V I Engineering and Microsoft Corp. Produce an End-of-Line Test System for the Xbox Controller Using PXI and LabVIEW 6*i*

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Products Used:

PXI-1002	4 Slot PXI Chassis
PXI-8156B	Pentium Embedded Controller
NI 5112 for PXI	100MHz, 100MS/s, 8-Bit Digitizer
PXI-6508	Digital I/O Module
LabVIEW 6*i*	Professional Development Software Environment

The Challenge: Creating a comprehensive end-of-line functional test system for a high-speed digital communications protocol with advanced diagnostic features.

The Solution: Using a custom designed automated software application powered by LabVIEW 6*i* along with PXI- based hardware and the NI 5112 100MHz scope card in a random interleaved sampling (RIS) mode, we acquired data with the required sampling rate of 2.5 GS/s for automated signal-quality analysis.

Introduction

V I Engineering, Inc., a Select Integrator in the National Instruments Alliance Program, in conjunction with Microsoft has developed an end-of-line functional test system that tests Microsoft Xbox controller devices as they roll off the production line. The system has the ability to test all device communication, and runs an automated test sequence that authorized users can save and configure. The system monitors all data packets at the bit level to verify that all controller functional messages are within a user configurable specification. Signals are also monitored at the chip level by analyzing the electrical signals for rise/fall times, min/max voltage levels, and additional current draw measurements. All tests are completed immediately after production of a controller and thereby an immediate pass/fail condition is determined. More than 250 individual test parameters are recorded to a data file, and each test station is linked to a main server via a LAN for seamless data management.

Functional Test Stations and System Description

An end-of-line Functional Test Station is a key component to any production line. The challenges in developing any production line functional tester are to package as many parallel test scenarios as possible within the allowed production cycle time, to collect as much data as is reasonable for post data analysis so that you can feedback improvements to the UUT for further production line and device enhancements, and produce a simple and easy-to- use interface with minimal manual operator requirements.

The Xbox controller functional test stations are capable of executing tests that are not typically performed in a production environment, (i.e. capable of tests frequently found in a R&D environment such device compliance testing) yet users can perform all tests well within the cycle time of the production line. As controllers roll off the production line, each completed test then sends over 250 data parameters to a dedicated LAN server for post-test analysis that helps improve both the production line and device. We needed to complete the test schedule, which encompasses all functional tests, in an easy and seamless manner, and we accomplished this via the basic user interface screen shown in Figure 1. The user simply follows the yellow brick regions, by pressing buttons and moving analog controls through the defined regions. As the user follows the yellow regions, they turn green or red depending on whether the station recognizes that the yellow region has been activated within user-defined limits. We accomplished seamless signal integrity tests during button testing and pass/fail results displayed at the bottom of the screen in Figure 1. In order to accomplish the signal quality tests, a sampling rate of 2.5 GS/s was necessary to

analyze the actual signaling waveform. This was accomplished using the NI 5112 digitizer in the random interleaved sampling (RIS) mode.

RIS-Based Signal Acquisition

RIS, or ETS (Equivalent Time Sampling) refers to a method used to sample signals in a manner that results in a perceived sampling rate that is much faster than the actual sampling rate. This effect is achieved by triggering at different offset points on the incoming signal at the actual sample rate, then reconstructing the incoming signal by interleaving the different data captures to produce a higher-resolution data capture. The limit of the perceived sampling rate is then constrained by the resolution of the time measurement, done via a time-to-digital converter (TDC), made from the initial trigger capture to the first data collection point.

Digitizers with RIS capabilities result in a very effective and lower-cost solution for acquiring data at much faster acquisition rates than that available on the given scope. This is therefore a very efficient way of acquiring averaged repetitive signal data at a very low cost because it is possible to create a reconstructed incoming signal in a reproducible manner. Users can take advantage of the NI 5112 oscilloscope in the RIS mode to capture data at a rate of 2.5GS/s. The NI 5112 RIS mode was the key feature that provided a low cost, quality solution to capture, monitor, and analyze data at a sampling rate typically found in much higher-cost oscilloscopes.

Figure 1: Production Test System Main Screen

Advanced Online Diagnostics Mode

When the end-of-line functional test station identifies possible production line problems, the functional test station has the ability to serve as an advanced diagnostics system. This feature provides for faster on-site debugging of component-batch failures and can resolve issues in real time on the production floor. Users can also immediately correct and retest with the diagnostics mode allowing for minimal production line down time. With the diagnostics

mode screen is shown in Figure 2 users can manually operate each automated test and view the raw input data. In the upper left corner, users can press all digital buttons and monitor the response of the button press. Analog buttons and their corresponding values are shown in the lower left portion of the screen. The software can hold min and max values as you go through the required range of motion, and also view the real-time data. Thumb stick regions are broken down into an x-y mapping and also display min/max values. Users can display the data packet values as raw voltage data values, or as you read them in 8, 16, 32, or 64 bit values. In the graph on the upper left corner, users see the real-time data and can focus on specific regions with a resolution of 400 Pico seconds thanks to the RIS mode of the NI 5112 scope.

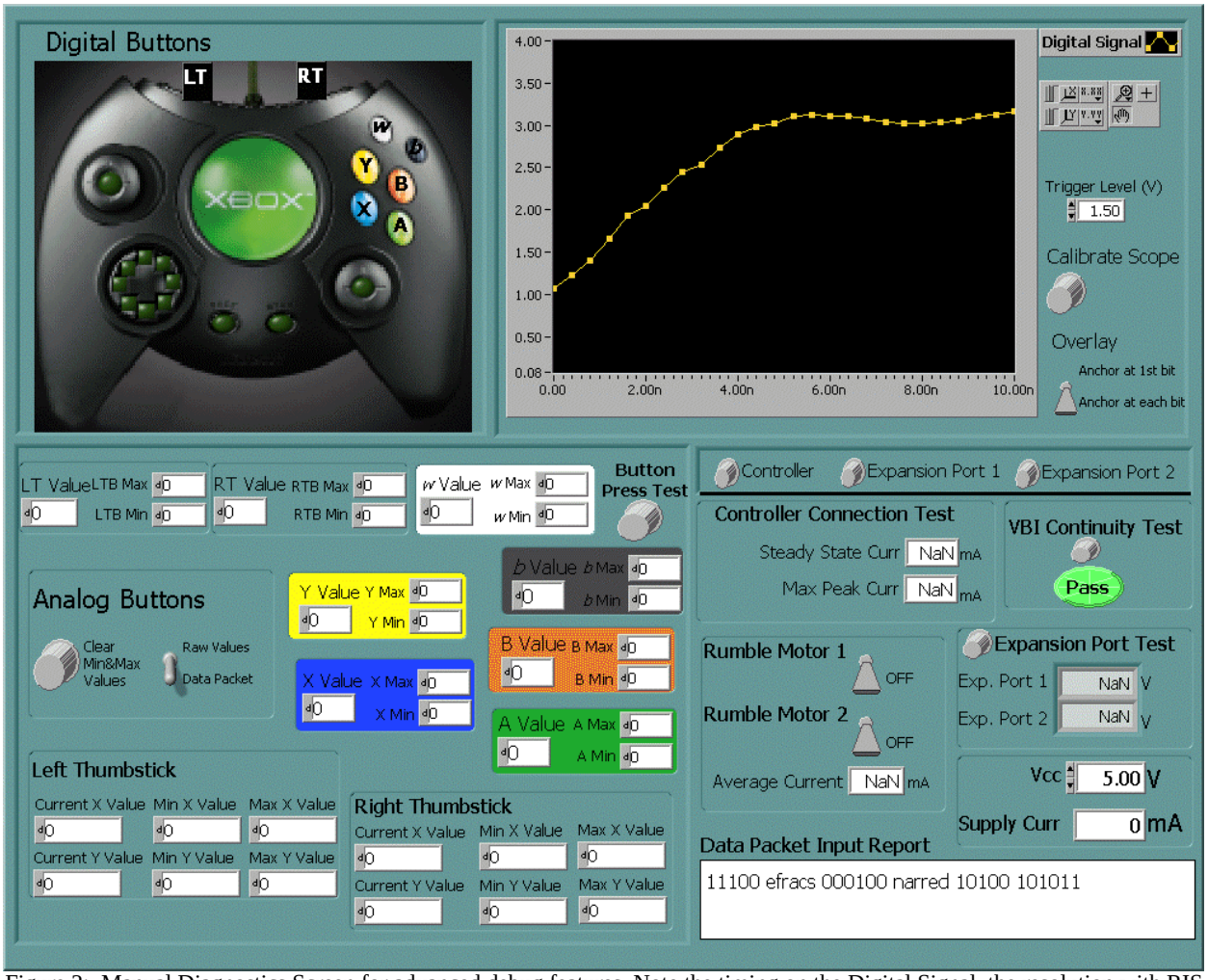

Figure 2: Manual Diagnostics Screen for advanced debug features. Note the timing on the Digital Signal, the resolution with RIS mode allows for a 400 Pico second sampling rate.

Summary

V I Engineering and Microsoft Corp. have produced end-of-line test systems for the Xbox controller using a PXI-based system, a customized signal breakout box and external power supply. With the PXI-based system you can achieve reliable production line testing. By leveraging the power of the PC, you can easily upgrade and maintain your system both now and in the future. Finally, with the advanced RIS mode of the PXI-5112 100MHz scope you can collect data at a rate of 2.5 GS/s for an amazingly low cost.