Automated Testing with PCs

PC-based 429 tester reduces the need for hardware through software and graphics.

by Raul Segredo

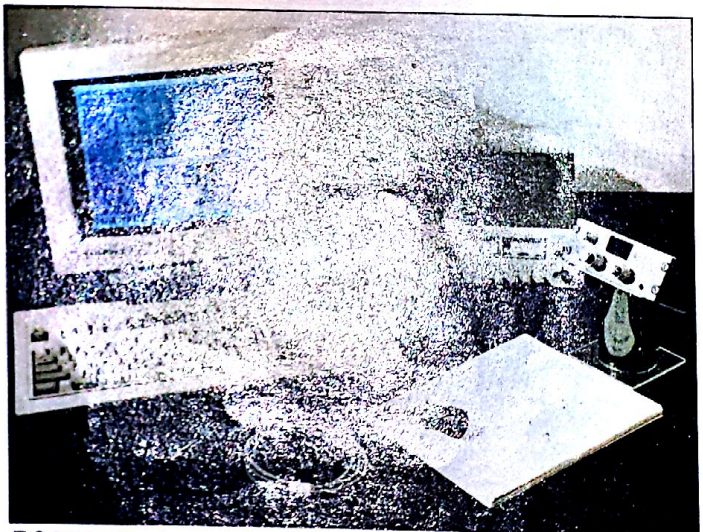
The availability of PCs, ARINC-429 interface hardware and high-level programming languages have simplified the testing of many ARINC-700 line-replaceable units (LRUs). A new trend will allow further penetration of the PC into the testing environment. An example, discussed in this article, is Sigma-Tek's RCAT: Reduced Complexity Automated Test.

Software-intensive, the set is designed to test simpler avionic LRUs without additional ARINC-429 interface hardware. These include units requiring up to two ARINC 429 transmitters, two ARINC-429 receivers and a dozen ARINC-410 discretes. This is perfectly suited for testing ARINC-700 control panels, indicators, flight instruments and certain black boxes.

The beauty of the concept lies in its simplicity; no plug-in boards are required. Using a standard PC and an interconnect cable, a test set is constructed that is affordable, transportable and easy to set up. The idea is enhanced by software that is easily modified and uses graphics to help interpret enoded information.

First on the list of complexity reductions is the elimination of ARINC-429 interface cards. The plug-in board is replaced by software that enables the PC serial interface to communicate with ARINC-429. Thus, without special hardware, just about any PC can serve as an ARINC-429 test set. This is even more appealing in light of the new portable PCs, which weigh less than five pounds and can easily be used at line stations and crowded cockpits.

A second benefit is less set-up and tear-down time. Since the set-up of a test is stored in a unique interconnect cable, it eliminates the connection of bus analyzers, scopes, switch boxes and breakout boxes. Within RCAT, a unique interface harness is created for each LRU. In this harness, connections are obvious with no need for documentation.



RCAT test set consists of a PC, RCAT software, interconnecting cable, power supply, a panel under test and the corresponding Component Maintenance Manual.

Graphic presentations also help the operator interpret Unit Under Test (UUT). For example, consider a VHF control panel, which converts entries of the operator, through switches and buttons on the front panel, to ARINC-429 transmissions. In an RCAT test set, the PC receives the panel's ARINC-429 transmission and presents it as a graphic of the panel's current state, mimicking the actual panel. Cycling controls on the panel and verifying agreement on the PC screen is a quick, heuristic way of testing operation.

New test sets can be created quickly. Flexibility in the software produces new tests as variants of old ones using a graphic and 429 structure library. Atlas and Smart are standardizing rack ATEs; RCAT standardizes PC-based test sets.

Conventional Method

The traditional concept of testing with a PC is straightforward. The computer is programmed to stimulate the Unit Under Test (UUT) and sense responses. The PC can validate responses automatically, or allow an operator to verify a correct function. If a unit has failed, the response of the UUT to test stimuli implies the nature and location of the fault.

ARINC 700 avionics communicate through the ARINC-429 serial databus. For years, test designers have used interface cards to allow the PC to communicate with LRUs.

Although the interface cards are effective, they limit the portability of a test set and increase cost. When complete, the test set generally

...as an isolated monolith, dedi-...ted to the test of a limited group of LRUs.

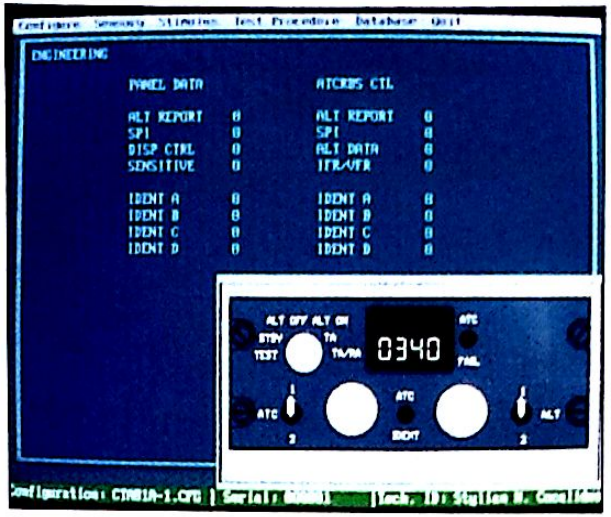
This concept is frequently pursued by manufacturers in supplying test equipment for their units; they create a unique piece of equipment, dedicated to their units.

RCAT

In an RCAT test set, the connection to the PC is made through standard interfaces. When one computer is busy or broken, you can move to another. If there is a need for measurements in the field, take a portable. The lack of specialized interfaces reduces cost and reduces the need for dedicated machines.

RCAT proposes a standard user interface using graphics to expedite testing and reduce learning curves. Particularly in testing controls and indicators, graphics are invaluable. Where a technician would previously become more efficient as he learned the breakdown of ARINC-429 communications, he is now aided by graphics—and differentiates right from wrong at the onset.

Finally, the set-up is quick. Traditional test sets utilize breakout boxes and wiring instructions. Time spent preparing for a test frequently eclipses the actual time spent testing. Further, intricate set-ups are prone to operator error.



RCAT receives and displays ARINC-429 and discrete signals. Graphical output helps to interpret coded data.

In an RCAT test set, the interface among computer, UUT and power is defined in the cabling harness. To the operator, it is obvious where to connect the computer, where to connect to the UUT, and where to connect power. The connectors differ so improper connection is impossible.

ARINC-429 from RS-232?

The connection of ARINC-429 signals to an RS-232 serial port may sound unusual. Close examination of specifications and the hardware, however, reveals a startling interconnectability. Reception of 429 signals can be done on a PC serial port with no external circuitry. Transmission of ARINC-429 signals from the serial port is achieved with a simple level translator circuit.

Receiving 429 uses RS-232 status inputs. RS-232 input signals are specified as; -25 to -3 Volts for a 1 state and +3 to +25 for 0 state. ARINC 429 specifies a tri-state, 10-volt differential signal centered around a ground reference. This translates to two +5/-5 signals. Each signal complies with requirements imposed by RS-232.

The formatting of data characters varies from RS-232 to ARINC 429. In RS-232, a transmission consists of 9 to 11 data bits clocked in reference to a synchronizing starting edge. In ARINC 429, a transmission consists of 32 data bits clocked in reference to

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a null state between each bit. For a PC to understand 429, its internal decoding circuity is disabled and replaced by interrupt driven software. The software then assumes the responsibility of clocking and storing input data.

The 429 transmission using an RS-232 interface is slightly more complex. Once again, two RS-232 status signal lines create the differential signal. This time, a few external components limit RS-232 voltages to ARINC-429 limits. The formatting of words, during reception, becomes an interrupt driven software task, receiving timing information from the PC internal clock.

Portable PCs can move diagnostic testing into the cockpit. They enable a diagnosis at rudimentary levels without affecting aircraft turnaround time. First, a portable may tap diagnostic information transmitted from suspect LRUs. Secondly, an RCAT graphically based test of the controller can determine which end of the wiring is not operating properly. By giving maintenance personnel better tools to diagnose problems without affecting response time, there will be fewer removals of good units; in particular, good control units.

Applications abound for the PC in the test lab and on the ramp, especially for testing controls and indicators. In these applications, graphical screen outputs reduce the task immensely. Other potential applications include simulation of expensive controls and indicators when testing more complex LRUs. For example, testing Flight Management Systems (FMS) with a simulated Multi-function Control Display Unit reduces the stocking level of real MCDUs. Still more applications exist, such as data loaders for the FMS.

RCAT is especially at home testing control panels and indicators, since the volume and low cost of these items does not warrant test time on large rack ATEs or expensive dedicated test equipment.

Another application is that of data loader. Using RCAT's ability to transmit 429, a run-of-the-mill portable PC can operate as a data loader for maintaining software of the FMS and loading flight plans. Further, the PC can also be used for flight planning, functions.

The RCAT concept was born out of a need to support control-panel test stations. It is evident that other applications for this reduced complexity concept still exist. On an airplane, many elements communicate via ARINC 429. The idea of communicating with ARINC 429 from a standard PC should provide other test solutions applications.

Raul Segredo, a Senior Engineer with Sigma-Tek's Commercial Aviation Division, has been developing avionics for the past 11 years. His designs are flying in Boeing, McDonnell Douglas, Fokker, British Aerospace and Gulfstream aircraft.