

# The Process and Requirements for LXI Device Compliance

BY MIKE DEWEY, EDITOR

With the release of the LAN Extensions for Instrumentation (LXI) standard in September 2005, instrument manufacturers now are focused on designing and deploying LXI instrumentation based on Revision 1.0 of the standard. The LXI consortium has adopted a proactive compliance process and methodology, which includes the use of plug-fests and a formalization of the overall compliance process. These processes are part of the consortium's overall effort to ensure that the standard is technically sound and that all LXI devices meet customers' expectations for performance and interoperability.

## Principles and Overview

Certification of an LXI instrument or device gives a vendor the license to use the LXI logo on its products and promote it as LXI compliant. The consortium licenses the LXI trademark and provides test procedures or recommendations regarding conformance testing. However, it is the responsibility of the vendor, not the consortium, to ensure that the product is fully LXI compliant.

The current Revision 1.0 LXI specification details the overall conformance testing and approval process.<sup>1</sup> To obtain certification, manufacturers can adopt one of three test methodologies:

- Test for interoperability against LXI devices from other manufacturers in a controlled environment using procedures approved by the consortium. The LXI Consortium sponsors plug-fests, which provide a forum where vendors can verify interoperability of their products and perform conformance testing with the assistance of members from the Conformance Working Group.

Plug-fests offer a collaborative, supportive environment to help vendors screen and improve their LXI implementations. A plug-fest typically is only one or two days long and involves multiple products from multiple vendors.

The tests are not exhaustive, and all corner cases cannot be covered unlike the testing that is part of a software, firm-

ware, or hardware product verification process. Consequently, passing a plug-fest, while a requirement for certification, is only part of the overall conformance process. A consortium member also can independently conduct an interoperability test that is witnessed by a designated member of the LXI technical committee.

- Apply for approval based on a written technical justification stating that the device has a direct legacy from and traceability to a previously approved LXI device. For example, a vendor could request approval of a B-version instrument where performance specifications are different but the communications, control, and physical specifications for the instrument are unchanged.

- Certification from an independent test laboratory approved by the consortium. The option to use an independent test lab provides LXI vendors with help in developing and certifying products from a third party while preserving product-development confidentiality and satisfying the requirements associated with the compliance process. To date, the consortium has identified one independent test house, Wheelwright Enterprises, as offering consulting and compliance testing services.<sup>2</sup>

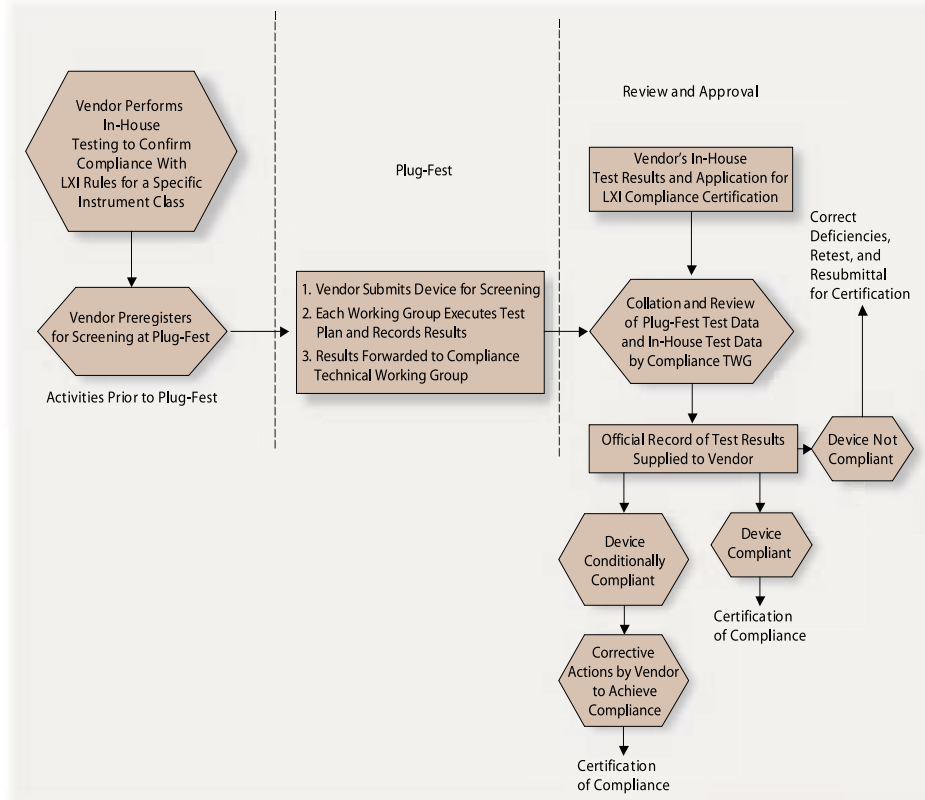
The overall test methodology for demonstrating compliance uses the LXI Conformance and Interoperability Test Procedures defined by the consortium's Compliance Technical Working Group. Basically, it confirms that all of the *rule* components of the standard are adhered to for a specific class of instrument. In addition, it verifies that a device being tested for compliance can interoperate successfully with at least one device from each of the three classes.

After completing a suite of interoperability and compliance tests, a vendor applying for certification of an LXI device is required to supply conformance documentation that provides specifics about the test process and product information including:

- Test compliance methodology—vendor tested, plug-fest, or independent test house

- Compliance to a specific LXI specification revision
- LXI conformance category: Class C, B, or A
- Vendor and primary contact
- Name, description, and firmware revision of the device

the product, Ethernet communications functions, driver functions, and web interface functionality. For Class B and Class A devices, device synchronization, LAN-based triggering, module-to-module communications, and hardware triggering functionality also are tested and verified.



**FIGURE 1. COMPLIANCE TEST PROCESS**

- LXI physical category: nonrack mounted device, full-width rack-mounted device built to IEC 60297, half-width rack-mounted device built to an industry standard, or an LXI unit per the LXI standard
- Driver information: device class if appropriate, revision, driver name, and driver vendor

After submittal of this information and review by the Compliance Working Group, approval or denial will be granted to the vendor. Approved devices are added to the overall approved device list maintained by the consortium. In the case of denial, vendors can pursue a defined arbitration and remediation process to resolve grievances or performance discrepancies.

**FIGURE 1** provides an overview of the sequence of steps involved in the compliance application process.

## Conformance and Interoperability Tests

Development and management of the overall conformance process are the responsibilities of the LXI Compliance Technical Working Group. This group is tasked with assembling the overall LXI Compliance Test Procedure that includes specific test procedures by each of the technical working groups.

For all three instrument classes, specific attributes, features, and functions are reviewed and/or tested including physical aspects of

## PHYSICAL ATTRIBUTES VERIFICATION

Besides confirming the presence and function of typical items such as power and LAN indicators; power, trigger, and LAN connectors; and other physical attributes, the LCI mechanism must be verified. The LCI function is required on all LXI devices, and testing involves verifying that it provides the following capabilities:

- Auto Negotiation enabled
- DHCP IP address configuration enabled
- Ping server enabled
- Web password set to factory default
- Dynamic DNS (if implemented) enabled
- An LCI protection mechanism

This mechanism can be a time-delay or mechanical implementation and prevents inadvertent operation of the LCI function. Verification of these functions requires actuating the LCI mechanism and then querying the instrument to confirm that the network and Web func-

tions are set to the correct default conditions and that a momentary (less than 1 s) actuation (if a time delay implementation) does not invoke the LCI mechanism.

## LAN INTERFACE COMPLIANCE

Most of the verification effort for an LXI device is associated with testing the LXI device's LAN interface/protocol. Specific functions that require verification include the following:

- 802.3 Ethernet MAC/PHY compliance
- Presence of a MAC address label which agrees with the device's MAC address
- TCP/IP, UDP, and IPv4 support
- Ping server (ICMP) functionality (default)
- Support for DHCP, Auto-IP, and manual LAN configuration methods
- Duplicate IP address detection (fault indication by the device and subsequent disconnection from the network)
- Indication of a LAN error upon failure to acquire a valid IP address, detection of duplicate IP addresses, failure to renew an already acquired DHCP lease, or disconnection of the LAN cable
- Auto MDIX functionality, if equipped
- Operation in lower speed networks; for example, if 100Base-T-capable, the device also must operate with a 10Base-T connection

*Continued on page 16*

- Support for VXI-11 discovery protocol and SCPI \*IDN? command. The device also must respond to an RPC null procedure within 1 s.

To properly verify LAN functionality, a test setup must include a PC with a LAN interface, Ethernet monitoring software, and an I/O software library supporting VXI-11, a network hub, a router supporting DHCP and reconfigurable for a different IP address, and the DUT. **FIGURE 2** details the test setup.

The use of a hub to interconnect the router, PC, and LXI device provides an easy way to monitor the LAN traffic to/from the LXI device. It also is a convenient means to disconnect the router without disconnecting the LAN between the PC and DUT, simulating the loss of a DHCP lease while still allowing the PC with its Ethernet monitoring software to observe how the LXI device responds to an expired DHCP lease.

The Ethernet monitoring software used by the consortium for compliance testing is Ethereal, an open source product for network monitoring and protocol analysis that supports a number of operating system platforms.<sup>3</sup> To confirm proper operation of the required LAN functions, the network monitoring software provides the following capabilities:

- Monitors DHCP traffic and ascertains that the LXI device requests IP, subnet, and gateway addresses from the server and that the device configures itself using these parameters from the server. Verification of these functions confirms basic Ethernet function capabilities and protocol support by the LXI device.
- Monitors the LAN network and confirms Ping server functionality, essentially verifying that the instrument can be accessed via a Ping (ICMP) function by the test PC for the purpose of diagnostics.
- Verifies RPC response time (<1 s) when the VXI-11 discovery function is invoked via the PC. This function also ascertains that the LAN discovery function is operating correctly.
- Monitors and verifies a DHCP lease renewal failure and configuration of the LXI device with new parameters. Simulation of a DHCP lease expiration can be performed by disconnecting the router and observing that the LXI device indicates a LAN error. With the establishment of a new DHCP lease, monitoring of DHCP traffic is required to confirm that the LXI device has received and configured itself to new DHCP values.
- Verifies proper LAN operation of the LXI device for Auto MDIX functionality if supported after insertion of a crossover cable.

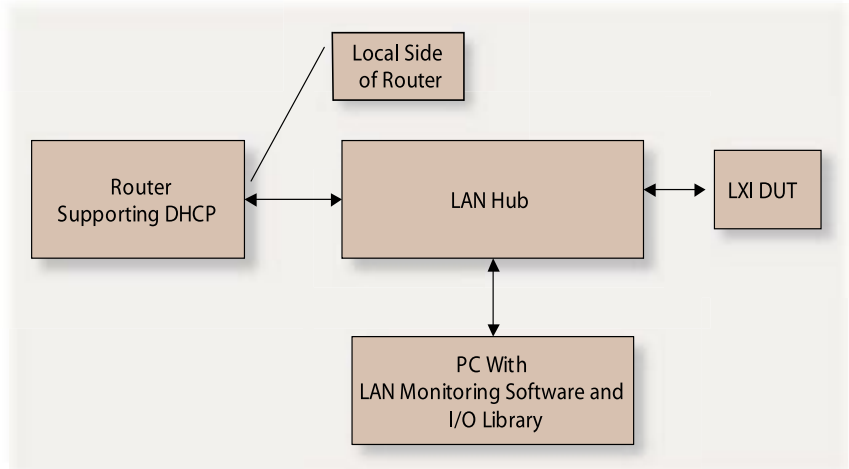
Additional verification for the LAN discovery mechanism is performed by issuing a SCPI \*IDN? command via the PC's I/O software library and confirming that the device returns four comma-separated fields indicating manufacturer, model, serial number, and firmware version.

#### WEB INTERFACE COMPLIANCE

All LXI devices must provide an HTML Web page that details basic information about the device and its LAN configuration and allows

users to modify LAN configuration parameters via the Web page. For Class B and Class A devices, additional information must be provided that details synchronization and triggering parameters.

Web interface compliance requires that content and functionality be verified as well as HTML compliance and compatibility with W3C-compliant browsers. To check for HTML and browser compliance, a browser such as Foxfire or IE6 with XP is used in conjunction with online tools such as markup validator<sup>4</sup> for validating markup conformance and style sheet conformance.<sup>5</sup>



**FIGURE 2. COMPLIANCE TEST SETUP**

The following Web information and functionality require validation as part of the conformance process:

- Confirmation that LXI devices accept HTTP connections on port 80 and serve the LXI-required welcome page as a response to such connection requests.
- Confirmation that the following information is displayed on the Web welcome page: instrument model, manufacturer, serial number, device description, LXI class, LXI version, hostname, MAC address, TCP/IP address, firmware and software revision, and IEEE 1588 PTP current time (required for Class A and B and optional for Class C instruments).
- Verification that the Web page provides device identification to control the LAN Status Indicator. Actuation of the Web function causes the LAN indicator located on the front panel of the device to flash green.
- Confirmation of the presence of two hyperlinks on the Web welcome page: one for the LAN configuration page and one for the Sync configuration page for Class A and B devices.
- Verification that the LAN configuration page provides the capability to display and configure, with password protection, LAN settings for the device's hostname, description, and specific TCP/IP configuration information including IP address value, subnet mask value, default gateway value, and DNS server(s).

Since an LXI device is required to support several methods of TCP/IP configuration, the functionality of the TCP/IP configuration field must be confirmed. Essentially, as part of the Web page functionality verification process, all three LAN configuration techniques,

DHCP, Dynamically Configured Link Local Addressing (Auto-IP), and manual IP, must be confirmed.

This is accomplished by checking the LAN interface via the test PC with Ethernet monitoring software, which can confirm the TCP/IP configuration as well as specific values for IP address, subnet mask, default IP address, and DNS server IP address(es). Verification of a DNS host name can be done via the test PC by using NSlookup or a Ping to confirm that the host name displayed on the Web page agrees with the name setup in the DNS.

## Glossary

API	application programming interface
Auto IP	automated assignment of an IP address
Auto MDIX	automatic media-dependent interface crossover
DHCP	dynamic host configuration protocol
DNS	domain naming system
HTML	HyperText Markup Language
HTTP	Hypertext transfer protocol
ICMP	Internet control message protocol
IE6	Internet Explorer 6
IP	Internet protocol
IPv4	Internet protocol version 4
IVI	interchangeable virtual instrument
LAN	local area network
LCI	LAN configuration initialize
LXI	LAN eXtensions for instrumentation
MAC/PHY	medium access control/physical address
MDIX	media-dependent interface crossover
PTP	precise time protocol
RPC	remote procedure call
SCPI	standard commands for programmable instrumentation
TCP/IP	transmission control protocol/Internet protocol
UDP	user datagram protocol
VISA	virtual instrumentation software architecture
VXI-11	TCP/IP instrument protocol specification
W3C	World Wide Web Consortium
XP	Windows operating system

For Class A and B devices, a synchronization configuration Web page must be supported. It contains information about synchronizing multiple LXI devices on the LAN as well as support for the control and display of IEEE 1588 and wired trigger parameters.

### PROGRAMMING INTERFACE CONFORMANCE

As part of an LXI device's compliance to the LXI specification, a device must be supplied with an IVI-specific driver. If the LXI instrument's functionality matches one of the defined instrument classes, then the LXI driver needs to be IVI class compliant as well. In addition, all drivers are required to accept VISA resource names, which can be of the following formats:

```
TCPIP[board]::host address[:LAN device name][::INSTR]
TCPIP[board]::host address::port::SOCKET
```

Verification of these requirements and the driver's functionality typically is completed by the vendor as part of the overall hardware and software verification process and not as part of a plug-fest verification activity. Essentially, the vendor provides self-declaration of the availability and compliance of the device's driver per the IVI standard.

However, for Class A and Class B devices, specific functionality supporting the API, as defined by the LXISync Interface Specification, requires that these functions be tested as part of the plug-fest conformance process. These tests involve the use of specific software test routines, Ethernet monitoring software to confirm the generation and reception of LAN triggers, and hardware to create and monitor hardware triggers.

## Summary

LXI product vendors are responsible for testing their devices against the standard and documenting conformance. However, to help facilitate the process, the consortium takes a proactive approach by sponsoring plug-fests and establishing an overall compliance process to help ensure interoperability and consistency in product performance.

This effort not only has included a definition of the conformance process, but also the definition and implementation of specific test methods for verifying key features and capabilities of an LXI device. By establishing a baseline set of conformance requirements and tests for the three instrument classes, vendors and customers alike can be assured that all LXI instruments, regardless of their class, will be interoperable, perform reliably, and have a consistent look and feel.

## References

1. LXI Specification Revision 1.0, Section 14
2. [www.wheelwrightenterprises.com](http://www.wheelwrightenterprises.com)
3. [www.ethereal.com](http://www.ethereal.com)
4. <http://validator.w3.org>
5. <http://jigsaw.w3.org/css-validator>

### ABOUT THE AUTHOR

Mike Dewey, the marketing product manager at Geotest-Marvin Test Systems, has previously held various positions in design engineering, engineering management, marketing, and product management with GenRad/Teradyne, ADR Ultrasound, and Motorola Government Electronics Group. He is a member of the IEEE and has served as a board member for both the PXI Systems Alliance and the VXI Consortium and been an LXI Consortium advisory member on the marketing, technical, and physical working group committees. Mr. Dewey received a B.S.M.E. from Syracuse University and an M.S.E.E. from Georgia Institute of Technology. e-mail: [miked@geotestinc.com](mailto:miked@geotestinc.com)

