SYSTEM SUCCESS

A new way of testing powertrain ECUs has led to reduced development times. By **Bethan Grylls**

"Software-defined testers will be critical in keeping up with the evolution in automotive design," said Jeff Phillips, Head of Automotive Marketing at National Instruments (NI) in an interview with New Electronics last year. "The semiconductor content will only continue to increase and as the technology improves so the ability to quickly reconfigure testers will be critical. Flexibility through software will be the key."

Chief among those technology trends is the growing electrification of the powertrain, the wide adoption of advanced safety systems and enhanced driving and comfort functionalities – all of which have significantly increased automotive complexity and the software vehicles need to operate.

The components and sub-systems need to work effectively and in synchrony, from the HVAC system to the infotainment system, and each system will likely have a dedicated electronic control unit (ECU) - an embedded computer that controls and manages those functions.

While some manufacturers favour consolidating ECU functionalities with the focus on sensor fusion, infotainment and those functions requiring less data – such as steering, air conditioning etc., others favour a more distributed architecture.

Whichever approach is favoured, a typical vehicle can have as many as 100 ECUs, which control, monitor and alter a car's various electronic systems.

Today, ECUs are becoming more complex, and a key player among them is the powertrain ECU.

Powertrain ECU

The powertrain is made up of the mechanical parts that power the vehicle, for example the engine, axels and drive shafts.

Now, driven by the demand for more efficient, eco-friendly and better performing vehicles, manufacturers have started to add more electric components to the powertrain. This includes electric motors, batteries, power inverters and control units such as battery management systems to make everything work either in sync with the engine in the case of hybrid systems or by itself in fully Electric Vehicles.

Above: Hyundai Kefico based the CP-Tester on CP-Standard which defines factors such as sensor/actuctor emulation and vehicle comms

"A battery management system, for example, will decide how to deliver the energy from the battery to the electric powertrain based on an algorithm that considers everything from the temperature of the battery, to the levels of charge in its cells. This data allows it to last longer and work more efficiently," said Arturo Vargas, Solutions Marketing Manager – Automotive, NI.

But, with all its performance benefits, the rise of electrification also means that the automotive industry is now presented with new, complicated challenges when it comes to testing and design.

Hyundai Kefico, which has supplied powertrain automotive electronics since 1972, is among those manufacturers faced with increased test demands and tighter emission regulations, along with having to manage budget and timeline challenges.

Hyundai Kefico

When Hyundai Kefico's powertrain ECUs reached 200 pins and the functional test needed to ensure quality stretched to 20,000 test steps for an increased variety of ECU types, its engineers realised that traditional methods would not suffice.

In the past, an ECU functional tester required Hyundai Kefico to design sensor/actuator emulators, vehicle communication modules, test execution engines and applications, test procedures, and test result management tools for each type of ECU. In other words, the company had to develop a new tester for each new ECU, with minimum reuse of test engineering assets and a negative impact to the cost of test.

To solve this, Hyundai Kefico adopted a customisable, user-defined test system using the NI automated

test platform.

"NI realised that these challenges are not exclusive to the automotive industry. So why would the technology need to be exclusive to it?" Vargas explained. "Adding wireless capabilities to chips and testing them is not significantly different than doing it for an ECU. The challenges are shared and thanks to our platform approach to technology, the technology is shared as well."

He continued: "This is made possible through software: sharing developments, IP, test modules, etc. The high level of reutilisation, flexibility and customisation possibilities of the NI automated test platform is what made it ideal for Hyundai Kefico's challenges."

By leveraging the NI Automated Test platform, Vargas says that Hyundai Kefico was able to build its system from a higher starting point with every new interaction, saving them time, money and effort.

The Platform consists of three parts – LabVIEW, TestStand and NI PXI. The latter is a modular instrumentation platform used to build compact, high-performance automated test systems, and is the system Hyundai Kefico used to create its solution.

In a PXI system, a chassis provides power, cooling, and a communication bus for modular instruments or I/O modules. These control modules can be controlled from either an embedded controller or an external PC, using one or several of NI's specialised engineering software tools to customise a system.

The process

The Hyundai engineers started with the development process and created the Common Platform Tester (CP-Tester), and the standardised ECU Functional Tester development process. They based the CP-Tester on standardised test assets called CP-Standard, which define sensor/actuator emulation, vehicle communication, test execution (test engine), operator interface (test application), and test result management.

The CP-Tester has a few key components that streamline the test development process, according to the Hyundai Kefico engineers. R&D or product engineers can use a test scripting modelling tool called CP-Editor to configure each test step and parameter by choosing from over 200 prebuilt functions to develop test sequences. They can map these test steps to the appropriate hardware I/O and reconfigure them for different ECU types.

The CP-Server is another component that engineers can use to effectively manage test result data to improve upon new test requirements.

The solution's adaptability to various types of powertrain ECUs not only offered shorter test times, but as it is able to reuse and reconfigure test steps from R&D to manufacturing, it also allowed for efficient use of test engineering assets. Moreover, the engineers say the system let them have access to more valuable test data due to data handling and traceability in standard format.

The NI PXI platform was selected as it was "better suited" to deal with the complexity of Hyundai Kefico's powertrain ECUs.

For example, high and flexible channel counts (over 200 pins) with different layouts; I/O configuration with source and measurement capabilities; and the ability to connect dummy loads (resistance and inductance) to properly test ECUs.

It also provided a variety of switching options and the facility to customise I/O through FPGA to implement special sensor communication protocols such as SENT (Single Edge Nibble Transmission and SAE J2716).

Most turnkey ECU testers on the market require 10–12 months to adopt new test plans for new products, and they still necessitate significant interaction with the vendors and high costs.

With short development times of the essence, NI's platform enabled the engineers to develop their own flexible standard tester within three months. As a result, there was an 80 per cent reduction in development time, while giving the engineering department the ability to add functionality like CAN with flexible data-rate in the future, as product requirements evolve.

At the company level, given the higher demands for ECUs, the NI PXI timing and synchronisation features improved test time by 15 per cent and cut the test system cost by 30 per cent.

Hyundai Kefico can also procure and assemble the CP-Tester at any of its manufacturing sites around the globe due to NI's worldwide presence, offering the company much more flexibility.

For the first 17 CP-Testers, Hyundai Kefico achieved an estimated 45 per cent better project ROI compared to its previous solution.

"Any development of a test system will have challenges around integration, functionality, etc. Those are inherent to using a technology

"What I see as the most significant challenge that Hyundai Kefico overcame was the decision to change and stick with it through planning, collaboration and vision," says Vargas.

"Changing a way of doing things is challenging for anyone," he continued. "For a company that's been developing automotive electronics since the 1970s, we can imagine the perception of risk and perhaps even the aversion to change.

"Yet, the team at Hyundai Kefico were able to lead that change in the organisation, increase the level of standardisation for the functional test of their ECUs and improve the company's position as a leader in their market."

"Change is challenging for anyone, but Hyundai stuck with it, and in doing so, increased the level of standardisation for the functional test of their ECUs."
Arturo Vargas