.

Relay hold time does not have effect on “fault” usage and on “fault” part of combined usage such as “thresholdfault”, “vectorfault”, "sta_lta_fault", "sta_lta_vector_fault".

Note: For the “power” usage of relay, hold time determines how long alarm will be kept after loss of input power from the power supply.

Default is 50 (5 seconds).

6.1.7. Relay Window Time

This is the time for detection of seismic events.

Window time started at threshold exceeding and during this window the algorithm search for "Maximal acceleration of event" for each axis (threshold or sta_lta usage) or for Vector sum (vector or sta_lta_vector usage).

The window is prolonged/restarted for each new sample if its amplitude is above threshold.

When the window is timed out, then "Maximal accelerations of Event" saved as an attribute of Event.

Must be specified in range from 2.0 to 6553.5 seconds.

Measured in 0.1 second counts.

Applicable only for "threshold", "vector", "sta_lta", "sta_lta_vector" parts of relay usage.

Default is 20 (2 seconds).

6.1.8. Relay Trip Time

This is the time, which specifies how long a seismic event should continue in order to enable alarm.

Must be specified in range from 0 to 6553.5 seconds.

Default is 0 (immediate alarm after exceeding of threshold).

Measured in 0.1 second counts.

Applicable only for threshold, vector, sta_lta, sta_lta_vector usage of relay.

Default is 0 (0 seconds).

6.1.9. Relay Beeper

The GeoSwitch can beep three times (500 ms beep, 500 ms silence) at start of each 10 seconds if alarm is active for specified relay.

Can be disabled or enabled.

Default is enabled.

6.1.10. Relay Inversion

State of relay contacts can be logically inverted.

If inversion disabled, then NO (Normally Opened) contacts will be closed only if GeoSwitch is powered on and alarm is active.

If inversion enabled, then NO contacts will be closed only if GeoSwitch is powered on and alarm is inactive.

Can be disabled or enabled.

Default is disabled.

This setting does not affect Alarm LEDs operation.

6.1.11. ClearSwitch Input

The ClearSwitch input can be configured to one of functions:

- reset – to reset GeoSwitch,
- alarm – to reset counters of registered events for all relays.

Default is to reset counters of registered events.

6.1.12. Frequency Band of Digital Filter

Digital band-pass filter of GeoSwitch can be configured to one of frequency bands:

- 0.5-10.0 Hz
- 1.0-10.0 Hz
- 1.1-7.7 Hz
- 2.0-3.0 Hz
- 0.1-15.0 Hz.

Default is 0.5-10 Hz.

6.1.13. Full Scale of Accelerometer

Acceleration sensor can be configured to use one of ranges:

- ±2 g (±1966 mg)
- ±4 g (±3932 mg)
- ±6 g (±5898 mg)
- ±8 g (±7864 mg)
- ±16 g (±16000 mg)

Default is ±2 g.

Real ranges for ±2, 4, 6, 8 g are slightly narrow, because of specific gains of the MEMS sensors at these ranges.

6.1.14. MODBUS Slave Address

Change of this setting will apply after reboot only.

The GeoSwitch MODBUS interface can be configured to use one of addresses from range 1-247.

Default is 1.

6.1.15. MODBUS Baud-rate

Change of this setting will apply after reboot only.

The GeoSwitch MODBUS interface can be configured to use one of baud-rates:

- 9600
- 19200
- 38400
- 57600

Default is 19200.

6.1.16. Time of RTC

The GeoSwitch has RTC which counts local time. Its time can be set to current time.

Supported range for years is 2000..2099.

6.1.17. Comment for Device

This value is write-protected and can be set up at factory only.
32 ASCII characters maximum.

6.1.18. Serial Number of Device

This value is write-protected and can be set up at factory only.
8 ASCII characters maximum.

6.1.19. Type of Device

This value is write-protected and can be set up at factory only.
16 ASCII characters maximum.

6.1.20. Date of Production, Calibration or Test

This value is write-protected and can be set up at factory only.
8 ASCII digits for each value.

6.2. Logging of Alarm Events

Activation of any alarm will be registered as an event and this event will be written into corresponding event buffer.

Each relay has its own event buffer.

Buffers are FIFO type and can keep up to 10 events each.

First event will be purged (lost) from buffer if new event pushed on top of existing 10 events.

Registered events can be seen by means of

- “Events> Relay N> Relay N Events> Events Log>” LCD menu.
- “events [1|2|3]” console command.
- GeoSwitch Configurator software.
- Software for MODBUS interface.

Event buffers preserved if external power disabled and internal backup power of GeoSwitch is completely exhausted.

Additionally, event buffers preserved during restart of GeoSwitch by ClearSwitch input.

But, events registered after last preservation of events will be lost if GeoSwitch is restarted by Reset button (S501).

6.2.1. Event Types

Registered events can be following types:

- Threshold (T) — for exceeding of acceleration threshold at any axis.
- Vector (V) — for exceeding of acceleration vector.
- Fault (F) — for any system error.
- Power (P) — for external power detection.
- Heartbeat (H) — for start of heartbeat operation.
- STA/LTA (S) — for exceeding of STA/LTA threshold at any axis.
- STA/LTA Vector (SV) — for exceeding of STA/LTA threshold at any axis.

6.3. Changing Configuration using GeoSwitch Configurator SW

The GeoSwitch Configurator SW is supplied with the instrument and can also be fetched from GeoSIG web server at “Downloads” page.

Unpack it onto some directory, for example into the “C:\tools\GeoSwitch”.

Start the sswgui executable file.

Below is a window of GeoSwitch Configurator SW with “About Application” sub-window (menu Help/About).

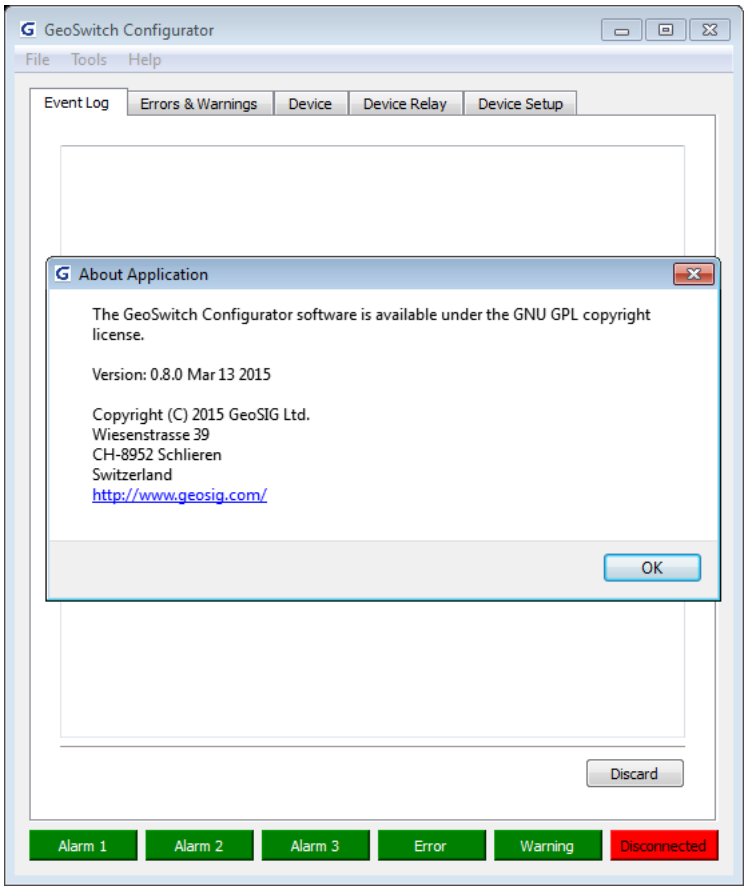


Figure 12. About GeoSwitch Configurator SW.

Connect the GeoSwitch to a USB port of a PC and switch on the GeoSwitch if not already done.

Press the Disconnected button or use menu Tools/Connect and a connection dialog window will appear. It is required to choose COM port of the GeoSwitch device and baud-rate.

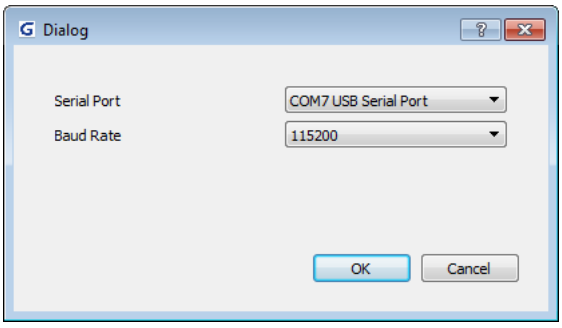


Figure 13. COM Port and Baud-rate Setup.

The GeoSwitch Configurator will automatically fetch the state of the GeoSwitch device and reflect it in the GeoSwitch Configurator.

State of ALARM, ERROR and WARNING LEDs is reflected by states of corresponding indicators/buttons at bottom of window. Red indicator is for active alarms, errors and warnings.

All registered alarm events are printed in the “Event Log” tab where the first digit is a relay number, next is a time stamp of event, third is alarm type and following is corresponding values for event.

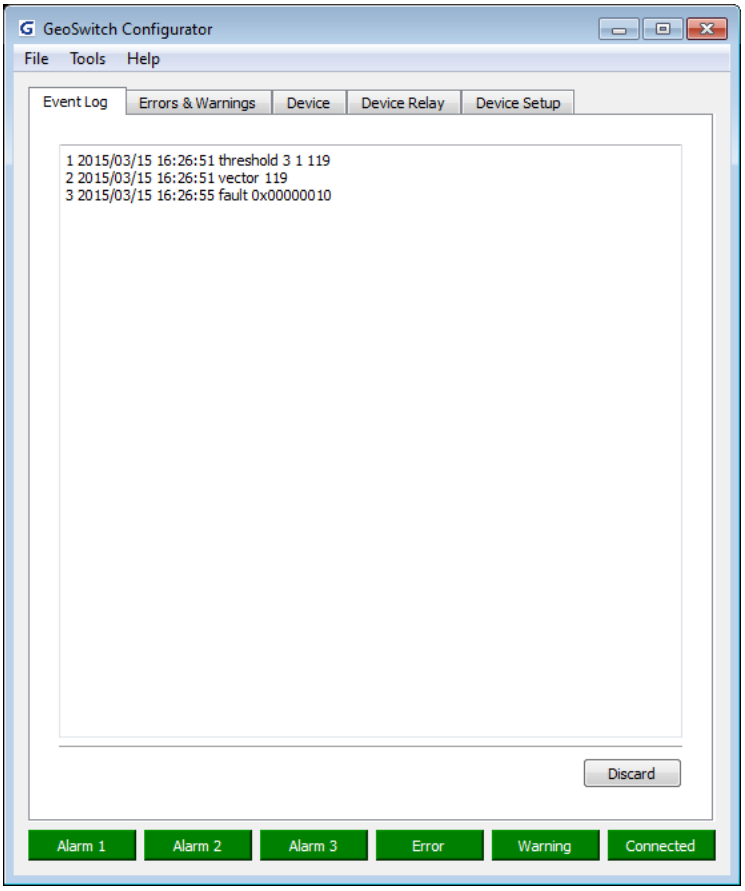


Figure 14. Event Log Tab of GeoSwitch Configurator.

Threshold and Vector event values are in mg for X, Y and Z axes or for vector sum.

Fault is a HEX code of error.

The “Errors & Warnings” tab reflects presence of any errors and warnings.

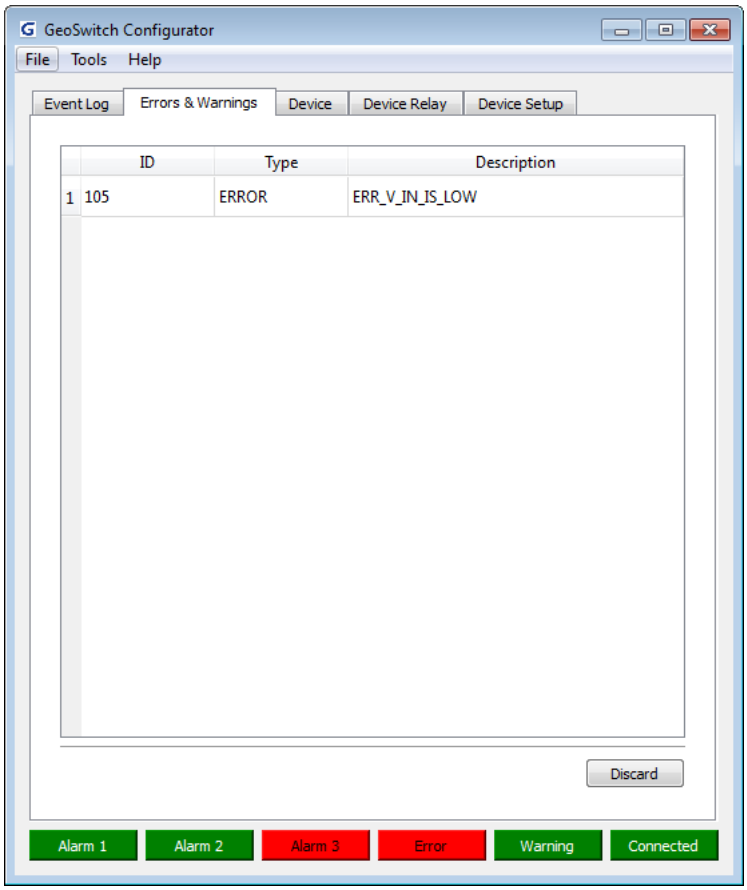


Figure 15. Errors & Warnings Tab.

The “Device” tab reflects factory set information such as device Type, Serial Number, Comment, dates of Production, Calibration, and Testing.

Additionally, this tab shows FW version, HW configuration, internal voltages at backup power source of RTC, main backup power source, Main, Input and System information.

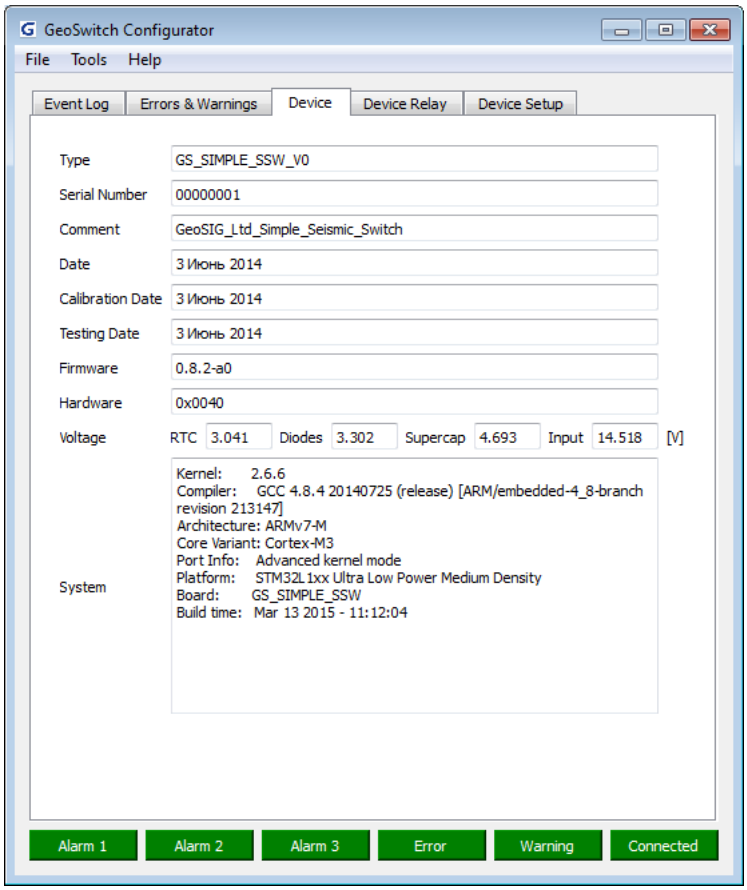


Figure 16. Device Tab.

The “Device Relay” and “Device Setup” tabs reflect current setup of device, allow changing configuration values and writing (Apply) changes into the GeoSwitch device.

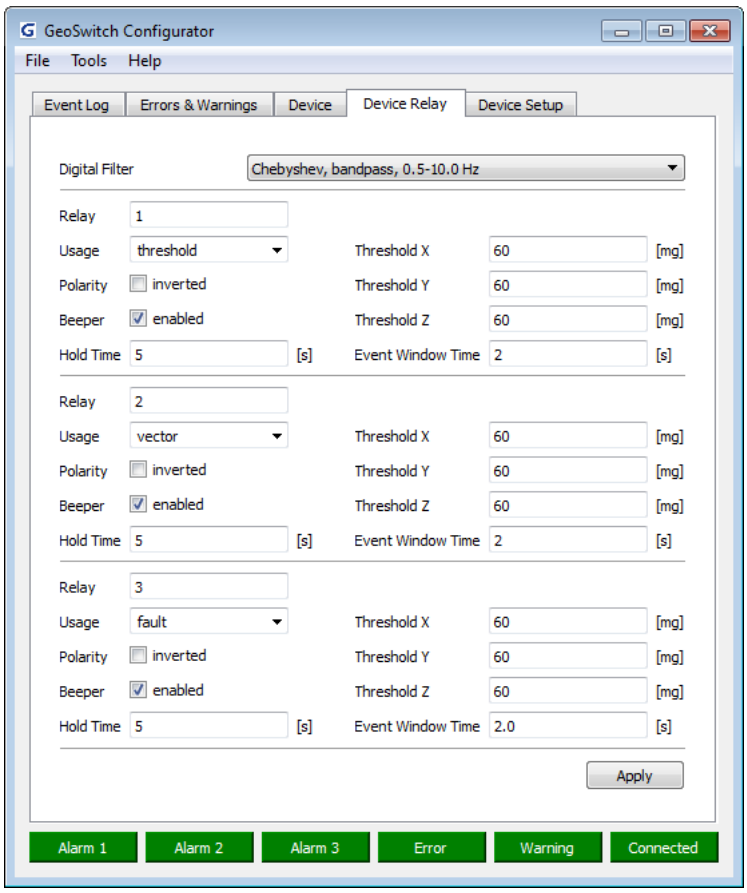


Figure 17. Device Relay Tab.

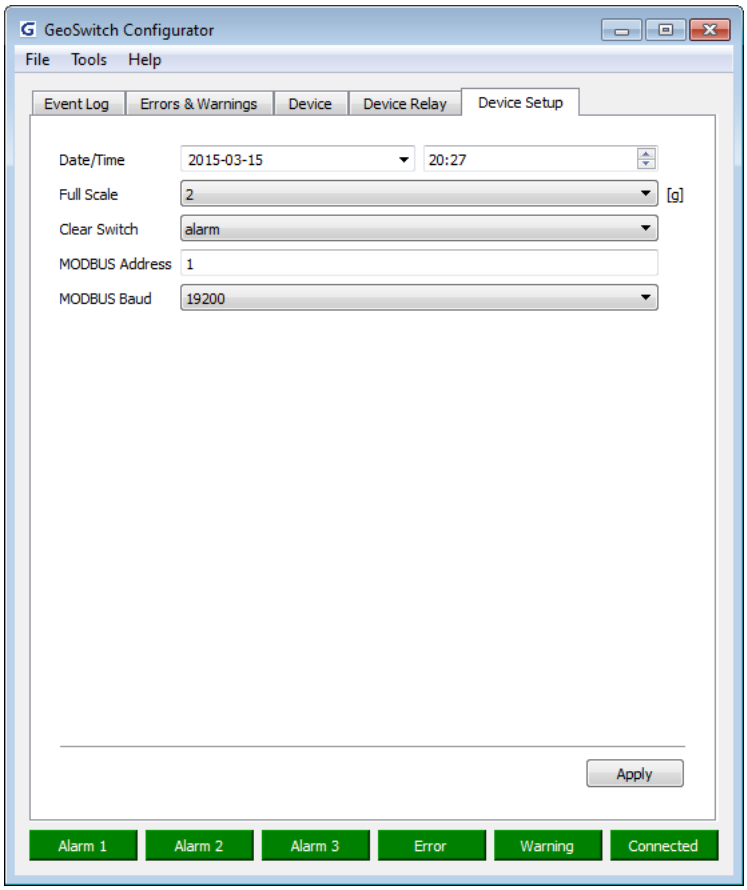


Figure 18. Device Setup Tab.

Change of MODBUS address and/or baud-rate will be applied after reboot only.

The File menu allows to Save configuration into a file and/or Load it when required.

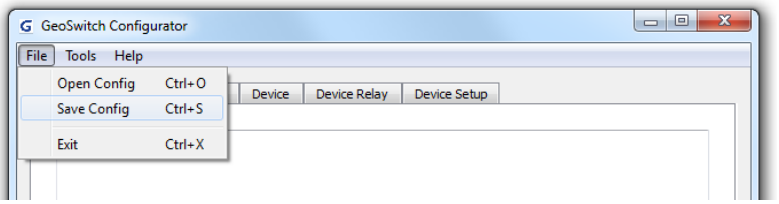


Figure 19. File menu.

6.4. Changing Configuration from Terminal by Console Commands

Note: STA/LTA feature added from version 1.1.0 of GeoSwitch FW.

Any serial terminal SW (hyperterminal, minicom, kermit, teraterm, ucon or other) can be used to communicate through Console Interface (USB).

Connect the GeoSwitch to a USB port of PC and switch on the GeoSwitch if not already done.
Configure serial terminal SW to use 115200 bauds, 8 bit, no parity, 1 stop bit.

6.4.1. Console Commands

Commands can have mandatory parameters (shown after command name without brackets) and/or optional parameters (shown in square brackets).

If the optional parameter is omitted, the current value will be printed.

Character '|' means logical OR. Only one of OR-ed parameters can be specified.

UPPER_CASE parameters should be replaced by real values like MODBUS address or time.

Command	Functionality
`help`	Show all available commands
`alarm`	Show numbers of activated alarms (relays).
`calibration x|y|z [make|clear]`	Make calibration or clear calibration values. Show by default.
`clearswitch [alarm|reset]`	Clear Switch usage (to clear alarms or reset GeoSwitch).
`debug`	Command for debugging purposes only. Not for use by end users.
`default`	Reset most of settings into default values.
`errors [clear|code]`	Error status of GeoSwitch. Text of error messages printed by default. See appendix for error codes.
`events [1|2|3] [clear]`	Show or clear alarm events for all or only for one of specified relay. Command print following fields: 1. Relay Number – e.g. '1', '2' or '3'. 2. Date – e.g. "2015/03/08". 3. Time – e.g. "23:01:00". 4. Event type – e.g. "threshold", "vector", "fault", "power", "heartbeat", "sta_lta", "sta_lta_vector". 5. Event values – e.g. 3 digits in mg for X, Y and Z accelerations for threshold or one digit in mg for vector, or HEX-code for error code. Example: "3 2015/05/05 16:01:51 threshold 338 620 15".
`exit`	Standard command to exit from OS shell. New shell thread started automatically.
`filter [0|1|2|3|4]`	Type of predefined digital filter. Filter numbers can be following: • 0 – 0.5-10.0 Hz, • 1 – 1.0-10.0 Hz, • 2 – 1.1-7.7 Hz,

	• 3 – 2.0-3.0 Hz, • 4 – 0.1-15.0 Hz.
`fullscale [2|4|6|8|16]`	Full scale of accelerometer in g. Values are ±2, ±4, ±6, ±8, ±16 g.
`info`	Information about OS kernel, compiler version, MCU architecture and core and other details.
`hardware`	Show HEX code of HW configuration.
`mbaddr [ADDRESS]`	MODBUS slave address (decimal digit from 1 to 247). ***Note: change of this setting will apply after reboot only!***
`mbbaud [9600|19200|38400|57600]`	Speed of MODBUS interface in bauds. ***Note: change of this setting will apply after reboot only!***
`mem`	Information about free RAM of OS.
`mems 1|2|3|4 offset|rms|acccel|raw`	Information about different kinds of accelerations from one of 4 MEMS sensors. Command for debugging purposes only. Not for use by end users.
`voltage rtc|diodes|backup|input`	Show voltages of the GeoSwitch power supplies in millivolts.
`writeprotection`	State of Write Protection ('1' means write protected).
`ps`	Information about running threads. Command for debugging purposes only. Not for use by end users.
`sta_duration [TIME]`	STA duration. Counted in 0.1 seconds. From 0.2 to 50.0 seconds. Default is 0.2. STA duration limited to be less then LTA duration.
`lta_duration [TIME]`	LTA duration. Counted in 0.1 seconds. From 1.0 to 250.0 seconds. Default is 0.2. LTA duration limited to be greater than STA duration.
`relay 1|2|3 usage [threshold|thresholdfault|vector|vectorfault|power|fault|heartbeat|sta_lta|sta_lta_vector|sta_lta_fault|sta_lta_vector_fault]`	Usage of relay in case of triggering. See chapter Relay Usage.
`relay 1|2|3 threshold [X Y Z]`	Thresholds for accelerations in mg. One digit only (X) should be specified in case of Vector usage.
`relay 1|2|3 sta_lta [X Y Z]`	Thresholds for STA/LTA. One digit only (X) should be specified in case of Vector usage. Multiplication factor is 10.
`relay 1|2|3 holdtime [TIME]`	The hold time of relay. Counted in 0.1 second. From 0 to 6553.5 seconds. Zero value means infinite hold time.
`relay 1|2|3 window [TIME]`	The window time for trigger detection algorithm. Counted in 0.1 second. From 2.0 to 6553.5 seconds. See chapter Event Detection Algorithm.
`relay 1|2|3 triptime [TIME]`	The trip time defines how long seismic event should continue to enable alarm. Counted in 0.1 seconds. From 0 to 6553.5 seconds. Default is 0 (immediate alarm after exceeding of threshold).

`relay 1|2|3 beeper [0|1]`	Disable or enable beeper in case of alarm.
`relay 1|2|3 inverted [0|1]`	Normal or inverted state of relay contacts.
`systest`	Run system test.
`systime`	Number of OS ticks from startup. Counted in milliseconds for GeoSwitch V1.
`time [YYYY/MM/DD hh:mm:ss]`	Show or set local time.
`unlockmenu`	Disable locking of LCD menu.
`version`	Show firmware version.
`warnings [clear|code]`	Show warning status of GeoSwitch. Text printed by default. See appendix for warning codes.

6.4.2. Console Commands with Write Protection Option

Following commands can be used for setup only at GeoSIG factory, because they are write-protected.

Command	Functionality
`comment [STRING]`	User defined string for device. 32 ASCII character maximum.
`serialnum [STRING]`	Serial number of device. 8 ASCII characters maximum.
`type [STRING]`	Type of device. 16 ASCII characters maximum.
`date production|calibration|test [YYYYMMDD]`	Date of production or calibration, or last test of GeoSwitch. 8 ASCII digits. E.g. 20150508.
`calibration x|y|z [make|clear]`	print, make or clear calibration for one of corresponding axis.

Typically, user allowed using these commands without parameters (only for data printing). Otherwise error message will be printed.

6.5. Setup of MODBUS Interface

See chapter Main Connector for proper set up of physical bus type for MODBUS interface.

6.6. Changing Configuration through MODBUS Interface

> ***Information about MODBUS registers of GeoSwitch can be found at the "Appendix A. MODBUS Registers".***

The **sswui** is a CLI SW for PC and can be used for communication through MODBUS interface over serial bus (RS485 or RS232).

Connect the GeoSwitch to a serial port of PC and apply power to the GeoSwitch if not already done.

The Instrument uses 19200 bauds, 8 bit, no parity and 1 stop bit by default.

If MODBUS settings were changed earlier, then it is required to know current MODBUS slave address of GeoSwitch (default is 1) and baud rate of serial port (default is 19200).

> ***If values of MODBUS slave address and baud-rate are not known (forgotten), then GeoSwitch can be forced to use default slave address and baud rate. Pins 1-2 of jumper JP205 must be closed for this purpose.***

> ***Change of MODBUS address and/or baud-rate will be applied after reboot only.***

Run **sswui** SW with "--help" option to print embedded help:

```
> sswui --help
Usage: sswui [-p PORT -b BAUDRATE -s ADDRESS] [-c FILE] [-d] -a ACTION --mb-dbg

  -h, --help                show help.
  -a, --action=ACTION       ACTION can be:
                                show-events;
                                show-fw-ver;
                                show-error-status;
                                show-warning-status;
                                show-sensors-raw;
                                set-time - setup local time of instrument;
                                get-config - get configuration from instrument into
file;
                                edit-config - edit configuration file;
                                put-config - put configuration from file into
instrument.
  -c FILE, --config-file=FILE name of configuration file.
                            The sswui.conf is default if not specified.
  -d, --default             load default data before to edit configuration file.
  -p PORT, --port=PORT      name of serial port device.
                            The COM1 by default if not specified.
  -b BAUD, --baudrate=BAUD serial port baud rate.
                            19200 bauds is default if not specified.
  -s ADDR, --slave=ADDR     MODBUS slave address.
                            1 is default if not specified.
  -V, --version             show version of software.
  -m, --mb-dbg              show MODBUS debugging information.

Examples:
  sswui -p COM1 -b 19200 -s 1 -a show-events
  sswui -p COM1 -b 19200 -s 1 -a get-config -c sswui.conf
  sswui -c sswui.conf -a edit-config
  sswui -c sswui.conf -a edit-config -d
  sswui -p COM1 -b 19200 -s 1 -a put-config -c sswui.conf
```

Configuration of GeoSwitch can be retrieved into the **sswui.conf** file by command

```
> sswui  -p COM1  -b 19200  -s 1 –a get-config –c sswui.conf
Start to read configuration from device...
Done
```

Such options as serial port name, baud-rate, slave address, configuration file name can be omitted if they are the same as default.

Configuration in the **sswui.conf** file can be edit by command

```
> sswui –a edit-config –c sswui.conf
Main Menu
  A) MODBUS Slave Address ... 1 (0x01)
  B) MODBUS Baud Rate ..... 19200
  C) Full Scale, +-g ..... 2
  D) Digital Filter Type .... Chebyshev, bandpass, 1-15Hz
  E) ClearSwitch Type ..... alarm
  F) STA Duration ........... 2 (0x02)
  G) LTA Duration ........... 10 (0x0A)
  H) Trigger for Relay 1 .... ->
  I) Trigger for Relay 2 .... ->
  J) Trigger for Relay 3 .... ->
  K) Factory Settings ..... ->
```

Press key ‘A’ to setup MODBUS slave address or another key for corresponding menu item to change.

Items with keys ‘H’, ‘I’, ‘J’ and ‘K’ are submenus.

Submenus “Trigger for Relay N” are similar, but corresponds to relays 1, 2 and 3. They have following structure:

```
Main Menu | Trigger 1 Settings
  A) Usage ..................... threshold
  B) Relay Polarity ............ normal
  C) Activate Beeper ........... No
  D) STA/LTA X ................. 45 (0x2D)
  E) STA/LTA Y ................. 46 (0x2E)
  F) STA/LTA Z ................. 47 (0x2F)
  G) Threshold X ............... 200 (0xC8)
  H) Threshold Y ............... 300 (0x12C)
  I) Threshold Z ............... 400 (0x190)
  J) Hold Time, 0.1 sec ........ 50 (0x32)
  K) Event Window Time, 0.1 sec ... 20 (0x14)
  L) Event Trip Time, 0.1 sec ..... 0 (0x00)

Select <A>...<H>. <Esc> back to Main Menu
```

If all settings are done, then press <ESC> key once (or twice to exit from submenu) and **sswui** will print

```
Save configuration to a file? (Y/N)...>
```

Press ‘Y’ key to save settings into a configuration file.

Configuration of GeoSwitch can be read from configuration file and put into the GeoSwitch by command

```
$ sswui –a put-config –c sswui.conf
Start to write holding registers...
Done
```

The GeoSwitch will shortly beep when configuration saved successfully.

Factory Settings can be changed only at the GeoSIG factory, because they are write-protected.

7. LCD Display and Push Buttons

STA/LTA feature added from version 1.1.0 of GeoSwitch FW.

Change of MODBUS address and/or baud-rate will be applied after reboot only.

After start-up, the top-level screen reflects current date, time and counter of seconds remaining for end of band-pass filter stabilization.

Figure 20 Start-up screen

When the band-pass filter has been stabilized, then LCD show number of registered events for each of relay.

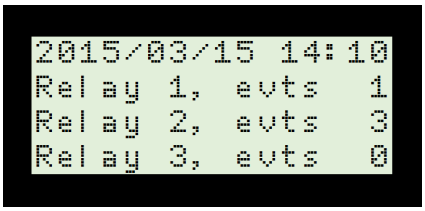


Figure 21 Screen after band-pass filter stabilization

The SELECT push-button should be pressed to enter into menus.
Blinking cursor will appear at one of menu items. It can be positioned to another menu item by using UP and DOWN push buttons.
Menus items with names like "**<**xxxx:" allow to return into upper level menus, while menu items with names like "xxxx**>**" allow to enter into submenu. The SELECT push-button should be used to enter into submenu or exit to upper level menu.

If cursor is placed at menu item with name like "<xxxx:", then SELECT push-button can be pushed to return into upper level menu.

If cursor is placed at menu item with name like "xxxx>", then SELECT push-button can be pushed to enter into submenu.

If it is required to change one of parameters of range type (e.g. 0-100), then parameter's value should be chosen by UP/DOWN push-buttons. The SELECT push-button need to be pushed to enter into modification mode. The UP/DOWN push-buttons can be used to increase/decrease value. The SELECT push-button need to be pushed to exit from modification mode.

If it is required to change one of parameters of list type (e.g. On, Off or 9600, 19200, 38400,…), then parameter's value should be chosen by UP/DOWN push-buttons and SELECT push-button should be pushed to select next value from the list.

See next figure for details about structure of the LCD menus.

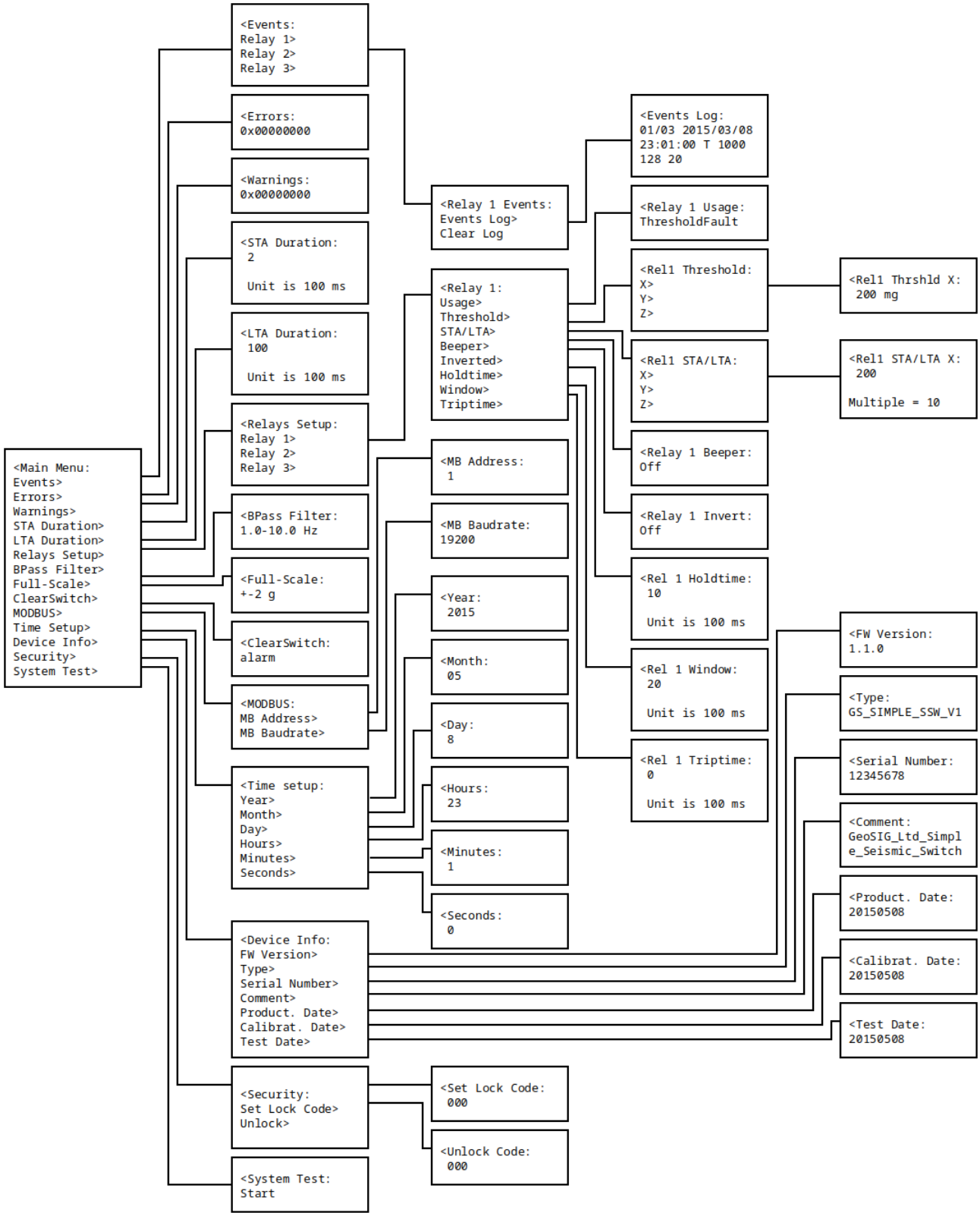


Figure 22. Structure of the LCD Menus.

7.1. Security of LCD Menus

Note: feature added from version 1.0.9 of GeoSwitch firmware.

LCD menu has no locking by default. However, user can lock it from LCD menu itself.

From moment of locking, it will be impossible to change or activate nearly all menu items:

- `Main Menu -> Events -> Relay N Events -> Clear Log;`
- `Main Menu -> STA Duration;`
- `Main Menu -> LTA Duration;`
- `Main Menu -> Relays Setup;`
- `Main Menu -> Bpass Filter;`
- `Main Menu -> Full-Scale;`
- `Main Menu -> ClearSwitch;`
- `Main Menu -> MODBUS -> MB Address;`
- `Main Menu -> MODBUS -> MB Baudrate;`
- `Main Menu -> Time Setup;`
- `Main Menu -> System Test.`

7.1.1. How to Lock LCD Menu

It is required to enter into LCD menu item

`Main Menu -> Security -> Set Lock Code`

and set up some digital code.

If locking code was set, then user will hear cautionary double beep when trying to change other settings from LCD menu.

Any attempt to change locked menu item will be indicated by GeoSwitch by double beep and "Menu item is locked" message at LCD display.

7.1.2. How to Unlock LCD Menu

User can unlock locked LCD menu with the same digital code as previously used for locking.

It is required to enter into LCD menu item

`Main Menu -> Security -> Unlock`

and enter same code as used previously to lock LCD menu.

Alternatively or when locking code is forgotten, user can connect USB console and type command

`unlockmenu`

This will deactivate LCD menu locking.

Additionally, locking can be disabled through MODBUS interface by writing non zero value into the “security.unlocked” register.

8. Firmware Programming or Upgrade

The GeoSwitch allows to program application code into internal Flash memory through UART interface.

The GeoSwitch device has a “USB Console” port, which organized with help of a USB to UART converter.

This port is as virtual COM port in the Linux/Windows OS and allows FW programming.

8.1. Hardware Setup

Remove the external power source from the GeoSwitch device.

Open transparent cover of housing.

Unscrew and take off top cover board.

Close pins 1-2 of the JP502 jumper on the GeoSwitch board.

Press the RESET button (S501) to restart MCU into bootloader mode.

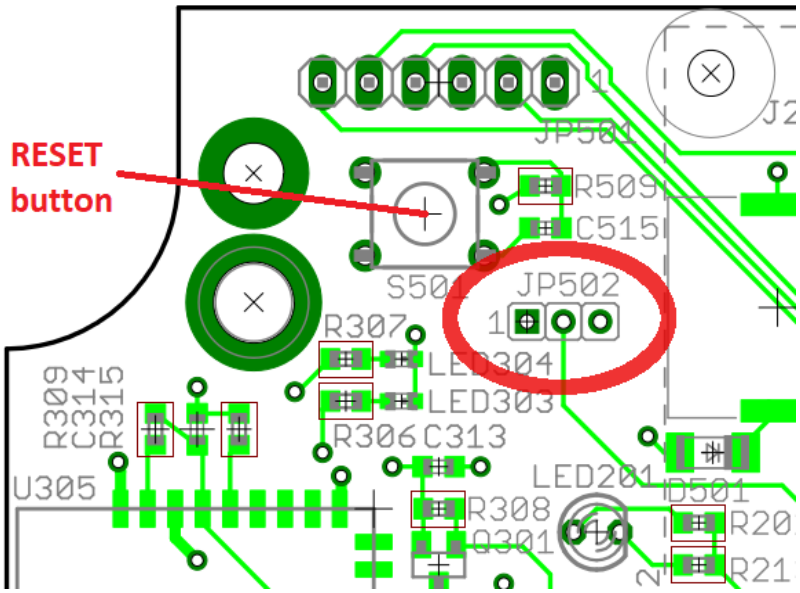


Figure 23. Location of the JP502.

Interconnect USB port of PC with “USB Console” port of GeoSwitch by USB cable.

Connect again the external power source.

8.2. Software Setup for Windows OS

Windows will detect new device and install drivers for the “USB Serial Port” device (FT232 chip from http://www.ftdichip.com).

Find out COM port number of “USB Serial Port” in the “Ports (COM & LPT)” category of Windows Device Manager.

Open link http://www.st.com/en/development-tools/stm32cubeprog.html and download software with Part Number “STM32CubeProg”.

Extract archive and run the **SetupSTM32CubeProgrammer-x.x.x.exe** installer. Install this SW with default settings.

Download latest FW file for the GeoSwitch – **ssw-fw-X.X.X.hex**. It can be fetched from GeoSIG web server at the “Downloads” page.

8.3. Firmware Programming

Run the “STM32CubeProgrammer” software.

Select “UART” as communication port.

Select the COM port name and click “Connect” button.

Leave Baud-rate and Parity settings to 115200 and Even.

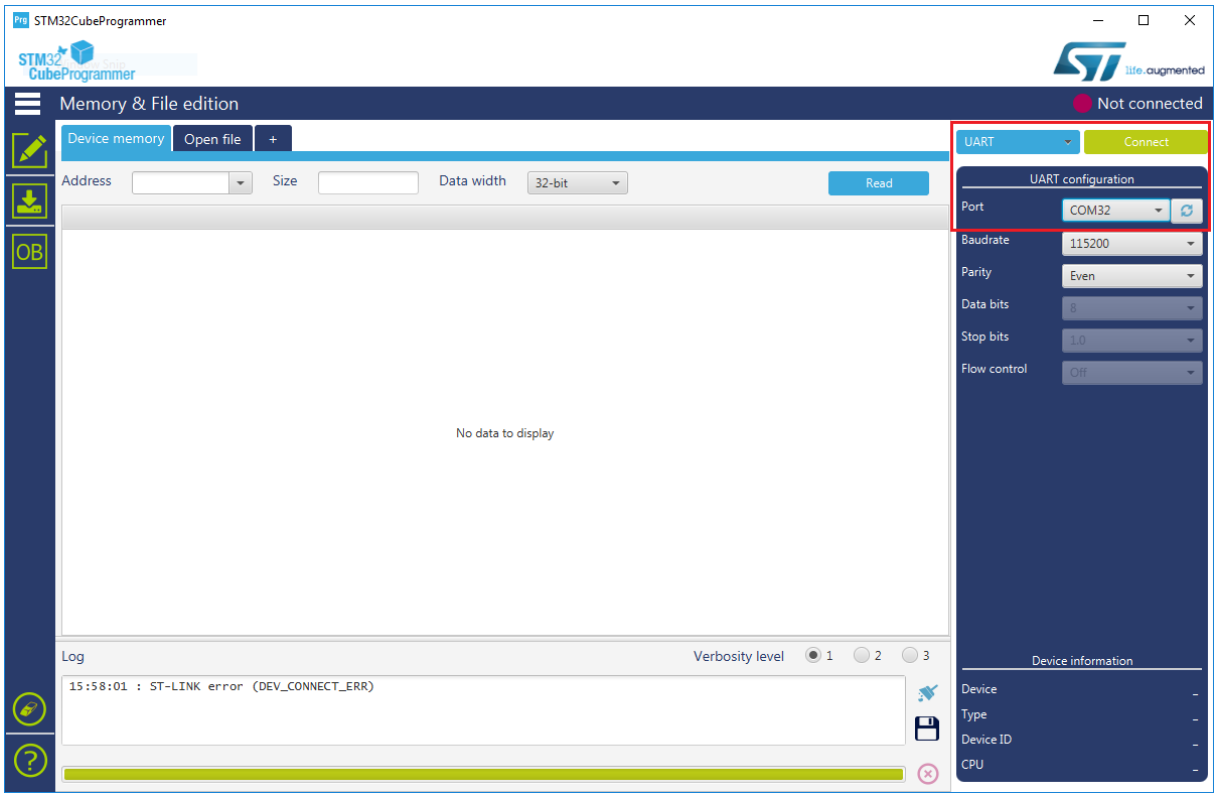


Figure 24: Communication settings for STM32CubeProgrammer

The “STM32CubeProgrammer” will inform about successful connection with the STM32 MCU of the GeoSwitch (Device).

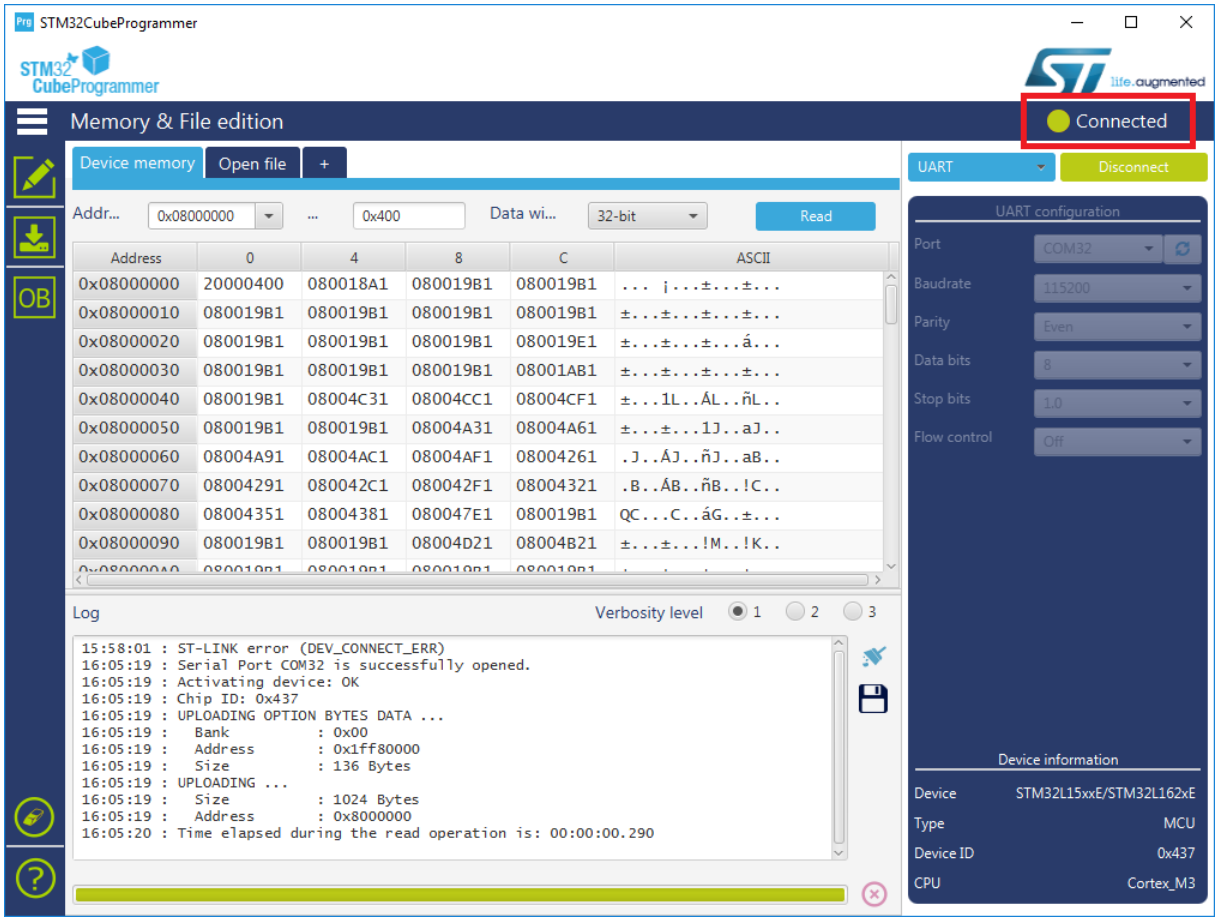


Figure 25: Information about successful connection of STM32CubeProgrammer with STM32 MCU

Select “Erasing & Programming” from the menu on the left.

Specify location of the **ssw-fw-X.X.X.hex** file in the “Browse” field.

Select “Verify programming” in the programming options list.

Click “Start Programming” button and programming with verification will start.

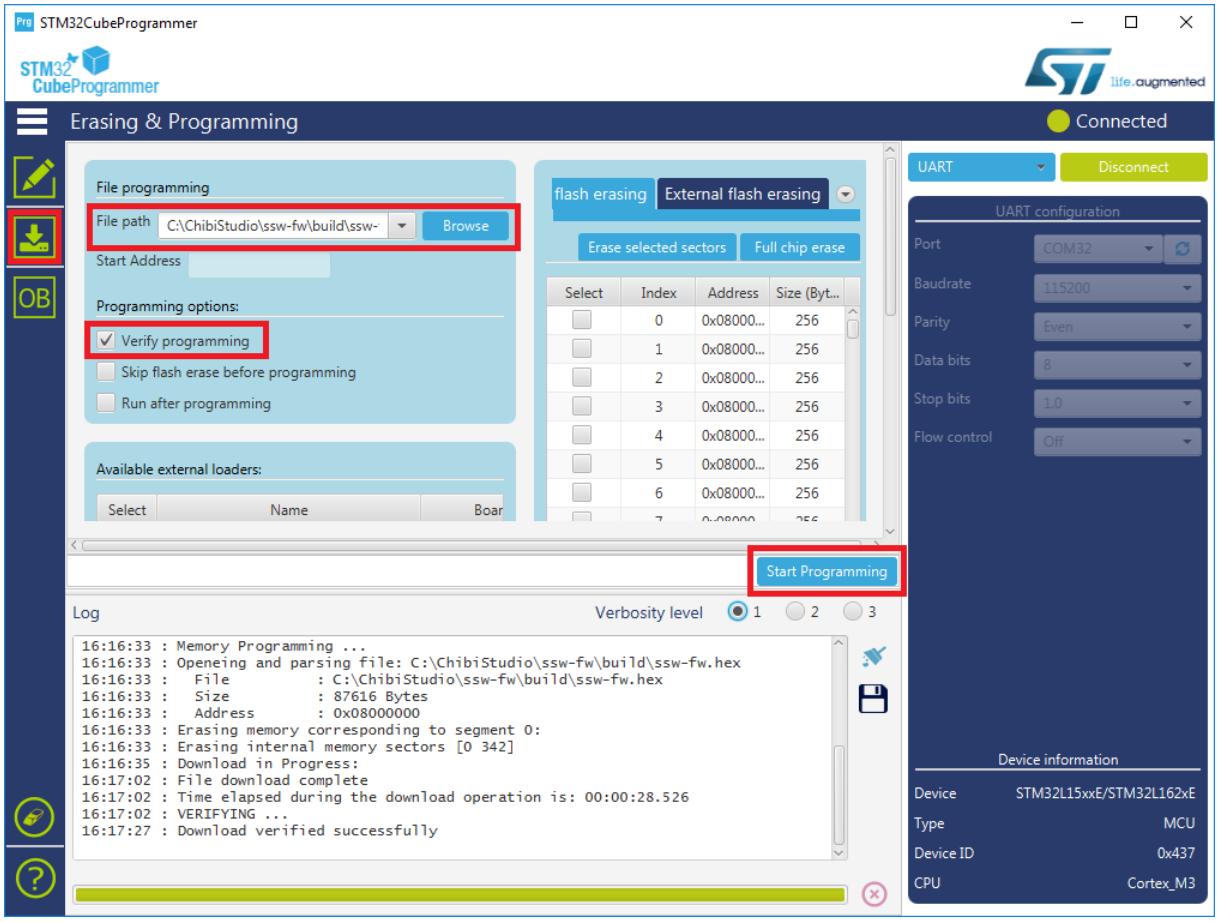


Figure 24: Firmware file selection in STM32CubeProgrammer

“Download verified successfully” message will be printed at the end.

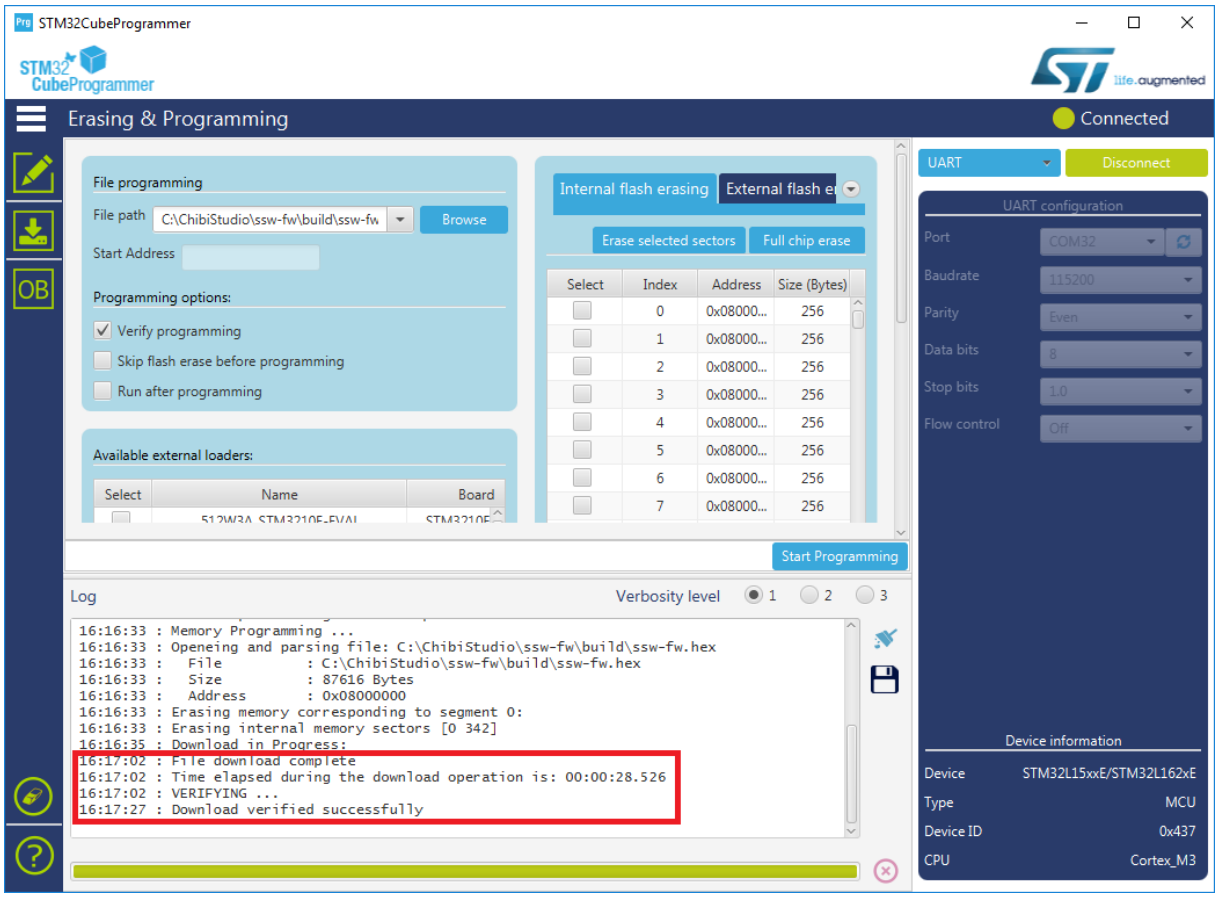


Figure 25: Programming verified successfully message

Click “Disconnect” button.

Disconnect external power source from the GeoSwitch device.

Close pins 2-3 of the JP502 jumper on the GeoSwitch board.

Connect external power source back again.

Appendix A. MODBUS Registers

MODBUS Holding Registers with Write Protection

Address	Data Type	Data Name	Words	Comment
1000	char	type[16]	8	String with device type.
1008	char	serial_num[8]	4	String with serial number.
1012	char	comment[32]	16	String with comment.
1028	char	date_production[8]	4	String with production date. Format is YYYYMMDD.
1032	char	date_calibration[8]	4	String with calibration date. Format is YYYYMMDD.
1036	char	date_last_test[8]	4	String with last test date. Format is YYYYMMDD.
1040	uint16_t	offset[5][4][3]	12	Calibration values for offsets of MEMS.
1100	uint16_t	gain[5][4][3]	48	Calibration values for gains of MEMS.

MODBUS Holding Registers

Change of MODBUS address and/or baud-rate will be applied after reboot only.

Address	Data Type	Data Name	Words	Comment
2000	uint16_t	netaddr	1	MODBUS slave address
2001	uint16_t	baudrate	1	MODBUS baud-rate. Available values: • 0 – 9600; • 1 – 19200; • 2 – 38400; • 3 – 57600.
2002	uint16_t	fscale	1	Accelerometer's full-scale range. Available values: • 0 – ±2 g; • 1 – ±4 g; • 2 – ±6 g; • 3 – ±8 g. • 4 – ±16 g. Accelerations of MEMS measured in counts. Gains for different full-scales are: • mg = 0.06 * counts for ±2 g; • mg = 0.12 * counts for ±4 g; • mg = 0.18 * counts for ±6 g; • mg = 0.24 * counts for ±8 g; • mg = 0.73 * counts for ±16 g.
2003	uint16_t	filter_type	1	Digital filter type. Available values: • 0 – 0.5 - 10.0 Hz; • 1 – 1.0 - 10.0 Hz;

				• 2 – 1.1 - 7.7 Hz; • 3 – 2.0 - 3.0 Hz; • 4 – 0.1 - 15.0 Hz.
2004	uint16_t	clearswitch_type	1	Type of Clear Switch input. Available values: • 0 – Events Clear; • 1 – Reset SSW.
2005	uint16_t	trigger1.inverted	1	Inversion of relay state. Available values: • 0 – not inverted contacts; • 1 – inverted contacts.
2006	uint16_t	trigger1.beeper	1	Operation of beeper on detection of event. Available values: • 0 – activated; • 1 – deactivated.
2007	uint16_t	trigger1.usage	1	Usage of relay 1 for different event types: • 0 – threshold; • 1 – thresholdfault; • 2 – vector; • 3 – vectorfault; • 4 – power; • 5 – fault; • 6 – heartbeat; • 7 – sta_lta; • 8 – sta_lta_fault; • 9 – sta_lta_vector; • 10 – sta_lta_vector_fault.
2008	uint16_t	trigger1.threshold[3]	3	Acceleration thresholds for X, Y, Z axes of relay1. Unit is in MEMS counts. See comment for register 2002.
2011	uint16_t	trigger1.holdtime	1	Hold time until relay 1 will deactivate after event termination. Unit is 100 ms.
2012	uint16_t	trigger1.window	1	Time window for detection of events for relay 1. Unit is 100 ms.
2013	uint16_t	trigget1.triptime	1	Minimal duration of event registered for relay 1. Unit is 100 ms.
2014	uint16_t	trigger2.inverted	1	Same as trigger1.inverted, but for relay 2.
...	...	...	...	...
2023	uint16_t	trigger3.inverted	1	Same as trigger1.inverted, but for relay 3.
...	...	...	...	...
2032	int64_t	time_set	4	Time to be set as current time of instrument. Unit is 1 nanosecond.

2036	uint16_t	event_fifo_clear1	1	Clear events inside of FIFO for relay 1. Available values: • 0 – do nothing; • 1 – clear events.
2037	uint16_t	event_fifo_clear2	1	Clear events inside of FIFO for relay 2. Available values: • 0 – do nothing; • 1 – clear events.
2038	uint16_t	event_fifo_clear3	1	Clear events inside of FIFO for relay 3. Available values: • 0 – do nothing; • 1 – clear events.
2039	uint16_t	security.lock_code	1	LCD Menu Lock Code. Available values 0 – 999.
2040	uint16_t	security.unlocked	1	State of LCD Menu locking: • 0 – locked; • 1 – unlocked.
2041	uint16_t	sta_duration	1	STA duration. Available values 2 – 500. Must be less than LTA duration. Unit is 100 ms.
2042	uint16_t	lta_duration	1	LTA duration. Available values 10 –2500. Must be greater than STA duration. Unit is 100 ms.
2043	uint16_t	sta_lta1[3]	3	STA/LTA thresholds for X, Y, Z axes for relay 1.
2046	uint16_t	sta_lta2[3]	3	STA/LTA thresholds for X, Y, Z axes for relay 2.
2049	uint16_t	sta_lta3[3]	3	STA/LTA thresholds for X, Y, Z axes for relay 3.

MODBUS Input Registers

Address	Data Type	Data Name	Words	Comment
3000	char	fw_ver[6]	3	Firmware version.
3003	int16_t	temperature	1	Temperature of device.
3004	int16_t	accel[3]	3	Current average accelerations from all good MEMS for X, Y, Z axes. Unit is in MEMS counts. See comment for register 2002. These data updated with 100 Hz rate and they go through low-pass filter selected in register 2003 (through LCD menu or MODBUS interface).
3007	uint16_t	relay_is_set[3]	3	Status of relays.

3010	uint16_t	wp	1	State of write protection ('1' means write protected).
3011	uint16_t	voltage[4]	4	Voltages at test points in mV.
3015	uint16_t	error_status_msb	1	Error status of instrument.
3016	uint16_t	error_status_lsb	1	Error status of instrument.
3017	uint16_t	warning_status_msb	1	Warning status of instrument.
3018	uint16_t	warning_status_lsb	1	Warning status of instrument.
3019	uint16_t	hw	1	Bit-fields for existing I2C devices. Filled during probing at power on.
3020	uint16_t	time[4]	4	Current time.
3024	uint16_t	event_fifo_counter[3]	3	Counters for event FIFOs (3 relays).
3027	uint16_t	event_fifo_rdptr[3]	3	Read pointers for event FIFOs (3 relays).
3030	uint16_t	event_fifo_wrptr[3]	3	Write pointers for event FIFOs (3 relays).
3033	struct event	event_fifo_buffer[3][10]	240	Event FIFO buffers (3 relays with 10 events each]. See details below table.
3273	uint16_t	event_fifo_crc16	1	CRC16 for all data of event FIFOs.

```
struct event {
    uint16_t    tstamp[4]; /**< 64-bit timestamp of event. Time since 2000/01/01 00:00:00, in ns.*/
    int16_t     usage; /**< Usage of relay. */
    int16_t     data[3]; /**< Data values of triggering event. */
};
```

The "data" fields of that structure can contain different types of data, because they depend from registered event. See table below.

Event type	**Data type**
Threshold	data[0..2] = maximal accelerations for X, Y, Z axes during event window.
Vector	data[0] = maximal acceleration vector during event window. data[1] = 0. data[2] = 0.
Fault	data[0], data[1] contain 32-bit system "Error code". data[2] = 0 Big-endian format used for words.
Power	data[0] = 1. data[1] = 0. data[2] = 0.
Heartbeat	data[0], data[1] contain system "Error code". Big-endian format used for words. data[2] = 0.
StaLta	data[0..2] = maximal accelerations for X, Y, Z axes during event window
StaLtaVector	data[0] = maximal acceleration vector during event window. data[1] = 0.

	data[2] = 0.

Event data for combined relay usages, like ThresholdFault or alike, contain data corresponding to exact event type from table above.

Appendix B. Error Codes

The GeoSwitch has 32-bit Error register, where each error encoded as a 1-bit flag.

Here is a table with error codes.

Error Definition	Error HEX Code	Error Text	Comment
ERR_CANNOT_INIT_MODBUS	0x0000 0001	MB init failed	Cannot initialize MODBUS interface. Can happen if slave address or baud rate is wrong.
ERR_CANNOT_SET_SLAVE_ID	0x0000 0002	MB address err	Cannot setup MODBUS slave address. Can happen if slave address is wrong.
ERR_CANNOT_ENABLE_MODBUS	0x0000 0004	MB enable fail	Cannot enable MODBUS interface. Can happen only in case of FW bug.
ERR_V_MAIN_IS_LOW	0x0000 0008	Vmain too low	Voltage of main DC-DC converter is lower than 3.20 VDC.
ERR_V_INPUT_IS_LOW	0x0000 0010	Vinput too low	Voltage of external power is lower than 8.95 VDC.
ERR_EEPROM_ADDRESS_IS_WRONG	0x0000 0020	EEPROM address	EEPROM address is wrong. Can happen only in case of FW bug.
ERR_V_BACKUP_IS_LOW	0x0000 0040	Vbackup too low	Voltage of main backup power source is too low. Can happen if external power is lower than minimum and backup power source exhausted.
ERR_EEPROM_WRITE_FAILED	0x0000 0080	EEPROM writing	EEPROM write was failed. Can happen only in case of FW bug or HW failure.
Reserved error code	0x0000 0100	---Reserved---	
ERR_EVT_FIFO_OVERFLOW	0x0000 0200	Events overflow	Event FIFO overflowed. Can happen only in case of FW bug.
ERR_V_RTC_IS_LOW	0x0000 0400	Vrtc too low	Voltage of RTC's backup power source is too low. External power is absent for too long time (more than a week) and RTC's backup power source discharged.
ERR_RELAY_FIFO_IS_FULL	0x0000 0800	Relay overflow	Relay FIFO overflowed. Can happen only in case of FW bug.
ERR_BUZZER_FIFO_OVERFLOW	0x0000 1000	Buzzer overflow	Buzzer FIFO overflowed. Can happen only in case of FW bug.
ERR_EEPROM_UNLOCK_FAILED	0x0000 2000	EEPROM unlock	EEPROM unlock was failed. Can happen only in case of FW bug or HW failure.
ERR_ACCEL_NOT_DETECTED	0x0000 4000	MEMS detection	MEMS accelerometer does not detect. Can happen only in case of HW failure.
Reserved error code	0x0000 8000	---Reserved---	
ERR_WRONG_CONFIG	0x0001 0000	Wrong config	One of configuration parameters is wrong. Can happen if parameter sent through MODBUS or console interfaces is wrong.
ERR_RESET_IS_BY_IWD	0x0002 0000	Reset by WD	Device was reset by watchdog. Can happen only in case of FW bug or HW problem.
ERR_G_FORCE_VECTOR_IS_BAD	0x0004 0000	g-force vector	Static g-force is not within 1 g ± 1 %. Can happen if MEMS produce incorrect data or device is not on the Earth planet (gravity ≠ 1 g).
Reserved error code	0x0008 0000	---Reserved---	
ERR_WRONG_HW_PLATFORM	0x0010 0000	Wrong HW ver	FW is written onto wrong HW type.
ERR_TOO_MUCH_OF_BAD_MEMS	0x0020 0000	Many bad MEMS	4 from 4 accelerometers are bad. All MEMS accelerometers was failed.
Reserved error code	0x0040 0000	---Reserved---	
Reserved error code	0x0080 0000	---Reserved---	
ERR_TEST_PULSE_BAD	0x0100 0000	MEMS test pulse	Test pulse of MEMS accelerometer does not give required feedback.

ERR_SHELL_INIT_FAILED	0x0200 0000	Schell init	Failed initialization of console shell. Can happen only in case of FW bug.
ERR_INVALID_TIME_TO_SET	0x0400 0000	RTC time wrong	Attempt to setup RTC by wrong value of time.
Reserved error code	0x0800 0000	---Reserved---	
Reserved error code	0x1000 0000	---Reserved---	
Reserved error code	0x2000 0000	---Reserved---	
Reserved error code	0x4000 0000	---Reserved---	
Reserved error code	0x8000 0000	---Reserved---	

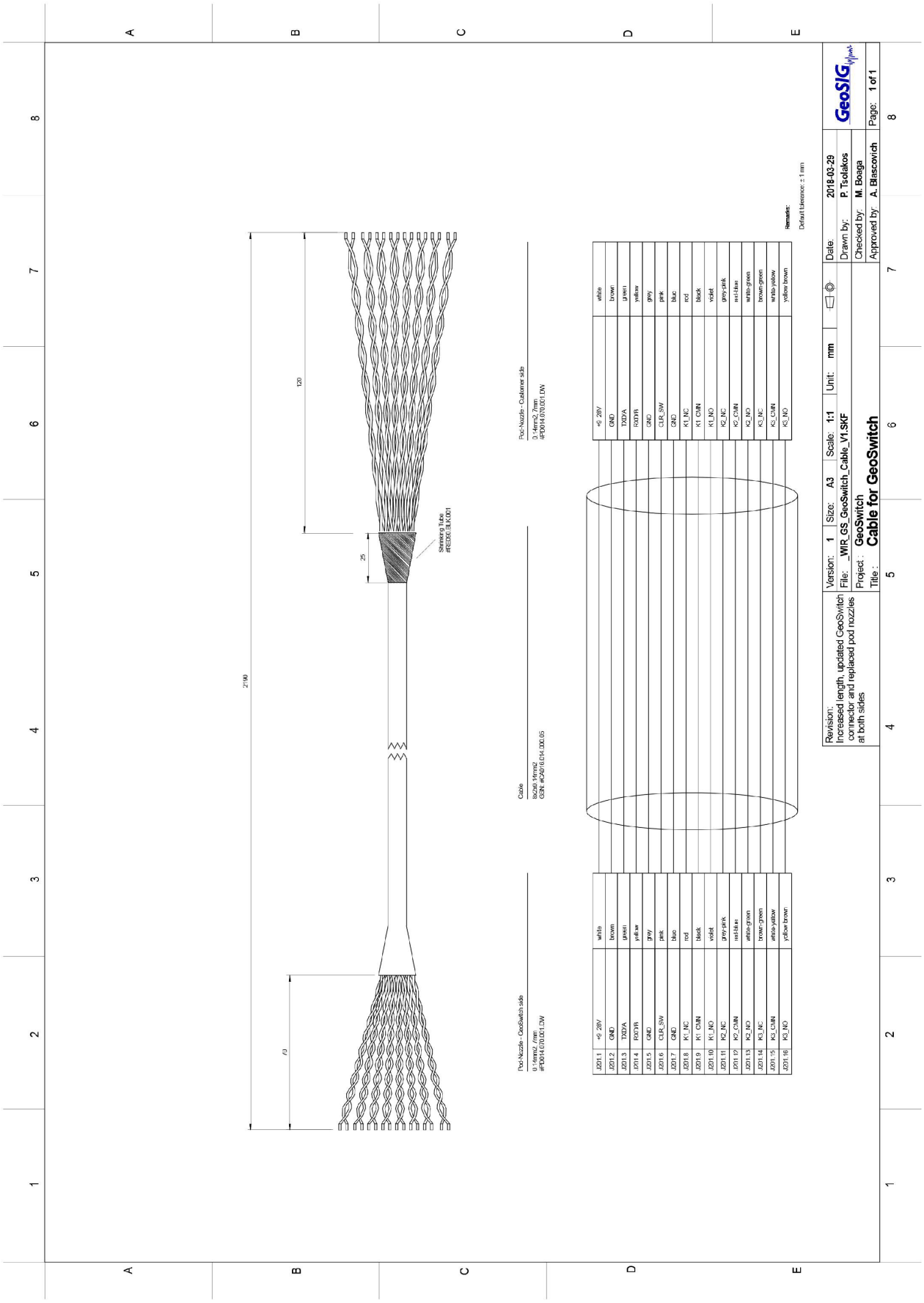
Appendix C. Warning Codes

The GeoSwitch has 32-bit Warning register, where each warning encoded as a 1-bit flag.

Here is a table with warning codes.

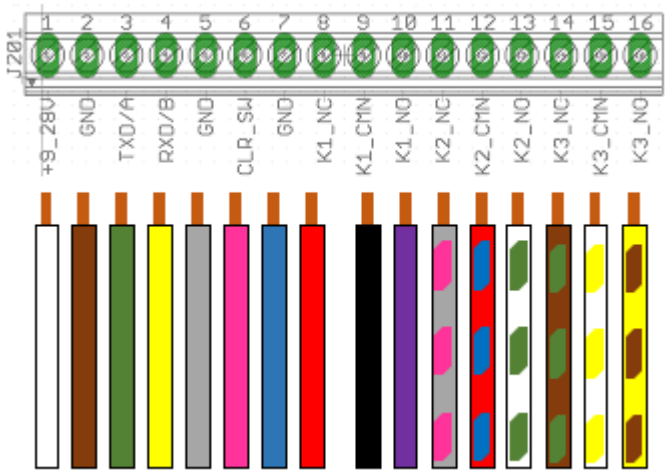
Warning Text	Warning HEX Code	Warning Text	Comment
WRN_EVT_PURGED	0x0000 0001	Event purged	Old event was purged from event FIFO. Happens when more than 10 events happened.
WRN_EVT_INPQUEUE_OVERFLOW	0x0000 0002	Keyboard overfl	Overflow of input queue for push button events. Can happen only in case of FW bug.
WRN_EVT_INPQUEUE_READ	0x0000 0004	Keyboard read	Unable to read input queue for push button events. Can happen only in case of FW bug.
Reserved warning code	0x0000 0008	---Reserved---	
WRN_RTC_TIME_WAS_LOST	0x0000 0010	RTC time lost	Backup energy was exhausted and time of RTC was lost.
WRN_HOLD_FACT_IS_RONLY	0x0000 0020	Hold reg R/O	Factory MODBUS Holding registers are write protected.

Appendix D. Cable Drawing



Appendix E. Connection to GeoSwitch with supplied cable

If the GeoSwitch comes with a preinstalled cable, it is connected as shown below:



Connector	Pin	Colour	Name	Comment
J201	1	White	+9-28 VDC	Power line for external power supply
	2	Brown	GND	Ground line for external power supply
	3	Green	TXD/A	TXD line of RS232 interface or A line of RS485 interface (MODBUS)
	4	Yellow	RXD/B	RXD line of RS232 interface or B line of RS485 interface (MODBUS)
	5	Grey	GND	Ground line for RS232 or RS485 interface (MODBUS)
	6	Pink	CLR_SW	Clear Switch input
	7	Blue	GND	Ground line for Clear Switch input
	8	Red	K1_NC	Normally closed contact of relay 1
	9	Black	K1_CMN	Common contact of relay 1
	10	Violet	K1_NO	Normally opened contact of relay 1
	11	Grey-pink	K2_NC	Normally closed contact of relay 2
	12	Red-blue	K2_CMN	Common contact of relay 2
	13	White-green	K2_NO	Normally opened contact of relay 2
	14	Brown-green	K3_NC	Normally closed contact of relay 3
	15	White-yellow	K3_CMN	Common contact of relay 3
	16	Yellow-brown	K3_NO	Normally opened contact of relay 3