Integrated Prototype Test Environment for Design Engineers

Introduction

Providing a suitable operating environment for testing prototype circuit boards during development has been a problem for many years. It has been difficult to justify spending the extra time and resources just to design and build a complete operating environment for prototype development and qualification. The trend toward more complex boards with embedded processors has only exacerbated this problem by adding weeks or months of firmware development and testing to the time that the operating environment is needed.

The Traditional Environment

In the traditional process of developing a new circuit board with an embedded processor, a hardware prototype is first created and then the firmware is developed. In most cases, individual features are added to the firmware, loaded into the prototype, and tested.

Figure 1. Typical Prototype Test Environment

The operating environment usually includes power supplies, switches, signal sources, output indicators, meters, and scopes. All too often, these are connected in a temporary nest of wires and connectors as shown in Figure 1.

While the original time to build the traditional setup is minimal, the time required to maintain, repair, and restore it becomes significant. Often development time is wasted discovering shorts and opens that have crept into the setup. It is difficult to move the setup aside to work on something else. Restoring the setup to test revisions or updates is almost like starting over. Finally, the rag-tag appearance of the setup does little to encourage careful hardware and firmware testing and validation.

Automatiq Measurement Systems LLC
797 Gatehouse Lane
Columbus OH 43235 ▪ USA
Voice ▪ 800-346-3938 614-431-2667
www.AutomatiqSystems.com

Circuit-Traq PRO Test System

The Circuit-Traq PRO Test System provides an integrated operating and testing environment for developing, debugging, and validating prototype circuit boards.

After development is complete, it also provides a complete functional testing platform for production and support.

The Circuit-Traq PRO Test System consists of three major components: the TestStation which houses the test circuits, the TestFixture which connects the test circuits to the prototype circuit board, and the TestWare program which runs on a Windows PC and controls the entire system.

Figure 2. TestStation with TestFixture

TestStation

The benchtop TestStation (shown in Figure 2) houses up to 20 TestModules. TestModules are circuit boards that provide programmable input and output signals that can be connected to the prototype circuit board. Various TestModules are available that feature programmable power supplies, output voltages, voltage measuring circuits, serial interfaces, etc. External instruments and instrument cards mounted within the host PC itself can be connected and controlled as well.

TestFixture

The TestFixture is a removable chassis that houses the wiring between the TestStation circuit connections and the prototype circuit board. The prototype circuit board is mounted securely to the top of the TestFixture.

TestFixtures for testing additional prototypes can be created in the same manner. Different prototypes can be tested by lifting out one TestFixture and dropping in another.

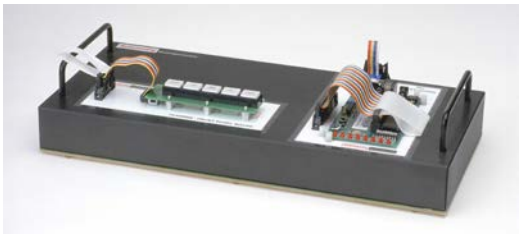

Figure 3. Typical Automatiq TestFixture

Automatiq Measurement Systems LLC
797 Gatehouse Lane
Columbus OH 43235 ▪ USA
Voice ▪ 800-346-3938 614-431-2667
www.AutomatiqSystems.com

Signals

Signals are a unique feature of the TestWare control program. Signals let the developer give a name to each input and output connection, define its source, and specify its limits, calibration data, logic level, etc. Signals hide the complexity of the connection and allow outputs to be set or inputs tested by simply referencing the Signal name in the test program.

All inputs and outputs can be used as either analog or digital signals. The Signal definition allows specification of any logic voltage system for each Signal.

Virtual TestBench

After a TestFixture is wired and the Signals are defined, the TestWare control program provides two ways to access and control the Signals.

The virtual TestBench provides a graphical interface to using the defined Signals. By dragging controls onto the virtual TestBench screen and attaching them to Signals, the values of Signals can be set or displayed. Some of the available controls are push button switches, LED displays, analog set points, meters, etc.

Figure 4. Virtual TestBench Screen

After the TestBench screen has been configured, the developer can interactively set stimulation values and view the corresponding outputs from the prototype circuit board. Any number of TestBench screens can be defined to test various prototype functions.

For complex circuit boards, setting up a test may require a long sequence of commands to put it into a particular state. Short TestScripts (described below) may be written and executed from the TestBench screen to run complex setups and test sequences.

Since the TestWare control software runs in Windows and makes minimal demands for memory and processing power, the PC is available for running other development tools (compilers, IDEs, loaders, debuggers, etc.) while the TestWare program is active.

TestScript

The TestWare software also includes a test programming language called TestScript. TestScript is a BASIC like language with extensions that simplify and streamline test program development. TestScript programs can set the states of output Signals and read

Automatiq Measurement Systems LLC
797 Gatehouse Lane
Columbus OH 43235 ▪ USA
Voice ▪ 800-346-3938 614-431-2667
www.AutomatiqSystems.com

the response of the prototype circuit. The full BASIC TestScript language provides almost unlimited control and signal processing capabilities.

TestScript programs to test the features and specifications of the prototype circuit can be developed quickly. Once these programs are written, extensive tests can be conducted in seconds or minutes.

In the Circuit-Traq PRO Test System environment, features are added to the firmware and then roughly tested by hand using the virtual TestBench. When the feature seems to be working, a short TestScript program is written to thoroughly test that feature to ensure it meets its specifications (validation testing).

Testing

In the traditional firmware development cycle, features are added to the firmware one at a time and manually tested to ensure that they work properly. Unfortunately, testing each feature manually takes a lot of time and effort. For that reason, manually testing all combinations of input conditions is often omitted.

However, the real vulnerability of this type of traditional validation procedure is that these tests are seldom rerun until the final qualification test (if then). This is understandable given the amount of time and effort required to run them manually. In addition, side effects from features added to the firmware later sometimes affect the operation of features developed earlier. These recurring problems are seldom found until final validation testing or after the product is shipped.

Validation Testing

With the Automatiq Test System, TestScript programs to test individual features are strung together to form a full Validation Test. The Validation Test can be run in seconds or minutes each time the firmware is updated! This means that problems are found and resolved early, improving firmware quality, reducing costs, and reducing the errors discovered after the product is shipped.

Regression Testing

Regression Testing has become a standard tool for testing large software projects. Each time a software bug is detected, it is first identified and a test is written to detect the error. Then the software is corrected and the test is run to ensure that the error was corrected. The key to Regression Testing, however, is that each of these bug tests is added to the

core Validation Test. It is run after each new build of the software to ensure that the new bug was really fixed and old bugs did not creep back into the software.

Regression Testing has not found great acceptance in traditional firmware development because of the lack of tools for automatically testing firmware. Performing manual Validation Tests and Regression Tests requires far too much time and effort to be done routinely with each firmware build.

The Circuit-Traq PRO TestSystem now allows full Validation Tests with Regression Tests to be run in seconds or minutes. This, combined with a well-designed practice of recording errors, anomalies, and unusual operation for later analysis, will result in a significant reduction of errors in delivered products.

Production Testing

Developing functional test equipment for Production Testing is a significant problem for product development organizations. In many companies, designing a new product takes all of the allotted development time (and often more). Provisions for Production Testing often get left until after the product is released for production. Competitive pressures often result in a production backlog before the product is released. This results in a testing crisis when production starts.

Traditionally, a new functional test system must be designed and built from scratch. For complex products with embedded processors, design engineers must either develop the test equipment themselves or write a complete test specification and provide significant support to the test system designer. This process usually takes weeks or months at a critical time in the development cycle.

With the Circuit-Track PRO Test System, however, the TestFixture that has been used in development can be duplicated quickly or turned over directly to production. In most cases, Production Test software can be generated from the Validation Test by removing the detailed tests that only test firmware and leaving only those tests that test the operation of the hardware. Both tasks can be completed in hours or days so that Production Testing is in place when the product is released for production.

Implementation and Cost

A complete Circuit-Traq PRO Test System — this includes a TestStation, three TestModules, a ready-to-wire TestFixture kit, and TestWare software — is priced at $10,995. Additional TestFixture kits (unwired) are only $295. Additional TestModules are available for $695 to $1,295 depending on the type of module.

Automatiq Measurement Systems LLC
797 Gatehouse Lane
Columbus OH 43235 ▪ USA
Voice ▪ 800-346-3938 614-431-2667
www.AutomatiqSystems.com

Firms that outsource circuit board assembly can provide a functional test system to the assembly site quickly and inexpensively. If the assembler already has a Circuit-Traq PRO Test System, only a duplicate TestFixture and TestScript program must be provided. Otherwise, the cost of the Circuit-Traq PRO Test System can be amortized over many board types.

Because of the low cost of the Circuit-Traq PRO Test System and duplicating TestFixtures, it is also feasible to provide the same high-quality functional test equipment for service departments, remote offices, fabrication sites, etc.

Summary

With the Circuit-Traq PRO Test System, problems are discovered much earlier in the product life cycle and the time, effort, and expense to resolve them is reduced. Because Validation Tests provide the software core for Production Tests and because the test fixture is designed during development, the costs and delays usually encountered in providing finished functional test equipment to production are substantially reduced.

The Circuit-Traq PRO Test System is a significant tool for reducing development costs, improving time to volume production, and shipping more reliable products.

Automatiq Measurement Systems LLC
797 Gatehouse Lane
Columbus OH 43235 ▪ USA
Voice ▪ 800-346-3938 614-431-2667
www.AutomatiqSystems.com