# MONITORING OF TEMPERATURE IN A MEDICAL REFRIGERATOR, SENSORS CALIBRATION

The use of the DL2/DL7 data logger and sensors for temperature measurement enables monitoring operation of the refrigerator. Advanced recording of process values with CRC control of archive files and use of alarm functions can be a confirmation of the conditions in which products were stored. Using the optional battery supply module (PS_BATT), device operation during power outage is possible and archiving continuity is ensured. Additional device functions, i.e. e-mail notifications, backup (battery supply), assigning alarms to relay outputs and math channels enable creating a customized measuring system.

Depending on the metrological needs, it is possible to calibrate measuring inputs of the data logger or the entire measuring path (sensors and data logger).

The application of DL2 data logger in the system for monitoring the medical refrigerator operation is described below.
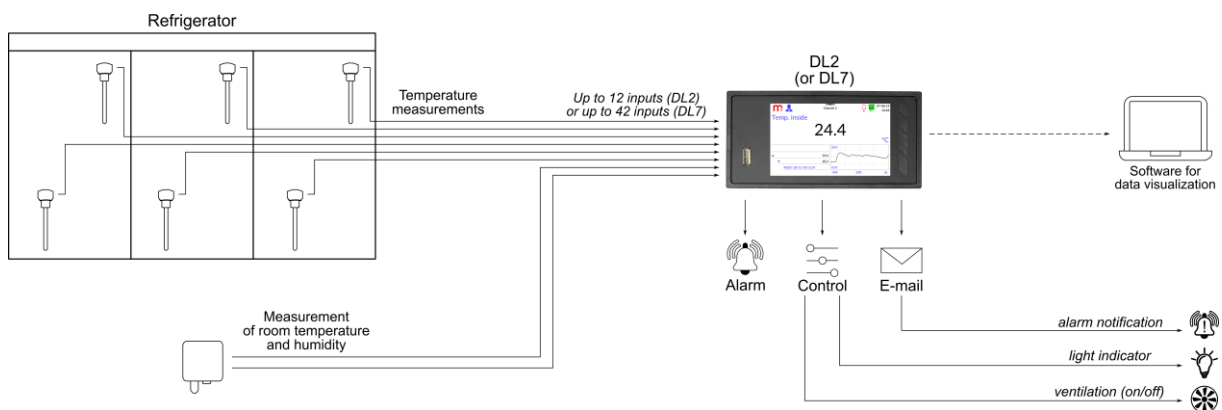

- **Description**

DL2 data logger reads data from sensors and assigns them to channels. Channel values are displayed on a color touch screen. The device can archive process values in a 2 seconds interval.

The data logger has a modular structure and depending on the user's needs can be extended with additional I/O modules, e.g. IN6RTD module (for connecting Pt100 sensors) or IN6V(24V) module (for connecting analog 0/4-20 mA signals). Up to 2 I/O modules can be installed in the DL2 data logger. Up to 7 I/O modules can be installed in the DL7 data logger.

- **Displaying data**

Results are displayed on a 4" (DL2) or 7" (DL7/DL7L) color touch screen. Each channel is displayed as a single result window (process value and minimum and maximum values of the channel). Depending on the user's needs, it is possible to configure a summary table (process values, minimum and maximum values of channels) or summary charts (only process values of channels). The device enable viewing the trend of value changes up to 1 hour back. If alarms are enabled, a window informing about the status of all alarms is displayed.

Examples of DL2 device screens are presented below.
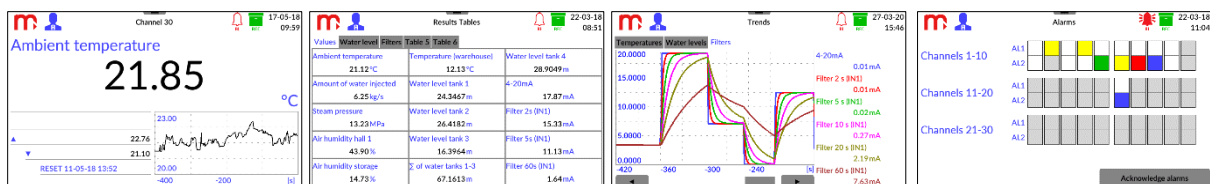
- **Archiving and reading results**

The device archives channel values, records exceeding alarm thresholds and records information on sending e-mail notifications in accordance with entered settings. Archive files contain CRC control.

Archive files are created according to entered settings in daily, weekly or monthly mode (typically in monthly mode). Interval of recording process values into the archive is configurable by the user (from every 2 seconds to every 24 hours). Interval of recording should be suited to the measurement process. If the recording interval is too short, the large data volumes will make it difficult to analyse the results. In the presented application, the typical recording interval is 1 min or 5 min.

Archive files can be downloaded from the device using a portable memory (USB key) or using an Ethernet cable and a web server. Additional software on the PC enables visualization of archived data or current values (DL2-RP/DL2-RPplus, DL7-RP/DL7-RPplus, mLog).

The user should remember to save files from the device periodically. The user must ensure secure archiving of saved files. The correctness of the archiving process should be checked periodically.

- ### Alarms and controls

Each channel can have assigned two independent alarms regarding the process value. Two functions are available: alarm (latched type) or control (non-latched type). Exceeding the indicated channel value (exceeding the alarm level) can cause alarm signaling and/or a change of state at the assigned relay output. For each channel, it is possible to set two alarm levels (L & H, L & LL, H & HH) and assign different relay outputs to them. The DL2 data logger has 4 relay outputs. An additional module of 6 relay outputs (OUT6RL) can be installed in the DL2/DL7 data logger.

- ### E-mail notifications

Due to e-mail notifications it is possible to obtain information about too low/too high temperature without constantly viewing the results. E-mail notifications with information on alarms state are sent after exceeding alarm threshold and after returning to the normal value. If the PS_BATT module is installed in the data logger, it is possible to send an e-mail notification about a power outage and device operation from battery. To send this information, the module operating status must be assigned to the channel, the alarm must be turned on, and then the alarm threshold must be set. Operating status 0 means that the device is powered by batteries connected to the PS_BATT module.

- ### Data transfer

Temperature and humidity values can be read using the Modbus TCP or Modbus RTU protocol. The DL2 device has one 4-20mA analog output which enable retransmission of the process value of any channel (including the math channel). The data logger can be connected to the SCADA master system.

- ### Additional functions - math channels and value averaging

Using the math channel, it is possible, for example, to determine the average value of the measured temperature/humidity or to present the process value assigned to the channel in another selected unit (e.g. $^{\circ}$C, K, %, hPa). Math channels compute the formula entered by the user, available math operations: $+, -, ^{\times}, \div, \sqrt{}, 2, 3, \wedge$. The value of another channel can be used for calculations (the channel number must be preceded by the # sign).

- ### Battery power supply (backup) - PS_BATT module

The optional PS_BATT module enable device operation in the event of a power outage (from 1 to 20 hours, depending on the configuration). The module operating parameters are assigned to subsequent virtual measurement inputs and can be archived. The use of a battery module ensures archiving continuity in the event of a power outage. If the data logger and the refrigerator are supplied from the same power source, it is possible to specify the time when the refrigerator was not powered.

- ### Calibration

Depending on the metrological needs, it is possible to calibrate the data logger's measuring inputs or entire measuring paths (data logger and sensors). The calibration procedure takes place in an accredited laboratory. After calibration, a certificate is provided. Calibration is an additional service.

- ### Wall enclosure for DL2/DL7 data logger

It is possible to order the DL2/DL7 device in the DL2W KIT/DL7W KIT set containing the power supply and a housing with a high degree of protection against water and hazardous parts (IP65). The set is dedicated for wall mounting.

- ### Information from the Manufacturer

All functions of the recorder are subject to modifications for the benefit of technical progress.

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