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Leveraging LXI for a Distributed PXI Express Ground Vibration Testing System for Commercial Aircraft

INDUSTRY

Aerospace

INTRODUCTION

Ground Vibration Testing (GVT) plays an important role in the verification process of structures, including aircraft. GVT testing for aircraft includes the basic dynamic responses needed to update the Finite Element Analysis (FEA), as well as full scale flutter tests required to validate structural instabilities for safety reasons. Completions of such tests are required before first flight to determine flight worthiness.

As GVT can often be expensive and time consuming, aircraft manufacturers are always looking for quicker and more efficient systems to validate and ensure the safety of their aircraft. When a large aerospace manufacturer was faced with upgrading a legacy test system, VTI was selected as the provider of a new solution. This case study will focus on methods and technology used by VTI Instruments to provide a precise, efficient GVT system.

CHALLENGES

An aircraft manufacturer needed to upgrade a legacy GVT system. Their existing implementation required the test instrumentation to be centralized in a control room in close proximity to the controlling PC to ensure synchronization of measurement data across all channels.

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CHALLENGES

- New system had to be easily distributed
- Acquire high speed data from >500 channels
- Test system size needed to be reduced
- Large Unit Under Test made cabling difficult

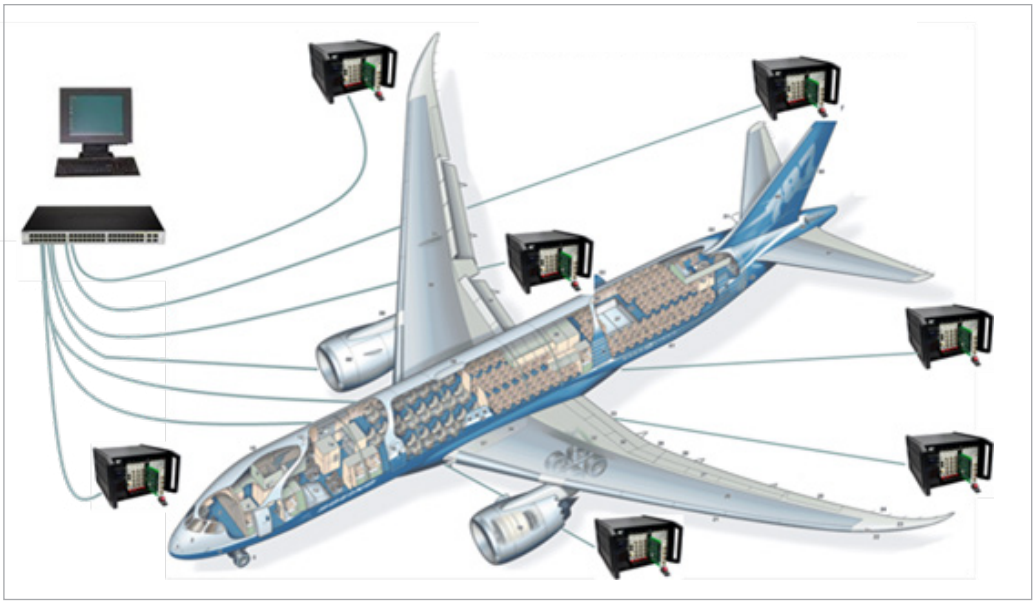
BENEFITS

- Lighter, Rugged PXIe mainframes made distribution in close proximity to UUT possible
- LXI PXIe controllers made distribution simple while maintaining synchronization
- Ability to use Cat 5e cables drastically reduce cabling costs
- Portable instruments allowed for quick setup and run data acquisition from any location

9-Slot 3U PXIe High Performance Rugged Chassis, up to 8 GB/s Bandwidth

The system was quite large and since the control room is located at a substantial distance from the test article, it was constructed using large runs of sensor cabling which complicated maintenance and part replacement.

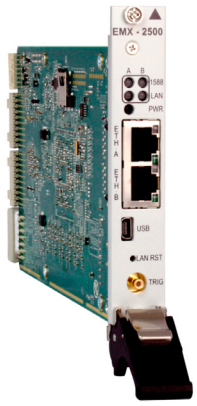
While the legacy system used by the manufacturer served its purpose at the time it was initially designed, it was burdened by limitations that added unnecessary cost. When the manufacturer established goals for their next generation GVT solution, they sought to reduce test system size, enable distribution of instruments while maintaining synchronization, and decrease cabling costs and setup times. The large size of the aircraft and number of sensors meant that the system had to be able to acquire high speed data from >500 channels.



Using LXI to Create a >500 Channel Distributed GVT System

SOLUTIONS/BENEFITS

This manufacturer wanted to move away from a centralized system to a distributed architecture with instruments located close and on the aircraft. Using multiple CMX09 nine slot rugged PXIe chassis, EMX-4250 digitizers, and several EMX-2500 gigabit Ethernet LXI controllers, VTI Instruments was able to break up the test system into several pieces that could be easily distributed around the aircraft. This facilitated easier transportation of the system, quicker setup times, simplified cabling (Cat 5e cables were used) and more efficient maintenance.



Gigabit Ethernet LXI Controller

The rugged design of the CMX09 PXI Express chassis meant that the units could be easily distributed in an industrial environment with a minimized risk of unit damage. By placing the instrumentation closer to the aircraft, the manufacturer was able to reduce the length of sensor cabling, reducing overall cost while improving signal integrity. The smart cooling of the system pulls air in from the sides and circulates throughout the chassis to maintain ideal temperature, allowing for tests to be conducted for long periods of time without overheating, eliminating the need for costly retests and ensuring accurate data. The chassis also offers health monitoring in the front of the mainframe, giving alerts when issues arise and allowing automatic shutdown in case of an error. With a loaded weight of 15 lbs., the CMX09 is also considerably lighter than the legacy mainframes that were in use, allowing for easy transport around the unit under test (UUT).

The PMX04 Portable 4-Slot PXIe 'Tablet' installed with EMX-4250's further improved ease of use and portability, as it provided the test engineers with a mobile test system that they could carry to any point near the aircraft and quickly set up and acquire data on the spot.

PMX04 PORTABLE 4-SLOT PXIE 'TABLET'

Leveraging the EMX-2500's LXI capabilities, and its integration of the IEEE-1588 protocol that is used to synchronize multiple mainframes to 10s of nanoseconds, VTI was able to provide the high speed digitizing capabilities of the PXI Express platform with precise synchronization. The IEEE-1588 synchronization used in the EMX-2500 provides a common reference from a master clock source over standard Ethernet cabling. This eliminates the need for ancillary cabling and hardware interfaces, significantly reducing total costs.

To increase ease of distribution, VTI also incorporated custom breakout boxes (BOBs) to the final solution. The previous legacy test system being used incorporated BOBs that were rack mounted. The new BOBs could be pulled out from the rack mount and distributed around the test bed.

EMX-4008 & EMX-4016 - 8 & 16 CHANNEL BREAKOUT BOXES

The EMX-4250 16 channel PXIe digitizer played an essential role in the system, as it provided 204.8 k samples/second/channel, ensuring sampling and bandwidth performance that accurately captured all critical frequency domain information.

By upgrading to VTI's latest PXI Express technology for their solution, the manufacturer was able to reduce the cost of the GVT system by nearly $150,000, compared to the previous legacy system. To further reduce costs associated with system maintenance and calibration, VTI was able to provide the manufacturer with a calibration kit, allowing all calibration to be completed in house.

The final system consisted of:

The solution provided by VTI Instruments to this manufacturer included:

- 13 X CMX09 – 9 Slot 3U PXIe Rugged Chassis
- 13 X EMX-2500 – Gigabit Ethernet LXI Controller for EMX Series
- 50 X EMX-4250 – 16 Channel, 204.8 kSa/s Smart PXIe DSA Digitizer
- 2 x PMX04 – Portable 4-Slot 3U PXI-H Tablet

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SUMMARY

When an international manufacturer of commercial aircraft required a new GVT system, VTI Instruments was selected to deliver a distributable, synchronized, test system. Building on 25 years of experience in precision data acquisition instrumentation, VTI was able to provide a solution that fused the distributed and low cost benefits of LAN/LXI with flexibilty and speed of PXI Express. This ensured that the system was synchronized, easy to setup and maintain, while reducing cabling costs by incorporating readily available Cat 5e cables.

VTI Instruments delivers precision instrumentation for electronic signal distribution, data acquisition, and monitoring. The company continues to lead in the development of open standards for test and measurement along with scalable, modular products that maximize performance in a small footprint. With nearly two decades of experience primarily in the aerospace, defense and power generation markets, VTI helps customers maintain a competitive edge and preserve the integrity of their brand.