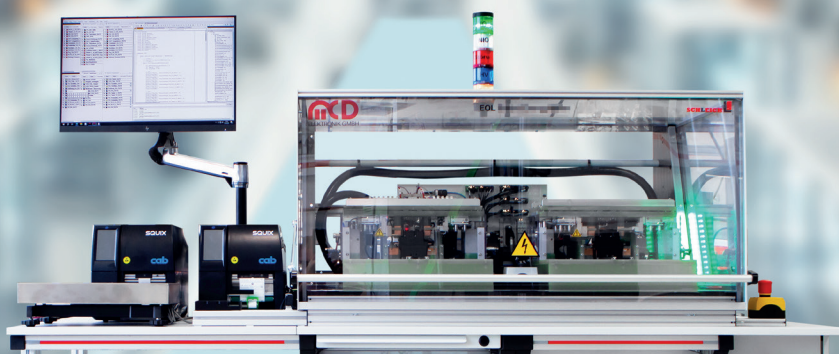


TESTING OF E-CHARGING TECHNOLOGY

Smart DC energy meters put to the test



The DC grid industry is experiencing strong growth, driven by the increasing use of renewable energy sources. In the field of electromobility, too, there is a growing demand for public **e-charging stations**. This requires high-precision energy meters that measure energy and bill it accordingly via a ticket system. In order to guarantee accurate electricity consumption and thus correct billing of costs for the consumer, these meters must be calibrated in accordance with legal requirements (such as calibration law/MID).

These DC Energy Meters are smart meters for direct current (DC) that precisely measure and analyze voltage, current, power, and energy in DC systems (e.g., solar systems, batteries, electric vehicle charging stations, telecommunications base stations); transmit the data digitally for remote monitoring and control, thus enabling an **efficient energy management** solution for optimizing consumption and integrating renewable energies.

INITIAL SITUATION

In the wake of climate change, sustainable alternatives are becoming increasingly important. Many drivers are increasingly turning to electric mobility and consciously avoiding vehicles powered by combustion engines. The customer in this exemplary project is a manufacturer of smart energy meters, which are ultimately used in charging stations for electric vehicles. What was needed was a highly accurate, safe, and reliable test system that could also be flexibly expanded for **future planned adjustments** and changes.

The task consisted of automatic programming, calibration, verification, and functional testing of the smart DC energy meters under high currents with a clear safety concept. The energy required for this was then to be billed automatically via a ticket system using highly accurate energy meters in accordance with legal requirements (e.g., calibration law).

OBJECTIVES AND CHALLENGES

One of the challenges of this project was the time-critical implementation that accompanied development. **A quick response** and adaptation to conceptual changes was essential, which is why a flexible test system solution was developed hand in hand right from the start. Future expansions had to be taken into account as early as the concept phase, with regard to different currents and voltages.

In addition, the implementation of accurate billing of charging costs for public charging stations in accordance with German calibration law (**calibration law compliance**) and the European "Measurement Instruments Directive" (MID) was a basic requirement. To ensure this conformity with calibration law, the automated and production-ready test system had to be developed in a flexible and modular manner and be capable of functional testing of components as well as programming them.

In addition, the system had to be as compact as possible and suitable for **synchronous testing of two test objects**.

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REQUIREMENTS

- **Programming & Communication:**
Programming the firmware and testing communication with the test object via RS485; basic initialization of the test object with parameter sets
- **Current & Voltage:**
Adjustment of current up to 1500ADC, DC voltage up to 1000VDC
- **Haptics & response behavior:**
Pressing buttons on the test item and reading the corresponding response
- **Verification of the energy quantity:**
Verify the previously executed measurement via specified measuring points; Comparison of the energy quantity with a high-precision reference measuring device
- **Simulation of the charging/discharging cycle:**
Reversal of the current direction to simulate charging
- **Interfaces & connection:**
Connection to a measurement database, production control system, and an OCMF server using custom middleware to verify the billed energy quantity into a ticket system and cross-check it
- **Definition & compliance with tolerances:**
Tolerances of $\pm 0.1\%$ over a current range
- **Simple & secure user guidance:**
User guidance via screen and mandatory procedures with special guidelines and specifications due to the safety-critical application; subsequent printing of the final customer label or fail label

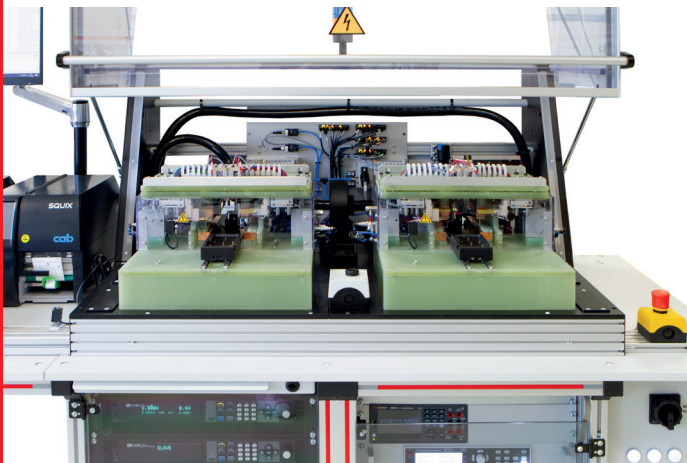
SOLUTION CONCEPT

MCD developed a modular test system based on the **VTS 2030** rack, a universal platform developed in-house, into which the relevant 19" measuring components are integrated. The table was constructed with an enlarged base area. The system included a large, fully insulated test hood designed to accommodate two test specimens (dual design: number of pieces vs. cycle time).



The system included two current paths: one with a current transformer for high currents and one without a current transformer for direct measurement of low currents. The overall concept also included 4-quadrant power supplies that serve both as a source (= power supply) and as a sink (= electronic load). The aim of this was to "reverse the direction" of the current flow. Contact was also made from four sides for high current, high voltage, communication, power supply, and programming pins.

An explicit **safety concept** with designated safety components was part of the development from the outset and was implemented in a targeted manner. This allowed currents **above 1500A DC** to be switched on, tested, and recorded via high-current contactors. The contact resistances of the high-current needles are of existential importance, which is why the voltage drop between the power supply and the test object is closely monitored. The test results are stored and logged in a measurement database and then output via an industrial-grade thermal transfer printer.



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CUSTOMER BENEFITS

With the modular and flexible test system, the customer was able to significantly reduce cycle times and automate and professionalize the entire quality assurance process in conjunction with the **MCD TestSuite** software and the associated tool monitors. From initial laboratory testing to a production-ready test system connected to the measurement database, the customer was supported throughout the process and a sustainable solution was designed together.

The compactness of the system is particularly noteworthy, as is its **dual testing** capability, including automated execution of all relevant test blocks. Cycle times were significantly reduced by optimizing the individual test sequences and synchronizing the testing of two test specimens. A wide range of performance variants and associated customer labels can now be easily assigned and processed automatically within a single system. The correct variant is selected automatically and the corresponding test parameters are loaded. This significantly simplifies the testing process and minimizes the susceptibility to errors in quality assurance.

All tests performed are documented in accordance with the specifications and traceable measurement and test results are **generated automatically**. Certification is carried out by the calibration centers with easily reproducible measurement series and endurance tests.

CONCLUSION

The **end-of-line test system** was designed as part of quality assurance for programming, calibration, verification, and functional testing of smart DC energy meters. These smart energy meters are required for accurate energy billing at public charging stations for electric cars, for example, and require a special safety concept due to the high currents and voltages involved.

Together with the customer, we were able to develop a safe, reliable, **compact**, and easy-to-use test system that also shortens cycle times in production and ensures certification in accordance with German calibration law.

Conceptual changes, adjustments, and future enhancements were also implemented and supported quickly and effectively, as they had already been considered during the concept phase. For example, suitable high-current needles were designed in such a way that the subsequent connection with cable lugs could already be simulated.

This project is a successful example of automation in the context of quality assurance – from an original laboratory test station to an automated EOLT (end-of-line test) system with a production control system connection.

