Batterymonitorsystem for multiple lead-acid battery packs

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Abstract: Intelligent monitoring systems for individual facilities are essential to ensure a reliable and safe energy supply with the help of energy storage systems. With their help, systems, supply stations and other facilities that benefit from energy storage can be equipped with basic security. Safety features designed to prevent minor and major damage to their own and other components. A clear monitoring of the system is ensured on the basis of data collected in real time. The following project presents the development process for the use of the 1-wire bus system, which is used to monitor lead-acid battery blocks. This monitoring determines, stores and transmits the significant values of several energy storage units and allows reliable monitoring and maintenance. The aim of this work is to use the 1-wire bus, which in this case serves as the foundation of the system, to create a reliable data transmission system in order to ensure a clear output of the significant values.

Introduction: Common electrical device in every system currently has a monitoring system that records important parameters. Values such as voltage, current, temperature and humidity, etc. These are transmitted to the central management system using sensors. With the simultaneously recorded values, preset safety precautions can be utilized to enable manual or automatic intervention if necessary. In this project, 24 lead-acid battery blocks are expected to be monitored. These have a high load due to their constant use. As a result, significant values must be recorded promptly, output and stored for an analysis of the stability. The IC sensor (DS2438) was selected for this project as it has all the properties required to measure the voltage and external temperature of the battery and transmit these via the 1-wire bus.

A Bus-Master is required to manage and control the 1-wire bus. This project uses development boards from the manufacturer „Arduino “to achieve this. With the appropriate programming, the control, management and transmission of the data are provided.

In order to send and receive the measured data via the local network, the master must be modified. The same manufacturer of the master offers an expansion board for the Arduino. This can be used to transmit data via the TCP/IP interface. Control of the extension must be permanently stored and assigned via the operating software.

Hardware: Several components are required for the arrangement. In addition to the bus master (Arduino Uno R3) and the sensor (DS2438) with the "1-Wire Battery Monitor" circuit made for it. The expansion board (Ethernet shield), certain self-made cabling and several network distributors (switch) are required. All components are briefly explained below:

Arduino Uno R3: Modern development boards are powerful descendants of electronic experimentation boxes. The Arduino is used to control and clock the bus and enables clear management of the connected sensors and their recorded data.

Figure 1: Arduino

DS2438: The sensor is mounted on the back of the "1-Wire Battery Monitor" circuit boards developed for this occasion; it can record the applied battery voltage via its port. The temperature is recorded via the current housing temperature of the sensor; internal technologies make this possible. The data is sent serially to the master via the 1-Wire interface.

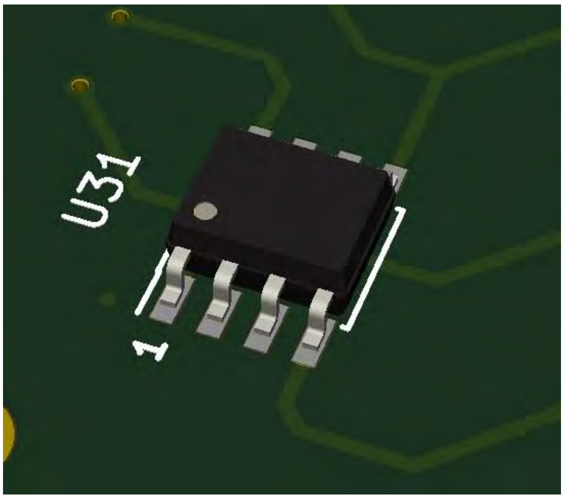

Figure 2: DS2438 on Board

Ethernet shield: Data can be sent via the network using the expansion board, which must be plugged into the Arduino. The data is transmitted via the TCP/IP interface.

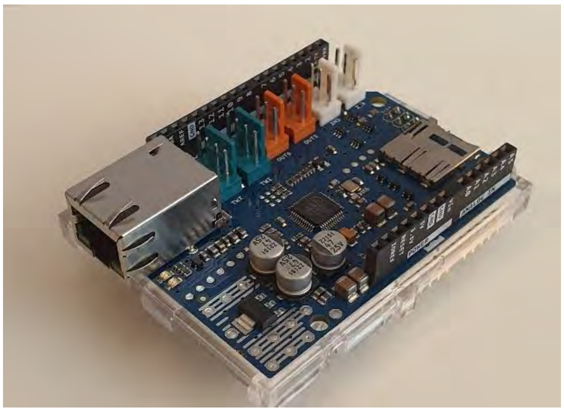

Figure 3: Ethern-Shield

Wiring: A kind of "busbar" is created for each rack for power, data and ground. The secondary side of the board (1-wire battery monitor) is power supplied via the Arduino. The primary side draws its energy from the battery, the loss of the Power is not taken into account. In local network operation, the Arduino has not a possibility of a power supply, so all masters require an additional power supply.

Figure 4: Busbar

Switch: The data is retrieved via the local network. To make this possible, a further collection point is required in addition to the recording and forwarding via the Ethernet shield. Each rack has its own switch as data is collected and forwarded to the main collection point.

Figure 5: Connecting via Switch

<u>Software:</u> Software: A fixed declaration of the components in the system is required to process the collected data. Fixed sequences are carried out in a specific time interval via the programming interface of the Arduino. These intervals record the two significant measured values, which are transmitted via the 1-wire bus that is defined as the medium in the process. The first data outputs via the local network have been successfully implemented, a GUI is required for clear control.

System structure:

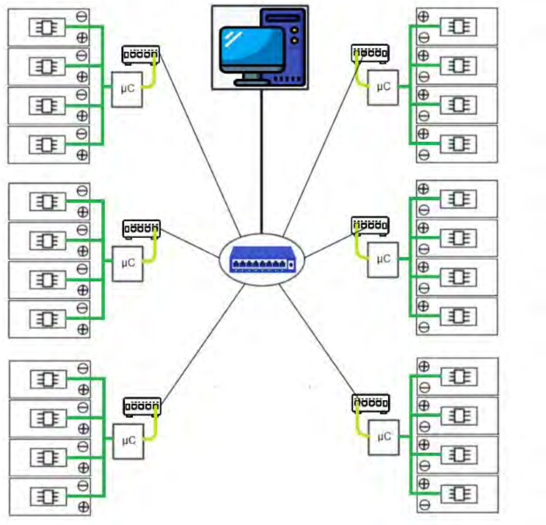

Figure 6: System Structure

The image shows the entire structure, with four "1-wire battery monitors" mounted on the batteries for each group (Pack). A bus master operates a Pack, which forwards the data to the switch. These are forwarded to the collection point.

<u>Algorithm and process:</u> For a more detailed analysis of the procedure, the following list demonstrates the sequence of processes:

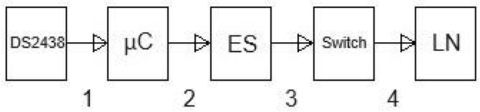

Figure 7:Process

1. 1. send recorded measurements to the bus master via the sensor
2. 2. transmit recorded data to the Ethernet shield
3. 3. send the data to the switch via the network
4. 4. forward data from the switch to the collection point.

1. DS2438: With a serial bidirectional communication in half-duplex, a transmission of the data via the 1-Wire BUS is ensured. Before this can take place, the timing of the sensor and the declaration are permanently stored in the program control via the bus master.
2. The data recorded by the sensor is transmitted directly via the connection to the Ethernet shield. This has a standard RF45 Ethernet jack, which can be used to connect to the local network over a conventional twisted pair category 5 Ethernet cable.
3. The data is forwarded to the central collection point via the respective switch in the rack.
4. At last, the data have an output at the collection point over a specially pre-programmed GUI. Initial data can already be displayed and evaluated via the browser.

Technological achievements

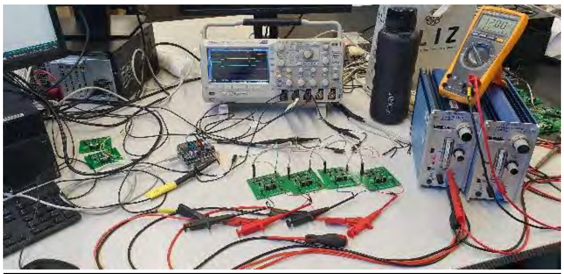

Figure 8: Konstruktion not in Rack

The following results were obtained from the construction, initial tests and controlling. In order to ensure the consistently reliable production of several "1-wire battery monitors", the design of the entire structure, identical components and the manufacturing process are essential components of the functionality. Through an automated process, several new circuit boards were built towards the end of the work, and their reliable functionality means that they find a place in the deployment. The control and management of the data via the 1-wire bus could be realized with the help of the bus master. After a fixed assignment and the time-defined control in the program process, the measured data are assigned to their sources and logged. This enables precise monitoring of the batteries. Complications of the individual components appeared at the beginning of the construction. The different presence times of the sensors resulted in malfunctions that could be reduced by adjustments, but not completely eliminated. Malfunctions that led to a lack of communication via the potential barrier of the "1-wire battery monitor". Adapted dimensioning and circuit-specific changes bring improvements, but further failure analyses are required to cancel them.

Figure 9: Malfunction Signals via Oscilloscpe