GSR-24 / GSD-24

GeoSIG

Operation Manual

Company:	**GeoSIG Ltd** Ahornweg 5A, 5504 Othmarsingen, Switzerland, Tel: +41 44 810 21 50, Fax: +41 44 810 23 50, E-mail: info@geosig.com
Author:	Patrick Camina
Checked:	Lukas Gaetzi
Approved:	Johannes Grob
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1. WARNINGS

STATIC ELECTRICITY!!

The GSR-24 recorder 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.

INSIDE THE RECORDER (MAINTENANCE)

In normal use, the covers of the printed circuit boards never need to be removed. Removal of those covers should be done by trained personnel only since AC power enters directly into the recorder, and can be dangerous if these protection covers are removed. Before removing one of the covers, always turn the main switch to "Stop", unplug the power connector (green **A**ctive **C**harge "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 check if all other parameters are set correctly.

BATTERY LIFE

The GSR-24 is shipped with the batteries 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 GSR-24; 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 drastically change depending on operating conditions. Strong discharge of the main battery must be avoided. When the GSR-24 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.

To prevent data losses, do not expose the memory card to high temperature.

2. INTRODUCTION

The **GSR-24** is a high dynamic range 24 Bit seismic data acquisition system (in this operation manual called "GSR-24" unless needed to be specific). Several sensors can be used, such as seismometers, geophones, accelerometers or other sensors having single ended or differential voltage output within the voltage range of ± 20.0V. The sensor is mounted internally or externally.

The GSR-24 stores event data in either on-board mounted flash memory or in removable ATA Compact Flash memory cards. 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 19 to 75 Hz are selectable, when selecting different sampling rates.

During normal operation the GSR-24 continuously amplifies, filters and converts sensor inputs to 24 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 **S**hort **T**erm **A**verage (STA) to **L**ong **T**erm **A**verage (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 GSR-24 starts recording.

The level trigger continuously compares the incoming signal to a selected threshold and triggers if the signal exceeds threshold. The triggering parameters and set points are set by the menu driven PC program **FieldView , AllView or GeoDAS** depending on the GSR-24 version supplied or by downloading previously determined set-up information from a PC.

Recorded data include the sensor data, clock/timing information and instrument set-up information. The option ATA Compact Flash card memory enables the user to store until 2 GB of data. The data can fast and easily be transferred to an IBM PC by removing it from the GSR-24 and connecting it to the PCMCIA slot.

The GSR-24 is configured by connecting a personal computer to a RS-232 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. Set-up and data access may also be accomplished remotely by the use of modems.

The GSR-24 recorder also supports a Serial Output option. With this option enabled, the recorder will send out data through the RS-232 connection when the user logs out. As soon as the communication software is used to log in, the GSR-24 stops the data output.

2.1. Description

2.1.1. Housing

The GSR-24 is housed in a weather-resistant, IP 65 aluminium cast housing with a hinged cover. Information regarding the unit's date of manufacture, serial number, etc. is contained on the ID label on the outside of the housing.
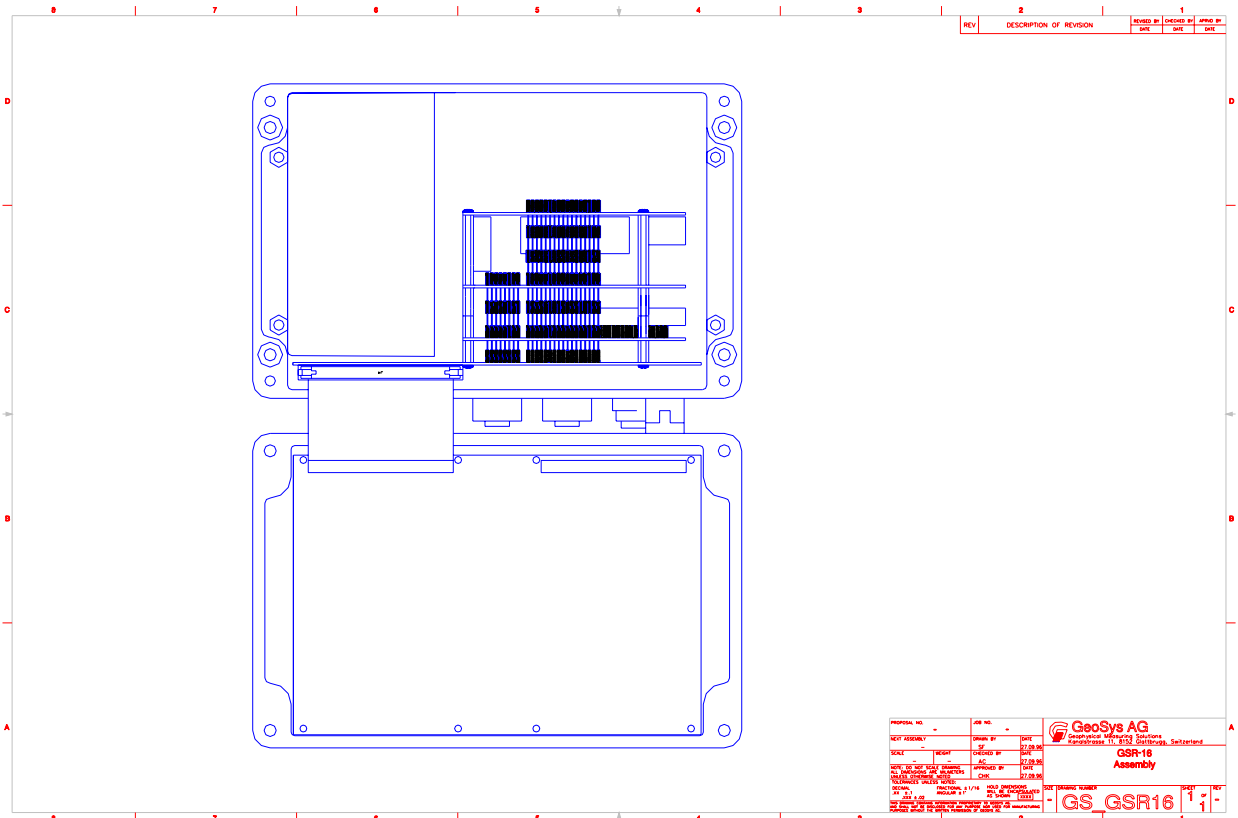
Fig. 1, the open GSR-24

To open the GSR-24 case, unscrew the 4 hexagon bolts (some housing with 4 phillips screws) located in the corners. This provides access to the main switch with its positions ON/OFF and the memory card (optional). To get access to the power supply, the battery pack, the fuse and the sensor (if internally mounted) unscrew the 4 screws of the protecting cover.

CAUTION: Unplug the AC Supply before removing the black protecting cover!

4 LED's and a LCD alpha-numeric display in the cover gives detailed information about the status, the incoming signal, date and time and error messages.

2.1.2. LCD

The alphanumeric display gives detailed information about the incoming signal, date and time, status and error messages. The information to be displayed is user programmable and can be set by the software program (see the software program manual)

2.1.3. LED's

AC (**A**ctive **C**harge)
This green LED indicates that the recorder is in state of **A**ctive **C**harge to charge the battery.

Run
This green blinking LED indicates, that the instrument is running.

Event
The yellow LED is illuminated during recording an event.

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

Fig. 2, GSR-24, Housing with LED's and optional Display

2.1.4. Printed Circuit Boards

Inside the GSR-24 are the printed circuit boards. Mounted to the hinged cover is the main circuit board. This printed circuit board holds the anti-aliasing filter circuitry, the A/D converter and the micro controller part with real time clock, memory etc. A second circuit board may be mounted on the side of the main board. This option board holds the memory card. A further circuit board is mounted to the side of the bottom. It terminates the external connectors, contains the connection for the internal sensor and the input protection circuits.

2.1.5. Internal Battery

The GSR-24 housing contains one 12 V, 6.5 Ah rechargeable sealed lead-acid battery. The battery pack provides approximately 38 hours of autonomy under normal operating conditions. To protect the battery the GSR-24 automatically turns off if the battery voltage drops under 10.6 volts and turns on again if the voltage overpasses 11.3 volts. A voltage of less than 11.1 volts is critical for the proper function of the analog conditioners, that's why a battery voltage error occurs. Additional battery capacity may be added externally. (For further information, please contact the manufacturer or their representative)

2.1.6. 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 GSR-24 is operating. The charger is powered by **230 VAC** as standard and unless ordered different by the customer. It can be powered by **115 VAC** upon request. Contact GeoSIG for different configuration.

Note: The battery charger is just a charger. It is *not* a battery eliminator. DO NOT operate the unit with *only* the charger attached. A battery must be connected.

Note: For an external battery an external charger has to be used. Select therefore a charger with appropriate charging characteristics for the used battery.

2.1.7. Connectors

The GSR-24 has five connectors (when fully equipped) which are arranged in a row on the outside of the housing. These are labelled, from left to right: Sensor, Interconnection, RS-232, Option, Power. (see appendix B for connector pin-outs.)
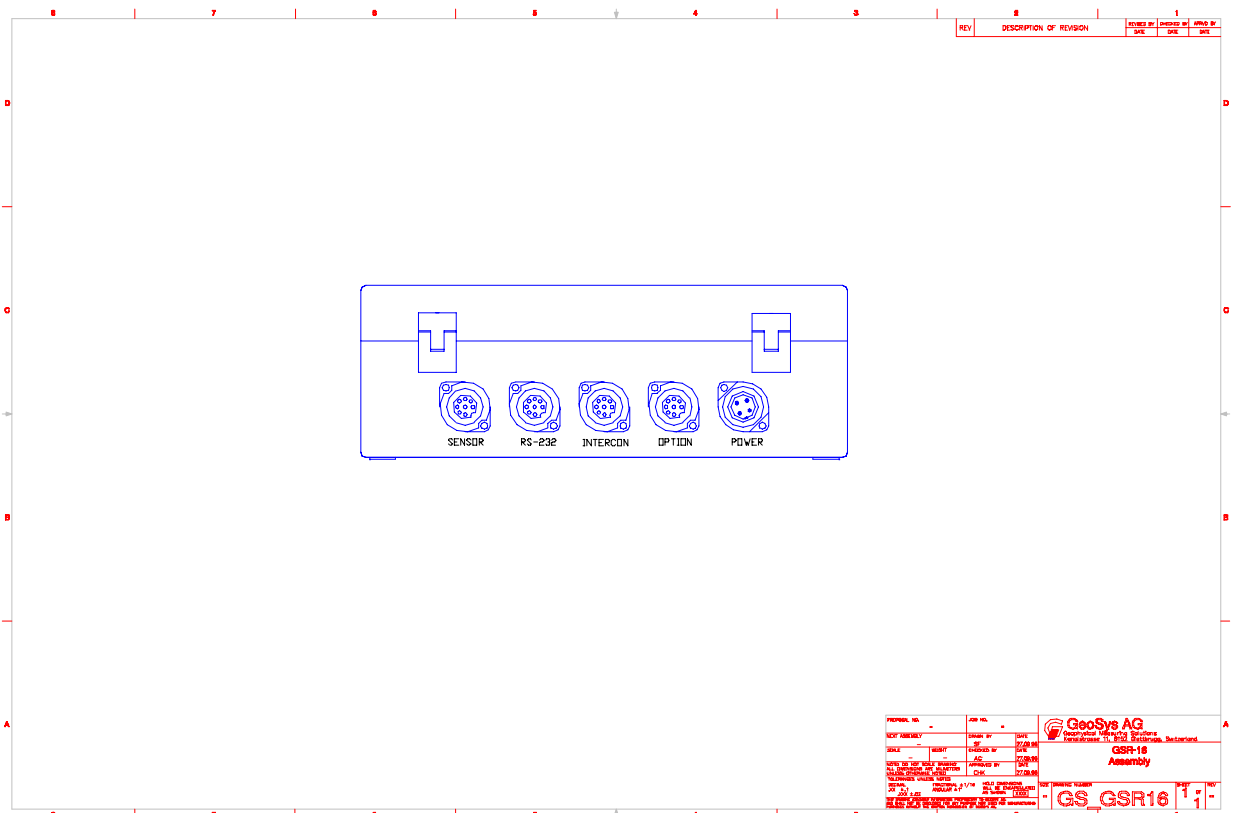

Fig. 3, GSR-24 Connectors

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 GSR-24 may be connected here (with DC Input Option).

Option Connector (optional)
Two options are supported by the option connector:
The alarm option gives an output signal (relay contacts) to activate alarm indicators such as buzzer or flash lights.
The connector is also used to connect an external time source such as GPS to the GSR-24. The signal of this external source can be either a pulse or a RS-232 level signal.

RS-232 Communication
This connector is for attaching a computer to the GSR-24 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 recorder (optional) and a telephone line for remote control and data retrieval.

Interconnection (optional)
This connector allows the GSR-24 to be interconnected to a recording array. Different types of interconnections may be realised. The interconnection connector will also be used to connect the recorder to the telephone line when using the recorder with an internal modem (optional).

Sensor Input (optional)
The sensor connector is a 12 pin connector which connects the external sensor to the GSR-24. It includes the output signals from the sensors and the test signals from the GSR-24. The sensor connector provides +12 Volt power to the sensor. Different types of sensors can be connected.

2.1.8. Test Data Sheet

The test data sheets issued with the GSR/GCR exactly characterises input filter performance and other parameters measured during production test. Consult GeoSIG for this sheet if you wish to have precise specifications of a particular instrument.

2.1.9. Options and Accessories

The following optional equipment is available for the GSR-24:

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.

Modem
The GSR-24 is also available with an external or internal modem. This option gives remote control to the GSR-24 via telephone line. On request the modem is capable of "Calling on Event". This means, as soon an event triggers the GSR-24, the modem automatically calls a pre-set telephone number and transmits the data of the event (optional).

GPS
The GPS option is a satellite navigation receiver attached to the GSR-24. This unit gives the exact information about time and position of the instrument. Full details are provided with the GPS option.

Alarm output
This option generates an alarm signal (for a threshold level) 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 output is 1 relay contact, either normally open or normally closed (to be specified at order).

Memory upgrade
The internal memory module can be expanded up to 2 GByte.

Removable memory card
ATA Compact Flash Memory Cards (JEIDA/PCMCIA) in available in different sizes upto 2 GBytes can be used.

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

2.2. Storage

When not in use, the GSR-24 should be stored at normal room temperature in a dry location. This will help to maximise the battery lifetime. If the instrument (recorder) is stored for more than a few weeks, the GSR-24 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 real time clock time is maintained by lithium battery. Recorded memory is kept since flash memory is non-volatile.

3. INCOMING INSPECTION

All instruments are carefully inspected both, electrically and mechanically before they leave the factory. The shipment should contain the following components listed in Chapter 3.1 (standard instrument without options).

3.1. Content of Shipment:

1   GSR-24 Recorder Unit
1   Sensor Unit (with external sensor only) with cable
1   Line Power Cable
1   RS-232 Cable
1   3 1/2" Disk containing the communication software program
1   GSR-24 Operation Manual

3.2. Damage During Shipment

When arranged with GeoSIG Ltd., 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.

3.3. Warranty

The seller warrants hardware and software products against defects in materials, workmanship and design for the defined period, starting from date of shipment and 5 years parts and 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
   or
   Improper preparation and maintenance of site.

4. SET-UP AND OPERATION

This chapter lists the operating procedures involved in installation, setting up and running the GSR-24. This chapter will treat the inputting of parameters as a step to be performed in the field or in house prior to placing the instrument in the field.

4.1. Site Selection

4.1.1. Environmental Considerations

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

Although the GSR-24 is housed in a solid, weatherproof case, it is certainly best if a location can be found for the unit which is free from direct sunlight, precipitation, the 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 event recorder installations, which must be recognised. The GSR-24 can record seismic activities for approximately 10 minutes (per MByte of storage and highest sample rate) 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 if the unit will be left in place for a long period of time (more than 38 hours). Although this is not necessary for the operation of the device, it does preclude concerns about battery charging.

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 (option).

- 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. The supply must consist of Phase, Neutral and Protection Earth.

- 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 GSR-24 in the field. The set-up functions, of course, may be performed while the charger is connected to the unit. The GSR-24 has to 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 GSR-24 can 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 GSR-24 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

Remark: Many times the locations of seismic equipment are highly exposed to static discharges caused by lightning or by the industrial environment. Even the GSR-24 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 GSR-24 may be powered from 115 VAC up to 230 VAC, 50 or 60 Hz. The GSR-24 contains a primary switched power supply which does not need any different configuration between 115 and 230 VAC. Just connect the GSR-24 power cable to the AC source and the green AC LED should illuminate.

If the AC LED does not illuminate check the fuse of the GSR-24 and if necessary replace it with a 500 mA slow blow type fuse. Verify the presence of the AC voltage.

4.2.2. Requirements for the GSR foundation

Minimum surface area requirements

with internal sensor:	50 x 50 cm
with external sensor:	50 x 75 cm
with external sensor and interconnection:	50 x 100 cm

Height requirements

Minimum surface area specifications indicated above are only applicable up to a height of maximum 25 cm. Foundation dimensions should be expanded in each direction proportionally by increasing height.

Anchorage requirements

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

4.2.3. Mounting the recorder with external sensor

The following are the items needed for installation (included in a shipment of a GSR-24 standard configuration):

    GSR-24 Recorder Unit
    Sensor
    Sensor Cable
    AC Power Cable
    RS-232 Cable
    CDROM containing communication software program
    GSR-24 Operation Manual
    Sensor Operation Manual

Required accessories:

    Set of Tools
    4 x M6 x 40 mm screws with concrete anchors, or GSR-24 mounting kit for the recorder.
    Screws and anchors depending on the sensor (see Sensor Operation Manual).
    Laptop computer with the installed communication software program to set up the recorder.

Recorder

- Find a suitable place for the recorder. It may be mounted in any convenient position within 3 meters of the desired sensor position.
- Remove the 4 top screws and open the top cover.
- Install the recorder with the 4 M6 screws and its concrete anchors through the holes on the corners of the housing (fig. 1, fixing screws).
- Depending on the location it may be necessary to earth the recorder properly. Therefore connect the earthing screw of the recorder via a wire of min. 1.5 mm^2 to a proper earth contact.

Sensor

Please consider that sensor with the compensation of the 1 g gravity have to be installed with one of its axis (X, Y or Z) in the exact upright position.
- Read Sensor Operation Manual for the appropriate mounting of the sensor.
- Find a suitable place for the sensor nearby the recorder.
- Level the 3 levelling screws using a water level. The levelling must be done within 2 degrees.
- Connect the sensor cable.
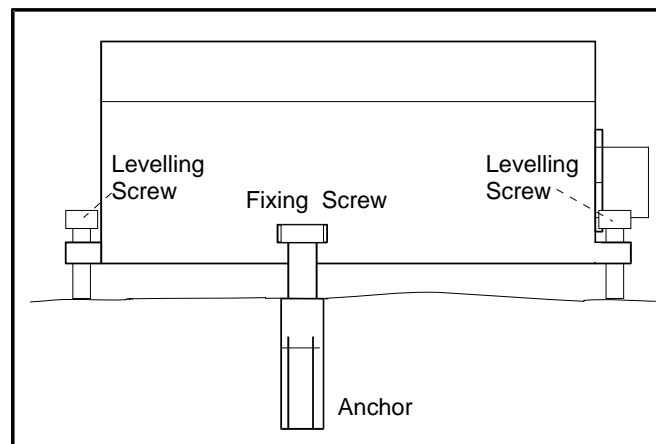- Fine adjust the levelling using your PC with the relevant software program (see the Software Program Manual).

Fig. 4, Mounting of the AC / VE Sensors

4.2.4. Mounting the recorder with internal sensor

The following are the items needed for installation (included in a shipment of a GSR-24 standard configuration):

GSR-24 Unit
AC Power Cable
RS-232 Cable
3 1/2" Disk containing communication software program
GSR-24 Operation Manual

Required accessories:

Set of Tools
GSR-24/Sensor Mounting Kit including platform and screws (optionally)
Computer with the communication software program to set up the recorder

- Find a suitable place for the recorder.
- Mount the recorder platform with the concrete anchor and the M8 screw in its centre hole on the floor, but do not bolt down permanently at this point.
- Level the platform with the 3 levelling screws using a water level. The levelling must be done within 2 degrees.
- Now bolt the platform permanently. The platform must be rigidly bolted to the structure or the sub terrain to be monitored.

- Remove the 4 top screws and lift off the top cover of the recorder.
- Four through holes within the case wall allow the mounting of the unit on the platform using the included 4 M6 screws.
- Depending on the location it may be necessary to earth the recorder properly. Therefore connect the earthing screw of the recorder via a wire of min. 1.5 mm^2 to a proper earth contact.
- Fine adjust the levelling using your PC with the supplied software communication program.

4.2.5. First Start

- Connect the AC power cable.
  The green AC LED indicator must turn on,
  If not:
  - Disconnect the AC power cable from the GSR-24.
  - Check if the internal FUSE is blown.
  - If so, then replace it with a 500 mA slow blow fuse
  - Check if the AC power is present at the plug.
  - When the problem is solved, reconnect the AC power cable to the GSR-24.

- Insert the memory card if applicable.
- Switch the main switch to its ON position.
  The LCD displays first the firmware version, then "GSR startup" appears and dots show the starting progress. The green RUN LED blinks once per second after start-up is performed. It indicates, that the instrument is running.

Note: Do not move or vibrate the sensor during the power up cycle. (The GSR-24 is calculating the baseline of the 3 incoming signals, any noise could distort this signals.)

- Connect the GSR-24 with the RS-232 cable to your computer and start the communication software program.

4.2.6. Terminating the Installation

- After checking the GSR-24 using the communication software program disconnect the RS-232 cable and close the cover of the sensor and the recorder. Fix the remaining cables, so that they may not influence the sensor signal by knocking or vibrating at the sensor.

4.3. Setting Operation Parameters

For setting parameters and for retrieving recorded data a personal computer with the GeoSIG supplied communication software program has to be used. This program provides facilities for setting up the GSR-24 prior to deployment, retrieving GSR-24 event data and displaying the captured data. The program runs on IBM PC compatible computers, including laptop models and is connected with the GSR-24 via serial data interface.

For the installation of FieldView / AllView / GeoDAS (whichever applicable) refer to the Software Manual.

(The Software Manuals FieldView / AllView or GeoDAS (whichever applicable) explains in full details the use of the Software program.)

4.3.1. Communication with the GSR-24

- Open the cover of the GSR-24 and move the toggle switch to the "ON" position. The LCD displays first the firmware version, then "GSR startup" appears and dots show the starting progress. The green RUN LED blinks once per second after start-up is performed. This indicates, that the instrument is running.

- Connect the cable from the computer to the RS-232 Port of the GSR-24 and follow the steps written in Software Program Manual.

4.3.2. Analog signals

- To verify the operation of the GSR-24 and its sensor follow the steps written in the Software Program Manual.

4.3.3. Date and Time

- To set date and time of the GSR-24 follow the steps written in the Software Program Manual.

4.3.4. Save and Load Configuration File

- To save and load configuration files to and from the GSR-24 follow the steps written in the Software Program Manual.

4.3.5. Recording Settings

- To change recording parameters in the GSR-24 follow the steps written in the Software Program Manual.

4.3.6. Serial Output

GSR-24 recorders support a Serial Output option. With this option enabled, the recorder will send out data through the RS-232 connection when the user logs out. As soon as the communication software is used to log in, the GBV stops the data output and it remains in this state until log out.

The serial data stream of the GSR-24 contains one or three channels. Depending on the configuration of the instrument that has been set with the communication software program, the user is able to Enable or Disable the serial data output and to choose the number of channels. The GSR-24 (one channel version) sends a data stream including only one channel.

For the recording and analysing on the computer, the data acquisition software **GeoDAS** or **SEISLOG,** and the analysing software **SEISAN** can be used.

Do never enable the 'Serial Output' and the internal modem at the same time!

Two modes of operation are available for the Serial Output function, Sample Protocol, and Packet Protocol.

- Sample orientated Mode: After log out, every sample is sent to the communication line.
- Packet orientated Mode: After log out, every second a one-second buffer is sent to the communication line.

Sample mode:

Set-up:
Log in to the recorder
Connect the cable from the computer to the RS-232 connector on the GSR-24.
If AllView is used as the communication software program select the user options **Serial Output Enable** and **Sample Protocol** to enable the sample orientated serial data mode.
If GeoDAS is used as the communication program please refer to the GeoDAS software manual.
Start of the serial data mode:
After logging out of the GSR-24 the GSR starts automatically the serial data mode after 2 seconds.
Stop of the serial data mode:
After logging in to the GSR, the serial data mode automatically stops and remains off for the time being logged in.

Data format:
11 bytes are sent with each sample to the Com port.

Byte 1, start byte: 0x0d (CR)
Byte 2, data byte 1:   z high
Byte 3, data byte 2:   z mid
Byte 4, data byte 3:   z low
Byte 5, data byte 4:   y high

Byte 6, data byte 5:   y mid
Byte 7, data byte 6:   y low
Byte 8, data byte 7:   x high
Byte 9, data byte 8:   x mid
Byte 10, data byte 9: x low
Byte 11, stop byte: 0x0a (LF)

Data format is binary.

Baud Rate:
The transmission baud rate depends on the settings made with the software communication program. The instrument checks if the baud rate guarantees transmission of all bytes for a specific amount of data. Otherwise, it refuses the setting (see below "Possible baud rates with serial data stream").

Packet mode:

Set-up:
Connect the cable from the computer to the RS-232 connector on the GSR-24.
Log in to the recorder.
Within AllView select the user option **Serial Output Enable** and deselect the user option **Sample Protocol** (Packet enabled) to enable the packet orientated serial data mode. If GeoDAS is used as communication software please refer to the corresponding software manual.
Starting the serial data mode:
After logging out of the GSR-24, it starts automatically the serial data mode after 2 seconds.
Stopping the serial data mode:
After logging in to the GSR, the serial data mode automatically stops and remains off for the time being logged in.

Data format:
For the GSR-24 the standard GSBU protocol is used. For detailed information see the GSBU_GSR-24 protocol definition in the appendix C.

The GSR can be directly connected to **GeoDAS** or **SEISLOG** in the 'Packet' mode, which increases the performance regarding event memory, event detection and online (SEISLOG) and offline (SEISAN) analysis enormously.

If SEISLOG is used please go through the SEISLOG manual to look up the settings required for the GSR-24 digitiser.

Possible baud rates with serial data stream:

	Communication speed						
	1200 Baud	2400 Baud	4800 Baud	9600 Baud	19200 Baud	38400 Baud	115200 Baud
PACKET mode, 3 channels							
50 SPS				X	X	X	
100 SPS					X	X	
200 SPS						X	
PACKET mode, 1 channel							
50 SPS			X	X	X	X	
100 SPS			X	X	X	X	
200 SPS				X	X	X	
SAMPLE mode, 3 channels							
50 SPS					X	X	X
100 SPS					X	X	X
200 SPS						X	X
SAMPLE mode, 1 channel							
50 SPS					X	X	X
100 SPS					X	X	X

200 SPS					X	X	X

4.3.7. SEISLOG

SEISLOG is a general purpose seismic data acquisition system designed for recording of earthquakes. The system can record 1-64 channels with 12-24 bits resolution and is based entirely on off the shelf hardware. The new PC based SEISLOG is implemented under the operating system QNX manufactured by Quantum Systems, Canada. It is a multiuser and multitasking real time operating system which makes it ideal for this type of application. MS-DOS with Windows may coexist with QNX on a separate disk partition.

4.3.8. SEISAN

The SEISAN seismic analysis system is a complete set of programs and a simple database for analysing earthquake data from analog and digital data. With this system it is possible using local and global earthquakes to enter phase readings manually or pick them with a cursor, locate events, edit events, determine spectral parameters, seismic moment, azimuth of arrival from 3-component stations and plot epicentres.
The SEISAN programs work on PC and SUN and no format conversion is needed to move data files (binary and ASCII) between the two systems.

4.3.9. File Handling

-    To retrieve files from the GSR-24 follow the steps written in the Software Program Manual.

4.3.10. Termination

-   After performing a **Logout,** (see the Software Program Manual) disconnect the computer from the GSR-24 before switching the computer off. Do not leave *any* unpowered device connected to the GSR-24.

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

5. TROUBLE SHOOTING AND MAINTENANCE

This chapter describes Trouble Shooting using the Self Test features of the GSR-24 and the maintenance needed to be done. Most of the work described can easily be done by the operator. But if you have any doubt please contact first the factory or your local GeoSIG representative.

5.1. Self Test

An extensive system test allows the operator to notice any malfunction of the instrument as soon it has occurred, so he may adjust it before he looses important data.
The system test checks periodically the functions of the GSR-24 and its sensor, some of the functions are even permanently supervised. Its period can be programmed by the operator. This Self Test is divided into 5 various groups:
-   Analog
-   Hardware
-   Real Time Clock "RTC"
-   Battery
-   Memory

Each of this group may be selected individually for the Self Test to be performed. Each group itself contains several test routines. A flag is set in the GSR-24 for every routine, which has failed in the test. 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-24.

The GSR/GCR distinguishes between Warnings and Errors. Warnings are malfunctions of the instrument, which are not serious. All the instruments' essential functions are still in tact, e.g. recording is still

possible, and the instrument is not stopped. An error indicates a severe problem of the instrument and may in some cases put the instrument out of function or stop recording.

Following you find the detailed description of every test routine and recommendations, what to do if a test has failed.

Important: Remember always to clear the Warning and Error flags before running the Self Test!

Note: Should a specific Warning or Error occur frequently, contact the factory or your local GeoSIG representative.

5.1.1. Analog

If "Analog" is selected in the Test menu, the following test routines will be performed with every Self Test:

The **Noise** Test observes the level on every analog channels over a period of time. If failed **Warning** will appear.

> 1. Check the location of the sensor. Some noise sources such as machines, wind or dripping water may intrude the sensor.
> 2. If the noise occurs only on one channel, check the corresponding sensor module and its electronic circuit.

The **Zero Level** Test observes the analog input levels before and after a test pulse has been given to the sensor/filter. If either of these levels do not correspond to an expected zero level, a **Warning** will appear.

> Check the corresponding sensor module.

The **No Sensor** Test monitors the input levels of every channel, and if one of these inputs reads the maximum or minimum value for a longer period of time, an **Error** will be indicated. The instruments keep all its functionality in the case of this error.

> 1. Check the sensor cable and its connectors. One wire may be interrupted.
> 2. Check the corresponding sensor module.

A test signal source is built into the GSR-24 to allow testing of accelerometers and analog circuits. The **Analog Response** Test applies a test pulse to the sensor and to the filter input. The responding analog signal is digitised and analysed. If the level measured is not within an expected range in reference to its zero level, a **Warning** will be indicated.

> 1. Check the levelling of the sensor.
> 2. Check the sensor cable and its connectors.
> 3. Check the corresponding sensor module.
> 4. The analog filter of the recorder unit may be defective, call your dealer.

The **ADC Resolution** Test monitors every value read from the AD Converter during system test. If any value is outside the expected range, a **Warning** will appear.

> The AD converter may have malfunctions. Run the Self Test again to see if the Warning flag remains set. If yes, contact your local GeoSIG representative.

The **ADC Conversion Time** Test checks the time taken to read every value from the AD Converter during test. If the time exceeds an acceptable value, an **Error** will be indicated.

> The AD converter may have malfunctions. Run the Self Test again to see if the Warning flag remains set. If yes, contact your local GeoSIG representative.

5.1.2. Hardware

If "Hardware" is selected in the Test menu, the following test routines will be performed with every Self Test:

The **EPROM Checksum** Test reads the firmware program of the GSR-24 stored in the EPROM and calculates its Checksum. An incorrect checksum causes a **Warning**.

> The stored program code is probably not anymore in its original form, as when it was programmed. Run the Self Test again to see if the Warning flag remains set. If yes, contact your local GeoSIG representative.

The **EEPROM Checksum** Test reads the GSR-24 configuration parameters stored in the EEPROM and calculates its Checksum. An incorrect checksum causes a **Warning**.

> A data corruption has probably occurred in the EEPROM. Run the Self Test again to see if the Warning flag remains set. If yes, save the GSR-24 configuration to the PC and perform a Set Default Settings command (refer to the software program manual). Clear the Warning Flag and run the Self Test again.

The **EE_RAM Checksum** Test reads the GSR-24 parameters stored within a copy of the EEPROM and calculates its Checksum. Is a working copy of the internal EEPROM, used during run-time to increase speed and reliability. An incorrect checksum causes a **Warning**.

> A data corruption has probably occurred in the EEPROM. Run the Self Test again to see if the Warning flag remains set. Check if all programmed parameters are set as required and reset the GSR-24 by switching the Main Switch to OFF and to ON again. Clear the Warning Flag and run the Self Test again.

The **Invalid Instruction** Test monitors the operation of the microprocessor if an attempt is made to execute an instruction with an undefined operation code or illegal addressing mode specification. Failing the test causes a **Warning**.

> Reset the GSR-24 by switching the Main Switch to OFF and to ON again. Clear the Warning Flag and run the Self Test again.

The **Address Error** Test monitors the operation of the microprocessor, if an attempt has been made to pre-fetch an instruction from an illegal address or word access to an odd address. Failing the test causes a **Warning**.

> Save the GSR-24 configuration to the PC and perform a Set Default Settings command (for further explanation please refer to the software manual). Clear the Warning Flag and run the Self Test again.

The **Stack Monitor** Test monitors the microprocessor run time stack. An overflow of the stack causes a **Warning**.

> Reset the GSR-24 by switching the Main Switch to OFF and to ON again. Clear the Warning Flag and run the Self Test again.

The **Divide by Zero Interrupt** Test fails if the microprocessor has attempted a mathematical divide by zero. In this case a **Warning** occurs.

> Reset the GSR-24 by switching the Main Switch to OFF and to ON again. Clear the Warning Flag and run the Self Test again.

The **Unexpected Interrupt** Test monitors all unused interrupts of the microprocessor. If an unexpected interrupt occurs the **Warning** flag will be set.

> Reset the GSR-24 by switching the Main Switch to OFF and to ON again. Clear the Warning Flag and run the Self Test again.

5.1.3. Real Time Clock RTC

If "RTC" is selected in the Test menu, the following test routines will be performed with every Self Test:

The **Valid Time and Date** Test reads the time and date stored within the internal Real Time Clock. If its contents correspond to an invalid time or date, a **Warning** flag will be set.

> Check Time and Date of the GSR-24 and reset it to the current Time and Date. Run the Self Test again.

The **Time Increment** Test reads the time and date stored within the internal Real Time Clock waits for 1 second and then reads it again. If the time has not incremented over this period, a **Warning** flag will be set.

> Check Time and Date of the GSR-24 and reset it to the current Time and Date. Run the Self Test again.

The **RTC Memory** Test writes to and reads from the memory of the Real Time Clock. By checking the consistency of the data read back, it indirectly checks the presence, operation and connections of the Real Time Clock. Failing the test causes a **Warning**.

> Check Time and Date of the GSR-24 and reset it to the current Time and Date. Run the Self Test again.

The **RTC Oscillator** Test reads a test flag within the internal Real Time Clock. If the Oscillator has failed since the last restart or since the last Self Test, a **Warning** flag will be set.

> A Warning indicates that since the last restart or Self Test any recorded events may have an incorrect time and date stamp!
> Check Time and Date of the GSR-24 and reset it to the current Time and Date. Run the Self Test again.

5.1.4. Battery

If "Battery" is selected in the Test menu, the following test routines will be performed with every Self Test:

The **Primary Battery Error** Test will set an **Error** flag if the voltage level of the main battery sinks below 11.1 Volts. This flag will be cleared again once the voltage level rises above 11.2 Volts.

> With this Error flag set the instrument is no longer able to record events reliably. Although this is a severe error recording is not blocked by the instrument but the error information is as always indicated in the header of an occurring event for later validation of the data.
>
> Connect AC power to the GSR/GCR to charge its main battery or replace the battery.

The **Primary Battery Warning** Test will set a **Warning** flag if the voltage level of the main battery sinks below 11.5 Volts. This flag will be cleared again once the voltage level rises above 11.6 Volts.

> Connect AC power to the GSR-24 to charge its main battery or replace the battery.

The **Back Up Battery** Test will set a **Warning** flag as soon the voltage level of the Backup battery sinks below 2.8 Volts.

> With this Warning flag set the GSR-24 may no longer maintain the correct time and may loose data within its internal memory when the unit is disconnected from the main battery.
> Replace the Backup battery on the main board.

5.1.5. Memory

The memory tests may be time consuming, depending on the amount of memory in the instrument. If "Memory" is selected in the Test menu, the following test routines will be performed with every Self Test:

The **Memory Full** Test is an on-line test and monitors the amount of data memory used. After the data occupy more than 90% of the memory available, a **Warning** occurs. An **Error** is indicated when the data memory has overflowed.

> Download your data to your computer and delete the Event Files.

The **Memory Read/Write** Test writes a 0 and a 1 to every location within the data memory without corrupting any data, and checks if there are no stuck bits. A **Warning** occurs if it detects any stuck bits.

> 1. Run the Self Test again. If the Warning flag remains set some data memory chips may need to be replaced. Contact your local GeoSIG representative.
> 2. If you are using a removable Memory Card replace it with a new card.

The **Memory Format** Test checks the data format within the event memory. A failed test causes a **Warning**.

> Run the Self Test again. If the Warning flag remains download all event files to your computer and delete all files in the GSR-24. Run the Self Test.

The **Memory Present** Test monitors on-line the event memory and if no memory is present e.g. Memory Card removed, a **Error** will occur.

> Insert Memory Card properly.

The **Data Checksum** Test determines the checksum of every file stored in the recorder's memory, and compares it to the value stored in the file header. The checksum stored in the file header is calculated during the event; any data corruption of memory either during or after recording will be detected and indicated as a **Warning**.

> Event files with a Warning message in their header may contain some corrupted data. They should be displayed graphically and critically analysed, to make sure that the data can be used for analysing. Download all event files to your computer before deleting them in the GSR/GCR. Run the Self Test.

The **Data Consistency** Test checks the block ordering of all files in the GSR-24s memory. If any disordering of blocks is detected, a **Warning** will be indicated.

> Download all event files to your computer and delete them all. Run the Self Test.

5.2. Maintenance

The GSR-24 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 self test indicates any irregularity as soon as it occurs. Therefore it is recommended, to check the recorded test at least **once a year**. Compare the signals of the 3 channels with older records. There should not be a distinctive change.

- The function of a sensor with DC response (capacitive, piezo-resistive and FB 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 This check should be performed **annually.**

- The function of the sensor has to be checked frequently with a tilt table. For testing the sensor has to be installed onto the tilt table. The whole range of ± 1g has to be checked with the table. Every axis shall 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 relay (option) **annually**. Therefore use the Test Alarm button in the "Alarm Configuration" window of the Communication 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 GSR-24 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 GSR-24 and disconnect the main battery, measure the voltage on the battery cables. The voltage should be 13.8 V.

- The physical condition of the recorder 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 GSR-24 by using the "Power and Batteries" display of the communication software program.

- The backup battery has to be replaced every **5 years**. After a replacement, program the date of installation and the date of the next replacement into the GSR-24 "Power and Batteries" display of the communication software program.

6. FUNCTIONAL DESCRIPTION

This section discusses some of the technical details of how the GSR-24 works. Input signal filtering and digitising, triggering, time accounting, data storage and event logging are among the function described.

6.1. Signal Conditioning

Signals from seismic sensors coming into the GSR-24 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-24 accepts signals from sensors within the voltage range of -5 to +5 resp. -20 to +20 volts depending on the gain.
A GSR-24 digitises and records the sensor signal as follows:

Analog Input Voltage AIV Gain ¼ (V)	Analog Input Voltage AIV Gain 1 (V)	Digital Value DV (Bit) 24 Bit	
		Decimal	Hex
-20.0	-5.0	-5'242'880	-0x500000
0.0	0.0	0	0x000000
+20.0	+5.0	+5'242'879	+0x4FFFFF

The digital values for analog input voltages can be determined using the following formula:

Gain ¼: $DV = AIV \bullet 262'144$
Gain 1.0: $DV = AIV \bullet 1'048'576$

6.1.1. Signal Amplification and Analog Input

The gain factor by which a sensor input is amplified in the GSR-24 analog circuit is factory set to the standard gain ¼ or 1.0. The input range for gain ¼ is +/- 20 volt, for gain 1.0 it is +/- 5 volt. The gain may be set independently on each signal channel on request.

The inputs are fully differential for a standard GSR with an input resistance of 22 kOhm at gain 1.0 and 15 kOhm at gain ¼.

6.1.2. Analog Signal Filtering

Since a Delta-Sigma architecture is used as A/D converter the anti-aliasing analog filter can be realised rather simple. The fourth order Delta-Sigma architecture allows over sampling of 4096 times. Therefore the analog filter is an RC with a corner frequency of 4.1 kHz. The filter removes signal energy at frequencies at the input sampling rate (205 kHz) so that these higher frequencies are not aliased by the sampling process, appearing as erroneous digitised data. The signal level at 205 kHz at the output of the analog filter is at least 35 dB below the input level.

6.1.3. Signal Digitising

The amplified and filtered analog signals are sampled at a rate of 205'000 SPS per channel and converted by a fourth order monolithic Delta-Sigma modulator designed especially for very high resolution of signals between dc and 1500 Hz. The modulator is configured with the appropriate monolithic Finite Impulse Response (FIR) filter with programmable decimation. As part of the digital filtering process, the over sampled data (x 4096) are "decimated" to reduce the sampling rate to either 200, 100 or 50 SPS. Damping at f3 is −130 dB for all Output Word Rates (see Fig. 5).
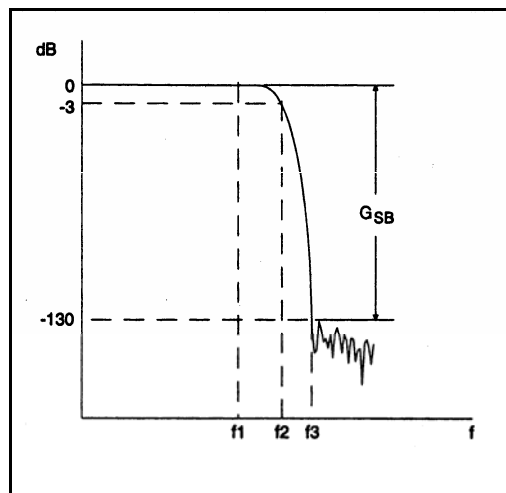

Fig. 5, Digital Filter Response

Filter Specifications:

Output Word Rate f0 (Hz)	Passband f1 (Hz)	Passsband Flatness (dB)	-3dB Freq. f2 (Hz)	Stopband f3 (Hz)	Group Delay (ms)
200	75	0.1	82.4	100	145
100	37.5	0.1	41.2	50	290
50	18.75	0.1	20.6	25	580

Note: G_{SB} = -130 dB for all Output Word Rates

The internal noise of the GSR-24 is excellently low (< 1 count rms @ 50 s/s) for high resolution recorders of this type. DC offset is stable with temperature and is trimmed internally. The maximum potential dynamic range is 132.1 dB @ 50 s/s.

Channel Isolation is typically 127 dB to 140 dB and channel to channel skew is zero since the GSR has three independent but synchronised modulator-filter pairs.

6.2. Triggering

Any of three methods may be used to trigger the GSR-24 to start recording data:

- The GSR-24 may be set to trigger internally when incoming sensor signals satisfy certain criteria.
- The GSR-24 may be set to start recording by software command from a connected PC.
- A trigger signal may be provided from another GSR-24 or other external source (with external trigger/network option).

Recording starts the pre-event time before trigger, continues as long as the trigger criterion is met and stops after the post-event time.
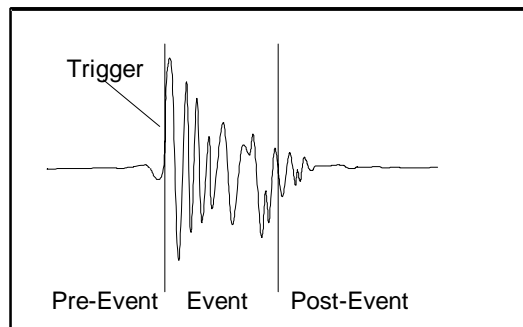
Fig. 5, Typical Recorded Data for 1 Channel

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-24 unit to interrupt the recording and select a different set of trigger criteria.

6.2.1. 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-24 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 communication software 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-24. 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:

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

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 be updated 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.

6.2.2. Software Triggering

The GSR-24 may be set up to begin recording data by command of the connected PC. The 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-24 records Pre- and Post Event Time. This feature is useful for measuring seismic noise levels.

6.2.3. External Triggering (option)

The GSR-24 may be externally triggered by connecting a trigger signal to the Interconnection connector (option). The external signal may come from another GSR-24 recorder, from a Control Centre or from some other source. The GSR-24 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-24 puts out a signal on the Master/Slave connector to be used as a trigger by other units, e.g., one GSR-24 may be set up to trigger internally on incoming sensor signals, and can then activate several other units to begin recording.

6.3. 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.
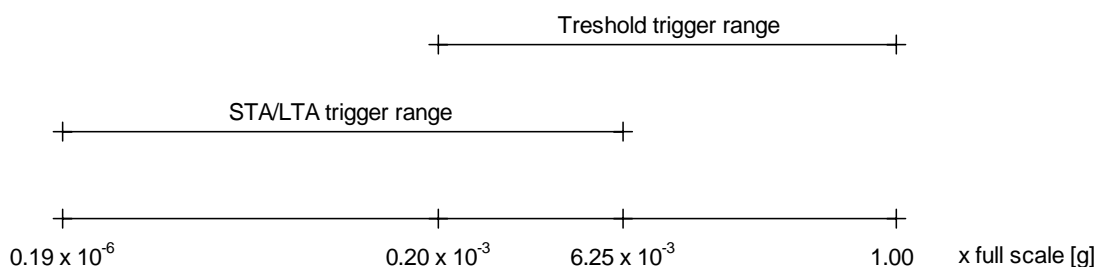

Fig. 6, Typical triggering ranges of the GSR

6.3.1. 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.

6.3.2. 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-24** 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:

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

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

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

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

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

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

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-24 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

6.4. Data Recording

An "event" is a period of time during which recording is triggered. When an event occurs, the GSR-24 stores digitised sensor data in its flash 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-24 also records sensor data occurring within a pre set 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 included as part of the record or the event.

The pre-event and post-event memory intervals are selected by the operator during GSR-24 set-up.

6.4.1. Event Directory

The GSR-24 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-24. The operator may then decide which event(s) are of interest and extract data from the GSR-24 for just those events.

6.4.2. Recording Capacity

The maximum recording time is related to the sample rate, the number of recorded channels and the amount of memory installed in the GSR-24. It may be calculated by:

$$t = \frac{M}{3 * CH * SR}$$

where
M = Memory (Byte)
SR = Sampling Rate (SPS)
CH = Channels (1 or 3)
t = time (sec.)

With 8 MByte memory installed, recording 3 channels and using a sample rate of 200 SPS we receive a maximum recording time of 1 hour 18 min.

6.4.3. Optional ATA Compact Flash Memory card

With the appropriate option the GSR-24 supports ATA Compact Flash Memory cards. These cards are removable and can be connected to a PCMCIA drive using an adapter. This enables you to transfer big amounts of recorded data fastest to a PC.

Card handling:
- To remove or connect a card to the GSR-24 always turn off power first.
- For first use or if the data format of the card is not valid any more you have to format it using the communication program of the GSR-24 (please refer to the software manual).
- The command "Format Card" erases all data on the card.
- Never write anything to the card when using it in a PC and you like to continue recording afterwards.
- When you write, defragment or format the card in a PC you cannot use it anymore in the GSR before you have not formatted it with the GSR-24 communication program.
- If you delete files within AllView or GeoDAS, you have to defragment it afterwards to get the freed space for further use.

6.5. Clock

The GSR-24 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.

6.5.1. 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-24.

6.6. Self Test

An extensive self test routine checks periodically the functions of the GSR-24 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 **Errors and Warnings** display of the communication program. Warnings and Errors are also indicated by the red LED on the lid of the GSR-24.

The GSR-24 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-24 are divided into various groups, Analog, Hardware, Real Time Clock (RTC), Battery and Memory.

See chapter 5 for detailed information about the Warning and Error messages.

6.7. Data Retrieval

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

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