Mass Interconnect Methods for PXI ATE

Submitted by: MAC Panel Inc.

The manufacturing line assembling today’s highly complex products must deal with limited physical test access, such as PCBA blind via’s; while also dealing with ultra-low voltage technologies and contact test points that are as small as .012inch. Test engineers are continually looking for ways to improve test efficiencies as they serve more complex application requirements. Some of the most common test methods used to ensure a quality product build post reflow include X-ray, In-circuit test, and Functional test (Figure 1). This article explores how addressing interfacing from the measurement instrument all the way to the device under test I/O pin is a requirement to thoroughness of test and product quality.

Figure 1. Typical board level manufacturing line

Open standards drive continued innovation in production test

By driving modular test approaches earlier into the production line, managers can reduce design and deployment time and potentially minimizing costs. An additional added value as a result includes potentially achieving expanded throughput and accuracy. PCI eXtensions for Instrumentation (PXI) has moved to the forefront in industry for product level functional test. With PXI, engineers can select measurement modules from a number of vendors and integrate them into a single PXI system.

PXI can help modularize test systems that live earlier in the production process, such are board level function test, and even ICT testing. Relative to traditional custom test systems, that have traditionally been used for ICT and Board Level Functional Test, PXI’s continued growth in product offerings is allowing test engineers to leverage PXI throughout the entire manufacturing flow.
Building modular board-level test systems

In the early evolution of PXI, a test fixture system interface to a product was often accomplished by selecting PXI instruments, and then simply directly cabling them together. The complexities today of cabling to PXI instruments, coupled with hours spent wiring and debugging, simply do not align with many test engineer project demands. So how does one ensure robust connectivity to the product, while also achieving the modular approach goals that we have been talking about?

Approaches to modular interconnection to instrumentation.

The most simplified approach would be to mount a modular receiver connector directly to your instrument rack. Instruments are then connected to the back side of the receiver connector. From this point, it is a matter of creating a connector and cross cable for each DUT being tested. When building a simple DUT cabling interface such as this, it is important to select interconnect that can provide both channel depth and the power needs for test completeness. A leading modular receiver connector is called Apex (Figure 2) by MAC Panel Inc. with pin diameters of 1.0mm vs .6mm diameter as found in most connectors. This allows for a 3x increase in pin strength. The 1mm pins also allow for current carrying capabilities up to 5Amps.

A second approach is to use a form called Mass Interconnect (Figure 3 and 4). A mass interconnect is a rugged and modular interconnection device that can allow for added flexibility versus the single receiver approach. The receiver incorporates rugged connector modules that are designed for a very high cycle count. Typically, all the I/O from all the instruments will be connected to the receiver connector modules, effectively creating a large and customer defined “plug and socket”. The plug side, often called an interchangeable test adapter (ITA) or Fixture, is a unit that is configured to accept the mating connector modules to those in the receiver. Connection between the receiver and fixture is often achieved by rotating an engagement handle that is found of the right/left side of the receiver. This is a very rugged, reliable and versatile method of connecting up to 1000’s of different signal types in a single operation that takes just a few seconds.

To truly realize the performance potential of the PXI platform, test engineers need a mass interconnect interface that eliminates as many cables as possible, thus eliminating the costly design and build processes. It also helps with performance problems synonymous with cabling; such as cross talk, signal losses, and skew. SCOUT eliminates cables between the PXI instruments and the system interface. It
replaces the cables with connection modules that attach direct to the PXI instruments, thus replacing the cables with rigid PCB connectivity. These connection modules are known as Direct Access Kits, or DAK’s (Figure 5). The advantages of replacing cables with a shielded module can help in a lot of ways, for example:

- Similar instruments will have identical performance at the system interface.
- One can easily remove your PXI Instruments and replace them in a few minutes without disturbing cables, because there are not many cables.
- And since there are not a lot of cables being disturbed, PXI instruments can be transported between identical systems very quickly.

A customer testimonial showed a savings of 24 days on duplicate project builds using this approach versus a traditional method of a completely cabled mass interconnect. It is efficient to use DAK adapters to incorporate custom circuitry, such as isolation to custom grade signals, and signal de-amplification. DAK connector schematic layouts are available in many board layout tools.

![Figure 3. SCOUT mass interconnect by MAC Panel Inc.](image)

![Figure 4. Example Fixture/Interface Test Adapter (ITA)](image)

![Figure 5. DAK Modules](image)

**Modular approaches to connecting Fixture/ITA to a product under test.**

We described two common methods of connecting a receiver to your instruments. Let’s now review modular approaches to connecting to a device under test (DUT). One option is a custom cable that connects directly to remote or distributed devices under test. As noted earlier, in the case of a cabled approach, it’s important that a rugged connector be used at the test system and DUT to ensure the reliability of frequent connects and disconnects over the life of the test system.
Another approach that is the use of a probe based test fixture or a through-connector based test fixture. Figure 6 shows a probe based fixture with spring touch probes that touch a circuit card assembly. These probes may be on the bottom, top, or both sides of the printed circuit board.

For probe based test fixtures one has several options to applying force to hold a product PCB against the spring test probes, including mechanical arrangements, pneumatics and vacuum. In a vacuum system the area between the probe plate and the product tested is a sealed cavity. A vacuum applied to this cavity pulls the two together. In a mechanical system the probe plate and the product PCB are brought together by mechanical cams, levers and linkages. Pneumatic based systems replace the labor required by an operator to engage the product with air pressure. There are a wide variety of schemes in use, differing in complexity and cost. In more sophisticated test systems, most of the complexity is ensuring that the planes of the product and the probe plate remain parallel as the fixture operates. In simpler systems the pressure plate supporting the hold-down posts simply hinges down over the product.

![Image](image1.jpg)

Figure 6. Board level probe based test fixture (Circuit Check Inc.)

Through-connector based test fixtures increase in popularity due to continued reductions in probable points on DUTs, buried vias on PCB assemblies, and the need to ensure signal integrity through the DUT output/input connector(s). Through-connector fixture-to-DUT engagement can be accomplished with simple mechanical linkages, or fully automated. Pneumatics is the most often used method of through-connector automation, however, motion stages or robotics may be required for precise movements. Figure 7 below shows the product interface for an automated though-connector based fixture. Not shown is the remainder of the fixture with the mass interconnect.

![Image](image2.jpg)

Figure 7. Automated through-connector test interface.
Figure 8 below shows a final product through-connector fixture with the test equipment mass interconnect on the reverse-side.

![Figure 8](image)

Figure 8. Through-connector test fixture for final assembly test.

**Conclusion**

Test system design and deployment success is only as good as the test plan. Before selecting a complement of PXI instruments and the interconnect method, clearly define the Intended Use, the Test Requirements and the Design Plan. This will help minimize challenges you face in the Design and Build stages. It will also assist in code layout, and design outputs. A well thought out plan for the system design will greatly simplify Validation and Verification of the system later on before deployment, along with a more simplified IQ and OQ.