SEND Signal Elektronik GmbH

GEOLON-MTS

Marine Tsunameter Seismocorder

User Manual

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User Manual

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1 Features

1.1 General

GEOLON-MTS is a high-precision instrument for acquisition, processing and storage of seismic signals and pressure data. It is optimised for long time (more than 1 year) stand-alone operation on the ocean bottom and comes in two flavours: A standard MTS version and the MTS-M version for tsunami detection and reporting via acoustic modem.

A front-end with four analog input channels behind the front plate is designed as exchangeable unit. Three channels are prepared for connection of a 3-axis-seismometer; adaptation of different types of seismometers is possible. One channel is prepared for connection of a hydrophone or a differential pressure sensor and therefore it is equipped with a low-noise preamplifier with four different preselectable gain factors. Additionally, a digital absolute pressure gauge can be connected to the auxiliary connector. By default, the MTS is delivered ready for deployment as a tsunameter with both pressure gauges.

List of GEOLON-MLS/MTS Versions

MLS	(MLS10)	Standard Geolon-MLS, 12 V and 50 mA for gimbaling
	(MLS12)	3,3V and 200 mA for gimbaling
MLT	(MLS11)	for acquiring data from tiltmeter
MLP	(MLS13)	for passive aquisition of pressure data from Digital Depth Sensor of Paroscientific via hydrophone connector
MTS	(MLS15)	for active aquisition of pressure data from Differential Pressure Gauge and Digital Absolute Pressure Sensor via additional RS232 interface
MTS-M		MTS with additional software for tsunami detection and data transmission via acoustic modem.

1.2 Key Features

Time synchronisation	DCF77 or single pulse
Internal time base drift	< 0.05 ppm (0 ... +30°C)
Power consumption	Recording: @ 50 sps 230 mW without preamplifier (LOWN2X) for hydrophone ; 250 mW with LOWN2x; 255 mW with 12 PCMCIA microdrives as storage devices; Lowbat standby: 100 mW
Storage medium	PCMCIA flash-disk / hard disk
Storage capacity	12 PCMCIA slots type II (at present good for 24 GB flash cards or 24 GB hard disks)
Weight	1.5 kg without batteries and PCMCIA storage modules

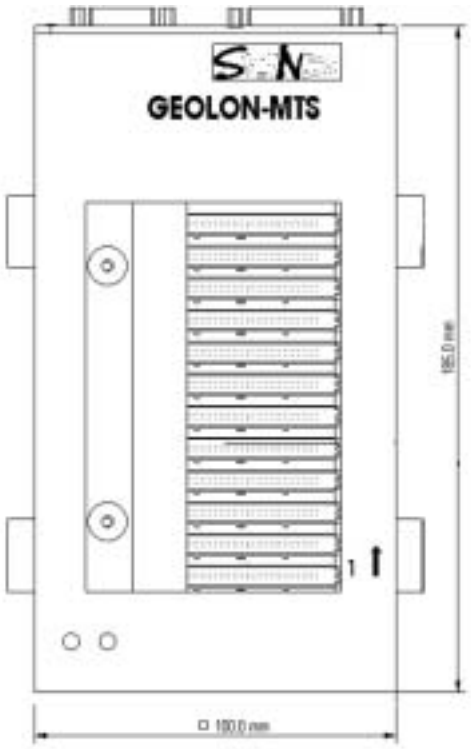
1.3 Sample Rates and Resolution

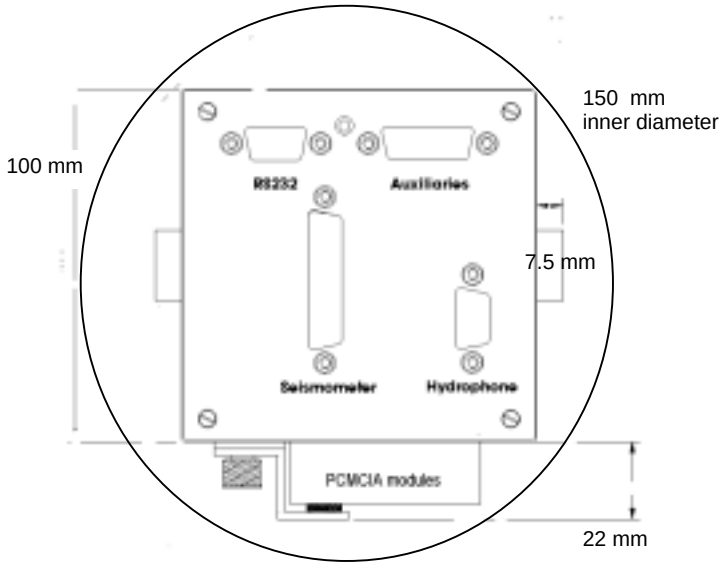
Samples per second	f-3dB (Hz)	Resolution (Bits)	Signal-to-Noise Ratio (dB)
1	0.3	22	120
2	0.7	22	120
5	1.7	22	120
10	3.3	22	114
20	6.7	21	110
30	10.0	20	106
50	16.7	19	100
100 *	33	18	96
200 *	67	15	78

Further sample rates selectable are: 3, 4, 6, 25, 40, 60, 75, 120*, 130*, 150* Hz

*optional

1.4 Physical Dimensions





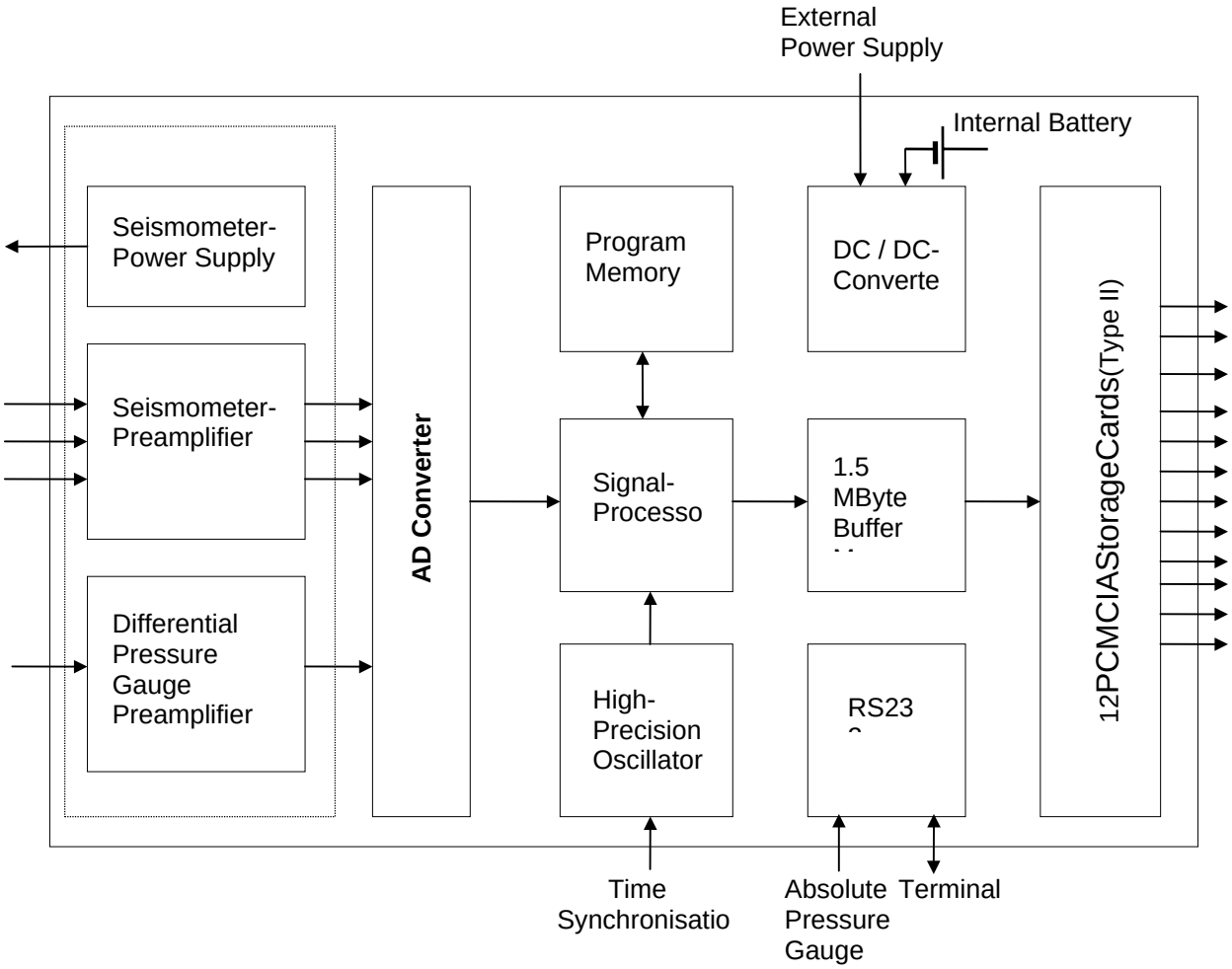
1.5 Environmental Properties

Operation Temperature:	using mil-spec flashcards	-20°C to 70°C
	using hard disks	0°C to 55°C
	for max. time base stability	0°C to 30°C
Storage Temperature:		-45°C to 70°C
Humidity		100% non condensing

2 Functional Description

2.1 General

In the block diagram the components of GEOLON-MTS are shown as well as the data flow with its successive processing steps.



Block Diagram

The instrument can be parameterised and programmed using an ASCII terminal via its RS232 interface. After low pass filtering the signals of the four input channels are digitised using Sigma-Delta A/D converters. A final decimating sharp digital low-pass filter is realised in software by a Digital Signal Processor. The effective signal resolution depends on the sample rate as shown in the table in chap.1.3 The sample rate is software selectable as described in chap. 5.3. An additional RS232 interface is used to retrieve data samples from a digital absolute pressure gauge.
Finally, the samples are permanently stored on PCMCIA flash- or hard-disk memory modules.

A high precision oscillator, which is synchronised using DCF77 compatible pulses, controls the time management hardware. Time deviation during recording is determined using the SKEW command and then written to the **MLS.SYS** file. Due to used oscillator technology, time slips can

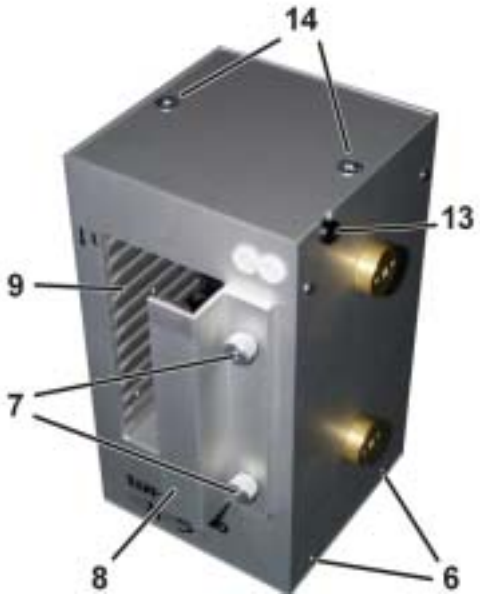
appear. Please find a detailed description in chap. **Fehler! Verweisquelle konnte nicht gefunden werden.**.

The recorded data is played back by plugging the PCMCIA storage cards into a PC with PCMCIA interface. All necessary PC-software is part of the standard deliverables (see chap.3). The software package SEND2X can be used for Linux computers to read the acquired data from PCMCIA storage disks and to generate a non standard SEG-Y file, which is compatible to the processing software of RefTek, as well as other formats.

2.2 Elements

Top view

Bottom view



1 Connector for serial interface (RS232)
2 LED
3 Auxiliary connector and absolute pressure gauge connector
4 Connector for 3-axis seismometer
5 Connector for hydrophone or differential pressure gauge or depth sensor
6 Screws to fix the exchangeable electronic unit
7 Screws to fix the PCMCIA card cover
8 Z-shaped PCMCIA card cover
9 12 PCMCIA card slots
10 Slot for screw driver to lift the front plate for exchange of electronic unit
11 Front plate of exchangeable electronic unit
12 Mounting adapters (on request)
13 Lead-in hole for power connection wires
14 Quick-fix screws for access to battery compartment

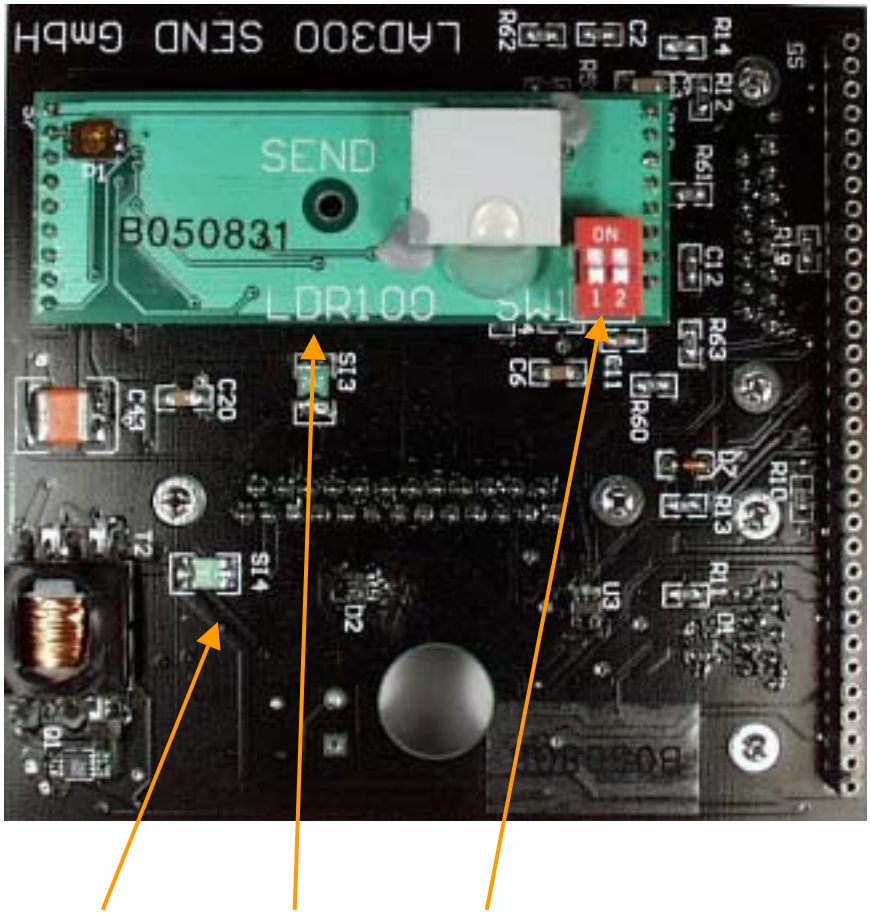
2.3 Modularity

The modular design of GEOLON-MTS enables easy adaptation to different sensor types. For this purpose the analog electronics are mounted on the rear side of the front plate and become accessible when the front plate is lifted. There are two PCBs that may be changed: the LAD1xx which is seismometer specific, and a smaller one for adaptation of a hydrophone (LHY100) or a pressure sensor (LDR100). Available PCBs for sensor adaptation and their specifications are described in chap. 4.2.

If the use of different sensor types is rather unlikely the suitable PCBs should be selected and installed. If a frequent change of sensors is expected, it is recommended to prepare different sensor specific exchange units each consisting of a front plate and the suitable PCBs. These analog units can easily be exchanged as a whole.

How to lift the front plate and how to change the sensor specific PCBs is shown in the following illustrations.

Insert a screw driver into the slot (N0. 10 in chapter 2.2) and twist it to loosen the front plate. Please note that there is a yellow/green grounding wire connecting lid and body, which has to be detached on one end first, before the lid can be taken off completely.

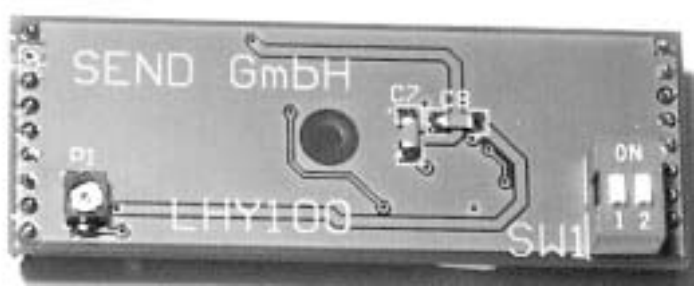


1 2 3

1 Seismometer specific PCB: LAD300

2 Piggy-back PCB for Differential Pressure Gauge: LDR100

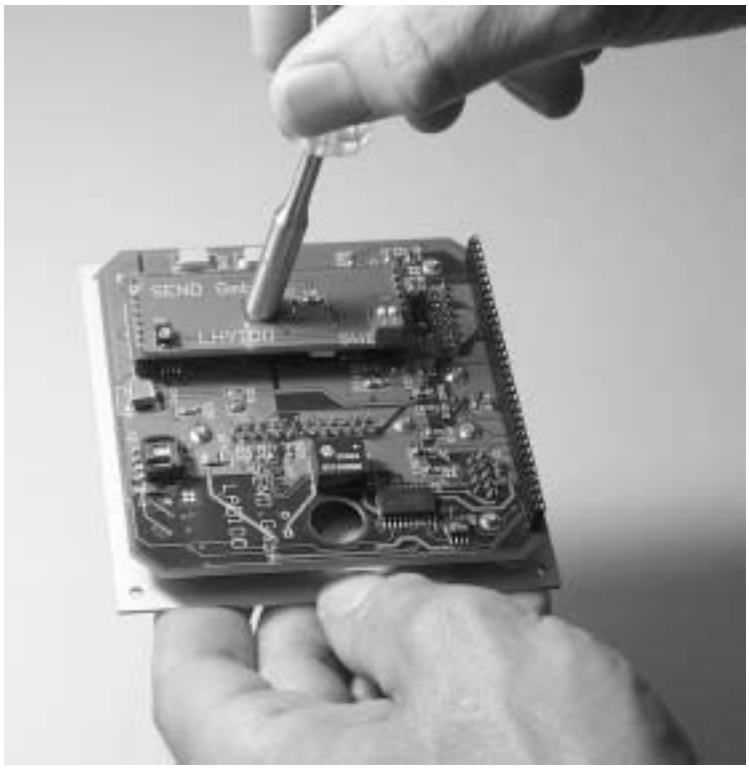
3 Switch SW1 for selection of preamplification gain (see also chap. 4.2.2)



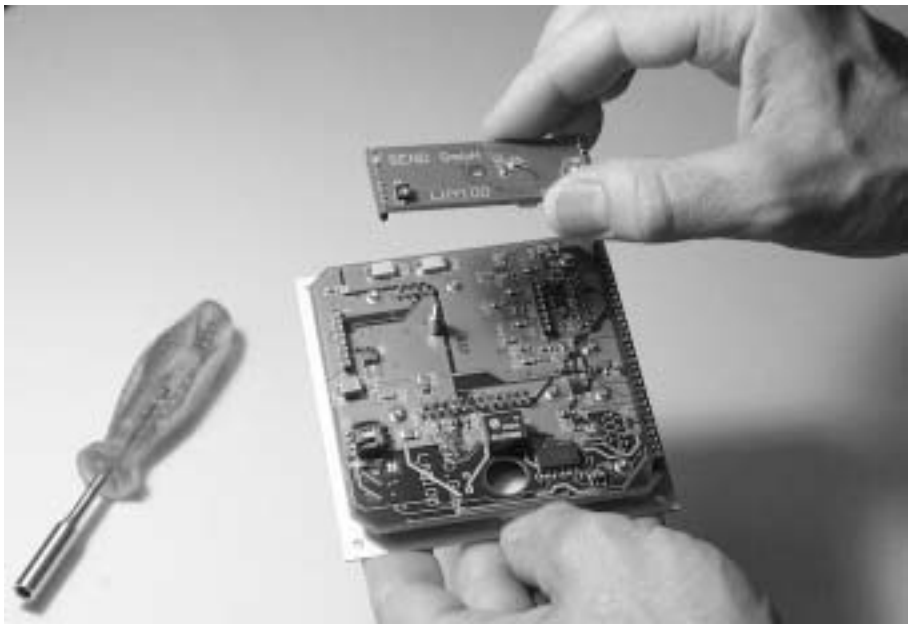
Analog electronic exchangeable unit

Piggy-back PCB for use of a hydrophone: LHY100

Changing the piggy-back PCB:



Remove the nut.



Remove / exchange the piggy-back PCB.

Since the hole for the fixing peg is positioned eccentrically in the PCB an incorrect plug in of the PCB is not possible.

2.4 How to Use PCMCIA Memory Modules

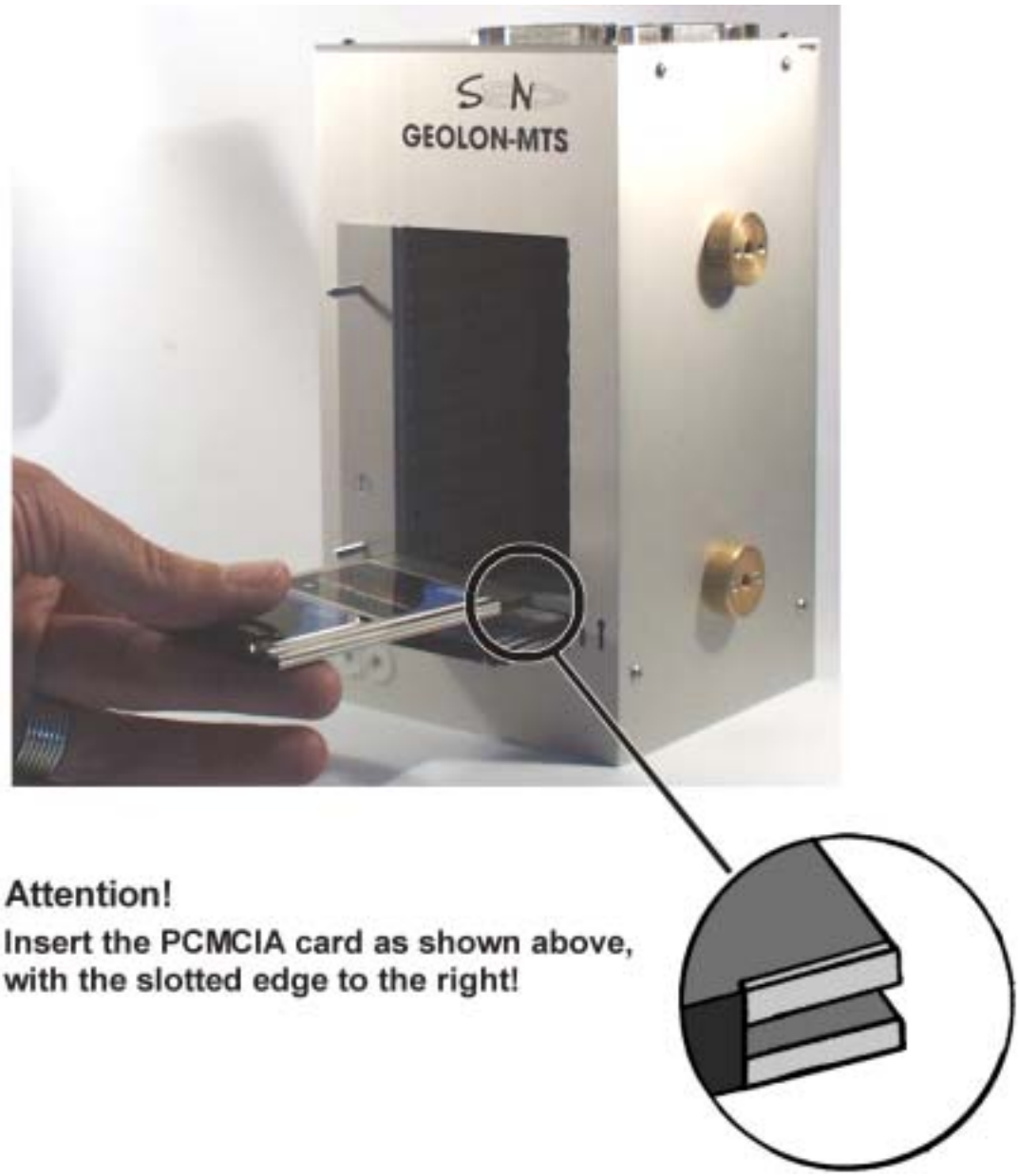
GEOLON-MTS is equipped with 12 slots for PCMCIA ATA memory modules. A maximum of 12 PCMCIA cards of Type II or Type I can be inserted. Cards of Type III need the space of two slots due to their thickness, so a maximum of 6 modules of Type III can be inserted.

PCMCIA flash cards as well as PCMCIA hard disks up to 2 Gbyte may be used, and they may be mixed arbitrarily. Slots to be used may be selected arbitrarily, too, with the exception of slot 1:

Note: the first card has to be inserted in slot 1 !

2.4.1 How to Plug In PCMCIA Storage Cards

The housings of PCMCIA ATA modules are coded as shown below in order to avoid an incorrect plug-in. In the correct position the cards can be inserted smoothly. If you feel significant resistance please make sure that the card is inserted in the correct position.



3 PC Software

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

SENDCOM
SEND2X

3.1 SENDCOM

This program is used to communicate with GEOLON-MTS via the RS232 interface, e.g. for interactive configuration and for real-time display of channel data on the PC monitor.

SENDCOM is a JAVA program, which can be run on any JAVA-enabled Windows or Linux computer.

As default, SENDCOM uses COM1 as communication port. If you want to connect to another port, you can do so from the SENDCOM menu bar.

The SHOW command of SENDCOM:

<string> SHOW
displays data of channel <string> on the PC. SHOW may be used to check the proper operation of the sensor electronics prior to starting an experiment. ^C (ctrl-C) will terminate the command. <string> selects the channel to be displayed.

A separate manual for SENDCOM is enclosed in the Appendix.

3.2 SEND2X

This program-package converts the compressed recordings of SEND recorders into different formats. SEND2X is available for the Linux operating system.

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

On the delivered CD-R 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-MTS, the library includes following programs:

mtsread
paroread
binwrite
wavewrite
seg-ywrite

These programs take their input from the standard input device and write to the standard output device, allowing easy combination of programs by piping.

smtsread (only for MTS-M)
pressure2ascii (only for MTS-M)
ph2ascii (only for MTS-M)

These programs read only from files and write to the standard output, allowing the data to be passed from file to follow-up programs by piping.

A detailed description of SEND2X can be found in the Appendix.

3.3 Files

GEOLON-MTS creates two different types of files:

- data files
- **MLS.SYS** - file

3.3.1 Data Files

Names of data files are automatically generated by GEOLON-MTS during recording and by the PC after conversion and they have the following structure:

<4-digit serial number>
<3-digit day-of-year>
<1-digit sequence number>
.
<2-digit hour>
<1-digit channel>

- <4-digit serial number>
  is derived from the GEOLON-MTS serial number and consists of 3 sub-fields:

  <1-digit year code> year since 1990, counting above "9" continues with "a", "b", etc.
  <1-digit month code> "a" for October etc.
  <2-digit serial number>
- <3-digit day-of-year>
  day number of the synchronisation time.
- <1-digit underline ("_") character>
- <2-digit hour>
  hour of the synchronisation time.
- <1-digit channel>

this field contains the slot number of the medium.

3.3.2 MLS.SYS

This file contains all control, status, and identification information of the actual experiment and the particular PCMCIA card. It is the first file on each PCMCIA card; the remaining storage capacity is available for data files. All settings that can be done via the serial console may also be used in the MLS.SYS file to set up an experiment, the MTS will
read this file at startup and execute the commands, if any.

As an example the contents of a typical MLS.SYS - file is described hereafter:

File content	Comment
Set of basic parameters:	
EVERY 7 DAYS **AFTER 3 HOURS LEVELLING**	activates the levelling signal 3 hours after beginning of recording, then weekly
50 RATE	sampling-frequency is 50 Sps
EXPERIMENT experiment_name" **COMMENT experiment_comment"**	
Optional passcal strings:	
PASSCAL	enter the PASSCAL sub menu
12 EXPNUMBER	
	EXPNAME already set (alias for EXPERIMENT)
	EXPCOMMENT already set (alias for COMMENT)

1234 STATNUMBER
STATNAME geolon tsunami detection"
STATCOMMENT geolon configuration by file on pc-card"

HYDROPHONE CHANNAME DPG"
HYDROPHONE CHANSENSOR Scribbs DPG"
HYDROPHONE CHANSENSORNUMBER #12345678901"
HYDROPHONE CHANCOMMENT preamplifier LPD300"

SEISMOMETER1 CHANNAME Güralp"
SEISMOMETER1 CHANSENSOR CMG-40T"
SEISMOMETER1 CHANSENSORNUMBER #23456789012"
SEISMOMETER1 CHANCOMMENT Z axis"

SEISMOMETER2 CHANNAME Güralp"
SEISMOMETER2 CHANSENSOR CMG-40T "
SEISMOMETER2 CHANSENSORNUMBER #34567890123"
SEISMOMETER2 CHANCOMMENT N-S axis"

SEISMOMETER3 CHANNAME Güralp"
SEISMOMETER3 CHANSENSOR CMG-40T "
SEISMOMETER3 CHANSENSORNUMBER #45678901234"
SEISMOMETER3 CHANCOMMENT E-W axis"

EXIT	leave PASSCAL sub menu
DCF77	synchronise time, format cards
REC	start recording

All subsequent messages will be written into MLS.SYS- file when the SKEW or CLOSE command is executed:

\\

[sync_time]
01.10.2005 12:17:00

[this_card]
card #1

[file_name]
card #1: B802028_.211

[skew_time]
08.10.2005 12:35:00

[system_time]
08.10.2005 12:34:59 and 689 ms

[deviation]
-311 ms

[messages]
0 messages

[settings]
Date & Unit 08.10.2005 12:35:20 050802
Synchronized 01.10.2005 12:17:00
Channels all

Sampling 50 Sps, 19 bits
Capacity 261312 KB data, cards closed
Start 01.10.2005 12:18:13
Stop 08.10.2005 12:51:34
Levelling Every 7 days After 3 hours
Status cards closed
Experiment experiment_name
Comment experiment_comment

[FIR-FILTER]
2 decimation
44 coefficients
#1 : -0.000022315
#2 : -0.000190424

... ...

#44 : -0.000022315

[delay]
240 ms, 12 samples

Delay introduced by the digital FIR filter. The delay will be corrected by using SEND2X for converting the data in a defined format (e.g. SEG-Y). The delay will not be corrected for the audio wave and binary format.

3.4 Time Slips

The Seascan oscillator inside the MTS has a free running 4 MHz oscillator with an immanent temperature dependency on frequency (about 20ppm). From this oscillator an intelligent "divider" is fed, producing a temperature compensated 1 Hz pulse. This pulse is used by the MTS for time keeping. The 4 MHz oscillation is used to generate the sampling frequency. Therefore, the sampling frequency is much less precise then the time marks. That means, while the time of the internal clock is accurate (especially after the linear correction of the drift of the oscillator) the sampling rate can vary slightly sometimes. Then, the sampling period is not constant every time. Over long measurement periods, these small failures could be summarised to a period of one sample period. Then you will get a "time slip" message during conversion of the data. That happens, whenever there are 99 (negative value) or 101 (positive value) samples between two second time marks (at a preset sample rate of 100 Hz). These information are given for the case, that for the detection of an event a precision is needed, which has to be better than one sample period. The utility package SEND2X contains the program RESAMPLE, which provides a resampling of the data for attaining an equidistant sample rate.

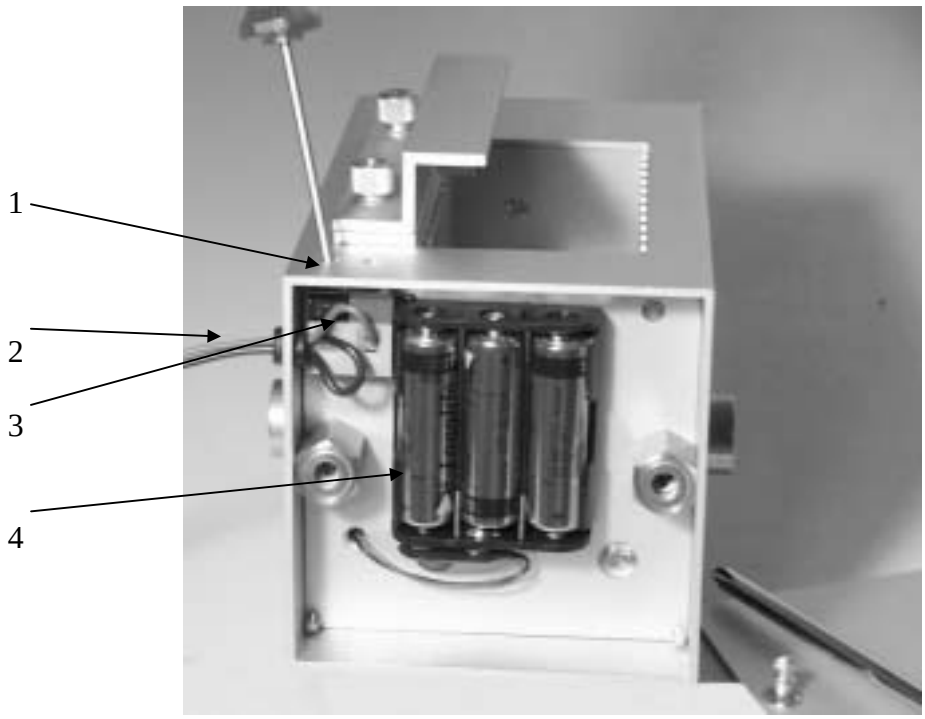
4 Interface Description

4.1 Power Supply

Power has to be supplied to GEOLON-MTS via the red (+) and black (-) terminals in the bottom case. The input voltage range is specified in the table. An integrated high-efficiency DC/DC converter generates the voltages needed by GEOLON-MTS.

Note: When hard disks are used as storage medium, the power supply must be capable of delivering at least 8 Watt of peak power during the acceleration phase of the hard disk!

In order to keep the time synchronisation during brief power interruptions, e.g. for experiment preparation, 3 size AA batteries can be inserted. The battery case is positioned adjacent to the power supply terminals as shown below. With the AA batteries only, it is **not possible** to record data!



Bottom case for power supply connection and batteries (opened)

1 Screw driver for terminal screws

2 Cables for power supply connection fed through the hole in the side wall

3 power supply terminals
red +
black -

4 three batteries inserted

External Input Voltage Range	Necessary Internal Battery Cells (Voltage)

6.2 ... 16.5 V	3 AA cells / (4.8 V)

Powering from the internal batteries will be activated if at least one PCMCIA card has been inserted and the external power supply is interrupted. This may also happen at the end of a survey, when the external power is disconnected and the PCMCIA cards are still inserted into the recorder.

Using three alkaline AA batteries as internal power source, the clock can be kept running for about 3,5 hours when RS232 interface is connected to PC, and 6 hours when RS232 interface is not connected.

After a two hour interruption from the external power unit, the voltage of the internal AA batteries drops down to a level, where the automatic switch from internal battery supply to the external power supply may not work properly when the external power is reconnected. An erratic behaviour of the recorder can be avoided by taking out the PCMCIA card or disk shortly before you connect the recorder to the external power supply. By doing this, you switch off supplying power from the internal batteries. The recorder starts its boot procedure and you can insert the PCMCIA card again. Due to an internal capacitor, which buffers some electric power, the recorder does not loose its synchronisation.

Without internal batteries and due to the capacitors on the circuit boards, the GEOLON-MTS is able to keep the synchronization and to resume the recording after a break of the external power supply of up to 75 seconds (45 seconds when RS232 interface is connected to PC).

A ‘low bat’ message will be generated when the input voltage of the **external battery** drops below 6.8 to 5.8 V. The recorder then stops recording and switches to stand-by mode. In this mode, it just keeps synchronization alive at a power consumption of about 17mA. A shut-down function is initiated when the input voltage drops below 4.4 V. This keeps the processor from operating in uncontrolled conditions.

When the external battery drops below the voltage delivered by the internal batteries, the internal batteries cannot take over the power supply, because they spill out their energy to the empty external battery as well as to the recorder. That means, the internal batteries will also drop empty immediately. That is also the case, when for whatever reason the voltage of the external battery drops under 4.4 V for a short moment only.

4.2 Analog Inputs

The GEOLON-MTS has four analog input channels. Three channels are earmarked for connection of a three-component seismometer (see chap. 4.2.1); one channel is prepared for connection of either a Differential Pressure Gauge or a hydrophone and is therefore equipped with an exchangeable preamplifier PCB (see chap. 4.2.2). Please note, that the MTS is adapted to the pressure gauge by default, using a LDR100 PCB. For acquisition of hydrophone data, the piggy-back PCB must be replaced with a LHY100 unit (see chap. 2.3).

4.2.1 Seismometer

The analog signal conditioning for the 3 seismometer channels is identical. The input is a single-ended current amplifier with an input current range of +/- 192 µA for a full-scale signal. Three one-

pole low-pass RC-filters (-3dB @ 150 Hz) give the necessary low-pass response in order to prevent aliasing under all operating conditions.

A current input has been realised in order to be independent from the different output signal levels of different seismometer models. It is best practice to install the series resistor which "converts" the voltage output of the seismometer into the current input for GEOLON-MTS on the seismometer side. This way the underwater cable which connects the seismometer output to GEOLON-MTS input is at "virtual ground" minimising the danger of electrolytic corrosion. Alternatively, this resistor may also be installed inside GEOLON-MTS on custom order.

Pinout of the Seismometer Connector

Pin	Signal	Remarks
1	AGND	Analog ground
2	AGND	
3	AGND	
4	AGND	
5	AGND	
6	AGND	
7	AGND	
8	unused	
9	unused	
10	GND	Power and logic ground
11	+5 V	Seismometer power supply, 25 mA max.
12	-5 V	Seismometer power supply, 25 mA max.
13	GND	
14	GEO_SIG1+	Single-ended input, +/- 192 µA full scale, Z+ seismometer signal.
15	AGND	
16	GEO_SIG2+	Single-ended input, +/- 192 µA full scale, NS+, X+ seismometer signal.
17	AGND	
18	GEO_SIG3+	Single-ended input, +/- 192 µA full scale, EW+, Y+ seismometer signal.
19	AGND	Analog ground
20	GND	Power and logic ground
21	unused	
22	level	Control signal for levelling. 3.3V logic level. See also "Levelling" command in chapter 5
23	GND	
24	GND	
25	GND	

Please note, that in the program SEND2X the first seismometer channel is referred to channel 2, whereas channel 1 is assigned to the hydrophone. Therefore you will find in all SEND2X programs at channel 1 data of the hydrophone, at channel 2 data of the x-component, at channel 3 data of the y-component and, at channel 4 data of the z- component from the seismometer. That is also valid for SENDCOM as far as in the GEOLON-MTS all channels are activated (see also chap. 5.6 “show command”).

Regarding the input sensitivity, there are several adaptations for passive and active seismometers. Especially the MTS-M is adapted to the CMG-OBS40T seismometer of Güralp.

Please get in touch with SEND GmbH for further information.

4.2.2 Hydrophone / Differential Pressure Sensor

For the regular version of MTS, two different types of sensors can be used: hydrophone or differential pressure gauge (DPG), which require different preamplifier modules as shown in the table below:

Sensor Type	Preamplifier Module
Hydrophone	LHY100
Differential pressure gauge	LDR100 and MKT capacitor

(See chap. 2.3 on how to access and change the preamplifier modules.)

The standard MTS model is equipped with LDR100, although the connector for the DPG has been marked with "Hydrophone".

The analog input signals coming from both sensor types are fed into the same 9-pin female D-SUB connector. Since different connector pins are used for different sensor types it is guaranteed that no damage can be caused in case of installation of the wrong preamplifier module. Nevertheless, before using GEOLON-MTS or installing it into a measurement device, be sure that the right preamplifier module (LHY100 or LDR100) is installed, because you will receive no signal with the wrong module. The LDR features a high pass filter circuit which limits the signal to periods smaller than 150s before feeding it into the pre-amplifier.

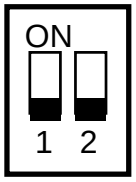
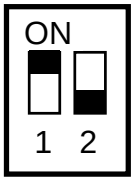
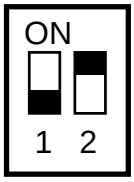
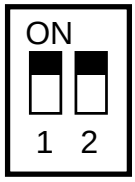
The input sensitivity may be preselected by setting a switch combination on the PCBs LHY100 or LDR100 respectively, see photo in chap. 2.3 to find switch SW1.

Hydrophone:

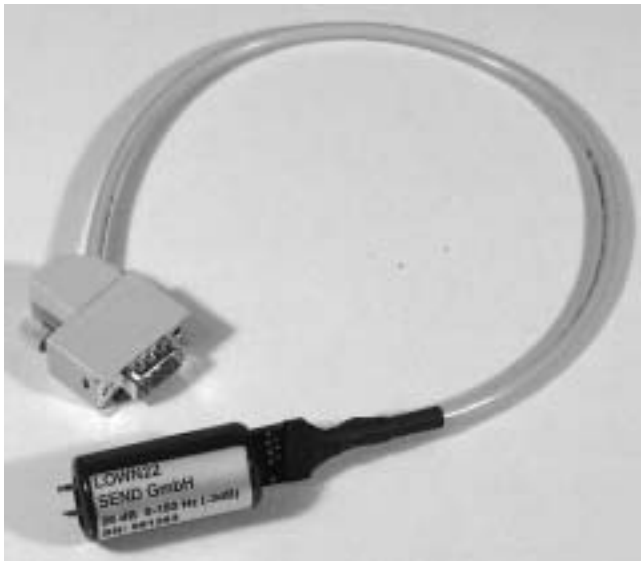
Pinout when using a hydrophone

Pin	Signal	Remarks
1	+5V	power supply for preamplifier module, 10 Ohm series resistor
3	IN	analog input, 0.03 ... 50 Hz, sensitivity switch-selectable (see below)
5	-5V	power supply for preamplifier module, 10 Ohm series resistor
8	GND	
9	GND	

Switch (SW1) positions for input sensitivity selection:

Switch position SW1 on LHY100:				
Input Sensitivity:	1.25 Vss	650 mVss	410 mVss	325 mVss

Note: Most hydrophones deliver very high impedance signals, which have to be preamplified before feeding into GEOLON-MTS. The use of the low-noise preamplifier LOWN22 is recommended which is best adapted to GEOLON-MTS. For connection SEND delivers special cables for different recorders. For the GEOLON-MTS please use only cables with a type label LNC10 and where the 9-pin female D-Sub connector is coloured grey regularily!



Low-noise preamplifier LOWN22 with connector cable LNC10

To suppress the 1/f noise, it is sometimes necessary to move the lower cut off freuqueny to higher frequencies. That can be realised by using a resistor parallel to the inner resistance of the LOWN preamplifier (and between pin 3 and GND of the hydrophone connector). To find the resistor suitable for the cut off frequency of your choice, you may use following formula:

$$R_{par} = R_{lown}/(f_g * C_{hyd} * R_{lown} * 2\pi - 1) \qquad \text{for } f_g > 0{,}1 \text{ Hz}$$

$R_{par:}$ Parallel resistor
$R_{lown:}$ Resistance of LOWN preamplifier
$f_{g:}$ lower cut off frequency
$C_{hyd:}$ Capacitance of hydrophone

E.g.: LOWN21 preamplifier, hydrophone HTI-01-PCA, f_g=0,5 Hz

$$R_{par} = 33M\Omega/(0{,}5Hz * 60nF * 33M\Omega * 2\pi - 1) = 6{,}33\ M\Omega$$

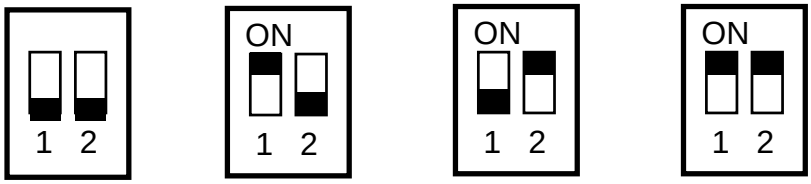
Differential Pressure Gauge:

Pinout when using a pressure sensor

Pin	Signal	Remarks
2	Bridge +	input 2 of pressure sensor
6	Bridge -	input 1 of pressure sensor
7	UREF	power supply for strain-gauge bridge (+5V)
8	GND	
9	GND	

Switch (SW1) positions for input sensitivity selection:

Switch position
SW1 on LDR100:



Input Sensitivity:	266 mVss	133 mVss	92 mVss	66 mVss

4.3 Serial Interface (RS232)

This interface is used for interactive operation with an ASCII terminal (e.g. for programming or parameterisation of GEOLON-MTS). If a modem is used for communication during stand-alone operation the modem can be connected to this interface too.

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

Pin	Signal	Remarks
1	DCD	always true (+5V)
2	RxD	serial data to host
3	TxD	serial data from host
4	CTS, DTR	input from modem or host. Indicates readiness to receive data from the MTS
5	GND	
6	DSR	always true (+5V)
8	RTS	output to modem or host. Indicates request to send data to the modem or host.

4.4 Auxiliary/Absolute Pressure Gauge

This 15-pin female D-SUB connector carries the signal needed for time synchronisation and additional outputs which may be used to control external equipment. All logic inputs and outputs carry TTL-compatible signals. Additionally, it interfaces the serial data from a digital absolute pressure gauge, e.g. Paroscientific sensors.

Pin	Signal	Remarks
1	+6V	output; power supply, 200 mA maximum
2	GND	
3	-DCF77	input for time synchronisation, low-active, 10 kOhm pull-up
7	PRxD	RxD - serial data from absolute pressure gauge
8	PTxD	TxD - serial data to absolute pressure gauge
11..15	GND	

4.4.1 -DCF77 (Pin 3)

This time synchronisation input is used to set the time and date using a DCF77 compatible pulse train. An active low input signal is needed which may be open-collector because a pull-up resistor is connected internally.

An appropriate signal has to be fed into this input when the SYNCHRONIZE, DCF77 or RESYNCHRONIZE commands are executed.

5 Command Description

GEOLON-MTS is controlled by commands, which are transferred via the RS232 interface. This chapter describes these commands, their parameters and their functions. The commands may be issued in any order; several commands may be entered on one line separated by spaces. Parameter settings are stored in non-volatile memory such that the current state will be retained even if power is removed.

Trigger	Tsunami Detection (MTS-M only)	31

5.1 Help

Each command is accompanied by a short help text line which briefly explains its use. To display the help text, the command must be preceded by a question-mark.

E.g. ?RATE <cr> displays
<n> RATE sets the effective sampling rate of the system
N may be between 1 and 200

5.2 Information

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

?
displays a list of all commands.

COMMENT <string>"
Defines <string> as a comment. It may be up to 40 characters long. <string> is terminated by either a " or <cr>. The same result is generated by ExpComment in the PASSCAL sub-menue.

EXPERIMENT <string>"
defines <string> as experiment name. It may be up to 24 characters long. <string> is delimited by either a " or <cr>. The same result is generated by ExpName in the PASSCAL sub-menue.

<key1> <key2> <n> LICENSE
activates software option <n>. When LICENSE is executed without parameters it displays the options which have been activated.

PASSCAL?
reports the setting of the PASSCAL description strings (only in PASSCAL menu).

SETTINGS
reports the actual setting of all configurable parameters. See the example in chap. 7.5

5.3 Acquisition Control

While GEOLON-MTS is in command-mode (before executing the REC command), the A/D converter parameters may be set.

<string> CHANNELS

activates the channels to be recorded. Valid strings for this command are:

3 or seismometer activates 3 channels for a 3-component seismometer

1 or hydrophone activates 1 hydrophone or DPG channel only

depths only available for recorder version MLP (or MLS 13, for depth sensors). The "depths" command replaces the "hydrophone" command and the "1" command activates the depths sensor channel only

all activates 3 channels for seismometer and 1 channel for DPG or hydrophone.

END

finishes a recording sequence. All data buffers are saved on the storage cards and GEOLON-MTS returns to command mode. Now power may be removed without loss of data.

LOAD

loads the file **MLS.SYS** of the storage card in slot 1. This file may contain any sequence of commands and loading this file is equivalent to typing all the information in. The size of the file is limited to 16k max. and it may be generated using a program editor on the PC and, after editing the file, copying it to the storage card.

When the SKEW command is executed, statistics about the recording sequences, time-of-synchronisation etc. will be appended to the command file of **MLS.SYS**.

When a storage card is present in slot 1 upon power-on, **MLS.SYS** will be loaded automatically when it is present.

<n> RATE

determines the sampling rate <n> in samples per second. n may be between 1 to 50 (standard) or between 1 to 200 when the 200_Sps option has been activated.

The -0.1 dB bandwidth of the highest signal frequency which may be reconstructed without aliasing is approximately 1/3 of the sampling rate. The actual sampling rate used may be slightly different from <n> and can be checked using the SETTINGS command.

REC

puts GEOLON-MTS 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 PASSCAL description strings as well as the time of synchronisation.

5.4 Time Services

Synchronisation is performed using a DCF77 compatible pulse train (see chap. 4.4). During periods of interruption of the external power supply, synchronisation will be maintained by the internal battery (see chap. 4.1). If no battery is present, synchronisation will be lost.

DCF77

synchronises the internal time base. A DCF77 pulse coded signal must be connected to Pin3 (active low) of the auxiliary connector.
During the synchronisation process following information is displayed:

press ctrl-C to abort
Waiting for a synchronisation pulse....
synchronized
These three messages will be displayed shortly after entering the DCF77 command.
Now, the synchronization procedure is looking for the next following minute signal in the DCF77 pulse train. After recognising it, the third line will continued by:

synchronized - time and date: - <sec> - <min> - <hour> - <day> - <month> - <year>
The complete synchronisation process may take up to 2 minutes due to the slow DCF77 pulse pattern.
The synchronisation is finished when the DCF77 procedure tries to format the PCMCIA flashdisks or microdrives.

(NB: No storage cards may be added or removed after time synchronization, otherwise proper operation is not guaranteed. If it is be necessary to add or remove storage cards, the FORMAT, DCF77 or SYNCHRONIZE command must be executed again prior to recording.)

DRIFT

Determines the deviation of the internal clock from DCF77 time. This is similiar to the SKEW command, but does not close the disks and does not write the deviation value to the MLS.SYS file.

EVERY <n1> SECS <n2> MINS <n3> HOURS <n4> DAYS AFTER <n5> SECS <n6> MINS <n7> HOURS <n8> DAYS LEVELLING

activates the levelling signal on Pin22 of the seismometer connector <n5> seconds and <n6> minutes <n7> hours <n8> days after REC has been executed for the first time and repeats it every <n1> seconds <n2> minutes <n3> hours and <n4> days. The levelling signal is activated (+3.3V output, see also paragraph 4.2.1) for 20 minutes.

If this command is not used (default), the levelling signal is activated once 3 hours after executing REC without repetition.

The parameters <n1>-<n8> have to be integer values or zero. It is possible to skip some commands, when only a part of the command is needed. For example, “AFTER 2 MINS LEVELLING” starts the levelling once 2 minutes after start of recording.

SKEW

determines the deviation in milliseconds of the internal oscillator and clock circuitry w.r.t. an external DCF77 compatible signal on the -DCF77 input pin.

After entering the SKEW command following information is displayed:

press ctrl-C to abort

skew locked
While displaying that, the skew procedure is looking for the next following minute signal in the retrieved DCF77 pulse train. After recognising it, the second line will continued by:

Skew locked - time and date: - <sec> - <min> - <hour> - <day> - <month> - <year>
The complete retrieval of DCF77 information may take up to 2 minutes due to the slow DCF77 pulse pattern.

After determining the time deviation the data files of the storage cards are adjusted to reflect the actual file length used and the recording parameters and error messages are written to the **MLS.SYS** files on all storage cards.

See also chap. 0 and 6.3.

<day month year hour minute second> SYNCHRONIZE
synchronises the internal clock to an external synchronisation pulse. The pulse must be applied to the -DCF77 input (high-to-low transition). The time and date information entered as numbers before the command will be the time and date to which GEOLON-MTS will be set by the synchronisation pulse.

5.5 PCMCIA Module Services

CLOSE
The data files on the current set of storage cards are adjusted to reflect the actual file length used and the recording parameters and error messages are written to the **MLS.SYS** files on all storage cards (similar to SKEW without time deviation determination).

FORMAT
All PCMCIA slots are checked for the presence of storage cards and their capacity is recorded. After this configuration step has been finished successfully all error messages that may have been stored in the message queue are erased, and the system is ready to record data.

Please note that no storage cards may be added or removed after formatting, otherwise a proper operation is not guaranteed. If it is necessary to add or remove storage cards the FORMAT, DCF77 or SYNCHRONIZE command must be executed again prior to recording.

<n> REPAIR
If a read error has been reported, this command may be used for repair. <n> is the slot number of the affected disk.

5.6 Accessing Data

<string> SHOW

displays data of channel <string> on the PC using program SENDCOM (for details, please see the SENDCOM manual in the appendix). SHOW may be used to check the proper operation of the sensor electronics prior to starting an experiment. ^C (ctrl-C) will terminate the command. <string> selects the channel to be displayed:

seismometer1	displays data of seismometer channel 1 (pins GND/14, reg. z-Comp.)
seismometer2	displays data of seismometer channel 2 (pins GND/16, reg. X-comp.)
seismometer3	displays data of seismometer channel 3 (pins GND/18, reg. Y-comp.)
hydrophone	displays data of hydrophone/DPG channel

It is also possible to use numbers only to display the data of the channels. For example:

1 SHOW displays data of channel 1, which are acquired by the DPG or hydrophone when all channels in the MTS are active or it displays data of the first seismometer component when only the seismometer is activated by the channels command.

Note: The show command cannot be used to display data received from the Digital Absolute Pressure sensor. For testing the Absolute Pressure sensor, please list the settings: The current pressure value will be displayed after the status line to indicate proper operation and communication with the pressure sensor (see also the example in chap. 7.5).

5.7 Definition of PASSCAL 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 into the PASSCAL data file on conversion.

PASSCAL

enters the PASSCAL sub-menu which allows the definition of the following character strings which are defined according to the PASSCAL file standard. These parameters can only be set once for an entire measurement campaign.

EXIT

leaves the PASSCAL sub-menu returning to the main menu.

<n> ExpNumber

sets the Experiment-Number. <n> may be up to 2 digits long.

ExpName <string>"

defines <string> as Experiment-Name. <string> may be up to 24 characters long and it is delimited by either " or a <cr>. The same result is generated by EXPERIMENT.

ExpComment <string>"

defines <string> as Experiment-Comment. <string> may be up to 40 characters long and it is delimited by either " or a <cr>. The same result is generated by COMMENT.

<n> StatNumber
sets the Station-Number. <n> may be up to 4 digits long.

StatName <string>"
defines <string> as Station-Name. <string> may be up to 24 characters long and it is delimited by either " or a <cr>.

StatComment <string>"
defines <string> as Station-Comment. <string> may be up to 40 characters long and it is delimited by either " or a <cr>.

<n> ChanName <string>"
defines <string> as Channel-Name of the <n>th channel. <string> may be up to 10 characters long and it is delimited by either " or a <cr>. <n> may be between 1 and 4.

<n> ChanSensor <string>"
defines <string> as Channel-Sensor model description of the <n>th channel. <string> may be up to 12 characters long and it is delimited by either " or a <cr>. <n> may be between 1 and 4.

<n> ChanSensorNumber <string>"
defines <string> as Channel-Sensor serial Number of the <n>th channel. <string> may be up to 12 characters long and it is delimited by either " or a <cr>. <n> may be between 1 and 4.

<n> ChanComment <string>"
defines <string> as Channel-Comment of the <n>th channel. <string> may be up to 40 characters long and it is delimited by either " or a <cr>. <n> may be between 1 and 4.

5.8 GEOLON MTS-M: Tsunami Detection

In the GEOLON-MTS-M a program is implemented, which looks for long term changes in the absolute pressure data indicating a Tsunami.

The required pressure data is retrieved in periods of 15 seconds from the absolute pressure sensor. In the current version, the MTS-M is adapted to a digital pressure sensor from Paroscientific.

The algorithm holds all pressure values of the last three hours plus the length of one time frame (**mean window**). The length of the mean window is freely selectable. All values in the mean window that are past the current time, are averaged continuously. Respectively, averaging is also done for values from 1, 2 and 3 hours ago. The factory setting for the mean window is 10 minutes. During averaging, the largest and smallest values are eliminated to suppress outliers.

The values from mean window averaging are used to calculate a prediction value according to Lagrange´s extrapolation method. The weighting values required for this have been taken from the DART-Algorithm and are stored in variables **W0 to W3**.

The absolute value of the difference between the current pressure value and the prediction value is then compared to a freely selectable threshold value. The value of the variable **COUNT** is used to determine how often the **threshold** value should be exceeded consecutively until a tsunami event is being reported via the acoustic modem. This prevents consecutive outliers in the data from triggering a tsunami event.

Additionally, the algorithm is coupled to the levelling signal of the seismometer. The time for the initial levelling of the seismometer can be set freely and at this point in time, the tsunami detection algorithm also starts. The levelling signal can even be used for starting the tsunami detection algorithm at any selected time if there is no seismometer connected at all.

After the tsunami algorithm has been started, data is being collected plus the length of the mean window without calculating a prediction value and without doing threshold value comparison. This time delay is necessary to gather sufficient data for calculating the prediction value. In conjunction with the levelling command, this ensures that valid pressure data are present which have not been disturbed by noise from the descending phase of the OBU.

The following commands can be used to set the described parameters.

<n> BLOCKSIZE

BLOCKSIZE sets a Variable for byte counting that determines how often a synch mark, followed by a sample count and an absolute value, is inserted into the <sample data> data stream between MTS-M and OBUD.

BLOCKSIZE should be adjusted to match the size of the acoustic modem´s packets, which are the smallest entity for forward error correction in the modems.

The minimum block size is 12 bytes due to the length of the (irregular) record header, which will be transferred error free by definition.

<n> BLOCKTIME
BLOCKTIME sets the duration in second for which tsunami triggering is inactive after a tsunami trigger event has been reported.

<W0> <W1> <W2> <W3> COEFFICIENTS
COEFFICIENTS sets the coefficients for the tsunami trigger algorithm and shows the new values. W0-W3 must be entered as values multiplied by 1,000,000 (One Million), eg: 0.6 has to be entered as 600,000.

<n> COUNT
COUNT sets the number of successive tsunami triggerings that have to occur before a tsunami triggering event is being reported.

<n> MEANWINDOW
MEANWINDOW sets the period for averaging of data (mean window) for the tsunami trigger to <n> seconds and shows the new setting. The values of <n> can be multiples of the pressure sample period only. ?MEANWINDOW will display the current pressure sample period.

<n> THRESHOLD
THRESHOLD sets the threshold value for tsunami triggering to <n> tenth of hPa and shows the new setting.

Please note: All settings related to tsunami detection are being stored in non-volatile memory and will only be reset to defaults upon reloading firmware or factory default reset.

TRIGGER
TRIGGER displays all settings related to tsunami detection which have been set with the commands in this chapter.

See also chapter 11 for a flow chart of the tsunami trigger algorithm and the default values stored in the MTS-M.

5.9 GEOLON MTS-M: OBU/Buoy communication

The MTS-M version for tsunami detection can communicate with a surface buoy via an acoustic modem. A customized program (e.g. SEND´s OBUD program for the project) running on the buoy´s computer can request several data sets from the Ocean Bottom Unit (OBU), the OBU itself just reports assumed tsunami events on it's own and otherwise only responds to OBUD requests.

The following messages use a simple form of data compression when the data is transferred across the acoustical modem or the radio satellite link in order to minimize power consumption. It has to be de-compressed again in the data center.

Predominantly, absolute pressure data will be transferred with a resolution of 10 Pa (0.1 mBar) per bit and therefore, 24 bits will suffice for 8300m water depth. Absolute pressure will be sampled every 15 seconds.

Messages start with an escape sequence repeating the command as a handshake signal. In most messages this handshake sequence is followed by a 16 bit length field quantifying the number of following bytes, and a 32 bit time stamp that relates to the first pressure sample that follows. The length includes the length of the time stamp (4 bytes).
In the following text, "command" is used for byte sequences, which are transferred from the OBUD to the OBU. "message" is used for the byte sequences, which are transferred from the OBU to the OBUD.

5.9.1 Endianess

All data is big-endian.
16 bit: b15...b8 || b7...b0
24 bit: b23...b16 || b15...b8 || b7...b0
32 bit: b31...b24 || b23...b16 || b15...b8 || b7...b0

5.9.2 Compression method

Whenever the difference of the present pressure sample compared to the previous sample fits into a 7-bit 2-s complement number, it will be stored as a byte whose most significant bit is set to serve as a tag bit. When it does not fit or if it is the first sample of a record, the pressure data will be stored as a 24 bit number whose most significant bit will be zero (tag bit).

5.9.3 Timing and data transfer

All time stamps relate to the internal time of the OBU, whose time base will be GPS (DCF77) synchronised to UTC prior to deployment. The OBU time may deviate up to 1.5 seconds/year. The time base can not be re-synchronised during the mission due to the imprecision of the acoustical modem channel. Therefore, the time deviation between the internal OBU time and absolute GPS time can only be determined in the data center by comparing seismic events that can be aligned to its equivalent event of another sensor with more accurate timing.

Due to bad weather conditions the acoustical modem transfer may take a long time or not be possible at all. It can not be guaranteed that a data record spanning a certain time interval can be transferred in that time span. As a consequence, a heap of as-of-yet un-transferred data may build up in the OBU's pressure queue. Therefore, the time span transferred in one Pressure Data message is variable, extending from the first sample that has not been transferred yet up to the most recent sample.

5.9.4 Modem Failure

Due to a number of reasons, modem communication may not be possible and therefore, commands may not be able to reach the OBU. In such a case the modem that discards a message responds with

Message: <esc>ABORTED<cr><lf>

5.9.5 Tsunami Alert

When the tsunami trigger detection is not in its hold-off period and the tsunami trigger algorithm detects a tsunami, a tsunami alert message will be actively sent to the buoy and the tsunami trigger detection will be disabled for a hold-off period of three hours. During the hold-off period the tsunami trigger detection algorithm will continue to run, but alert messages will not be transferred to the buoy. If a message is being transferred while a tsunami trigger occurs, the OBU waits for the message transmission to comple before sending the tsunami alert.

When a tsunami is detected, the tsunami pointer as well as the pressure data pointer will be set to point to the latest sample in the pressure queue. Those samples preceeding the tsunami pointer constitute the pre-trigger Pressure History. At the end of the hold-off period (3 hours after tsunami detection), the tsunami pointer will be reset to zero.

Message: <esc>\TA<cr><lf><time-of-tsunami-detection>

The Tsunami Alert messages also will be stored in the non volatile memory of the recorder that holds system and error messages. After retrieval of the unit, the SKEW command or the END and CLOSE commands will read the messages and write them to the MLS.SYS file.

In case of an unexpected end of the recording due to power loss or low power, the error messages will be displayed at next boot up, along with any Tsunami Alert messages. This information then can be saved to the PC using SendCom with the “FILE-Save Logfile” Option.

5.10 Commands

All command descriptions in chapter 5.10 only refer to the OBUD buoy computer program for the GITEWS as an Example. The OBUD software itself is not supplied with the Geolon MTS-M by default

5.10.1 Averaged Pressure Data

When the OBUD is in "Capturing Normal Mode", averaged pressure data will be requested by the OBUD every hour. 20 suceeding pressure samples will be averaged to yield 5 minute averages. All samples from the first one that has not been transferred yet up to the most recent averaged sample will be transferred. When no pressure data has been requested or no Tsunami Alert has been raised for more than 3 hours, the pressure data pointer will be reset to point to the present time and therefore, no pressure sample will be transferred in this message.

Command: AP<cr>

Message: <esc>\AP<cr><lf><length><time-of-first-sample><averaged pressure samples>

Total length for 1 hour: 26 bytes.

5.10.2 Pressure History

When the OBU has transferred a tsunami trigger, the data center may retrieve pre-trigger pressure data in order to fully replicate the tsunami trigger condition. 3 hours and 10 minutes of pre-trigger pressure data @ 15 seconds sampling rate will be transferred. When the tsunami pointer is zero, because no tsunami had been detected since the end of the most recent hold-off period, the most recent history will be transferred and the pressure data pointer will be reset as well.

Command: PH<cr>

Message: <esc>\PH<cr><lf><length><time-of-first-sample><pressure samples>

Total length: 774 ... 800 bytes.

The PH command will return tagged data in order to do error recovery on missing samples due to acoustic modem transmission errors.

The data types for the PH records are as follows:

Data type	bytes	tagged data
Absolute Value	3	0vvv vvvv vvvv vvvv vvvv vvvv
Differential Value	1	10dd dddd
Sample Counter	2	110c cccc cccc cccc
Synch Mark	2	1110 0000 1111 0000
Corrupted data	1	1111 1111
Undefined	1	all other patterns

The <pressure data> starts with an absolute value, which is sample number zero. The Sample Counter is the count of the next sample following.

One PH record always transfers 760 samples.

Whenever mod(current size, blocksize) is less than three, a Synch Mark, Sample Count and Absolute Value are inserted as the “beginning of the next block”.

The minimum block size is 12 bytes due to the length of the (irregular) record header, which must be transferred error free by definition.

5.10.3 Pressure Data

When the OBUD is in "Capturing Tsunami Mode", pressure data @ 15 seconds sampling rate will be requested by the OBUD every 2 minutes. All pressure samples from the first one that has not been transferred yet up to the present sample will be transferred. When no pressure data has been requested or no Tsunami Alert has been raised for more than 3 hours, the internal pressure data pointer will be reset to point to the present time and therefore, no pressure sample will be transferred in this message.

Command: PD<cr>
Message: <esc>\PD<cr><lf><length><time-of-first-sample><pressure samples>
Total length for 2 minutes: 22 bytes.

5.10.4 Seek Seismic Data

When the data center requests a seismic data section starting at a certain time and date, this command sets the seismic data pointer appropriately. A seismic sequence record header will be transferred.

Command: <MTS-second> SS<cr>
Message: <esc>\SS<cr><lf><length><record header>
Total length: 26 bytes.

5.11 Seismic Data

After the seismic data pointer has been set using Seek Seismic Data, this command will transfer 1 second of seismic and pressure data in the internal Geolon-MTS data format and advance the seismic data pointer. This command must be used repetitively until the amount of data requested by the data center has been transferred to the buoy. SEND2X must be used later on to de-compress the data.

Command: SD<cr>
Message: <esc>\SD<cr><lf><length><compressed seismic data>
Total length: Typically 350 bytes.

5.12 Tsunami Detect

The OBU may detect a false tsunami event e.g. because of a passing thunderstorm system. This will put the OBU into its tsunami hold-off period and therefore, the OBU would be "tsunami blind" for the next three hours. The data center may override the hold-off and put the OBU back into tsunami detection mode immediately.

Command: TD<cr>

Message: <esc>\TD<cr><lf>

5.13 Ping

This command is used to validate that the modem link is operational.

Command: PI<cr>

Message: <esc>\PI<cr><lf><state-of-health><cr><lf>

<state-of-health> may be as follows

Message	**Description**
cards closed	data recording has been finished
cards full	data recording has been finished due to insufficient disc space
not active	not recording
battery low	data recording finished due to low battery
recording	normal recording state
firmware error	severe, non servicable error

6 System Responses

6.1 Interactive Operation

6.1.1 List of Messages

INFORMATION FOR THE USER
System
- (0) space key detected
- (1) loading *.MTS-file
- (2) loading MLS.SYS-file
- (5) unrecoverable error, shutdown

Self-check
- (11) card-access is stuck, rebooting
- (12) REC-command is stuck, rebooting

Error-recovery
- (20) resuming recording
- (21) finishing recording
- (22) trying to restore settings
- (23) settings restored, rebooting
- (24) boot_delay
- (25) abnormal termination, files not adjusted
- (26) depth sensor not responding, MTS requested data again

USER-ERRORS
Invalid parameters
- (30) range 1 to 12
- (32) mask requires numeric input
- (33) invalid option number
- (34) sample rate not supported
- (35) out of range
- (36) range 1, 3, or 4
- (37) range 1 to 4

Invalid status
- (40) not synchronized
- (41) not while recording
- (45) disks have been closed
- (46) has not been licensed
- (50) needs a parameter
- (51) no card found
- (52) can't format any cards
- (53) insert disk in slot #1 first
- (55) mask can only be used from terminal
- (56) channel not active

Out of capacity
- (60) cards full
- (61) battery low
- (62) data not available

UNLIKELY-ERRORS (indicating hardware trouble):

(70) card write error
(71) card read error, rebooting
(72) can't access card, rebooting
(73) directory corrupted, rebooting
(74) repairing bad sector
(75) skipping data due to slow card
(77) ADC-converter not present, rebooting

INTERNAL-ERRORS (Please give information to SEND):
(80) directory overflow
(81) card out of range, rebooting
(82) no more buffers, rebooting
(83) illegal geometry, rebooting
(85) init adc-seconds failed

6.1.2 Explanation of Error Messages

(0) If - for any reasons - you have problems communicating with the MTS command-line interface, hold down the SPACE-key while resetting the MTS and then deny to "abort escape-boot-sequence"(type **n**o) and afterwards confirm to "ERASE MTS-STATE"(type **y**es). This will reset all non-volatile variables (except the PASSCAL configuration and tsunami trigger settings). If this is of no help, please follow the instructions of chapter 9.1.

(1) To update the firmware disconnect power for 5 minutes until the GEOLON-MTS is unsynchronised and put a PCMCIA-card with a firmware-update file (*.MTS) in slot #1. The update will be performed in two steps:
1. The version- and ROM-number will be checked whether an update is sensible and possible; in this case the old firmware will be erased.
2. If no firmware is present the new firmware will be loaded. Due to this procedure message (1) appears three times.

(2) To download measurement-programs automatically, remove power for 5 minutes until GEOLON-MTS is unsynchronised and put a PCMCIA-card with measurement-program file (MlS.SYS) in slot #1. If the previous recording was finished with the SKEW command GEOLON-MTS will attempt to download and execute the measurement-program file (otherwise use LOAD). If no measurement-program is defined and started GEOLON-MTS will enter interactive mode.

(5) After several reboots without writing any data to disk GEOLON-MTS shuts down. This may result from missing or defective PCMCIA-cards, measurement programs with syntax errors or hardware defects.

(11 to 12)
A hang-up of an internal task has been detected caused by either time-out or a reported error-condition. GEOLON-MTS will be reset autonomously and resume recording.

(20) GEOLON-MTS was reset during recording. The record time-window is not yet over, so recording is resumed. Attention: a certain amount of data could be missing. Please inform SEND about this reset.
(21) GEOLON-MTS was reset during recording. The record time-window is over, so recording is finished.

(22) After several resets in vain GEOLON-MTS tries once to rebuild its internal state completely.

(23) system restoration is over, rebooting system.

(24) system reboots cyclic; the delay between the attempts is increasing exponentially to save Flash-cards from reaching their maximum write-count early. Press RETURN anytime to skip such boot delays.

(25) something went wrong during recording, the files won't be truncated to allow to save any data which may be on the disks to a PC for later examination and recovery

(26) depth sensor did not respond to data request, GEOLON-MTS has sent new request

(30) your PCMCIA slot parameter was out of range.

(32) you should only enter numbers and displayed delimiters for the timemask.

(33) Licence key not valid

(34) your rate-parameter was out of range.

(35) time deviation was out of range. Perhaps an indication that synchronisation was lost.

(36) your analog input channel parameter was out of range.

(37) your channel parameter for show function was out of range

(38) minimum block size for PH is 12

(40) the command you entered needs a synchronised timebase (via DCF77).

(41) you can't change record-parameter while recording.

(45) you can't record any more after you executed SKEW.

(46) you did not license this feature

(50) refer to command description for syntax-details.

(51) you should insert any cards before entering DCF77 or SYNCHRONIZE.

(52) login of any cards failed due to old unsaved data on some disks. Execute DCF77 or SYNCHRONIZE manually to find the offending card.

(53) enter a card in slot #1 to download measurement programs via LOAD**.**

(55) you can't read any user entry within a measurement program.

(56) you can't watch data from a channel, which is not activated by CHANNELS.

(60) all disks are full of data, you can't record anything more.

(61) detection of low voltage: the system will interrupt recording immediately and store data left in the buffers including the directory before entering sleep mode until the voltage is in nominal range again.

(62) a date and time has been specified for the RETRIEVE command for which no data is available on the current set of storage cards.

(70) A write error of the PCMCIA-card occurred. You may have reached the end of the lifecycle of your card. Check your PCMCIA-card on the PC with a vendor-specific service-program.

(71) A read error of the PCMCIA-card occurred. This typically happens after a sudden power failure during writing. GEOLON-MTS itself will try automatically to repair such sectors after it encountered them. If this fails you get this message, probably the controller of the card has crashed, otherwise the card itself may be worn out.

(72) Very unlikely read error of the PCMCIA-card's identify sector. The card may have hung up due to hot plugging or bad contact. Eject and insert PCMCIA-card, reset GEOLON-MTS and try again.

(73) Invalid data in the assumed directory block. This error will occur if you change PCMCIA-cards after formatting. Reformat disks.

(74) Trying to repair a sector with wrong CRC-sum, this might lead to further trouble if the directory block was concerned.

(75) the write-performance of the PCMCIA-card is not sufficient to record all data. GEOLON-MTS switches to halt temporarily to provide big blocks of valid data (instead of skipping single samples).

(77) no data provided by the A/D-module, check whether it is attached firmly.

(80) you exceeded the maximum of 8000 recordings per PCMCIA-card, this is probably due to a corrupted directory.

(81) The software tries to access non-existent slots or sectors. This error will occur if you change PCMCIA-cards after formatting. Reformat disks.

(82) The system does not provide enough buffers. This error should never occur. Reload firmware.

(83) Illegal sector, heads or cylinder numbers in the identify sector. The card may have hung up due to hot plugging or bad contact. Eject and insert PCMCIA-card, reset GEOLON-MTS and try again.

(85) Please contact SEND support

6.2 Stand-alone Operation

Operation without PC is supported by the green LED in the front plate between the RS232 and auxiliary connector. The meanings of the blink signals are as follows:

Signal	Meaning of signal
————————	(continuously ON) ready for operation
·_ _ ·_ _ ·_ _	(Morse alphabet: W) waiting for synchronise pulse
··· ··· ···	(Morse alphabet: S) waiting for DCF77 synchronisation
··_· ··_·	(Morse alphabet: F) failure: old data on disk which are not saved
_ _ _ _ _ _	(Morse alphabet: O) formatting finished (ok); signal continues until next command causes change of signal
Flickering	access to storage cards
·····-·····	(continuously short, twice a second) recording

6.3 Error Indication

If an error occurs during a measurement campaign, an error message will be stored in non-volatile memory. Each message includes the time and date, the task in which the error occurred and a brief error description.

If GEOLON-MTS is reset or if it is switched on after an error, an error report is displayed following the sign-on message. After the report, the user may choose to erase the report or retain it in non-volatile memory for a later time by answering "y" or "n" to the prompt.

When the CLOSE or SKEW command is executed upon termination of an experiment, all error messages are displayed and appended to the file **MLS.SYS** on the storage card in slot 1.

7 Description of a Typical Operation Session

7.1 Interactive Operation via External PC

7.1.1 Software Preparation

Install the software from the disk delivered with GEOLON-MTS on your PC. The different programs are described in chap. 3. **SENDCOM** is used for communication via the RS232 interface, e.g. for interactive configuration of GEOLON-MTS. **SEND2X** is used for conversion of recorded data into several formats.

7.1.2 Hardware Preparation

Due to the modular design of GEOLON-MTS with regard to the sensor interface (e.g. seismometer, hydrophone or pressure sensor etc), the user has to check whether GEOLON-MTS is equipped with the correct analog input modules. Usually the front plate should be labelled accordingly. If not, the instrument has to be opened as described in chap. 2.3 in order to get access to the analog PCB. The codes for the different sensor specific A/D converters are listed in chap. 4.2. Please make sure that the correct PCBs for seismometer and if necessary, for a hydrophone or a pressure sensor are installed. If a hydrophone or a pressure sensor is to be used the switches for the preamplifier gain preselection have to be set according to chap. 4.2.2.

After closing the front plate as described in chap. 2.3 the cable connections can be installed:

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

Connect GEOLON-MTS to the external power supply specified in chap. 4.1.

Connect the auxiliary signals necessary for your measurement project to the interface described in chap. 4.4. Connect at least the input for the time synchronisation (Pin3).

7.1.3 Preparation of a Measurement Campaign

The necessary storage cards have to be inserted into the slots of GEOLON-MTS always starting at slot 1. The capacities of the storage cards should be sufficient for the predicted duration of the measurement campaign; otherwise the recording will be prematurely terminated.

(Note: The storage cards will always be repartitioned and reformatted during initialisation on GEOLON-MTS to ensure a defragmented file-system. GEOLON-MTS will preserve the integrity of the MLS.SYS configuration file.)

A measurement campaign is prepared by using the commands described in chap. 5. In particular the following parameters must be set:

- sampling rate
- how many and which channels should be activated
- levelling condition (if needed)

It is recommended to add some descriptive information:

- PASSCAL character strings for experiment documentation like definition of sensor types used and sensor specific parameters

Configuration data are stored in non-volatile memory and remain available even after power down.

Before starting the data recording a time synchronisation according to chap. 5.4 has to be executed. The internal battery assures that GEOLON-MTS will not lose its time synchronisation while external power has been removed during experiment preparation.

Removal, exchange, or adding of storage cards is not allowed after formatting (because GEOLON-MTS holds a copy of the disk parameter block and the disk state in its non-volatile memory). If it should be necessary to make any PCMCIA-card changes, you have to repeat the time synchronisation by either the command DCF77 or SYNCHRONIZE (which both include the disk-initialisation), or by means of the FORMAT command, before any data recording can be started. The benefit of this process is that all PCMCIA-cards, which were used during a recording session, contain a unique ID consisting of a timestamp and the serial number of the specific GEOLON-MTS used.

The REC command puts GEOLON-MTS into recording mode, using the parameters defined before or the settings of the last recording (default values), respectively.

7.1.4 Closing an autonomous recording session

The autonomous recording session is described in chap. 7.2. The formal closing is executed interactively after having connected DCF77 to GEOLON-MTS and GEOLON-MTS to the PC again.

The SKEW command determines the deviation of the internal oscillator compared to a DCF77 signal on the -DCF77 input pin. After determining the deviation, the data files on the current set of storage cards are adjusted to reflect the actual file length used and the recording parameters and error messages are written to the **MLS.SYS** file on each card.
Thereafter, the cards may be removed.

7.2 Stand-Alone Operation without PC

GEOLON-MTS is designed for stand-alone data recording following a previously defined configuration and parameterization, which can be performed either interactively as described above or by using **MLS.SYS** on the storage card in slot 1.

After executing the preparatory tasks as described in chap. 7.1.3, GEOLON-MTS may be installed in the fixture for stand-alone operation, and external power should be connected as soon as possible due to the limited capacity of the internal batteries. Also the measurement sensors have to be connected to the activated and configured analog input channels. If a hydrophone with preamplifier (e. g. LOWN22, see note in chap. 4.2.2) is used, only cables with a grey connector shell should be used.

Data recording will be performed according to the actual parameters or until either the storage cards are full or the battery is discharged to the low-voltage threshold. In any case, GEOLON-MTS will finish the recording, writing all data remaining in internal buffers on the PCMCIA-disks before it shuts down. The power consumption during shutdown is reduced to a minimum because only the internal time base is maintained. This normally allows you to execute the SKEW command later on.

Operation without PC is supported by the green LED on top between the connectors for RS232 and Auxiliaries. The meanings of the blink signals are described in chap. 6.2.

7.3 Analysis of Recorded Data

After data recording, the storage cards can be played back using a PC with PCMCIA interface and the SEND2X software. This software generates several file formats on any mass storage device of the PC and thus enables analysis and evaluation of recorded data by means of any suitable program.

7.4 Brief Description for Experienced Users

For users who have already experience with the operating instructions as described in chapters 7.1 to 7.3 the following short description may be a useful; it may also be used as a check-list.

1. Plug in all PCMCIA modules
2. Connect DCF77
3. Connect external power
4. **MLS.SYS** file is read;

Standard contents: **50 RATE**
DCF77
REC

1. Wait until synchronisation is completed and recording starts
2. (LED signal: continuous short)
3. Disconnect DCF77.

---------(Take note of step 4-9 only if you like to handle the MTS without a connection to the external power supply) ----------

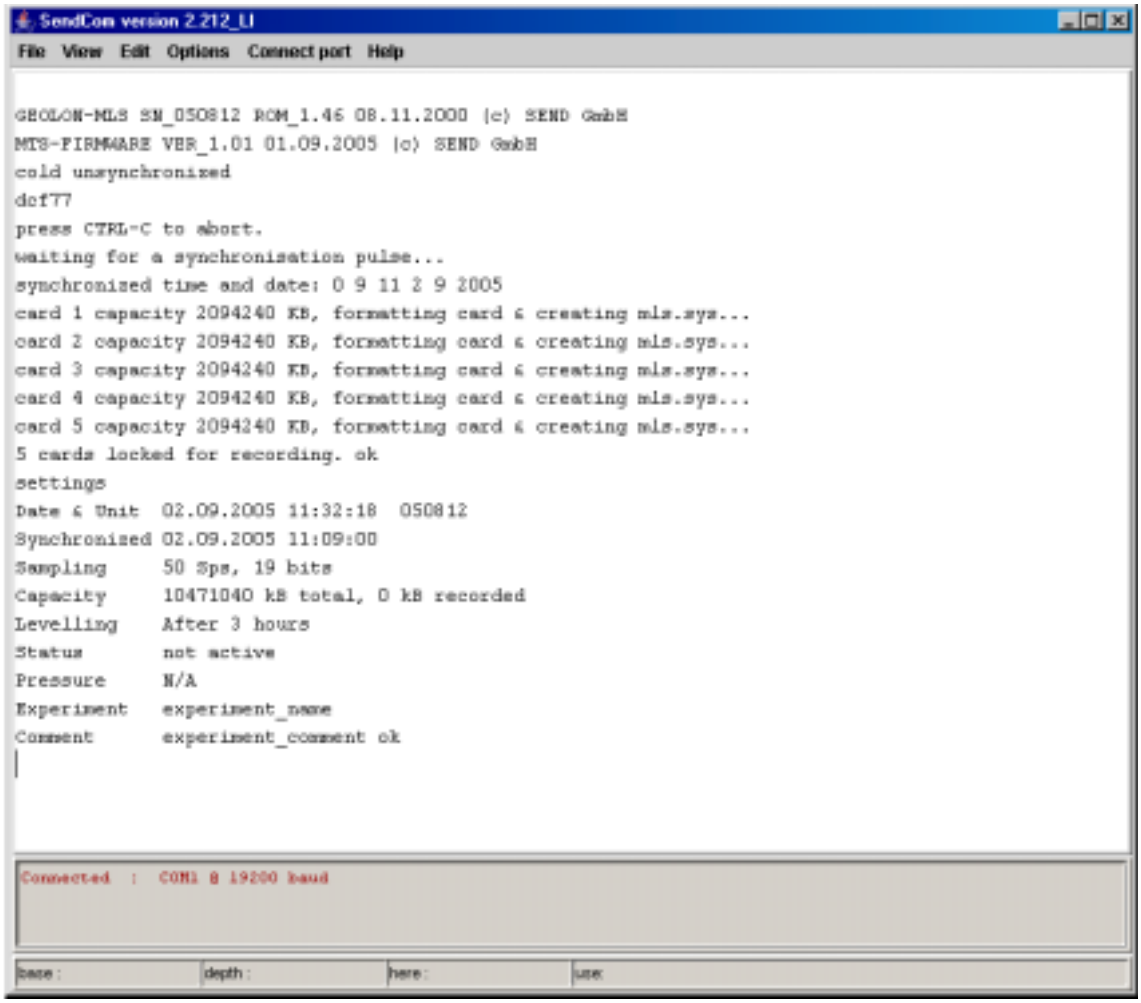
4. Insert three new AA cells into the compartment for internal batteries.
5. Disconnect the external power.
6. The MTS is now ready for independent handling.
7. Carry out all installation work required for experiment preparation.
8. During this time, the MTS is powered by its internal batteries.
9. Switch on or connect external power: REC is restarted.

---

10. Time counting for levelling starts from 0 (again).
11. Normally now the mission is executed.
12. After completion or interruption of the experiment, GEOLON-MTS is recovered.
13. Connect DCF77.
14. Connect RS232 link to PC.
15. Start SENDCOM.
16. Issue END and SKEW.

7.5 Examples for Interactive Operation

7.5.1 Interactive Preparation of an Autonomous Recording Session



1 Response after switch-on GEOLON-MTS (Series-Nr. and installed firmware)

2 Response after synchronisation pulse

3 Formatting of all inserted PCMCIA-cards (5 cards are inserted)

4 Command SETTINGS followed by a report of actual parameters; this command is issued here just to display the parameters. If the MTS is connected to an absolute pressure sensor, the current pressure value will be displayed after the status line. If no absolute pressure sensor has been connected and recording has been started , values of zero mbar or random values may be displayed.

8 Loading a New Software Release

Whenever a new software release of "MTS" firmware becomes available it will be delivered as an ASCII-file with the filename <3-digit-type><3-digit-release>.MTS, e.g. MTS100.MTS. This stands for "software for MTS units, release 1.00".

This file must be copied to a storage card on the PC. Then the storage card must be inserted into slot 1 of GEOLON-MTS and power must be switched on. The software will be loaded in two steps:

- The *.MTS-file will be read off the card and stored in internal memory. During the process, the LED is blinking twice per second.
- The software will be compiled and stored into non-volatile program memory. During the process, the LED is blinking once per second.

As soon as the LED stops blinking the new software release has been successfully loaded. After phase 1 is finished, the storage card may be removed from slot 1. Before updating the firmware, the *.MTS-file integrity is checked using a CRC; if it fails no update is performed.

9 Troubleshooting

9.1 Emergency firmware erase for booting problems

In very rare cases, GEOLON-MTS may get into a state in which it will not respond to the RS232 command interface, even after reset. Then the (faulty) firmware may be erased using the following procedure:

- Disconnect power.
- Connect pins 3 and 4 of the auxiliary connector by e.g. using a paper clip.
- Connect power and wait for 10 seconds.
- Disconnect power again and remove the connection between pins 3 and 4.
- Reconnect power.

Now GEOLON-MTS should boot with the ROM operating system sign-on message and new firmware can be loaded.

9.2 MTS not responding/hanging

In very rare cases, GEOLON-MTS might not return from a command issued, e.g. when trying to synchronize or skew with a faulty time pulse. In this case, power should be disconnected for a period of at least 10 minutes. Please note that this may affect the accuracy of your recorded data, since it is not possible to determine the skew once synchronization has been lost.

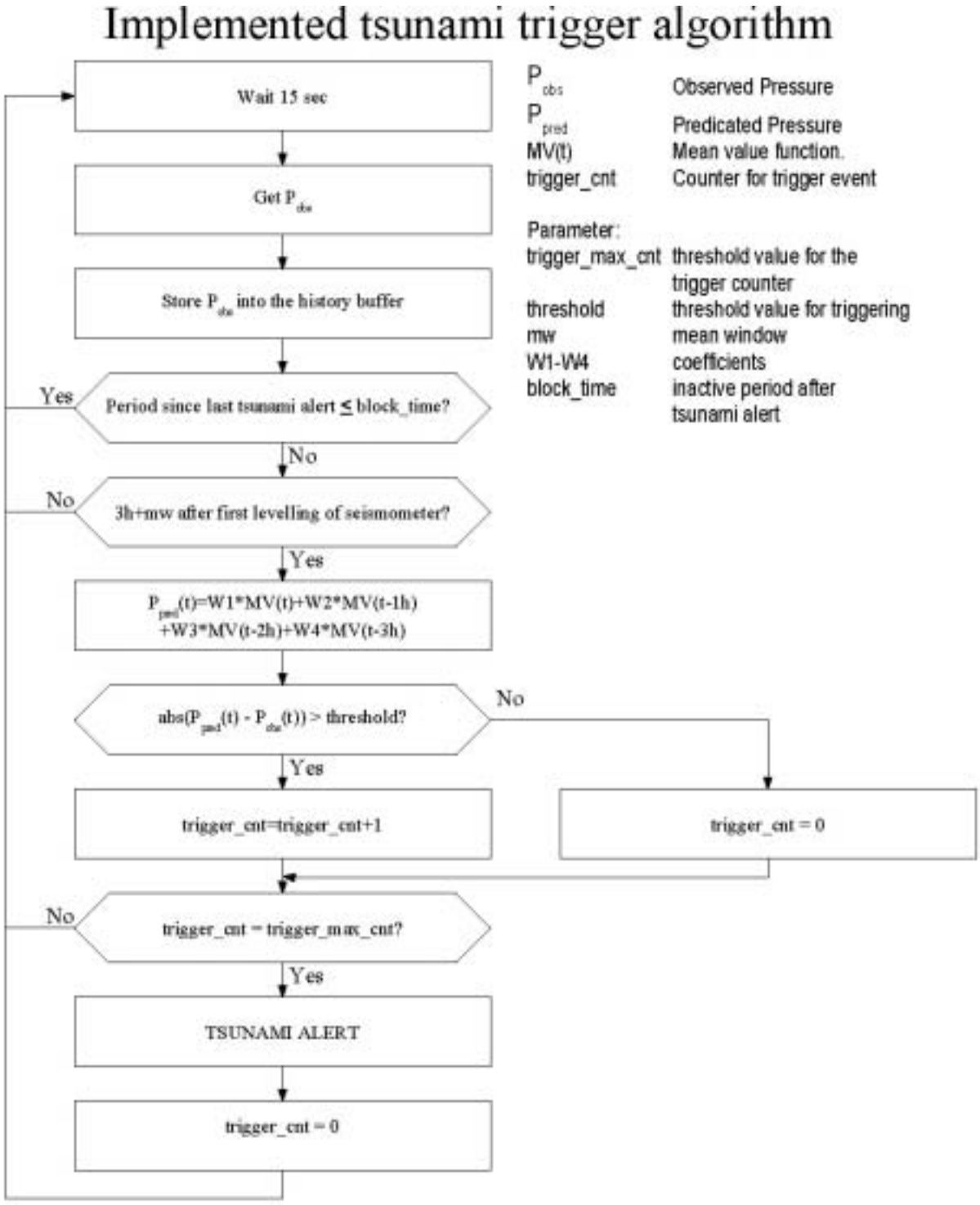
10 Support and Service

If any problem with GEOLON-MTS should arise, or if you need any support for operating it, please contact SEND GmbH via

e-mail: support@send.de
fon: +49 40 375 008 03
fax: +49 40 375 008 93

11 Appendix: Tsunami Detection Algorithm

Version 12. September 2005 - Flow chart:



$$MV(t)=\frac{\sum_{i=t-15s}^{t-mw-15s} P_{obs}(i)-max(P_{obs}(t-15s)\ldots P_{obs}(t-mw-15s))-min(P_{obs}(t-15s)\ldots P_{obs}(t-mw-15s))}{mw-2}$$

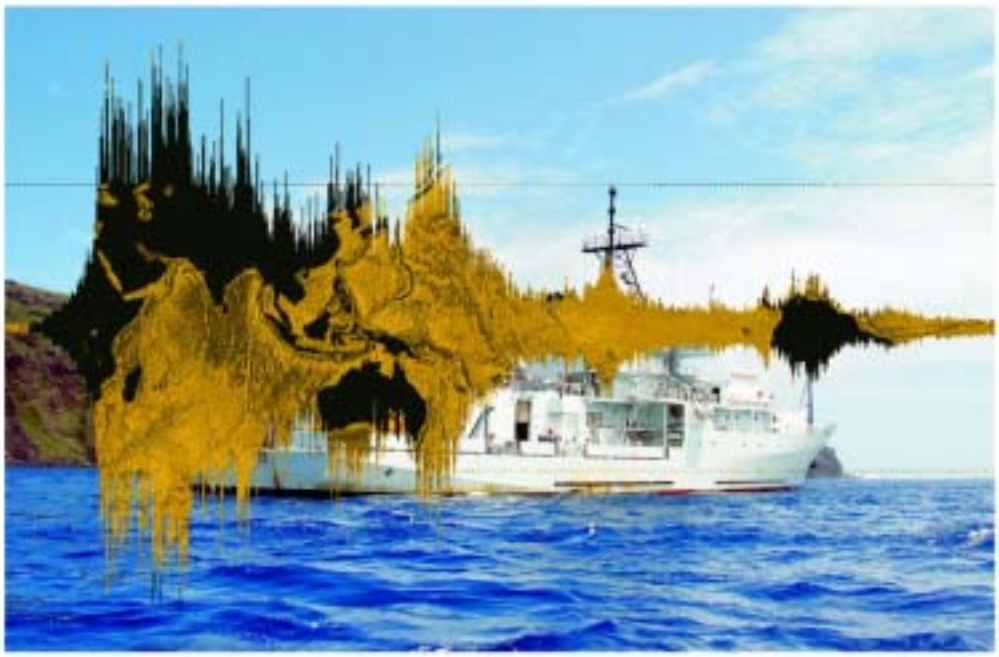
Factory Setting of Parameters:

Mean Window: 600 sec
Blocktime: 11400 sec
Threshold: 3,2 mbar
trigger max count = 1 is equivalent to COUNT in chap. 5.8
W1 = 1,168185 is equivalent to W0 in chap. 5.8
W2 = -0,281976 is equivalent to W1 in chap. 5.8
W3 = 0,146897 is equivalent to W2 in chap. 5.8
W4 = 0,033106 is equivalent to W3 in chap. 5.8

12 Appendix: Send2X Manual

13 Appendix: SendCom Manual

SEND2X



Data handling and conversion suite for Geolon Recorders

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Fax: +49 40 375008-93

Software
Version 2.6x

Manual
Version 2.62

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This program-package converts the compressed recordings of the SEND data loggers into different formats. SEND2X **version 2.60** is available for the Linux operating system.

This version allows the conversion of raw data into a binary file, an audio-wave file, a special Reftek SEG-Y format for seismological data and into the standard SEG-Y format if an appropriate shot file is available.

This manual includes the description of utilities, which are required to save and process the data of SEND's data loggers Methusalem-MBS, Geolon-MCS, Geolon-MES, Geolon-MLS and Geolon-MTS.

On the delivered CD-R 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.

The library consists of the device specific files

for the Geolon-**MCS**:

mcscopy, mcslog, mcsread and mcsupload

for the Geolon-**MES**:

mescopy, meslog and mesread

for the Geolon-**MLS**:

mlsread

for the Geolon-**MTS/MTS-M**:

mtsread, smtsread, paroread, pressure2ascii and ph2ascii

for the Geolon-**MBS**:

mbsread

The device-dependent programs can only be used while working with the corresponding device and the data retrieved can then be further processed with the following device independent programs:

binwrite

wavewrite

seg-ywrite

gsewrite

paswrite

sacwrite

resample

All programs use the standard input as input device, and the standard output as output device most of the time. This allows an easy combination of the different programs by 'pipeing'.

Specific Linux issues

To allow handling of files larger than 20 Gbytes and more, please format the harddisk of your Linux computer with the maximum cluster and sector size. Also, depending on your Linux distribution, it might be necessary to work with root-privileges when performing hardware related tasks, e.g. retrieving data from IEEE1394 drives utilized by the MES data recorder.

Installing the programs

The programs can simply be copied from the distribution CD-ROM to the harddrive of your Linux system, e.g. to /usr/send2x/bin. It is recommended that you append your path-variable with the path to the send2x files. Example: ***PATH = $PATH:/usr/send2x/bin***

1.1 Description of individual programs

In the following description, the symbols

< > will be used to include variables which should be entered.

< > are also used as symbols for standard in- and output as part of the command.

The option **`--help`** can be used for all listed programs to display a brief description of the program on the screen.

1.1.1 mcscopy

This program module copies all recorded data from Geolon-MCS's harddisk via standard input and standard output to the harddisk of your computer. For the execution of mcscopy, the standard input has to be assigned to the device path and file of the Firewire interface, which is directly connected to the MCS's harddisk (e.g. /dev/*devicefile*). Also, the standard output has to be assigned to the destination directory and file on your computer. We recommend '.raw' as extension for the data file on your harddisk. For example:

`mcscopy < /dev/sda > <`*`working_directory/data_file_name.raw`*`>`

In the case of a corrupted data file (e.g. due to an unclosed file, system crash or reboot of the MCS while recording data), mcscopy will not be able to determine the correct size of the data file. Therefore, mcscopy displays a comment, requesting to enter an estimated file size and to restart mcscopy using the option:

`--save` *`<file size in Mbytes>`*

The file size can be estimated using the following calculation:

<File size in MBytes> =<sample rate in Hz> * 0.33 * <recording days> * <active channels> +50

1.1.2 mescopy

This program module copies all recorded data from Geolon-MES's harddisk via standard input and standard output to the harddisk of your computer. For the execution of mescopy, the standard input has to be assigned to the device path and file of the Firewire interface, which is directly connected to the MES's harddisk (e.g. /dev/*devicefile*). Also, the standard output has to be assigned to the destination directory and file on your computer. We recommend '.raw' as extension for the data file on your harddisk. For example:

`mescopy < /dev/sda >` *`<working_directory/data_file_name.raw>`*

In the case of a corrupted data file (e.g. due to an unclosed file, system crash or reboot of the MES while recording data), mescopy will not be able to determine the correct size of the data file. Therefore, mescopy displays a comment, requesting to enter an estimated file size and to restart mescopy using the option:

`--save` *`<file size in Mbytes>`*

The file size can be estimated using the following calculation:

<File size in MBytes> =<sample rate in Hz> * 0.33 * <recording days> * <active channels> +50

1.1.3 mcslog

Mcslog displays the MCS-log file on the screen of your PC. The log file includes the settings, control, status, and identification information of all experiments, which were carried out since the last disc format (synchronization). To copy the log file to your computer instead of displaying it on the screen, the standard output has to be redirected to a file on your PC. For executing mcslog, the standard input has to be assigned to the device path and file of the Firewire interface, which is connected to the MCS.

For example:

`mcslog < /dev/sda`

displays the log-file on the screen and

`mcslog < /dev/sda >` *`<directory/log_file_name.txt>`*

copies the log file to the harddisk of your computer.

1.1.4 meslog

Meslog displays the MES-log file on the screen of your PC. The log file includes the settings, control, status, and identification information of all experiments, which were carried out since the last disc format (synchronization). To copy the log file to your computer instead of displaying it on the screen, the standard output has to be redirected to a file on your PC. For executing meslog, the standard input has to be assigned to the device path and file of the Firewire interface which is connected to the MES.

For example:

```
meslog < /dev/sda
```

displays the log-file on the screen and

```
meslog < /dev/sda > <directory/log_file_name.txt>
```

copies the log file to the harddisk of your computer.

1.1.5 mcsread

This program module reads, decompresses and converts the raw data (recorded by Geolon-MCS) into the internal send2x format. In addition, it generates an ASCII file, containing the acquired engineering data (for a detailed description see: "1.2 Files").

Again, the program can read the compressed raw data via standard input through the Firewire interface from the MCS's harddisk. To do this, the standard input has to be assigned to the Firewire device connecting the MCS to the PC. Alternatively, the standard input can be assigned to the data file, which was stored by mcscopy on the harddisk of your computer. The converted data will be transferred to the standard output. Again, the standard output can be assigned to a destination file.

For example:

mcsread < <raw_data_ file> > *<directory/file_name.s2x>*

Because the decompression and conversion of the raw data needs more processing time than the simple copy procedure, we recommend to use mcscopy at first and then to use mcsread as the next processing step.

mcsread includes the following options (values in <> are variables which must be entered):

--begin_sec *<integer in GPS seconds>*

or

--begin_date *<formatted_time_string_yyyy.mm.dd_hh:mm:ss>*

together with

--end_sec *<integer in GPS seconds>*

or

--end_date *<formatted_time_string_yyyy.mm.dd_hh:mm:ss>*

Using these options restricts the data conversion to the time-window of interest. The resulting file will contain only data within this time window. We recommend to use the time of the first and the last shot of a survey-line.

GPS seconds means the number of seconds since GPS start on January 6th 1980, 00:00 o'clock.

Examples:

--begin_sec 708669934 --end_sec 708685565

or

--begin_date 2002.06.21_04:45:34 --end 2002.06.21_09:06:05

--skew *<+/-_skew_time_in_µs>*

This option allows to store a manually entered skew value in the send2x file instead of the skew value from the raw data file.

Example: **--skew -1000**

Instead of the skew value of the raw data file, a skew value of -1 ms will be recorded in the send2x file.

`--timeshift` *<+/-value_in_seconds>*

The use of this option allows to shift all data by a constant time. The value has to be in full seconds (integer value). Use this command for the correction of differences in time, if different time standards have been used for synchronising the data logger and for synchronising the airgun controller on the shooting vessel.

Example: GPS-RTS delivers the time in UTC, the shooting vessel provides the shot time as GPS time. The difference between these two time standards is 14 seconds and therefore, you have to enter:

`--timeshift 14`

`--no_eng`

The engineering data will be stored automatically in a file in the current working directory with a filename according to chapter 1.2.2.

The option **`--no_eng`** suppresses the automatic file generation.

`-- log` *<filename>*

This option generates a log-file of the current mcsread-run in the current working directory. Without using the option, the log-file will be written automatically to the file "mcsread.log".

`--no_log`

No log file will be generated.

1.1.6 mesread

This program module reads, decompresses and converts the raw data (recorded by Geolon-MES) into the internal send2x format. In addition, it generates an ASCII file, containing the acquired engineering data (for a detailed description see: "1.2 Files").

Again, the program can read the compressed raw data via standard input through the Firewire interface from the MES's harddisk. To do this, the standard input has to be assigned to the Firewire device connecting the MES to the PC. Alternatively, the standard input can be assigned to the data file, which was stored by mescopy on the harddisk of your computer. The converted data will be transferred to the standard output. Again, the standard output can be assigned to a destination file.

For example:

mesread < *<raw_data_ file>* **>** *<directory/file_name.s2x>*

Because the decompression and conversion of the raw data needs more processing time than the simple copy procedure, we recommend to use mescopy at first and then to use mesread as the next processing step.

mesread includes the following options (values in <> are variables which must be entered):

--begin_sec *<integer in GPS seconds>*

or

--begin_date *<formatted_time_string_yyyy.mm.dd_hh:mm:ss>*

together with

--end_sec *<integer in GPS seconds>*

or

--end_date *<formatted_time_string_yyyy.mm.dd_hh:mm:ss>*

Using these options restricts the data conversion to the time-window of interest. The resulting file will contain only data within this time window. We recommend to use the time of the first and the last shot of a survey-line. Mesread internally subtracts 60 seconds from 'begin time' and adds 60 seconds to 'end time' (the time window thus becomes: begin-60secs till end+60secs).

GPS seconds means the number of seconds since GPS start on January 6th 1980, 00:00 o'clock.

Examples:

--begin_sec 708669934 --end_sec 708685565

or

--begin_date 2002.06.21_04:45:34 --end 2002.06.21_09:06:05

--skew *<+/-_skew_time_in_µs>*

This option allows to store a manually entered skew value in the send2x file instead of the skew value from the raw data file.

Example: **--skew -1000**

Instead of the skew value of the raw data file, a skew value of -1 ms will be recorded in the send2x file.

--timeshift *<+/-value_in_seconds>*

The use of this option allows to shift all data by a constant time. The value has to be in full seconds (integer value). Use this command for the correction of differences in time, if different time standards have been used for synchronising the data logger and for synchronising the airgun controller on the shooting vessel.

Example: GPS77 delivers the time in UTC, the shooting vessel provides the shot time as GPS time. The difference between these two time standards is 14 seconds and therefore, you have to enter:

--timeshift 14

--no_eng

The engineering data will be stored automatically in a file in the current working directory with a filename according to chapter 1.2.2.

The option **--no_eng** suppresses the automatic file generation.

-- log *<filename>*

This option generates a log-file of the current mesread-run in the current working directory. Without using the option, the log-file will be written automatically to the file "mesread.log".

--no_log

No log file will be generated.

1.1.7 mbsread

Mbsread has to be used to convert raw data acquired by the Methusalem-MBS data logger. At first, the raw data of all PCMCIA cards of one recording session as well as one of the MBS.SYS files must be copied to a directory using e.g. the cp command. Then mbsread is used to decompress and convert the raw data into the internal send2x format.

Mbsread reads the raw data from either the current directory or from the directory specified by the --src option. The converted data will be transferred to the standard output, which usually will be re-directed to a destination file.

For example:

mbsread --src *<directory>* **>** *<directory/file.s2x>*

mbsread includes the following options (values in <> are required variables):

--src *<directory>*

specifies the directory, which is used as raw data input. --src may be omitted if the input comes from the current directory. The directory must contain all raw data files, which may have been copied from multiple PCMCIA cards belonging to one recording session as well as the MBS.SYS file from one of the PCMCIA cards.

--help displays a list of all options with brief explanations

--begin_sec *<integer_in_GPS_seconds>*

or

--begin_date *<formatted_string_yyyy.mm.dd_hh:mm:ss>*

--end_sec *<integer_in_GPS_seconds>*

or

--end_date *<formatted_string_yyyy.mm.dd_hh:mm:ss>*

Using these options restricts the data conversion to the time-window of interest. The resulting file will contain only data within this time window. We recommend to use the time of the first and the last shot of a survey-line. Mbsread internally subtracts 60 seconds from 'begin time' and adds 60 seconds to 'end time' (the time window thus becomes: begin-60secs till end+60secs).

GPS seconds means the number of seconds since GPS start on January 6th 1980, 00:00 o'clock.

Example:

--begin_sec 708669934 --end_sec 708685565

or

--begin_date 2002.06.21_04:45:34 --end 2002.06.21_09:06:05

--skew *<+/-_skew_in_µs>*

This option allows to store a manually entered skew value in the send2x file instead of the skew value from the raw data file(s).

Example: **--skew -1000**

Instead of the skew value of the raw data file, a skew value of -1 ms will be recorded in the send2x file.

--timeshift *<+/-value_in_seconds>*

The use of this option allows to shift all data by a constant time. The value has to be in full seconds (integer value). Use this command for the correction of differences in time, if different time standards have been used for synchronising the data logger and for synchronising the airgun controller on the shooting vessel.

Example: GPS77 delivers the time in UTC, the shooting vessel provides the shot time as GPS time. The difference between these two time standards is 14 seconds and therefore, you must enter:

--timeshift 14

--log *<filename>*

This option generates a log file of the current mbsread run in the current directory. Without using this option, the log file will be written "mbsread.log".

`--no_log`

No log file will be generated.

`--nc`

If this option is used, no messages will be produced when mbsread is executed.

1.1.8 mlsread

Mlsread has to be used to convert raw data acquired by the GEOLON-MLS data logger. At first, the raw data of all PCMCIA cards belonging to one recording session as well the corresponding MLS.SYS file must be copied to a directory using e.g. the cp command. Then mlsread is used to decompress and convert the raw data into the internal send2x format.

Mlsread reads the raw data from either the current directory or from the directory specified by the --src option. The converted data will be transferred to the standard output, which usually will be re-directed to a destination file.

For example:

mlsread --src *<directory>* **>** *<directory/file.s2x>*

mlsread includes the following options (values in <> are required variables):

--src *<directory>*

specifies the directory, which is used as raw data input. --src may be omitted if the input comes from the current directory. The directory must contain all raw data files, which may have been copied from multiple PCMCIA cards belonging to one recording session as well as the MLS.SYS file from one of the PCMCIA cards.

--help or **-h** displays a list of all options with brief explanations

--begin_sec *<integer_in_GPS_seconds>*

or

--begin_date *<formatted_string_yyyy.mm.dd_hh:mm:ss>*

--end_sec *<integer_in_GPS_seconds>*

or

--end_date *<formatted_string_yyyy.mm.dd_hh:mm:ss>*

Using these options restricts the data conversion to the time-window of interest. The resulting file will contain only data within this time window. We recommend to use the time of the first and the last shot of a survey-line. Mlsread internally subtracts 60 seconds from 'begin time' and adds 60 seconds to 'end time' (the time window thus becomes: begin-60secs till end+60secs).

GPS seconds means the number of seconds since GPS start on January 6th 1980, 00:00 o'clock.

Example:

--begin_sec 708669934 --end_sec 708685565

or

--begin_date 2002.06.21_04:45:34 --end 2002.06.21_09:06:05

--skew *<+/-_skew_in_µs>*

This option allows to store a manually entered skew value in the send2x file instead of the skew value from the raw data file(s).

Example: **`--skew -1000`**

Instead of the skew value of the raw data file, a skew value of -1 ms will be recorded in the send2x file.

`--timeshift` *<+/-value_in_seconds>*

The use of this option allows to shift all data by a constant time. The value has to be in full seconds (integer value). Use this command for the correction of differences in time, if different time standards have been used for synchronising the data logger and for synchronising the airgun controller on the shooting vessel.

Example: GPS77 delivers the time in UTC, the shooting vessel provides the shot time as GPS time. The difference between these two time standards is 14 seconds and therefore, you must enter:

`--timeshift 14`

`--log` *<filename>*

This option generates a log file of the current mlsread run in the current directory. Without using this option, the log file will be saved as "mlsread.log".

`--no_log`

No log file will be generated.

`--nc`

If this option is used, no messages will be produced when mlsread is executed.

1.1.9 mtsread

Mtsread has to be used to convert raw data acquired by the GEOLON-MTS/MTS-M data logger. At first, the raw data of all PCMCIA cards belonging to one recording session as well as the corresponding MLS.SYS file must be copied to a directory using e.g. the cp command. Then mtsread is used to decompress and convert the raw seismic data into the internal send2x format.

The raw data of the absolute pressure gauge will be converted into ASCII format and stored in a separate file. The name of this file will be generated automatically with the channel number 5 and the extension **.pressure** (see also chap. 1.3.3).

The resulting ASCII file looks like this:

```
************************************************************
time                    pressure (mBar)
------------------------------------------------------------
13:30:13 16.08.2005      1088.6
13:30:28 16.08.2005      1088.7
13:30:43 16.08.2005      1088.8
13:30:58 16.08.2005      1088.9
.................          ...
************************************************************
```

Mtsread reads the raw data from either the current directory or from the directory specified by the --src option. The converted data will be transferred to the standard output, which usually will be re-directed to a destination file.

For example:

mtsread --src *<directory>* **>** *<directory/file.s2x>*

mtsread includes the following options (values in <> are required variables):

--src *<directory>*

specifies the directory, which is used as raw data input. --src may be omitted if the input comes from the current directory. The directory must contain all raw data files, which may have been copied from multiple PCMCIA cards belonging to one recording session as well as the MLS.SYS file from one of the PCMCIA cards.

--help displays a list of all options with brief explanations

--begin_sec *<integer_in_GPS_seconds>*

or

--begin_date *<formatted_string_yyyy.mm.dd_hh:mm:ss>*

--end_sec *<integer_in_GPS_seconds>*

or

--end_date *<formatted_string_yyyy.mm.dd_hh:mm:ss>*

Using these options restricts the data conversion to the time-window of interest. The resulting file will contain only data within this time window. We recommend to use the time of the first and the last shot of a survey-line.

GPS seconds means the number of seconds since GPS start on January 6th 1980, 00:00 o'clock.

Example:

--begin_sec 708669934 --end_sec 708685565

or

--begin_date 2002.06.21_04:45:34 --end 2002.06.21_09:06:05

--skew *<+/-_skew_in_µs>*

This option allows to store a manually entered skew value in the send2x file instead of the skew value from the raw data file(s).

Example: **--skew -1000**

Instead of the skew value of the raw data file, a skew value of -1 ms will be recorded in the send2x file.

--timeshift *<+/-value_in_seconds>*

The use of this option allows to shift all data by a constant time. The value has to be in full seconds (integer value). Use this command for the correction of differences in time, if different time standards have been used for synchronising the data logger and for synchronising the airgun controller on the shooting vessel.

Example: Your GPS receiver delivers the time in UTC, the shooting vessel provides the shot time as GPS time. The difference between these two time standards is 14 seconds and therefore, you must enter:

--timeshift 14

--log *<filename>*

This option generates a log file of the current mtsread run in the current directory. Without using this option, the log file will be stored in a file with the name "mtsread.log".

--no_log

No log file will be generated.

--nc

If this option is used, no messages will be produced when mtsread is executed.

`--report_slips`

This option starts a reporting of time slip messages on the screen during the conversion of the data. For a description of time slips, please see the chap. "Time Slips" in the MTS Manual.

1.1.10 paroread

paroread extracts pressure data of a Paroscientific absolute pressure sensor from raw data files recorded with MTS and MTS-M tsunameter seismocorders and writes it to an ASCII text file.

No parameters are required, paroread will gather all neccessary information from a MLS.SYS file in the current working directory and generate the pressure data filename according to the Send2X standard naming convention with ".pressure" as extension.

A sample of a pressure data file name is:

991257.05.00.01.2007.003.22.56.05.pressure

The first value is the recorder´s serial number, followed by channel number, date and time.
Please note that the channel number for the pressure data is set to "05", regardless of the number of ADC channels used in a recording.

The resulting ASCII file conforms to the CSV standard and looks like this:

date & time of first sample;06.02.2006 07:28:16
sample time;pressure (mBar)
0;1088,6
15;1088,7
30;1088,7
..;.....
3000;1088,0

There are only two options for **paroread** :
-V displays the current version info
-h displays the help file for paroread

Options can be combined in any order.

Please note that this command can only be used to read data from regular memory cards with recorded data, but not to read the special format used in the modem-buoy communication as stored by the buoy computer of a tsunami warning system.

1.1.11 mcsupload

This program allows uploading of user programs to the Geolon-MCS via the IEEE1394-interface. The order of options is not important. Options are.

--usp <*filename*>

This option defines the filename of the user program if StdIn is not used.

--log <*filename*>

This option defines the name of the logfile. If this option is not given, “mcsupload.log” will be used by default.

EXAMPLES:

mcsupload </data/user.mcs >/dev/*mcsdevice*

mcsupload –usp /data/user.mcs >dev/*mcsdevice*

mcsupload –p /var/log/mcs/mcsupload.log –usp /data/user.mcs >dev/*mcsdevice*

1.1.12 mesupload

This program allows uploading of user programs, new operating system software and new firmware versions to the Geolon-MES via the IEEE1394-interface. Options are.

--usp <*filename*>

This option defines the filename of the user program if StdIn is not used.

--rom <*filename*>

This option defines the filename of the operating system software to be loaded.

--fw <*filename*>

This option defines the filename of the firmware to be loaded.

EXAMPLES:

mesupload </data/user.mes >/dev/*mesdevice*

mesupload --usp /data/user.mes >dev/*mesdevice*

mesupload --fw /data/mes113a_fw.mes >dev/*mesdevice*

Please note, that new operating system software and new firmware will not be installed automatically by the MES recorder. Please consult the MES manual for details, how to store these files from the internal harddrive to nonvolatile memory.

1.1.13 binwrite

This program has to be used to convert the data from internal send2x format into 32 bit binary format. It reads the data via standard input and writes for each activated channel and each recording period (sequence) a file into a destination directory. The filenames are generated automatically. Corresponding to chapter 5.3.3, they consist of the recorder's serial number, channel no, sequence no and the date and time of recording-start. Furthermore, each file will be marked by the extension '.bin'. Following options are important:

`--dest` *<path/destination directory/>*

This option defines the destination directory.

`--no_head`

The application of no_head suppresses the text header in the output file. Otherwise, a header of 1024 Byte will be written.

1.1.14 wavewrite

As binwrite, wavewrite also reads the data from standard input. But now, the data will be converted into a 16 bit PCM wave (audio wave) format and stored in a separate file for each channel. The filenames will be generated automatically. Corresponding to chapter 5.3.3, the filename consists of the recorder's serial number, channel no, sequence no and the date and time of recording-start. In addition, each file will be marked by the extension '.wav'.

Options:

`--dest` *`<path/destination directory/>`*

This option defines the directory in which the converted data files will be stored.

`--lower`

Please use this option, if you would like to preserve the 16 least significant bits of the 24 bit data. Without using this option, wavewrite neglects the 8 least significant bits (as default).

1.1.15 seg-ywrite

This program module converts the internal send2x format into SEG-Y format. The program requires a shot file for cutting the long raw data stream into single traces. Please find a description of the shot file structure at the end of this chapter.

If no shot file is available, a single and long SEG-Y trace can be generated using the option --reftek.

As well as the other writing programs, seg-ywrite reads the data via standard input and writes for each activated channel and for each recording period (sequence) a file into a destination directory. The filenames will be generated automatically and marked by the extension '.segy'. Each filename consists of the recorder's serial number, channel no, sequence no and the date and time of recording-start, using the nomenclature as described in chapter 5.3.3.

Options:

`--dest` *`<path/directory/>`*

Please enter the complete path to and the name of the destination directory where the resulting (converted) files should be stored.

`--shot` *`<path/directory/filename>`*

Please enter the directory and filename where the shot file is located.

`--tracelen` *`<number of samples>`*

The option --tracelen allows to cut all traces to a common length.

Example: --tracelen 2000

will write traces consisting of 2000 samples.

The resulting trace length in seconds can be calculated by:

trace length in ms = (number of samples) * (sample period in ms)

e.g.: (2000)*(4ms)=8000 ms trace length

`--fill_null`

If the entered trace length in option --tracelen is longer than the time period between two shots, the option --fill_null can be used to fill the traces with zeros (0) up to the defined trace length.

Following the SEG-Y standard, the trace length can not exceed 32767 samples.

`--reftek`

This option stores the complete data in one single trace. As this file can be longer than 32767 samples, it is not written in standard SEG-Y. Instead of this, the file is compatible to the file format provided by the program REF2SEGY of REFTEK. Especially the trace headers are modified. The option --reftek can not be used in combination with --shot. Please note, that only the start-time of the first sample of the one single trace will be corrected by the automatic skew correction.

`--msb`

converts the data in 2byte, two's complement integer format, whereas only the most significant 16 bits will be copied.

`--lsb`

converts the data in 2byte, two's complement integer format, whereas only the least significant 16 bits will be copied.

`--trace_cut` *<value in seconds>*

If no shot file is available and the raw data should be cut into traces to display the data as 'seismic section', then the option --trace_cut can be used. Thereby the long raw data stream will be cut into traces of equal length, given by the entered number of seconds. The value has to be in full seconds (integer value). The option --trace_cut can not be used in combination with --reftek or --shot.

`--skew` *<+/- skew in µs>*

If you enter --skew 0, the program will apply no skew correction and ignores the skew-value written in the raw data file.

If you don't use this option, the skew value written in the raw data will automatically be used to correct the start time of each trace.

Example: --skew -1000

Instead of processing the skew value supplied with the raw data, the skew correction will now be performed using a skew value of -1 ms. Please note, that with the –reftek option, the skew is treated the same way as when using traces, no matter whether the skew is entered manually oder taken

from the raw data automatically: The proportional skew per second is calculated and used to determine the start sample for the output file.

--gcx *<integer value>*

Please enter the x coordinate for the geophone group (here for the OBS location), if available.

--gcy *<integer value>*

Please enter the y coordinate for the geophone group (here for the OBS location). if available

Following the SEG-Y standard, the x and y coordinates have to be in seconds of arc, if spherical coordinates are used. Then, the x value should represent longitude and the y-value latitude. A positive value designates the number of seconds east of Greenwich Meridian or north of the equator and a negative value designates the number of seconds south or west.

--data_le

This option controls the byte order in the data area of the resulting SEG-Y file:

Without using the option, seg-ywrite stores the trace header and the data in "Big Endian" format (recommended for PC's).

By using --data_le, the data will be written in "Little Endian" format.

--le

Both, data and header will be written in "Little Endian" format.

--out_int

If this option will be used, then the data in the SEGY- file will be written in 4-byte, two's complement integer format. Without using the option, the data will be written in "IEEE floating point" format (as default).

--log *<filename>*

This option generates a log file of the current seg-ywrite run in the current directory. Without using this option, the log file will be stored in a file with the name "seg-ywrite.log".

1.1.16 gsewrite

The gsewrite module converts data from the send2x format to GSE (Group of Seismic Experts) standard file format. It reads data from standard input and writes the output into files. For each active channel in the raw data, a separate GSE file will be written, using the standard nomenclature for file names as described in chapter 5.3.3. Optionally, a customized file name can be created using the - - nameform option. Target files will be written to the current directory unless a target directory is spezified using the - - dest option.

Usage:

```
gsewrite [options] <rawdata.s2x
```

Options:

-- dest PATH or -d PATH	Sets output for target files to given path/directory
-- nameform FORM or –n FORM	Sets file name format according to format string FORM.
	FORM is a string literal which may not contain spaces or whitespace. It can take up any ASCII characters and the following placeholder symbols:
	%n device serial number
	%c channel number
	%q record sequence number
	%v event number
	%e experiment number
	%E experiment name
	%t station number
	%T station name
	%Y year of the first sample
	%J julian day of the first sample
	%D day of month of the first sample
	%M month of the first sample
	%h hour of the first sample
	%m minute of the first sample
	%s seconds of the first sample
	%g gain value
	%r sample rate of recording
	%p sample period (in micro seconds) of recording
	The default setting to form filenames according to chapter 5.3.3. thus is: %n.%c.%q.%v.%Y%J.%h.%m.%s.gse
--split SEC or –t SEC	split the output files into segments of <SEC> seconds worth of samples each

--slice SIZE or -c SIZE	slice the output files into segments of <SIZE> megabytes size each
--verbose or -v	verbose mode with additional information for debugging
--version or -V	print version information and exit
--silent or -s	suppresses all regular message output
--help or -h	display this help and exit

1.1.17 paswrite

The paswrite module converts data from the send2x format to PASSCAL data format. It reads data from standard input and writes the output into files. For each active channel in the raw data, a separate PASSCAL file will be written, using the standard nomenclature for file names as described in chapter 5.3.3. Optionally, a customized file name can be created using the - - nameform option. Target files will be written to the current directory unless a target directory is spezified using the - - dest option. Finally, a multiplexed target file, containing interleaved data from all channels, can be written using the –multiplexed option. By default, the 16 most significant bits from each sample will be written to the target file, unless the --lsb option is used to switch to the 16 least significant bits from each sample.

Usage:

paswrite [options]<*infile*

or

paswrite [-h] [-V]

Options:

-- dest PATH or -d PATH	Sets output for target files to given path/directory
-- nameform FORM or –n FORM	Sets file name format according to format string FORM.

FORM is a string literal which may not contain spaces or whitespace. It can take up any ASCII characters and the following placeholder symbols:

%n	device serial number
%c	channel number
%q	record sequence number
%v	event number
%e	experiment number
%E	experiment name
%t	station number
%T	station name
%Y	year of the first sample
%J	julian day of the first sample
%D	day of month of the first sample
%M	month of the first sample
%h	hour of the first sample
%m	minute of the first sample
%s	seconds of the first sample

	%g gain value %r sample rate of recording %p sample period (in micro seconds) of recording The default setting to form filenames according to chapter 5.3.3. thus is: %n.%c.%q.%v.%Y%J.%h.%m.%s.passcal
--split SEC or –t SEC	split the output files into segments of <SEC> seconds worth of samples each
--slice SIZE or -c SIZE	slice the output files into segments of <SIZE> megabytes size each
--lsb or –l	only write the 16 least significant bits of samples to target file
--msb or –m	only write the 16 most significant bits of samples to target file
--multiplexed or –x	write data from all channels into a single target file
--verbose or -v	verbose mode with additional information for debugging
--version or -V	print version information and exit
--silent or -s	suppresses all regular message output
--help or -h	display this help and exit

1.1.18 sacwrite

The sacwrite module converts data from the send2x format to SAC (Seismic Analysis Code) data format. It reads data from standard input and writes the output into files. For each active channel in the raw data, a separate SAC file will be written, using the standard nomenclature for file names as described in chapter 5.3.3. Optionally, a customized file name can be created using the - - nameform option. Target files will be written to the current directory unless a target directory is spezified using the - - dest option. Optionally, the geographic location of the station may be provided as input parameter.

Usage:

sacwrite [options]<*infile*

or

sacwrite [-h] [-V]

Options:

-- dest PATH or -d PATH	Sets output for target files to given path/directory
-- nameform FORM or –n FORM	Sets file name format according to format string FORM.

FORM is a string literal which may not contain spaces or whitespace. It can take up any ASCII characters and the following placeholder symbols:

%n	device serial number
%c	channel number
%q	record sequence number
%v	event number
%e	experiment number
%E	experiment name
%t	station number
%T	station name
%Y	year of the first sample
%J	julian day of the first sample
%D	day of month of the first sample
%M	month of the first sample
%h	hour of the first sample
%m	minute of the first sample
%s	seconds of the first sample
%g	gain value

	%r sample rate of recording %p sample period (in micro seconds) of recording The default setting to form filenames according to chapter 5.3.3. thus is: %n.%c.%q.%v.%Y%J.%h.%m.%s.sac
--split SEC or -t SEC	split the output files into segments of <SEC> seconds worth of samples each
--slice SIZE or -c SIZE	slice the output files into segments of <SIZE> megabytes size each
--latitude <deg> or -a <deg>	set latitude of station to <deg> degrees, where <deg> is a floating point number with north being a positive value
--longitude <deg> or -o <deg>	set longitude of station to <deg> degrees, where <deg> is a floating point number with east being a positive value
--verbose or -v	verbose mode with additional information for debugging
--version or -V	print version information and exit
--silent or -s	suppresses all regular message output
--help or -h	display this help and exit

1.1.19 resample

Data recorded with the GEOLON-MLS and GEOLONON-MTS or MTS-M may show so-called "time slips", due to differences between the long term stabilization of the internal clock and the sample frequency clock. Thus, within a given sample period, less or more samples than required are recorded. e.g. 99 samples instead of 100. If this misalignment of sample periods and samples actually collected is influencing the precision of your experiment, you can correct the data using RESAMPLE. RESAMPLE does not correct time slips for other GEOLON Data Loggers, but may be helpful for correction of filter influences and adjusting skew times.

Usage:

resample [-v] [-s *size*] [-c *seconds*] <*infile* >*outfile*

or

resample [-h] [-V]

Options:

-h Help. Displays a list of all available options.

-V Version. Displays the version number of resample

-v Verbose. Displays process information on **stderr**

-s Sets the size of the internal data buffer to *size* MB. Default value is 16MB.

-c Sets the time in *seconds*, which must pass between consecutive time slips before re-interpolation starts

Remarks:

With the GEOLON-MLS, -MTS or -MTS-M, either a –c value or a –s value, or both, must be given or the command will abort indicating an error. With the GEOLON MES and MCS, normally no parameters should be given, since by design they do not show time slips and you are likely to run into buffer memory problems when setting parameters.

RESAMPLE can react to three special situations:

1. Data gaps. In this case, RESAMPLE will handle the data before and after the gap as separate streams of data.
2. If the time between two time slips is larger than the time covered by the data in the internal buffer of RESAMPLE, an error message will be displayed. In this case, the –s parameter can

be used to increase the buffer size accordingly. Please note that there is one buffer for each channel of data, so the value for this parameter is limited by the total amount of real and virtual memory of the computer, divided by the number of channels recorded. It also means, that for large files with great distances between timeslips, the memory requirement can exceed the limits of any state of the art PC. In this case we suggest splitting the input file and trying to correct smaller snippets, which can later be reassembled by concatenation.

3. Frequent discrepancies. If time slips occur in rapid succession, typically with alternating signs (+1 sample, -1 sample, etc.), the number of samples between slips is insufficient for proper interpolation. In this case, the –s parameter be set to a threshold in seconds, that has to pass without a new time slip, before a new interpolation is done.

1.1.20 smtsread

This programs converts data sequences that have been requested from a MTS-M tsunameter seismocorder in an ocean bottom unit (OBU) by the buoy computer´s OBUD program. It works similar to mtsread, just without mls.sys file information, which is replaced by the header information in the data sequence file.

Data in- and output can be pipes or files only, with no additional parameters:

EXAMPLE:

smtsread </data/inputfilename >/data/outputfilename

Please note that this command cannot be used to read data from regular memory cards with recorded data, but only to read the special format used in the modem-buoy communication as stored by the buoy computer

1.1.21 pressure2ascii

This programs converts sequences of pressure data that have been retrieved from a MTS-M tsunameter seismocorder in an ocean bottom unit (OBU) by the buoy computer´s OBUD program.

It writes the data as ascii-text into standard output or into a file with a filename of your choice.

The input file has to be generated by the OBUD software. These data files can be read by pressure2ascii using the --file option.

EXAMPLE:

pressure2ascii --file 765432_10.obud.2 >/data/outputtextfile

-where '765432_IO.obud.2' is a file stored by the OBUD software on the buoy computer after retrieving pressure data from the OBU.

- where ' /data/outputtextfile ' is a path and filename of your choice. If you leave this string in your command, the ASCII data will be piped into standard output.

The resulting ASCII file conforms to the CSV standard and looks like:

```
date & time of first sample;06.02.2006 07:28:16
sample time;pressure (mBar)
0;1088,6
15;1088,7
30;1088,7
..;......
```

The start time of the measurement is noted in the first line of the file. The second line explains the sorting of the following data. The first value in the data lines stands for the seconds gone since the measurement was started.

Please note that this command cannot be used to read data from regular memory cards with recorded data, but only to read the special format used in the modem-buoy communication as stored by the buoy computer

1.1.22 ph2ascii

This programs converts sequences of pressure history that have been retrieved from a MTS-M tsunameter seismocorder in an ocean bottom unit (OBU) by the buoy computer´s OBUD program.

It writes the data as ascii-text into standard output or into a file with a filename of your choice.

The input file has to be generated by the OBUD software. These data files can be read by pressure2ascii using the --file option.

EXAMPLE:

ph2ascii --file 765432_10.obud.2 >/data/outputtextfile

-where '765432_IO.obud.2' is a file stored by the OBUD software on the buoy computer after retrieving pressure data from the OBU.

- where ' /data/outputtextfile ' is a path and filename of your choice. If you leave this string in your command, the ASCII data will be piped into standard output.

The resulting ASCII file looks like:

```
date & time of first sample;06.02.2006 07:28:16
sample time;pressure (mBar)
0;1088,6
15;1088,7
30;1088,7
..;......
```

The start time of the measurement is reported in the first line of the file. The second line explains the sequence of the following data. The first value in the data lines stands for the seconds passed since the start of the measurement.

Please note that this command cannot be used to read data from regular memory cards with recorded data, but only to read the special format used in the modem-buoy communication as stored by the buoy computer.

Combining the programs

The concept to use standard input and output allows to hand over the data easily from program to program and to combine the program modules in 'pipes'.

Example 1:

$ mesread --begin 708669934 --end 708685565 < /dev/sdc | seg-ywrite --dest ~/segy_data/ --shot ~/shots/shotfile.txt --tracelen 2000

In this example, mesread cut out data from the raw data file on GEOLON's harddisk between the GPS time 708669934 seconds and 708685565 seconds and passes them over to seg-ywrite via standard output. Seg-ywrite cuts the data stream into traces of 2000 samples regarding the shot times in the shot-time file shotfile.txt. In the example this file is located in the subdirectory 'shots/' of your home directory. For each activated channel during recording, a file with the extension '.segy' will be stored in the directory ~/segy_data/. The complete sequence of commands could also be arranged in a script.

Example 2:

$ mesread --begin 708669934 --end 708685565 </dev/*devicefile* > ~/temp.s2x
$ seg-ywrite < ~/temp.s2x --dest ~/segy_data/ --shot ~/shots/shotfile.txt --tracelen 2000
$ wavewrite < ~/temp.s2x --dest ~/wave_data/

Here, mesread cut out data from the raw data file on GEOLON's harddisk (via Firewire connection, established through the *devicefile*) between the GPS time 708669934 seconds and 708685565 seconds and writes standard output into the file 'temp.s2x' in your home directory. In the second line you find the command to start seg-ywrite, which cuts the data stream into traces of 2000 samples regarding the shot times in the shot-time file shotfile.txt. The third line shows how the same file 'temp.s2x' can be used for data conversion into audio wave format. If you would use pipes to get the same result, mesread would be started twice: The first time in the pipe combining mesread with seg-ywrite and the second time combining mesread with wavewrite.

1.1.23 Structure of the shot file

Normally, the program uses a shot file for converting the raw data file in a file of single traces. The shot file has to contain the name of shooting-line (or profile), the shot point number, and shot time at minimum. Also the entry of the geographical coordinates of the shot points are possible. Together with the coordinates for the receiver, provided by the options --gcx and --gcy of seg-ywrite, the complete geographical positioning information of shot and receiver can be stored in the resulting SEG-Y file.

Shotfiles generally consist of a header line containing field descriptions and parameter options, followed by lines of data and terminated by a blank line containing a single carriage return.

Seg-ywrite can read following shot file formats:

1: GPS time in seconds.microseconds

LINENAME	SHOTPOINT	GPS-TIME:SEC
abcd-1234	1234	1234567.123456
abcd-1237	1237	1234597.123456

abcd-1314	1314	1234607.123456

2: GPS time in seconds.microseconds + coordinates of shotpoint

LINENAME	SHOTPOINT	GPS-TIME:SEC	X-COORDINATE	Y-COORDINATE
abcd-1234	1234	1234567.123456	374136	6456332
abcd-1237	1237	1234597.123456	374136	6456332
abcd-1314	1314	1234607.123456	374136	6456332

3: GPS time in year.month.day_hour:minute:second.microsecond

e.g.: 2003.05.07_06:14:49.123456

LINENAME	SHOTPOINT	GPS-TIME:DATE
abcd-1234	1234	2003.05.07_06:14:49.123456
abcd-1237	1237	2003.05.07_06:14:50.123456
abcd-1314	1314	2003.05.07_06:14:51.123456

4: GPS time in year.month.day_hour:minute:second.microsecond + coordinates of shotpoint

LINENAME	SHOTPOINT	GPS-TIME:DATE	X-COORDINATE	Y-COORDINATE
abcd-1234	1234	2003.05.07_06:14:49.123456	374136	6456332
abcd-1237	1237	2003.05.07_06:14:50.123456	374136	6456332
abcd-1314	1314	2003.05.07_06:14:51.123456	374136	6456332

The header line contains the following field discriptors:

LINENAME: The corresponding fields contain descriptive string up to 16 characters long.

SHOTPOINT: The corresponding fields contain an ASCII coded number up to 2147482648.

GPS-TIME: The corresponding fields contain ASCII coded time information. The colon-separated parameter options may be either **DATE** for a human-readable timeformat or **SEC** for time values in GPS seconds since start of service on January 5th, 1980.

The data format for the **SEC** option is SECONDS.MICROSECONDS.

The data format for the **DATE** option is YYYY.MM.DD_HH:MM:SS.ssssss, where

YYYY	holds the year as a four digit number
MM	holds the month as a two digit number with leading zero
DD	holds the day as two digit number with leading zero
HH	holds the hour as two digit number with leading zero
MM	holds the minute as two digit number with leading zero
SS	holds the seconds as two digit number with leading zero
ssssss	holds the microseconds as six digit number

Please note, that all GPS time formats have a common requirement: The microseconds must consist of figures with 6 numbers after the decimal point.

The program expects pure GPS-time, which is counted in seconds after 6th January 1980, 00:00 o'clock (start of GPS by USA). Often UTC is used instead of the GPS-time. UTC time is currently (in 2006) 14 seconds behind GPS Time, that means:

GPS-time = UTC + 14 seconds

When you use UTC-time for the synchronisation of the recorder and the GPS of the gun-boat delivers GPS-time, then 14 sec have to be added to your recorder-time (see option -timeshift) to get a comparable time basis.

X-COORDINATE: The corresponding fields optionally contain the x-coordinate of the shot position.

Y-COORDINATE: The corresponding fields optionally contain the x-coordinate of the shot position.

Following the SEG-Y standard, the x and y coordinates have to be in seconds of arc, if spherical coordinates are used. Then, the x value should represent longitude and the y-value latitude. A positive value designates the number of seconds east of Greenwich Meridian or north of the equator and a negative value designates the number of seconds south or west.

Seg-ywrite automatically recognises if your shot file contains only 3 columns instead of 5 (if no coordinates are available). The columns have to be separated by empty spaces or tabs.

Seg-ywrite writes four SEG-Y files, each containing the data of one channel.

If you have no shot file, please use the program option wavewrite. The resulting '.wav' file can be displayed using a sound-display program as for example COOLEDIT.

1.2 Files

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

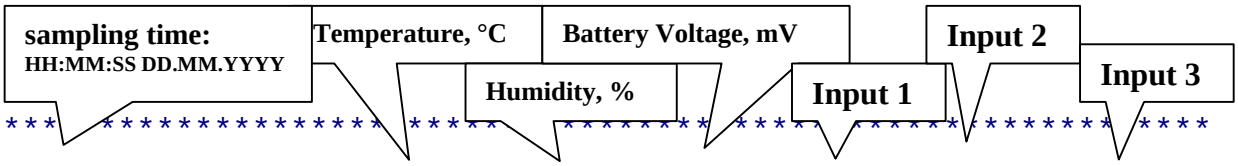
1.2.1 Log - File of Geolon-MES and Geolon MCS

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 meslog 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 kind of *log file_ name*.txt.

1.2.2 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 programs mesread and mcsread provide the extraction of the engineering data out of the recorded data stream. The file will automatically be written in the current working directory. The corresponding file name is described in chapter 1.3.3.

The engineering data file looks like:

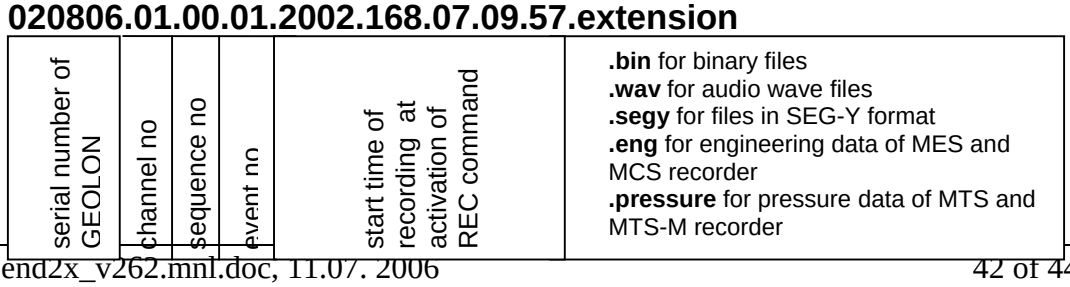



```
***************************************************************************
time                    temp  hydr   ubat   ain1   ain2   ain3
06:14:49 07.05.2003      27    49   13623
06:15:49 07.05.2003      27    49   13623
 ..    ..    ....      ...   ...   ...     ...    ...     ...
***************************************************************************
```

Input 1-3: free channels for user defined input. For the GEOLON-MTS and MTS-M variants, the engineering data files contain the pressure values recorded for the corresponding pressure sensor.

1.2.3 Data Files

The programs binwrite, wavewrite and seg-ywrite generate automatically files with names of following nomenclature:



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