



SEND Signal Elektronik GmbH

GEOLON-MCS

Marine Compact Seismocorder



User Manual

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User Manual

MCS1.09.mnl.doc,
November 2009

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1 Technical Data

Number of inputs	4 differential input channels 3 geophone inputs and 1 high impedance hydrophone input
Input sensitivity	software selectable from 5 V _{pp} to 80 mV _{pp} in seven steps
Sample rate	1, 5, 10, 25, 40, 50, 100, 125, 200, 250, 333, 500, 1000 Sps, (1000ms, 200ms, 100ms, 40ms, 25ms, 20ms, 10ms, 8ms, 5ms, 4ms, 3ms, 2ms, 1ms)
Frequency range	DC - 0.42 * sample rate, linear response
Resolution	24 bits
Signal-to-noise ratio	> 130 dB
Crystal oscillator precision (MCXO)	< 2ppm = 1.728milliseconds/day. Possibility for recalibration after each experiment, allows even better precision.
Temperature compensation for crystal oscillator	-5 to +35 degrees Celsius
Temperature range for operation	-10 to +75 degrees Celsius
Time synchronisation	GPS time pulse
Storage medium	20 GByte hard disk
Storage interface	IEEE 1394 Firewire transfer rate: 5 GB in < 10 min
Engineering signals	Temperature, Humidity, Battery voltage, 3 additional analog inputs, 0 -2.5 V, 12 bits resolution sampled every minute
Power supply	8 – 30 Volts
Power consumption	mission dependant - see tables below
Weight	1,00kg

Power consumption

MCS 12, 500sps, all channels, no RS232

U _{supply} (Volt)	I _{supply} (mA)	P (mW)
7	70,4	492,8
10	49,5	495,0
15	34,0	510,0
20	26,8	536,0
25	23,1	577,5
29	21,8	610,4

MCS 20 and 30, 500sps, all channels, no RS232, no seismometer:

U _{supply} (Volt)	I _{supply} (mA)	P (mW)
5	103,0	515,0
7	73,0	511,0
10	51,0	510,0
15	34,9	523,5
20	27,4	548,0
25	23,6	590,0
29	21,8	632,2

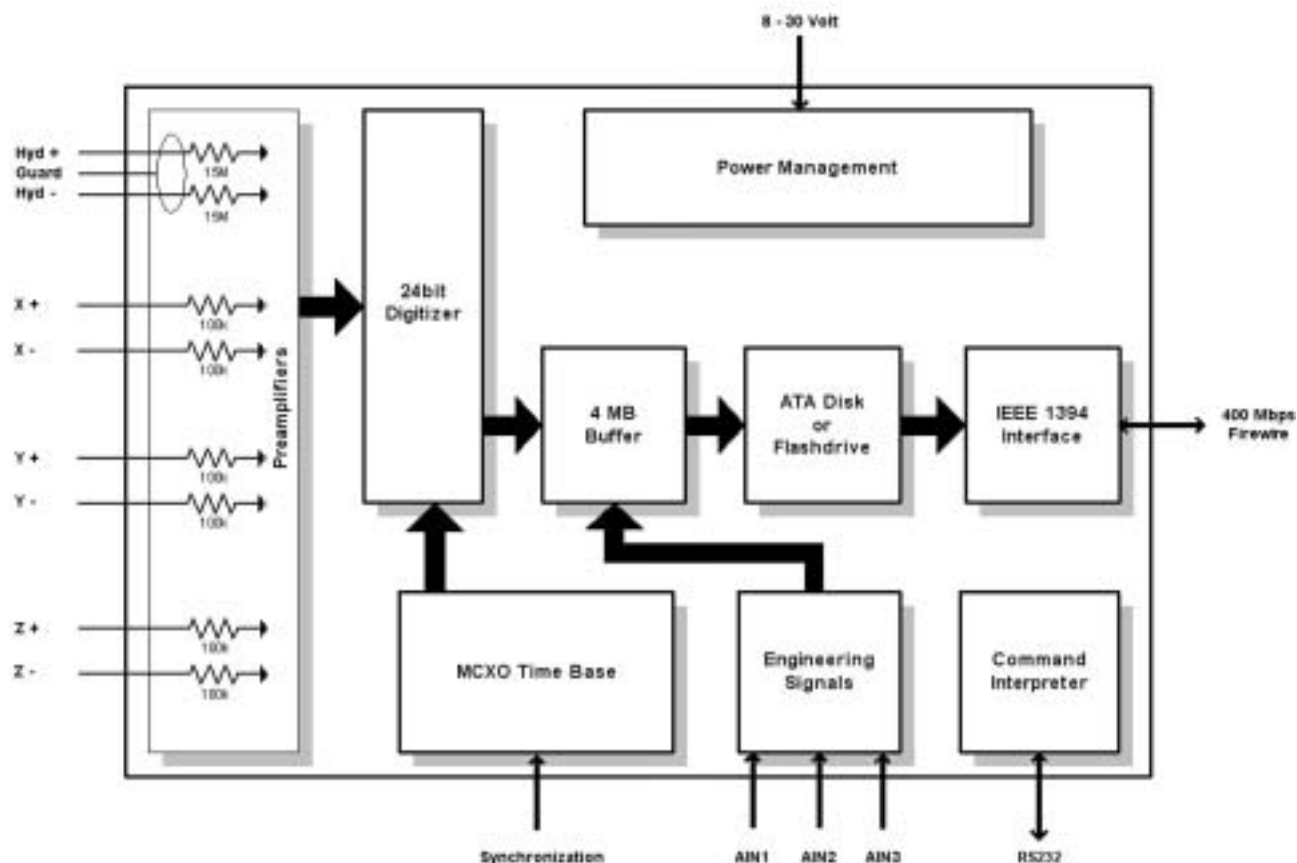
MCS 20 and 30, 500sps, all channels, no RS232, Güralp seismometer CMG-40T:

U _{supply} (Volt)	I _{supply} (mA)	P (mW)
5	123,5	617,5
7	87,5	612,5
10	60,8	608,0
15	41,5	622,5
20	32,4	648,0
25	27,6	690,0
29	25,0	725,0

Functional Description

1.1 General

The GEOLON-MCS is a seismic exploration data logger optimised for the marine environment. Currently, two variants are available: The MCS 12 with standard connectors and the MCS 30 with modified pinout for reading directional information from an additional digital compass. The MCS 30 is functionally identical to the MCS 20, with redesigned circuit boards, modified internal mechanical layout and 32GB flashdrive as standard storage. As of 2009, both MCS 12 and 20 are out of production.



Block Diagram

One Hydrophone, one 3-component geophone or all 4 components may be recorded using differential input signals. The pre-amplification is software selectable in seven 6 dB steps from 0 dB - 36 dB. Then each channel is digitised using a high-performance 24-bit sigma-delta A/D-converter that produces software selectable sample rates needed for seismic exploration.

A high-performance microprocessor controlled crystal oscillator (MCXO) produces timing signals that are synchronised before deployment using GPS time signals. The time information together with the sampled data is temporarily stored in a 4 MB buffer. In addition, internal (temperature, humidity, battery voltage) as well as 3 external engineering signals are recorded every minute.

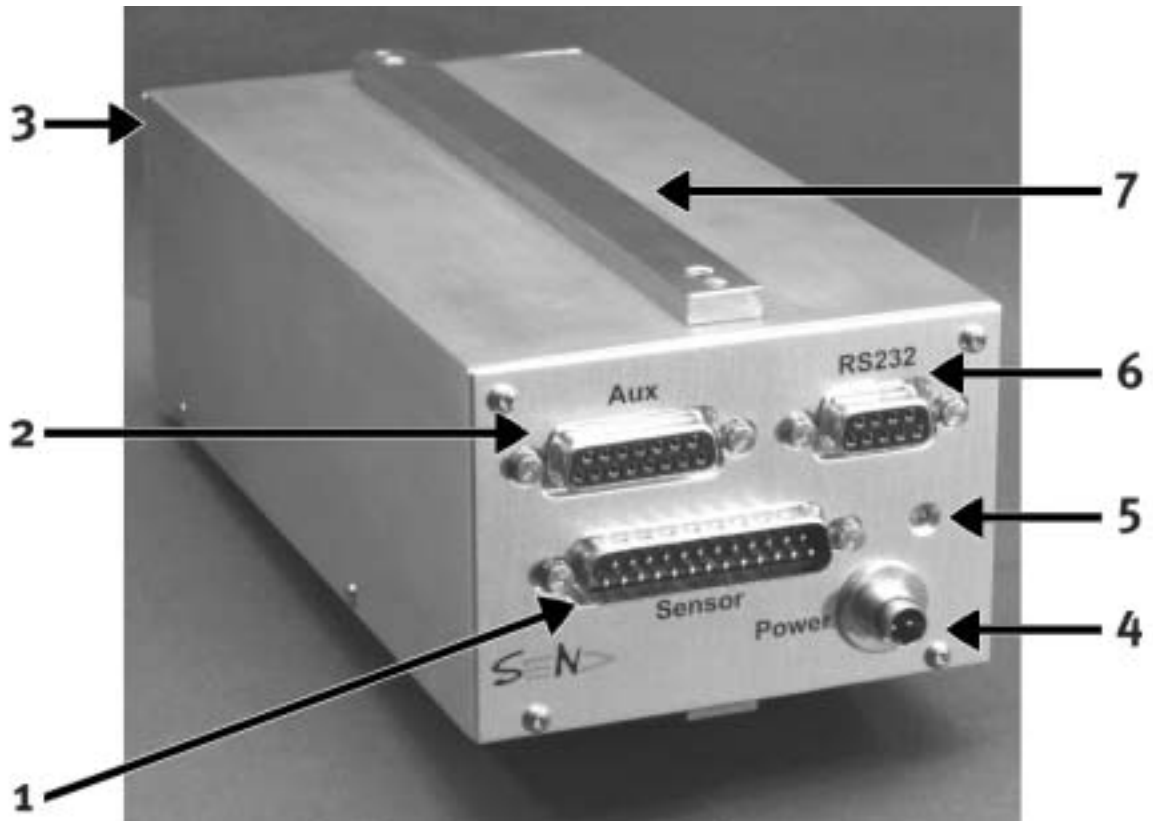
Whenever the buffer is full, a 20 GB hard disk (MCS30: 32GB solid state drive) is powered up and the buffer is transferred to the disk.

- Configuration and parameterisation of GEOLON-MCS may be carried out interactively via a PC using the communication program **SENDCOM 2** or **SENDCOM3**.

Configuration data is stored in non-volatile memory to make GEOLON-MCS independent from the external PC during data recording. The interactive configuration uses the serial RS232 port (COM1 or COM2) of the PC, communicating at 19.2 kBaud (8N1).

After deployment and recovery the recorded seismic data as well as the engineering signals are copied via an IEEE-1394 Firewire interface to a Linux-PC (see also chapter 6.3). The program library SEND2X can be used to decompress the data and to convert it into a binary, audio-wave or SEG-Y format.

1.2 Elements



1 sensor connector

2 auxiliary connector

3 IEEE 1394 (Firewire) connector with plugged cable on back side

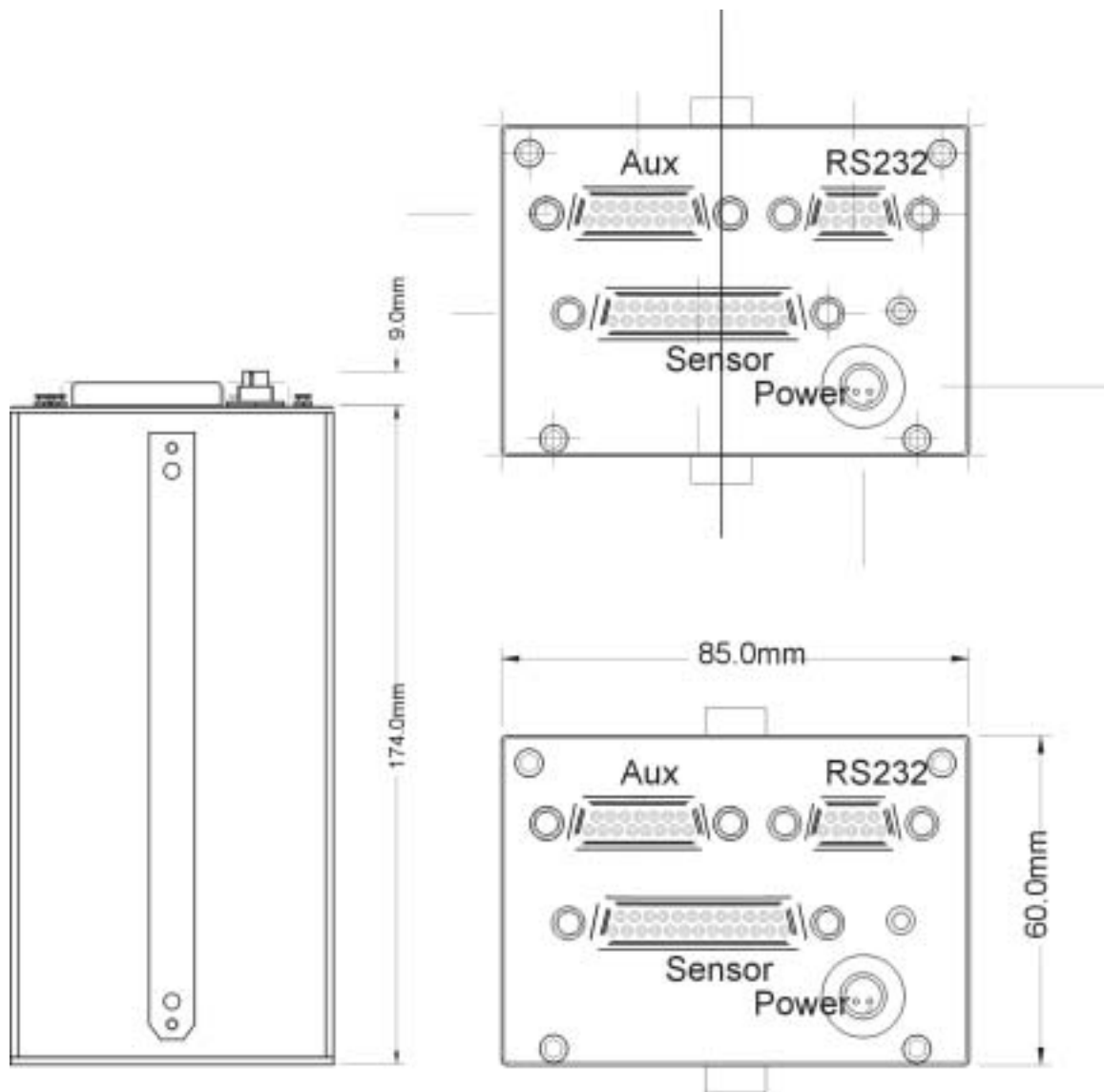
4 Connector for power supply

5 LED

6 RS232 connector

7 mounting rail (optional)

1.3 Physical Dimensions



2 Hardware Description

2.1 Power Supply

Power has to be supplied to GEOLON-MCS with an input voltage range of 8 - 15 Volts via the connector on the top side.

The integrated high-efficiency DC/DC converter has a "low-battery" detector that triggers as soon as the input voltage falls below 6 Volts. Once the low-battery detector has triggered, the input voltage has to be raised above 8 Volts again to reset it.

If the low-battery status is sensed during data recording, recording is terminated immediately and GEOLON-MCS goes into standby-mode. All data prior to low-battery detection will be safely stored on the internal disk.

A storage capacitor buffers the power supply for the oscillator and time base module. Therefore, GEOLON-MCS may be disconnected from the power supply for up to five seconds before it loses time synchronisation once established.

The LED on the connector panel will always light steady while the MCS is drawing power from the batteries or external power supply. All message indication by the LED is established by inverse blinking, i.e. the LED will shortly go dark in the intervals given for the particular message.

2.2 RS232 Interface

The signals are viewed from the DTE side and adhere to the standard PC pin-out. A 9-pin modem extension cable is needed to connect GEOLON to a COM interface on the PC.

Pin	Signal	Remarks
1	DCD	Always high (+3.3V)
2	RxD	Output into DTE
3	TxD	Input from DTE
4	DTR	Input - wake-up signal
5	GND	
6	DSR	Vcc batt. (through 20kOhms)
7	RTS	Input from DTE
8	CTS	Always high (+3.3V)
9	IEEE1394	Output to DTE: MCS busy on Firewire interface

After connecting MCS to the power supply, the MCS waits for a DTR signal before it can start the boot sequence. The DTR signal usually will be provided by a terminal program (like SENDCOM) via the RS232 interface. Another possibility is to connect pin 4 to Vcc batt at pin 6.

2.3 Auxiliary Signals

This 15-pin D-SUB connector (sockets) carries all signals which are needed for synchronisation, external triggering etc. Different plugs should be prepared to control the required function.

All logic inputs and outputs are TTL-compatible signals.

The pinout for the **MCS 12** is as follows:

Pin	Signal	Remarks
1	+3,3V	output; power supply, 100mA max.
2, 14	AGND	ground return for single ended analog inputs
3	/SYNC	input for time synchronisation, active-low, 1 kOhm pull-up
4	SYNCHRONIZED	output, high when synchronised (220 Ohm in series)
5	POWERED	output, low while not draining current , 1Hz blinking while in standby mode, high when active (220 Ohm in series)
6	AIN3	analog input into a 12-Bit A/D-converter for engineering signals
7	TRIGGER or NMEA-UART	input for external trigger, active-high, 10 kOhm pull-down or serial input for GPS NMEA messages
8	SECOND	output of the internal 1pps time base (220 Ohm in series)
9	AIN1	analog input into a 12-Bit A/D-converter for engineering signals
10	AIN2	analog input into a 12-Bit A/D-converter for engineering signals
11-13, 15	DGND	ground return for all logic in- and outputs

The pinout for the **MCS 20** and **MCS 30** is as follows:

Pin	Signal	Remarks
1	+3,3V	output; power supply, 100mA max.
3	/SYNC	input for time synchronisation, active-low, 1 kOhm pull-up
4	/RE-LEVEL	output, low for 10 seconds when re-levelling the seismometer
5	Compass PWR	output, switched battery power for compass, 50 mA max.
6	external LED	output for an external LED showing QC results
7	NMEA-UART	serial input for GPS NMEA messages
8	TRIGGER / QC	input for remote trigger signal and quality control via releaser unit (see page 34 for details)
9	Compass RxD	input, serial data from compass
10	/TEST	input for test signal (active low) for manual self test / quality control, 1.6 kOhm pull-up. (see page 34 for details)
2, 14	AGND	ground return for single ended analog inputs
11-13, 15	DGND	ground return for all logic in- and outputs

2.3.1 /SYNC

The time synchronisation input is used to synchronise the MCS to an external time pulse. The signal synchronises on a high-low transition to mark the beginning of a second. In addition, GPS-NMEA messages have to be fed into Pin 7 (NMEA-UART). The GPS receiver has to be configured for sending the NMEA messages with the following settings: 4800 Baud rate, 8N1 modus, no follow control, sending ZDA and GGA records. Please note that the ZDA message always has to follow "its" /SYNC-pulse. Some GPS receivers may not be able to do this, which renders those useless.

2.3.2 SYNCHRONIZED

This output is set to a high level as long as time synchronisation is maintained.

2.3.3 POWERED

MCS 12 only: This output is set to high level when the device is active. It is set to low level when the device does not drain current from the power source and it is alternating (blinking) at 1Hz between high and low in standby-mode.

2.3.4 RE-LEVEL

MCS 20/30 only: This output is set to low level for re-levelling an attached seismometer that supports releveling. e.g. Güralp. It is set to high level during normal operation.

2.3.5 Compass PWR

MCS20/30 only: This pin is set to high level as a power supply for the digital compass of the AWI OBS. It is set to low while no compass readout is due. Compass reading takes place during re-levelling.

2.3.6 TRIGGER / NMEA-UART

This input may be used to start and stop recording of data if the trigger has been activated using the EXTERNAL command. As long as the input is at a high-level, data are recorded. While the input is at a low-level, data recording is halted. Each time the trigger is activated, a new recording sequence is started.

Alternatively, this input is also used for time synchronization during the set-up of an experiment. The NMEA signal of a GPS-receiver has to be connected to this input, please see chapter 8 for details.

2.3.7 SECOND

MCS 12 only: This output signal provides the 1pps time pulse of the internal time base.

2.3.8 QCREL

MCS 20/30 only: This input signal triggers the internal self test and quality control system by utilizing a trigger output of the releaser system, which itself is triggered via an acoustic command from a vessel.

2.3.9 AIN1, AIN2, AIN3

MCS 12 only: These inputs are sampled every minute by a 12 bit A/D-converter. The input range is from - 1 to + 1 Volt. That means:

- 1 Volt generates a hexadecimal number \$800,
- 0 Volt generates a hexadecimal number \$000,
- +1Volt generates a hexadecimal number \$7FF.

2.3.10 AIN3

MCS 20/30 only: This input is sampled every minute by a 12 bit A/D-converter. The input range is from - 1 to + 1 Volt. That means:

- 1 Volt generates a hexadecimal number \$800,
- 0 Volt generates a hexadecimal number \$000,
- +1Volt generates a hexadecimal number \$7FF.

2.3.11 COMPRX

MCS 20/30 only: This input reads the serial data from a digital compass to determine the orientation of the ocean bottom unit.

2.3.12 TEST

MCS 20/30 only: This input signal triggers the internal self test and quality control facilities by manual request from an external switch, typically on board of a vessel prior to deployment.

2.4 Analog Inputs

The GEOLON-MCS has four differential input channels for 4C recordings. Channel 1 has a very high impedance of 30 MOhm (MCS12) or 150MOhm (MCS20 and 30) as well as a guard output to directly connect to a hydrophone. Channels 2 - 4 have an input impedance of 200 kOhm for connecting to geophones.

The channels may be activated alone or in sensible combinations using the **CHANNEL** command: H(ydrophone), (Geophone-)XYZ, HZ, and any single channel of the geophone.

The preamplifier gain for each channel may be set using the **GAIN** command. The minimum amplification factor is 1 and the maximum is 64 in 7 discrete steps of 6 dB each.

The input sensitivity UIN_{0dB} can be determined using the following formula:

$$UIN_{0dB} = 5 \text{ V} / \text{GAIN} \quad [V_{pp \text{ differential}}]$$

and $1 \leq \text{GAIN} \leq 64$ in seven steps (powers of two: 1, 2, 4, 8, 16, 32, 64)

2.5 Sensors

The sensors are connected to a male D-SUB 25 plug that also connects the case of the GEOLON-MCS to analog ground and offers additional I/O functions. These function differ between the MCS 12 and MCS 20/30.

The pinout for the **MCS 12** is as follows:

Pin	Signal	Remarks
1, 3, 5, 15, 17, 19	AGND	analog ground
2	GEO_X-	differential input of the Z-component, 100 kOhm to AGND
4	GEO_Y-	differential input of the X-component, 100 kOhm to AGND
6	GEO_Z-	differential input of the Y-component, 100 kOhm to AGND
7	GUARD	guard output for hydrophone cable shield
8	HYDRO-	differential input of the hydrophone, 15MOhm to AGND
9	AUX0	auxiliary logic input or output under software control
10	AUX2	auxiliary logic input or output under software control
11	+2,7V	sensor power supply, 50mA max
12	-2,7V	sensor power supply, 50 mA max
13	+3,3V	sensor power supply, 50mA max
14	GEO_X+	differential input of the Z-component, 100 kOhm to AGND
16	GEO_Y+	differential input of the X-component, 100 kOhm to AGND
18	GEO_Z+	differential input of the Y-component, 100 kOhm to AGND
20	HYDRO+	differential input of the hydrophone, 15MOhm to AGND
21	GND	ground return for AUXn logic in- and outputs
22	AUX1	auxiliary logic input or output under software control
23	AUX3	auxiliary logic input or output under software control
24,25	GND	ground return for AUXn logic in- and outputs

Please note, that in the program SEND2X the sensor inputs will be assigned to channels as follows:

Input at MCS	Output of SEND2X
HYDRO	channel 1
GEO_Z	channel 2
GEO_Y	channel 3
GEO_X	channel 4

The pinout for the **MCS 20** and **MCS 30** is as follows:

Pin	Signal	Remarks
1, 3, 5, 15, 17, 19	AGND	analog ground
2	GEO_X-	differential input of the Z-component, 100 kOhm to AGND
4	GEO_Y-	differential input of the X-component, 100 kOhm to AGND
6	GEO_Z-	differential input of the Y-component, 100 kOhm to AGND
7	GUARD	guard output for hydrophone cable shield
8	HYDRO-	differential input of the hydrophone, 500MOhm to AGND
9	REL1	logic input: sleep mode control via releaser signal
10	REL3	logic input: control via releaser signal, presently unassigned
11	+2,7V	sensor power supply, 50 mA max
12	-2,7V	sensor power supply, 50 mA max
13	+3,3V	sensor power supply, 50 mA max
14	GEO_X+	differential input of the Z-component, 100 kOhm to AGND
16	GEO_Y+	differential input of the X-component, 100 kOhm to AGND
18	GEO_Z+	differential input of the Y-component, 100 kOhm to AGND
20	HYDRO+	differential input of the hydrophone, 15MOhm to AGND
21	GND	ground return for AUXn logic in- and outputs
22	AUX1	auxiliary logic input or output under software control
23	RELPNG	logic output: report q/a results via releaser ping signal
24,25	GND	ground return for AUXn logic in- and outputs

3 Error Indication

If an error occurs during deployment, an error log will be stored on the disk. Each log includes the time and date, the task in which the error occurred and a brief error description.

All error and status messages will be displayed using the **LOG** command.

Additionally, the **MCS 20/30** features an internal quality control system which can report either wirebound on deck of vessel or in the lab by status lights in an external control box or by utilizing the triggering and signalling system of a releaser system while being submerged.

4 PC Software

The CD-R with PC software contains the following programs:

SENDCOM
SEND2X

4.1 SENDCOM

This program is used to communicate with GEOLON-MCS via the RS232 interface, e.g. for automatic booting of MCS, interactive configuration (using the commands as described in chapter 6) and for display of recorded data on the PC monitor by using the SHOW command.

SENDCOM is a JAVA program, which runs on both WINDOWS and LINUX operating systems. For installation of the JAVA utilities required, please carefully read the installation-instructions on the CD-R. After starting SENDCOM, a window like the following appears:

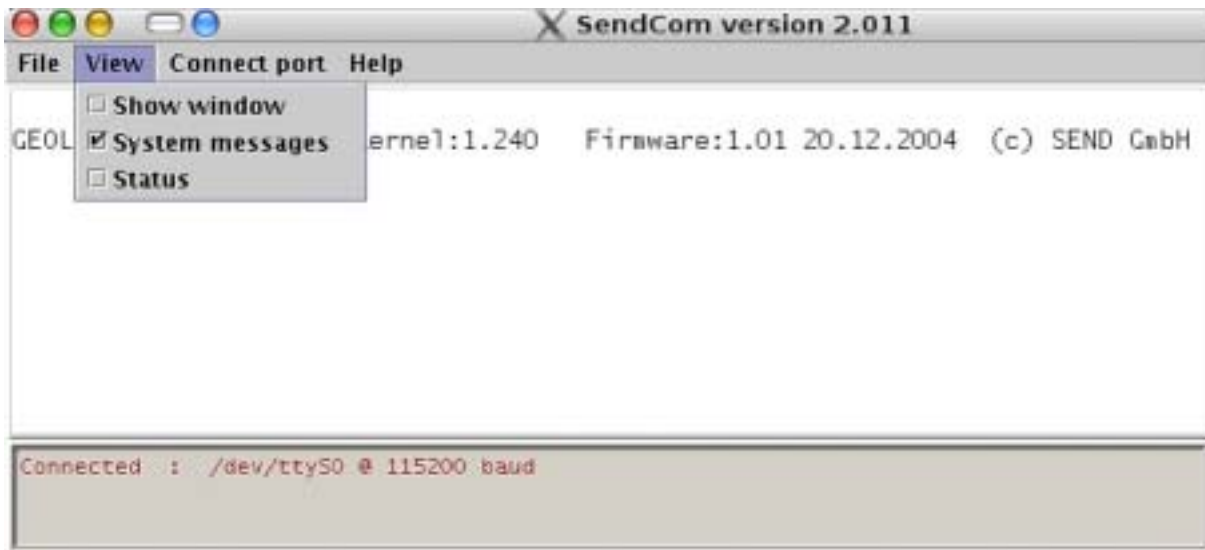


As default, SENDCOM uses COM1 as communication port. If you want to connect to COM2, you have to click on the 'com2' button in the 'connect port' option.

In the first part of window under the menu bar, you can enter commands manually. Messages from the operating system of the MCS will also be displayed here.

The lowest part of the window displays status information of the connected recorder (e.g. about the current memory stack depth or the loaded firmware file).

The display areas for system messages and status information can be switched off by using the 'View' option:

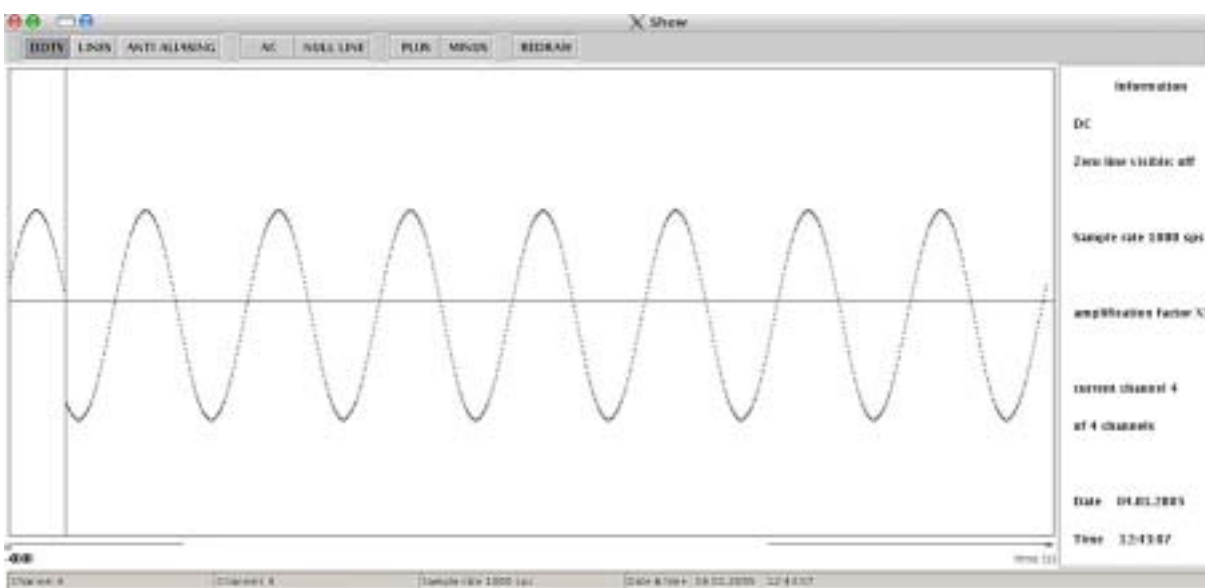


The **SHOW** command can be used to display the current signals at a selected channel. SHOW may be used to check the proper operation of the sensor electronics prior to starting an experiment.

<string> SHOW

displays data of channel <string>, so <string> selects the channel to be displayed. ^C (ctrl-C) will terminate the command.

With the current development stage of SENDCOM, SHOW can only be activated by typing in the SHOW command. After entering the command following window pops up:



On the top menu bar, the activated options are marked by darkened buttons. In the example displayed above, the option LINES is activated. LINES connects the data points by a line. Other options are:

DOTS:	only the data points will be displayed
ANTI_ALIASING:	smoothes stepped lines, which are generated due to insufficient resolution of the screen
AC:	in AC mode, any DC offset will be removed
NULL LINE:	although the null line will be displayed as grey line already, this option activates a modus in which each second data dot will be set to null and marks the null line
PLUS:	Amplifies current signal by a factor of 2
MINUS:	Decreases current signal by factor of 2
REDRAW:	Redraws the screen, use in case of display artefacts

For the MLS and MCS recorders, the current status of the options will be displayed in the 'information' field at the right side of the SHOW window.

Due to the maximum transfer rate of the data via the RS232 interface, a time delay in the display of the signals can appear for sampling rates of about 500 Hz and higher (depends on PC capability). For these frequencies not all data can be displayed, so a small time gap exists between two redraws of the screen.

Exiting the SHOW window and SENDCOM

Please click on the X button on the right top corner of the window for closing the SHOW window.

To exit SENDCOM you can either click on the exit option in the file submenu or click on the X button on the right top corner of the SENDCOM window.

4.2 SENDCOM 3

SENDCOM3 is a special Version of SENDCOM featuring a graphical user interface which allows communication with MCS recorders by just a few mouse clicks. Please see the separate manual for SENDCOM3.

4.3 SEND2X

This program-package converts the compressed recordings of GEOLON-MCS into different formats. SEND2X currently is available for the Linux operating system only. Adaptations for other operating systems are under development.

The current version allows the conversion of raw data into a binary file, an audio-wave file, or into the SEG-Y format if an appropriate shot file is available.

On the CD-R supplied with your GEOLON-MCS you will find a program-library and a script, which includes an example of combining the different programs. Each of the programs can be used separately.

Concerning GEOLON-MCS, the library includes following programs:

- mscopy
- mcslog
- mcsread
- mcsupload
- binwrite
- wavewrite
- segywrite

All programs use the standard input as input device, and some of them also use the standard output as output device. This allows an easy combination of the respective programs through 'piping'. A detailed description of SEND2X can be found in the Appendix.

4.4 Files

The nomenclature of the automatically generated files will be described hereafter.

4.4.1 Log - File

All control, status, and identification information of the current experiment are stored on GEOLON's harddisk. Furthermore, the log data includes the parameter settings such as the sample rate and the amplifier gain for each channel. Normally the program mcslog displays these data on the screen. Through the assignment of the standard output to the harddisk on the connected external PC, these data can alternatively be stored in a text-file. The user has to define the filename and the destination directory in the form of *log file_name.txt*.

4.4.2 Engineering data

The internal temperature and humidity as well as the battery voltage will be stored together with the recorded seismic data on the internal disk. The program mcsread provides the extraction of the engineering data out of the recorded data stream. As for the log-file, the destination directory and the filename for the engineering data has to be defined manually. We recommend to use the extension '.eng'.

The engineering data file looks like:

sampling time: HH:MM:SS DD.MM.YYYY	Temperature, °C	Battery Voltage, mV		Humidity, %	Input 1	Input 2	Input 3
time	temp	hydr	ubat	ain1	ain2	ain3	
06:14:49 07.05.2003	27	49	13623				
06:15:49 07.05.2003	27	49	13623				
..

Input 1-3: free channels for user defined information

4.4.3 Data Files

The programs binwrite, wavewrite and segywrite automatically generate files with names according to the following nomenclature:

020806.01.00.01.2002.168.07.09.57.extension

serial number of GEOLON	channel no	sequence no	event no	start time of recording at activation of REC command	.bin for binary files .wav for audio wave files .segy for files in SEG-Y format .eng for engineering data
-------------------------	------------	-------------	----------	--	--

The start time of recording consists of:

the year	2002
number of days since the beginning of the year	168
the hour	07
minutes	09
seconds	57

5 Command Description

GEOLON is controlled by commands, which are transferred by the SENDCOM program via the RS232 interface. This chapter describes all commands, their parameters and their functions. Before you can set up a communication, GEOLON-MCS has to be connected to the power supply. After the SENDCOM program has been started, the recorder automatically boots with the last stored settings.

The commands may be issued in any order and they are stored on the disk so that the current state will be retained even if power is removed. Please be aware that GEOLON will lose time synchronisation after removing power for an extended period (longer than 7 seconds). Several commands may be entered on the same line, separated by spaces.

Available Commands in Alphabetic Order

Command	Command Group	Page
? <Questionmark>	Listing of all commands	21
ALL	Configuring the A/D Converter	22
CHANNELS	Configuring the A/D Converter	22
ChanName	TEXTINFO Parameters	27
COMMENT	Definition of a Measurement Sequence	23
END	Definition of a Measurement Sequence	23
ENDLESS	Definition of a Measurement Sequence	23
EXPERIMENT	Definition of a Measurement Sequence	23
EXTERNAL	Definition of a Measurement Sequence	24
FORMAT	Time Services	25
GAIN	Configuring the A/D Converter	22
GPS	Time and Storage Services	25
H	Configuring the A/D Converter	22
HZ	Configuring the A/D Converter	22
LEVELLING	Definition of a Measurement Sequence	24
LOG	Information Commands	21
RATE	Configuring the A/D Converter	22
REC	Definition of a Measurement Sequence	23
SETTINGS or ST	Information Commands	21
SHOW	Displaying Data	25
SHUTDOWN	Power Management	27
SKEW	Time Services	26
SKEWTIME	Time Services	
START	Definition of a Measurement Sequence	22
StatComment	TEXTINFO Parameters	27
StatName	TEXTINFO Parameters	27
STOP	Definition of a Measurement Sequence	22
SYNCHRONIZE	Time Services	25
TEXTINFO	TEXTINFO Parameters	27

VOLTAGE	Power Management	27
VOLTAGE ?	Power Management	28
X	Configuring the A/D Converter	22
XYZ	Configuring the A/D Converter	22
Y	Configuring the A/D Converter	22
Z	Configuring the A/D Converter	22

5.1 Help

Each command is accompanied by a short help text line, which shows the input parameters in brief. To display the help text, the command must be preceded by a questionmark.

Example: (values in <> are variables which must be entered):

?CHANNELS <cr>

this command displays on the screen:

CHANNELS selects the channels to be recorded.

May be h, z, y, x, hz, xyz or all.

(for an explanation, please see 6.3)

?

displays a list of all commands.

5.2 Information Commands

LOG

displays the log-file of a completed measurement campaign on the terminal screen. For details, please see chapter 5.3.1. The space-key can be used to stop the listing and start the listing again.

The following commands display information on the current setting of parameters.

SETTINGS or its short synonym ST

reports the actual setting of most configurable parameters and some additional information:

```

SENDGmb version 2.20
File View Connect port Help
GEOLON-MCS-AWI SN:050905 Kernel:2.119 Firmware:1.08 01.03.2006 (=) SEND GmbH
QC test ok
ok
st
Date & Unit 29.02.2000 00:00:27 SN:050905 < time/date and serial number
Synchronized no < synchronization status
ADC QC Hiok Z:ok Y:ok X:ok < AD-Converter quality check
Channels HXYZ : 350 sps : 24 bits < Channel settings
Gain H:1 Z:1 Y:1 X:1 < Gain settings
Eng. Data Temp: 21C Humidity: 34% Ubat: 11.9 Volt < Engineering data for MCS
Usage Time 19 days < Total usage time
Capacity 19.518.656 Kb total, 47.033 Kb recorded < Hard drive capacity
Levelling 1 hours after recording start < Seismometer levelling settings
Status idle < MCS operational status
Start immediately < defined start time for recording
Stop endless < defined stop time for recording
Experiment: Experiment Base < Experiment info
Comment: Experiment Comment < Experiment info
ok
  
```

TEXTINFO

reports the setting of the TEXTINFO-record descriptive strings. The TEXTINFO parameters can be used to store survey parameters (e.g. station number or comments about the survey)

5.3 Configuring the A/D Converter

While GEOLON is in command-mode (before issuing the **REC** command), following parameters for the A/D converter may be set:

<n> CHANNELS

determines the channels to be recorded. **<n>** may be **h, z, y, x, hz, xyz** or **all**. For example:

h CHANNELS activates the hydrophone channel only

xyz CHANNELS activates all three geophone channels

hz CHANNELS activates the hydrophone channel and the z-channel of the geophone

all CHANNELS activates all four channels

<n> <chan> GAIN

sets the gain for the analog preamplifier of **<chan>** (that may be **h, z, y, x, hz, xyz** or **all**, see **CHANNELS**). **<n>** may be any power of 2 number between 1 and 64. A full scale signal at gain 1 requires an amplitude of 5 V_{ppdiff} at the A/D converter input.

<n> RATE

determines the sampling rate **<n>** in samples per second. Valid sample rates are 1 (1000ms), 5 (200ms), 10 (100ms), 25 (40ms), 40 (25ms), 50 (20ms), 100 (10ms), 125 (8ms), 200 (5ms), 250 (4ms), 333 (3ms), 500 (2ms), 1000 (1ms) Sps. Please note that the response to this command can be delayed at lower sampling rates, since the MCS will switch to lower CPU cycles to avoid unnecessary power consumption.

5.4 Definition of a Measurement Sequence

While in command-mode, the duration of a measurement campaign can be defined. Recording of data may begin at a certain start time and last until a certain stop time or it may be controlled by an external trigger signal. In addition a recurring interval may be defined consisting of a recording time and a period duration. Further, a levelling sequence may be set to ensure re-levelling of the seismotor (e.g. Guralp) in fixed intervals during recording.

After all these parameters have been set, GEOLON is activated using the **REC** command. This puts GEOLON into recording-mode.

<day month year hour minute second> START or STOP

defines the beginning and the end of a recording sequence. The **<year>** parameter has to be entered as a four digit decimal number. The parameters **<day>**, **<month>** etc. are entered as regular decimal numbers, separated by blanks before **START** or **STOP**,

e.g.: *08 12 2006 13 31 07*

ENDLESS

erases the **START** and **STOP** time settings and cancels the **EXTERNAL** command. Thereafter, recording can be controlled using the commands **REC** and **END**.

REC

puts GEOLON into "recording-mode" using the parameters which have been entered previously and which may be displayed using the **SETTINGS** command. A new recording sequence is started with its unique initialisation block containing all **TEXTINFO** description strings as well as the time of synchronisation.

If **START** and **STOP** times have been defined, actual data recording will be delayed until the start time has elapsed. It will continue until the stop time has been reached. If no start time has been defined, recording will start immediately. When no stop time has been defined, recording will continue until either

1. the **END** command is issued
2. the harddisk is full
3. the batteries are empty.

If **EXTERNAL** mode has been set, **REC** will record according to the state of the input signal on pin 7 of the auxiliary connector.

If **REC** has been issued, the LED will start to blink. While GEOLON is in standby-mode (not recording data because the start time has not been reached or because it is in an inactive interval period) the LED blinks three times in four seconds. While data are recorded the LED blinks twice each second. The LED will be switched off automatically after five minutes, when no key has been pressed within this period and DTR-signal of the RS232 interface has been deactivated. The LED will remain off until DTR is set or any key will be pressed.

If a start time has been defined, GEOLON will go into sleep-mode as soon as the DTR-signal of the RS232 interface is deactivated. This dramatically reduces power consumption, only powering the internal oscillator maintaining time synchronisation until the start time has been reached.

END

finishes a recording sequence. All data buffers are saved to the storage media and GEOLON returns to command-mode. The green LED lights permanently again. Now power may be removed without loss of data. As an interactive command it can't be compiled into user-commands and will be ignored in that context.

COMMENT <string>

defines <string> as a comment. It may be up to 40 characters long. <string> is delimited by either a " or <cr>.

EXPERIMENT <string>

defines <string> as experiment name. It may be up to 24 characters long. <string> is delimited by either a " or <cr>.

EXTERNAL (MCS12)

puts the recorder into external triggering mode. After issuing the REC command, the GEOLON MCS will only record data while an external signal is present on pin 7 of the auxiliary connector.

Please note: Pin 7 of the auxiliary connector is also used for GPS synchronization. Thus, if the GPS signal is still present on the connector, and both EXTERNAL and REC have been issued, the recorder might start and stop data acquisition at quasi-random intervals. Please make sure to change the connector properly before starting external mode.

EXTERNAL (MCS20)

puts the recorder into external triggering mode. After issuing the REC command, the GEOLON MCS will only start recording data after being triggered by an external signal on pin 8 of the auxiliary connector. The trigger signal typically is provided by the releaser unit's pinger system. Recording can be stopped by a similar trigger signal on pin 9 of the sensor connector.

LEVELLING

sets the time for the first re-levelling of the seismometer and optionally an interval for periodic levelling. This command generally will only be executed in record mode. The full format of the command is:

EVERY <n> DAYS <n> HOURS <n> MINS <n> SECS AFTER <n> DAYS <n> HOURS <n> MINS <n> SECS LEVELLING

If "EVERY" or "AFTER" is specified, at least one time parameter has to be specified for each setting.. The "EVERY" setting is optional, using an "AFTER" setting only results in a single re-levelling event at the specified time.

Examples:

AFTER 42 DAYS 23HOURS LEVELLING

If recording, the MCS will activate the LEVELLING output 42 days and 23 hours after the begin of the recording.

EVERY 24 HOURS AFTER 42 DAYS 23 HOURS 11 MINS 7 SECS LEVELLING

If recording, the MCS will activate the LEVELLING output 42 days, 23 hours, 11 minutes and 7 seconds after begin of the recording and then every 24 hours thereafter.

(Please note, that it is not possible to use the "EVERY" setting without the "AFTER" setting. So, for a strict 10 day interval of re-levelling, you must use EVERY 10 DAYS AFTER 10 DAYS LEVELLING.)

5.5 Displaying Data

With the following command, the proper operation of the sensor electronics may be checked.

<n> SHOW

displays data of channel <n> (**X**, **Y**, **Z**, or **H**) on the PC using the program **SENDCOM.EXE**.
For further information, please see: 5.1 SENDCOM.EXE

5.6 Time and Storage Services

GEOLON has one internal oscillator from which all timing information is derived. After power-on, GEOLON is not synchronised as far as time and date is concerned. This can be accomplished using a GPS 1pps pulse and NMEA messages (ZDA and GGA). Synchronisation will be maintained as long as the power supply is not interrupted for more than 7 seconds.

<day month year hour minute second> SYNCHRONIZE

synchronises the internal clock to an external synchronisation pulse. The time and date information entered as numbers before the command will be the time and date to which GEOLON will be set by the synchronisation pulse.

Example: A date of 26 December 2004, 16:05:30 o'clock can be entered as
26 12 2004 16 5 30 synchronize

When the **SYNCHRONIZE** command has been issued, the system waits for an active (high-to-low) edge on the /**SYNC** input pin of the auxiliary connector.

(Please note: With the GEOLON MCS, the format command will not be executed automatically after synchronisation, but has to be done manually **before** synchronizing. This is meant to allow future enhancements.)

GPS

synchronises the internal oscillator. A GPS 1pps signal (active low) must be connected to Pin 3, and the NMEA messages to pin 7 (and GND to pin 11) of the auxiliary connector.

During the synchronisation process, progress information will be displayed in SENDCOM. Time synchronisation as well as the actual recording status will be maintained as long as the power supply for GEOLON is not interrupted for more then 7 seconds. If you plan to use **EXTERNAL** triggering mode for recording, please make sure to change connectors before issuing the record command. In case of GPS failure this might deadlock the MCS, the command can then be cancelled with CTRL-C and the MCS will return to normal operation, albeit unsynchronized.

FORMAT

The internal harddisk of GEOLON will be initialised. Previously recorded data will be overwritten. **FORMAT** must be carried before application of **SYNCHRONIZE**.

SKEW

determines the deviation in milliseconds of the internal oscillator and clock circuitry compared to an external GPS time pulse. The skew value will be stored in the log file on the harddisk. If the skew value is “plausible” with respect to it’s size and the length of the recording, the user will be offered the possibility to re-calibrate the recorder’s clock. Doing this after each recording session will over time improve the precision of the clock much further than the factory precision of 2ppm.

For more information about the logfile please also see chap. 5.3.1 and the appendix.

<day month year hour minute second> SKEWTIME

re-synchronises the internal clock with an external synchronisation pulse. The time and date information entered as numbers before the command will be the time and date which will be used to determine the deviation (SKEW) of the internal clock since synchronization. This command is for emergency cases only, for instance when the GPS receiver is malfunctioning or in wrong operation mode and no valid NMEA messages can be read, but the second pulse still is present.

5.7 Definition of TEXTINFO Parameters

A number of descriptive character strings can be set which will be stored in non-volatile memory. These strings are stored in every recording sequence and copied or read together with the data file.

TEXTINFO

lists all entries in the following **TEXTINFO** parameter fields. The nomenclature for the entries are defined according to the PASSCAL file standard.

StatName <string>

defines <string> as Station-Name. <string> may be up to 24 characters.

StatComment <string>

defines <string> as Station-Comment. <string> may be up to 40 characters.

<n> ChanName <string>

defines <string> as Channel-Name of the <n>th channel. <string> may be up to 10 characters. <n> may be between 1 and 4.

5.8 Power Management

After connecting MCS to the power supply, the MCS waits for a DTR signal before it will start the boot sequence. The DTR signal will be provided by a terminal program (like SENDCOM) via the RS232 connector.

SHUTDOWN

This command allows switching off the GEOLON in a closed pressure cylinder. For this, the RS232 interface must be linked to an external connector at the housing.

SHUTDOWN activates a mode, which is waiting for the disconnection of the RS232 connector (e.g. at the PC or at the pressure housing) or the termination of SENDCOM. Therefore, the program is looking for the presence of a DTR signal at the RS232 interface. If there is no signal, the GEOLON will be powered down. The only remaining process is probing for the DTR signal. This process consumes very low power of about t.b.d. microamps. Therefore, the connection to a power supply has to be maintained. As soon as the RS232 interface is reconnected to a PC and the SENDCOM program is running, the GEOLON will wake up again.

<n> VOLTAGE

At boot time, the MCS recorder is comparing the power supply voltage with a predefined threshold value. If the power supply voltage is below this threshold, a warning message will be issued. The VOLTAGE command can be used to set the threshold value to a new value.

Example: 10 VOLTAGE sets the threshold to 10 Volts. Consequently, a warning message will be issued at boot time if the supplied voltage is below 10 Volts at that point in time. Please note that this a notification only with no further consequences. Internally the MCS is hardwired to stop recording below 6 Volts. This setting cannot be changed.

VOLTAGE?

This command takes no parameters and displays the currently set threshold voltage for power supply voltage comparison.

6 Description of a Typical Operation Session

6.1 Interactive Operation via External PC

6.1.1 Software Preparation

Install the software from the disk delivered with GEOLON-MCS on your PC. The different programs are described in chap. 5. For communication with the PC please use **SENDCOM.EXE**. It can be used for interactive configuration of GEOLON and for defining measurement sequences. The program-library **SEND2X** is used for conversion of recorded data into binary, audio wave or SEG-Y files.

6.1.2 Hardware Preparation

Connect GEOLON to the PC you want to use for interactive operation via the RS232 interface by means of a 9-pin modem extension cable.

Connect GEOLON to the external power supply specified in chap. 3.1.

The GEOLON-MCS does not start until a DTR signal is sent by a terminal program to the RS232 interface. Therefore the SENDCOM program has to be started before the recorder will boot automatically with the last stored settings.

Connect the auxiliary signals necessary for your measurement project to the interface described in chap. 3.3. Connect at least the input for time synchronisation (pin 3).

6.1.3 Preparation of a Measurement Campaign

For measurement campaign preparation, the A/D converter has to be configured and the measurement parameters have to be defined. Configuration data and parameters of the measurement sequence are stored in non-volatile memory. Consequently, GEOLON will always boot with its last configuration as default settings. During measurement campaigns, a steady power supply is required. However, GEOLON will tolerate short power-fails of up to 7 seconds without losing its time synchronisation and resume recording after the power supply is re-established.

Configuring the A/D Converter

The A/D converter has to be configured concerning the necessities of the experiment (see chap. 6.3). In particular

- the number of channels
- the gain for the analogue preamplifier
- and the sampling rate

have to be defined.

Definition of a measurement sequence

The measurement sequence is defined by using suitable commands for operation and setting appropriate parameters. For details see chaps. 6.4 and 6.5. In addition, several descriptive parameters of the experiment or survey can be entered via TEXTINFO character strings according to chap. 6.7.

6.2 Stand-Alone Data Acquisition

GEOLON is designed for stand-alone data recording following a previously defined configuration and parameterisation (as described above).

The power supply through batteries should be sufficient for the predicted duration of the measurement campaign; otherwise the experiment could be interrupted before completion. In addition, the measurement sensors have to be connected to the configured analog input channels.

Note: At present, GEOLON's harddisk must always be re-formatted during initialisation using the **FORMAT** command. During formatting the configuration file will be preserved. The format command has to be issued before time synchronization.

Before starting data recording, a time synchronisation according to chap. 6.6 has to be performed. This is done by connecting a GPS receiver with an output for a 1pps time pulse signal to the auxiliary connector. Be aware that GEOLON may lose its time synchronisation if power is removed for more than 7 seconds and in this case, no recording will be possible.

Before synchronisation, the **FORMAT** should be executed to ensure that the GEOLON-MCS can overwrite older data files on its harddisk. Otherwise the older data file will not be deleted and the data recently acquired will be stored in an additional file.

The **REC** command puts GEOLON into "recording mode" using the parameters defined before, respectively the settings of the last recording (default values). If a **START** time has been defined (chap. 6.4) before, the GEOLON will now be switched into stand-by mode. When the **START** time has been reached, the recorder will wake up and begin data recording.

Once the **REC** command has been entered, the RS232 cable can be disconnected.

The duration of the measurement campaign usually is defined using commands described in chapter 6.4. Otherwise, data recording will continue until either the harddisk is full or the battery is almost empty. In either case, GEOLON will properly finish the recording by writing all data from the internal buffers to disk before going into stand-by. The power consumption during stand-by is reduced to a minimum because only the internal time base is maintained. Normally, this still allows execution of a **SKEW** command later on. (To recover from stand-by mode, the supply-voltage has to be raised to the nominal level.)

In addition, the green LED on top between the RS232 and Auxiliary connectors produces different blinking signals according to its status:

Signal	Semantics
—————	(continuous ON) = ready for operation
flickering	access to harddisk and execution of commands
.....	(continuous short) = recording
-----	(continuous long) = stop during recording

6.3 Data retrieval via external PC

After the end of a measurement survey, the GEOLON MCS has to be connected to a GPS receiver (via the auxiliary connector). Then the serial link has to be established to your computer (via the RS232 connector). After that, please start the program SENDCOM on your PC.

The **SKEW** command determines the deviation of the internal time base to an external reference signal. After determining the deviation, the skew value and time and date of its determination are written to the log-file.

6.3.1 Data retrieval via FireWire

By establishing the Firewire connection to the GEOLON, your PC should be able to provide direct access to GEOLON's harddisk and recognise it as a new device. It also is possible to read and copy the data without connecting a PC to the GEOLON via the RS232 interface, when the IEEE interface at your computer provides a power supply (A 6 pin to 6 pin FireWire cable is mandatory in this case).

Please note that the FireWire link has the priority over commands which require access to the disk: Several commands as e.g. **GAIN**, **GPS**, or **SKEW** won't work while the FireWire link is established. Please, also be aware that, if you send the **FORMAT** command, it's execution will be halted while the FireWire connection is established. When you disconnect the FireWire cable, the halted command will resume execution.

Due to the huge number of different products, the operation via PCMCIA-FireWire interface is also not tested for all adapters available on the market. If you experience difficulties with one of the latter types of interfaces, please get in touch with SEND. For example, ATEN's PCMCIA-FireWire Card cannot establish a proper link to the MCS.

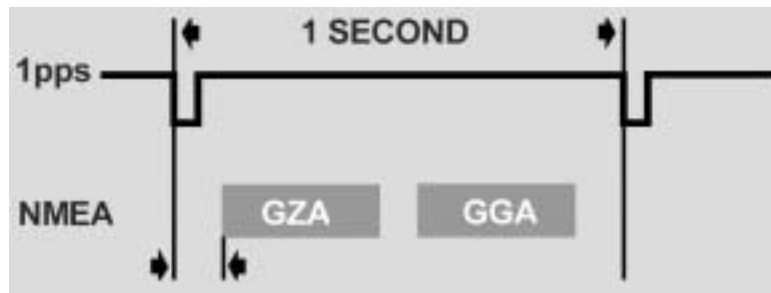
If your computer only has a FireWire interface without power supply (i.e. with a 4 pin plug), then you have to connect the MCS to an external power supply. In addition, the MCS needs a DTR-signal on the RS232 connector. Alternatively, the battery power can be connected through a 20 kOhm series resistor with Pin 6 of the RS232 connector. Connecting Pins 4 (DTR) and 6 will wake up the GEOLON and start the internal harddrive. Please note, that in this case, it is not possible to disconnect and reattach the IEEE1394 cable, for instance to access the MCS with different PCs in sequence. The MCS then must either be powered down or be put in shutdown mode first in order to be able to recognize the presence of the IEEE1394 connection. This limitation is caused by the missing power supply on the four lead cable, it is not a limitation of the MCS. Again, with a full fledged six lead IEEE1394 cable, the MCS will always recognize the connection after replugging the connector.

6.4 Analysis of Recorded Data

After recording, the stored data can be read using an external PC with an IEEE 1394 FireWire interface and the **SEND2X** software. The program `mcslog` of the `Send2x`-library provides a glance at the Log-File on the screen of the connected PC. Either you use the program `mcs-copy` to copy the raw data to your PC as it is, or you combine the program `mcs-read` with `segywrite` to convert the raw and compressed data into a standard SEG-Y format. Regarding these programs, please follow the instructions in chap.5.2 and the corresponding appendix. As of now, all programs of **SEND2X** are running under the LINUX operating system. Users who do not have a LINUX operated computer may request a KNOPPIX CD-R from us. KNOPPIX allows booting a working LINUX environment directly from CD-R.

7 GPS Signal Requirements

As described in Chapter 3, time synchronization of the GEOLON-MCS is done by the time information of the Global Positioning System GPS. Two different signals are required, the one second time pulse and two messages contained in the NMEA signal. These signals must be aligned according to the following figure:



In other words: The GZA message must follow the time pulse it is associated with and, consequently, it must end before the next time pulse. The GZA message contains the time and date information and is only valid, if the information contained in the GZA message indicates that a sufficient number of satellites are being received.

Unfortunately, some GPS systems do not follow this pattern but send the GZA packet just somewhere “around” the time pulse, which is not precise enough for the GEOLON-MCS. Some GPS systems can provide the proper signal sequence, but are set up differently by default and therefore have to be put into “strict” mode before applying the signals to the MCS.

Please make sure that the GPS-System you are planning to use to synchronize the MCS utilizes strict mode as shown above, or at least can be switched to that mode.

8 Internal Quality Control

The MCS20 has extended self test and quality control facilities which can be utilized by remote control. There are two different ways to perform self tests: First, a self test can be requested via a signal on pin 10 of the auxiliary connector, which is triggered by a button on the GPD30 switching box. The results of this test are reported back via a LED on the GPD30 switching box and acoustic signals from the releaser unit. This testing method is typically used onboard a vessel, shortly before deployment of the OBS, e.g. after the pressure cylinders have been closed and the sensors connected. The LED on the GPD30 will show the same inverse blinking as the “internal” LED on the MCS connector panel, i.e. it will be on steadily while the MCS is in normal working modes and will just go dark for short periods to signal messages. The only difference is in the sleep and recording modes, where the LED in the MCS will not light, but the LED on the GPD30 will. This is intentionally to give a clear indication when the MCS will not consume any power at all. Only then the LED on the GPD30 will not light even when DTR still is provided to the MCS.

The second way to initiate a self test can be performed while the system is submerged, partially even during an active recording session. This self test is triggered by signals from the releaser system, which can be activated by sending acoustic commands from a vessel. It reports back to the vessel via acoustic codes from the releaser pinging system.

The test results are reported as four different error levels, represented by the four different acoustic codes from the releaser when submerged and by four correspondent light signals on the GPD30 when tested onboard. For both methods, the error levels are defined as follows:

Error level 1:	7 pulses, 100ms duration each, 1100ms between pulses
Error level 2:	15 pulses, 100ms duration each, 1100ms between pulses
Error level 3:	7 pulses, 100ms duration each, 2000ms between pulses
Error level 4:	15 pulses, 100ms duration each, 2000ms between pulses

Depending on the recording status of the MCS, up to five functions will be tested and evaluated:

- 1. Harddrive/Flashdrive function:** write/read/verify tests. If in recording mode, only the state of the last drive access can be reported. The errorlevel for this test can only be 1 (ok) or 4 (failed)
- 2. Synchronization:** The internal synchronization status is reported. The errorlevel for this test can only be 1 (synchronized) or 4 (not synchronized)
- 3. AD Converter:** The inputs of the ADC are first set to ground level internally and checked for signal noise. Then the inputs are set to a reference voltage and both signal quality and noise level are checked. The errorlevel for this test can only be 1 (ok) or 4 (one or both parts of the test failed) *This test cannot be performed while recording.*
- 4. Seismometer:** This test is only available via the releaser signal. The seismometer and the A/D-converter will be activated automatically for this test. The test is being passed if the mean signal (averaged over a one second period) is less than 25 percent of the maximum amplitude possible. The errorlevel for this test can only be 1 (ok) or 4 (failed)

5. Storage Capacity: This test determines the usage of the internal harddrive or flashdrive. It reports back the percentage of space used for recorded data as follows:

- Error level 1: < 25% storage capacity used
- Error level 3: < 75% storage capacity used
- Error level 4: > 75% storage capacity used

Due to the restrictions of the releaser pinging system, the MCS will report only one error level per test. **This “final” result is determined by comparing the single results and simply selecting the worst value for reporting.**

The final result thus can be interpreted as follows:

- Error level 1: The unit is fully functional and is currently recording, or has already finished a scheduled recording
- Error level 2: The unit is fully functional and is waiting for the start time of a scheduled recording
- Error level 3: The unit is fully functional and has at least 25% free storage capacity.
- Error level 4: Either one of the components is malfunctioning or the harddrive is almost full; in any case no valid data can further be recorded. This error level is also given in case that the unit is fully functional, synchronized, is not waiting for a scheduled recording to start, and the REC command has not been issued.

9 Support and Service

Should any problem arise with the GEOLON-MCS or its software, please contact us for bug reporting or any other support issue via:

e-mail: support@send.de

phone: +49 40 180362342

fax: +49 40 180362349

10 Appendix: SEND2X manual