IEEE-1445 (DTIF) Based Digital Test Solution

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Abstract— The digital test interchange format (DTIF) is defined by the IEEE-1445 specification and provides a standardized digital data interchange format that can be used with various digital test environments. This standardized format, when used in conjunction with tools for post-processing of DTIF files and appropriate functional test digital hardware, offers a cost effective and viable solution for migrating legacy TPS's to a modern digital test system platform.

This paper provides an overview of how DTIF files generated by simulator tools such as Teradyne's LASAR simulator can be used in conjunction with modern digital test post-processing tools and hardware to provide a robust TPS migration strategy for legacy digital test applications including support for Go / No-Go tests, guided probe and fault dictionary functionality. This methodology offers wide applicability for a number of applications that were originally developed on digital test platforms such as the GenRad 1795 / 1796 / 2225/ 2235/ 2750, the Hewlett Packard DTS-70, Teradyne L200 / L300, and Schlumberger 790.

Keywords— IEEE-1445; digital test interchange format; LASAR; guided probe; digital test

I. OVERVIEW - TEST SOLUTION DESCRIPTION

The DTIF based test solution includes both software and hardware components. The test platform is PXI-based and includes a digital subsystem, guided probe hardware and other instruments as required by the application. The software tool set includes tools for importing DTIF files to the XML format, a graphic editor for importing of UUT images – simplifying probing sequences, and a test executive for managing the overall execution and debugging of the TPS.

The test solution’s hardware is based on the PXI architecture and employs the following test system components:

- 3U or 6U PXI chassis (depending on selected digital instrumentation)
- Digital subsystem with PXI digital I/O cards, supporting up to 384 channels
- UUT interface, including receiver and cabling
- Digital probe with status indicator and probe button
- Optional instruments to support additional functional test, UUT power, and measurement requirements

Depending on the application, several digital subsystem options are available. For low voltage level applications, such as TTL levels or lower (including LVDS) a PXI 3U digital subsystem is available, supporting 32 channels per card and offering dynamic direction control on a per channel and per vector basis, and supporting vector rates up to 100 MHz. Alternatively, for high voltage applications such as might be used with GR179x or GR2225 applications, a PXI 6U digital subsystem is available, supporting 32 channels per card and providing programmable drive / sense voltage levels from -10 to +15 volts. Note that in either case, the digital channels can be configured on a per channel basis, offering the opportunity to combine I/O channels that in the legacy application may have been configured as dedicated input an output channels, resulting in a lower channel count digital test solution.

The test solution’s software tools offer the following features and capabilities:

- A DTIF Test Executive which controls and manages program execution, debug, probing and the logging of test results
- A DTIF Wizard which generates the test framework for each UUT
- Support for importing and converting .tap files to an XML format which can support specific digital test instrumentation and guided probe sequencing
- A Graphic Editor for importing of UUT images, marking of components and pins to support guided probe applications
- Support for execution of go / no-go test sequences, fault dictionary and guided probe applications
- Support for a DLL based function library which allows other languages such as LabVIEW and Visual Studio to execute test sequences such as, go/ no-go, fault dictionary, and guided probe sequences.

The test solution’s tool set employs an XML file format for managing and configuring the digital test vectors, probe sequences, UUT pin mapping and other digital test specific features. This data is then used to load stimulus / expect test vectors into the hardware, drive the guided probe algorithm, as well as provide fault dictionary information.
II. DTIF (.TAP) Files

The DTIF (.tap) files are generated by the digital simulator such as Teradyne’s LASAR simulator. A full complement of DTIF files consists of 39 text files, which are summarized below:

- **UUT Model Group** (15 data files) – describes UUT topology, pin components, interconnections, and dependencies between input and outputs of devices
- **Stimulus and Response Group** (9 data files) – describes logic values of applied stimulus and response, timing, edge transitions, and pin grouping
- **Fault Dictionary Group** (6 data files) – describes the fault signature (failing response patterns) which are compared against the UUT’s response to identify component faults and interconnections
- **Probe Group** (8 data files) – describes the history of logic state and timing for every device pin

When upgrading or replacing a legacy test system, these .tap files can be used in conjunction with the DTIF conversion tools to re-host a simulator based TPS to a new test platform with associated new digital test hardware. In cases where the existing test programs do not have access to the .tap files, an alternative migration strategy is to re-simulate the UUT and then use the resulting .tap files in conjunction with the DTIF conversion tools to migrate to a new digital test platform. In either case, the resulting test solution will invariably be more cost effective, maintainable, and compact compared to maintaining the legacy test solution or employing other more traditional test solutions.

III. TEST DEVELOPMENT PROCESS

The overall test development process for importing and using DTIF files for a digital test application is shown in Figure 1.

The process includes the following steps:

1. **Simulation**: As noted previously, if the application does not have access to .tap files, then a simulation of the UUT must be performed to create the DTIF (.tap) files. Typically, Teradyne’s LASAR simulator is used to generate the DTIF (.tap) files for each UUT.

2. **Configure, setup, and execute the DTIF conversion software**: This process includes importing and post-processing the .tap files for use by the conversion tool (see Figure 2). The process is mostly automatic however several additional / optional steps are part of this process:
   - The DTIF wizard can be used to generate or add a UUT to the project file as well as include additional instrumentation
   - Configure the system’s instruments
   - Optionally add additional non-1445 based tests to the program, using switching, stimulus, UUT power, or measurement instrumentation
   - Run the DTIF based project which will execute the following tasks:
     - Imports the tap folder which creates XML-based DTIF post processor files
     - Configures the tester’s I/O pins and maps them to the UUT’s pins
     - Optionally, import UUT images or a schematic diagram of the UUT and designate the UUT components and nodes on the UUT image which need to be probed. This step will allow the software to show the user where to probe when the guided probe algorithm is used to detect failed components or connections

3. **Build the UUT connection**: This function creates the connection between the UUT pins and the digital IO subsystem adapter or test system receiver. Typically a special cable or fixture will be created to connect the UUT to the test system’s interface. The fixture wiring of the cable adapter utilizes the UUT / IO pin mapping defined in the prior step. If guided probe is employed, the probe is used with 3 channels of the DIO instrument. Additional connections between the optional instruments provide power, stimuli, and measurement functions. Figure 3 details the digital I/O pin mapping supported by the tool.

Figure 1: Test Development and DTIF Post Processing

Figure 2: Import .tap files tool

Figure 3: Digital I/O pin mapping supported by the tool
IV. TESTING AND DEBUGGING

Once the test development process is complete and the necessary interface cabling / fixturing has been created, the user can perform testing and debug of the application. After verifying the Go / No-go test sequences, verification of the guided probe and fault dictionary tests can be done which typically involves fault insertion and detection.

The overall process of developing and testing an application is summarized below:

1. Run the application which will display the created project
2. Select the UUT
3. Using the Start command, this will run the Go / no-go sequence and will log the results
4. Optionally, enter the serial number for the UUT
5. If the Go / no-go test fails, due to an injected fault or UUT fault, invoke the guided probe or fault dictionary test
6. Guided Probe – Perform a guided probe sequence until the failed component or injected fault is detected
7. Fault dictionary – identify the failed component or injected fault based on the Fault Dictionary

The Guided Probe algorithm is driven by the probe and UUT model group files. Historically, guided probe tools have presented to the user only textual information about where to place the probe – e.g. probe U1, pin 1. This has required that a layout of the UUT (or board silk screen) be available to the user in order to probe UUT points correctly. The DTIF tool set improves upon this by allowing the user to import an image of the UUT and identifying component and pin locations, providing a superior user interface for the end user.

The overall guided probe process consists of the following steps:

- The user presses the probe button to start the test. The probe LED will illuminate which indicates a test is running and then turns off, indicating it is ready for the next probe.

If the acquired data is ambiguous or inconsistent, the software will prompt the user to re-probe. (See Figure 5)

Based on the guided probe algorithm, the software will then prompt the user to probe the next UUT node and will record the probed node’s value. This process will continue until the fault is located. Both probe steps and probe values are logged for each probe event. Figure 6 details the results of a fault analysis and probe sequence.

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The overall guided probe process consists of the following steps:

- The DTIF test executive software displays the UUT image (or component ID with pin number) and highlights the point to probe on the UUT. (See Figure 4)
SUMMARY

The availability of a full-featured, DTIF conversion tool set and hardware system provides the opportunity to upgrade legacy digital test systems. In particular, if the legacy applications have access to the DTIF (.tap) files which were used to create the original test programs, upgrading to a new generation test system with an integrated software / hardware DTIF post processor solution can be very time and cost effective. Similarly, for those applications where support of legacy products must be maintained and the current test system is unsupportable, using a LASAR – based solution in conjunction with a modern software / hardware post processing solution can provide a very viable and supportable solution.

References


Application

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