MONITORING OF ELECTRICITY CONSUMPTION USING SUB-METERS AND MODBUS RTU PROTOCOL

TS-35 sub-meters available on the market with the option of data sharing in the Modbus RTU protocol enable the determination of the electricity consumption in a separate part of the electrical installation, e.g. in a building. The installation of sub-meters enables internal settlements and the control of electricity consumption, e.g. by selected electric receivers.

Using the DL2/DL7 data logger enables reading measured values from sub-meters, comparison of measured parameters, data logging and remote viewing data. Based on displayed and archived data it is possible to analyze electricity consumption and determine the efficiency of devices, which may lead to improvement of the quality of the production process and reduction of production costs.

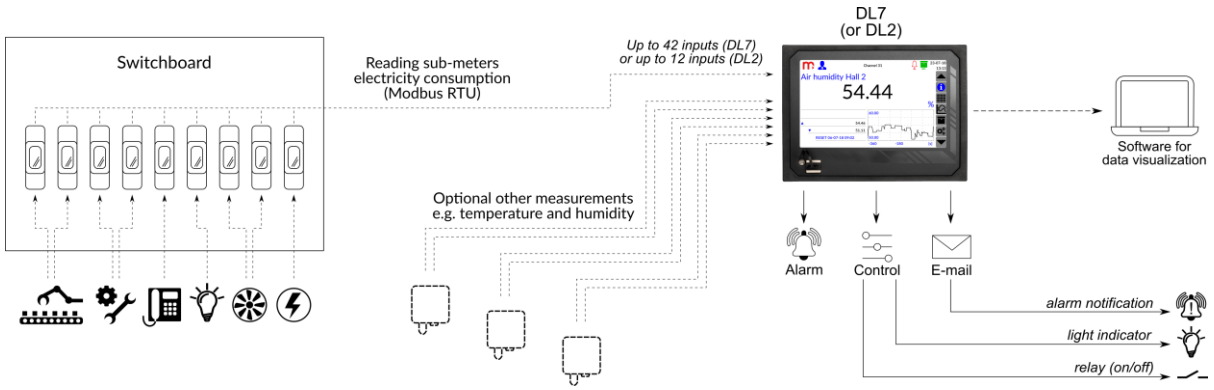
The modular construction of the DL2/DL7 data logger and individual I/O configuration enables connecting sensors for digital communication e.g. in Modbus RTU standard or analog sensors. Depending on the selected type of electricity consumption sub-meter (e.g. single-phase or three-phase sub-meter), selected parameters can be sent via Modbus RTU protocol, e.g. active power (kW), reactive power (kvar), apparent power (kVA), voltage (V), frequency (Hz), power factor, active energy (kWh) and reactive energy (kvarh).

100 channels (DL7) or 30 channels (DL2), which can be used as measurement channels or math channels are available to the user. Math channels compute formulas entered by the user and can determine e.g. the sum of the consumed current. The use of alarms and relay outputs for switching on/off the relays enables the implementation of a simple notification system for service operators.

Additional device functions, i.e. totalizers (counting the instantaneous value of the channel in the selected mode), remote viewing of values (web server), e-mail notifications about exceeding the alarm states, cyclic e-mail reports with the values of totalizers and backup (battery supply) enable creating a customized measuring system. For example, the process supervisor may receive e-mail notifications about exceeding the instantaneous power value or cyclic e-mail messages in the form of a report with totalizers values.

Advanced recording of process values with CRC control of archive files and use of alarm functions can be a confirmation of measured values. Using the optional battery supply module (PS_BATT), device operation during power outage is possible and archiving continuity is ensured.

It is possible to order the entire measurement set, including a data logger and a sub-meter or sub-meters of electricity consumption. The application of DL7 data logger in the system for monitoring electricity consumption in a factory with the simultaneous measurement and recording of other values (e.g. temperature, humidity) is described below.



• Measuring inputs

The electrical parameters are analyzed and processed by the electricity consumption sub-meter. The DL2/DL7 data logger reads data from the sub-meter 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. 2RS485(24V) module (for connecting sensors operating in the Modbus RTU protocol) or IN6V(24V) module (for connecting analog 0/4-20 mA signals). The device enables reading values in the HART or in the Modbus TCP protocol. Up to 7 I/O modules can be installed in the DL7 data logger. Up to 2 I/O modules can be installed in the DL2 data logger.

The use of the Modbus RTU communication protocol and grouping of request (grouping of registers) enables frequent refreshing of results and current viewing of values. Within one module for communication with sensors in the Modbus RTU standard (i.e. 2RS485(24V) or 2RS485), up to 25 variables can be read.

• Totalizers (counting the instantaneous value based on the time base)

Each channel can have two independent totalizers (Σ1 and Σ2) that count the instantaneous value of the channel based on the time base. Totalizers can operate in daily, weekly, monthly, resettable or unresettable mode. For each totalizer, it is possible to select a multiplier: 0.001, 1 or 1000. The device can send cyclic e-mail reports containing totalizer values.

For example, the channel type has been selected as measurement for the channel and the instantaneous value of the channel is the active power, read in MW. It is possible to configure the week totalizer with a multiplier of 1. If the time base has been set as /h, then the totalizer value will be determined in MWh (enter the unit during configuration). This application enables analysis the weekly electricity consumption of the selected load.

• Math channels (additional functions)

Math channels compute the formula entered by the user. Operations available for math channels: +, -, ˣ, ÷, √, ², ³, ^. The value of another channel can be used for calculations (the channel number must be preceded by the # sign). Using math channels it is possible, for example, to determine the sum of the consumed current.

• Alarms and controls (output relays)

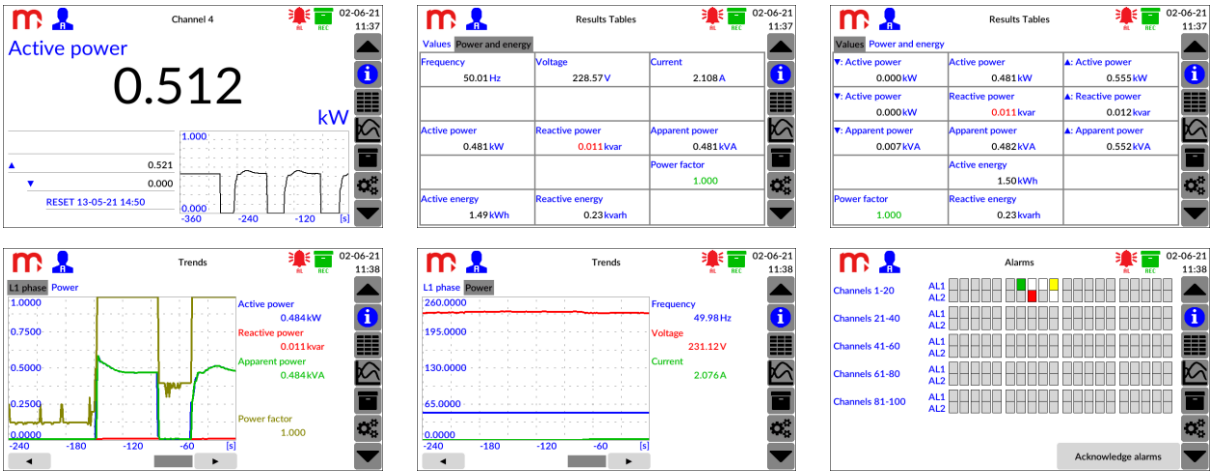
Each channel can have assigned two independent alarms regarding the process value. Two functions are available: alarm (latched type) or control (non-latched type). Exceeding the indicated channel value (exceeding the alarm level) can cause alarm signaling and/or a change of state at the assigned relay 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.

• Displaying data

Results are displayed on a 7" (DL7/DL7L) or 4" (DL2) color touch screen. Each channel is displayed as a single result window (process value, minimum and maximum values of the channel and values of enabled totalizers. If alarms are enabled, then a window informing about the status of all alarms is displayed.

Depending on the user's needs, it is possible to configure up to six 15-element summary tables (process values, minimum and maximum values of channels, totalizer values) and up to six 6-element summary trends (only process values of channels). The device enable viewing the trend of value changes up to 1 hour back.

Examples of DL7 device screens are presented below.



• E-mail notifications

Due to e-mail notifications it is possible to obtain information about too low/too high channel value 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.

The data logger can send a cyclic e-mail report with values of totalizers configured for channels. E-mail messages can be sent in the mode: Daily (select Hour of sending the message), Weekly (select Day of the week and Hour of sending the message) or Monthly (select Day of the month and Hour of sending the message). The e-mail will be sent at the indicated time and will contain the values and units of totalizers in the form of a table.

If the PS_BATT module is installed in the data logger, it is possible to send an e-mail notification about 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.

• 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.

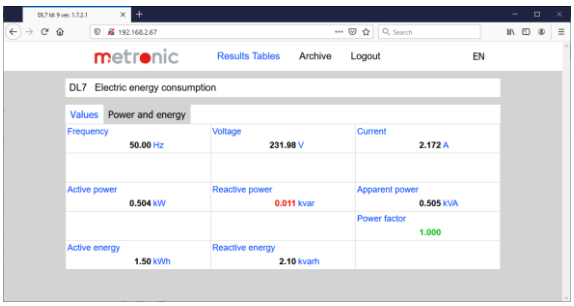
Archive files are created according to entered settings in daily, weekly or monthly mode (typically in monthly mode). Interval of recording process values into the archive is configurable by the user (from every 2 seconds to every 24 hours). Interval of recording should be suited to the measurement process. 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.

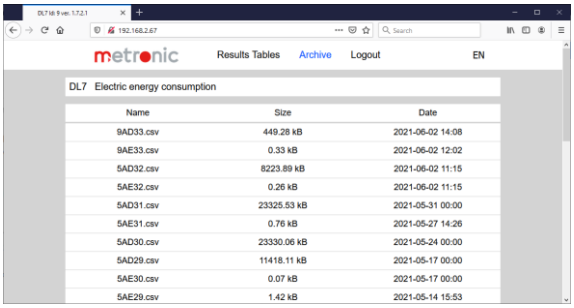
Archive files can be downloaded from the device using a portable memory (USB key) or using an Ethernet cable and a web server. Additional software on the PC enables visualization of archived data or current values (DL7-RP/DL7-RPplus, DL2-RP/DL2-RPplus, mLog).

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.

- ## Web server (remote viewing of values and downloading archive files)

Using the web server it is possible to download archive files and view the data displayed in the data logger table. Values presented in the table are refreshed automatically, which enables the evaluation of the process. The device must be connected to the network with an Ethernet cable. Access to the web server is protected by the user's password (the password can be removed).





- ## Data transfer

Channel values and totalizer values can be read using the Modbus TCP or Modbus RTU protocol. The data logger can be connected to the SCADA master system.

The DL2/DL7 data logger can be extended with a 3 outputs OUT3 module (each output can work as an active current loop source in the ranges: 0-20 mA, 4-20 mA, 0-24 mA or as an voltage source in the ranges: 0-5 V, 0-10 V). The DL2 device has one 4-20 mA analog output. Analog outputs enable retransmission of the process value of any channel (including the math channel).

- ## 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.

- ## 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.

A typical DL7W KIT set is presented below.

- ## Information from the Manufacturer

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

Manufacturer: METRONIC AKP Sp. J.
PL 31-426 Kraków, ul. Żmujdzka 3
T: (+48) 12 312 16 80
www.metronic.pl

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