Introducing PXI Instrumentation Into An Existing VXI Based Tester

Kevin Paton
Teradyne, Inc.
North Reading MA
Kevin.Paton@teradyne.com

Abstract — **With the large number of PXI form factor instruments that are now available, many users are looking to introduce these instruments into existing VXI based systems. Adding PXI instruments to existing systems is much more cost effective versus building a new tester since various assets, such as user power supplies and the system controller can be shared by both instrument types. But introducing this new instrumentation presents the System Engineer with many design issues that need to be considered. One major consideration is whether to use the existing VXI user interface or to expand to a second interface.**

It is not uncommon that when a PXI chassis is added to an existing system that only a few instruments are introduced. When a small number of instruments are added it may make sense to just provide cabling that allows the user to connect to the existing interface, connect a wire harness directly to the ITA, or simply cable from a PXI instrument directly to an I/O port of the UUT. However, if the design of the cabling becomes too complex these approaches may become impractical. In this case the user's only practical choice is to use a second interface.

Another factor when determining the best interface choice is the technology used by the new instrumentation. If the signals are differential then the cable lengths are less of an issue, although shorter cables are always preferred. But, single ended technology such as LVTTL signals, may only support cabling up to a foot or two and this can force the System Designer to institute a second user interface option in front of the PXI chassis.

If it is determined that a second interface is required there are other decisions that have to be made regarding the sharing or addition of system, assets.

This paper will discuss all of these issues using real life examples of systems which have combined both VXI and PXI instrumentation. The examples will show various instrumentation and the cabling solutions employed.

I. Introduction

With the large number of PXI form factor instruments that are now available, many users are looking to introduce these instruments into existing VXI based systems. Adding the PXI instruments to existing systems is much more cost effective than building a new tester since various assets, such as user power supplies and the system controller, can be shared by both instrument types. While the benefits can be significant, it is important to recognize that introducing this new instrumentation presents the System Engineer with many design issues that need to be considered. One major consideration is whether to use the existing VXI user interface or to expand to a second interface.

It is not uncommon that when a PXI chassis is added to an existing system, only a few instruments are introduced. When a small number of instruments are added it may be sufficient to just provide cabling that allows the user to connect to the existing interface, connect a wire harness directly to the ITA, or simply cable from PXI instrument directly to an I/O port of the UUT. However, if the complexity of the cabling becomes too complicated, these approaches may become impractical. In this case the user's only practical choice is to use a second interface.

Another factor when determining the best interface choice is the technology used by the new instrumentation. If the signals are differential, the cable lengths are less of an issue, although shorter cables are always preferred. It is important to recognize that single ended technology such as LVTTL signals may only support cabling up to two feet in length, which can force the System Designer to institute a second user interface option in front of the PXI chassis. If it is determined that a second interface is required, there are other decisions that have to be made regarding the sharing or addition of system assets.

This paper will discuss these issues using real life examples of systems which have combined both VXI and PXI instrumentation. The examples will show various instrumentation and the cabling solutions employed.

II. Determining Which Approach to Take

When the System Designer is incorporating new PXI instrumentation into their system one major question is "Can an existing tester's user interface be used and, if not, what are other options?" When contemplating this question there are several factors to consider:

- What types of signals are being transmitted?
- Is there room in the existing interface for the additional PXI signals?
- Can the user interface be expanded by moving to a larger interface?
- If modifying the existing interface is not feasible, could external connectors be used on the test fixture to allow the instruments from a PXI chassis to be cabled directly?

A. Types of Signals being Transmitted

When looking at the signals that need to be accommodated, characteristics, such as the frequencies of the signals that are being transmitted as well as if the signals are single ended or differential, may help to drive this decision. Differential signals allow the cable lengths to be much longer, which in turn allows cabling from the PXI chassis to be run to most any point in a typical system, including an existing user interface that may require a long cable run to reach. However, any type

of single-ended signal module could force the System Designer to introduce a second user interface in very close proximity to the chassis or to even bypass a user interface and use a cabling approach where the instrument is connected directly to the TPS fixture.

Signals like LVTTL and even TTL can have serious limitations in transmission distances. For example, TTL may function acceptably out to many feet but if that cabling is then bundled with other instrumentation cabling, which is not unusual, the noise susceptibility becomes more of an issue. LVTTL signals are even more susceptible to noise. There are newer transmission technologies such as Digitally Controlled Impedance, that Xilinx provides, which allows longer transmission of LVTTL signals. But, the devices that are being tested may have drive capabilities that can handle transmissions over a very short distance. For example, a PC board may only need to transmit signals to another PC board in an adjacent slot so the drivers used may have very limited transmission distances. If that same PC board gets put on a test fixture, it may only be able to drive a signal a foot or two. So cabling for these signals need to be as short as possible. Figure 1 shows an example of a PXI chassis placement which provides the shortest possible transmission distance using an existing VXI interface.

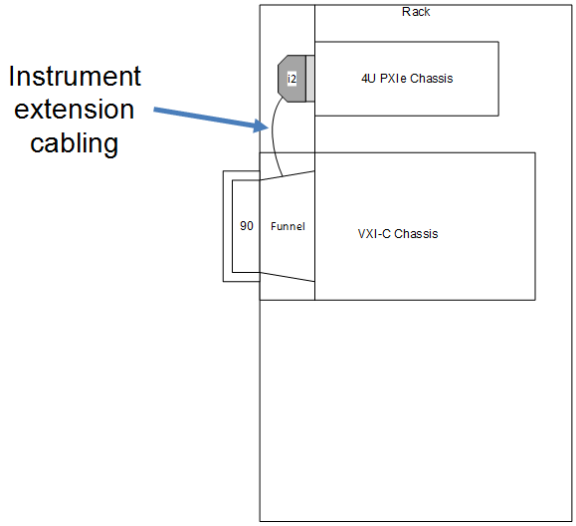

Figure 1: PXI Chassis in Close Proximity to Existing User Interface.

B. Determining if the Existing User Interface can Support the New Signals

After the types of signals to be added have been determined, it is a fairly easy process to determine if the existing user interface can accommodate the new signals. In some instances there will be interface connectors that are the correct match for the new signals such as RF, signal, and power. If those connectors are not currently available, new connectors may be added to the user interface.

An additional consideration is whether the user interface has enough room for expansion if additional PXI instruments may occur in the future. If the existing user interface can accommodate the new instruments but has no room for future instruments, it is wise to consider an expanded user interface approach when the new PXI chassis is added.

C. Expansion of an Existing User Interface

Two of the most common interface types found on existing VXI based test systems are the VPC series 90 and the TTI pogo-pin style interfaces. Both of these vendor interfaces offer single-tier and double-tier interfaces. The VPC series 90 even offers a three-tier option. Therefore, it will likely be possible that an existing system could have the user interface expanded, although it may require the repositioning of the existing tester assets.

If adding additional tiers to these interfaces, keep in mind that any existing single-tier fixtures will still work with the new, multi-tier interface.

Figure 2 shows a single-tier system with a VPC series 90 interface which has been expanded to support a second tier. Note that the upper tier remains unchanged and that the fixture mounting hardware on the two-tier approach has the same mechanical layout to accommodate the use of single-tier fixtures.

Figure 2: One-Tier VPC 90 Interface Expanded to Incorporate a Second Tier of Pins**.**

Figure 3 illustrates a TTI user interface that has been expanded to two tiers to accommodate addition system assets.

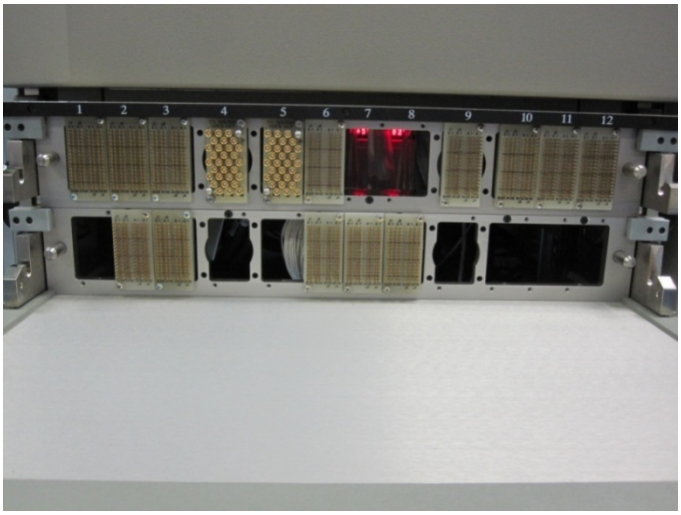

Figure 3: Example of a Two-Tier TTI Interface.

D. Use of External Cabling Connected Directly to the Test Fixture or LRU (Line Replaceable Unit)

If there is no room on the existing fixture and adding an additional PXI user interface does not provide an acceptable solution, cables could be run directly to the test fixture.

On many existing test set-ups it is not uncommon to bring external assets into a test fixture using cabling external to the tester. Figure 4 shows an example of a test fixture that has both a connection to a user interface and external connections.

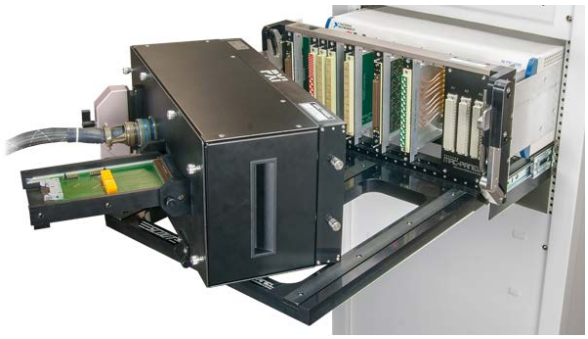

Figure 4: Example of a Test Fixture That Also Uses External connections.

There are several approaches that can be employed if new PXI assets are to be externally cabled to a TPS fixture:

- Cabling from a PXI module directly connected to external connectors on a TPS fixture
- Cabling from a PXI interface adapter to external connectors on TPS fixture mounted on the existing user interface
- Cabling from individual PXI interface connectors to external connectors on TPS fixture mounted on the existing user interface

Mechanically there are many approaches that can be implemented along with a wide variety of 3rd party vendor hardware that allows the user to design these approaches. Many of the following examples demonstrate these approaches using the VPC products.

Figure 5 shows an ICA/ITA pair.

The ICA is the connection that comes from the instrument to the user interface. This could either be part of a funnel assembly or a cable running from the instrument front panel to the VPC interface connector.

The ITA is the connection to the front of the user interface that could either be part of a complete test fixture adapter or attach directly to an ICA connector. (Figure 6)

ICA ITA

Figure 5: Both Sides of a VPC Connection Combination.

Figure 6: ITA Cable to ICA Attachment.

There are many connector/cable combinations available, supporting power and high and low frequency signals, including video. Figure 7 illustrates several examples of cables that can be interfaced to a PXI user interface.

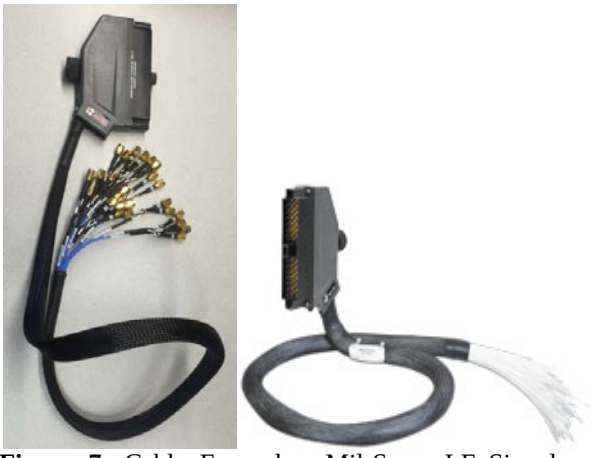

Figure 7: Cable Examples: Mil-Spec, LF Signals, and RF Signals.

After the cable types are defined, the next consideration is how to accomplish the cabling. Can a simple point-A to point-B connection approach be used or will the cables have to split off to various connectors?

Figure 8 illustrates a point-A to point-B cabling concept. In this example the cables are connected directly to the unit under test (UUT). Since many military LRUs have mil-spec connectors as an interface, this cabling approach is a very straight forward approach.

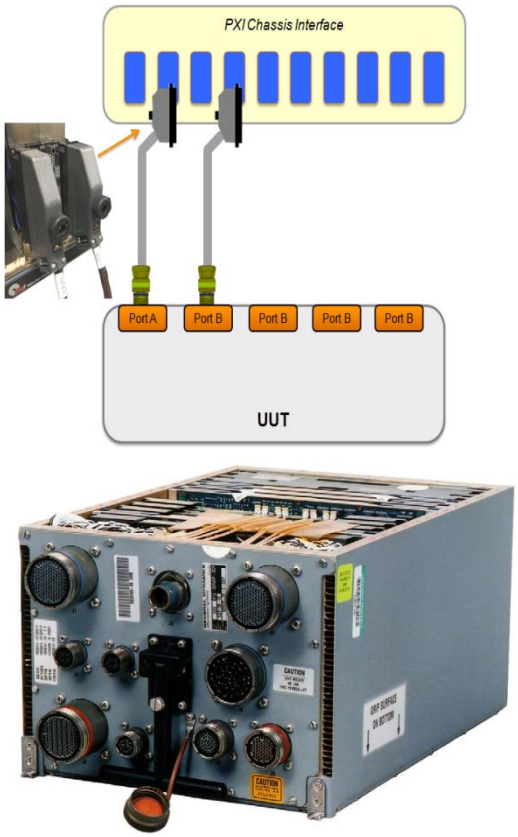

Figure 8: Point-A to Point-B Direct to the UUT.

A more complicated, multi-point approach (Figure 9) may be needed when the LRU connectors have connections that require more than one instrument type for operation and test.

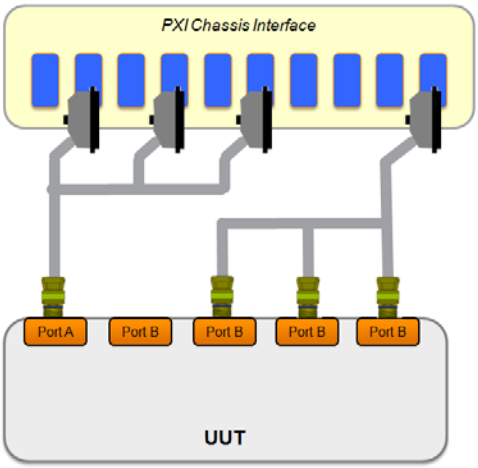

Figure 9: Multi-Point Connection Approach.

Figure 10 illustrates the concept where multi-point cabling connects to the test fixture.

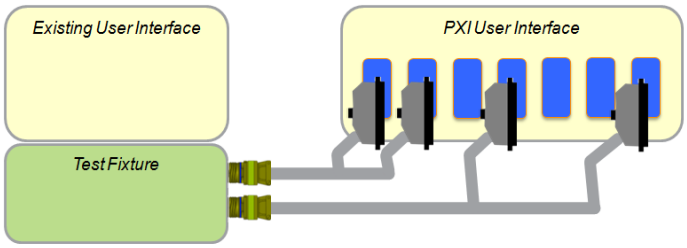

Figure 10: Multi-Point Connection Connected to the Test Fixture.

E. PROs and CONs of Direct Cable Connections vs. Test Adapter Access

Direct UUT Cable Connections

PROs

- Simplest approach when a small number of instruments are required
- Minimizes the layers of interconnections
- Avoids the need for another TPS test adapter
- Works well with a variety of subsystem configurations
- Ideal for simple 1:1 instrument to UUT port interconnect

CONs

- Requires storage and insertion of multiple individual cables
- No provision for termination/buffering circuits
- Cables become very complex when multiple instruments or UUT ports are involved in a single cable assembly
- Many pieces to manage

If a standalone PXI interface will be employed, the user must determine if the assets will be brought out to the user via cabling or through a funnel approach. Since VPC interfaces are the most common, those approaches will be used here to discuss funnel verses cabling options.

Figure 11 illustrates a funnel approach that brings the instrument connections out to the user. These funnels contain the actual cabling and allow for easy removal and insertion of the instrument. This approach also offers a level of protection both physically and electrically for the cabling. The funnel hardware could be eliminated and the cabling brought out to the user interface.

Figure 11: PXI Module Using a Funnel Interface with a VPC Connector.

An advantage of the funnel approach is that signal conditioning and other circuitry can be added to the funnel.

Figure 12 shows an example of a PXI chassis that is cabled to an existing VXI interface. In this case the signals being transmitted were differential signals which could transmit over longer distances but this placement could limit expansion to other technologies such as LVTTL devices.

Figure 12: No Funnels for the PXI Instrumentation. The cables run directly to the existing user interface.

The tester in Figure 13 shows the PXI chassis instrumentation brought out to its own user interface. This approach was required because the PXI instrumentation involved had some LVTTL signals that could only be run very short distances.

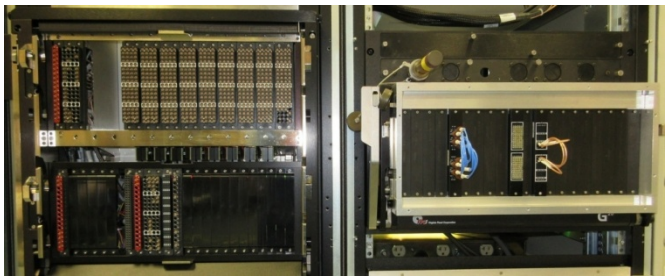

Figure 13: Tester with Two Separate User Interfaces.

Various hybrid approaches also could be used where instrumentation from the system, such as DC power supplies, could be run to the PXI interface. Also, other PXI assets could be run over to the main VPC 90 interface.

Figure 14 provides an example in which both a mass interconnect user interface and mil-spec direct connectors are available.

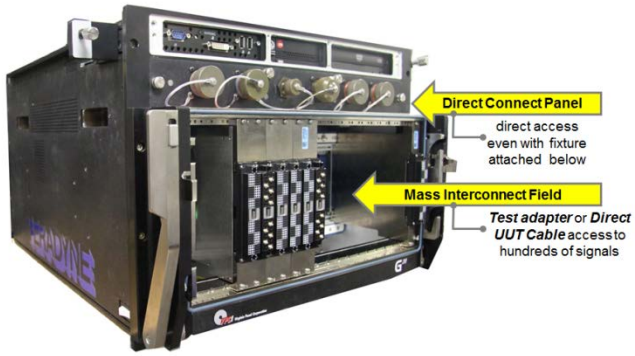

Figure 14: Mass Interconnect User Interface with Direct Connect Mil-Spec.

Test Adapter Approach

When using a test adapter approach on a new PXI chassis there are some PROs and CONs:

PROs

- Proven approach for complex instrument to UUT cable topologies including support for signal conditioning circuitry
- Accesses many instruments with a single action (large TPSs, System Self-Test fixtures)
- Can simplify insertion of multiple direct i2 cables to UUT
- Electrical fixture ID allows TPS to check for correct test adapter (ID)
- Shortest path to UUT for critical high speed interfaces (SRA test)

CONs

- When required, introduces an additional test adapter (ID)
- May add an additional interconnect layer
- A System Self-Test Adapter is required for each unique configuration
- Additional subsystem cost

III. System Controller

Since the test system being modified will already have a PC controlling the hardware, the preferred method of adding a PXI chassis is to add a PXI chassis controller to the PC. Controllers are available for both PCI and PCIe slots, including PCI express modules for X1, X4, X8 and X16 slots. Therefore, if the existing PC has an available slot, an external controller approach is available.

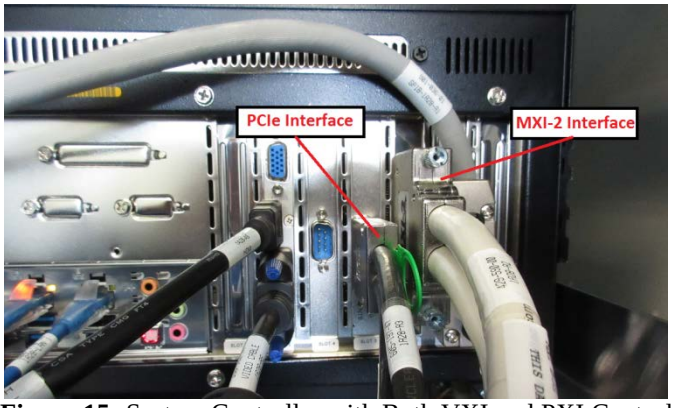

Figure 15: System Controller with Both VXI and PXI Control Modules.

If there is no slot available in the existing PC, an embedded PC approach can be used in which the PC is a standalone module that resides in the PXI chassis. See Figure 16.

Figure 16: Embedded PC Controller.

The existing system PC can communicate with the PXI chassis embedded PC via an Ethernet connection using Windows "Remote Desktop Communication".

Another approach would be to add a 1U PC along with the PXI chassis as shown in Figure 17. There are several factors that could drive the need for this type of PC solution:

- The existing system PC could be an older, 32 bit, PC but the PXI modules may require a 64 bit PC.
- The existing system PC may not have any slots available to accommodate the PXI chassis controller.
- When adding test capabilities to an existing system there may be additional PC based boards that are needed to support these capabilities.

Figure 17: 1U PC Controller Positioned above the PXI Chassis.

IV. Conclusion

When adding a PXI chassis to an existing system there are many considerations that must be taken into account. To provide the best solution possible the System Designer must consider:

- What types of instruments are being added and their characteristics. Do their signals require very short cabling?
- If these modules are to be incorporated into an existing user interface, how much real estate is available?
- Where will the PXI chassis be located for the best signal integrity?
- If the existing user interface will not be used, what approach will be taken: a totally new interface or just a cabling approach?
- Are there existing system assets that could be routed to a new user interface if that approach is used?

After all of these factors are investigated thoroughly, the System Designer can then move forward implementing the integration of a new PXI chassis.

V. Bibliography

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Figure 4 – Fixture photo

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Info on interfacing TTL signals

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Figure 8 - LRU photo