

Automated testing of Electronic Control Units (ECUs)

Automating the test process of electric windows and seats with imc solutions

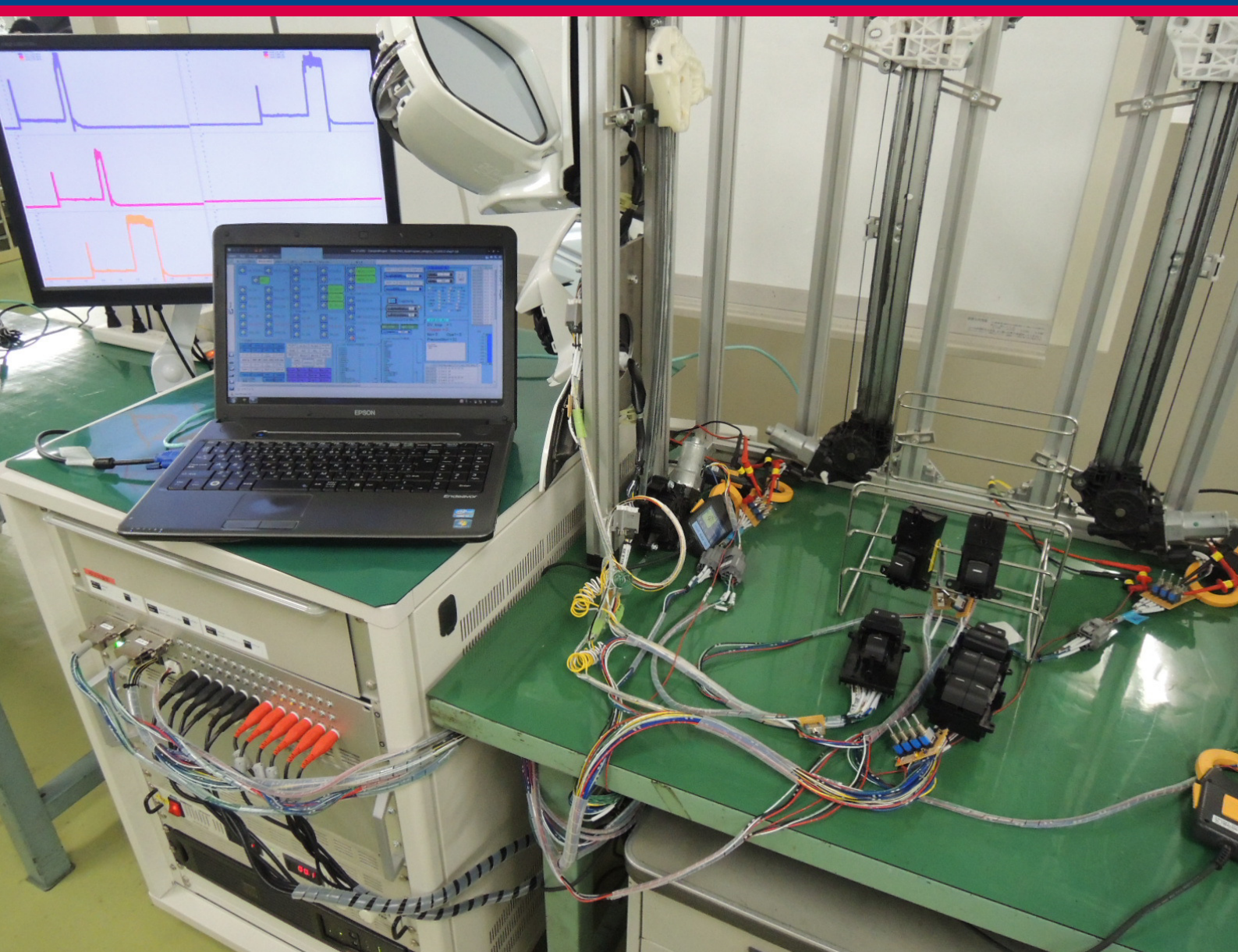


Fig. 1: The setup: imc CRONOScompact enclosed in a 19" rack, imc STUDIO & imc FAMOS software.

Automation leads to productivity

The Japanese automotive supplier Toyodenso Co. develops and manufactures more than 4,000 types of electrical components. Their product portfolio encompasses, for instance, solenoid valves, distributor/ignition coils, AT position switches, oil pressure sensors, transformers for HID, vapor device valves, steering switches and sensors, vanity mirrors, instrument panel switches or pedal switches. Another group of components developed by Toyodenso are Electronic Control Units (ECU). These devices enable the communication between one or more electrical systems in the vehicle, such as electric windows and seats.

At Toyodenso, the verification division is responsible for the testing of ECU functions and quality. Therefore, they are always searching for tools and systems that can make their testing processes more productive.

Up to this point, Toyodenso had been testing the functions of electric window and seat ECUs by manually pressing and pulling the switches. Because it was impossible to manually conduct exhaustive tests with an extremely large number of test cases, they required the functional verification to be executed in an automated manner. They needed a viable solution that would ensure an efficient test process, even with a limited workforce and without hindering current testing.

Outlining and implementing a long-term plan

imc's Japanese distributor came up with a step-by-step test solution that aimed to gradually transition from manual testing to model-based development using HiL (Hardware-in-the-Loop).

Step 1: Apply imc STUDIO Automation to the existing evaluation environment. The objec-

tive was to replace manual operation of the switches by an automated process. Using imc STUDIO, switches could now be activated electronically.

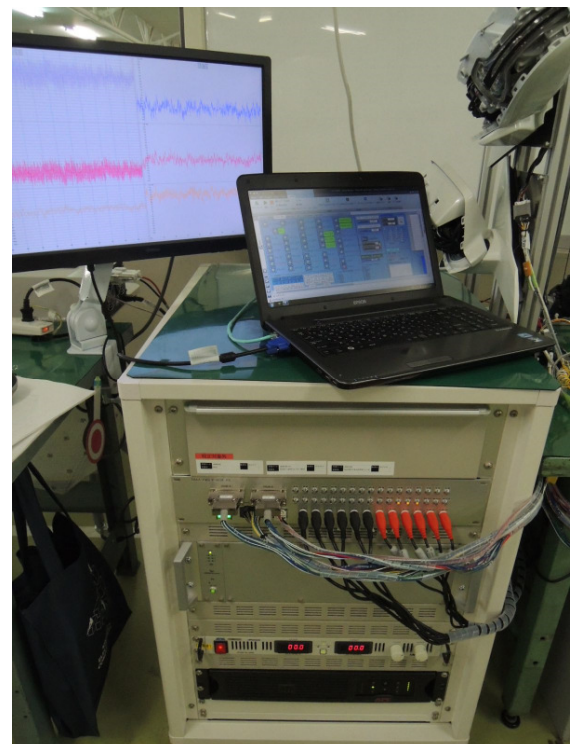
Step 2: Replace the door mechanism with a model and set up an environment that can simulate the load applied to the electric window motors.

Step 3: Replace all further mechanisms including windows, motors, etc. with models and set-up the complete simulation environment.

Step 1 realization

The heart of the solution featured an imc CRONOS*compact* measurement system in a 19" rack along with UPS, mixed signal recording and onboard real-time data analysis and reduction. 48 channels were integrated to measure temperatures, currents and Hall sensors.

With extensive control capabilities and simultaneous recording of analog, digital, and field/vehicle-bus data, the imc CRONOS*compact* makes the perfect fit for the tasks the Toyodenso verification division has to handle.



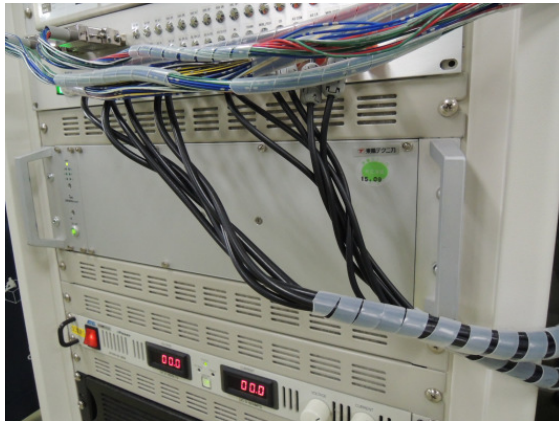


Fig. 2-3: imc CRONOScompact, UPS, power supply and interface box in a 19" rack.

Modular, reconfigurable hardware adaptable to changing test requirements

The imc CRONOScompact integrates measurement, control and simulation into one device, thus providing reliability of absolute synchronization. The embedded HiL processing module is able to simulate variables in real time, such as the friction caused by the window tracks, the RPM and torque of the motors as well as variable operating temperatures.

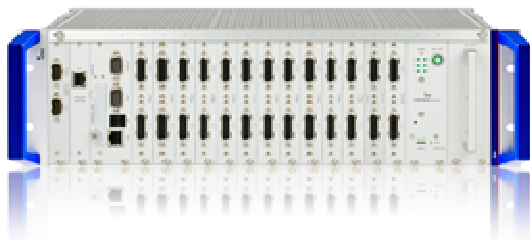


Fig. 4: imc CRONOScompact in 19" rack version

System overview:

imc measurement device
imc CRONOScompact CRC-400-AC-RACK
Amplifiers
CRC/DO-16-HC 16 isolated control signals with enhanced current bearing capacity (to simulate the electrical switching action)
CRC/DI16-DO8-ENC4 16 digital inputs, 8 digital outputs and 4 inputs for capture of incremental counter signals, RPM, angle, frequencies etc.
CRC/LV3-8 8-channel differential amplifier for measuring voltage, current and ICP-sensors
CRC/DAC8 enables analog output of up to 8 analog values and can be defined as the results of calculations performed by Online FAMOS on data from combinations of measurement channels
Field buses
CRC/CAN
CRC/LIN
imc software
imc Online FAMOS Pro Real-time data analysis framework running on imc CRONOS devices
imc STUDIO Developer Comprehensive test & measurement software for the entire testing process: measurement, visualization, automation, data analysis

Fig. 5: Utilizing a variety of signal conditioners, imc measurement systems cover a wide spectrum of testing requirements.

Software integration

The customer used two software components offered by imc: the imc STUDIO software platform for measurement and control and the imc FAMOS software for data analysis and documentation.

With the modular software imc STUDIO, the measurement, data analysis, visualization and automation are combined in a seamless and integrated environment. An additional functionality of the system comes from the pre-

processing and evaluation capabilities of imc Online FAMOS – specifically, its ability to simulate CAN signals.

In order to simulate non-existing components, customers often create circuit boards using micro-controllers to simulate CAN output (breadboards). In the case of Toyodenso, they formerly had to physically build a breadboard for each test series.

In the imc STUDIO-based system, on the other hand, an automated test system was successfully created using virtual channels to simulate the actual processes, behavior and environments found in the vehicle, thus simplifying and reducing the development period without the need for any such boards.

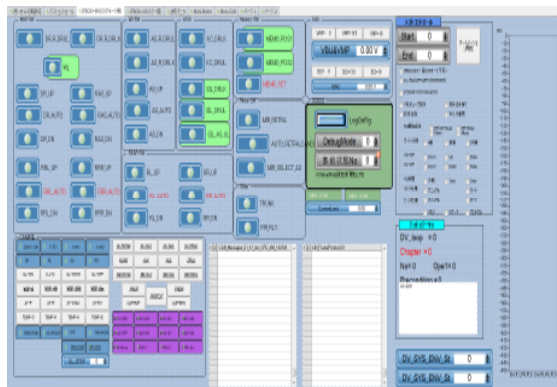


Fig. 6: imc STUDIO panel page to simplify and reduce development time.

Automated tests for 160,000 or more sequences are conducted around the clock. Toyodenso uses Excel, imc FAMOS and imc STUDIO to smoothen the workflow for achieving an efficient test circle. Users write test flows on Excel spreadsheets and have them loaded into imc STUDIO via imc FAMOS and the imc STUDIO Sequencer. imc FAMOS automatically evaluates the measurement results (pass or fail) and writes the results from the testing into the Excel spreadsheets.

Conclusion

One of the biggest benefits for the test engineers at Toyodenso was the flexibility and ease of use when designing control schemes and test procedures using imc STUDIO Sequencer and Automation.

Additional benefits to the customer:

- The creation & loading of test cases into imc STUDIO via imc FAMOS using Excel
- Reduced development times
- Improved quality
- Detection and diagnosis of defects
- Unmanned overnight operation
- Automatic pass/fail evaluation
- Prevention of failures in the field

In this project, Toyodenso built two automation systems.

They are now considering a new project, in which automated reliability tests will be conducted in a constant-temperature or an anechoic chamber.

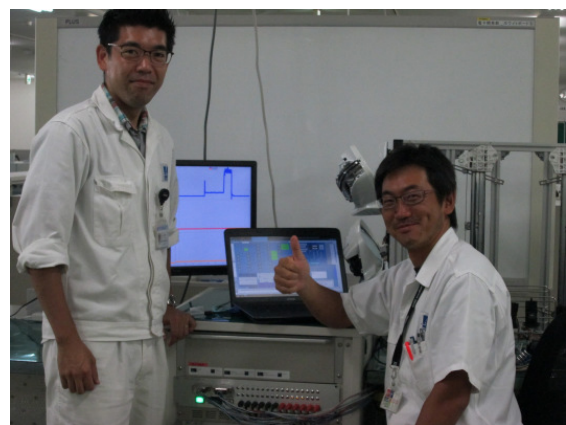


Fig. 7: Engineers from Toyodenso at work using the new imc automation system.

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imc Test & Measurement GmbH is a manufacturer and solution provider of productive test and measurement systems. imc implements metrological solutions for research, development, service and production. imc has particular expertise in the design and production of turnkey electric motor test benches. Precisely outfitted sensor and telemetry systems complement our customer applications.

Our customers from the fields of automotive engineering, mechanical engineering, railway, aerospace and energy use imc measurement devices, software solutions and test stands to validate prototypes, optimize products, monitor processes and gain insights from measurement data. As a solution

provider, imc offers their customers an attractive and comprehensive range of services. These include project consulting, contracted measurements, data evaluation, specialist deployment, customer-specific software development and system integration. imc consistently pursues its claim of providing services for “productive testing”.

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