Microwave Journal

A Common Test Software Platform for High Performance Automatic Test Systems

With 30 years of experience as a supplier of space-qualified components and subsystems, COM DEV is well familiar with the challenges faced by the space industry in testing low volume, high performance, high reliability components. Thorough testing under difficult test conditions is required at each step of the production cycle. The cost of an in-orbit failure is too high — every product must operate flawlessly during the satellite's life in orbit. In addition, every piece of hardware must be accompanied by a thorough review of comprehensive test reports including raw RF data, calibration data and post-processing routines that are then kept on file for the life of the product.

Despite the recent trend to standardize hardware, components for space applications are still very much designed to order. As a result, test systems must cope with all kinds of RF interfaces that are application specific. Also, due to the increase in test equipment capabilities and product complexities in recent years, very large amounts of data must be managed, along with complex calibration procedures. All this results in large non-recurring costs to assemble the required test systems for these products.

THE TEST SOFTWARE PLATFORM

Automating and standardizing the test process in this context, even for small quantity projects, is no longer an option. The amount of data and the cost of mistakes are just too high. Over the years, COM DEV has developed a unique test platform that is deployed across the entire company and used on all products and projects (more than 100 stations in two facilities, with 60 permanent users). The CodeOne™ platform requires no software development for new applications — thus it is truly a common test software platform.

In the past, RF test engineers would either develop unique software for each product using rapid development tools, or develop a generic software platform that could be used on all products through a robust configuration mechanism. The advantage of using rapid development tools to come up with a unique program was that the tools were easy to use and the test program development could be handled by the test engineers themselves. Unfortunately, maintaining the software configuration is difficult and re-usability is often limit-

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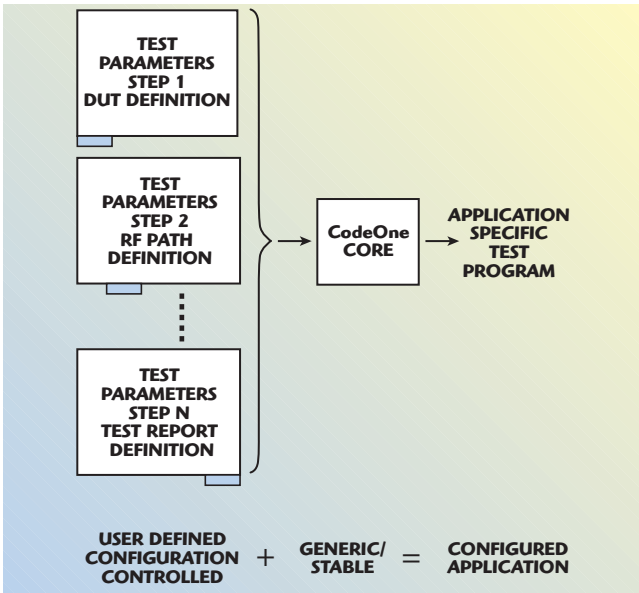


Fig. 1 The CodeOne platform.

ed. Also, this approach does not favor standard data management.

Conversely, the generic software platform can be reused on all products and projects through a robust configuration mechanism. Although this capability sounds attractive, its implementation is often difficult since it requires specialized resources (software developers) that are often not RF specialists. As a result, the software definition can take a long time to converge and be much more expensive than planned. Also, it leads to two extremes — it is either too simple (the platform never actually does what is required and needs endless additions and modifications); or it is too complex, designed to fulfill every possible requirement. Thus, it becomes a behemoth that takes more time to learn than to use and is very expensive to maintain.

The CodeOne platform takes the approach that, providing one can standardize the test process (which is under the test engineer's control), it must be possible to organize and bound the list of variables required for each test application. It is designed to allow the test engineer to describe the variables of any test application in a simple, but powerful and flexible way (a variable being a number, a formula or a complex routine). It captures the generic aspects of the test engineering process in the software and finally finds a way to parameterize the generic software using a list of variables.

Initially this set of tasks was not simple; however, over a long period of time a stable solution was arrived at and ultimately the approach was applied to a very large variety of products (from simple RF passive components to very complex microwave active equipment, base station transceivers, space instruments and even SAW wafers). The tool has basically allowed test engineers to focus on what really matters — test specifications and test results, as opposed to writing software.

HOW DOES IT WORK?

Users of the CodeOne platform first define the process parameters using Excel.™ The parameters are organized

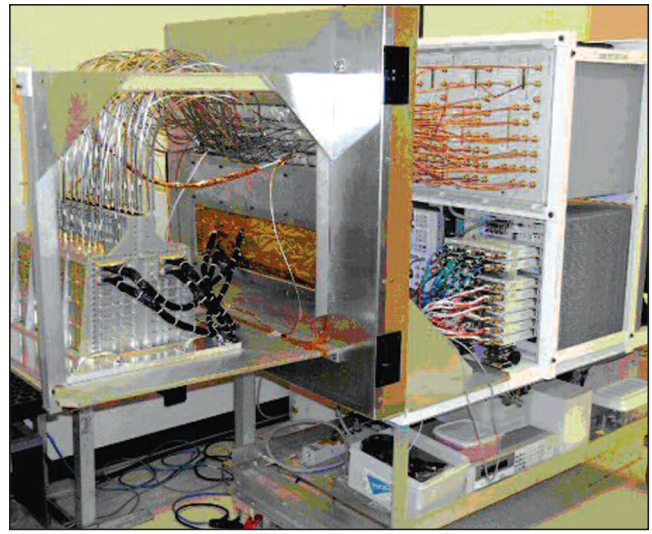


Fig. 2 Calibrating a 14x36 switch matrix.

by configuration sheets, each of which parameterize a particular aspect (or step) of the test process. One sheet, for example, would describe all the test phases, another all of the RF paths used during the tests, and so on. The parameters define the behavior of the CodeOne core software at run time. They are stored with the test data to ensure full traceability.

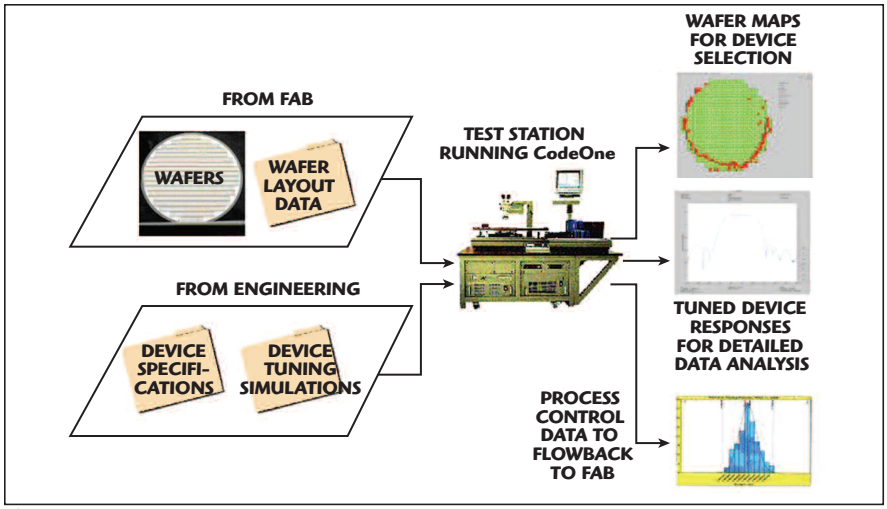
The core software has been extremely stable over the past few years. However, a number of doors have been opened in the core software to allow users to "connect" their own software. In particular, user-specific post-processing routines can be coded using Matlab,™ for instance. Similarly, users can design their own device-under-test (DUT) control and monitoring software, or their own thermal chamber control software. ***Figure 1*** shows a simplified diagram of the CodeOne platform.

The CodeOne platform is designed to handle one application from project definition to test reports. This feature is essential to ensure consistency and traceability. The same test platform is used to:

- Define a new project
- Manage user access
- Import/export data
- During test: perform calibration, acquire data, calculate and retrieve data, and issue test reports and test summaries

In a multi-port configuration, performing the calibration can be tedious and prone to costly mistakes. Acquiring error terms, ensuring that the measurements are using the correct calibration set and storing the data are all critical to the success of the testing scenario. All aspects of advanced calibration techniques are embedded in the software structure to avoid these errors and ensure correct measurements.

CodeOne-based systems are designed around high performance, broadband switch matrices. A patented calibration technique that reduces the number of connections and disconnections during calibration has been developed and is employed. For example, the calibration of a 14×36 switch matrix (see ***Figure 2***) only requires the measurement of 50 paths, as opposed to many thousands of isolation paths under normal techniques.



▲ *Fig. 3 A wafer test station running CodeOne software.*

TEST ENGINEERING SERVICES

COM DEV is now offering its CodeOne platform as part of a Test Engineering Service Package. The test software platform can be deployed on a stand-alone basis or as a complete enterprise solution (networked test stations). Depending on the requirements, the company can design and deliver turnkey solutions, including training and post delivery maintenance and support, or license the CodeOne platform and train the test engineering team to deploy its own CodeOne-based solutions.

As an option, the CodeOne platform can include a "Special Test Equipment (STE) Toolbox," which is a combination of hardware and software that operates the DUT (power, telecommand, telemetry). STEs are often application/equipment specific, and the Toolbox is designed to enable the efficient design of such equipment. It is based on a generic input/output card that can be programmed to emulate almost any protocol (serial or parallel) and has been designed to easily interface with the CodeOne-based solution.

EXAMPLES OF CodeOne SOLUTIONS

The following three test systems were designed to test three different levels of assembly of an RF processor. All of the test racks used the same traceable software and the same rack architecture. The racks were part of a common network and the test data was accessible to all individuals involved in the project at all times.

Component Level: SAW Wafer and Package Testing

The requirement was to test up to 8000 SAW devices on a wafer and process the data in quasi-real time. The tests included S-parameters to determine bandwidth, loss and phase. The solution was to design an automatic feed and probe system using the CodeOne platform (see ***Figure 3***). The resulting test time per SAW device was reduced to less than a second including the probe station movement time. Statistical analysis of the various parameters was performed to enhance the manufacturing process. Test data was then ported to the next higher assembly level.

Subassembly Level: Amplifier-SAW-Amplifier

The requirement was to measure the Amp/SAW/Amp subassemblies by batches in a thermal environment using a multi-port RF system, while maintaining calibration during a two-week cycle. The solution was to design a test system using high performance switch matrices. Each CodeOne test station had a throughput of 25 assemblies and included measurements of gain, phase, return loss, third-order intermodulation, isolation and spurious, without disconnection.

Final Assembly Level: The RF Processor

The requirement was to test a complex active RF processor (12 × 8 ports at L-band) for phase noise, phase and amplitude tracking, group delay, gain and gain monitoring, IM3 and isolation. Each test could generate up to 2 Gb of data. The solution was a multi-port test system using the same switch matrices as before and the same core software.

CONCLUSION

A versatile common test software platform has been described that has been borne out of COM DEV's extensive heritage in manufacturing equipment for space applications. The challenges faced in testing space hardware are typically those of low volume, high mix, high performance and high reliability. Similar requirements are faced by the aerospace and medical industries. The CodeOne platform has been designed to address the requirements of a large number of tests under difficult testing conditions with full traceability and low product standardization. The CodeOne solution provides flexibility, high reliability and high performance in automatic testing, thus minimizing cost and lowering capital expenditures.

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