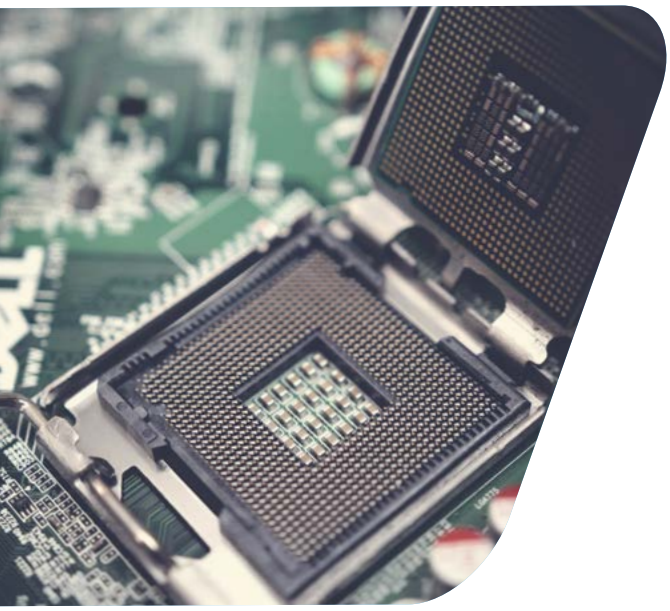
APPLICATION NOTE

CAS DATALOGGERS

# Modern State Space Representation Using ADwin DAQ Systems

## ADwin Provides High Throughput and Simulink© Integration



CAS DataLoggers provided the ADwin data acquisition and control solution to an internationally-known consumer electronics manufacturer using Model-Based Design (MBD) in a vehicular control engineering application. This project focuses on establishing a state space representation to mathematically model a corresponding real-world system. This state space representation takes several sensor inputs and outputs into account and expresses these variables mathematically. In this way the physical system's state is given in vector format, making it much simpler to work with and analyze. Having already installed an ADwin-Pro-II control system delivered in May 2014, the company is now expanding its automotive test application to incorporate CANbus communication. For this latest addition, the customer's laboratory requested an ADwin system featuring all these capabilities and which fit within a $25,000 budget.

## Installation

To match this unique project, CAS DataLoggers supplied the manufacturer with ADwin PRO-II Data Acquisition and Control Systems. With the addition of this latest system, the project is currently using three ADwin Pro-II models. The extraordinary acquisition and real-time processing speed of these systems satisfies applications demanding a high data rate. In addition, ADwin's fast T12 processor allows an intelligent pre-selection of relevant data, mathematical functions or digital signal filtering. The ADwin Pro-II is available in a variety of robust housings for various applications, in this case as a full 19" rack system for the lab.


ADwin hardware features analog and digital I/Os and interfaces such as CANbus, RS232, ProfiBus, SSI decoders and more to connect the ADwin to the test environment. Communication with the PC is via the Ethernet interface. Multiple PCs can communicate with one ADwin system which can be useful during program implementation and commissioning.

As the lead engineer of the project explains, "We spent a week or two with the demo unit CAS DataLoggers sent us—it's high speed and easy to use. Now we're heavily using the two ADwin Pro-II systems we purchased earlier and we're already incorporating this newest one.

"Our ADwin systems are installed in the laboratory space we've devoted to this project. We're using three similar, independent PRO-II systems in the same facility located in different departmental subgroups. Control for our application is provided by a modern state space-based controller."

## USAGE

These ADwin-PRO-II systems are benchtop units featuring a ½ 19" enclosure (9-inch wide, 5 ¼ inch high), a 10-35V DC-DC converter and 7 data acquisition card slots. All modules are mounted from the front side.

The ADwin PRO-II T12 processor module features the Xilinx Zynqtm  dual-core ARM Cortex-A9, 64 bit FPU with 1 GB main memory for code and data. The T12 processor has extremely short response times so control or regulatory processes run reliably with cycle frequencies far above 1 MHz. The ADwin processor enables complex calculations such as this application's state space representation differential equations. The team's systems also feature the optional accelerated Ethernet Interface (10/100MBIT/S) for high-speed communication and data transmission to the PC.

The team is using ADwin in a control environment to prevent a certain event in a continually-running loop. As the lead engineer explains, "We chose ADwin because the system has very low latency from inputs to outputs; it has ample computational horsepower; and it integrates seamlessly with Simulink. Your hardware is good for low-latency applications such as closed-loop feedback control.

"Our application uses a standard state-space algorithm and we're running our ADwin systems as fast as they will go. We knew that ADwin had a 100kHz sample rate, but we were impressed to find that the hardware can run that fast on a sample-by-sample basis. Lots of hardware can sample at 100kHz, but usually it's only buffered in chunks of samples, which is useless for controls applications. The I/O latency of our systems is less than 10 micro-seconds."

## Data Acquisition Cards

ADwin's wide variety of different modules are the flexible foundation for rapid real-time applications. This control project takes advantage of ADwin's wide range of data acquisition cards, utilizing many different ADwin modules including co-processor modules, analog input and output cards, and high-speed CAN bus interfaces for vehicular communication.

The analog input cards offer 8 to 32 analog inputs and the analog output cards add 8 outputs each. The high-speed CAN interface features 2x CAN bus, a high-speed 9pin D-sub connector, and ADwin's real-time TICO processor. The bus bandwidth of up to 200 MByte/s significantly increases the capacity of the internal traffic between the processor module and the new Pro-II output modules.

All new Pro-II modules operate on the same backplane clock, allowing fully-synchronized time measurements from multiple modules without any special software effort.

## Real-Time Development

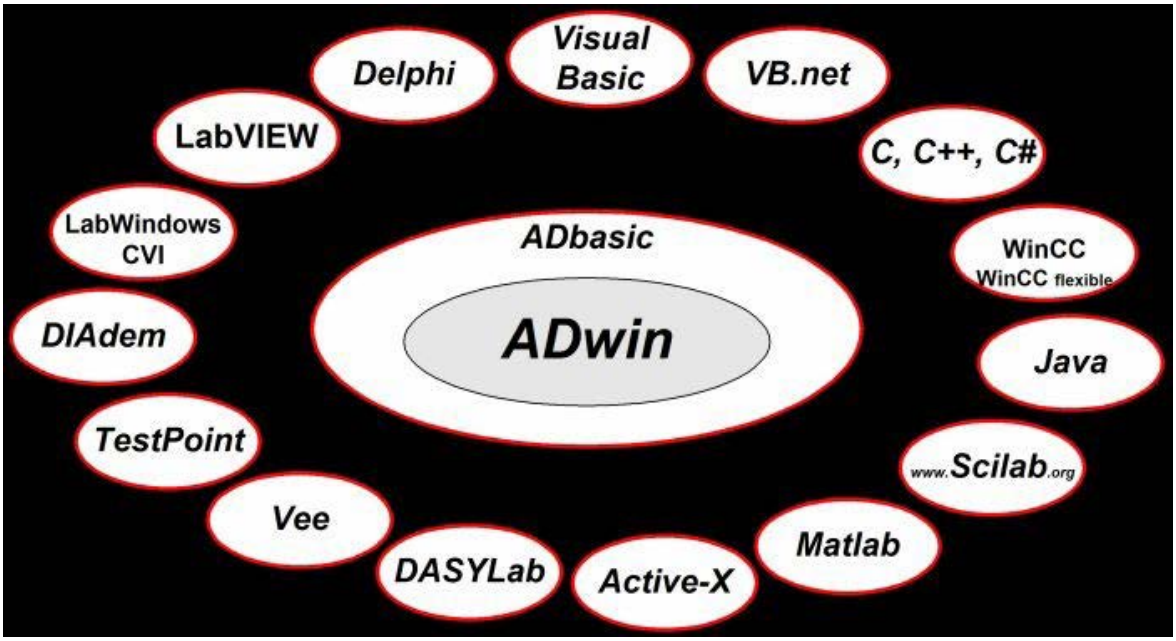
This application makes use of several ADwin software tools including ADbasic, ADsim and ADlab. The ADwin software environment can be used under all Windows versions and LINUX, or as a stand-alone data acquisition system. The ADsimDesk graphical user interface runs real-time models on the ADwin-Pro II hardware. ADsimDesk allows users to display and modify model parameters and signals for development and debugging. Users can control and test the running model from ADsimDesk or with the free ADtools applications for Windows.

With just a few mouse clicks, users can insert the ADwin system's I/Os as blocks into the model and start C code generation with Simulink Coder™. After compilation, the model runs on the ADwin system at extremely high speed (up to 100 kHz) with precise timing and predictability.

ADwin's Simulink® integration was another significant aid to the project's dynamic Model-Based Design. MATLAB has its own optimized ADwin driver, 'ADlab.' Users can communicate with ADwin via the Command Window or M-file, or create a stand-alone application seamlessly on the control task. It's easy to insert inputs and outputs for the ADwin system as blocks into the model and start C code generation. After compilation, the model runs on the ADwin system in real-time with absolute deterministic timing and precision.

## Benefits

Thanks to ADwin's flexibility, the team was able to order customized modular systems to satisfy their unique application. Their three ADwin PRO-II systems are equipped with processor modules, analog I/O cards and high-speed CAN bus interfaces to enable their vehicular project needs.



Coming in just under the project budget, ADwin has proved to be an affordable data acquisition and control solution able to analyze this multi-input and output application and establish the desired state space representation. ADwin offers sophisticated control and runs Simulink models in real time, up to 100 kHz speed, via the ADsim blockset and ADsimDesk GUI. In this way project development and testing is simplified and users can more easily integrate algorithms into models and analyze the results.

The project lead comments, “Our team has been looking at this application for a long time now. If we had known about ADwin years ago I’d have gotten five of these systems back then. For us the major benefit is the ADwin system’s high throughput which lets us get a sample in and out at extremely fast speeds. Your systems definitely work as advertised.”

For more information on ADwin test control systems, state space representation or to find the ideal solution for your application-specific needs, contact a CAS DataLogger Application Specialist at **(800) 956-4437** or www.DataLoggerInc.com.