
ULSTEIN®
ULSTEIN EMS™
– POWERED BY X-CONNECT™
ULSTEIN.COM

Prepare your ship for a digital future

New technologies can radically improve the efficiency of how a ship is operated. The future is about embracing these possibilities, developing products for safer and more efficient operations.

This is at the core of product development in X-CONNECT™. With our effort on offering products and systems that utilize digital possibilities, you can offer ship intelligence that make your business smarter, safer and greener.

Prepare your ship with solutions utilizing digital opportunities.

1 Energy Management System

In general, an Energy Management System (EMS) is controlling the use of available energy sources in the power system. Its task is to utilize available energy sources in an optimal way, with regards to fuel resources and operational requirements.

2 ULSTEIN EMS™

The ULSTEIN EMS™ is an EMS system specifically controlling the use of battery energy. The system is integrated with the ULSTEIN PMS™ (Power Management System), and the ULSTEIN IAS™ (Integrated Automation System).

The EMS system controls charging/discharging the battery's energy according to the operator's selected mode. In collaboration with the PMS, the required battery contribution to the power system is obtained.

The EMS system is interfaced to the battery internal control system (BMS), the battery converter (BC) and the circuit breaker, and coordinates, monitors and controls the use of each system/device. Together they form a complete energy storage system (ESS), ref Figure 1. The system is adaptable to different hardware solutions for synchronizing and connecting to the grid.

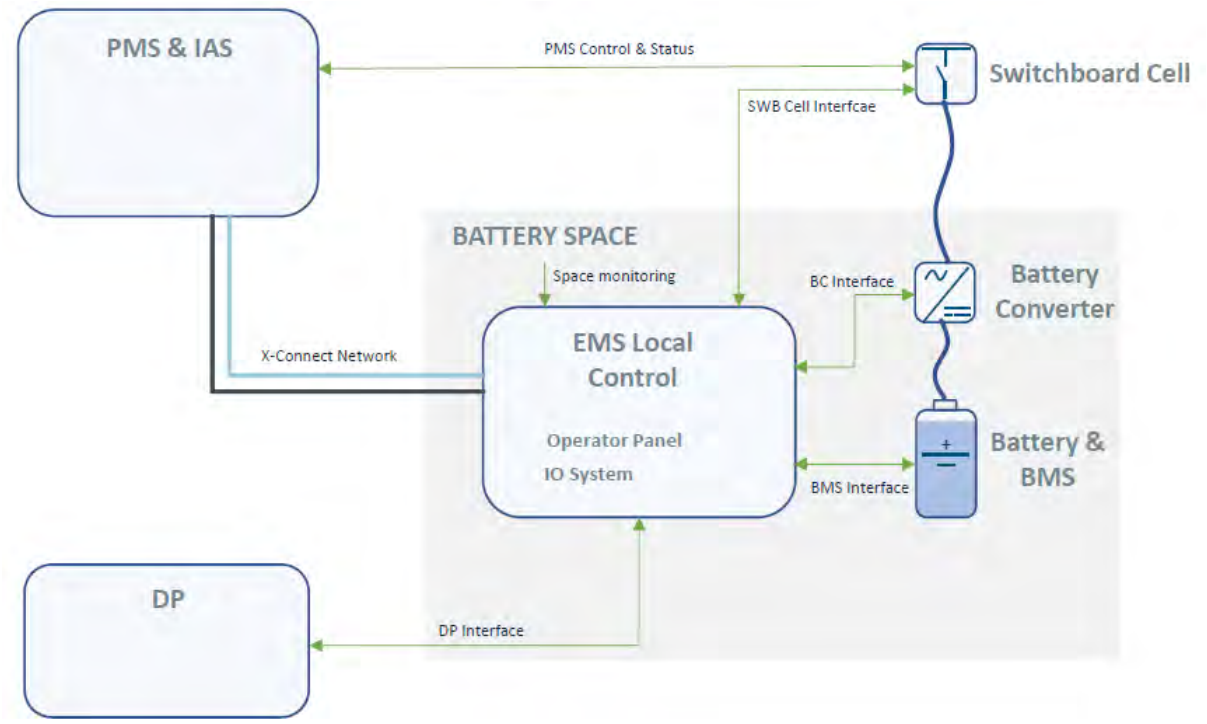

Figure 1: Interface architecture

The integration with the PMS/IAS ensures an easy interface to necessary power system data and provides user interface, monitoring and alarm handling facilities. Also an operator panel for local control is available. If local control is not required by class notations or a customer,

simpler and cheaper hardware solutions can be adopted.

2.1 User interface

As for the other products built on X-CONNECT™ the ULSTEIN EMS™ has a clean GUI design with good overview of the different components. Control of different operations can be done from this view, and the operator can easily access a popover window with more advanced functionality by clicking on a component's settings, ref Figure 2 and Figure 3. Easy access to important class required monitoring data and calculations is also provided, ref Figure 4 and Figure 5.

Figure 2: EMS symbol in the single line diagram GUI mimic

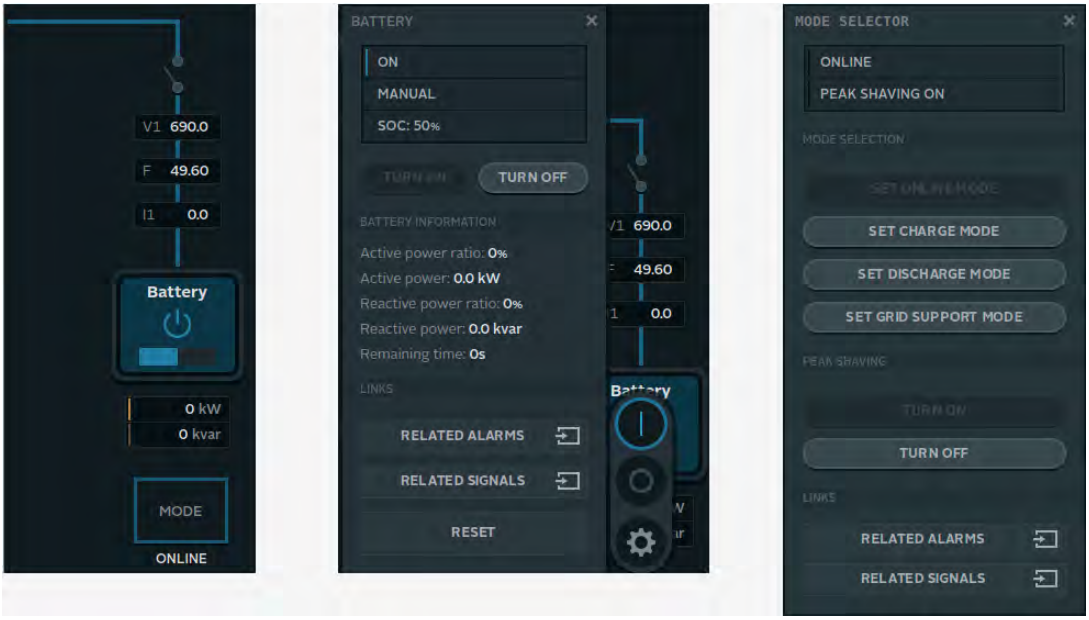

Figure 3: EMS control GUI with popover windows

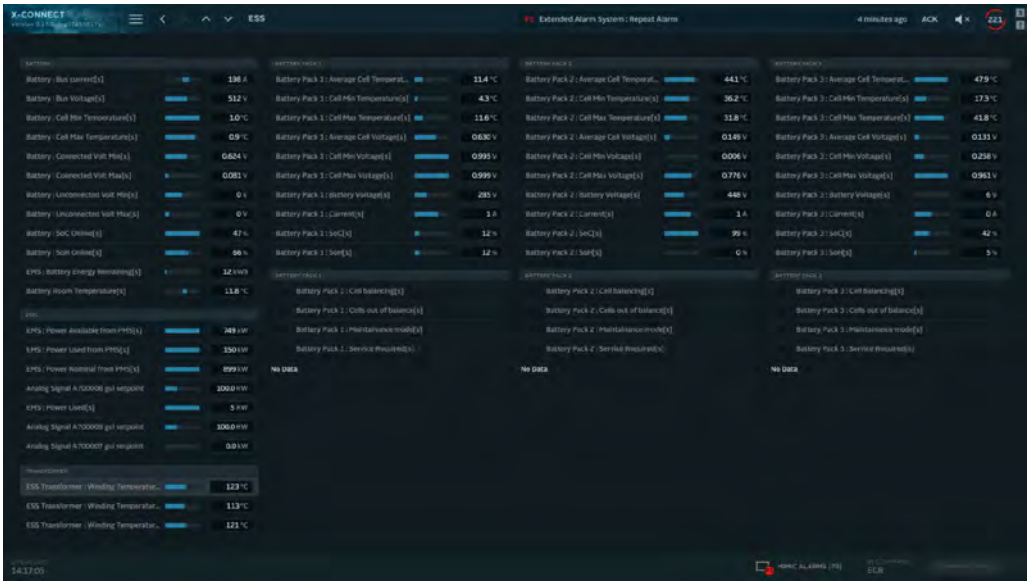

Figure 4: EMS battery monitoring GUI example mimic

Figure 5: ESS monitoring GUI example mimic

2.2 Functionality

The operator controls the system through the GUI components. Starting and stopping the system is done in a semi-automatic way.

Default startup procedure

When the operator press *turn on*, the EMS will first check if the battery packs are connected to the battery DC-bus. If not, the EMS sets a *connect all packs charging/discharging* command

to the battery's internal control system (BMS). The BMS selects the correct pack to connect first, according to the pack's state of charge (SoC), and connects it. The battery releases its hardware interlock to the battery converter and the converter powers up its internal DC-bus. When ready for start, the battery converter signals this to the EMS.

The EMS then sends a *start* command to the battery converter, which starts the converters procedure for powering up the AC side to nominal voltage and frequency. When powering up is finished, the EMS expects a running signal from the battery converter.

The EMS sets *idle* mode to the converter and starts the procedure for synchronization and connection of the ESS to the grid by *increase/decrease* signals to the converter based on measurements around the breaker.

When connected, the EMS sets *charge/discharge* mode and a current set-point to the converter, charging/discharging the first battery pack. The battery's internal control system (BMS) then connects remaining packs one by one in an optimal sequence, while charging/discharging the connected packs to the next pack in the sequence's voltage level. The current set-point is meanwhile adjusted by the EMS according to the number of battery packs connected.

The EMS detects when all available (and the configured required minimum number of packs) are connected, and then unblocks the other operational modes for the operator.

The EMS is adaptable also to other synchronization and connection variations.

EMS Modes

The system can be configured to deliver a selection of modes according to the specific vessel requirements, the battery converter features and the battery capacity, ref Figure 6.

Offline mode: The ESS system is not connected to the power grid, the battery converter can be running or not running.

Idle mode: The ESS is connected to the power grid but is not delivering or consuming any power, i.e. the battery converter regulates the power/current flow to zero. The idle mode is the base mode for all the other modes, meaning transitions to other modes goes via this mode. Also, in case of EMS detected failures, the EMS forces the ESS to idle mode. The mode requires minimum one other power source to be connected to the grid in parallel.

Charge mode: In charge mode the operator manually selects charging of the battery from another grid connected power source with an operator selected current set-point. Another configurable function is limiting operator set-points according to the power grid's available power, ESS equipment's design limits and the battery's run-time charge current limit. This mode requires minimum one other power source to be connected to the grid in parallel.

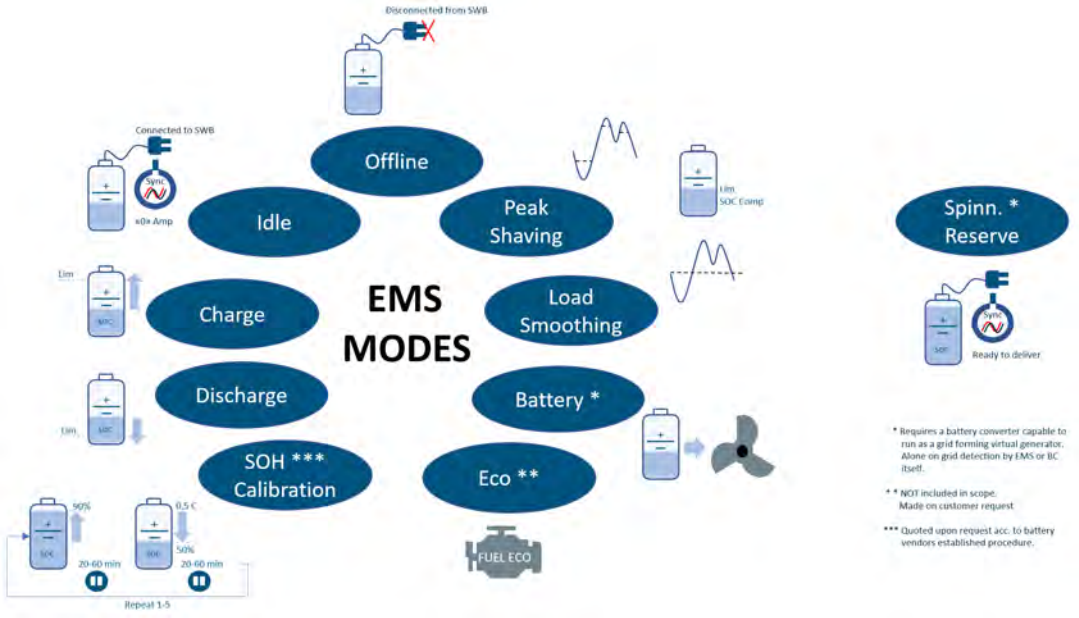

Figure 6: Overview of EMS modes

Discharge mode: In discharge mode the operator manually selects discharging of the battery to the grid with an operator selected current set-point. Another configurable function is limiting operator set-points according to the power grid's current load, ESS equipment's design limits and the battery's run-time discharge current limit. This mode requires minimum one other power source to be connected to the grid in parallel.

Peak shaving/Load smoothing mode: In these modes the EMS is calculating a power set-point to the battery converter which is *shaving of* grid power variations, and/or *smoothing* the other power sources' load variations. The desired amount of shaving effect is set by a configurable hysteresis. To secure the required amount of battery energy for spinning reserve during peak shaving (e.g. DP-operations), a configurable SoC compensation can be added on the calculated peak shaving power set-point. To support several ship operational requirements without operator adjustments, the EMS can be configured with several versions of the mode with different configured shaving effects and SoC compensations. Another configurable function is limiting the calculated shaving/smoothing power set-point according to the power grid's available power, ESS equipment's design limits and the battery's run-time charge current limit. These modes require minimum one other power source to be connected to the grid in parallel.

Battery mode: In battery mode the use of the ESS as the only power source on the grid is prioritized. Other power sources will only be connected when needed for recharging the battery or due to heavy load on the ESS. The battery converter must be designed for operation as a standalone virtual generator, and the battery dimensioned for the operational requirements.

Other: If the battery converter is designed for operation as a standalone virtual generator and the battery dimensioned for such an operation, the ESS can function as a spinning reserve, i.e. as an instant power backup. The battery converter can then detect that it is alone on the grid by itself or by a signal from the EMS, and deliver the required grid power. The EMS will then calculate the ESS current power capacity for the PMS, which in turn restricts the available power to controllable heavy consumers or sheds unimportant loads.

In conjunction with the ULSTEIN PMS™, the ULSTEIN EMS™ system is extendable for other required modes and functions, upon request.

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