Geosignal ™

Dataloggers

XP 101K USB

Version 1.0.1

User Manual

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Introduction

Thank you for purchasing a data logger XP 101K USB (waterproof standard alone pressure data logger.

XP 101K is a stand alone pressure data logger storing up to 3.9 million measures on its internal memory, it is implemented as generic USB disks and is designed to operate under any operating system capable to read standard USB flash drives (pen drives).

Some of the features XP 101K are:
- One analog channel with 16 bit oversampling resolution.
- Double calibration for maximum precision.
- Multiple starts with separate timestamps for each sampling section.
- Text file output compatible with common software like Open Office and Excel.
- Memory erasing protected by password.
- Programmable sampling interval from one millisecond to one week.
- Rechargeable High quality NiMH 2.4V battery,

XP 101K does not need a specific software for data downloading and programming, as programming is done by editing a text file "CONTROL.TXT" which is found in the disk itself.

Type A

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Type B

Data is saved on a read only file named "DATALOGS.CSV"

The data logger will start scan at the given time with the given scan rate after it will be detached from the USB socket.

Getting Started

Initialising

- The data logger is password protected and needs to be initialised before use. Each data logger has a different password (code) which is required for erasing and initialising.
- Please keep the code in a safe place as it is always required for erasing the memory.
- Pull to remove the waterproof cap and connect the data logger to a USB socket of a USB host enabled device (PC, tablet, etc), to guarantee waterproofness make sure that a layer of silicon grease is always present on the o-ring.
- The data logger will appear like a USB disk storing three files: and DATALOGS.CSV, CONTROL.TXT, and CALIBRAT.TXT. Open the file CONTROL.TXT with a simple text editor. If your system does not have a native text editor please install one before using the logger. We have tested Notepad on Windows, Gedit on Ubuntu, and Ted on Android 4.0.
- Please note that some Android devices have no host capability, others do not immediately open USB drives and require a specific app to manage USB drives, check with device specifications for USB Host capability.
- The latest Mac versions can open the logger in read only mode an error message is shown "Cannot repair disk": however this logger works up to Snow Leopard. In this case Mac users should install a "Virtual Machine" (VirtualBox) that can be downloaded for free and run a Snow Leopard image or a free Linux image or a Windows one to program the device. However the logger remain fully readable by the latest Macs OS Versions: Data can be downloaded (sampling will resume once the device is unplugged, excluding millisecond sampling).
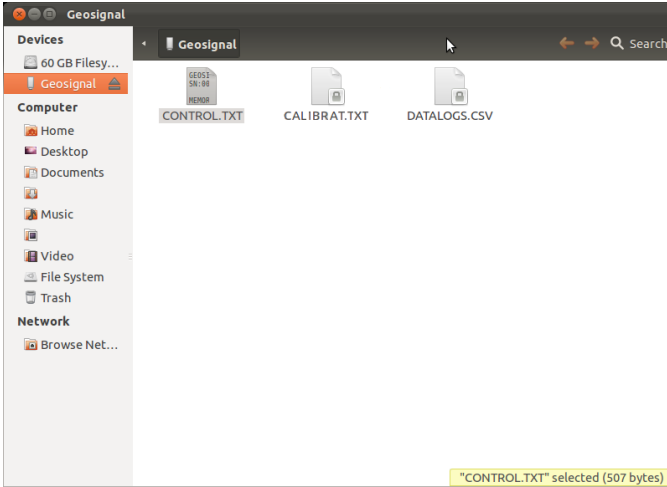
The file CONTROL.TXT on a XP 101K will appear as below:

```
GEOSIGNAL USB DATA LOGGER
SN:00000001

MEMORY: code?
DATE: 18Y/04M/06D Fr
TIME: 12H:00M:48S
SCAN RATE: 00s
START TIME: 05M/04D 12H:00M:30S Fr
CLOCK: +000
SENSOR:000.50 Bar+0000 Bt50%

Edit values & save file to program them.
Do not change position/length of fields.
Detach and plug device to show actual
programmed values.
Log starts at Start Time after device is
detached from USB.
Scans: @ms 00s 01s 10s 01m 10m 01h 01d
Clock +-sec per week
Sensor  Bar/Psi +-.0015%
Input code to unlock device.
```

(Note: Above colours are not shown on the file; they are only for clarity)

- Replace the line "MEMORY: code?" with "MEMORY: xxxxx" where xxxxx is the 5 digit code specific to your data logger. For example if your code is 01234, type:
- "MEMORY: 01234"
- Save the file to activate the code: the red LED of the data logger will quickly flash for a few seconds and the data logger will restart. (The LED is located near the USB plug behind the transparent window cap).
- Close and and reopen the file CONTROL.TXT. Now, if the code was correct, it will read: "Memory: 00000" indicating that the memory is blank and the device ready.

Programming: Adjust Time, Date, Scan Rate

- Each time the data logger is connected to a USB socket and CONTROL.TXT is read by the computer operating system: the data logger reads its memory, registers and sensor and changes the information contained in CONTROL.TXT. Please NOTE: we have found that after the data logger has been connected to a USB socket, all the different operating systems (we have tested) read the file just ONCE.
- CONTROL TEXT IS CASE SENSITIVE! Use the indicated characters. Do not change low case with High case one and viceversa.
- Open CONTROL.TXT and edit the scan rate, current time, and starting time; do not change position and length of the fields; for example: "DATE: 18Y/01M/01D Mo" must not be changed in "DATE: 18Y/1M/1D Mo"
- Possible scan rates are: @ms, 01s 10s, 01m, 10m, 01h, 01d, (00s means stop)
- Save the file, the data logger LED will blink.
- If the data logger LED did not blink the file was not really saved, but it is just temporarily stored in the computer cache. This behaviour depends on the operating system. Windows and Ubuntu immediately save the file but some other operating systems or older versions may require you to unmount the device or go through the process of "Safely remove the device".

- Please also note that the data logger internal time is programmed into the data logger in the precise moment the red LED blinks: what is written in CONTROL.TXT is what is programmed when the led blink.
- Detach the data logger to start the acquisition.
- Close the waterproof cap <u>making sure an uniform layer of silicon grease</u> has been placed all around the o-rings.
- If the starting time is past the data logger will start immediately, if the weekday is incorrect the logger will wait indefinitely to start even if the starting time is past.
- If you instead only wanted to stop the data logger then you should have programmed the scan rate as: "`SCAN RATE: 00s`"
- At scan time the red led will blink for an instant.
- "`SCAN RATE: @ms`" will set the logger to scan at millisecond scan rate which needs to be set with a separate command (please see the below millisecond scan rate paragraph).

Downloading Data
- Connect the data logger to any USB socket of a computer.
- If the logger shows "`SCAN RATE: pgm`" that indicates it is still waiting for the first scan.
- Scan will stop and will be resumed once the data logger is detached.
- Copy the file DATALOGS.CSV from the disk drive to your computer and open it with a text editor, or Open Office, or Excel.
- Large files need more time to be copied please be patient, do not overload the memory if not necessary.
- Make sure the data has been actually copied onto your computer hard disk before erasing the data logger memory.

Erasing memory
- Connect the data logger to any USB socket of a computer.
- Do not try to erase directly the file DATALOGS.CSV as it will only be removed from the computer cache, not from the memory of the data logger.
- Open the file CONTROL.TXT with a text editor,

- Replace the line "MEMORY: 32767" with "Memory: ERASExxxxx" where xxxxx is the 5 digit code specific to your data logger. For example if your code is 01234, type: "Memory: ERASE01234"
- Please note: The command is case sensitive "ERASE" must be in capital letters.
- Save the file to activate the code: the red LED of the data logger will quickly flash for a few seconds and the data logger will restart.
- <u>CLOSE</u> the file CONTROL.TXT and reopen it: Now, if the code was correct, it will read: "Memory: 00000" indicating that the memory is blank and the device ready.

Charging battery
- Please note that the battery of the logger is charged while the logger is connected to the USB port.
- Battery Life Expectancy: A battery with 50% charge would allow the logger to record a full memory a few times.
- Battery voltage is checked automatically by the data logger when it is inserted into the USB socket. The charge percentage is shown as "Bt 99%" in the file CONTROL.TXT and it is worked out from the battery voltage which may not reflect the real level of charge all the times, charge the logger to 70% for a few hours, please take also in account that the battery may have an internal self discharge.
- 99% (2.9V) is the maximum level of charge possible and it depends on the battery brand and age normally a 70% (2.75V) is acceptable. Batteries polarise and show less after a few minutes charging has stopped, as the battery ages the effect increases.
- Procedure: Make sure the data logger is stopped and it is not sampling in the next minutes, close the file CONTROL.TXT, detach the data logger from the USB socket, reattach the data logger to the USB socket, reopen the file CONTROL.TXT, read the updated battery value.
- The charge level shown can vary between 0% and 99%

Reset
- To properly reset the data logger: Use the tip of a pen to press the reset button located at the top of the USB plug inside the logger.
- After that the file CONTROL.TXT of the data logger will show that the current time has been reset and needs to be reprogrammed.
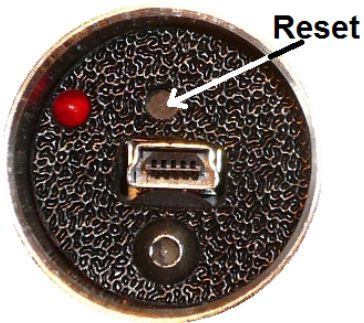
Read inputs in real time
- The data logger reads its input just once when it is connect to a USB socket. The current value is shown in CONTROL.TXT
- It would be possible to read the input again by reading the sector 0x89 by direct disk access.

Changing Measurement Units
- Calibration and measurement units can be changed by editing CONTROL.TXT.
- For example: it is possible to change between BAR and PSI by editing the line "`SENSOR:010.00` `BAR``+0000`" to "`SENSOR: 010.00` `PSI``+0000`" and saving the CONTROL.TXT.
- The data logger will restart.
- Close and reopen the file CONTROL.TXT, it will show: "`SENSOR: 145.04 PSI+0000`"

Millisecond Scan Rate
The datalogger can scan at fast rate with 12bit resolution. The fast scan rate can be set with:
`SENSOR: 000.00` `Mls``+``0100`
sets 100 millisecond scan rate (or any other value from 500 to 1 ms
The fast scan rate will be activated by selecting by the basic scan rate command: "@ms" when programming the starting time into CONTROL.TXT.
The file CALIBRAT.TXT shows the current millisecond scan rate.

Memory Structure

The memory of the data logger is flash memory and structured in pages translated in sectors of a generic detachable USB drive. Each page contains 120 datapoints.
The maximum number of pages is 32768. Each page is timestamped (TO THE SECOND PRECISON!) then the timestamp of each datapoint is calculated according the given scan rate.

The data logger will appear as a disk storing three files: DATALOGS.CSV, CONTROL.TXT and CALIBRAT.TXT.
CONTROL.TXT is meant to control the data logger and to show its current state, memory and time.
DATALOGS.CSV contains the data. If it is empty its length is zero.
CLAIBRAT.TXT show the calibration constants and other parameters.
CONTROL.TXT once opened with a text editor like notepad will appear as follow:

```
GEOSIGNAL USB DATA LOGGER
SN:00000001

MEMORY: 00136
DATE: 18Y/01M/01D Mo
TIME: 12H:40M:48S
SCAN RATE: 10s
START TIME: 01M/01D 12H:00M:30S Th
CLOCK: +000
SENSOR:050.00 PSI+000 Bt50%

Edit values & save file to program them.
Do not change position/length of fields.
Detach and plug device to show actual programmed
values.
Log starts at Start Time after device is detached
from USB.
Scans: @ms 00s 01s 10s 01m 10m 01h 01d
Clock +-sec per week
Sensor Bar/Psi +-.0015%
To Erase: MEMORY: ERASE+code.
```

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(Note: previous colours are not shown on the file; they are only for clarification)

This file is created when the data logger is connected to a USB socket and the operating system of the computer or tablet or host device reads the contents of the file.
It important to understand that the file is not necessarily created when the file is opened by you.

When editing this file it is extremely important not to change the position and length of the fields and the case of the characters as the data logger will refuse to program itself if data is found in the wrong position/format.
Also take in account that the parameters typed into the file that you are editing with the computer are transferred to the data logger only when the computer decides to. Normally this happens when you 'Save' with the text editor, but some operating systems require you to unmount the data logger (UNIX command) or to go through the process of 'Safely remove the drive' before the data is actually programmed into the data logger.
The data logger features a red LED to inform you that data has been actually stored on its memory by the computer operating system.
The data logger will also restart when an important data change like erasing or calibration has been performed, these changes have priority over date, time, starting time and scan rate which are not programmed when a restart is processed.
When a restart occurs the data logger detaches and reattaches itself to the USB, the device will update its local instance of the file CONTROL.TXT and you need to close and reopen the file to see the changes and to edit the file again.

The disk is supposed to be read only with the exclusion of CONTROL.TXT, hence the disk cannot be formatted nor other files can be written on it: any attempt will produce a disk error.

CONTROL.TXT shows:

`SN:00000001`   (Serial number which is unique for each data logger)

`MEMORY:` `00136` (Memory used: stored pages of 120 datapoints). It can also be used to erase the memory.

`DATE:` `18Y/01M/01D Mo` (Current Date in reverse order Year/Month/Day)

`TIME:` `12H:40M:48S` (Current Time actually when the data logger was inserted into USB)

`SCAN RATE:` `10s` (Current Scan rate which can be: `00s`, stopped; `01s`, one second; `10s`, ten seconds; `01m`, one minute; `10m`, ten minutes; `01h`, one hour; `01d`, one day; `@ms`, milliseconds as per millisecond scan rate to be set beforehand, shown in CALIBRAT.TXT).

`START TIME:` `01M/01D 12H:00M:30S Th`

in decreasing importance order: Month/Day Hour:Minute:Second Weekday.

The weekday (Mo Tu..) is always necessary as the logger will not start if weekday is incorrect

The starting time has to be consistent (correct weekday) even if the starting time is past and not being used.

`CLOCK:` `+000` indicates the clock calibration in + or – seconds per week and can be changed to adjust the internal clock if it is running fast or slow.

`SENSOR:` `050.00 PSI`+0000   indicate the current reading

The possible options are (file need to be edited and saved):

`SENSOR:000.00 `Bar`+0000` set BAR as measurement unit

`SENSOR: 000.0 `Psi`+0000` set PSI as measurement unit.

`SENSOR: 000.00 `Off`+`0001 sets the Offset calibration.

`SENSOR: 000.00 `Sca`+`0001 sets the Scale calibration (Gain).

`SENSOR: 000.00 `Mls`+`0100 sets 100 millisecond scan rate.

`Bt50%` is the indicative level of charge of the battery. This value is related to the actual voltage of the internal battery, it does not take in account of the charging history of the battery, so it will be higher immediately after a charging session. Avoid overcharging the battery and disconnect the logger as soon as possible from the USB if Bat99% is shown.

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Data File Structure

The stored data is accessible by opening a text file in csv format (comma separated values). Formerly: comma separated vector.
The format of the file can be as following:

```
2018/04/19,10:06:00,111.01  ,BAR
2018/04/19,10:06:01,111.01  ,BAR
2018/04/19,10:06:02,111.01  ,BAR
2018/04/19,10:06:03,        ,BAR
2018/04/19,10:06:03,        ,BAR
2018/04/19,10:06:03,        ,BAR
2018/04/19,10:06:03,        ,BAR
```

The date is in reverse order: year/month/day.
Time is in 24h format.
The pressure datum takes a eight character field.
The last field marks the measurement units, BAR in this case.
The values of an existing file are automatically converted in PSI when the logger is set to operate in PSI.

All fields are separated by a comma and the period marks the decimal point.
If the logger is used in a country where comma is used for the decimal point please adjust the file import options of the software you are using.
The format of date and time can be changed after importing.
The blank fields indicate that the logger has been stopped, then restarted and the last memory page has not been completely filled.
Negative pressure measurements can also be shown.

Calibration

The data logger allows two point calibration of its pressure sensor and a 'seconds per week' calibration of the internal quartz clock.

Calibration is done by editing and saving the parameters SENSOR or CLOCK of the file CONTROL.TXT

CLOCK: +012   for example will add approx 12 seconds per week on a slow clock, it is possible to add up to 127 seconds or to detract -128.

Offset and scale Calibration:

The datalogger stores the raw data into the memory separated from the calibration constants, then during file access the raw data is converted into a more readable text/csv file.
If the offset and scale values are changed the contents of the file will also change.
Although small negative pressure values can be shown because of calculation and errors the logger cannot measure negative values (depression).

To compensate for zero and gain errors XP 101K can be programmed with the following:

The offset calibration compensates for any zero pressure offset errors:
SENSOR:000.00 Off+0001 set the offset calibration: add input x FS x offset (0001) x 0.0000152, this will increase or decrease the raw output of the sensor up to +15% of FS (000.00 Off+9830) and down to -15% of FS (000.00 Off-9830) in order to compensate for any offset errors.
The offset compensation is always added to the measures.

The Scale calibration compensates for any pressure gain errors:
SENSOR: 000.00 Sca+0001 set the scale calibration: add input x FS x scale (0001) x 0.0000305, this will increase or decrease the gain on the sensor up to about +30% of FS (000.00 Sca+9830) and

down to about -30% of FS `(000.00 Sca-9830)` in order to compensate for any gain errors.

The scale compensation is proportionally added to the measures but only after the offset calibration has been added.

Shown Values = (Raw data + Offset) * (2^15 + Scale)/2^15 * FS / (2^16).

No decimal fractions are allowed in programming the scale and offset values, the input values must be always a sign (+ or -) followed by a four digit figure formatted with leading zeroes.

The file CALIBRAT.TXT shows the current offset, scale, FS (Full Scale), and millisecond scan rate constants currently operating within the instrument.

It also shows the equivalent values in term of pressure (when applicable).

Calculating Offset and Scale

Please note that the offset does not correspond to the output of the instrument at zero pressure as the sensor is not always linear in proximity of zero pressure.

To calculate the Offset and Scale constants a calibrator (pressure reference) must be used.

A low pressure water column has been used with this example for working out the offset of a low pressure logger.

Take a few measurements at different known pressures.
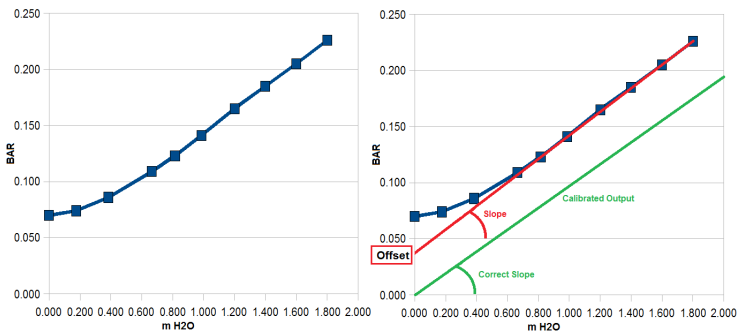
The acquired data should appear more or less like the below chart. The datapoints should follow a straight line the Y intercept is the pressure offset (0.039 Bar in this case).

The datapoints not following the line should be discarded.
To calculate the Instrument offset (to be programmed into the control file) use the following formula:
(0.039 / FS) * 65536 = 148
FS is the full scale: 17.236 Bar in this case (as show by CALIBRAT.TXT)

Note: 65536 = 2^16bit

.
Calculating the Scale Constant requires us to calculate the ratio between the ideal slope and the current one.

Calibration should be done at about ¾ of the FS of the instrument with a reference pressure (after the instrument has been programmed with the correct offset).

The correct slope should be 1.000 (Reference pressure / Read pressure).

A ratio of 1.000 indicates: no need of scale calibration; a ratio smaller than 1.000 indicates that the gain needs to be lowered; a ratio greater than 1.000 indicates that the gain needs to be increased.

For Example: analysing some datapoints the ratio between reference pressure / read pressure works out as 0.99684.

To calculate the Instrument scale (to be programmed into the control file) use the following formula:
ratio * 32768 -32768 = offset → 0.99684 * 32768 -32768 = -104

Note: 32768 = 2^16bit / 2
If the instrument is set to operate in Psi the calculation does not change, just replace FS with the Psi FS value (249.99) in this case as 249.99 Psi = 17.236 Bar. There is no need to recalibrate nor change offset and scale values when switching between measurement units (between Psi, Bar).

Troubleshooting

Datalogger does not connect to PC

- Battery flat: allow a few minutes to charge
- Perform a reset: Please try a few times.

Inconsistent date and time or keep showing "pgm" without starting

- Reprogram date and time unplug and re-plug the data logger.
- Perform a reset: Please try a few times.

Datalogger does not program scan rate or date and time:

- After saving CONTROL.TXT make sure device is unmounted or "Safely removed"

Datalogger is connected but an error is produced when downloading data file:
- Erase memory

Measures downloaded are inconsistent:

- Change the operating range to one more appropriate.

Datalogger does not store data:
- Scan rate was not programmed or mistake in setting the starting date and time. Always check twice for the correct start time and for correct parameters (case sensitive) before saving CONTROL.TXT.
- Out of Memory: Erase memory

Technical specifications

Please note that specifications may change without notice.

Model	XP 101K USB	
Analog channels	1	16bit resolution by oversampling (Scan ≥ 1 second)
Ranges	BAR	Type A: 17.2 BAR (gage) Type B: 8.6 bar; to 680 bar (gage)
Ranges	PSI	Type A: 250 Type B: 100; to 10000
AD Converter	1	12 bit
Un-calibrated Accuracy	%	Type A: 2% Type B: 1%
Power supply	2	1.2V NiMH 700 mAh batteries
Current absorption	µA	3µA in standby mode; 10mA while connected to USB
Communications	1	USB
Internal Timer	Yes	100 year calendar with leap year
Sampling interval		1-500msec, 1 sec, 10 sec, 1 min, 10 min, 1 hour, 1 day
Software	No	Not required
Operating Temp.	℃	-40 + 85 °C (excluding battery)
Compensated Temperature	℃	Type A: 0°C to +50°C Type B: 0°C to +55°C
Media Compatibility		Type A: All fluids compatible with 304 stainless steel, PPA plastic, fluorosilicon rubber, Type B: Monolithic stainless steel construction all fluids compatible with17-4 stainless steel.
Maximum Media Temperature.	℃	Type A: 0°C to +100°C Type B: 0°C to +125°C
Overpressure		2X FS
Pressure Port		Type A: ¼ BSP Type B: ¼ NPT
Dimensions(max.)	mm	137 x 26 x 25.4 mm
Weight	g	Type A: 140g Type B: 185g
Protection Grade		IP 67 waterproof

Order Code

Order codes
XP 101K-A: (250 PSI / 17.2 BAR)

XP 101K-B-[range]
ranges:
100 PSI (6.88 BAR)
250 PSI (17.2 BAR)
1000 PSI (68.8 BAR)
5000 PSI (344 BAR)
10000 PSI (688 BAR)

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