VDAS2

Rev.8.4

DynAmp

Modular Membrane Cell Voltage Monitoring System

Objective :

Provide a cost effective monitoring, data acquisition and alarming system for Membrane Cell Electrolyzers with individual cell resolution.

Key System Benefits :

- Enable users to maintain and optimize individual cell and overall electrolyzer performance and efficiency.
- Enable users to predict maintenance
- Enable users to replace/rebuild on actual cell condition
- Provide the basis to optimize overall production lines per product requirements and individual electrolyzer performance, efficiency and condition.
- Prevent electrolyzer damage and possible safety issues via comprehensive and fail-safe alarm capabilities
- Provide true industrial safety ratings regarding IP rating and electrical isolation.

Key System Considerations :

- Provide complete, industrially-safe electrical isolation
- Incorporate individual cell, "hard-wired" protection alarm capabilities which are completely independent from microprocessor and network dependence
- Allow for variable and intelligent cell data sampling to support long term trending, startup/shutdown tracking as well as high-speed monitoring as needed
- Allow users to utilize their own process control software to customize the system to their technology and monitoring approach.
- Provide optional local controller for automated data acquisition and storage as well as onward digital communication.

Technical Overview :

Modular Design : The system is based on individual, purpose-built 12-cell monitoring modules. The number of modules per system depends on the number of cells in the electrolyzer. In addition to the 12-cell module, single channel modules are available provide the system with other data such as electrolyzer current.

Electrical Safety : Each module only has two 'downstream' connections. 'Network' and 'Protection'. The network connection provides 2.5kV of isolation between the cell voltages and the network. The 'Protection' alarm provides 1.5kV of isolation. If the modules are optionally externally powered, this connection also provides 1.5kV of isolation.

Module to Cell Connection : Voltage sense wires are connected from the module to each cell. Each module can be powered directly by the voltage drop across the cells it is monitoring. Alternatively, the modules can be externally powered by 5…60VDC. No AC mains power is required.

Cell Voltage Measurement : Each module measures individual cell voltages at better than 1.25mV resolution storing measurements in local memory for subsequent network transmission.

Cell Voltage Warning Alarm : Each module compares each of its cell voltage measurements against two user configurable alarm limits. If one or more of the measured cell voltages are outside of the alarm levels, this alarm is made available via the network and is indicated on the module itself via dedicated LEDs.

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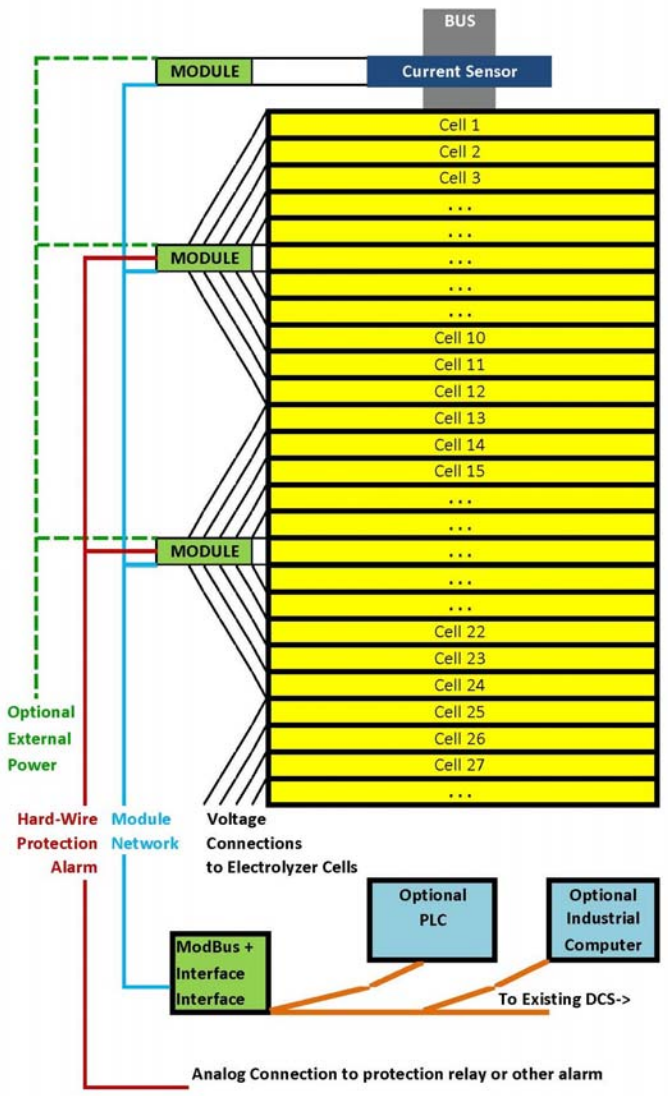
Cell Voltage Protection Alarm : Each module also incorporates a fail-safe 'protection' alarm circuit. This 'protection' alarm is completely independent of the modules digital data acquisition and communication processes to provide protection in all situations. If a measured value exceeds the 'safety' alarm limit, a fail-safe relay is actuated which allows the user immediate protective action without the influence of microprocessor multitasking, network speeds etc. If this 'protection' alarm is triggered, a cell specific LED is illuminated on the module.



Module Networking : Individual modules are connected together and to an interface module which includes a industrially robust RS485 MODBUS RTU connection for downstream equipment.

Module Data Processing : Each module updates its internal cell data registers at the rate of 0.1sec including cell voltage, alarm status 1 and alarm status 2. This data can then be accessed via MODBUS to transmit a complete set of cell data at 0.1sec per cell on an unburdened network.

This modular architecture is designed to allow the highest degree of flexibility regarding data acquisition and system integration.

Extremely flexible data sampling.

a) 'Normal' Mode i.e. all cell voltages nominal

In this condition, the system could operate using a 'consistent' sampling approach meaning each cell voltage would be sampled at the same rate. While the system could provide a complete set of cell voltages from typical electrolyzer in well under 20 seconds, most of the time this data would be simply checked for anomalies and if none were found, simply overwritten. For sake of trending the cell voltages over the long-term, the system could periodically store a complete set of electrolyzer data every hour or so.

b) 'Priority' Mode : i.e. some cells exhibiting inconsistent, extremely low or high cell voltages.

If this were to occur, the system could automatically modify its sampling to a 'prioritized' approach allowing 'suspect' cells to be sampled more frequently than others. This condition could be triggered by either module alarms or another criteria determined by the PC or DCS. In this mode, 'suspect' cells would be sampled at a faster rate to provide a more detailed picture of the cell condition while the remaining 'normal' cells would be sampled at a slightly lower rate. For example, the 'suspect' cell might be sampled every second in this condition while the

complete set of remaining cells might be sampled every 20 seconds or so.

c) 'Detail' Mode : One or more cells are selected for real-time sampling.

In this mode, triggered by condition or manually, the system would focus on one or more cells sampling multiple times per second to provide the highest resolution. This could be valuable to operators during start-up to track and be sure all cells are starting correctly and without risk of damage.

Optional dedicated local controller :

An optional, industrial local controller is available which enables the system to operate on a totally stand-alone basis if desired. This controller offers the following functions.

- automated data acquisition
- long-term data recording on removable memory card
- capability to automatically send recorded data by FTP
- real-time access to data and functionality via digital network including standardized internet browser interface. Includes local laptop connection.

The overall design objective is to provide a modular, truly industrially safe system for electrolyzer monitoring and true fail-safe alarming when needed. Users can configure the system to meet their needs exactly, from a cost effective standalone system to a low-cost 'front end' for existing DCS systems and programs.

Module Environmental Rating : Each module is packaged in an IP66 enclosure for mounting directly with the electrolyzer structure.

Example Configuration Overview :

3 electrolyzers with each having 14pcs of 12-cell Data Acquisition and Alarm (DAQA) modules
(504 cells total : can increase/decrease as needed)

DAQA Modules
- Voltage sense inputs for each cell 0…5VDC
  - 12 bit resolution / 1.2mV resolution
- Parasite powered via cell voltage drops
  - Low voltage DC direct power optional
- 2500VRMS isolation input to communications bus
- Fail Safe hard-wire alarm
  - Form C Relay Contact output each module
  - LED indicator on module for each cell
- Network-programmable alarms
  - High Voltage & Low Voltage with Module LED
- Enclosure IP66 (ABS Plastic) 24x16x9cm

DAQA Network Interface Module
- Data Communication with DAQA modules
- MODBUS+ communication to plant DCS and/or
- Optional Industrial Computer and/or PLC

Optional stand-alone Industrial Computer
- GUI for system configuration
- Real-time Data display
- Archival Data storage

NOTE : DAQA Network Interface Module and one rack mounted industrial computer can support multiple electrolyzers depending on desired sampling rates.

System engineering needed to provide formal quotation
- Definition of connection points for DAQA voltage sense wires. (cell technology provider dependent)
- Selection of DAQA power : parasite or ext. DC
- Definition of monitoring schema including sampling rates, alarm annunciation, computer display configuration, long-term data storage, etc.
- Site engineering responsibility
- Installation and Commissioning responsibility
- Engineering responsibility of interface and data exchange with existing DCS system.

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DynAmp, LLC

Formed with the integration of knowledge from LEM SA and Halmar, DynAmp has a unique, in-depth understanding of High current applications. With over 50 years of experience, thousands of systems have been installed in Aluminium smelters, Chlor-Alkali plants and other energy intensive processes world-wide.

DynAmp's know-how extends well beyond electrical current measurement. We understand the value of the information our systems provide and how it enables users to optimize, improve and protect their processes.

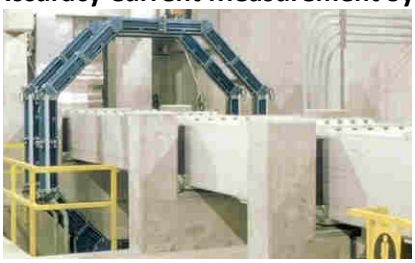
Our in-depth understanding of both harsh industrial and electromagnetic environments allowed us to develop our exclusive OLOP technology as well as the only fully compensated, closed loop optical technology for a new generation of measurement systems.

The need for energy intensive processes to optimize power conversion, increase process efficiency and objectively compare multiple lines has never been higher. The DynAmp team stands committed to helping you meet the challenges you face today as well as those of tomorrow.

DynAmp Product Line Overview

LKCO : Fully Compensated, Closed Loop Optical High Accuracy Current Measurement System

LKP : Highly Proven, Closed Loop High Accuracy Current Measurement System



LKAT : Integrated Rectifier Current Measurement and Protection System

BRP : Highly Cost Effective Rectifier Reverse Current Protection System

RCEM : Rectifier Monitoring and Current Balance Analysis System

COP : Portable Clamp-on Current Measurement System for large bus bars and conductors

RR Series : Flexible pulse DC and AC current measurement products

Systems : Customized Process Monitoring, Analysis, Reporting and Control Systems