Reducing Cost by Using the Right Connectivity Method for your PXI Test System

Submitted by MAC Panel

Planning and development of PXI based automated test equipment (ATE) can present many challenges, from the design stages all the way through to test deployment. As the design and build progresses, changes become costlier at each stage. Furthermore, attempting to change aspects related to the connectivity between test equipment and device under test can be detrimental and could even force a redesign of the entire system.

There are several considerations when selecting an interconnect solution for your PXI based ATE, from relatively simple choices of which style of contact to use (pin and socket or surface to surface) to more complex decisions such as choosing to use a wired approach or a reduced wired solution that use PCBs or flex circuit connections. With a PXI based test system it is also paramount that thought be given to maintaining the modularity and flexibility that the PXI platform provides. A connectivity solution that ignores these fundamental requirements will inevitably lead to increased cost over the life of the system.

Modularity:

PXI has revolutionized the design of test systems by providing modular solutions that meet the technical and cost objectives in a wide range of applications. During the earlier years of PXI most customers would simply select the PXI instrumentation and then select a direct cabled solution to connect to the test fixture. However, this method can ultimately lead to a higher cost of test in many applications. Individual cables need to be manufactured or modified to meet specific needs and are often used for only one test or specific DUT. When a change needs to be made or a new product is introduced a whole new set of cables needs to be produced. This can be costly and can also increase the time to market as it involves design, manufacturing and inspection time. So how do we decrease the amount of time and cost associated with direct wiring?

Two options are available. The first is the use of a modular system using high density connectors with mating cables in which the connector is cabled to the PXI instruments. At this point a cabled solution terminated to a modular rugged connector would be selected for each DUT being tested.

The Second approach is to use Mass Interconnect. Mass Interconnect is a more modular solution that utilizes various connector modules (fig. 1). This type of interconnect approach allows for all the I/O from the instrumentation to be connected to the receiver connector modules, which creates a large and customer designed plug and socket. The plug is identified as an "Interchangeable Test Adapter" (ITA) and it mates directly with the connector modules in the receiver. It is engaged by lifting an engagement and the mechanism ensures that the ITA and connector modules are properly aligned with no risk of crashing or damaged contacts. Systems of this type are usually specified to work without problems for around 20,000 cycles. This approach ensures that all the required outputs from the tester are connected simultaneously, dramatically reducing the time taken to connect the DUT but also ensuring that all connections are routed correctly every time. No risk of the wrong cable being used or being connected to the wrong output.

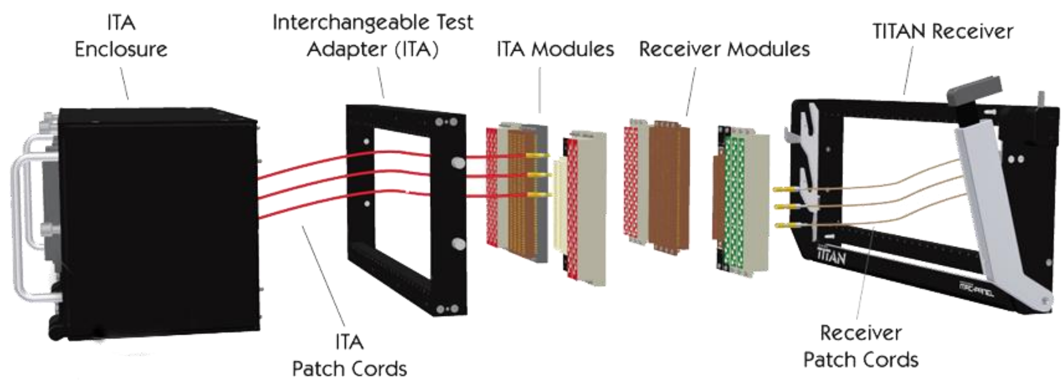

Fig. 1 – Traditional Mass Interconnect

An advanced mass interconnect approach helps to increase the modularity of PXI instrumentation even more by using self-enclosed connector modules that reduce or eliminate the use of wires whenever possible. One leading Advanced Mass interconnect solution, SCOUT which is offered by MAC Panel Company, uses its proprietary Direct Access Kits (DAK) (fig. 2) that use PCBs and Flex Circuits in place of wires.

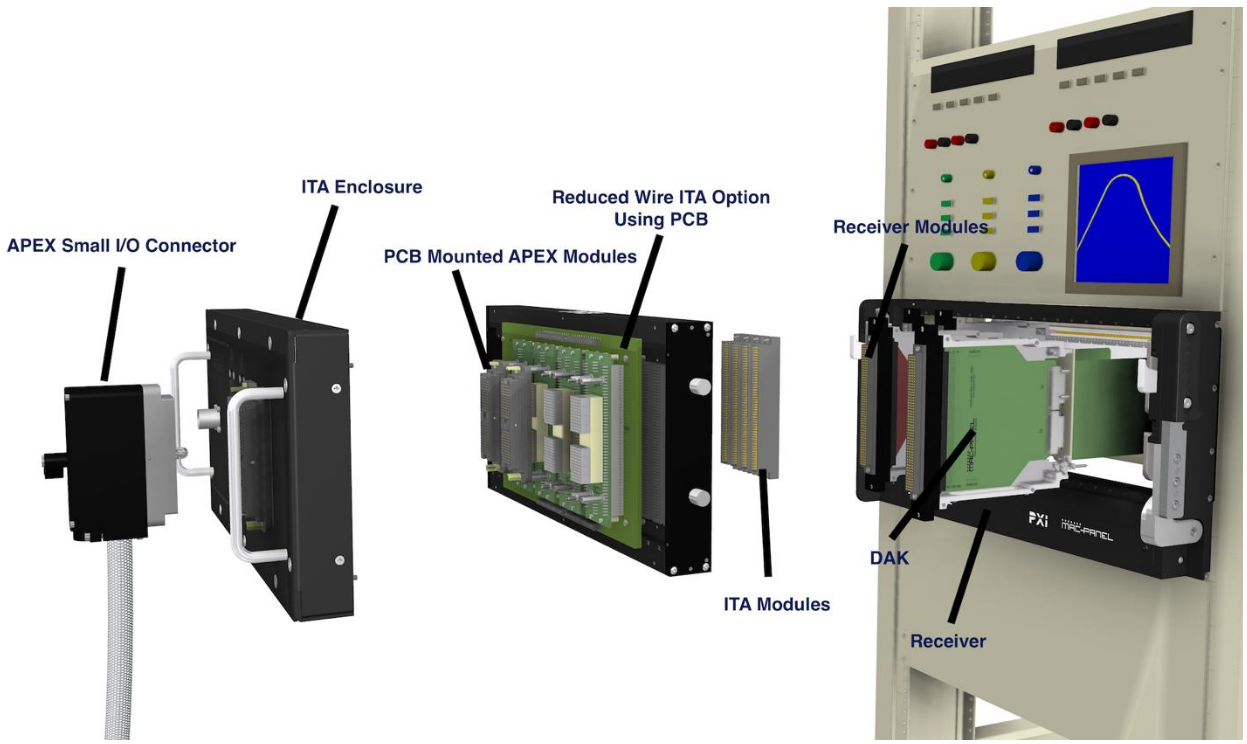

Fig. 2 – Advanced Mass Interconnec

Some of the advantages to this modular approach include:

- A modular connectivity solution retains the modularity of the PXI platform
- Design time and build time can both be dramatically reduced leading to lower initial capital expenditure
- No cable disturbance in the interconnect during maintenance, initial debugging, and validation
- Quick replacement of the PXI instrumentation during system upgrade
- Truly identical systems can be built and shipped worldwide. Any cabled system will run the risk of variability in the build process and, often more importantly, will be prone to movement/damage during shipping and installation at the final location.

Flexibility:

As stated earlier, traditional interconnect approaches used direct wiring between the test fixture and the ATE and were anything but flexible. Once the wiring had been cabled the test fixture was fixed to the ATE with no possibility of being removed without undergoing a major operation which would include de-wiring the interconnect solution. Today, with the advent of advanced mass interconnect and its use of ITAs and Direct Access Kits, flexibility is definitely an option. PXI was developed and introduced to the market with flexibility in mind, and so should its interconnect solution. Interchangeable test adapters, by definition, allow for several DUTs to be tested using the same PXI ATE with changeover easily taking just a few minutes, rather than hours or days. Moreover, DAKs compliment this idea even further by allowing the changeover of instrumentation to be done quickly, giving a new standard of flexible interconnect solutions.

The PXI Systems Alliance web site hosts many materials from each of its members describing their test-system build methods. In order to mitigate risks caused by improper connectivity methods between the PXI instrumentation and device-under-test, it is important to understand the various interconnect methods and trade-offs for each. One such white-paper can be found here.

Case Study:

Analyzing the Interconnect Need

A medical device manufacturer that builds medical grade test systems in-house, selected PXI for its smaller footprint and performance. After defining measurement needs, the team referred to interconnect methods described in the earlier referenced white-paper. Below is a table from this article. Referencing the table (Figure 3), the customer formulated a ranking criterion to select the most appropriate interconnect for their use-case application.

Below ○ Average ◒ Above ●

	Cables	Mass Interconnect With Cables	Mass Interconnect With PCBs or Flex Circuits
Frequent Changeover Between DUTs	○	●	●
Optimized for Design and Characterization	●	○	○
Optimized for Verification and Validation (V&V)	◒	◒	◒
Optimized for Test Production	○	●	●
Signal Quality	◒	◒	●
Continuity of Performance (System to System)	◒	◒	●
Ease of System Maintenance and Upgradability	○	●	●
System Reconfiguration (that is, Scalability)	○	●	●
Ease of Duplication (for example, Global Deployments)	○	◒	●
Instrument to Module Pin Efficiency	○	●	◒
Repairability in the Field	●	●	○
Instrument Card Rev. Control Tolerance	●	●	○

Table 1. Cables are useful for designing and characterizing a device, but a mass interconnect is ideal for a production test environment.

Figure 3 – Importance Ranking Criteria for Mass Interconnect

The team required a test-bed for its wireless medical device that could measure RF within the industrial, scientific, and medical (ISM) radio band in order to ensure the device's signal integrity met FDA requirements. The focus of test was on all protocols within the 2.4 GHz ISM band, including Bluetooth, ZigBee, and IEEE Standard 802.11. The tester targeted functional-level tests of the power supply, user interface, and human engineering features.

To complement the PXI modular instrument hardware selection, the team leveraged off-the-shelf software libraries to simplify application generation. Next, the team defined an interchangeable test adapter for the DUT (Device Under Test) modality so as to define a company-wide common tester in order to lower re-engineering costs.

Cabling inside the test system was a specific concern because of the engineering costs associated with duplicating the test platform. Human errors made by connecting numerous cables increased time to validate the test system to their GAMP (Good Automation Manufacturing Practice) risk-based requirements. To overcome the challenge, the team needed a mass interconnect with PCB and Flex-circuits at the PXI instrumentation interconnect to enable tester reuse and reduce re-validation time (Continuity of Performance, fig. 1). The mass interconnect architecture required the highest level of signal integrity connectivity to the PXI instrumentation (Signal Quality, fig 1), while also needed a simplified direct cabling to traditional, non-PXI power supplies inside the test rack.

A form of cabling was required external to the test system from the mass interconnect toward the DUT due to the form factor of the product under test. To ease global deployment duplication, and to support multiple product-type test capabilities, the team required a high performance Interchangeable Test Adapter (ITA) enclosure with rugged cabled interconnects (System Reconfiguration, fig. 1). Below is a graphic representation of the complete test system interconnect architecture need (Figure 4).

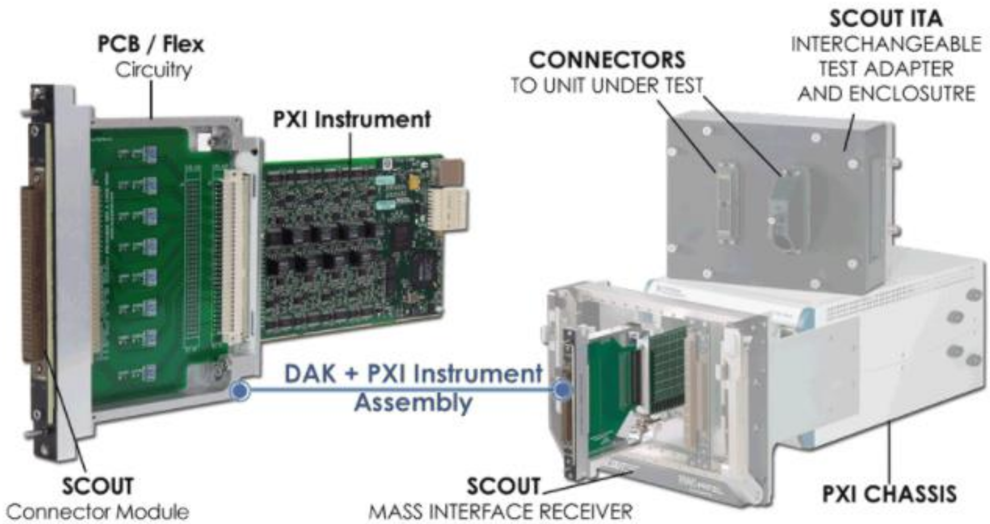

Figure 4. Mass Interconnect with PCB/Flex adapters for signal integraty and test system repeatability. Interface Test Adapter with interchangable cable connectors to support multiple DUT types.

Selection of the PXI Interconnect Solution:

The test engineering team selected a MAC Panel SCOUT as the method to reduce direct cables between the PXI instruments and the receiver connector inside the test rack. Direct Access Kits (DAK) were used to attach each PXI instrument face connector to form a single assembly. Each DAK included metal shielding to eliminate noise. The SCOUT family of off-the-shelf DAK adapters provided a solution to connectivity supporting multi-vendors of PXI instruments. Furthermore, the DAK adapters incorporated custom circuitry for LVDS, isolation to medical grade signals, and signal de-amplification.

This style of interconnect solution for PXI based test systems allowed for nontraditional instrument connectivity and signal path routing to the USB based power supplies. The mass interconnect (SCOUT) minimized all cabling inside the test rack.

External to the receiver, the team built (ITA) interchangeable test adapters that housed high-performance interchangeable cable connectors to support multiple product testers. To minimize the possibility of bending pins during cable insertion, the team selected MAC Panel APEX connectors. The APEX cabled interconnect included a unique 1.0mm contact that is many times stronger than contacts in many 0.1" pitch connectors. The stronger contact offered a 5-amp current rating and accommodated 20awg wire.

Results:

Combining the benefits of multi-vendor PXI modular instruments and a well-thought-out interconnect architecture, the team reduced the number of days required to build duplicate PXI test systems from 35 person-days to 11 person-days. This combination saved time, increased profitability and helped insure test system quality as required by the FDA in the medical device production setting. A few of the advantages to this completely modular interfacing architecture approach include:

- Quick replacement of the PXI instrumentation.
- No cable disturbance within the tester interconnect during maintenance.
- Truly identical systems can be built without concern of non-identical interconnect.
- Cost savings in design and build times as well as reduced system maintenance.

In summary, no one approach is a best fit for all ATE applications. The PXI Systems Alliance web site hosts many good materials from each of its members describing test test-system build methods. In this application, signal integrity and test system build repeatability were a top priority. In order to mitigate risk the customer allotted extra time to clearly define the Intended Use, the Test Requirements, and the Design Plan. This helped the team to minimize challenges faced in the Design and Build stages.