

Simulation & Test System for Electronic Control Units (ECUs)

Introduction

The development of Electronic Control Units (ECUs) is an important factor in the expanding adoption of electronically controlled devices in vehicles. Growing concerns related to safety, comfort, increased competitive pressure, fuel efficiency, and technological advancement drive the development of new ECUs. These devices are widely used in the automotive industry (cars, trucks, motorcycles), as well as in other forms of industries (e.g., aerospace engines, gas turbine control).

ADwin[®] systems support the implementation of powerful real-time techniques for development and production testing of ECUs. The *ADwin* family of products provides deterministic, real-time control under the Windows[®] environment. These control and measurement systems combine hardware and software and are available in three basic form factors, with a number of configuration options and accessories. Each *ADwin* system comes complete with its own microprocessor, a variety of analog and digital I/O, and local memory.

ECU Testing

The complexity of today's ECU software requires performing comprehensive real-life simulation tests. Endurance and environmental test plans are created to mimic actual operating conditions as closely as possible, including factors such as vibration, temperature, humidity, etc. Rigorous testing is used to ensure a new ECU's functional integrity before it is approved for production.

The *ADwin* product family offers solutions for functional testing of ECUs and other devices, including CAN-based units, sensors, actuators, etc. These tests are performed during the device development process, as well as during the design assurance, production test, burn-in/stress testing, and quality assurance processes.

The *ADwin* unit can drive analog/digital input signals to the ECU under test, while the timing of all output signals and messages can be evaluated online. The control unit can be completely tested with microsecond timing accuracy.

Automatic Test Development for ECUs

The analog and digital outputs from the *ADwin* system are programmed to replicate the sensor signals, which would be



connected to the inputs of the ECU. These test signals can be periodic or non-periodic analog or digital waveforms. Recorded values from test drives are possible, too.

The *ADwin* unit drives the ECU inputs while simultaneously monitoring and measuring the responses from the outputs. The amplitude and timing of the ECU's responses are evaluated internally, allowing different ECU-specific parameters to be extracted and confirmed.

The ability to generate all the input signals and monitor the outputs allows an *ADwin* system to verify whether an ECU's response conforms to specifications.

If the control unit has additional interfaces like CAN-bus, SPI, LIN, RS-232/xx, etc., signals on the communication lines can also be included in the ECU's test plan.

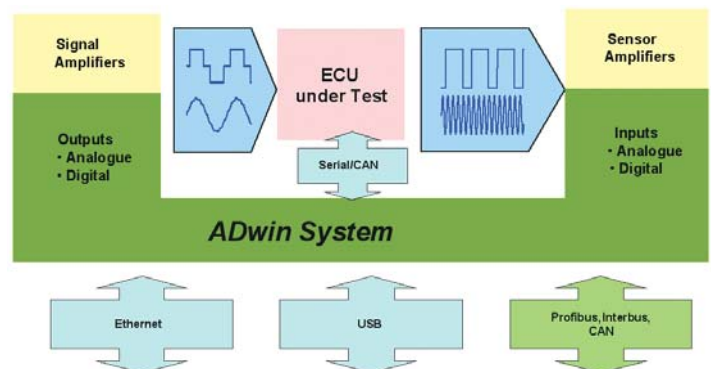


Figure 1. Example test configuration. The *ADwin* system drives the ECU inputs, measures the response, and makes an online evaluation. Typically, in R&D, the *ADwin* system is connected to a PC via an Ethernet or USB interface, in order to exchange data and start the test run. In a production environment, Fieldbus interfaces like PROFIBUS or Ethernet can be used.

Other Applications—Sensor and Actuator Testing

Similar procedures can be used to test sensors or actuators. An *ADwin* system can generate test signals and measure the response of the device under test. This approach can be used to test a wide variety of automotive devices and components.

Example 1—Testing an Airbag ECU

Modern cars are equipped with several airbags and a number of acceleration sensors to detect a safety critical impact during a collision. Today, more than 20 acceleration sensors can be built into a vehicle's chassis.

Airbag ECUs have a number of connections:

- Analog inputs to monitor all acceleration sensors.
- Digital outputs for airbag ignition.
- An additional CAN interface in some designs.

The sensor inputs of the ECU are driven by the *ADwin* system's analog outputs (100 μ s update interval) with signals recorded from acceleration sensors during test drives. In parallel with this, all digital outputs are monitored and the *ADwin* system confirms valid 'fire' signals for the airbags.

In more complex test configurations, internal analog/digital signals and communications (CAN) can be included in the test loop.

Example 2—Testing a Turbine ECU

A turbine's rotational speed is controlled by an ECU. The speed is measured using an incremental angular encoder, providing two sine wave signals, which are 90° out of phase. Each sine wave period reflects 0.1° revolution, so 3600 periods equals 360° or one revolution.

One specific test for this turbine ECU is to simulate disturbances at the encoder input. This test is performed to verify the ECU's immunity to different types of interference.

Under normal circumstances, the incremental encoder signal may consist of:

- Two 90° shifted sine waves: A and B.
- Signals at a standard amplitude (+5V).
- One period sine wave = 0.1° revolution.
- All 3600 periods on A and B of the same length.

In the testing process, the *ADwin* system simulates the two analog outputs of the incremental encoder. In addition to the normal signal outputs, the *ADwin* system handles:

- Variation of the standard amplitude of A or B.
- Addition of defined peaks or noise on A or B.
- Cyclical variation of the periods of A and B (to mimic symptoms of poor alignment of the encoder disk on the turbine shaft).

What type of *ADwin* system can be used for ECU testing?

ADwin-L16

- 8 analog in, 2 analog out, 6 digital in, 6 digital out, 2 counters
- Options: 32 digital I/O, CAN, 2 counters (incremental encoder, pulse, period)

ADwin-Gold

- 16 analog in, 2 analog out, 32 digital I/O
- Options: 6 analog out, CAN, 4 counters (incremental encoder, pulse, period)

ADwin-Pro

- Modular system design, which allows configuring the test system to meet the required number and type of I/Os

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