Datalogger

UNI LOG MINI CUBE

Models VC, VV/VX, CC, VF

User's Manual

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1 DATALOGGER GENERAL DESCRIPTION

Datalogger MiniCube is battery-supplied equipment for automatic data recording in demanding field applications. They are designed for easy connection of wide range of different sensors. The waterproof case allows the placement everywhere in nature without any additional box. The removable terminals and cable outlets placed in datalogger lid allow the flexible change between the field and laboratory use.

1.1 MAIN FEATURES

- high storage capacity 220 000 values
- different ways of power supplying
- high IP rating case, no additional weather shielding required
- programmable output switch
- built-in current source for direct temperature measurement with Pt100 or Ni100 temperature sensors in four-wire connection
- advanced Windows® software for device setting, data retrieval and processing
- ready for remote access via GSM modem
- four models available according to channel configuration

1.2 MODELS AVAILABLE

Model	**VC**	**VV/VX**	**CC**	**VF**
Voltage inputs	6 differential	12 differential	--	6 differential
Pulse inputs	4 (two 8-bit, two 16-bit)	1 (8-bit, opt.)	10 (8-bit)	1 (16-bit)
Terminal temperature	YES	YES	NO	YES
Prog. output switch	YES	YES (optional)	YES	YES
Frequency	--	--	--	6

1.3 SPECIFICATIONS

Channel types	voltage differential, counters 8 bit, 16 bit, frequency
Voltage inputs	± 20mV up to ± 2,5V in eight ranges
Voltage limit	maximum +5 Volts from GND on any input terminal
Accuracy	0.01% of full scale
Resolution	16 bits
Counting input types	el. pulses (Lo < 1 Volt, Hi > 4 Volts)
	contact closure (R threshold 1000 ohms)
Max. frequency of pulses	400 Hz
Frequency inputs	15 Hz to 40 kHz in eight ranges (>2.5 V sinusoidal)
Measuring interval	3 sec to 24 hrs
Averaging interval	3 sec to 24 hrs
Warm-up time	common up to 5 sec; up to 100 msec by freqv.chan.
Exciting voltage	5 Volts ± 50 mV
max. load	30 mA
voltage drop	Approx. 6 mV/mA of loading current
Measuring current	500 to 650 µA, temperature dependent
Maximum voltage per one section	350 mV
Overvoltage protection	diode suppressors connected to each input terminal
Power supplying:	
A/ internal 4.5 Volts	- three C-type alkaline battery - three rechargeable NiCd or NiMh C-type battery (7 to 15 Volts for proper charging necessary) - external 5 to 15 V; 300 mA (3 mA idle)
B/ external 5.5 to 16 Volts	batteries or any power supply
Power consumption idle/measuring:	
Internal batteries 4.5 V	80 µA / 80 mA (see table at section 0 for bat.life)
External batteries (@ 9Volts)	40 µA / 40 mA
Memory capacity	220 000 records
Output programmable switch	bistable relay 125 V A.C., 0.5 A
Size	120 x 120 x 130 (80 mm without the lid)
Weight	0.95 kg with alkaline batteries
Operating range	-20 to 60 deg.C

1.4 POWER SUPPLYING

There are two types of MiniCube dataloggers according to their power supplying by all models. **They differ just by the voltage values written on the datalogger front panel**:

1.4.1 INTERNAL BATTERIES (4.5 V)

- three internal alkaline C-type (baby) monocells (1.5 V, cca 7 Ahrs). Look at section 5.2 for their duration according to the measurement setup.
- internal NiCd or NiMH C-type cells (1.2 Volts, cca 2.2 Ahrs) continuously recharged from the external power supply (solar panel, power grid...). The external D.C. voltage must range between 7 and 15 Volts.
- an external power supply with the voltage between 5.5 and 15 Volts. The internal batteries have to be removed from the logger! The idle power consumption in this case is about 3-5 mA. **Be aware that in these cases the battery voltage shown on the screen is not concerned with external batteries**. It shows just the voltage behind the internal stabilizer (about 4.4 Volts).

1.4.2 EXTERNAL BATTERIES (5.5 TO 16 V)

Any voltage corresponding with voltage mentioned on the front panel label is allowed. As for the battery duration, its voltage and capacity should be considered. The easiest way of comparison to previous type is to multiply the nominal voltage and capacity and compare with those of previous type (4.5 V times 7 Ahrs = 31.5 Whrs). Than, the battery life is proportional to Whrs ratio.

The low battery voltage warning differs according to mentioned type, too. Low voltage warning with internal batteries appears by 3.3 Volts, with external ones by 6.6 Volts.

1.5 GROUNDING

All voltage channels are arranged as differential ones but the maximum voltage level 5 Volts is allowed between the negative pole of power supply and each terminal. Note also that the negative pole of power supply is internally connected with all terminals marked as "GND" including that one placed outside the lid. This is connected with the terminal row located inside the lid. For the lightning protection, the shields of sensor cables should be connected to those terminals and the grounding terminal outside should be grounded as well as it is possible.

1.6 BATTERY REPLACEMENT

To replace the batteries, the datalogger assembly must be removed from the enclosure. Two milled nuts below the lid have to be screwed off first.

The batteries can be replaced independently on the data logging process, neither data nor the program will be lost, which is guarded by the back-up battery.

The lithium button-shaped back-up battery should last eight years at least. Its removing will cause the irreversible firmware and data loss!

1.7 POWER MANAGEMENT

All types of datalogger are well protected against power cut. It is possible to remove batteries even during the measurement without the data loss or damage the memory structure. However, in such a case the time for system shut down is very limited and there is no time left to set the proper time of next measurement. Consequently, the logger will continue running as late as at midnight. In order to continue the measurements just after the replacement of batteries the manual reset can be done by any communication with connected computer.

If low voltage due to flat batteries occurs during the measurement (threshold value 2.7 or 5.5 Volts according to power supplying type), the system stops operating until midnight. Than it continues measuring until next low voltage occurrence. This way, (i) a small amount of energy should remain for data download and (ii) the measurement could continue after possible battery recharging.

In case if it is impossible to access the data or convert the data file due to a serious damage of data structure in the datalogger memory (by lightning etc.), it is always possible to export the whole memory content (hardcopy of memory). Even in the worst case when the program is damaged, too, it is possible to save the memory content after the uploading the new firmware. Take advantage of this possibility in emergency case! Download the hardcopy of memory and send it to producer for free encoding.

2 CHANNEL TYPES

MiniCube dataloggers have basically four channel types - voltage, counters, frequency and internal (terminal) temperature.

2.1 VOLTAGE

The range of voltage channel has to be set manually during the datalogger configuration. For those gauges that are included in library, the proper sensor range is mentioned beside the gauge name (refer to Mini32 software manual). The range of user-defined sensors should be set according to the knowledge of their output characteristic. If the input signal exceeds the range, the voltage value is replaced with missing value symbol (refer to Mini32 software manual for details). Please note that the maximum voltage range from zero up to +5 Volts regarding to GND (or negative pole of external power supply) on each terminal is allowed otherwise an interference between channels will occur!

2.2 COUNTERS

There are two kinds of counters, 8-bit and 16-bit what means in practice that the counter capacity within the measuring interval is 256 or 65 536 pulses respectively. This capacity should be considered when setting the measuring interval. If the number of pulses exceeds the counting capacity, the counter starts to count again from zero so the pulse number equal to counter capacity is forgotten (for instance, instead of 260 pulses we get just 260 - 256 = 4 concerning 8-bit counter).

The maximum frequency range of all counters is limited because of noise suppressing by input circuit to 400 pulses per second (Hz) in both cases.

The output of counters as well as of the voltage channels is saved as a 2-byte-number. This precision is satisfactory for 8-bit counters. As for 16-bit counters, there are two virtual ranges, **F**ast and **S**low.

The **F**ast one stores the pulse number in memory as an average from the measuring intervals the same way as by voltage channels (the pulses from each measuring interval are summarized and that divided by the averaging/measuring interval ratio). However, because the pulse average is stored as integer it causes a significant rounding error by small amount of pulses. On the other hand, the **F**ast range allows using the whole counter capacity (65 536 pulses) in each measuring period.

The error of the measurement low frequency pulses with **F**ast range depends on the interval ratio and the pulse number. See following example showing the worst cases:

Averaging/measuring interval ratio = 10					
Number of pulses coming within the **averaging** interval	2	5	15	35	95
Output value in data file [pulses per **measuring** period]	0	1	2	4	10
Right value [pulses per **measuring** period]	0.2	0.5	1.5	3.5	9.5
Error in %	100	50	33	14	5

The maximal rounding error decreases with the pulse frequency and rises up with the interval ratio. So please set the **S**low range for low frequency pulse signals (tipping bucket rain gauge i.e.).

The **S**low range is completely exact because pulses are stored not as the average but as the total per averaging interval and the calculation of mean value is made in computer with high accuracy. However, the maximum pulse number in the averaging period cannot exceed the counter capacity (65 366 pulses). As the consequence, the maximal number of pulses allowed to come within the measuring period is reduced by interval ratio:

Slow range						
Averaging / measuring interval ratio	1	2	5	10	20	50
Max. pulse number allowed in measuring interval	65536	32768	13107	6553	2376	1310

Summarized: ***Slow*** **range should be preferred until the expected number of pulses coming within the measuring interval does not exceed the value calculated as 65536/interval ratio. Otherwise, the** ***Fast*** **one has to be set.**

Note: there are (besides the ground) two input terminals belonging to each channel: the electrical pulses matching TTL logic voltage levels (+5 V) and switch closure (except of VX model where only mechanical switch can be used).

2.3 FREQUENCY

These channels are aimed for the measurement of frequency of an electrical signal. In contrast to counters that register pulses continuously, frequency measurement is performed only at the time of regular measurements.

The input range of measuring signal is limited by clamping diodes (bipolar transil) to ±16 Volts regarding to GND (negative supply voltage terminal). The signal input resistance behind the decoupling capacitor (68 nF) is ca 100 kohms. For proper operation the signal amplitude of 2.5 Volts is required although even lower value (but 1 Volt at least) might be sufficient when the square wave signal is measured.

There are six ranges of measurement that should be chosen according to the lowest measured frequency and demanded resolution. The maximum measured value is up to 40,000 Hz independently on the range.

Note: The principal of the measurement is the evaluation of the time between the following pulses (waves). Consequently, the measurement of very low frequencies would takes a lot of time as the time period is inversely proportional to frequency. For this reason, the measurement of one channel is limited to 60 msec what corresponds to the lowest measuring value by certain range. The lower values are taken as the missing ones. Further, for better resolution by higher frequencies, the time interval of more period is measured at the expense of lowest measured frequency. So the range should be selected according to the frequency range and demanded resolution.

The frequency range properties are shown in following table:

Range	Number of measured periods	Resolution better than 0.1%	Resolution better than 1%
> 15 Hz	1	up to 1 kHz	up to 10 kHz
> 30 Hz	2	up to 2 kHz	up to 20 kHz
> 60 Hz	4	up to 4 kHz	in full range
> 120 Hz	8	up to 8 kHz	in full range
> 240 Hz	16	up to 16 kHz	in full range
> 4800 Hz	32	up to 32 kHz	in full range

2.4 INTERNAL (TERMINAL) TEMPERATURE

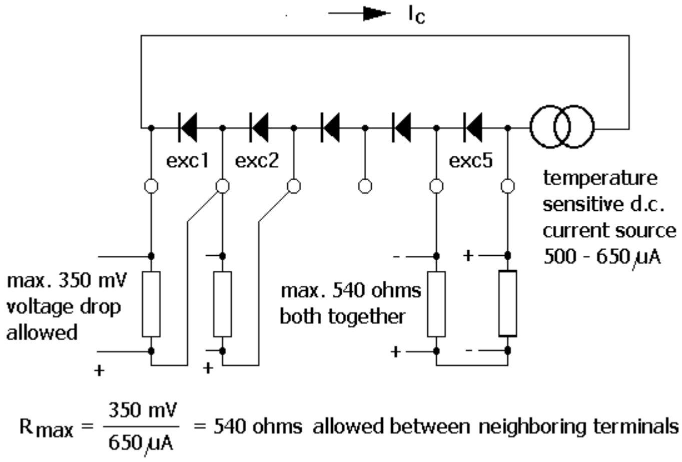
This variable is necessary for the temperature measurement with the thermocouples. The terminals are used as the reference junction and therefore the knowledge of their temperature is necessary. The measurement of internal temperature is switched on automatically when the thermocouple based gauge is chosen. Note that by VV model the terminal temperature sensor is placed close to terminals of channels 1-6. Considering the possible temperature gradient inside the datalogger box, the first six channels should be preferred for the measurement with thermocouples.

3 SENSOR EXCITATION

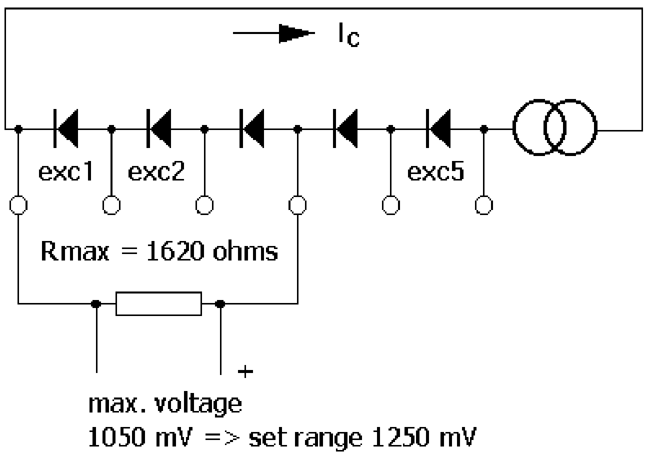
Some sensors need energy for their supplying or for the measurement itself. For this purpose, the datalogger contains two excitation sources - the voltage and current ones - which are activated during the measurement.

3.1 EXCITATION CURRENT

It is used mainly for the resistance measurement. The most common application is temperature measurement based on Pt100, Ni100 or thermistor, the wind direction sensors, position sensors of different type etc. For this purpose, the temperature dependent D.C. current is used which is also used for the measurement of internal datalogger temperature (see section 2.4). This measuring current ranges from 500 to 650 μA and it comes through five diodes connected in series between neighboring excitation terminals. When the measured resistance is connected between terminals, the current passes through it. However, there are some rules that should be considered - see drawing:

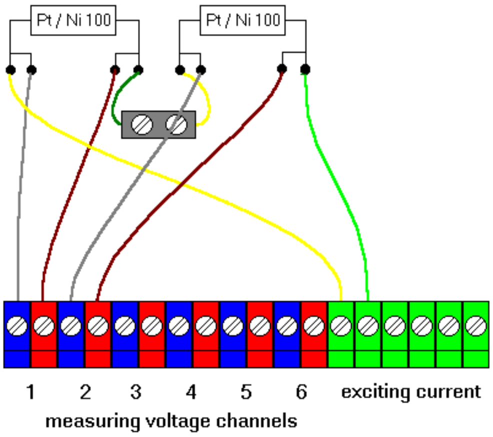


The maximum voltage drop of one diode must not exceed 350 mV in order to assure that the whole current in passing through the sensor connected in parallel to diode. Therefore, the maximum resistance should be lower than about 540 ohms considering the worst situation (the highest datalogger temperature - 60 deg.C). For higher resistance, it is necessary to connect the resistor across more diodes, like this:

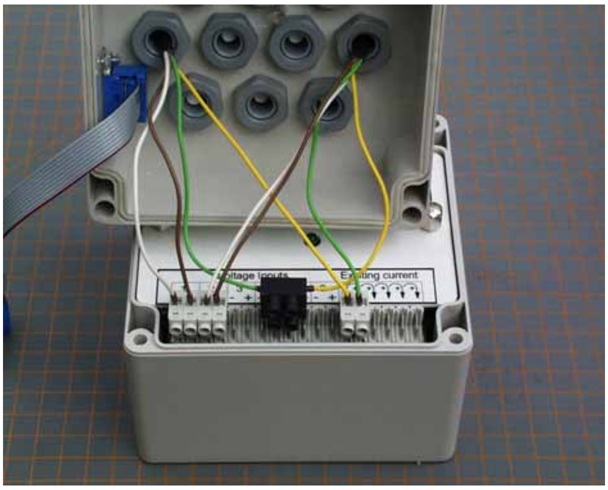


Be aware of that another sensors cannot use already bypassed terminals!

On the other hand, concerning the sensors with lower resistance, more of them can be connected to one section as shown on the pictures bellow. The maximum voltage drop allowed on one sensor is 170 ohms what fits to two Ni100 sensors at 180 deg.C.



Connection of two Ni100 or Pt100 temperature sensors between the neighboring terminals of excitation current.



3.2 EXCITATION VOLTAGE

This voltage is usually used for supply the sensors which need the power supply for operation, for example: Rotronic temperature and humidity sensors, Delta-T Theta probes, EMS Campbell 223 Gypsum Block Interface, EMS 32 temperature and humidity sensors and others. It can be used also as a signal for switching on the external power supply for measuring systems demanding higher power.

The voltage of 5 Volts appears between the voltage excitation terminals when the system is running i.e. during the measuring process as well as during the communication. The maximum current load for this voltage output is 30 mA with voltage drop of approx. 6 mV per mA of loading current. This voltage source is protected against shortage by current limitation about 40 mA.

Note: The measurement might be delayed behind the excitation – see chapter 5.

3.3 ENABLE – FREQUENCY CHANNELS – VF

Frequency channels by VF model are equipped with "enable" terminal that switches on the sensor for the necessary time period. This reduces the energy consumption for sensor supplying and also excludes the interference between simultaneously running sensors (Campbell CS615 soil moisture sensors for instance).

With respect to battery life and proper sensor operation, the "enable" signal is switched off when the power supply voltage drops bellow the certain threshold. This value can be chosen on the configuration panel according to type of used battery. Note that only externally powered loggers support this feature!

As for the operation, the datalogger measures battery voltage after each frequency channel. If the low voltage is found, the last value is forgotten and the measurement of remaining channel is skipped. This way fully excludes a wrong measurement due to low voltage.

4 GAUGE TYPES

The following set of common gauges is predefined in attached software Mini32 relevant to MiniCube models:

4.1 VOLTAGE CHANNELS

- Resistance
- Pt 100 temperature sensors
- Ni 100 temperature sensors
- T- type (Cu-Co) thermocouples measuring temperature difference
- T- type (Cu-Co) thermocouples using the terminal temperature as reference
- K- type (NiCr-NiAl) thermocouples using the terminal temperature as reference
- Rotronic HP101A air temperature
- Rotronic HP101A air humidity
- EMS 32 air temperature (individual parameters are required)
- EMS 32 air humidity (individual parameters required)
- $Y = A + B \cdot V + C \cdot V^2$ (V is voltage as the input variable)
- $Y = A + B \cdot V^C$ (V is voltage as the input variable)
- $Y = A + B \cdot R + C \cdot R^2$ (R is resistance as the input variable)

4.2 COUNTERS

- number of pulses per measuring period (Pm)
- number of pulses per period of averaging (Ps)
- $Y = A + B \cdot f$ (f is frequency measured by pulse counters)
- $Y = A + B \cdot Ps$ (Ps is period of averaging – pulse counters)

4.3 FREQUENCY CHANNELS

- Frequency of signal (Hz)
- Time period of signal (msec)
- $Y = A + B \cdot f + C \cdot f^2$ (f is frequency)
- $Y = A + B \cdot T + C \cdot T^2$ (T is period)

For user-defined sensors, the set of general equations is included. The parameters of these equations have to be set according to the sensor properties.

Refer to Mini32 software manual for more details.

5 TIMING OF THE MEASUREMENT

There are two different time periods that should be mentioned - measuring period and the period of averaging (storing into the memory). Another time period, called "warm-up" time (1 to 5 seconds), can be set if some sensors need settling time higher than one hundred milliseconds for stabilizing. All these periods influence the memory capacity and the battery lifetime, too.

In frequency channels (model VF), there is another "warm-up" time selectable individually for each channel up to 100 milliseconds. Datalogger waits this time to perform the measurement after sensor enable.

5.1 STORAGE CAPACITY

The memory is organized in cycle so the oldest data are continuously overwritten with the newest ones. The total memory capacity is slightly above 220,000 values independently on the channel type.

The following table shows the possible number of days stored in the datalogger memory:

Interval of storing [s]:	5	10	30	60	300	600	3600
Channels in use:							
1	12.7	25	76	152	764	1527	9166
2	6.4	12.7	38	76	382	764	4583
3	4.3	8.5	25	51	255	509	3055
4	3.2	6.3	19	38	191	382	2292
5	2.5	5	15.2	30	153	306	1834
6	2.1	4.2	12.7	25	127	255	1528
7	1.8	3.6	11	22	109	218	1310
8	1.6	3.2	9.5	19	95	191	1146
9	1.4	2.8	8.4	17	85	170	1018
10	1.2	2.5	7.6	15	76	152	917
11	1.1	2.3	7	14	70	139	834
12	1	2.1	6.3	13	63	127	764

5.2 BATTERY LIFETIME

The battery duration time in days depends on the number of voltage or frequency channels active, on the interval of measurement and the warm-up time (see the table bellow). The counters demand to power supply is negligible. The using of three 1.5 volts, 7 Ahrs C-type alkaline batteries are supposed. The warm-up time reduces the battery life significantly - the second number (*italic*) relates to 3 sec of warm-up time.

Measuring Interval [s]:	5	10	30	60	300
Channels in use:					
1	60/*13*	117/*25*	327/*75*	>1 Y/*147*	>1 Y/*>1 Y*
2	40/*12*	79/*23*	226/*68*	>1 Y/*133*	>1 Y/*>1 Y*
3	30/*11*	60/*21*	172/*62*	327/*122*	>1 Y/*>1 Y*
4	24/*10*	48/*19*	140/*57*	268/*113*	>1 Y/*>1 Y*
5	20/*9*	40/*18*	117/*53*	226/*105*	>1 Y/*>1 Y*
6	17/*8*	34/*17*	101/*50*	196/*98*	>1 Y/*>1 Y*
7	15/*8*	30/*16*	89/*46*	173/*91*	>1 Y/*>1 Y*
8	13/*7*	27/*15*	79/*44*	154/*86*	>1 Y/*>1 Y*
9	12/*7*	24/*14*	71/*41*	140/*81*	>1 Y/*>1 Y*
10	11/*6*	22/*13*	65/*39*	127/*77*	>1 Y/*351*
11	10/*6*	20/*12*	60/*37*	117/*73*	>1 Y/*335*
12	9/*6*	19/*12*	55/*35*	108/*70*	>1 Y/*320*

Note: Since the frequency channels have variable time of the measurement, the result may vary according to measured frequency, range and individual warm-up time. Generally, the real battery lifetime will be rather longer in case of using more frequency channels that voltage ones.

The battery duration concerning the CC model (ten counters) shows next table. The first number regards to the on/off interval ratio 10%, the second to 90%. In other words, the power consumption is proportional to the switch closure time. The sensors based on switch closure should be designed so that it should be most of time disconnected.

Measuring Interval [s]:	5	10	30	60
Channels in use:				
1	267/207	>1 Year/313	>1 Year	> 1 Year
2	258/165	>1 Year/226	>1 Year/301	> 1 Year
3	249/137	>1 Year/177	>1 Year/219	> 1 Year/246
4	240/117	>1 Year/145	>1 Year/173	> 1 Year/189
5	232/102	>1 Year/123	>1 Year/142	> 1 Year/153
6	225/91	358/107	>1 Year/121	> 1 Year/129
7	218/82	341/94	>1 Year/105	> 1 Year/111
8	211/74	326/84	>1 Year/93	> 1 Year/98
9	205/68	312/76	>1 Year/84	> 1 Year/87
10	199/63	299/70	>1 Year/76	> 1 Year/79

6 PROGRAMMABLE SWITCH

The programmable output switch is aimed for the control of external systems. The typical use is switching the modem for the remote data transfer in certain time period in selected days in order to save the batteries, switching the external power supply during the measurement process etc. The switch can be basically programmed in diurnal or hourly cycle. Up to ten switching on periods per unit (day, hour) can be set and activate in each unit or selected ones. Refer to Mini32 software manual for more information.

7 DATALOGGER COMMUNICATION

The MiniCube dataloggers do not have any display or keyboard; the datalogger setting, data downloading and viewing suppose the use of PC® computer. Computer can be connected to the datalogger directly via enclosed null-modem cable or by remote connection (see next topic). The ninepin D-sub connector arranged in waterproof manner is fastened on sidewall of the datalogger lid and connected with another connector on the front panel. For laboratory use when the lid is missing, the cable is put directly into the connector placed on the front panel. Make sure that when the lid is used, the cable connecting both connectors is plugged-in here.

7.1 REMOTE CONNECTION

All MiniCube dataloggers and the Mini32 software are applicable for remote communication and the data transfer via modem in GSM or normal telephone network. When the remote connection is required, the datalogger must be supplied from the external batteries and datalogger, modem and external batteries are placed in an additional waterproof box of the size 30 x 20 x 16 cm.

8 SOFTWARE

The program Mini.exe (16-bit version working under all Windows® operating system) or Mini32.exe (Windows® 95, 98, NT) supports all necessary operations for datalogger setting, data handling and file processing via RS232 serial line connection (three wire null–modem cable is required). The software components are placed in the directory c:\Program Files\EMSoft\Mini32\ if not specified otherwise during the installation process. On-line help facility will guide you through particular software topics.

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

Since the software includes a lot of sophisticated options like statistics, advanced graphics, user defined calculation etc., some options might be accessible in future after the registration only.

Refer to Mini16 or Mini32 user's manual for software details and other related information.

9 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.