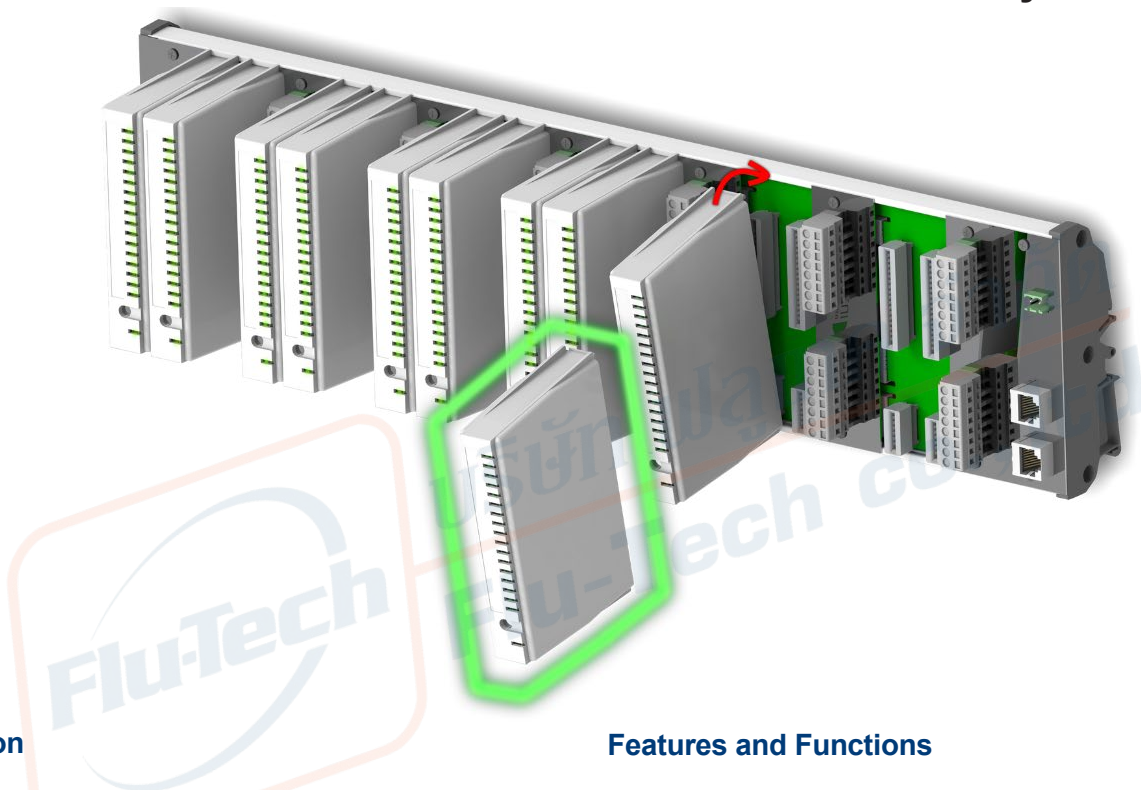


# HydraSafe

## High Performance Cell Voltage Monitoring in Electrolyser Stacks



### Application

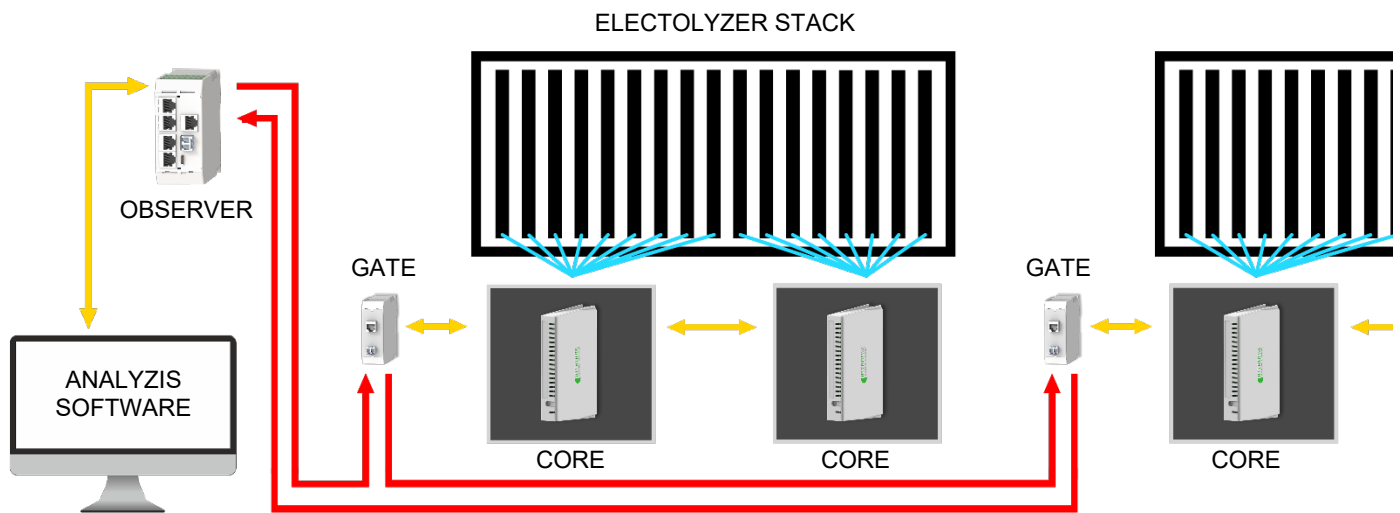
Monitoring the single cell voltages of an electrolyzer gives the operator an insight into the efficiency, stability and safety of the hydrogen electrolysis process. It allows to identify membrane degradation and defects, e.g. pin holes, cell leakage, insufficient electrolyte feed, electrode loss of coating and other events. As consequence, the operator can adapt process parameters or schedule maintenance work.

HydraSafe is the best system on the market for this purpose. It is designed to collect all the relevant data of an electrolyzer, including voltage, current, temperature and other readings. Its high sampling rate enables highest data quality, provided in real-time and including all the tools to analyze it over long periods of time. A SIL2-rated version adds an extra safety layer and is a perfect solution in combination with MÜTECs SIL2-rated HVT transmitters.

### Features and Functions

HydraSafe is modular and scalable from 16 to 500 cells. It works with AEL, PEM, SOEC and other technologies. It is prepared for multiple protocols and PLCs, including OPC UA, ProfiNet, Modbus and Profisafe. HydraSafe thus integrates seamlessly into existing control systems, being the easiest way for a manufacturer, an EPC or a plant operator to design a monitoring system – based on standard components.

HydraSafe was developed by experts with decades of experience in the hydrogen and alkali chlorine industry.. The main benefit is its flexibility – no matter how the electrolyzer setup looks like, no matter if it is integrated into the manufacturer's PLC or requires a separate analysis software, the HydraSafe system offers the perfect toolkit. It combines its flexibility with safety and robustness, as it works up to an ambient temperature of 100°C and a safety level of SIL2.



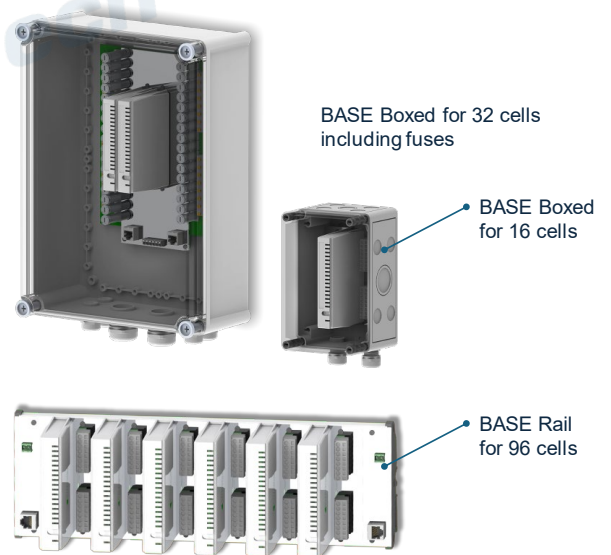
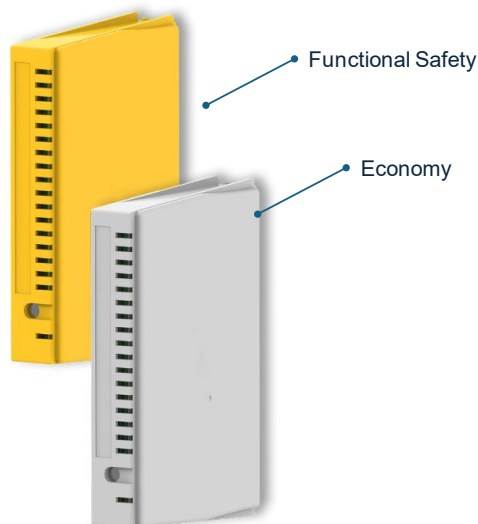
Schematic drawing of a HydraSafe system. 16 cells are connected with a CORE, multiple CORES are combined on a BASE. The GATE is used to convert Fast Ethernet to optical fibre. An OBSERVER gathers and analyses the data.

### CORE and BASE unit

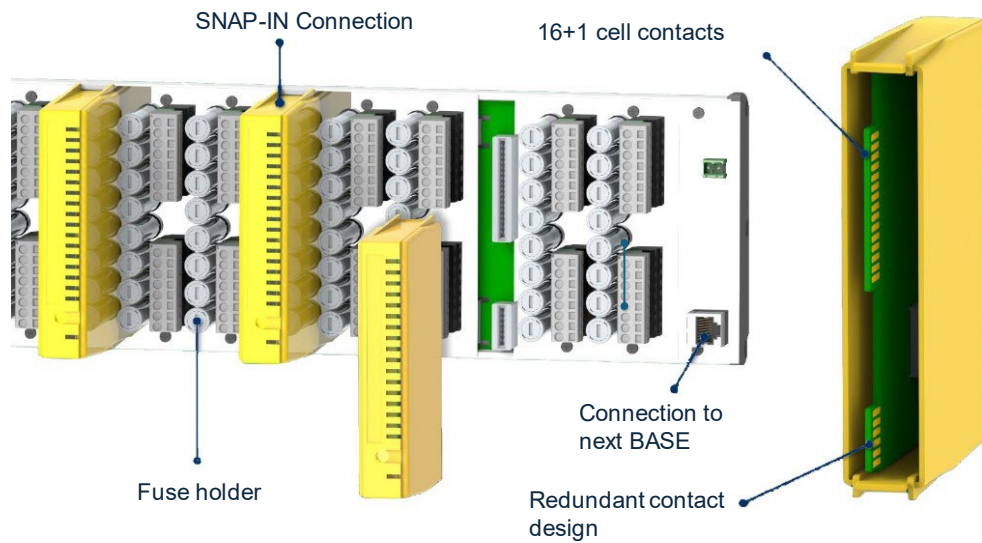
The CORE module provides precise voltage measurement for up to 16 cells and is easy to install thanks to its compact design. We have experience with multiple connection technologies and can offer the most suitable type for your electrolyzer.

The COREs are placed close to the electrolyzer, can be completely sealed and are optimized to handle the hot and challenging conditions in the cell room. A LED bar signals the availability of a voltage signal or a cable break, and allows the operator to easily assess the status of the stack.

Two versions of the CORE are available: a standard one and a version for SIL2 rated setups. They are standardized, don't need to be calibrated and can easily be replaced using click-in-technology.



The BASE unit acts as central interface between the electrolyzer and the measurement modules. It offers flexible and easy mounting for both cabinet and field installations. There are three versions available: a BASE rail, a BASE box for 16 or a box for 32 cells. The BASES can also be configured with integrated fuses or pre-assembled cable harnesses. All BASE units can be combined to long, nearly infinite systems.



*BASE rail with three CORE units. The CORE units are automatically connected internally. The BASE can easily be connected to the next one, both 24V supply and internal cabling are build as chain line. There is enough space to mount the cell cables, and fuses can already be integrated to save space and time.*

A lot of thought was invested in speeding up the assembly of the electrolyzer. The same short cable harnesses can always be used, there is enough space to connect the cables, and pre-assembly in the factory allows fast mounting at site.

The HydraSafe system can easily be extended to fit all stack sizes by connecting multiple bases – only the maximum number of 500 cells is the limit.

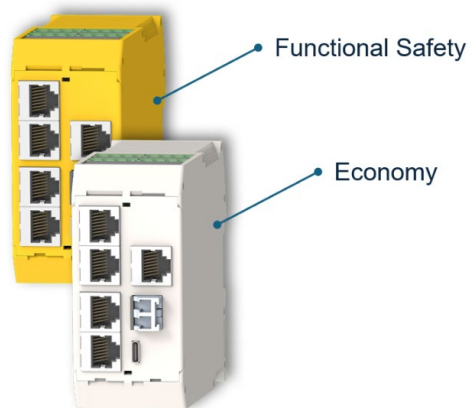
### GATE - Fiber converter

Voltage readings can be taken up to 10 times per second. Multiplied with hundreds of cells, this creates a lot of data. Therefore, fast data transmission is crucial. HydraSafe uses HydraLink CAT5E high speed cables and converts the information on a GATE to fibre optics. This is best way for fast data transmission over wide distances, up to 2 km.

The GATE is compatible with standard fiber optics (OS1/2) and allows for various architectures, from remote evaluation units to complete fiber optic cabling and grouping of multiple measurement modules. This creates a flexible and robust infrastructure.

### OBSERVER data analysis

All measurement data, the voltage values from up to 500 cells, but also current measurement or temperature readings are gathered in the OBSERVER. It is the brain of the HydraSafe system and the interface to an external PLC or to MÜTECs analysis software. The OBSERVER works with standard protocols, e.g. Profinet, Profi Safe, OPC UA and Modbus, but can also be adapted to other protocols. It already includes a Modbus TCP Server and an OPCUA server. 8 alarm outputs allow a flexible setup.



## Analysis software

A powerful, web-based software tool to analyze the data is in preparation. It allows to set the alarm values, assess historical data, identify trends and use algorithm and artificial intelligence to evaluate the performance of the electrolyzer. A main benefit of the HydraSafe system is that data like the voltage-time-relation for each individual cell, can be stored for long time, making it analyzable for years to come.

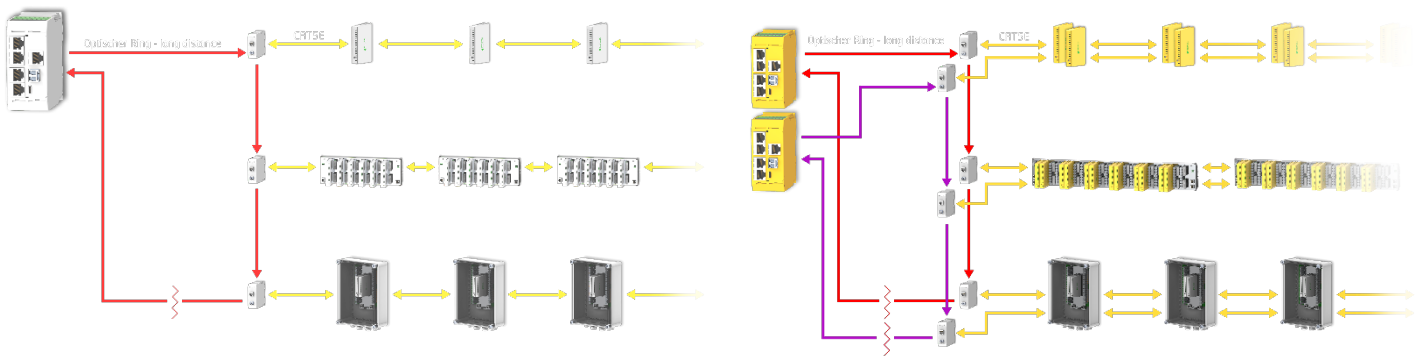
## SIL2-version

A SIL2-rated version of the HydraSafe is in preparation. Its goal is to offer protection during all modes of operations and against all known events in a cell-room. The single cell voltage measurement delivers all the necessary information for this purpose and provides an adequate level of protection at any point of operation, not only at maximum or partial load, but also during load changes at startup and shutdown.

### Improved operation with HydraSafe

HydraSafe helps to identify the most common events and operate the electrolyzer efficiently and safely:

- Establish a range of acceptable voltages for each cell - at any given moment and in all operating regimes (startup up, normal operation, etc.)
- Issue an alarm or shut-off the electrolyzer if the individual cell voltage reaches a warning level
- Detect all known events that can occur in a cellroom such as: leaking cells, membrane pinholes, tears and blisters, membrane poisoning, insufficient electrolyte feed, anode loss of coating, cathode loss of coating, electrode passivation, cell temperature control fails, electrolyte concentration control fails, differential pressure out of range, short circuits
- Protect the electrolyzer against consequential damages in case of evolving malfunctions (e.g. insufficient electrolyte feed, failing temperature control)
- Give valuable information for performance analyses
- implement a predictive maintenance strategy, e.g. plan based on facts when to replace membranes



Standard system (left) and redundant SIL2-rated system with maximum availability of CORES, GATES and OBERSERVERS.

## Advantages

- Modular, scalable cell voltage monitoring
- Can be used for any electrolyzer technology and any size, up to 500 cells per system
- Available with and without analysis software, can also be integrated into the customers PLC
- High flexibility and easy integration, e.g. system is prepared to work with multiple protocols and PLCs, e.g. Profinet, Profi Safe, Modbus, OPC UA etc.
- Supports optical and Ethernet connections, up to 2,5 km distance
- Seamless integration into Fast Ethernet infrastructure with SFP modules
- Easy cable handling and fast installation
- Pre-assembly, pre-wiring and integration of fuses to reduce work on site
- Simple configuration, no calibration needed
- Optional test module for verification and safety checks
- Fast maintenance and repair, all modules can be swapped during operation
- Robust system, designed for temperatures up to 100°C
- Safe SIL2-rated version, allows to integrate alarm settings, emergency shut-offs etc,
- Easy to implement redundancy (measurement, transmission, evaluation)
- High sampling rate for maximum precision
- Fast data transfer and data analysis
- Powerful analysis software, allows to detect possible errors and deterioration
- unprecedented speed, accuracy and stability