Agilent 3070 In-Circuit Test

Flexible Test:
Your World,
You Shape It

Electronics manufacturers and contract manufacturers share a common viewpoint when it comes to board test. It's crucial that tests be reliable, repeatable, and easily transportable. A year ago it was a matter of money. Today it's a matter of survival.

Agilent 3070 board tests are reliable, repeatable and transportable. Here's why.

Many, many factors go into making an Agilent 3070 test reliable, repeatable and transportable. This paper selects a few of the most important ones. It explains why the Agilent 3070 is the preferred platform1 for manufacturers who need to move tests and testers from line to line or site to site, across a facility or around the world. With the Agilent 3070, manufacturers have the agility they need to adapt to ever-changing market conditions. It's no accident. It's a fundamental design attribute of the 3070: Agilent tests and testers can be moved anywhere in the world, and they come up running. The keys: hardware, software, fixtures and reporting tools.

Agilent 3070 Hardware

Analog Subsystem

The Agilent 3070 analog subsystem, the AIM card, is a single-card Analog Stimulus Response Unit (ASRU). The ASRU, the analog "heart" of the HP 3060 and HP 3065 board test systems, is a state-of-the-art instrument for making analog in-circuit measurements. Its design was proven through years of use in the Hewlett-Packard board test systems that preceded the Agilent 3070. The ASRU pioneered and perfected many features that are taken for granted today, such as the measuring operational amplifier, guarding, multi-wire (including six-wire) measurements, and real-time analog debug. These features and more are available on the Agilent 3070.

1 According to Prime Data Corp. (2001), the Agilent 3070 is chosen two-to-one over its nearest competitor in in-circuit test. The world's 20 largest OEMs and ten largest contract manufacturers use the Agilent 3070 for in-circuit test.

Agilent Technologies

The ASRU was completely redesigned for the Agilent 3070. Specifications were tightened and speed was increased. It was redesigned from a multi-board instrument to one circuit board, improving accuracy, reliability, and measurement repeatability. It was moved into the testhead to eliminate cable and connector impedances and to improve electrical connections to the device under test (DUT). Finally, the computing power of the ASRU was dramatically increased so enhanced measurements can be captured more quickly.

Reliability, repeatability and transportability of analog tests on the Agilent 3070 were further improved with additions to the 3070 design specification. Technician (manual) adjustment was replaced with auto-adjustment: the 3070 AIM card automatically measures its own drift and adjusts internal calibration tables as needed. Thus the 3070 never needs to be taken out of service for calibration, saving maintenance costs while increasing asset utilization. And if an AIM ever needs to be replaced, the new AIM automatically calibrates itself to identical specifications. Calibration can be fully automatic or initiated by user command.

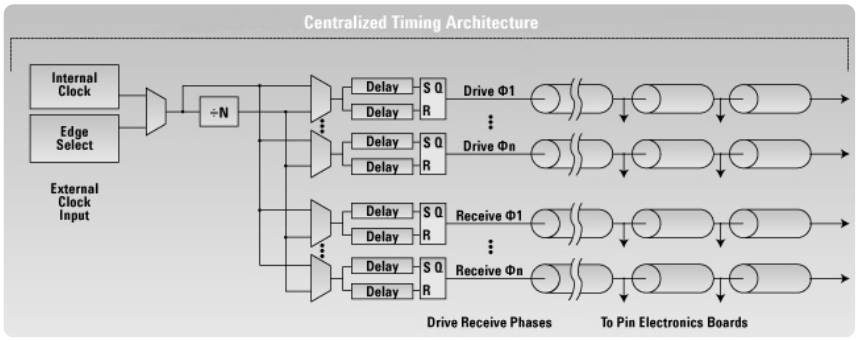
The Agilent 3070 even auto-calibrates if it senses a change in ambient temperature. For example, if a tester is shipped from one continent to another, say from North to South America, the system will auto-calibrate after installation if it senses a temperature difference of five degrees Celsius or more.

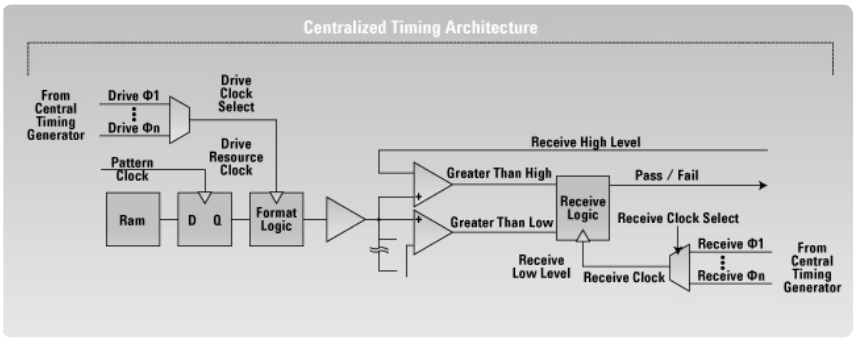
Digital Subsystem

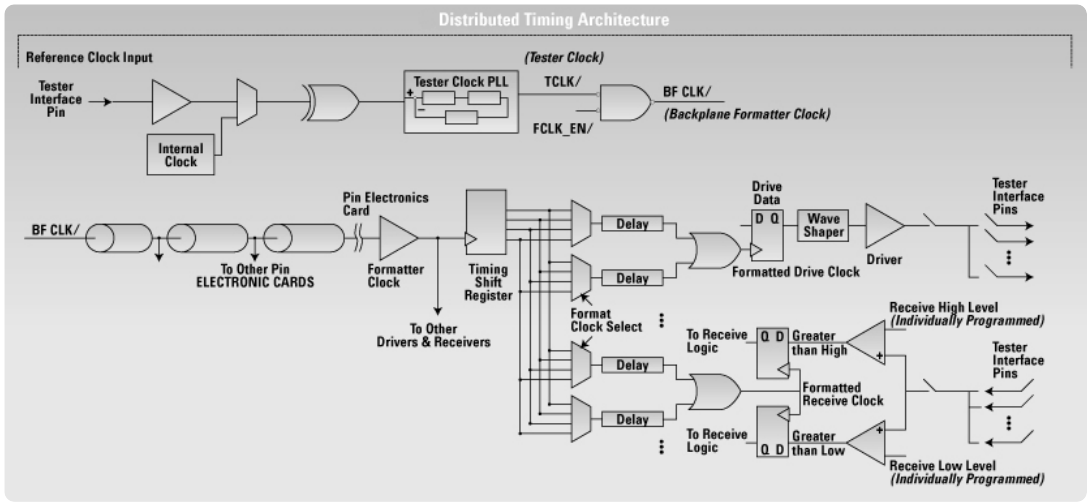
The Agilent 3070 digital subsystem introduced Agilent's patented distributed timing architecture. Unlike the older and more expensive centralized architecture used by many competitive systems, the Agilent 3070 distributes timing adjustments throughout each digital signal path. Each signal path is adjusted independently, allowing closed-loop control of each digital signal (both amplitude and timing).

Auto-adjust works automatically, giving the Agilent 3070 the unique ability to specify absolute edge placement accuracy. The tester actually delivers each edge at the specified time, at the input of the DUT.

Even more important is the specification of the placement of the receive strobe. Again, Agilent specifies absolute accuracy rather than skew. The strobe is guaranteed to occur within ±10 nsecs of its specified position. This is important because it is much harder for a test engineer to measure the placement of the receive strobe than that of the drive strobe. Drive strobes cause edges on the digital signals, so they can be measured with an oscilloscope, logic analyzer, or counter. Receive strobes, although equally important to test reliability, do not cause an electrical event on a signal line, so they're difficult to measure.







Night and Day

Centralized timing requires channel-by-channel synchronization. Distributed timing is adjusted automatically and individually at the channel level, saving time and headaches.

There is power in these simple specifications: they virtually guarantee reliable, repeatable and transportable digital tests. Agilent guarantees drive and receive edge placement accuracy to within ±10 nsec (typical specification is even better). This takes the guesswork out of digital testing. When a digital test is moved to a different tester, across the floor or across an ocean, Agilent guarantees that each edge will remain within 10 nsec of its specified position. The same is true if a pin card is replaced or the temperature changes by five degrees: Agilent guarantees that each edge remains within 10 nsec of its specified position.

Instead of trying to interpret a jumble of timing specs, test engineers know all they need to know: an edge specified at time T actually occurs at time T ±10 nsecs, at the DUT, on any and all Agilent testers. Digital tests that are written with this specification work everywhere. It's the ultimate in "write once, run anywhere" technology.

Agilent 3070 Test Generation Software

The Agilent 3070 has a sophisticated in-circuit program generator (IPG) that virtually eliminates manual debug. The analog portion of IPG (Analog Program Generator, or APG) uses Monte Carlo simulation to write robust, reliable and repeatable analog tests. APG models the device under test (DUT) and those aspects of the AIM that affect analog measurements. APG uses this model to compute the statistics of the measurement, allowing it to write optimal tests for any Agilent tester and any DUT. In a sense, APG pre-debugs analog tests before they are ever run on a real board, fixture, and tester, greatly accelerating test development. The tests are ready to go when the fixture and first boards arrive.

Also, because APG knows the statistics of the tester and the DUT, it anticipates real-world tolerance issues and incorporates them into analog tests in advance. Analog tests work not only on the local tester where they're first run, but also on all Agilent 3070s around the world. In fact, they run on testers that haven't even been built yet. The effects of part tolerances on the DUT are also built into the tests, so design, vendor, and process changes do not affect the analog tests. That's a strong statement, but it's key: there's no other way to guarantee reliability, repeatability and transportability.

On the digital side, Agilent's program generator also anticipates and eliminates real-world problems by analyzing topology conflicts on the DUT. Digital library tests are written under the "all-pins-free" assumption, meaning that all pins of a digital part are assumed free to "move" independently. Unfortunately, on real boards, digital pins are often tied to fixed nodes or to each other. An all-pins-free test cannot be used to test parts in these topologies. The Agilent 3070 uses a two-part strategy to attack this problem.

First, each digital library test is a collection of independent units. Each unit is a self-contained test for the digital device. Any number of units can be used to test a particular topology. A library test has one or more units for each topology, as well as one or more units for the all-pins-free case.

Agilent's digital program generator (DPG) analyzes each unit in each library test against the board topology. DPG drops units that conflict with the topology when it writes the digital executable test. This means that each digital device is tested as it is actually used on the board. Test engineers don't waste time trying to debug units that are doomed to fail. The executable digital test is inherently more reliable and transportable because it tests the device as it is actually used on the board.

Another key feature of the DPG is automatic device disabling and conditioning. Digital tests simply cannot be stable and transportable when nearby parts change state or oscillate during the test. Repeatability and transportability of tests absolutely require that this electrical noise be eliminated. Agilent 3070 library tests specify how to disable or condition the digital part. During the topology analysis mentioned above, DPG selects an optimal disabling method and puts it into every digital executable test whose reliability would otherwise be compromised. In addition to guaranteeing stability, this reduces the risk of device damage due to backdriving.

Second, the Agilent 3070 has a "board grader" (a better name would be "test grader") that takes the debugged testplan and measures its actual test coverage and repeatability. After each test has been debugged, the board grader measures the quality and stability of the overall testplan.

The board grader is configurable. It can analyze any combination of multiple classes of tests: pins, pre-shorts, shorts, analog in-circuit, digital in-circuit, digital functional, and analog functional. Test engineers concerned about analog tests, for example, can focus the board grader there. If they want want a full picture of test coverage and stability, that is also available.

The board grader then runs each analog test with vacuum off to make sure that the test detects a missing part. It then applies vacuum and recycles the test while it collects statistics of the measurement. It writes a report with the mean, standard deviation, and "Cpk" (coefficient of producibility) for each test. Engineers can then concentrate their efforts on stabilizing the important tests before trying to transport the testplan. The "Cpk" data alone is invaluable to a quality department.

Agilent Short-Wire Fixturing

Short-wire fixtures are another contribution to the reliability, repeatability and transportability of Agilent 3070 tests.

Long signal paths reduce signal quality. The farther an analog signal travels, the more it passes through cables and connectors, the more corruption it encounters in the form of resistive drop, noise and thermal offsets. The 3070 uses advanced techniques to correct these errors, but it's even better to eliminate them altogether when possible. Short-wire fixtures minimize both the physical and electrical distances between the tester and the DUT. The connection is typically two or three inches of 28 gauge wire. This puts the tester electronics as close to the DUT as is physically possible. The accuracy and repeatability of Agilent analog tests is limited only by the DUT itself.

The effect on digital tests is just as dramatic. Putting the Agilent digital driver so close to the board gives the highest possible signal fidelity where it matters most: at the input to the DUT. Eliminating overshoot and ringing at DUT inputs reduces double clocking, ground bounce, and other factors that affect test reliability, repeatability and transportability. A similar improvement appears at the DUT outputs (which usually have much less drive current than the 3070 drivers and are therefore more susceptible to noise). The 3070 receivers are so close to the DUT outputs that propagation delay and loading issues are negligible. That translates directly into higher yields and lower costs.

The Agilent 3070 In-Circuit Test (ICT) System is flexible test on a global scale. Its four key attributes—agile test technology, profit-enhancing business services, constant technology breakthroughs, and its adoption worldwide—make the 3070 a perfect fit for electronics manufacturing. No other platform provides the freedom, flexibility or agility required to thrive and survive in a chaotic world.

Agilent Reporting Tools

The Agilent 3070 has a full complement of reporting tools. The built-in graphical debugger supports debug of analog, digital and mixed-signal tests. In analog testing, for example, it can recycle the test and collect statistics to assess its stability. It can plot a histogram of all the measurements along with a mean, standard deviation, and coefficient of producibility. Test engineers can see whether changes to the analog test improve not only the test but also the statistics of the test. These statistics are an accurate predictor of test transportability.

Agilent's Push Button Debug, included with every 3070, collects and displays statistics from some or all tests on one or more boards. It increases the probability that tests will be repeatable and transportable by automatically gathering data from multiple fixture actuations on multiple boards.

Q-Stats, a quality statistics tool for the Agilent 3070, can log test results from several testers simultaneously in real time. It can be used, for example, to concurrently monitor all production lines that are making a given board type anywhere in the world. It can, therefore, measure all the factors affecting test repeatability and transportability including variations among "identical" fixtures, differences among production processes, bare board and part vendor changes. It can be used to shift production to the lines with the highest yield. It can anticipate the need for fixture maintenance. It has a real-time alarm feature that supports automatic notification when a process drifts outside control limits. It produces a full suite of quality reports such as control charts. In short, it can detect trends before they become problems.

FROST & SULLIVAN

Market Engineering Award Recipient

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Other Factors

Other factors that ensure the inherent reliability, repeatability and transportability of Agilent 3070 tests include:

- Semi-automated fixture construction
- Split driver/receiver pins
- Safeguard
- Combinational (combined functional and in-circuit) test
- Built-in instruments including function generator, arbitrary waveform generator, digitizer, and time interval counter
- Per-pin architecture to vary the amplitude, timing, and slew rate of digital signals on each channel independently
- Built-in software support for Boundary Scan and FlashRam programming
- Software tools including Access Consultant, Board Consultant, Test Consultant, Fixture Consultant, and Update Consultant
- Agilent's worldwide network of hardware, software, and sales support

Contact Agilent to Learn More

Agilent has deep, flexible resources to put the 3070 at your sites on your terms, including leasing and rental programs, refurbished systems, Pay-Per-Use and much more.
o learn how Agilent can ensure the reliability, repeatability and transportability of your tests, please call your nearest Agilent sales representative, or visit us online.

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