



GNC-CR12 / 16 / 18 / 20 / 24

Operation Manual

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INSTALLATION DOCUMENTS

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.

1. INCOMING INSPECTION

1.1. Content of Shipment:

All instruments are carefully inspected both, electrically and mechanically before they leave the factory. The shipment should contain the following components (standard instrument without options):

GNC-CR 12/16/18/20/24 Unit

Sensor Unit with Cable and Manual

Power Cable

RS-232 Cable

3 ½" Disk or a CD containing either FieldView/AllView/GeoDAS Software Package

FieldView/AllView/GeoDAS User Manual

GNC-CR 12/16/18/20/24 Operation Manual

Certificate of Compliance or Test Data Sheet

1.1.1. Damage During Shipment:

When arranged with GeoSIG, 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 your local GeoSIG representative or GeoSIG directly

Keep all packaging and shipping documents

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

1.2. Warranty:

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

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 for the instrument

Improper preparation and maintenance of site.

1.3. Test Data Sheet

The test data sheets shipped with the GNC-CR exactly characterises input filter performance and other parameters measured during production test. Consult this sheet for precise specifications of a particular instrument.

2. POWER CONNECTION WARNINGS

2.1. STATIC ELECTRICITY!!

The GNC-CR system and its sensor unit contain 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.

2.2. INSIDE THE SYSTEM (MAINTENANCE) :

In normal use, the GNC-CR front panel should never need to be removed. Removal of the front panel for calibration or maintenance should be done by trained personnel only since AC power enters directly into the system, and can be dangerous if these panels are removed. Before removing the panels, always turn the main switch to "OFF", unplug the power connector (green AC LED indicator must be off) and disconnect the main battery. If you remove an electronic board, you will probably need to reset the time and date, and verify all other parameters are set correctly.

2.2.1. BATTERY LIFE:

The GNC-CR is shipped with the battery installed and connected, ready for use. If you do not install it directly, you will need to disconnect the main battery. Do not forget to reconnect the battery when you install the GNC-CR; the red cable on "+", the black cable on "-" of the battery.

In order to prevent loss of data, the user should be aware that when a memory card, memory module, back-up battery or main battery are in use, the batteries should be replaced before their expected life time expires. Battery minimum life times under normal conditions are:

Main battery	Panasonic LCR-12V6,5P	3 years
	Yuasa NP 6-12 or NP 7-12	3 years
	Fiamm-GS FG20721 or FG20651	3 years
Back-up battery	Varta CR 1/2 AA SLF	5 years

The lifetime of the main battery and back-up battery life can dramatically change depending on operating conditions. Strong discharge of the main battery must be avoided. When the GNC-CR is not powered up, the back-up battery provides power to the clock chip and to the memory module for a total time of one year. During normal operation, power comes from the main battery and the back-up battery life is at least 5 years.

2.3. STORAGE AND OPERATING TEMPERATURE:

To prevent data losses, do not expose the memory module to high temperature. The recommended storage temperature is -40°C to +85°C. Operating temperature range is -20°C to +70°C.

2.3.1. STORAGE

When not in use, the GNC-CR should be stored in a cool dry location. These same conditions will also tend to maximize battery life. In the event that storage for greater than several weeks is anticipated, the GNC-CR should be attached to a charger for 24 hours to top off the battery charge. The user should remove all data records from memory. Note that the real time clock operates when the POWER switch is in the OFF position. A minimum amount of current (less than 90 microamps) is required from the 12 volt supply. Therefore, to maximise the battery storage life and replace the clock current drain, the unit will require occasional recharging. Recharging for 24 hours every month is recommended.

3. INTRODUCTION

The **GNC-CR 12/16/18/20/24** is a 12, 16, 18, 20 or 24 Bit seismic data acquisition system (in this operation manual called "**GNC-CR**" unless needed to be specific). Several sensors may be used such as seismometers, geophones, accelerometers or other sensors having a voltage output within the voltage range of $2.5V \pm 2.5V$. Sensors are externally mounted. Uniaxial, biaxial or triaxial sensors as well as sensors with current loop may be used.

Up to 45 channels of data may be recorded in one system. The channels are grouped into units of 3 channels. Each unit is assigned to a specific station number for communication purposes.

The **GNC-CR** stores the event data in battery-maintained static CMOS RAM or memory card. Frequency response depends on the low-pass filter chosen. The instrument has several digital low pass filters which may be chosen from a menu during set-up. Filter cut-off frequencies between 50, 100 or 315 Hz are selectable.

During normal operation the **GNC-CR** continuously amplifies, filters and converts sensor inputs to 12 or 16 Bit digital form and passes these to a pre-event memory. When the specified triggering criteria have been met, the instrument begins recording the data from the pre-event memory. By selecting the correct length of the pre-event memory, the operator can ensure that the entire event, including the first arrival, will be recorded.

Trigger algorithms include **Short Term Average (STA) to Long Term Average (LTA)** ratio triggering and level triggering. The (STA/LTA) ratio trigger computes the short term and long term signal averages fifty times per second (every 0.02 seconds). When the STA exceeds a pre-selected multiple of the LTA, the **GNC-CR** begins recording data.

The level trigger continuously compares the incoming signal to a selected threshold and triggers when its value exceeds the threshold. The triggering parameters and set points are set by the menu driven software program FieldView/AllView/GeoDAS or by downloading previously determined set-up information from a PC.

Recorded data include sensor data, clock/timing information and instrument set-up information. Data is stored in CMOS static RAM memory with power maintained by internal and/or external batteries or in Memory Cards (Flash EEPROM/SRAM, PCMCIA).

The GNC-CR is configured by connecting a personal computer with an RS-232 communications port. Use of a portable computer enables the operator to both set-up the unit and to perform a complete in-the-field check of the system from the sensor to the data storage memory.

Access to recorded data is also possible via computer connection. High-speed communication (up to 115200 Baud) capability allows data to be extracted very quickly.

With the FieldView/AllView/GeoDAS program, running on any IBM compatible personal computer, set-up and retrieving of recorded data is performed. Set-up and data access may also be accomplished remotely through the use of modems.

3.1. Description

Multiple channel systems can record up to 45 channels of analog signal. The 45 channels are divided up into 3 channel units. Therefore a complete system will consist of 15 recorder module cards (RMC), associated input/output connector cards, back plane cards, a front panel card and one master controller card. The master controller card allows the system to have synchronized timing, sampling and triggering. Units of less than 9 channels with master controller can be mounted in 3U, 5.25in (133mm) height chassis. From 12 channels with master on up to 45 the mounting is in 6U, 10.5in(267mm) height chassis.

3.1.1. Housing

The GNC-CR is typically housed in a standard 19" wide rack. The enclosure is available in 6 HU (Height Unit) or 12 HU. The 19" rack is mounted in a Tecnopac Cabinet. Information regarding the unit's date of manufacture, serial number, etc. is contained on the ID label on the outside of the housing.

Mounted in the front panel is the LCD display and four LEDs for instrument status indication. The main power switch is also on the front panel. This switch provides power to the electronics. It does not need to be on to charge the optional internal battery. This battery is mounted either to the right side of the chassis behind the front panel display or located in the bottom of the cabinet.

3.2. LCD DISPLAY

The alpha-numeric display gives detailed information about the incoming signal, date and time, status and error messages. The information to be displayed is user programmable and may be set by the FieldView/AllView/GeoDAS software program.

3.3. LED'S

AC

This green LED indicates the connection of AC power to the system to charge the battery.

Run

Run LED blinks once per second during the "Turn-On Delay" period. This typically lasts for 15 seconds after switching the GNC-CR 12/16/18/20/24 on. It then blinks every two seconds indicating that the instrument is running.

Event

The yellow LED is illuminated during recording an event. After recording the LED indicates the presence of one or more events by blinking. The number of flashes within 10 seconds indicates the amount of memory used, in units of 10%.

Error

The red LED blinks if an error or a warning has occurred (e.g. memory full, sensor bad, low battery, etc.).

3.4. Printed Circuit Boards

The recorder modules are located behind the front panel. The recorder modules (RMC) are plugged into a four slot backplane. A RMC board contains the hardware filter, A/D converter, clock and microprocessor. The system may also contain a master controller card which provides common timing, common sampling, common triggering and controls the RMC modules. The backplane is connected to the front panel display and rear panel connector card by ribbon cables. All connections to the external sensors are made to the connector cards on the rear panel. A variety of connectors and terminal blocks are available. Other connectors are also mounted to the rear panel. These are RS232 (Computer/Modem), OPTION (Alarms), INTERCON and POWER. The AC to DC converter and optional internal battery are also mounted in the rear of the chassis.

3.5. Internal Battery

The GNC-CR housing contains one 12 V, 6.5 Ah rechargeable sealed lead-acid battery. The battery pack provides autonomy when AC power is lost. The period of autonomy depends on the configuration of the system. Additional battery capacity may be added externally (For further information please contact GeoSIG or their representative).

3.6. Battery Charger

The built-in battery charger will keep the internal battery pack charged to optimum level without the risk of overcharging. The charger has sufficient capacity to recharge depleted batteries while the GNC-CR is operating. The charger can be powered by 115 VAC or 230 VAC without requiring a different connection configuration.

Note:

For an external battery an external charger must be used. Therefore, select a charger with appropriate charging characteristics for the used battery.

3.7. Connectors

The GNC-CR will be configured with sensor connectors / cable inlets depending on the required amount of sensors. The sensor connectors are located on the rear panel. The Option and Power connectors are also mounted on the rear panel, the RS-232 connector is either on the front or the rear panel depending on the system configuration,. (see the relevant technical drawing). Site specific connection drawings are provided when special input/output signal requirements have been selected.

The function of each connector is:

Power

Through this four-pin connector the internal battery charger is supplied with 115/230 VAC power. Alternatively, external batteries for powering the GNC-CR may be connected here (with DC Input Option).

Option Connector (optional)

Two options are supported by the option connector:

The alarm option gives three different output signals (relay contacts) to activate alarm indicators such as buzzer or lights.

The connector is also used to connect an external time source such as GPS to the GNC-CR. The signal from this external source can be either a pulse or a RS-232 level signal.

Intercon (optional)

This connector is used for interconnecting multiple units to a network. It may also be used for special functions as required.

RS-232 Communication

This connector is for attaching a PC to the GNC-CR. The PC is used for setting operating parameters or retrieving recorded data. Maximum data rate is 115.2 kBaud. It may also be used for an external Modem connected between the system (optional) and a telephone line for remote control and data retrieval.

Sensor Connection

The sensor connector is either an 8 pin connector or a 10 or 16 point terminal block. Sensor cables may already be installed according to customers requirements or may be assembled when the system is being installed at the site. The sensor connection provides +12, ± 12 Volt or +7.4 Volt DC power to the sensor. Different types of sensors may be connected. The typical input is 2.5 ± 2.5 vdc, other ranges are available. Consult GeoSIG Ltd. or the representative for additional data. Lightning protection is also available.

3.8. Options and Accessories

The following optional equipment is available for the GNC-CR:

3.8.1. LCD

The alpha-numeric display gives detailed information about the incoming signal, date and time, status and error messages. The information to be displayed is user programmable.

3.8.2. Modem

The GNC-CR is available with an external modem. This option gives remote control to the GNC-CR via telephone line. On request the modem is capable of "Calling on Event". This means, as soon an event triggers the GNC-CR, the modem automatically calls a pre-set telephone number and transmits the data of the event.

3.8.3. GPS

The GPS option is a satellite navigation receiver attached to the GNC-CR. The GPS gives the exact information about time and position of the instrument. Full details are provided with the GPS option.

3.8.4. Alarm output

This option generates two alarm signals (for two threshold levels) in a way similar to that of the recording trigger, thus allowing the personnel in charge to be informed immediately on the severity of a strong event. The outputs are 2 relay contacts, either normally open or normally closed (to be specified at order), and an additional alarm relay may be designated for system trigger or indication of a GNC-CR warning or error.

3.8.5. DC Charger

The DC charger enables the user to charge the system off a single 12 VDC source. This is useful if it is necessary to charge the system by a single 12 V car battery. This option is factory installed.

3.8.6. TCXO Clock

A high accuracy clock oscillator is available. Frequency stability is 0.3 ppm. This reduces clock drift to 26 msec maximum.

4. SET-UP AND OPERATION

This chapter lists the operating procedures involved in installation, setting up and running the GNC-CR. This chapter will treat the input of parameters as steps to be performed in the field or in house prior to placing the instrument in the field. This manual provides data on the installation of the hardware and preliminary startup. Refer to the FieldView/AllView/GeoDAS manual.

4.1. Site Selection

4.1.1. Environmental Considerations

The choice of an installation site for a seismic event system is similar in most respects to that of a regular continuous recording seismic station.

The GNC-CR is typically housed in a non sealed case. Therefore a location must be found for the unit which is free from direct sunlight, precipitation, dangers 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..

There are also special considerations for system installations which must be recognized. The GNC-CR can record seismic activities for approximately 30 minutes (per MByte of storage) with a 12-Bit or 25 minutes with a 16-Bit system before the data storage capacity is depleted, so it is important to select the site and set the trigger level to avoid unwanted data recording, such as 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 and using up the memory.

In addition, the user should select a site with a provision for 115/230 VAC electrical power.

The operator 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 recording mechanism. These will have to be considered when setting the trigger parameters.

4.1.2. Power Supply Considerations

The unit may be powered from a 115/230 VAC supply, the internal battery, or a 12 VDC external supply such as an automotive battery or solar panel.

If the supply in the field will be from a 115/230 VAC line, the operator needs to connect the AC power cable to the source only. The unit operates continuously, providing a trickle charge to the internal battery.

If the supply will be exclusively from the unit's internal battery, it is necessary to charge the batteries sufficiently beforehand. Allow at least 24 hours of uninterrupted charging prior to leaving the GNC-CR in the field. The set-up functions, of course, may be performed while the charger is connected to the unit. The GNC-CR must be plugged to 115/230 VAC for charging the internal battery.

A convenient approach to the set-up of the instrument is to use the internal battery along with the AC power at the remote site. In the lab, the GNC-CR may be checked out and set for the correct time and trigger. It may then be carried to the remote site (with the power switch in the "OFF" position to conserve the internal batteries) and then connected to the AC power. After switching to "ON", the GNC-CR runs with the pre-set parameter values. This reduces the amount of time needed to program in the field; an important consideration in an adverse condition.

4.2. Installation

Many times the installation sites of seismic equipment are highly exposed to static discharges caused by lightning or by the industrial environment. Even though the GNC-CR contains over voltage protection, it may sometimes be necessary to use additional surge protectors for the equipment. Contact GeoSIG or your local representative for more information.

4.2.1. Supply Voltage Selection

The GNC-CR may be powered from 115 VAC up to 230 VAC, 50 or 60 Hz. The GNC-CR contains a primary switched power supply which will automatically adjust to either 115 and 230 VAC input. Just connect the GNC-CR power cable to the AC source and the green AC lamp should illuminate.

If the AC lamp does not illuminate check the fuse of the GNC-CR and if necessary replace it with a 500 mA slow blow type fuse. Verify the presence of the AC voltage.

4.2.2. Sensor Installation

- See the Sensor Manual for specific instructions if necessary.
- When installing the cable between the GNC-CR and the sensor, Locate cable away from sources of EMI/RFI interference.
- Terminate the field cables with the appropriate connectors. see the relevant technical drawing for GNC connector data. Verify connection using an Ohmmeter before applying power.
- Connect the sensor cable to the sensor and GNC-CR.
- Connect your Laptop PC to the recorder.
- Start the FieldView/AllView/GeoDAS program and Login to the recorder (See FieldView/AllView/GeoDAS Manual).
- Fine adjust the leveling using your PC with the FieldView/AllView/GeoDAS program. Choose **Recorder Display** in the **Recorder** option and select **Analog Signals** [FieldView/AllView/GeoDAS: Recorder, Recorder Display, Analog Signals]. The actual analog values (“A/D Value”) of the three channels are visible in raw digital counts.
- Level the sensor until the values of each axis show approx. 2048 counts (within ± 10 counts) or 32768 (within ± 300 counts).
- Make sure, the sensor is still rigidly bolted to the structure or the sub-terrain after leveling.
- Click “A/D Calibrate Now” to adjust the zero line (“A/D Zero”) to the actual sensor signal and click “OK” to leave the dialogue box.
- To verify operation of the sensor, enter the **Self Test** window in the **Recorder** drop-down menu [FieldView/AllView/GeoDAS: Recorder, Test Config.]. Mark the “Analog” and “Record Test Pulse”. Perform a self test by clicking the “Test” button. This will give a test signal to the sensor. The output from the sensor is recorded by the GNC-CR as a pseudo event which is downloaded and displayed to verify the sensor, preamplifier and filter response. The result should be a square wave output. Its magnitude varies by the different sensor types (refer to the test sheet, delivered with the sensor).

4.2.3. System Installation

The GNC-CR is generally supplied installed into a standard 19” wide instrument rack enclosure (See Section 1.1.1, Housing). The enclosure is typically 50.0cm(20”) deep. Allow room behind for cable entry. Secure the enclosure to a suitable surface. Protect from moisture, direct sunlight, high/low temperatures and falling debris.

Optionally it is possible to mount external GSR recorders with sensors and integrate them into the central recording system (Local Recording System).

The following are the items needed for such an installation:

- GNC-CR12/16/18/20/24 Unit
- GNC-CR12/16/18/20/24 Operation Manual

4.2.4. First Start

Connect the AC power cable.

The green AC LED indicator must turn on,

If not:

Disconnect the AC power cable from the GNC-CR.

Check if the internal FUSE is blown.

If so, then replace it with a 500 mA or 1 amp slow blow fuse as required.

Check if the AC power is present at the plug.

When the problem is solved, reconnect the AC power cable to the GNC-CR.

Insert the memory card if applicable.

Switch the main switch to its ON position.

The green RUN LED should blink once per second for about 15 seconds. Afterwards it will change to one pulses every two seconds. This indicates, that the instrument is running.

Note: Do not move or vibrate the sensor during the power up cycle. (The GNC-CR is calculating the baseline of the 3 incoming signals, any noise could distort this signals.)

Connect the GNC-CR with the RS-232 cable to your computer and start the FieldView/AllView/GeoDAS program. Refer to FieldView/AllView/GeoDAS manual.

4.2.5. Terminating the Installation

After checking the GNC-CR using the FieldView/AllView/GeoDAS program disconnect the RS-232 cable. Fix the remaining cables, so that they may not influence the sensor signal by knocking or vibrating at the sensor.

After performing a **Logout**, (See FieldView/AllView/GeoDAS Manual) disconnect the computer from the GNC-CR before switching the computer off. Do not leave *any* unpowered device connected to the GNC-CR.

Do not touch the sensors and leave the area of the equipment as quietly as possible.

4.3. Setting Operation Parameters

For setting parameters and for retrieving recorded data a personal computer with the FieldView/AllView/GeoDAS software program must be used. This program provides facilities for setting up the GNC-CR prior to deployment, retrieving GNC-CR event data and displaying the captured data. FieldView/AllView/GeoDAS runs on IBM PC compatible computers, including laptop models and is connected with the GNC-CR via serial data interface.

5. FUNCTIONAL DESCRIPTION

This section discusses some of the technical details of how the GSR works. Input signal filtering and digitising, triggering, time accounting, data storage and event logging are among the function described.

5.1. Signal Conditioning

Signals from seismic sensors coming into the GSR are range-adjusted in preparation for conversion to digital form and are filtered to prevent aliasing effects. The signals are next sampled and digitised, and then digitally filtered under software control to further reduce noise. Only full-filtered data are used for triggering and recording.

The GSR accepts signals from sensors within the voltage range of 0.5 to 4.5 volts. A standard GSR with a gain of one, digitises and records the sensor signal as follows:

Analog Input Voltage AIV (V)	Digital Value DV		(Bit)	
	Decimal	Hex	Decimal	Hex
		12 Bit		16 Bit
0.500	0	0x0000	0	0
0.501	1	0x0001	10	10
2.500	2048	0x0800	32768	8000
4.499	4094	0x0FFE	65520	FFE0
4.500	4095	0x0FFF	65535	FFFF

The digital values for voltages between 0.5 and 4.5 V can be determined using the following formula

$$\begin{array}{l}
 \text{12 Bit:} \quad \text{DV} = \frac{(AIV - 0.5) 4096}{4} \\
 \text{16 Bit:} \quad \text{DV} = \frac{(AIV - 0.5) 65535}{4}
 \end{array}$$

5.1.1. Signal Amplification

The gain factor by which a sensor input is amplified in the GSR analog circuit is factory set to the standard gain 1 or 2. The gain may be set independently on each signal channel on request.

5.1.2. Analog Signal Filtering

Each signal channel has a low-pass 100 Hz 6th-order Butterworth analog filter. The sensor input signal passes through this filter prior to being sampled and converted to digital form. This filter removes signal energy at frequencies above one-half the input sampling rate (800 Hz) so that these higher frequencies are not aliased by the sampling process, appearing as erroneous digitised data. The signal level above 400 Hz at the output of the analog filter is at least 72 dB below the input level. This affects the data values by one count maximum at the digitising resolution of 16 Bit.

5.1.3. Signal Digitising

The amplified and filtered analog signals are sampled at a rate of 800 SPS per channel and converted by a successive-approximation analog-to-digital converter to 16 Bit digital data values. The 800 SPS is a greater number of samples than what actually is recorded. The digitised data still contain signal frequencies up to 400 Hz which must be filtered digitally. As part of the digital filtering process, the data are "decimated" to reduce the sampling rate to 200 or 400 SPS, depending on the digital filter cut-off frequency.

5.1.4. Digital Signal Filtering

The digitised sensor data are digitally filtered 6th order Butterworth to restrict the signal to the selected bandwidth (50,60, 70, 80, 90 and 100 Hz).

Sampling Rate Decimation

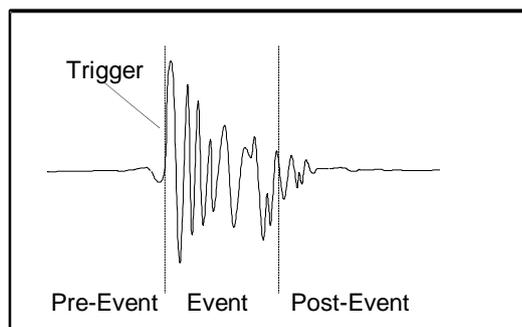
Based on the analog and digital signal filtering the sampling rate of 800 SPS can be decimated to 200 or 400 SPS, depending on the selected signal bandwidth. The digital filtering algorithms also decimate the data, resulting in reduced sample rates. At the Nyquist frequency (half the decimated sample rate) the signal is at least 84 dB below the input level due to the combined effect of the 100 Hz analog filter and the digital filter. Since data are digitised and stored at 16 Bit resolution, signals above the Nyquist frequency, even full-scale signals, do not affect the final stored data values at all.

It is important to note that every filter introduces a phase shift to the data. The phase shift of digital filter is -270° at the cut-off frequency. This is due to the fact that it is a 6th order filter with each pole contributing 45° of phase shift at the cut-off frequency.

5.2. Triggering

Any of four methods may be used to trigger the GSR to start recording data:

- The GSR may be set to trigger internally when incoming sensor signals satisfy certain criteria.
- The GSR may be set to start recording at a specific time.
- The GSR may be set to start recording by software command from a connected PC.
- A trigger signal may be provided from another GSR or other external source (with external trigger/network option).
- Recording starts the pre-event time before trigger, continues as long as the trigger criterion are met and stops after the post-event time.



Typical Recorded Data for 1 Channel

If the user sets up trigger parameters that are continually met by the environment, the system will trigger continuously. This will be indicated by the yellow event LED which is always on. The user can connect a PC to the GSR unit to interrupt the recording and select a different set of trigger criteria.

5.2.1. Internal Triggering

Internal triggering requires that incoming sensor data satisfy certain pre-set criteria for recording to begin. The digitised and digitally filtered sensor data are used as input to the internal triggering system.

Either of two criteria may be used for internal triggering. The Threshold Trigger simply determines if the signal amplitude has exceeded a pre-set threshold. The Short Term Average/Long Term Average (STA/LTA) Ratio Trigger determines if there is a sudden increase in signal amplitude. A combination of both Threshold and STA/LTA triggers may also be selected so that the GSR will start recording when either trigger criterion is met.

Threshold Trigger

The Threshold Trigger compares the signal amplitude of the filtered trigger signal to a threshold value. The sensor data are first processed by a digital high-pass filter with a corner frequency of about 0.1 Hz to remove any DC offset. The data are then filtered and rectified to give an absolute-value signal amplitude ranging from 0 to a maximum of 2048. Data recording is initiated when the amplitude exceeds the pre-set threshold value. The user may enter the threshold values in the selected channel unit. The FieldView/AllView/GeoDAS program calculates it to raw counts (LSB) and puts the value into the recorder. If the threshold is set to 10 counts, then a signal greater than 10 counts will cause a trigger.

STA/LTA Ratio Trigger

The STA/LTA ratio trigger uses an algorithm which will filter out background noise and allow only those data which pass through its filters to trigger the record function of the GSR. This filter method uses a Long Term Average of data inputs to set the background noise base level and compares this to a Short Term Average of data which is more responsive to changes in the data input stream. During the steady state of the system, the STA and the LTA will be nearly equal. The shorter the STA averaging period, the more quickly it will change with the input. The trigger condition occurs when the ratio of the STA versus the LTA exceeds a present level, ALPHA.

To use the (STA/LTA) ratio trigger, four pieces of information must be supplied:

- The short term time period
- The long term time period
- The ratio (ALPHA) dB of short term average to long term average which will trigger recording, and, whether or not to update the LTA during the event.

The averaging time for the STA and LTA may be set as follows:

STA 0.1 to 10.0 seconds

LTA 1 to 100 seconds

Note: The LTA may not be set smaller than the STA.

The ratio of STA to LTA, ALPHA, is defined as:

$$\text{ALPHA} = 20 \times \log_{10} \frac{\text{STA}}{\text{LTA}}$$

The probability of having a false trigger due to noise will be minimised if a long STA averaging time is selected. Obviously, the STA should not be chosen longer than the shortest event of interest. In addition, the STA should be shorter than the block of pre-event data stores in the Pre-event Memory. If not, the initial portion of an event may not be recorded.

If the LTA is allowed to update during the event, and the event is long relative to the length of the LTA period, then the instrument will determine that the event is actually part of the background noise and the trigger condition will terminate. The user has the option of enabling or disabling the LTA update.

5.2.2. Time Triggering

The GSR may be set up to begin recording data at predetermined times. Up to four dates and times may be programmed into the unit during set-up. A recording duration for each recording time is also specified. Once set by the operator, the GSR uses its internal clock to keep track of the date and time-of-day until reset again by the operator.

5.2.3. Software Triggering

The GSR may be set up to begin recording data by command of the connected PC. The FieldView/AllView/GeoDAS program supports triggering by key stroke. If the Software Trigger in the Trigger Settings window is enabled, the operator may start recording by clicking Trigger Now in the Directory of Instrument Files. The GSR records Pre- and Post Event Time. This feature is useful for measuring seismic noise levels.

5.2.4. External Triggering (option)

The GSR may be externally triggered by connecting a trigger signal to the Interconnection connector (option). The external signal may come from another GSR recorder, from a Control Centre or from some other source. The GSR begins recording data when the external trigger signal goes to a low (0 V) on a falling edge. Several data recorders may be connected in "bus" fashion and triggered simultaneously by one trigger signal. Whenever it is triggered, regardless of trigger source, the GSR puts out a signal on the Master/Slave connector to be used as a trigger by other units, e.g., one GSR may be set up to trigger internally on incoming sensor signals, and can then activate several other units to begin recording.

5.3. Triggering Guidelines

It is important to note that the input signal for the trigger channel is digitally high-pass filtered to remove any DC offsets. The digital high-pass filters have a corner frequency of approx. 0.1 Hz.

5.3.1. Threshold Trigger

The threshold trigger compares the digitally low-pass filtered and rectified input (sensor) signal with the value of the threshold level in the **Trigger** menu. The corner frequency of the filter has to be set in the **Filter** menu.

5.3.2. STA/LTA Ratio Trigger

The STA/LTA (Short Time Average/Long Time Average) ratio trigger computes the short term and long term averages of the rectified input (sensor) signal. When the STA exceeds a pre-selected multiple of the LTA, the **GSR** begins to record data. The advantage of this trigger type is that the trigger sensitivity adapts to the seismic background signal. With an increasing noise level the trigger sensitivity decreases and therefore less false triggering occur.

To use the STA/LTA ratio trigger, four following information must be supplied:

- the short term time period
- the long term time period
- the ratio dB of short term average to long term average which will trigger recording
- if you want to have the value of the long term average updated during an event.

The average time for the STA and LTA may be set as follows:

- STA 0.1 to 10 seconds
- LTA 1 to 100 seconds

Note: The LTA may not be set smaller than the STA.

The ratio of STA to LTA, ALPHA, is defined as:

$$\text{ALPHA} = 20 \times \log_{10} \frac{\text{STA}}{\text{LTA}}$$

The probability of having a false trigger due to noise can be minimised if a long STA averaging time is selected. Obviously, the STA should not be chosen longer than the shortest event of interest. In addition, the STA should be shorter than the block of pre-event data stored in the Pre-event Memory. If not, the initial portion of an event may not be recorded.

The average period for the LTA should be chosen short enough to adapt to any changes in the level of background noise. However, the LTA time should be long compared to the STA time, otherwise, the LTA will adapt to an event as if it was simply a change in the background noise level.

Please note that it is possible to select a combination of STA, LTA and ALPHA which will not meet the trigger conditions and no internally generated trigger will occur. For example with

$$\begin{aligned} \text{STA} &= 1.0 \\ \text{LTA} &= 10 \\ \text{ALPHA} &= 23 \text{ dB} \end{aligned}$$

the STA/LTA ratio of 14.125 (23 dB) never could be reached because the LTA adapts to the signal before the STA value gets to the trigger level.

In this case, the theoretical maximum value for ALPHA would be

$$\text{ALPHA} = 20 \times \log_{10} \frac{2048}{205}$$

$$\text{ALPHA} = 20 \text{ dB}$$

This would indicate that any value of ALPHA greater than 20 dB could never be used for any LTA period/STA period ratio equal to 10. Some sample STA/LTA values and the greatest possible ALPHA that would allow a trigger are given hereafter .

STA	LTA	Maximum ALPHA
2.0	10	14 dB
1.0	10	20 dB
0.5	10	26 dB
0.5	20	32 dB
0.2	20	40 dB

Max. values of ALPHA for some sample STA/LTA ratios.

If the LTA Update is enabled, the long term average value (LTA) will be periodically updated even during an event. The recording of a long event could be cut off since the LTA value increases until the ratio of STA/LTA has reached a value where the trigger condition is no more fulfilled. With an adequate "Post-Event Time" the loss of data can be minimised.

If the LTA Update is disabled, the long term average value (LTA) will be "frozen" during recording. With a permanent seismic noise signal where the input signal does not decrease for a long time, the short term average value (STA) will no more reach a value below the trigger level any more after triggering. The GSR will not stop recording until its memory is full. Therefore it is recommended to have the LTA Update "enabled" for standard applications.

Three examples of typical applications and the suggested trigger parameters are given below

- Micro Event Detection

For this application, the unit should trigger on both low level and short events. consequently, the STA/LTA ratio is set low and the STA averaging time is set short.

STA = 0.1 to 0.5 seconds
LTA = 10 seconds
ALPHA = 10 to 18 dB
LTA Update : YES

Note: At this setting, some false triggers should be expected in most locations.

- Local Earthquake Detection

In this situation, the unit should trigger on small local earthquakes. The expected amplitude of the events will be larger than in the previous case.

STA = 0.5 to 1 seconds
LTA = 20 seconds
ALPHA = 14 to 24 dB
LTA Update : YES

- Strong Motion Detection

For this application, the unit will record only strong motion events and there will be almost no false triggers.

STA = 1 second
LTA = 20 seconds
ALPHA = 18 to 26 dB
LTA Update : YES

5.4. Data Recording

An "event" is a period of time during which recording is triggered. When an event occurs, the GSR stores digitised sensor data in its battery-backed memory for later retrieval. Recording continues as long as trigger criteria are met, and then for an additional period of time to make sure the end of the event is captured. Storage allocated for this additional recording interval is referred to as "post-event memory".

For recording to stop, there must be no trigger condition for at least the post-event interval. If trigger condition disappears and then the same, or some other trigger condition is re-established within the post-event interval, the event is considered to be continuing and recording is not terminated.

The GSR also records sensor data occurring within a preset time interval prior to an event. This is accomplished by continuously keeping an updated record of the most recent sensor data in "pre-event memory". When a trigger occurs, these data are include as part of the record or the event.

The pre-event and post-event memory intervals are selected by the operator during GSR set-up.

5.4.1. Event Directory

The GSR maintains a directory of recorded event files and a summary of key information about each event. This data may be displayed in tabular format by attaching a PC to the GSR. The operator may then decide which event(s) are of interest and extract data from the GSR for just those events.

5.4.2. Recording Capacity

The maximum recording time is related to the sample rate, due data compression the amplitude of the signals, the number of recorded events, and the amount of memory installed in the GSR. It may be approximated by

$$t = \frac{M}{2.4 SR}$$

where M = Memory (Byte)
 SR = Sampling Rate (SPS)
 t = time (sec.)

With 512 kByte memory using a sample rate of 200 SPS we receive a maximum recording time of approx. 18 min. There is no limit other than memory size on the number of events which may be recorded.

If the linear memory model is selected, the GSR will not record over previously obtained data. When memory is full, recording automatically stops. If the circular memory model is programmed by the user, the GSR starts to record over previously obtained data after the memory is full. The GSR begins to overwrite the files older than a predefined time, starting with the oldest file. The time after a file may be overwritten can also be set by the user.

5.5. Clock

The GSR has a complete, self-contained time-keeping system. This clock keeps track of days, hours, minutes and seconds. The instrument has the ability to set the clock to the current time manually, or to set the time and synchronise the clock automatically with an encoded external time signal. The clock operates from the internal battery and runs regardless of the position of the ON/OFF switch.

5.5.1. GPS Option

The GPS (Global Positioning System) is originally used for navigation. It contains 24 satellites which orbit the earth in a distance of about 20 000 km. The signals transmitted by the satellites are used to get the position; minimum 4 satellites have to be received by the GPS receiver to find its exact position. The transmitted signals contain also precise time information, which is used to update the internal clock of the GSR.

5.6. Self Test

An extensive self test routine checks periodically the functions of the GSR and its sensor, some of the functions are even permanently supervised. The detailed result of the last test is stored in the header of every event file and can be seen with the Header Information. The actual test result is visible in the **Recorder Display: Warnings and Errors**. Warnings and Errors are also indicated in the Status Line of the main menu and by the red LED on the lid of the GSR.

The GSR distinguishes between Warnings and Errors. Warnings are malfunctions of the instrument, but it is still running and capable to record data. With an error the instrument is out of function.

The different self tests performed by the GSR are divided into various groups, Analog, Hardware, Real Time Clock (RTC), Battery and Memory.

See FieldView/AllView/GeoDAS User Manual for detailed information about the Warning and Error messages.

5.7. Data Retrieval

In order to retrieve event data, an IBM-PC compatible personal computer running the FieldView/AllView/GeoDAS program or other software with data capture capabilities must be used.

6. Maintenance

Additional instructions for troubleshooting and for implementing the self test may be found in the FieldView/AllView/GeoDAS Manual.

6.1. Storage

When not in use, the GNC-CR should be stored at normal room temperature in a dry location. This will help to maximize the battery lifetime. If the system is stored for more than a few weeks, the GNC-CR should be attached to AC power for 24 hours to top off the battery charge. In this case the operator should remove all data records from the memory. Note that the real time clock also operates when the main switch is in the OFF position. Therefore, unless the clock is turned off by disconnecting the cable from the main battery, the unit will require occasional recharging. Recharging for 24 hours every 2 month is recommended. In the event of a battery failure, the memory and the real time clock are maintained by lithium battery.

6.2. Testing

The GNC-CR has been designed in a way, that it requires a minimum of maintenance. If the following procedures are performed frequently, the instrument will last for many years.

The periodic Software Self Test indicates any irregularity as soon as it occurs. Therefore it is recommended that this test be performed at least **once a year**. Compare the signals of the 3 channels with older records. There should not be a distinctive change.

If changes occur in the accelerometer (analog) response of the sensor it is recommended that a tilt test be performed.

The function of a sensor with DC response (capacitive, piezo-resistive and force-balance sensors) can be checked by inclining the sensor in every axis. An inclination of 90° causes an acceleration of 1.0 g, 30° an acceleration of 0.5 g and 14.7° an acceleration of 0.25 g. Check that value for every channel [FieldView/AllView/GeoDAS: Recorder, Recorder Display, Analog Signals]. For testing the sensor has to be installed onto the tilt table. Every axis should be performed. The output signal has to be compared with the calibration values given by the manufacturer.

A sensor without DC response needs to be checked by using a shaking table. The period of this check depends on the used sensor type. For detailed information refer to the data sheet of your sensor.

Check the function of the alarm relays (option) **annually**. Therefore use the Test Low Alarm and Test High Alarm button in the “Alarm Configuration” window of the FieldView/AllView/GeoDAS program.

The voltage of the main battery and the charging voltage of the charger shall be measured **annually**. Disconnect the AC power to measure the battery voltage, keep the GNC-CR switched on. The voltage should be between 11.8 and 13.2 V, depending on its charge. Reconnect the AC power cable, switch off the GNC-CR and disconnect the main battery, measure the voltage on the battery cables. The voltage should be 13.8 V.

The physical condition of the system and the sensor should be checked **annually**. Make sure every cable and connector is in good condition and plugged in properly.

The main battery has to be replaced every **3 years**. After replacement program the date of installation and the date of the next replacement into the GNC-CR by using the “Power and Batteries” window of the FieldView/AllView/GeoDAS program [FieldView/AllView/GeoDAS: Recorder, Recorder Display, Power and Batteries].

The backup battery has to be replaced every **5 years**. After replacement program the date of installation and the date of the next replacement into the GNC-CR “Power and Batteries” window of the FieldView/AllView/GeoDAS program [FieldView/AllView/GeoDAS: Recorder, Recorder Display, Power and Batteries].

6.3. Spare Parts

In some cases it may be appropriate for some spare parts to be maintained on site. The following is a list of recommended spare parts. These parts would also be useful for troubleshooting. See the test data sheet for model or part number or examine the suspected faulty card. Contact GeoSIG for further information.

- RMC Recorder Module Board
- Controller Board
- Overvoltage Protection Board
- Connectors
- Main Battery +12V
- Memory Battery 3.5V
- Fuses

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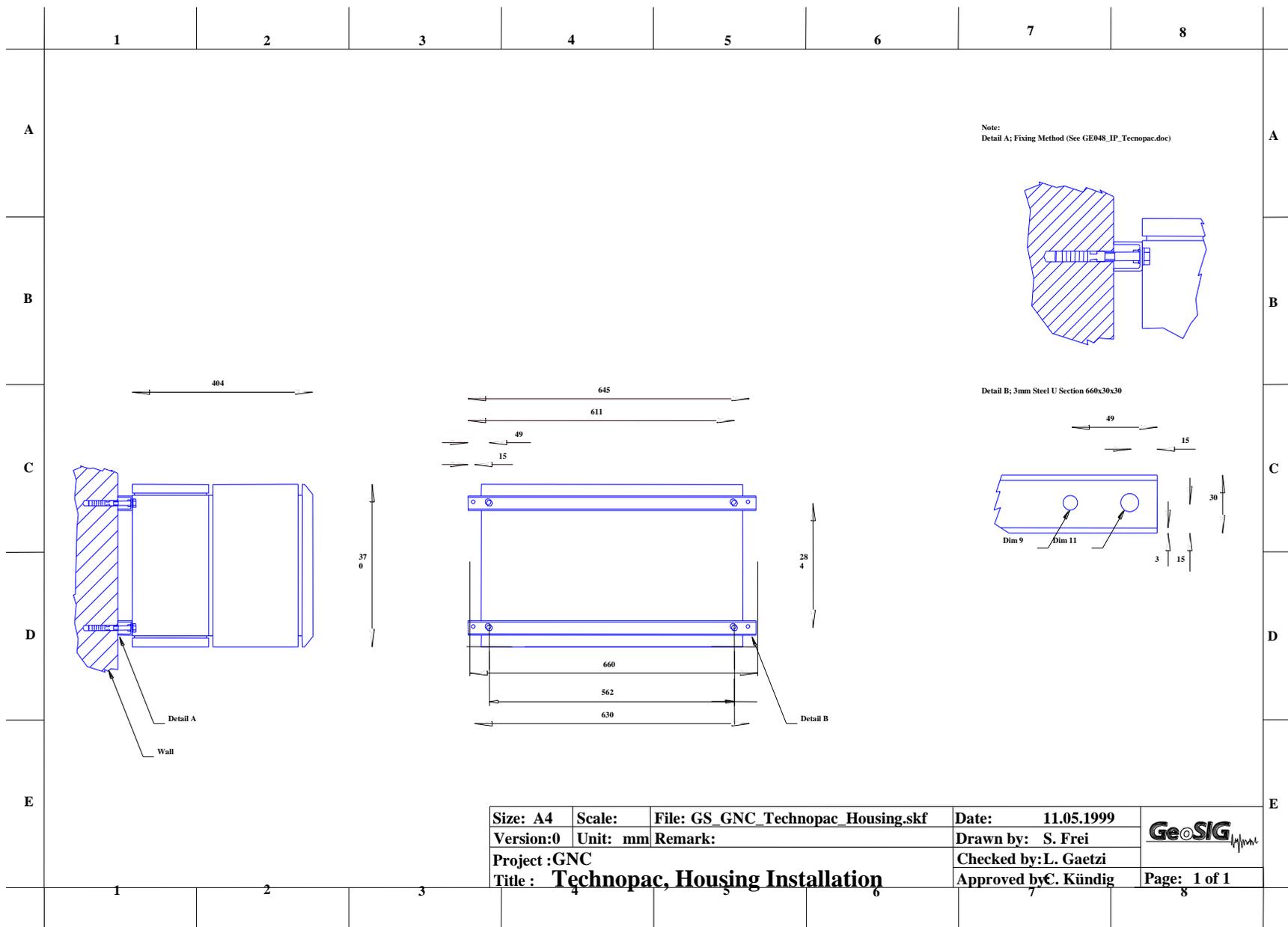
GNC-CR12 / 16 / 18 / 20 / 24

INSTALLATION DOCUMENTS

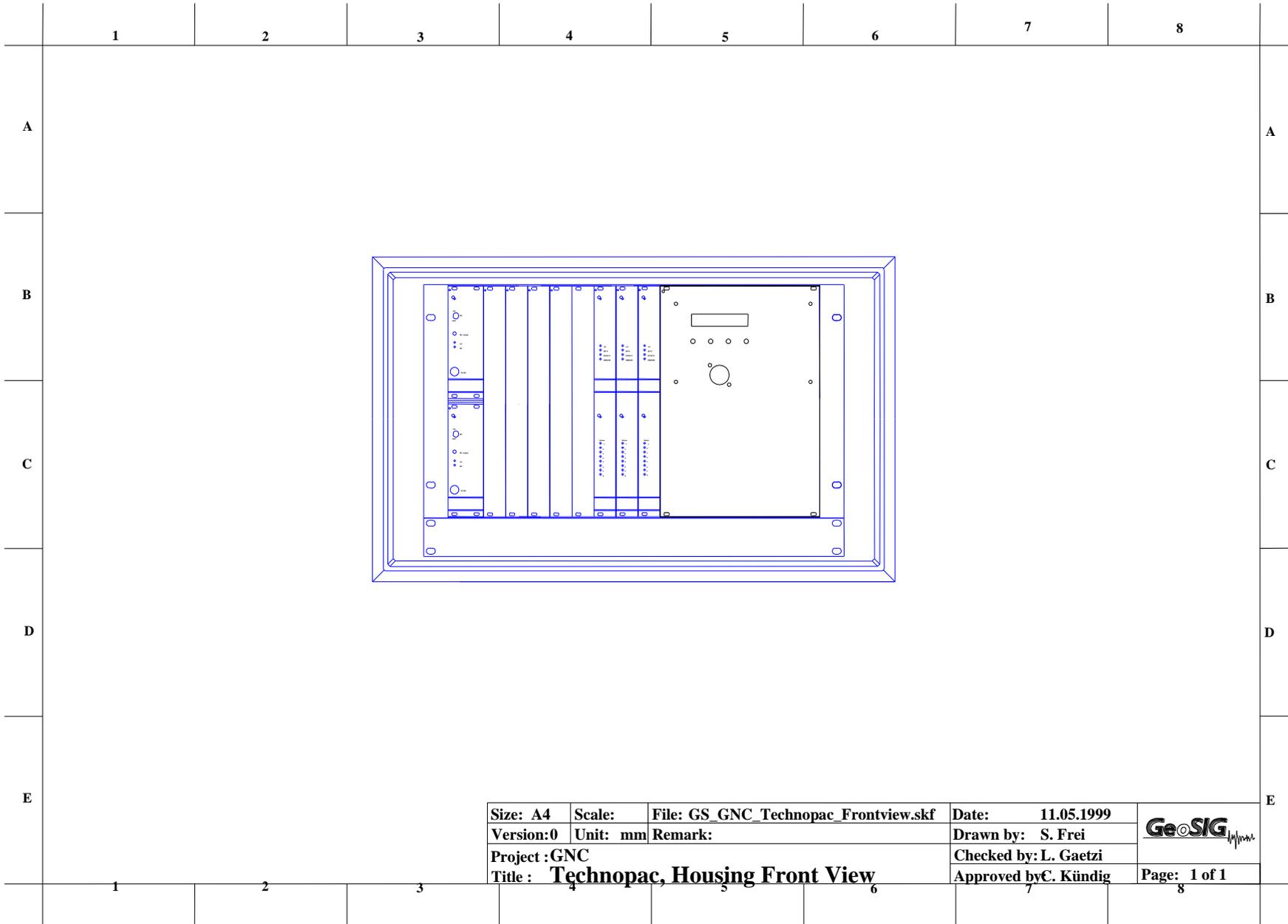
Company:	GeoSIG Ltd. Europastrasse 11, 8152 Glattbrugg, Switzerland, Tel: +41 44 810 21 50, Fax: +41 44 810 23 50, E-mail: info@geosig.com
Author:	Lukas Gätzi
Checked:	Sergio Frei
Approved:	Johannes Grob
Distribution:	GeoSIG Ltd. (1), Customer on request

Installation of GNC Technopac Rack

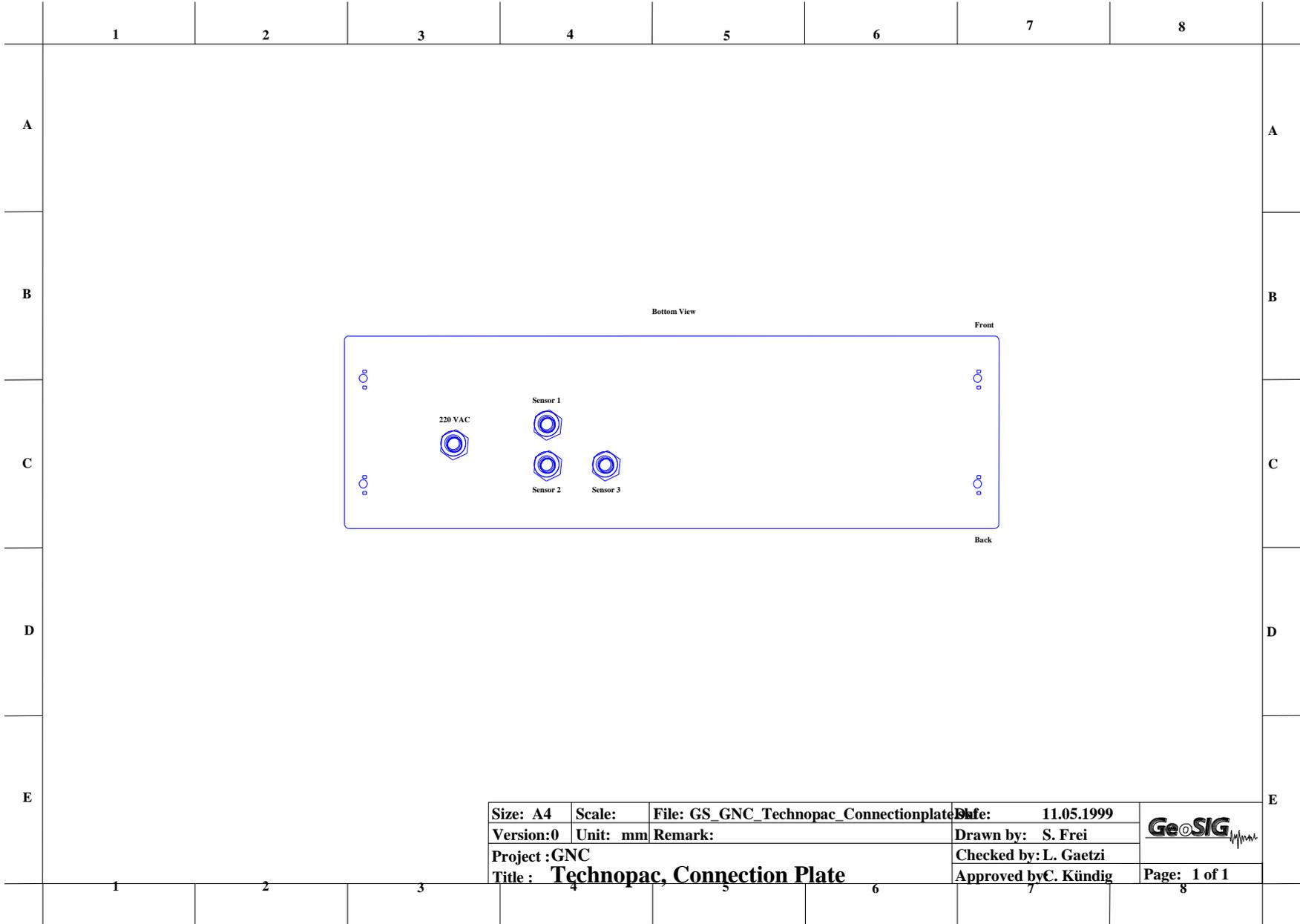
Topic	Description	Checking Parameters	Report
Installation Equipment	<ul style="list-style-type: none"> - Spanner AF 17 - Spanner AF 13 - Hand held drill - concrete drill 3 mm - concrete drill 8 mm - Hammer 		OK: __
Needed Material	<ul style="list-style-type: none"> - 4x M8x20mm Bolts - 4x M8 Washers - 4x M10x60mm Bolts - 4x M10 Washers - 4x Dowel - Steel U section 3mm thick 660x30 mmx30 		
Preparing the U Section	<ul style="list-style-type: none"> - Indicate the drill positions by referring to the drawing (LT003xxx) - Drill into the U sections the holes for mounting on the Tecnopac - Drill into the U section the holes for mounting on to the wall 		
Preparing the Dowels	<ul style="list-style-type: none"> - Mark the position of the holes on the wall - Drill a guide hole 40mm deep using the 3 mm concrete drill - Drill the main hole 40 mm deep using the 8 mm concrete drill - Drive in the Dowel with a hammer 10mm below the surface 		
Preparing the Tecnopac	<ul style="list-style-type: none"> - Match the holes on the U section with the ones on the Tecnopac - Insert the M8 washer over the M8 bolts and bolt the U section to the Tecnopac - Use the AF13 spanner to tighten the bolts 		
Mounting the Tecnopac	<ul style="list-style-type: none"> - Lift the Tecnopac and match the holes on the U section with the corresponding ones on the wall - Insert a M10 washer over the M10 bolt then screw into the wall through the holes in the U section - Screw the M10 bolts into the wall and tighten with the AF 17 spanner 		



Size: A4	Scale:	File: GS_GNC_Tecnopac_Housing.skf	Date: 11.05.1999
Version:0	Unit: mm	Remark:	Drawn by: S. Frei
Project :GNC			Checked by:L. Gaetzi
Title : Technopac, Housing Installation			Approved by:C. Kündig



Size: A4	Scale:	File: GS_GNC_Technopac_Frontview.skf	Date: 11.05.1999	
Version:0	Unit: mm	Remark:	Drawn by: S. Frei	
Project :GNC			Checked by: L. Gaetzi	Page: 1 of 1
Title : Technopac, Housing Front View			Approved by: C. Kündig	



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Version:0	Unit: mm	Remark:	Drawn by: S. Frei
Project :GNC		Checked by: L. Gaetzi	
Title : Technopac, Connection Plate		Approved by: C. Kündig	Page: 1 of 1

