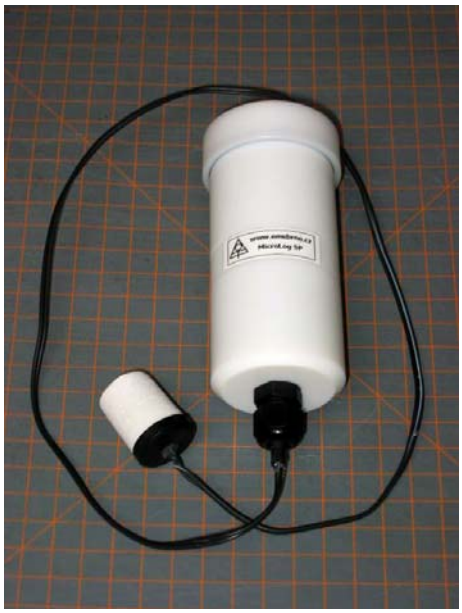
MicroLog SP

One-channel datalogger for soil water potential measurement.

User's manual



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Obsah:

1 General information

MicroLog SP is a small water-sealed datalogger designed for the resistance measurement using of square wave symmetrical alternating current. It is intended for the measurement of soil water potential with sensors whose electrical conductivity is related to soil water content (gypsum block, Watermark sensor). Since the datalogger processor measures also its own temperature, the logger body can be used also for the measurement of ambient or soil temperature.

The datalogger case is made from high-density polyethylene allowing its long term leaving in soil. It also survives a temporary immersion to water.

Data memory can store typically 25,000 readings what means ca 28 months of continuous measurement of soil water potential or more than one year of storing of both soil water potential and temperature data. One record in memory generally represents the average of more measurement within the storing interval. Both intervals can be set independently.

The datalogger memory (non-volatile type) saves data also under totally discharged or damaged battry. Two ways of memory handling it is possible to choose during datalogger initialization: (i) system stops operation when the memory is full or (ii) it keeps running rewriting the oldest data with the newest ones.

PC with a Windows© 95 system or higher is required for datalogger setting and data handling. However, a simple reading unit for field data downloading of many EMS datalogger is under development.

Mini32 fancy graphical software with many useful options including base statistics is a part of delivery.

Battery duration of 3.6 V lithium battery reaches up to six years of continuous work in hourly measuring intervals. The battery replacement can be easy done directly in the field without any tool.

2 Specifications

Measuring range	0 to 35 kOhm
Measuring frequency	160 Hz
Measuring current (constant)	33 µA
Measuring signal wave form	Square wave, symmetrical
Accuracy:	Better than 0.5 % of reading over the whole temperature range
Operating range:	
- temperature	-30 to 80 °C
- relative humidity	0 to 100 %
Datalogging unit:	
- memory capacity	25,000 values typically
- measuring interval	10 min to 24 hrs
- averaging (storing) interval	10 min to 24 hrs
- internal clock accuracy (-10 to 40°)	±2 minute per month
- input voltage resolution	16-bit
Battery lifetime:	Lithium LS14250 3,6 V; 900 mAh
- storage time/idle run (logging stopped)	8/6 years
- when measured every 10 minutes	3 years
- when measured every 1 hour	ca 6 years
Size (diameter x length)	32 x 110 mm
Weight (incl. battery)	cca 100 g

3 Soil water (matrix) potential sensors and their calibration

The above mentioned sensors make use of stable dependence of electrical conductivity on the water content in certain porous matter. Since the soil water potential of sensor body and surrounding soils should be equal, the sensor water content can be expressed in terms of water potential. Ion conductivity of water solution inside the sensor which generally influences the electrical conductivity is stabilized by the sensor chemical composition based on calcium sulphate.

3.1 Gypsum block

Delmhorst Instrument Copany, NJ, U.S.A. is one of the most known manufacturer of gypsum blocks. A truncated cone made from gypsum contains two concentric electrodes made from stainless mesh. The electrical conductivity of sulfate solution measured between those electrodes depends also on the temperature and soil structure. See e.g. http://www.emsbrno.cz/pdf/Dela2001.pdf. It should be mentioned, that there is no

common opinion concerning el. conductivity versus soil water potential depencence. The equation offered by Mini32 sensor library was derived from the table issued by producer (see GB 2 data sheet in appendix). The whole measuring range is up to 15 bars.

3.2 Watermark

Watermark soil sensor is a product of IRROMETER Company Inc., CA, U.S.A. Its design is more sophisticated than by gypsum block. Its stainless steel perforated coat strewed with a textile membrane is inside filled in with silica sand complemented with a gypsum capsule and two concentric stainless electrodes.

The 2 bars range fits to agricultural and irrigation purposes – see manufacturer information in appendix.

As for calibration to soil water potential and temperature, there is more available information yet. The Mini32 sensor library offers four equations of calculation soil water potential from measured a.c. resistance [kOhms]:

- linear (*rough*)

  kPa = (R-500)/135
- acc to Prof. Shock (*Shock 25*)

  kPa=(4.093+3.213*R)/(1-0.009733*R-0.01205*T)
- acc. to Watermark Meter made by IRROMETR company (*Irrometer*)

  kPa=(p1+p2*R+p3*R^2+p4*R^3+p5*R^4+p6*R^5)*(p7+T^p8) where

  p1 = -0.00121186
  p2 = 0.011105989
  p3 = -0.00026006
  p4 = 2.34E-05
  p5 = -6.37E-07
  p6 = 5.90E-09
  p7 = 368.1438832
  p8 = 1.699405795
- M. K. Hansen Company, WA, U.S.A. compatible (*Hansen*)

  kPa=(p1+p2*R+p3*R^2+p4*R^3+p5*R^4+p6*R^5)*(p7+T^p8) where

  p1 = -0.066892878
  p1 = 0.196380649
  p1 = -0.018840164
  p1 = 0.001736559
  p1 = -6.30E-05
  p1 = 0.01E-07
  p1 = 28.57229871
  p1 = 0.974296541

Note: In Mini32 software, all equations are implemented for temperature T=25 °C.

4 Operation

MicroLog SP datalogger can be used in any environment non-aggressive against polyethylene and synthetic rubber. The operating temperature should not exceed the range -30 to 80 deg.C and the overpressure 0.2 bar (two meters of water column).

MicroLog SP has no power switch. It is ready to run immediately after inserting of the battery before dispatching. The system configuration needs a connected PC running the Mini32 software.

When it is not in use (operation off), the battery lasts for about six years what is comparable with the total battery lifetime. Nevertheless, remove the battery from the system when the use in next month in not supposed. Note that the system will ask for initialization before next operation. See section After battery replacement or power drop-out.

4.1 Start operation

4.1.1 Basic setting

Screw off the lid that covers the datalogger electronics. Plug-in the PC cable to 2.5 mm socket on the front panel. **It is recommended to touch the metal front panel with the connector tip before plug-in in order to drain the static charge.**

Avoid water penetration inside the system when the system is opened. In case of long-term exposition of opened system to humid environment (hours or days) it is recommended to throw up the electronics from the case and blow in the case dry air (available as cleaning spray for electronic parts).

Run Mini32 software which is the part of delivery and push "Configuration" button. Set both interval of measurement and two-character device code.

Double click on a channel line opens a channel setting window. Set channel on, choose the sensor type (gauge) and add a description. Set the temperature measurement ON if it is demanded.

Left mouse click on ON/OFF button starts/stops data logging.

Press "Put" button in order to send the configuration to the datalogger.

4.1.2 Advanced setting

Push "More" button in "Configuration" window in order to approach advanced setting screen. This option enables:

- Datalogger reset (initialization). Initializing resets all system variables to default values, changes datalogger time and password, erases all the data from memory and sets the memory operation mode – see General information. System calls for initializing automatically always when the supply voltage has dropped bellow 2.9 Volts, i.e. after battery replacement or its total discharge. In such a case is the user asked for initializing after each communication attempt. Warning – save data always before initializing – they are lost afterwards!

- Memory erase (RAM clear) should be performed when the memory is full and the data overwriting is disabled and also when the data continuity is senseless or misleading – when the sensor in moved to different location for instance. Make sure the data were successfully saved before memory erasing!
- Hardcopy of memory (HCM). The whole memory content will be saved to file. Use it in case of problem with data conversion after downloading which could be caused by damaged data structure due to external factors. Send the file to producer for free encoding.
- Password. A four-character word can be introduced. Password disables unauthorized changes of configuration.

4.2 After battery replacement or power drop-out

It is necessary to initialize the datalogger always when the battery voltage drops bellow 2.9 Volt. This comes usually after the battery replacement or after its removing. See Advanced setting.

Note: The battery status is continuously calculated since the time of the last system reset. Naturally, the full capacity of the new battery (900 mAh) is supposed. Therefore, the battery duration will be overestimated in case of using a partially discharged battery. See also Battery replacement.

4.3 Memory capacity

Maximum number of days of the measurement stored in memory can be estimated according to formula

N = 25000/(n*k)

where

n = number of records stored each day

k = number of channels in use

Example: Soil water potential and temperature values stored to memory in hourly intervals will fill in the memory in 570 days.

Note: When storing the data of one channel each two hours or less often, the real memory capacity slightly decreases due to 15 bytes long system information stored into the data memory every day. When measuring in one channel once a day the memory lasts for ten years only instead of theoretically calculated 69 years.

5 Data processing

EMS Mini32 universal software supports also the data handling and processing.

Data download and saving process is activated after pushing "Download" button. All data from memory are saved in the file XY_2005_04_28.hex where XY is device code (see Basic setting) and 2005_04_28 is computer date (YMD). This *.hex file contains the stored data and complete configuration information including the last battery voltage and datalogger time in a compressed format suitable for fast transfer to computer. Since this format is not usable for next data processing, the file is subsequently converted to

another format - *.dcv (XY_2005_04_28.dcv). This file contains the same information as *.hex one, it is typically four time larger but suitable for fast processing as file mixing and chaining, time averaging, drawing, editing, statistical processing etc. In case of accidental wrong data processing in *.dcv file it is easy to create the *.dcv file again after opening the original *.hex file. Therefore, please save the original *.hex files for archive purposes.

Mini32 software offers a wide range of data operation, mainly:

- connection files of the same configuration coming from different time periods
- mixing files of different systems
- calculation mean values of different time intervals (hours, days)
- drawing selected variables in time with the possibility of easy erasing of irrelevant values
- export of data to text, Excel or Lotus format
- export of graphs to *.bmp format
- drawing of vertical profiles of variables it a certain time
- printing of graphs
- basic statistical analysis
- regression data analysis
- user defined calculation
- non-linear multi-regression analysis

6 Maintenance

Datalogger *MicroLog SP* does not need any special maintenance except of cable and sensor checking.

6.1 Battery replacement

The battery replacement is easy so it can be done directly in the field (not under rainy condition if possible).

- Screw out the datalogger lid
- Loose the hexagonal cap nut of sensor cable outlet
- Push-out the electronics by shifting the sensor cable down the case
- Remove the battery from the battery holder
- Short circuit the battery holder contacts with a metal part (pocket knife) in order to safely reset the battery life counter
- Insert new battery
- Make system reset. See After power drop-out.

6.2 Sensor replacement

Push out the electronics from the case the same way as by battery replacement. Loose the terminal screws and replace the sensor. Push the electronics back to the case and tight the cap nut. Check the setting and run actual values reading for sure.

Note: Use only the sensors adapted for this logger type by datalogger manufacturer. Connecting of sensors with flat cable will cause the water penetration inside the system and its serious damage. The warranty will void in such a case.

7 Warranty

The producer warrants right function of the measuring system for three years after it is accepted by a customer. All the faults will be removed free of charge during this time, at the measuring device itself as well as at sensors. The producer is not responsible for the faults originated by careless manipulation, incorrect operations, wrong applications or theft. The warranty covers the battery failure for three months only.

The fright to producer is paid by customer; the sending back is paid by producer.

8 Appendix

- MicroLog SP factory brochure
- GB 2 brochure (issued by EMS)
- Watermark brochure (issued by EMS)
- Watermark factory information