ATI ACCURATE TECHNOLOGIES

EPOWERLABS

ATI & Klaric Electric Ferry High Voltage Troubleshooting

Increasingly aware of its carbon emissions footprint, the marine sector is starting to adopt powertrain electrification, particularly for short range vessels where significant cost benefits on both maintenance and fuel can be achieved.

In these instances, Accurate Technologies Inc. (ATI), a leading independent supplier of electronic control system development tools, can assist marine specialists with detailed electric powertrain test and validation. Whether in test cell or on-vessel, ATI's powerful ecosystem of HV-suited software and Klaric hardware tools provides a robust, user-friendly solution, as recently demonstrated by EPowerlabs (EPL) in Spain.

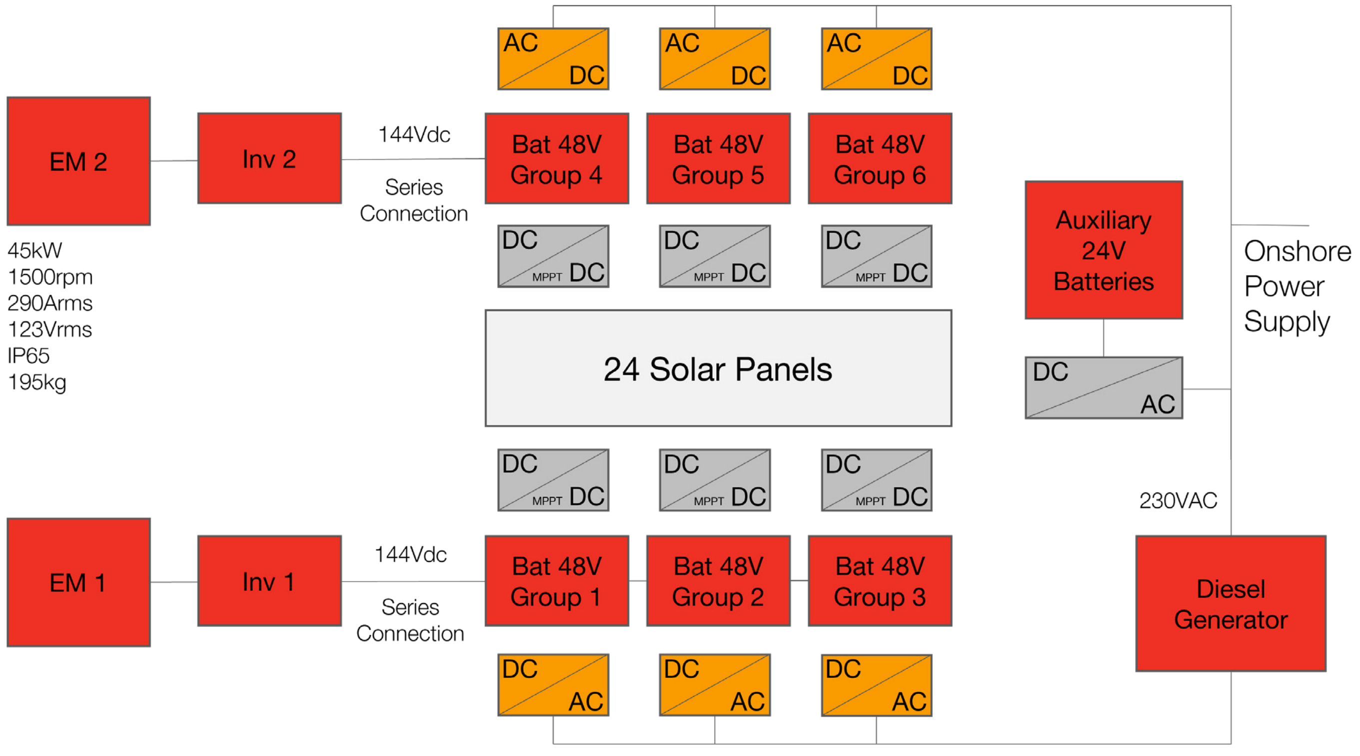
About EPowerlabs

EPowerlabs was born in 2020 with the mission of helping to accelerate the transition in mobility and energy applications towards electrification and sustainability. Since 2020 EPowerlabs has been working to develop cutting-edge solutions in power electronics that allow them to improve the technological competitiveness of their clients to help them be leaders in the present and in the future.

How ATI Products Helped EPowerlabs Meet the Development Challenges

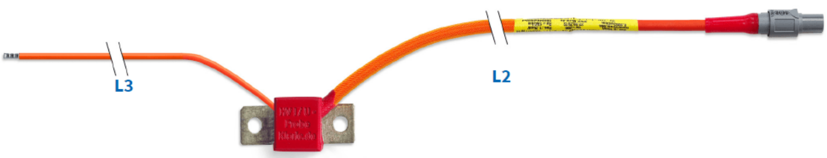
This use case was based on an electric passenger ferry operated by Motoras de la Isla (MDLS) serving the picturesque bay of the Basque city of San Sebastian, carrying passengers from the port to Santa Clara Island and offering small trips around the cove.

Known as the EKO KAT, the ship's powertrain uses two asynchronous AC induction 40kW motors with associated inverters. The motor / inverter set is a model EM300-75W supplied by Bellmarine, using a Curtis 1239E inverter.



The powertrain is supplied by high voltage batteries, charged via 24 solar panels located in the roof of the vessel. In addition, a diesel generator supplies the boat's low voltage system and recharges the drivetrain batteries as a back-up power source.

MDLS had experienced problems with the operation of the vessel since its introduction into service. These issues appeared whilst working at full state of charge and carrying out different manoeuvres, resulting in the loss of power from one of the vessel's motors or even fire developing in the corresponding inverter. Consequently, the motor inverters had been replaced on several occasions without success. In view of this unsustainable scenario, EPL was called in to diagnose the possible problem sources using the KLARI-QUAD 2 1500V, supplied by ATI.



With regard to the instrumentation setup, although KLARI-QUAD 2 modules allow simultaneous measurement of current and voltage with a single probe, on this occasion separate sensors were used. A current probe was connected in series with a safety fuse located in the DC supply rail, while a voltage probe was connected to the inverter input.

The KLARI-QUAD 2 was attached to the steps linking the machine room to the main boat deck and connected to a laptop PC via CAN. Klaric devices are compatible with any PC software package that can receive and interpret CAN bus messages or acquire data on XCP over ethernet; including ATI software VISION and CANLab.

Once EPL had completed and verified the installation, the boat operated for 1,5 – 2 hours during a continuous data acquisition session. During this time, the boat undertook a typical operation journey (around 10 minutes), simulated various common situations and made “custom” manoeuvres in order to verify precisely the problematic scenarios.

These manoeuvres were all carried out with the vessel in ‘eco’ mode, on a single driveline and with the batteries at 80% state of charge. Initially overcast weather conditions on the test day soon gave way to sunshine, enabling the solar panels to recharge the high voltage batteries and increase the DC supply rail voltage.

Test measurements showed that the DC bus voltage seen by the inverter was around 155V. This was dangerously close to the inverter’s maximum voltage rating of 170V, particularly considering the batteries were not at 100% state of charge.

To check if this was the source of the problems, additional manoeuvres were made, in order to verify under which conditions this DC voltage increased. Tests were made with the boat at full power ahead and then full power astern. The transition from “ahead” to “neutral” was also tested.

It was found that sudden changes in current caused by the manoeuvres generated a voltage rise in the DC bus of the inverter, with the most severe action being the transition between astern and neutral. The voltage increased in this case by 9V, with a rise of 6% in 1s.

As these tests were carried out with the batteries below maximum state of charge and with the drivetrain in ‘eco’ mode (i.e., limited) it can be extrapolated that in more critical conditions the voltage increase would be more drastic, easily exceeding the 170V rated maximum that the inverter is able to withstand. This hypothesis can explain the type of problems and their timing.

Conclusion

Thanks to the measurements obtained by EPL using the KLARI-QUAD 2 the team confirmed that the working voltage of the entire system exceeds the maximum 170V DC rating of the inverter when the batteries are fully charged via the solar panel array. Additionally, the measured voltage spikes generated during the transitions between ahead, astern and neutral compound the issue.

In view of this, EPL recommended that using the current powertrain design, drive selection transition should be undertaken smoothly by the operator, avoiding sudden changes and always in ‘eco’ mode, especially when the batteries are at a full state of charge. In the longer term, EPL recommended replacing the motor inverter with a unit having a higher rated maximum voltage range.

This testing also confirmed that the maximum power recorded in drivetrain ‘eco’ mode did not exceed 18kW per engine. The DC current ramps are at worst 120A/s.

For further information visit their respective websites:
http://motorasdelaisla.com/en/
https://epowerlabs.com/en/
https://www.accuratetechnologies.com/