GeoSwitch
User Manual
## Document Revision

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Modification</th>
<th>Prepared</th>
<th>Checked</th>
<th>Released</th>
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<tr>
<td>1</td>
<td>03.11.2014</td>
<td>Document created</td>
<td>IGP</td>
<td></td>
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<tr>
<td>2</td>
<td>13.03.2015</td>
<td>Various corrections in text and figures. Added information about configuration of GeoSwitch, GeoSwitch Configurator software, Console Commands, LCD display and push buttons, MODBUS registers.</td>
<td>IGP</td>
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<tr>
<td>3</td>
<td>16.03.2015</td>
<td>Added symbols explanation. Minor corrections. Updated address.</td>
<td>JON</td>
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<td>4</td>
<td>20.03.2015</td>
<td>The “power” usage of relay was corrected.</td>
<td>IGP</td>
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<td>5</td>
<td>2.04.2015</td>
<td>MODBUS registers adjusted to correspond recent FW.</td>
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<td>6</td>
<td>22.04.2015</td>
<td>MODBUS baud rate register changed. Now it holds index of baudrate.</td>
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<td>7</td>
<td>12.05.2015</td>
<td>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.</td>
<td>IGP</td>
<td>JON</td>
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<td>8</td>
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<td>Update warnings and safety.</td>
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<td>9</td>
<td>26.10.2015</td>
<td>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.</td>
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<td>10</td>
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<td>The “Redundant Quadruplet Matrix” and “System Test” chapters added. &quot;System Test&quot; item added into LCD menus and “systest” into console commands. Some error codes changed.</td>
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<td>11</td>
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<td>12</td>
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<td>Addition of “GeoSIG Cybersecurity Recommendations” section</td>
<td>KEC</td>
<td>VAG</td>
<td>VAG</td>
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<td>13</td>
<td>23.05.2017</td>
<td>Adding Appendix D: Cable Drawing</td>
<td>JOG</td>
<td>PAT</td>
<td>JOG</td>
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<tr>
<td>14</td>
<td>27.03.2018</td>
<td>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.</td>
<td>PAT</td>
<td>WES</td>
<td>VAG</td>
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<td>15</td>
<td>20.04.2018</td>
<td>Appendix D updated</td>
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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:

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Serial number / Firmware version or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>GeoSwitch S/N</td>
<td>Serial number of GeoSwitch product</td>
<td>102600</td>
</tr>
<tr>
<td>GeoSwitch FW</td>
<td>Firmware version of GeoSwitch</td>
<td>1.0.13</td>
</tr>
</tbody>
</table>

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).
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

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

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Direct current. This symbol indicates a direct current (DC) power line derived 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 two connectors – **Main connector** and **USB Console socket**.

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

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

![Figure 2. Location of Connectors on the Instrument. The transparent and the internal black cover are shown removed](image-url)
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.

![Main Connector pinnout](image)

### Connector Pin Name Comment

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

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.

![Schematic of Relay Contacts](image)

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

<table>
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<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>RS232</td>
<td>1-2</td>
<td>1-2</td>
<td>1-2</td>
<td>1-2</td>
</tr>
<tr>
<td>RS485</td>
<td>2-3</td>
<td>2-3</td>
<td>2-3</td>
<td>2-3</td>
</tr>
</tbody>
</table>

If the physical interface is configured to RS485, a termination resistor (120 Ohm) can be enabled by closing JP213.
3.2.2. GeoSwitch Cable

Please refer to Appendix D for cable drawing with pin color 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.

3.3. Visual Indicators

Several visual indicators (LCD and LED’s) show the status of the instrument.

![Figure 5. LCD and LEDs](image)

3.3.1. LEDs

<table>
<thead>
<tr>
<th>Color</th>
<th>Indication</th>
<th>States</th>
</tr>
</thead>
<tbody>
<tr>
<td>GREEN</td>
<td>POWER</td>
<td>Blinks once per second when external power supply is operating or when internal supercap has enough charge.</td>
</tr>
</tbody>
</table>
| 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.](image)

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, but right after power ON it can consume up to 6.5 W for about 10-20 seconds during supercap charging.

The GeoSwitch has two internal supercaps as backup power sources. Supercaps instead of batteries are used as they are maintenance free and provide an unlimited number of charge and discharge cycles.

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.

The second supercap provides backup power for the RTC for up to 10 days. Its charge time is around 2 minutes.

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

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 can **not** 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 the setup of 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 cubicle of 1 m³ 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.](image-url)
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.
- Cleanup dust at area of holes.
- Mount the housing in place and fix it by screws.

\[\text{Do not overtighten the screws.}\]

### 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 mm² 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.

\[\text{It is required to connect relays to controlled equipment in such a way, so in case of power outage for GeoSwitch, its relays should block operation or activate brakes of controlled equipment for safety reasons. Additionally, it is required to configure triggering of GeoSwitch to block operation or activate brakes of controlled equipment in case of alarm or errors.}\]
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 or Bluetooth).

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.

![GeoSwitch Interfaces](image)

Figure 8. 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.

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. Statical 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

All the configuration changes can be either done through:

- USB or Bluetooth 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 Bluetooth Console port of GeoSwitch is not supported in hardware version 1.

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

The GeoSwitch have various configuration features.

6.1.1. 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.

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 \( V = \sqrt{X^2 + Y^2 + Z^2} \).

6.1.2. Relay Threshold Values

Relays configured to be used on 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 should be specified in mg (Milli g).

Applicable only for Threshold and Vector usage of relay.

Default is 1000 milli g.

6.1.3. Relay Hold Time

This is the time during which the relay will be active after disappearing of an alarm event.
Should 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” and “vectorfault”.

*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).

### 6.1.4. Relay Window Time

This is the time for detection of seismic events.
Window is started at threshold exceeding and during this window the algorithm search for "Maximal acceleration of event" for each axis (Threshold usage) or for Vector sum (Vector usage).
The window is prolonged/restarted for each new sample if its amplitude is above threshold.
When the window is timed out "Maximal accelerations of Event" are saved as an attribute of Event.
Should be specified in range from 2.0 to 6553.5 seconds.
Measured in 0.1 second counts.
Applicable only for Threshold and Vector usage of relay.
Default is 20 (2 seconds).

### 6.1.5. Relay Trip Time

This is the time which specifies how long a seismic event should continue in order to enable alarm.
Should 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 and Vector usage of relay.
Default is 0 (0 seconds).

### 6.1.6. 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.

### 6.1.7. 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.
6.1.8. 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.

6.1.9. 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.

6.1.10. 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.

6.1.11. MODBUS Slave Address
The GeoSwitch MODBUS interface can be configured to use one of addresses from range 1-247.
Default is 1.

6.1.12. MODBUS Baudrate
The GeoSwitch MODBUS interface can be configured to use one of baudrates:
- 9600
- 19200
- 38400
- 57600
- 115200
Default is 19200.

6.1.13. Time of RTC
The GeoSwitch has RTC which counts local time. Its time can be set to current time.
Note: Supported range for years is 2000..2099.

6.1.14. Comment for Device
This is a factory set up string.
32 ASCII characters maximum.
Value is write-protected.

6.1.15. Serial Number of Device
This is a factory set up serial number.
8 ASCII characters maximum.
Value is write-protected.

6.1.16. Type of Device
This is a factory set up string.
16 ASCII characters maximum.
Value is write-protected.

6.1.17. Date of Production, Calibration or Test
This is a factory set up strings.
8 ASCII digits for each value.
Values are write-protected.
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 will be 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.
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 10. About GeoSwitch Configurator SW.](image)

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 baudrate.

![Figure 11. COM Port and Baudrate Setup.](image)
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.

![Event Log Tab of GeoSwitch Configurator.](image)

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.

![Errors & Warnings Tab](image-url)

Figure 13. Errors & Warnings Tab.
The “Device” tab reflects factory set information such as device Type, Serial Number, Comment, dates of Production, Calibration, Testing.

Additionally, this tab shows FW version, HW configuration, internal voltages at supercap of RTC, main Supercap, Diodes, Input and System information.

![Device Tab](image)

Figure 14. 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 15. Device Relay Tab.
The File menu allows to Save configuration into a file and/or Load it when required.

Figure 16. Device Setup Tab.

Figure 17. File menu.
6.4. Changing Configuration from Terminal by Console Commands

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

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 optional parameter is omitted, then current value will be printed.

Character '|' means logical OR (only one of parameters can be specified).

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

<table>
<thead>
<tr>
<th>Command</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>help</td>
<td>Show all available commands</td>
</tr>
<tr>
<td>alarm</td>
<td>Show numbers of activated alarms (relays).</td>
</tr>
<tr>
<td>calibration x</td>
<td>y</td>
</tr>
<tr>
<td>clearswitch [alarm</td>
<td>reset]</td>
</tr>
<tr>
<td>debug</td>
<td>Command for debugging purposes only. Not for use by end users.</td>
</tr>
<tr>
<td>default</td>
<td>Reset most of settings into default values.</td>
</tr>
<tr>
<td></td>
<td>See appendix for error codes.</td>
</tr>
<tr>
<td>events [1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Command print following fields:</td>
</tr>
<tr>
<td></td>
<td>1. Relay Number – e.g. ‘1’, ‘2’ or ‘3’.</td>
</tr>
<tr>
<td></td>
<td>2. Date – e.g. “2015/03/08”.</td>
</tr>
<tr>
<td></td>
<td>3. Time – e.g. “23:01:00”.</td>
</tr>
<tr>
<td></td>
<td>4. Event type – e.g. “threshold”, “vector”, “fault”, “power”, “heartbeat”.</td>
</tr>
<tr>
<td></td>
<td>5. Event values – e.g. 3 digits in mg for X, Y and Z accelerations for</td>
</tr>
<tr>
<td></td>
<td>threshold or one digit in mg for vector, or HEX-code for error code.</td>
</tr>
<tr>
<td></td>
<td>Example: “3 2015/05/06 16:01:51 threshold 338 620 15”.</td>
</tr>
<tr>
<td>exit</td>
<td>Standard command to exit from OS shell. New shell thread started automatically.</td>
</tr>
<tr>
<td>filter [0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• 0 – 0.5-10.0 Hz,</td>
</tr>
<tr>
<td></td>
<td>• 1 – 1.0-10.0 Hz,</td>
</tr>
<tr>
<td></td>
<td>• 2 – 1.1-7.7 Hz,</td>
</tr>
<tr>
<td></td>
<td>• 3 – 2.0-3.0 Hz,</td>
</tr>
</tbody>
</table>
- 4 – 0.1-15.0 Hz.

<table>
<thead>
<tr>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>fullscale [2</td>
<td>4</td>
</tr>
<tr>
<td>info</td>
<td>Information about OS kernel, compiler version, MCU architecture and core and other details.</td>
</tr>
<tr>
<td>hardware</td>
<td>Show HEX code of HW configuration.</td>
</tr>
<tr>
<td>mbaddr [ADDRESS]</td>
<td>MODBUS slave address (decimal digit from 1 to 247).</td>
</tr>
<tr>
<td>mbbaud [9600</td>
<td>19200</td>
</tr>
<tr>
<td>mem</td>
<td>Information about free RAM of OS.</td>
</tr>
<tr>
<td>mems 1</td>
<td>2</td>
</tr>
<tr>
<td>voltage rtc</td>
<td>diodes</td>
</tr>
<tr>
<td>writeprotection</td>
<td>State of Write Protection jumper ('1' means write protected).</td>
</tr>
<tr>
<td>ps</td>
<td>Information about running threads. Command for debugging purposes only. Not for use by end users.</td>
</tr>
<tr>
<td>relay 1</td>
<td>2</td>
</tr>
<tr>
<td>relay 1</td>
<td>2</td>
</tr>
<tr>
<td>relay 1</td>
<td>2</td>
</tr>
<tr>
<td>relay 1</td>
<td>2</td>
</tr>
<tr>
<td>relay 1</td>
<td>2</td>
</tr>
<tr>
<td>relay 1</td>
<td>2</td>
</tr>
<tr>
<td>relay 1</td>
<td>2</td>
</tr>
<tr>
<td>systest</td>
<td>Run system test.</td>
</tr>
<tr>
<td>systime</td>
<td>Number of OS ticks from startup. Counted in milliseconds for GeoSwitch V1.</td>
</tr>
<tr>
<td>time [YYYY/MM/DD hh:mm:ss]</td>
<td>Show or set local time.</td>
</tr>
<tr>
<td>unlockmenu</td>
<td>Disable locking of LCD menu.</td>
</tr>
<tr>
<td>version</td>
<td>Show firmware version.</td>
</tr>
<tr>
<td>warnings [clear</td>
<td>code]</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Command</th>
<th>Functionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>comment [STRING]</td>
<td>User defined string for device. 32 ASCII character maximum.</td>
</tr>
<tr>
<td>serialnum [STRING]</td>
<td>Serial number of device. 8 ASCII characters maximum.</td>
</tr>
<tr>
<td>type [STRING]</td>
<td>Type of device. 16 ASCII chars maximum.</td>
</tr>
<tr>
<td>date production</td>
<td>calibration</td>
</tr>
<tr>
<td>calibration x</td>
<td>y</td>
</tr>
</tbody>
</table>

Typically, user allowed using these commands without parameters (only for data printing). Otherwise error message will be printed.
6.5. 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 to communicate through MODBUS interface over serial bus (RS485 or RS232).

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

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

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

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
       -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
                                          get-config
                                          edit-config
                                          put-config
       -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 baudrate.
                                          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

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, config 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) Trigger for Relay 1 .... ->
G) Trigger for Relay 2 .... ->
H) Trigger for Relay 3 .... ->
I) Factory Settings ........ ->
Select <A>...<I>. <Esc> to exit
```

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


Submenus “Trigger for Relay X” 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) Threshold X ................ 199 (0xC7)
E) Threshold Y ............... 210 (0xD2)
F) Threshold Z ................ 220 (0xDC)
G) Hold Time, 0.1 sec ........ 50 (0x32)
H) Event Window Time, 0.1 sec ... 20 (0x14)
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

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

![Start-up screen](image)

Figure 18 Start-up screen

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

![Screen after band-pass filter stabilization](image)

Figure 19 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.
7.1. Security of LCD Menus

Note: feature added from version 1.0.9 of GeoSwitch firmware.

If it is required, then user can have the possibility to lock changing GeoSwitch parameters from LCD menus. To do so, it is required to enter into the “<Security”, “<Set Lock Code” LCD menu and choose a Lock Code between 0 and 999 using the UP and DOWN buttons.

If the Lock Code was set, then user will hear cautionary double beep, when will try to change settings from LCD menu.

If locking is not required anymore, then user should enter the same Unlock Code as used for locking.
Unlocking can be forced without knowledge of the Lock Code by means of “unlockmenu” console command or through MODBUS interface by writing non zero value into the “menu.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 is organized with help of a USB to UART converter. This port is represented 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.

Press the RESET button (S501) to turn it off.

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

![Figure 21. Location of the JP502.](image)

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.


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.bin. 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 Baudrate and Parity settings to 115200 and Even.

Figure 22: Communication settings for STM32CubeProgrammer
The “STM32CubeProgrammer” will inform about successful connection with the STM32 MCU of the GeoSwitch (Device).

Figure 23: 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.bin 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.

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

### Holding Registers with Write Protection

<table>
<thead>
<tr>
<th>Address</th>
<th>Data Type</th>
<th>Data Name</th>
<th>Words</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>char</td>
<td>type[16]</td>
<td>8</td>
<td>Device type</td>
</tr>
<tr>
<td>1008</td>
<td>char</td>
<td>serial_number[8]</td>
<td>4</td>
<td>Serial number</td>
</tr>
<tr>
<td>1012</td>
<td>char</td>
<td>comment[32]</td>
<td>16</td>
<td>Comment</td>
</tr>
<tr>
<td>1028</td>
<td>char</td>
<td>date_production[8]</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1032</td>
<td>char</td>
<td>date_calibration[8]</td>
<td>4</td>
<td>Dates in format YYYYMMDD</td>
</tr>
<tr>
<td>1036</td>
<td>char</td>
<td>date_last_test[8]</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>1040</td>
<td>uint16_t</td>
<td>compensation_offset[4][3]</td>
<td>12</td>
<td>Calibration values for offsets of MEMS</td>
</tr>
<tr>
<td>1052</td>
<td>double</td>
<td>compensation_gain[4][3]</td>
<td>48</td>
<td>Calibration values for gains of MEMS</td>
</tr>
</tbody>
</table>
### Holding Registers

<table>
<thead>
<tr>
<th>Address</th>
<th>Data Type</th>
<th>Data Name</th>
<th>Words</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>uint16_t</td>
<td>netaddr</td>
<td>1</td>
<td>MODBUS slave address</td>
</tr>
<tr>
<td>2001</td>
<td>uint16_t</td>
<td>baudrate</td>
<td>1</td>
<td>MODBUS baud rate&lt;br&gt;0 - 9600,&lt;br&gt;1 - 19200,&lt;br&gt;2 - 38400,&lt;br&gt;3 - 57600,&lt;br&gt;4 - 115200</td>
</tr>
<tr>
<td>2002</td>
<td>uint16_t</td>
<td>fscale</td>
<td>1</td>
<td>Accelerometer's full scale range can be:&lt;br&gt;0 – ± 2 g&lt;br&gt;1 – ± 4 g&lt;br&gt;2 – ± 8 g</td>
</tr>
<tr>
<td>2003</td>
<td>uint16_t</td>
<td>filter_type</td>
<td>1</td>
<td>Digital filter type (0, 1, 2, 3, 4)</td>
</tr>
<tr>
<td>2004</td>
<td>uint16_t</td>
<td>clearswitch_type</td>
<td>1</td>
<td>How to use Clear Switch input:&lt;br&gt;0 – Events Clear,&lt;br&gt;1 – Reset SSW.</td>
</tr>
<tr>
<td>2005</td>
<td>struct</td>
<td>trigger[3]</td>
<td>27</td>
<td>Configurations of Event Triggers</td>
</tr>
<tr>
<td>2032</td>
<td>int64_t</td>
<td>time_set</td>
<td>4</td>
<td>Time to setup RTC in nanoseconds</td>
</tr>
<tr>
<td>2036</td>
<td>uint16_t</td>
<td>event_fifo_clear[3]</td>
<td>3</td>
<td>Flag to clear events in one of FIFO.&lt;br&gt;1 – to clear FIFO.</td>
</tr>
</tbody>
</table>

```c
struct trigger {
    uint16_t inverted;
    uint16_t beeper;
    uint16_t usage;
    uint16_t threshold[3];
    uint16_t holdtime;
    uint16_t window;
    uint16_t triptime;
};

struct security {
    uint16_t lock_code;
    uint16_t unlocked
};
```

Security of LCD Menu

Holding Registers
## Input Registers

<table>
<thead>
<tr>
<th>Address</th>
<th>Data Type</th>
<th>Data Name</th>
<th>Words</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3000</td>
<td>char</td>
<td>fw_ver[6]</td>
<td>3</td>
<td>Firmware version</td>
</tr>
<tr>
<td>3003</td>
<td>int16_t</td>
<td>temperature</td>
<td>1</td>
<td>Temperature of device</td>
</tr>
<tr>
<td>3004</td>
<td>int16_t</td>
<td>accel[3]</td>
<td>3</td>
<td>Current acceleration (X, Y, Z)</td>
</tr>
<tr>
<td>3007</td>
<td>uint16_t</td>
<td>relay_is_set[3]</td>
<td>3</td>
<td>Status of relays</td>
</tr>
<tr>
<td>3010</td>
<td>uint16_t</td>
<td>wp</td>
<td>1</td>
<td>State of write protection jumper</td>
</tr>
<tr>
<td>3011</td>
<td>uint16_t</td>
<td>voltage[4]</td>
<td>4</td>
<td>Voltages at testpoints in mV</td>
</tr>
<tr>
<td>3015</td>
<td>uint16_t</td>
<td>error_status_msb</td>
<td>1</td>
<td>Error status of iSensor</td>
</tr>
<tr>
<td>3016</td>
<td>uint16_t</td>
<td>error_status_lsb</td>
<td>1</td>
<td>Error status of iSensor</td>
</tr>
<tr>
<td>3017</td>
<td>uint16_t</td>
<td>warning_status_msb</td>
<td>1</td>
<td>Error status of iSensor</td>
</tr>
<tr>
<td>3018</td>
<td>uint16_t</td>
<td>warning_status_lsb</td>
<td>1</td>
<td>Error status of iSensor</td>
</tr>
<tr>
<td>3019</td>
<td>uint16_t</td>
<td>hw</td>
<td>1</td>
<td>Bitfields for existing I2C devices. Filled during probing at power on.</td>
</tr>
<tr>
<td>3020</td>
<td>uint16_t</td>
<td>time[4]</td>
<td>4</td>
<td>Current time</td>
</tr>
<tr>
<td>3024</td>
<td>uint16_t</td>
<td>event_fifo_counter[3]</td>
<td>3</td>
<td>Counters for event FIFOs (3 relays).</td>
</tr>
<tr>
<td>3027</td>
<td>uint16_t</td>
<td>event_fifo_rdptr[3]</td>
<td>3</td>
<td>Read pointers for event FIFOs (3 relays).</td>
</tr>
<tr>
<td>3030</td>
<td>uint16_t</td>
<td>event_fifo_wrptr[3]</td>
<td>3</td>
<td>Write pointers for event FIFOs (3 relays).</td>
</tr>
<tr>
<td>3033</td>
<td>struct event</td>
<td>event_fifo_buffer[3][10]</td>
<td>240</td>
<td>Event FIFO buffers (3 relays with 10 events each).</td>
</tr>
<tr>
<td>3273</td>
<td>uint16_t</td>
<td>event_fifo_crc16</td>
<td>1</td>
<td>CRC16 for all data of event FIFOs.</td>
</tr>
</tbody>
</table>

```c
struct event {
    int64_t start; // Start time of event in nanoseconds.
    int16_t usage; // Usage of relay
    int16_t data[3]; // Data values of triggering event
};
```
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.

<table>
<thead>
<tr>
<th>Error Text</th>
<th>Error HEX Code</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERR_CANNOT_INIT_MODBUS</td>
<td>0x0000 0001</td>
<td>Cannot initialize MODBUS interface. Can happen if slave address or baud rate is wrong.</td>
</tr>
<tr>
<td>ERR_CANNOT_SET_SLAVE_ID</td>
<td>0x0000 0002</td>
<td>Cannot setup MODBUS slave address. Can happen if slave address is wrong.</td>
</tr>
<tr>
<td>ERR_CANNOT_ENABLE_MODBUS</td>
<td>0x0000 0004</td>
<td>Cannot enable MODBUS interface. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>ERR_V_DIODES_IS_LOW</td>
<td>0x0000 0008</td>
<td>Voltage of main DC-DC converter is lower than 3.20 VDC.</td>
</tr>
<tr>
<td>ERR_V_IN_IS_LOW</td>
<td>0x0000 0010</td>
<td>Voltage of external power is lower than 8.95 VDC.</td>
</tr>
<tr>
<td>ERR_EEPROM_ADDRESS_IS_WRONG</td>
<td>0x0000 0020</td>
<td>EEPROM address is wrong. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>ERR_V_SUPERCAP_IS_LOW</td>
<td>0x0000 0040</td>
<td>Voltage of main supercap is lower than 2.0 VDC. Can happen if external power is lower than minimum and supercap power is exhausted.</td>
</tr>
<tr>
<td>ERR_EEPROM_WRITE_FAILED</td>
<td>0x0000 0080</td>
<td>EEPROM write was failed. Can happen only in case of FW bug or HW failure.</td>
</tr>
<tr>
<td>ERR_HOLD_FACT_IS_RONLY</td>
<td>0x0000 0100</td>
<td>Factory MODBUS Holding registers are write protected by jumper.</td>
</tr>
<tr>
<td>ERR_EVT_FIFO_OVERFLOW</td>
<td>0x0000 0200</td>
<td>Event FIFO overflowed. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>ERR_V_RTC_IS_LOW</td>
<td>0x0000 0400</td>
<td>Voltage of RTC’s supercap is lower than 2.5 VDC. External power is absent for too long time (more than a week) and RTC’s supercap is discharged.</td>
</tr>
<tr>
<td>ERR_RELAY_FIFO_IS_FULL</td>
<td>0x0000 0800</td>
<td>Relay FIFO overflowed. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>ERR_BUZZER_FIFO_OVERFLOW</td>
<td>0x0000 1000</td>
<td>Buzzer FIFO overflowed. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>ERR_EEPROM_UNLOCK_FAILED</td>
<td>0x0000 2000</td>
<td>EEPROM unlock was failed. Can happen only in case of FW bug or HW failure.</td>
</tr>
<tr>
<td>ERR_ACCEL_NOT_DETECTED</td>
<td>0x0000 4000</td>
<td>MEMS accelerometer does not detect. Can happen only in case of HW failure.</td>
</tr>
<tr>
<td>Reserved error code</td>
<td>0x0000 8000</td>
<td></td>
</tr>
<tr>
<td>ERR_WRONG_CONFIG</td>
<td>0x0001 0000</td>
<td>One of configuration parameters is wrong. Can happen if parameter sent through MODBUS or console interfaces is wrong.</td>
</tr>
<tr>
<td>ERR_RESET_IS_BY_IWD</td>
<td>0x0002 0000</td>
<td>Device was reset by watchdog. Can happen only in case of FW bug or HW problem.</td>
</tr>
<tr>
<td>ERR_G_FORCE_VECTOR_IS_BAD</td>
<td>0x0004 0000</td>
<td>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).</td>
</tr>
<tr>
<td>Reserved error code</td>
<td>0x0008 0000</td>
<td></td>
</tr>
<tr>
<td>ERR WRONGS_HW_PLATFORM</td>
<td>0x0010 0000</td>
<td>FW is written onto wrong HW type.</td>
</tr>
<tr>
<td>ERR_TOO_MUCH_OF_BAD_MEMS</td>
<td>0x0020 0000</td>
<td>4 from 4 accelerometers are bad. All MEMS accelerometers was failed.</td>
</tr>
<tr>
<td>Reserved error code</td>
<td>0x0040 0000</td>
<td></td>
</tr>
<tr>
<td>Reserved error code</td>
<td>0x0080 0000</td>
<td></td>
</tr>
<tr>
<td>ERR_TEST_PULSE_BAD</td>
<td>0x0100 0000</td>
<td>Test pulse of MEMS accelerometer does not give required feedback.</td>
</tr>
<tr>
<td>ERR_SHELL_INIT_FAILED</td>
<td>0x0200 0000</td>
<td>Failed initialization of console shell. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>ERR_INVALID_TIME_TO_SET</td>
<td>0x0400 0000</td>
<td>Attempt to setup RTC by wrong value of time.</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Warning Text</th>
<th>Warning HEX Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>WRN_EVT_PURGED</td>
<td>0x0000 0001</td>
<td>Old event was purged from event FIFO. Happens when more than 10 events happened.</td>
</tr>
<tr>
<td>WRN_EVT_INPQUEUE_OVERFLOW</td>
<td>0x0000 0002</td>
<td>Overflow of input queue for push button events. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>WRN_EVT_INPQUEUE_READ</td>
<td>0x0000 0004</td>
<td>Unable to read input queue for push button events. Can happen only in case of FW bug.</td>
</tr>
<tr>
<td>Reserved warning code</td>
<td>0x0000 0008</td>
<td></td>
</tr>
<tr>
<td>WRN_RTC_TIME_WAS_LOST</td>
<td>0x0000 0010</td>
<td>Backup energy was exhausted and time of RTC was lost.</td>
</tr>
</tbody>
</table>
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:

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