EMS Brno

Data Acquisition Environment

Hardware – Software – Cloud application

www.emsbrno.cz

RailBox datalogger product line

User's manual

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Content:

1. General description

The RailBox is a concept of flexible modular dataloggers with extremely low power consumption, high resolution and accurate measurement of voltages in microvolt range completed with sources of excitation for RTD sensors. The modules are ready for easy fixing to DIN-rail.

Besides of voltage and pulse input the dataloggers contain digital interface for connection of sensors sending data via serial line or SDI-12 bus. The system is ready for connection of up to 64 sensors; dataloggers support a maximum of 107 digital channels generated by those sensors.

These loggers are intended for larger custom applications like metostations, soil water systems, large sap flow systems, etc.

1.1. Main features

- Modular concept for DIN rail mounting
- Up to 64 voltage inputs and 8 counters
- 16 bit resolution
- extremely byte-saving data format (two bytes per value only)
- fast data download
- non-volatile data memory
- SDI-12 input
- Additional modules available: Modem, LAN interface, Power unit with solar charger
- storage capacity 220,000 (450,000 optionally) values
- low current consumption
- advanced Windows® software for datalogger configuration, data retrieval and processing
- ready for remote access via GSM modem
- large sensor library
- ready for remote access via GSM modem

1.1.1. Models available

The available models have up to 64 Voltage channels, 8 counters and 30 excitation outputs for connection of RTD temperature sensors (Pt 100, Pt 500 or Pt 1000). The attached sensors can be enabled or powered in both measuring and/or averaging intervals (see section 1.2.3).

Each final model may be assembled from

- 16, 32 or 64 voltage inputs

- 4 or 8 counters

- digital input which can be configured as

  - SDI-12 network

  - specifically, supported sensor connected by RS 232 or RS 485 (Gill WindSonic, Waisala WXT)

1.1.2. Accessories

Besides of a datalogger the RB system following modules can be added:

- GPRS modem EMS-GB2

- LAN interface EMS-L03

- Power module PSM14 for protecting the both the system against overvoltage and batteries from deep discharge. The module also manages recharging the batteries from a connected solar panel. The module has extremely low power consumption for operation in small systems with low energy demand.

- R-intf, F-intf and RF-intf – SDI-12 module for measuring of resistance with A.C. voltage (Gypsum block, Watermark sensors) and frequency (CS616 soil sensors, flow meters, etc.).

1.1.3. Specification

Number of voltage channels	16, 32 or 64
Ranges	± 20 mV up to ± 2.5 V in eight ranges
Resolution	16 bit
Accuracy	0.03% of full scale
Voltage limit	maximum +5 Volts from GND on any input terminal
Number of counters	4 or 8
Resolution	16 bit
Max. frequency of pulses	400 Hz
Input	Open collector, mechanical switch, TTL (max. voltage 16 V)
SDI-12 input	Up to 64 sensors, max. 108 logged variables
Datalogging part:	Non-volatile memory, 521 kB (optionally 1024 kB)
Capacity	250,000 (500,000) values
Measuring interval	3 sec to 4 hrs
Averaging interval	3 sec to 4 hrs
Warm-up time	1 to 5 sec, independently set for time of measurement and averaging
Exciting voltage	5 V ± 2 mV, independent outputs for excitation in time of measurement and averaging
max. load	30 mA
voltage drop	Approx. 10 mV/mA of loading current
Programmable switch	Two synchronized outputs – switched Ub and open collector (100 mA max)
RTD excitation current	Approx. 150 uA, multiplexed to each output
Auxiliary input for Pt1000 temperature sensor intended for the measurement of the temperature of the thermocouple reference junction – ratio based measurement	
Overvoltage protection	Diode suppressors connected to each input terminal completed with limiting circuit with warning sound
Power supply voltage	6.5 to 16 Volts
Power consumption – idle	Less than 1 mA (depends on arrangement)

Power consumption – measuring	30 mA (without excited load)
System back-up	Lithium coin type battery CR2032, 3 V
Back-up battery lifetime	5 years at least
Protection	Waterproof enclosure IP65 (optionally on demand)
Size (L x W x H)	25 to 105 x 120 mm
Weight	0.15 to 0.6 kg
Operating range	-40 to 60 °C

1.2. Hardware

The datalogger consists of 25 mm modules with DIN rail lock. Some of the modules have front panels equipped with switches, LED indicators or connectors covered by transparent lid. Frequently used elements are approachable by slots in the lid (RS232 connector Jack 2.5 mm, check button etc.).

All terminals are designed as removable connectors with screws for fixing wires. It allows comfortable wiring and easy module replacement.

For fast connection to a customized terminal board the voltage inputs can be connected via a flat cable.

1.2.1. Power supply

The datalogger is powered from external voltage 6.5 to 16 Volts. When the power is disconnected or the system is off, the internal real time clock is supplied from the build-in back-up battery. All data and system variables are stored in a non-volatile memory. **The back-up battery should be replaced every five years despite its specified lifetime is longer.**

The battery and system status are indicated by two LEDs on the upper panel. The green LED indicates normal operation. During the regular measurement it is on as well as when communicating with PC or other external system (modem).

The system status can be briefly tested after pushing the small button bellow LEDs.

The possible responses are:

- 3 x green correct datalogger status
- 3 x green + yellow low power voltage (bellow 6.5 Volts)
- 12 x yellow (quickly) incorrect system status

When the yellow LED flashes quickly, the datalogger has to be connected to a PC with running Mini32 software to amend the system status.

1.2.2. Memory

The datalogger measures electrical signals at input channels in regular intervals and stores the measured values in the memory.

The datalogger operates in two modes according to user's definition of how to proceed in case the memory is full:

- the logger continues operating and replaces oldest data in memory with actual values
- the logger stops operation

The operating mode is set by the process of datalogger reset (Initialization).

1.2.3. Data averaging

The measured values are saved directly or (more often) as an average within certain time interval. For instance, the logger measures every minute, calculates the hourly average and saves this value to the memory.

In this context two different time intervals are defined:

- measuring interval
- interval of averaging/storing

Both intervals have to be set as an integer fraction of minutes or hours and the ratio of both intervals has to be integer number, too. Therefore, there is a limited number of time intervals available: 1, 2, 3, 4, 5, 6, 10, 15, 20, 30 (seconds, minutes or hours).

Values of both intervals are checked by the software during the system configuration. Moreover, minimal time period is limited with respect to number of channels in use and the warm-up time setting (see 1.2.6). The maximal time period is limited by the hardware features to four hours.

1.2.4. Data format

The measured values are stored as two-byte integer numbers in a kind of database format. This way saves not only the memory space but also duration of data transfer to a connected PC or to GSM network. The conversion to technical units is performed later in the computer running Mini32 software. All information necessary for the conversion is stored in the downloaded file, too.

Downloaded file has an extension HEX and its length in bytes is roughly twice the number of stored values. The conversion to DCV format used by Mini32 software for data visualization and processing is offered during the downloading procedure. However, it can also be done any time later. Since the channel configuration in HEX file is editable, potential error in configuration can be fixed before the conversion to final values. See Mini32 user's manual for details.

Export to another format (text, MS Excel) is supported by Mini32 software.

1.2.5. Input channels

There are generally two types of input channels – voltage and pulses. The resistance is measured as a voltage on a resistor supplied with known electric current value. The other electrical variables like frequency, or resistance measured with a.c. current need an additional interface modules.

1.2.6. Excitation

Beside of self-powered sensors (powered directly by the measured media) most of sensors need electrical power supply for operation. Dataloggers support two main types of excitation:

- Excitation of variable resistance sensors, mostly RTD (resistance temperature detector). This approach is used typically in temperature sensors with Pt100, Pt1000 sensing elements. These sensors are connected to the current source during the measurement only in order to avoid self-heating. The value of the excitation current is kept around 150 uA and it is measured concurrently with the voltage drop on the resistor and stored in the data file for later calculation of resistance.
- Excitation in terms of power supply of sensors. For this purpose, the datalogger has two independent voltage outputs delivering 5 V with the maximum load of 30 mA. One output is active in each period of the measurement (PM), while the second output is activated in the period of averaging only (PS). Since also the measurement of each voltage input can be performed in averaging period only, some sensors measuring slow processes need not to be measured so frequently as other sensors. It generally saves energy especially when power demanding sensors are used.

Since more and more sensors use sophisticated electronic with microprocessors, it is necessary to wake them up some time before the scheduled measurement. Therefore,

there is a possibility to switch on independently both excitation outputs up to five second in advance. See paragraph 2.2.

1.2.7. Counters

The particularity of counting channels is its cumulative nature. The sensors have to be powered continuously and each lost pulse is irretrievable. This feature makes them more sensitive to power drops and any other kind of disturbance. Because the pulses are rarely rectangular and they are often followed by oscillations, the input signal has to be shaped before processing. This needs a front-end low pass filter removing false pulses. Therefore, the maximum frequency of incoming pulses is limited (See specifications 1.1.2).

1.2.8. Programmable switch

Beside of excitation outputs the datalogger is equipped with a bi-stable programmable switch. This switch can be programmed in hourly or daily cycles. It is used for the switching the modem or other systems whose demands are not directly linked to regular datalogger operation. The switch status can be changed in the measuring interval only when the system is active.

1.2.9. SDI-12 connection

All sensors matching SDI-12 standard are connected to common three-wire network. Note, the sensors connected to this SDI-12 network have to be supported by Mini32 software.

The sensor connection is easy but requires that each sensor has unique address otherwise this digital part of data logging won't give any value. The configuration of SDI-12 sensors is intuitively supported by Mini32 software.

2. Datalogger operation

There are no operating elements like display or keyboard on the datalogger. Datalogger configuration, data download and maintenance can be performed only by the computer and Mini32 software. Apart from communication with dataloggers, Mini32 offers large number of functions for efficient data visualization and operation. The software development started on the 1998 with main respect to fast processing of long time data series.

2.1. Communication with PC

A serial cable with 2.5 Jack/9-pin D-sub connector with USB/RS232 interface is necessary for connection to common notebooks. Desktop PC has still a COM port but occasional problems are reported. FTDI convertor with a proper driver seems to be less troublesome solution.

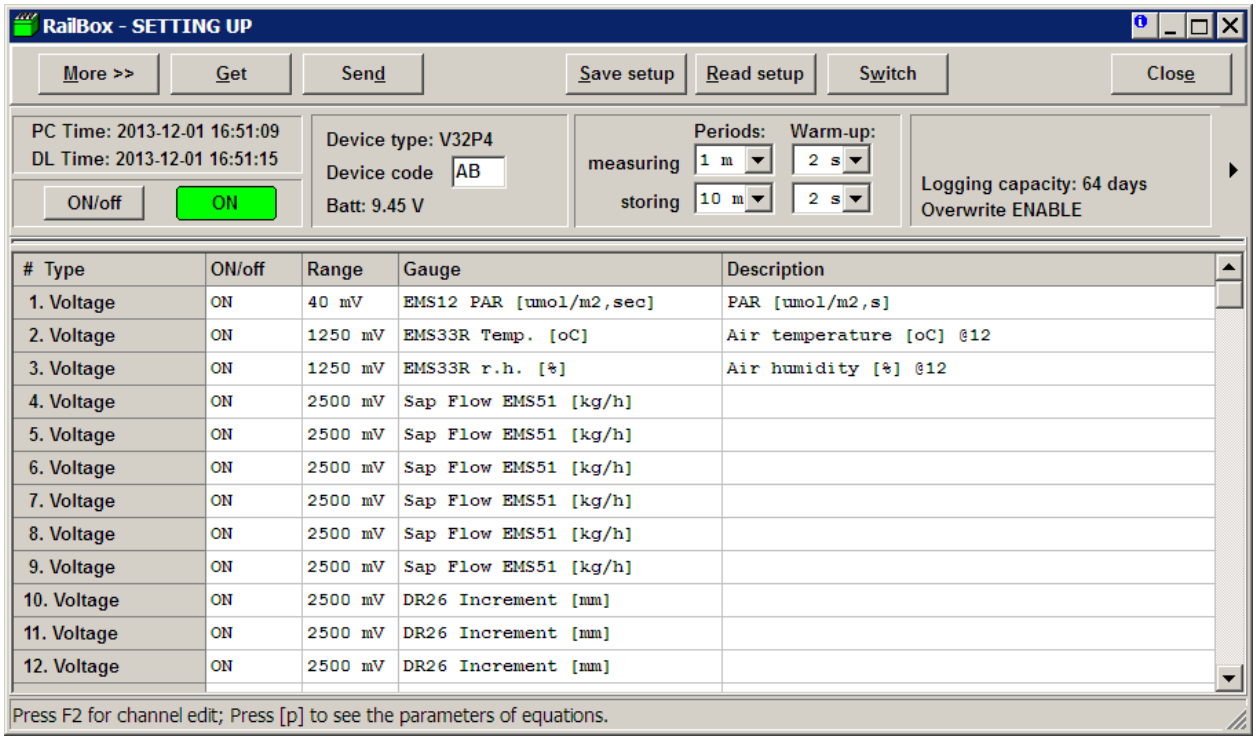
For wireless communication, there is an RS232/IrDA interface available. It is intended for mounting on the enclosure. A special USB/IrDA cable is required but this solution allows the communication with a PC without opening the datalogger enclosure. Frequent datalogger opening in rain or humid environment is discouraged in order to protect the electronics inside.

The communication is supported by Mini32 software compatible with all EMS dataloggers and smart sensors.

2.2. Datalogger configuration

Configuration business can be divided into two parts:

- general configuration
- channel setting
- programmable switch



2.2.1. General system configuration means to set

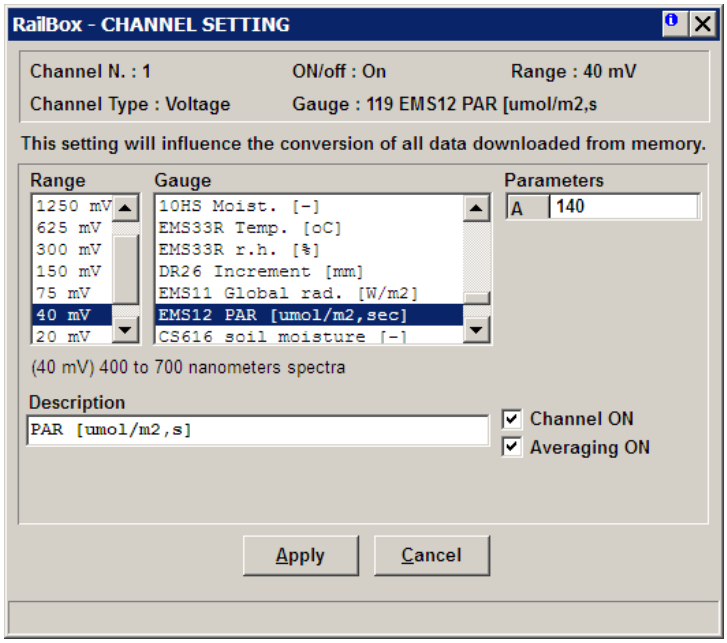
- Memory mode – overwriting the oldest data or not (see 1.2.2)
- Time intervals – both periods of measurement and averaging as well as warm-up time for both periods individually. Warm-up setting requires the knowledge of sensor properties.

  - The device code. Device code is two-character "name" that identifies certain datalogger among other dataloggers. From the factory the last two digits of serial number are used.

2.2.2. Channel setting

The configuration of each channel is made according to sensor properties. The configuration is consists of setting the range, gauge type (from the sensor library) and parameters and some other details. The channel configuration window is opened by double click on appropriate channel row.

Example:



EMS12 is the sensor measuring the photosynthetic active radiation.

Gauge was chosen from the sensor library

Range – 40 mV is the value recommended by the information below

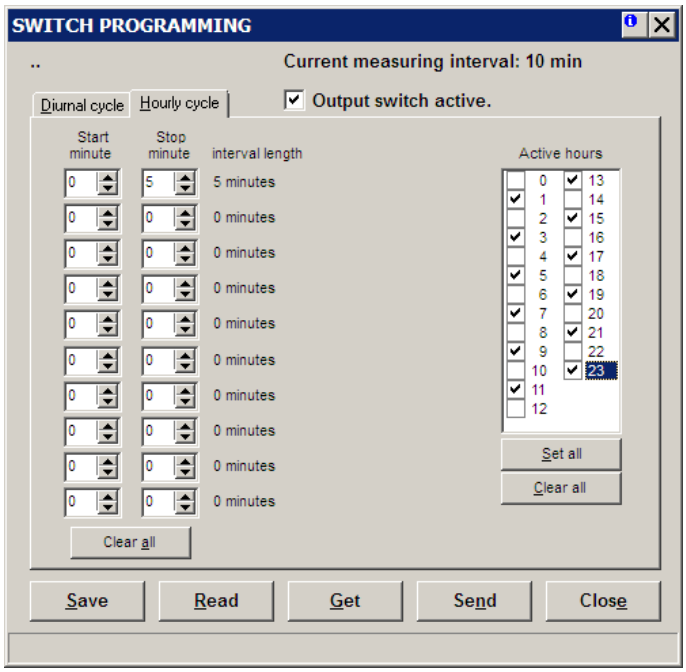
Parameters – 140 is the sensor sensitivity

Channel ON – logging status

Averaging ON – if not checked, the logger will measure this channel only on the end of the interval of storing to memory. Averaging is excluded!

A possibility to use general equations from the library exists for sensors not listed within the gauges; i.e. 2-nd order polynomial and reciprocal equations with voltage or resistance inputs.

2.2.3. Programmable switch



This example shows configuration for switching on the GSM modem every other hour for five minutes. Note, up to ten independent time intervals can be set within one hour.

The configuration is finished by uploading to the datalogger (SEND button).

Warning: Be careful when changing the configuration during measurement. The downloaded data in HEX format are converted to physical values according to the last datalogger configuration. The data stored to the memory earlier would be badly converted! The software will pop-up a warning of such an incorrect configuration change suggesting to start a new measurement with new device code and empty memory.

2.3. Start of operation

The datalogger is running until turned off with the switch on the front panel. In this case the real time clock is continuously powered from the internal back-up battery. Because of the negligible current consumption of the real time chip the battery lifetime is not significantly reduced.

After the configuration for a new measuring campaign is finished, check the measured values (On-line mode of Mini32). The **memory has to be be erased** in order to delete the values remaining from the previous measurement.

Note, the actual values can be measured and displayed also when the logging status is off.

3. Software

The program Mini32 works under all Windows® operating systems. It supports all necessary operations for datalogger setting, data handling and file processing via RS232 serial line connection (special PC cable is required).

On-line help service will guide you through particular software topics.

The installation of Mini32 software includes also DLC files containing datalogger firmware of all supported hardware systems.

Refer to Mini32 user's manual for software details and other related information.

4. Warranty

The product is warranted by exporter against defects in material and workmanship for a period of **two years** from the date of shipment from the company.

The product found to be defective during the warranty period will be repaired or replaced and returned freight prepaid.

The producer is not responsible for the faults originated by careless manipulation, incorrect operations, wrong applications or the destruction of seals.