müller+krahmer

Script-based automation solution with compactRIO and DIAdem

Summary

Automated measurement and testing means solving many subtasks: data must be acquired, scaled, visualized and stored. Acquired signals have to be processed and control signals output. Stored data has to be reviewed, analyzed and condensed. Changing requirements call for adapting measurement and test sequences. Users should be guided by user interfaces tailored to their needs and supported in their work. The actual goal comes at the end of all this effort: the test result, documented in a meaningful report or entered into a database in a structured way.

Solving these tasks is challenging enough in itself and becomes even more demanding when hardware and software products with diverse interfaces and different programming languages have to be combined. It becomes easier when an integrated hardware and software solution with predefined functions for all these tasks is used.

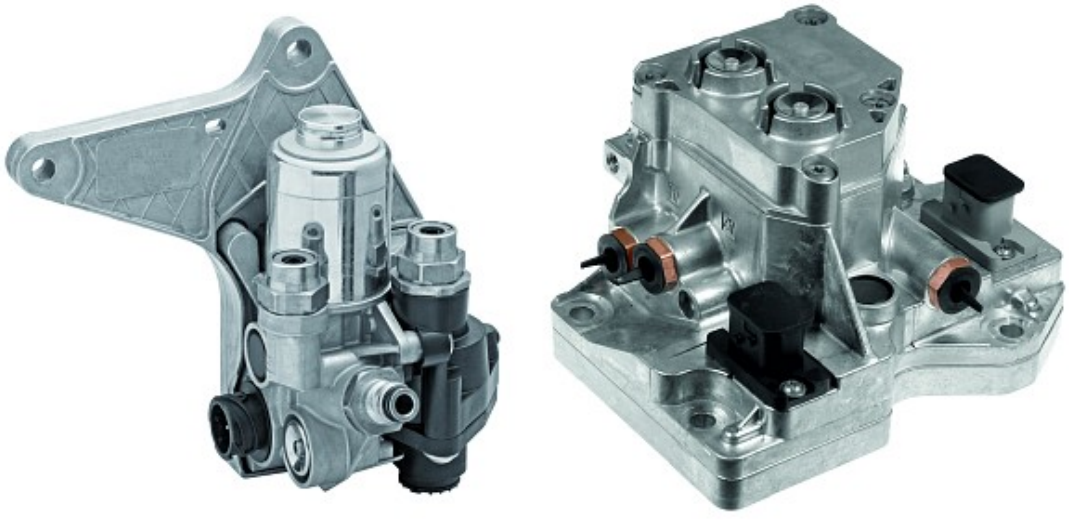
This article describes an example of a complete automation solution based on compactRIO and DIAdem that covers all the functions mentioned and offers them in a uniform script environment.

Flexible and clear in one script

Applications for end-of-line testing of electropneumatic components are usually as complex as the devices they are developed to test. On the one hand, they have to cover the range of requirements placed on such devices with a variety of test algorithms; on the other hand, modern production structures demand short test times and maximum stability of the test software. The result is extensive program structures that can only be adapted to new test tasks by experienced software specialists and in which the operator's options are limited to parameterizing the test processes.

This contrasts with the requirement to be able to implement and test new test algorithms quickly and easily when developing new devices or adapting the test to new customer specifications. Ideally, this should be done by those who have the application know-how regarding the devices under test. However, these specialists for electrical, pneumatic or mechanical tasks usually simply lack the time to familiarize themselves intensively with complex software.

After an intensive assessment of the possible solutions to this problem, Aventics GmbH in Laatzen came up with the idea of equipping the existing universal test benches for electropneumatic components with a script-based programming environment that allows simple and flexible use of the existing complex test functionality. Restricting it to pure script programming ensures that the control software is easy to read. Doing without separate storage and editing of parameters – as is usual with fully programmed applications – and inserting them directly into the script also helps to improve clarity, especially for occasional users.



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Figure 1: Thanks to the script control, devices of different designs and functions can be tested on one test bench. (Aventics)

This programming environment, named Script Control, was implemented by employees of müller+krahmer GmbH, who had already been responsible for developing the test bench software. The hardware setup of the test benches – a National Instruments compactRIO programmable automation controller (PAC) with numerous C Series modules for acquiring and outputting analog, digital and bus signals, and a PC as the platform for operation, sequence control and data management – was to remain unchanged, as was the software structure. It consists of a DIAdem application on the PC and a LabVIEW application on the controller, both program levels in turn consisting of various components with a sophisticated division of tasks. The DIAdem application consists of two instances that ensure the shortest possible test times by processing measurement and control functions and evaluation functions in parallel. The LabVIEW application comprises several FPGA modules for fast tasks and a real-time application for complex hardware-related tasks.

The communication interface between PC and cRIO exists in two variants. In the originally implemented variant, both levels exchange data via TCP/IP. This interface requires no additional hardware or software but, lacking real-time capability, has the disadvantage that all acquisition and output functions with high timing requirements can only be implemented on the cRIO. Corresponding functions that are also available in the DIAdem measurement and control module DAC can only be used for quasi-static processes. In the newly developed version using a DIAdem EtherCAT driver, on the other hand, data is exchanged between PC and PAC in real time, so that the very easy-to-use and flexible acquisition and output functions of DIAdem DAC can also be used without restriction. In addition, this interface offers greater data throughput, which allows both a higher sampling rate and a larger number of channels for acquisition and output.

The DIAdem EtherCAT driver is an interface extension of DIAdem DAC based on the EtherCAT master from Kithara Software GmbH. Since it supports standard network cards, no special PC hardware is required for the process connection. The counterpart on the PAC side is the cRIO EtherCAT master, which is used as standard for connecting expansion chassis to cRIO controllers. To enable communication between two masters in this specific case, a so-called EtherCAT bridge is required, which is parameterized via the DIAdem EtherCAT driver.

All analog, digital and bus signals acquired and output by the PAC are integrated into data acquisition. However, to keep the application manageable and limit the amount of data generated, not all signals are transferred permanently; instead, a configurable selection of signals (n out of m) is passed to the PC. The parameters of the signal selection each comprise source (hardware) and target (software) channel as well as a predefined scaling assigned to this combination.

Unrestricted hardware access

Script Control was implemented as a command extension of DIAdem Script in the form of so-called user commands, i.e. application-specific Visual Basic Script functions that are globally available after registration. This approach makes it possible to use all the resources already available in DIAdem for editing, debugging and calling scripts, and to limit the implementation effort to the actual test functionality.

Script Control provides read and write access to all signals available on the hardware side. In addition to the signals directly relevant to the test, which are acquired from or output to the device under test and its peripherals, these also include the parameters of the test bench, which are only indirectly involved in the test. The range extends from analog signals of various kinds and static and dynamic digital signals to bus signals exchanged via CAN, Profibus or EtherCAT.

Unlike fully automatic test procedures, there is also full access to the sensors and actuators of the electrical and pneumatic test bench setup. With the exception of safety-critical functions, all automatic, PAC-controlled sequences are deactivated when Script Control is activated.

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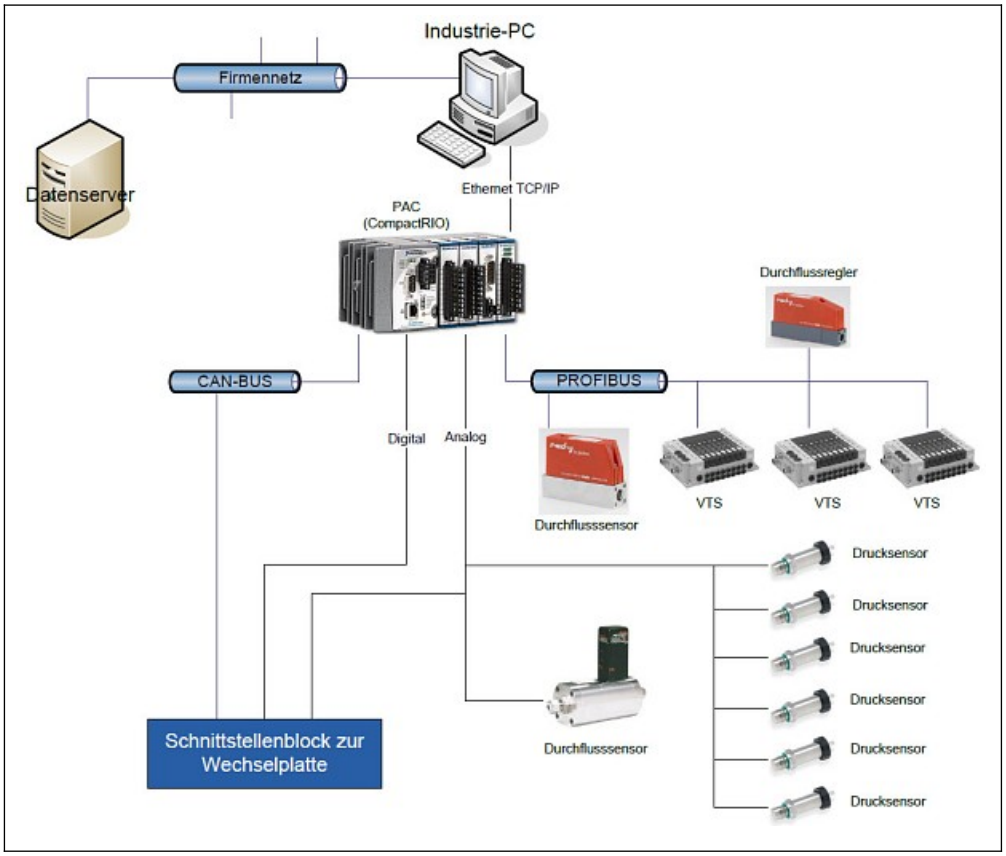


Figure 2: All actuators and sensors of the universal test benches are available for use in Script Control. (Aventics)

A special DIAdem DAC diagram acts as an interface converter between the acyclic script commands and the cyclic communication with the PAC during the test sequence. It has no control functionality of its own and only a rudimentary visualization for diagnostic purposes. For control signals that are present only briefly, a latching function is implemented that allows the control script to react independently of its latency. All necessary reactions to these signals are in turn implemented by the user in the control script. The latching of the signals is reset by corresponding script commands.

Small command – big effect

Although Script Control extends DIAdem's standard command set, which remains fully available, by only a manageable number of application-specific commands, these mean a considerable increase in functionality, as they usually involve simultaneous access to several modules and numerous parameters.

Basic functions are the specification and acquisition of quasi-static setpoints and actual values. Using individual channel names or channel lists, analog, digital or bus signals can be output or acquired and made available for further processing. The user does not need to parameterize the DAC diagram, for example – all necessary settings are made by the corresponding command.

If the timing behavior of the signals matters, a single command can likewise generate a setpoint curve file for transfer to the PAC. Setpoint curves can be generated by any functions within DIAdem or imported from external programs and file formats – either interactively or automatically using DIAdem's standard functions. To ensure a PAC-compatible structure, the function adapts the channel structure of the generated setpoint curve files. Further commands allow this setpoint curve file, stored in TDMS format, to be transferred to the PAC via FTP and the output of the signal time histories it contains to be started on the PAC. Each physically available output signal is assigned a channel in the structure of the setpoint curve file. The time history of a signal is output as long as values are available in the respective channel (one value per clock cycle). After that, the quasi-static setpoint last specified for the signal is output. This is also output if the setpoint curve file contains no channel for the signal.

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During the dynamic setpoint generation described above, further commands can trigger the storage of time histories of individual or all acquisition signals and selected setpoint signals in a measurement file. Individual time sections of the signal can be given identifiers that serve to identify these sections when the file is loaded later, so that only relevant data is loaded, evaluated and finally saved in a file in the specified format.

The visualization options the application offers for current values and time histories of signals as well as for the status of the test sequence were to be just as flexible as the control sequences that can be implemented with Script Control. That is why the possibilities resulting from the combination of the DIAdem module VIEW and the scriptable SUD user dialogs were used here. While the dialogs allow tailored user interfaces to be designed in an almost unlimited variety, predefined functions transfer large amounts of data quickly into the module's graphical displays, where they can be zoomed and scrolled with cursor functions and also edited graphically. The fact that data can be continuously updated and extended at runtime is thanks to an innovation introduced with DIAdem 2014 – the so-called worker technology. It allows several DIAdem instances to process tasks in parallel while making optimal use of PC resources and to exchange both commands and data via standard interfaces.

Summary

Thanks to the use of compactRIO in combination with DIAdem, a flexible test system has been created that can be adapted quickly and easily to new test tasks and requirements. The uniform script environment means that this task is no longer reserved for software specialists alone.

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