Industry: Biomedical
Products Used: LabVIEW™ 6.1 • NI PXI

PXI-Based Oscilloscope Breaks New Ground in Real-Time Monitoring

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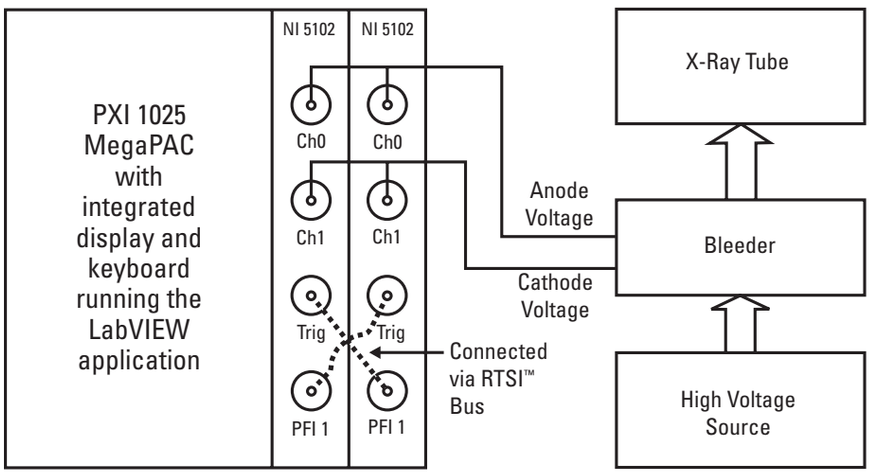
The Challenge: **Automating the real-time monitoring of "spits," or arcing, inside X-ray tubes – a high-speed phenomenon not possible using our previous method of a traditional oscilloscope and a PC with GPIB.**

The Solution: **Developing a PXI-based oscilloscope solution combining the superior data transfer capabilities of the PCI bus with the flexibility of National Instruments software drivers to configure data acquisition.**



Schematic of the System with the Connections

Monitoring and Recording Spits

To produce X-rays, we apply high voltage across the anode and cathode of an X-ray tube, which forms the heart of X-ray sources used in medical imaging equipment. A spit occurs when the dielectric inside the tube breaks down, causing arcing between either the anode and cathode (insert spit), or anode and a grounded part of the tube (anode spit), or cathode and ground (cathode spit).

We estimate that the potential savings to the customer is $40,000 per year from higher manufacturing productivity, space saving, and defect tracking and analysis capabilities.

During manufacturing, we "season" a new tube by subjecting it to different voltages for various exposure durations. We typically define spits in terms of a drop in the voltage of more than 20 percent for 40 microseconds or longer.

A leading manufacturer of medical imaging equipment in India wanted an automated system to monitor and record the spits, and the ability to raise an alarm if the number of spits exceeded a user specified limit during the hour runs. A major oscilloscope vendor, who had supplied the scopes for the manual monitoring of spits, was called to automate the process using GPIB. After substantial study and trials, the company determined that the triggering capabilities offered by a traditional scope could not reliably capture the spits. Subsequently, the company contracted Soliton Automation Pvt. Ltd. because we have an established record of delivering solutions to challenging measurement and automation problems using National Instruments products.

A PXI-Based Solution

We determined that a PXI-based solution using two NI PXI-5102 (15 MHz) scope cards cost effectively meets the requirements of the customer. To meet the portability requirement, we chose the NI PXI 1025 MegaPAC chassis with the integrated display, keyboard, and mouse.

Two Different Modes

We configured scopes 1 and 2 to trigger on the falling edges of the anode voltage and cathode voltage, respectively. At each trigger, a fixed number of samples acquires, corresponding to the maximum expected duration of a spit. Two software loops, running in parallel, acquired the time-stamped data from the two scopes and transferred it to an algorithm to detect and record the spits.

We needed this mode for noisy signals. The noise triggers the scopes, which was not a problem since our spit detection algorithm would filter out these events. But when the frequency of false triggers is high, the system partly or fully misses genuine spits during the "rearm" time – the time taken by the scopes to arm themselves for the next trigger after an acquisition completes. In this case, continuous acquisition with the spit detection done in software proved to be a better solution.

We found an effective way to perform continuous acquisition with the two 5102 scope cards. We connected each scope's PFI1 line, on which we can access the end-of-acquisition signal, to the other scope's TRIG line via the RTSI bus. Scope 1 would acquire 125,000 samples, and at the end of acquisition would trigger Scope 2 and rearm itself while Scope 2 acquired 125,000 samples, which in turn would trigger Scope 1 at the end of its acquisition, and so on. We could not get the scopes to reliably stream data to memory at 250 KS/s/channel, which was the maximum limit for the spit detection algorithm in software.

Comparison Parameter	Traditional Scope-Based System	PXI Scope-Based System
Triggering Flexibility	Could not set up the scope to trigger on a spit reliably using the falling edge due to noise. We ruled out level-based triggering because the normal amplitude varied during the run.	Besides the availability of the same hardware triggering capabilities, we could stream data to memory where we used software "triggers," providing tremendous flexibility.
Size and Portability	Need two separate oscilloscopes to trigger on two channels. Including the PC, the system would be bulky and stationary.	Two PXI scope cards in an NI PXI-1025 chassis with integrated display, keyboard, and mouse complete the system. This is a portable solution that is four times more compact.

Comparison with Traditional Oscilloscope-Based System

Software Success

Using the LabVIEW 6*i* signal processing VIs, we developed reliable spit detection algorithms quickly. The challenge proved in getting the data acquisition, the spit detection and recording, and the user interface for reviewing the stored data to work simultaneously. Our software application ran reliably at a data rate of 500 KB/sec on an 866 MHz PXI Controller with 128 MB of RAM.

System Benefits

The main benefit to the customer was the automation of a manual process that occupied a person full-time. It also met their requirement for a compact and portable solution to maximize utilization of scarce floor space. We estimate that the potential savings to the customer is $40,000 per year from higher manufacturing productivity, space saving, and defect tracking and analysis capabilities.

In this application, the virtual instrumentation solution clearly stands out because a traditional scope-based system could not meet the requirement. We delivered a very cost-effective and high-performance solution using National Instruments products and custom-developed software. The customer was delighted that we developed and validated the solution in 12 weeks, despite the fact that spits rarely occur and validating the system was time consuming. We believe that the PXI-based scope breaks new ground for oscilloscope applications requiring high-data throughput combined with unconventional software and hardware triggering. ■

We delivered a very cost-effective and high-performance solution using products from National Instruments and custom-developed software.

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