



CAL-BAY SYSTEMS

Solutions for Test, Measurement & Automation

Delivering global “Risk-Free” Solutions based on National Instruments products

- Bio-Medical
- Vibration Analysis
- Aerospace and Defense
- Telecomm and RF
- Semiconductor
- HASS / HALT testing

Productivity Enhancing T&M Products

- FlexATE™ Low Volume/High Mix Functional Test Solutions
- Vibration and Rotating Machinery Analysis
- Test Data Management, Analysis and Report Generation

CUSTOMER SOLUTIONS AND PRODUCT GUIDE

AUGUST 2008



W W W . C A L B A Y . C O M

CONTENTS

POWER POINT PRESENTATIONS

1-24

- Corporate Overview
- Fundamentals of Solid Software Design
- FlexATE™ Overview

BIO-MEDICAL

25-46

- Test Solutions for Electronic Medical Devices Presentation
- LabVIEW Control System Assures Artificial Heart Doesn't Skip a Beat
- Medical Stent Production Test
- Automating the Validation Process of New Implantable Insulin Pump Designs
- FlexATE™ -PMET Patient Monitoring Equipment Test System
- FlexATE™ -IDT Implanted Device Functional Tester

VIBRATION AND ROTATING MACHINERY ANALYSIS PRODUCTS

47-58

- vibDaq Transient
- vibDaq Continuous Monitoring
- Saving Money and Increasing Productivity for Small Business with ComponentWorks and Visual Basic
- LabVIEW Brushless Servo Motor Control System for Vibration Monitoring
- Case History Cocked/Misaligned Sleeve Bearing
- FPGA-Based Tachometer Signal Acquisition for Vibration Monitoring Applications

AEROSPACE, DEFENSE, & HIGH CHANNEL COUNT DATA ACQUISITION

59-80

- Data Acquisition and Control System for Testing Aerospace Fluidic Components
- Enhancing Productivity in Microwave Test with LabVIEW
- Multi-Point Temperature Control System for Simulated Space Environment
- Honeywell Implements Distributed, High-Channel-Count Data Acquisition System
- FlexATE™ -HASS Reliability Tester
- LabVIEW-based Control Test System for Aircraft Panels
- Aircraft Actuator Life Cycle Testing
- Ballistics Testing using PXI and LabVIEW at US Army Yuma Proving Grounds

CONTENTS - CONTINUED

TELECOMM, RF & SEMICONDUCTOR

81-100

- IBM Disk Drive Heads Get Put to the Test
- PacBell Replaces Outdated Fade Analyzer with Fieldpoint 2000 Based Instrument
- Production Test system for a High-Bandwidth Optical Network Switch
- A Bed of nails Tester/Calibrator Created From LabVIEW and E-series DAQ
- Silicon Valley Startup Uses BridgeVIEW and FieldPoint To Validate New Wafer Cleaning Technology
- A Low-Cost, Expandable, PXI-Based Solution for Mixed-Signal ASIC Test
- FlexATE™ -RF Functional Test System

TEST DATA MANAGEMENT, ANALYSIS AND REPORT GENERATION PRODUCTS

101-114

- IntraStage Overview Presentation
- IntraStage Brochure

POWER POINT PRESENTATIONS

Corporate Overview



Fundamentals of Solid Software Design



FlexATE™ Overview

CAL-BAY SYSTEMS CORPORATE OVERVIEW

- +WHO IS CAL-BAY?
- +WHERE IS CAL-BAY?
- +CAL-BAY SERVICES
- +WHY CHOOSE CAL-BAY?



1



WHO IS CAL-BAY?

- + Cal-Bay Systems is quickly becoming the **largest, worldwide** solution provider for Test & Measurement systems, with operations in more than 10 cities.
 - Founded in 1992
 - Select Integrator of National Instruments (top 5 out of 700+ NI alliance partners)
 - Agilent Channel Partner
- + Prize-winning projects and innovative products
 - Over 100 User Solutions
 - Web-based marketplaces like justTESTx.com
 - Platform products like the FlexATE™ and IntraStage

2



WHERE IS CAL-BAY?



3



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

GLOBAL BRANCH OFFICES...

- + Headquartered near San Francisco
 - + Other California offices: San Diego, Irvine
- + West Coast: Portland, Seattle, Arizona
- + Rest of US: Texas, Virginia, Maryland
- + Europe: UK, Spain
- + Asia: Bangalore, India

4



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

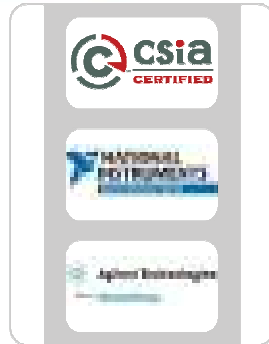
CAL-BAY QUALIFICATIONS

■ CSIA Certified Member, audited in areas of:

- PROJECT MANAGEMENT
- ENGINEERING PRACTICES
- FINANCIAL MANAGEMENT
- STANDARDS & QUALITY PROCEDURES

+ Engineering Practices

- RE-USABLE CODE & TECHNOLOGIES
- SOURCE CODE CONTROL
- INTELLECTUAL PROPERTY PROTECTION
- ON-LINE BUG TRACKING



5



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

SOFTWARE DEVELOPMENT

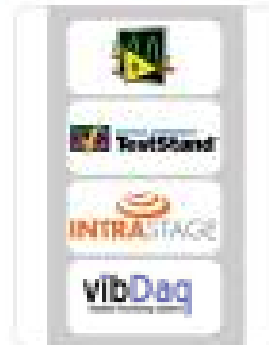
+ Software Expertise:

- LabVIEW
- TestStand
- Visual Basic / C / CVI
- Test Data Management (IntraStage)



+ Applications:

- Low Volume / High Mix Functional Test
- Automation with Instrument Drivers
- Vibration Test & Monitoring
- Windows-Based / Embedded / Real-Time
- Motion, Vision, Industrial Control



6



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

HARDWARE INTEGRATION

+ Mechanical Design

- + Solid Modeling
- + Enclosures

+ Electrical Design

- PCA's
- Custom Wiring Harnesses
- Analog / Digital Design
- Simulation

+ Fabrication & Assembly

- Order a complete test system as a single line item
- Rigorous Configuration Management (CM) with online PLM



7



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

PROJECT MANAGEMENT

+ Cal-Bay's Core Competence:

- Project Management of Automated Test Systems

+ The three constraints of Project Management

- Cost
- Schedule
- Feature Set

+ Best Practices

- Spend proper time up-front on design and architecture
- Break the project into manageable components
- Do "Build vs Buy" analysis on every component

8



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

TEST PROJECT PHASES

+ SPECIFICATION

- What the System MUST do (taking into account ALL stakeholders)
- Interactions with DUT (Device Under Test)
- Use Cases / Process; Initial User Manual / Screen Shots
- Well-Formed Requirements (capable of Acceptance Test)

+ DESIGN & DESIGN REVIEWS

- Preliminary Design Review (PDR) and Critical Design Review (CDR)
- Risks, Prototyping, and Risk Mitigation Processes

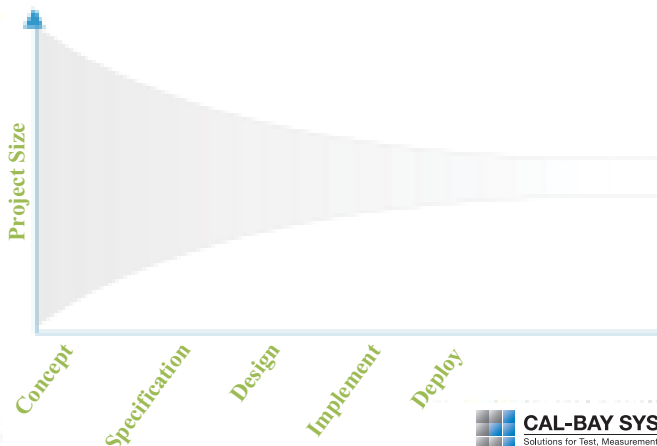
■ IMPLEMENTATION

■ VALIDATION AND ACCEPTANCE TEST

■ DELIVERY

9

MAKE YOUR TEST PROJECT A SUCCESS BY UNDERSTANDING THE CONE OF UNCERTAINTY



10

WAYS TO ENGAGE WITH CAL-BAY...

- + There is NO “One-Size-Fits-All”
 - Every client engagement is unique
- + **FIXED PRICE**
 - With a “good spec”, we can deliver “Turn-key” Systems
- + **TIME & MATERIALS**
 - Without a detailed spec, we can place skilled engineers on-site
- + **HYBRID**
 - T&M in early phases, followed by Fixed Price integration



11



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

CAL-BAY CLIENTS INCLUDE...



12



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

WHY OUR CLIENTS OUTSOURCE...

- ✦ Our clients are focused on improving the designs and profit margins of their products
 - Automated Test is a “necessary evil” to achieve this goal
 - In R/D, they use automated test for characterization
 - In Production, they need functional test systems & debug stations
 - They also need to support field test
- ✦ Our clients’ core competency is NOT automated test system development
 - In-house staff are often “lean”
 - Clients count on Cal-Bay to know latest technologies and best practices
 - Clients know that Cal-Bay can support them later, long after the initial project is finished

13



TOP FIVE REASONS CLIENTS CHOOSE TO OUTSOURCE WITH CAL-BAY SYSTEMS

1. THE POWER OF TEAM
 - Cal-Bay has more certified LabVIEW and TestStand engineers than virtually any company in the world
2. OUR CORE COMPETENCY: AUTOMATED TEST
 - With world-class standards for Project Management
3. UNMATCHED TEST SYSTEM EXPERIENCE
 - Thousands of solutions integrated for hundreds of clients
4. A TRUSTED PARTNER
 - Financially stable; 16 years of growth; Solid Reputation
5. SIGNIFICANTLY LOWER RISK
 - A track record of staying on budget and on schedule

14



CAL-BAY SUMMARY

- TIME-TESTED AND PROVEN
 - 16-year track record
- OUR CORE COMPETENCY:
 - Project Management of Automated Test Systems
- Basically:
 - Cal-Bay **LOWERS** the **RISK** of Automated Test Projects
- Let's build an extraordinary solution together!



15



FUNDAMENTALS OF SOLID SOFTWARE DESIGN

➤ FIVE KEYS TO SUCCESS

➤ PROJECT PHASES

➤ OUTSOURCING TIPS

➤ HELPFUL RESOURCES

➤ COST REDUCTION



1



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

FIVE KEYS TO SUCCESS

➤ FIVE KEYS to SUCCESS in Software Design:

1. Understand the “Cone of Uncertainty”
2. Use Project Management Best Practices
3. Create Precise Documentation of the Test System Requirements, from all stakeholder perspectives
4. Employ a Qualified Team of Developers
5. Select a Scalable Software Architecture

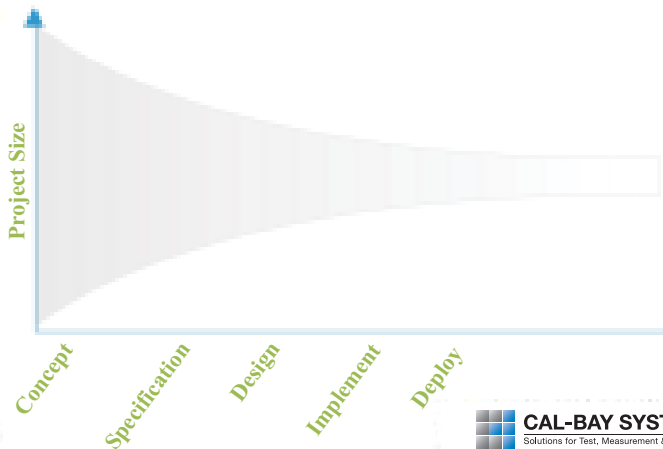
➤ This PPT will give advice and tips on each of the five keys for success

2



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

MAKE YOUR TEST PROJECT A SUCCESS BY UNDERSTANDING THE CONE OF UNCERTAINTY



PROJECT MANAGEMENT

+ The three constraints of Project Management

- Cost
- Schedule
- Feature Set

+ Best Practices

- Spend proper time up-front on design and architecture
- Break the project into manageable components
- Do “Build vs Buy” analysis on every component

TEST PROJECT PHASES

+ SPECIFICATION

- What the System MUST do (taking into account ALL stakeholders)
- Interactions with DUT (Device Under Test)
- Use Cases / Process; Initial User Manual / Screen Shots
- Well-Formed Requirements (capable of Acceptance Test)

+ DESIGN & DESIGN REVIEWS

- Preliminary Design Review (PDR) and Critical Design Review (CDR)
- Risks, Prototyping, and Risk Mitigation Processes

+ IMPLEMENTATION

+ VALIDATION AND ACCEPTANCE TEST

+ DELIVERY

5



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

REQUIREMENTS GATHERING

+ Documenting Requirements

- Test Systems have more than 10 different categories of requirements, including software, hardware, instrumentation, reporting, etc.
- Detailing this process is beyond the scope of this PPT

+ WEB RESOURCE

- + <http://www.justTESTprojects.com>
- + FREE resources to document 360-degree set of requirements
- + Also allows you to communicate with your team and external vendors (if you want a competitive bid)

6



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

QUALIFIED TEAM OF DEVELOPERS (1)

+ Solid Software Design in Test requires knowledge in a variety of disciplines:

- Programming Languages
- Test Architectures
- Instrumentation Control
- Databases and Reporting tools
- DUT-specific knowledge
- Math / Statistical knowledge
- Graphical User Interface (GUI) design techniques
- Software Architecture Methodologies
- Connectivity to Third-Party Tools

7



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

SCALABLE SOFTWARE ARCHITECTURE

+ Build your house on rock, not sand...

- Choosing the wrong software architecture is almost as bad as building a house without an architectural plan
- Make sure that a member of your team has experience with software architecture; if not, hire a consultant to help
- Look for certified NI LabVIEW and NI TestStand engineers

+ You don't have to "reinvent the wheel"

- There are lots of tools and books that you can leverage
- NI TestStand provides an architecture for test sequencing
- NI LabVIEW ships with many architecture examples
- NI advanced training classes also covers these topics

8

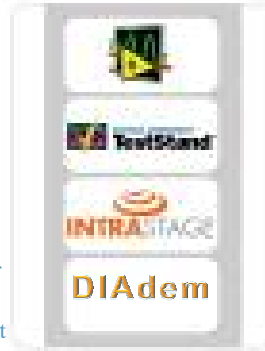
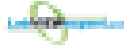


CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

REAL-WORLD ARCHITECTURE (EXAMPLE)

+ Many Cal-Bay projects use the following architecture:

- + LabVIEW
- + TestStand
- + Test Data Management (IntraStage)
- + DIAdem, Excel and web-reports



+ Benefits:

- LabVIEW speeds development time
- TestStand allows for an off-the-shelf sequencer and existing best practice docs
- IntraStage & DIAdem offer an off-the-shelf test database and reporting mechanism

9



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

WHY SOME CLIENTS OUTSOURCE...

+ Most customers are focused on improving the designs and profit margins of their products

- Automated Test is a “necessary evil” to achieve this goal
 - In R/D, you use automated test for characterization
 - In Production, you need functional test systems & debug stations
 - Most clients also need to support field test

+ In many cases, your core competency is NOT automated test system development

- In-house staff may be “lean”
- You may look to an outside firm to know the latest technologies and best practices
- This firm can also support you later, long after the initial project is finished

10



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

TOP 5 CONSIDERATIONS WHEN SELECTING AN INTEGRATOR

1. Knowledge of Tools & Technologies
 - ex: LabVIEW, TestStand, etc.
2. Solid Processes for Software Development
3. Long-Term Support Capabilities
4. Past Industry or Application Experience
5. Track Record of Success in Past Projects

11



SUMMARY: THE FIVE KEYS

- TO MINIMIZE YOUR TEST SOFTWARE COSTS, USE...
- THE FIVE KEYS TO SUCCESS
 1. Know the “Cone of Uncertainty”
 2. Use Project Management Best Practices
 3. Create Precise Documentation of the Test System Requirements
 4. Employ a Qualified Team of Developers
 5. Select a Scalable Software Architecture



12



ADDITIONAL RESOURCES

- + www.NI.com/training - Find classes / Get certified!
- + www.LabVIEWjobs.com - Find certified engineers!
- + www.calbay.com – Turnkey systems and on-site support!
- + www.justTESTtoolkits.com – Third-party tools for faster system integration; “Build vs. Buy” Analysis
- + www.IntraStage.com – Test Data Management solutions for storing test data and generating reports

13



AGENDA: FlexATE™ OVERVIEW

- + TYPICAL CLIENTS & INDUSTRIES
- + WHAT IS THE FlexATE™?
- + OPTIONS AVAILABLE?
- + WHERE TO FIND OUT MORE...



1



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

TYPICAL BUYERS OF THE FlexATE™

- + Engineering Directors & Test Managers
 - + When *flexibility* and *expandability* are important
 - + When *quality* is a real driving issue
- + Low-Mid Volume / High Mix
 - + When the tester must support a *variety* of products through a standardized system interface
- + Typical Industries:
 - + Medical Devices & Aerospace Electronics
 - + Both in R/D, Validation and Production

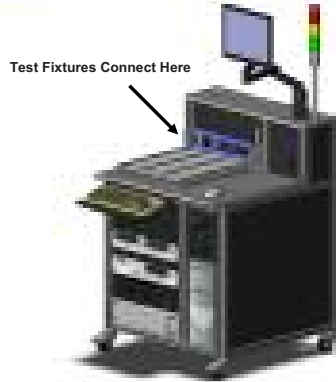
2



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

WHAT IS THE FlexATE™?

- The FlexATE™ is a Test Platform
 - Utilizes Industry Best Practices
 - Minimal changeover time allows economical use of small batch sizes
- + PXI + Mass Interconnect:
 - Maximum ROI on capital with high utilization
- Self Test Diagnostic Fixture (STDF)
 - Eliminates need for multiple golden units for tester checkout



3



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

STANDARD FEATURES:

- + FlexATE™ = Flexible Automated Test Equipment
 - Allows for RAPID SETUP times between different DUTs
 - Equals Efficient Use of Capital Equipment
- + EIA Standard rack space for:
 - GPIB/LXI box instruments
 - PXI Chassis
- + Cleanly integrated workstation with:
 - Tower PC, keyboard, flexible monitor and mouse
 - “Manage-by-Sight” Light Tower
 - ESD Safe work surface
 - Master switch and spare outlets on front of tester

4



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

TAKE A LOOK INSIDE...

- Cal-Bay handles all wiring and delivers a “ready-to-run” system
- ✦ This custom system contains:
 - 18 slot PXI Chassis
 - Virginia Panel Mass Interconnect
- Typical Equipment:
 - Scope, Arb, DMM, Matrix
 - Relay drivers, DAQ, DIO
 - Specialty Cards
 - GPIB rack and stack
 - Power supplies



5



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

WHAT OPTIONS ARE AVAILABLE?

- ✦ Every FlexATE™ system is completely personalized for your unique test needs
 - ✦ PXI & GPIB equipment is selected by qualified engineers working with your team
 - ✦ Cal-Bay certified engineers can write TestStand and LabVIEW software for the system
 - ✦ Fixture design and fabrication services are also available
- ✦ Once the design is complete, you will have a single Cal-Bay part # for ordering duplicates

6



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

EXAMPLE SYSTEM (1): BIOMEDICAL

- + **NI and Keithley instruments**
 - ▣ Scope, AWG, DMM
 - ▣ HSDIO
 - ▣ Precision source meters
 - ▣ Timers, etc
 - ▣ Switch matrix with custom bypass card
 - ▣ 128 channel relay drivers
- + **Comprehensive STDF**
 - ▣ Cal-Bay designed and validated:
 - ▣ The Self-Test Diagnostic Fixture
 - ▣ All STDF code modules (TestStand)



7

CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

EXAMPLE SYSTEM (2): AEROSPACE

- + **Connects to HASS chamber via custom cable**
 - ▣ Allows for Stress Testing
- + **Tests 8 or 16 DUT's of a given type simultaneously**
- + **Many unique tests**
 - ▣ Audio testing
 - ▣ Video Display testing
 - ▣ RF protocol testing
- + **Custom Power Box**
 - ▣ Built by Cal-Bay to handle 16 different DUTs simultaneously



8

CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

EX. 2: HASS SYSTEM REAR VIEW



9



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

STANDARD OPTIONS

- + STDF – Self Test Diagnostic Fixture
- + “Manage-By-Sight” Light Tower
- + AC Utility Panel
- + Computer Options:
 - Removable HD / Recovery HD
 - Folding Keyboard
 - Monitor Arm
- + DC Power Options
 - Too many to list...
- + Interface Options:
 - USB Hub (4 port)
 - LAN, MXI, RS-232, etc.
- + Other Options:
 - Bar-code Reader
 - USB Temperature Monitoring
 - Accessory Shelves
- + Etc.

10



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

SELF TEST DIAGNOSTIC FIXTURE

+ Test Coverage Advantages vs. Golden DUT

1. Instruments can be tested across their full operating range
 - ✓ False passes can be detected as well as false failures
 2. All ATE functionality is tested
 - ✓ Not just what is exercised by a particular DUT
 3. Potentially better ATE diagnosis
 - ✓ Self-Test software is focused on testing ATE subsystems rather than DUT subsystems
- ✓ Only one STDF vs. many Golden DUT's
1. Eliminate the problems with “missing Golden DUTs”

11



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

“MANAGE-BY-SIGHT” LIGHT TOWER

+ Very Popular Option!

+ Offers visual and audio indicators of test status

+ Includes LabVIEW drivers, power supply, wiring



+ Also available (stand-alone):

+ justTESTtoolkits.com

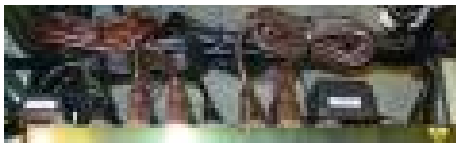
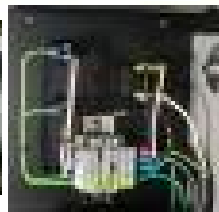
12



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

AC UTILITY PANEL

- + Master Power Switch & Circuit Breaker
 - + Easy Access
- + Two AC Outlets
 - + On Front Panel
- + Optional LED indicator available
 - + Indicate When High Voltage is ON
- + 2nd power strip
- + Long main power cord



13



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

COMPUTER OPTIONS...

- + Monitor Arm
 - + Includes Power & Signal Cabling
 - + Supports up to 19" flat panels
 - + Mount screen above or below
- + Folding Keyboard Tray
 - + Easily toggles up and down
 - + Standard keyboard is attached
- + Removable Hard Drive
- + Backup / Ghost / Etc.



14



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

WHERE TO FIND OUT MORE...

+ Contact Cal-Bay
today for a
FlexATE™ quote!!

+ www.calbay.com

+ sales@calbay.com

+ 415-258-9400



15



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

BIO-MEDICAL

Test Solutions for Electronic
Medical Devices Presentation



LabVIEW Control System Assures
Artificial Heart Doesn't Skip a Beat



Medical Stent Production Test



Automating the Validation Process of
New Implantable Insulin Pump Designs



FlexATE™-PMET Patient Monitoring Equipment Test System



FlexATE™-IDT Implanted Device Functional Tester

Test Solutions for Electronic Medical Devices

1



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Goals of Presentation:

- ✦ This presentation will address:
 - ✦ Specific test needs in Biomed/Biotech
 - ✦ Cal-Bay Systems experience in the market
 - ✦ Best Practices discovered and off-the-shelf tools
- ✦ Scope of this presentation:
 - ✦ Limited to electronic medical devices
 - ✦ Limited to Functional Test
 - ✦ Focused on R/D and Production environments

2

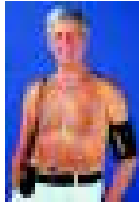


CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Medical Device Examples



Bedside Patient Monitor:
Measures ECG, NIBP, SpO₂, Temperature



Ambulatory Monitor:
Measures pH, ECG, NIBP
over extended time
periods; battery powered



Implanted Devices
Heart Pacemakers, Defibrillators
that help overcome organ failure

3



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Device Categories:

- ✦ **Non-invasive Patient Monitoring**
 - ✦ ECG, NIBP, SpO₂, Temperature
- ✦ **Implanted devices**
 - ✦ Pacemakers, Defibrillators
- ✦ **Wireless telemetry devices (in-body sensor)**
 - ✦ Ambulatory PH, ECG, Temperature
- ✦ **Human Body Simulation**
 - ✦ Simulation of body responses to validate and calibrate medical instrumentation

4



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Functional Test Requirements

- ✦ On one hand, testing medical devices is similar to testing other electronic devices
 - ✦ There are a variety of analog and digital signals that need to be monitored
 - ✦ Fixtures need to be built to interface between instruments and the DUT (Device Under Test)
 - ✦ Test Software needs to be written and validated
 - ✦ Results need to be written to file or databases
 - ✦ Managers and engineers need reports from data
- ✦ These requirements are similar for all electronic test systems

5



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Unique to Biomedical Devices...

- ✦ On the other hand, testing biomedical devices is **very different** from other electronic devices
- ✦ There are often **Regulatory Issues**:
 - ✦ The system may require audits related to FDA regulations
 - ✦ This may involve validation of the test software, the instrumentation, and the operator process
- ✦ **Biomedical Devices typically have longer life cycles**
 - ✦ For example, while a cell phone can be obsolete and break down in two years...
 - ✦ An implanted device may need to last 20 years inside a human body

6



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Best Practices for Functional Test

- ✦ Use a flexible test rack with a mass interconnect
 - ✦ Same instrumentation, different DUTs (Low Volume / High Mix)
 - ✦ Different fixtures plug into the mass-interconnect
 - ✦ The DUT plugs into the fixture and not the instruments
- ✦ Use a scalable software architecture
 - ✦ Test Executive software which is standardized for all DUTs
 - ✦ Re-use GUIs, instrument drivers, result logging methodology, configuration methodology, report tools
 - ✦ Only the high-level test steps change
- ✦ Use a Self-Test Diagnostic Fixture (STDF)
 - ✦ This fixture and code lets you quickly “Test The Tester”
 - ✦ No need for “golden DUTs”

7



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Case Study: Automated Test for Patient Monitoring

8



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

What is Patient Monitoring?

- + Non-Invasive instruments that measure basic vital signs
 - + Pulse Rate
 - + Blood Pressure
 - + Blood Oxygen Concentration
 - + Electro Cardiogram (ECG)
 - + Temperature
 - + Respiration
- + Used by doctors, nurses and consumers

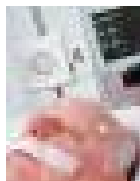
9



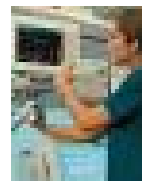
Typical Problems with Testing

- + Multiple products and variations of products to test
- + Individual pod or module testing combined with final system (pre-delivery) test
- + Difficulty sourcing one test solution as each module's test needs are extremely varied

Typical Pod Device



Typical Final System



10



Scenario: Bedside Patient Monitor Manufacturer Test System

The Challenge

Replacing manual module test procedures with automated systems for the development and production test of combined patient monitoring products

The Solution

Using LabVIEW as the common software platform and PXI-based instrumentation hardware, we simulated sensors to test the modules, and replicated the user interface. The results were faster test times and more repeatable and accurate results.



11



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Typical test requirements for individual measurements

12



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Pulse Rate and Blood Oxygen

- ✦ Both parameters are often measured with a Near Infrared (NIR) Sensor.
- ✦ Commonly called SpO2, the sensor often clips on the finger
- ✦ Typical test requirements
 - ✦ SpO2 sensor simulation LabVIEW control of SmartSat Simulator (by Clinical Dynamics)
 - ✦ Multiplexing between SmartSat and fingerclip sensors
 - ✦ Module calibration
 - ✦ Pass/ Fail module test

13



Non-Invasive Blood Pressure (NIBP)

- ✦ Automated measurements
 - ✦ Use pumps and pressure sensors to replace manual squeeze bulb and pressure gauge
- ✦ Typical test requirements
 - ✦ Mechanical pump test (including over-pressure test)
 - ✦ Pressure sensor calibration (precise to 1 mm Hg)
 - ✦ Pass/ Fail module test

14



Electrocardiogram (ECG)

- ✦ Measure action of heart muscles
- ✦ Typical test requirements
 - ✦ Simulation of ECG signals with AWG and custom signal conditioning
 - ✦ Analysis of module response
 - ✦ Pass/ Fail module analysis
 - ✦ Simulation Signal can be very small (microvolt waveforms)

15



Solution: FlexATE™ & IntraStage

- ✦ To solve the measurements, we used an FlexATE™ -PMET solution
 - ✦ Test Rack designed to handle these sensors and measurements
 - Agilent and NI Instruments
 - Virginia Panels Mass Interconnect
 - ✦ Standard, Scalable Software Architecture
 - TestStand Test Executive
 - LabVIEW test steps
- ✦ To solve the test reporting needs, we chose IntraStage

16



Cal-Bay Systems FlexATE™ Core Medical Device Tester

- ✚ One test rack designed to test multiple DUTs
 - ✚ Test Fixtures can be quickly swapped through use of a mass interconnect panel
- ✚ A typical facility will have several FlexATE™ systems and multiple fixtures
 - ✚ By standardizing, all maintenance is identical (setup, self-test, calibration)
- ✚ PXI & LabVIEW lower tester cost
- ✚ FlexATE™ & IntraStage lower NRE cost



17

CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

FlexATE™ Example “Flavors”

FlexATE™-IDT (Implanted Devices Tester)

- Pacemaker
- Defib
- Micro pump
- Various wireless XDUCER
- Wireless telemetry
- Ambulatory pH, ECG, BP
- Human body sensors test

FlexATE™-PMET (Patient Monitoring Eqpt Tester)

- SPO2
- NIBP
- ECG
- Emp-ETC

FlexATE™-HASS (Stress Testing)

- Temperature
- Pressure
- Vibration
- Shock



FlexATE™ Core spec:

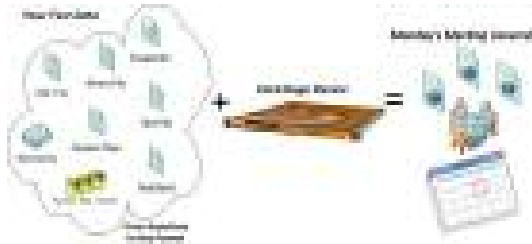
- Ruggedized mechanical enclosure
- High quality fixture interconnect
- Short cable lengths (provides low noise and leakage)
- Small footprint
- State of the art PC performance options
- High quality PXI based Modular Instrumentation
- Swing arm mounted monitor for ease of use
- Optional Light Tower
- System Self test using gold standard fixture (option)
 - Medical grade QA
 - Documented validation
 - FDA process capable

18

CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Managing Your Test Data

+ We have standardized on **INTRASTAGE**



19

Why IntraStage?

- + IntraStage, Inc. offers products and services specifically for managing Test Data
 - + Exclusive focus on this core competency
 - + Test data from multiple ATE's is automatically pulled into this standardized database
 - + Web-based reports are served up for engineers and managers
 - + The ability to integrate with ERP systems and other enterprise databases is easily handled
- + "Out of the box" solution for data storage and reporting

20

Cal-Bay Total Solution

- + Custom design and build a FlexATE™ system per each unique client's requirements
 - + Once designed and validated, the solution becomes an orderable part (single line item) from Cal-Bay
- + Architect and develop custom software leveraging LabVIEW & TestStand
- + IntraStage for Test Data Management
- + Design custom hardware fixtures
- + Assist in regulatory audits of the system

21



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

Track Record of Success

- + Cal-Bay Systems has delivered solutions to many of the top Medical Device Manufacturers
 - + For both R/D and Production test environments
- + Some of our customers include:



St. Jude Medical

WELLCOR



22



CAL-BAY SYSTEMS
Solutions for Test, Measurement & Automation

LabVIEW Control System Assures Artificial Heart Doesn't Skip a Beat

The Challenge

Developing a closed-loop control system to test the reliability of blood pumps used in circulatory support systems. The control system was also used to develop new control algorithms subject to FDA review and was eventually used in functional validation trials on animals.

The Solution

The multithreaded features of LabVIEW along with a PC-based data acquisition card enabled dependable control of four pumps for an extended period of time.

Abstract

An implantable ventricular assist device (VAD) is a pneumatically controlled device (pump) used to assist a patient's ailing heart until a donor heart becomes available for a transplant. A closed-loop control system had to be developed for use during reliability testing of a new pump design and to enable the fine-tuning of a new control algorithm. A laboratory version of the system controlled eight pumps, uninterruptedly, for a period of over six months while a portable version of the same system was used in field validation trials on animals. The LabVIEW software running on a laptop controlled a VAD that assisted the natural heart rhythm of a test subject for a period of up to 45 consecutive days.

The experiments conducted with this system provided critical data during the design verification and validation process for the new pump, thereby obtaining valuable information necessary for the FDA approval process. To date, Thoratec has received permission from the FDA to begin clinical trials on human subjects.

Introduction

A pneumatic implantable ventricular assist device (VAD) system consists of three major components: a blood pump, two cannulae and an external drive console (Figure 1). The blood pump is connected to the heart with two connecting tube cannulae; one providing inflow and the other, outflow. The external drive console, provides alternating pulses of vacuum and pressure to fill and empty the blood pump. It also maintains control of the pump by using various control algorithms running on a micro-controller.

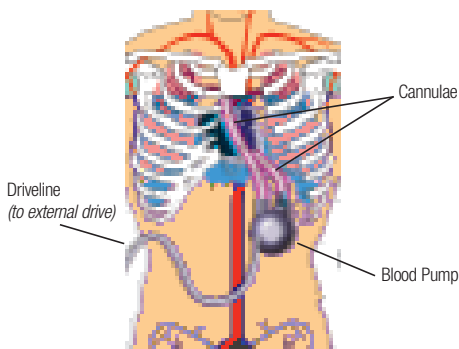


Figure 1. Implantable VAD system shows the assisting blood pump and the cannulae (external drive not shown)

An infrared proximity sensor mounted inside the pump (Figure 2) detects when the pump is filled with blood and sends a signal to the driver to initiate the empty cycle. In essence, the VAD is a closed loop control system with one analog input, the proximity sensor, and one digital output, the signal that triggers the console to empty or fill the pump. The fill/empty cycle of the pump runs at a rate of about one second, whereas the control loop

for the entire system runs at a rate of 4 milliseconds. Therefore, strict timing must be maintained by the console to ensure this artificial heart system doesn't skip a beat.

Thoratec Corporation of Pleasanton, California is the world's leading manufacturer of VAD systems approved by the United States Food and Drug Administration (FDA). During the development of this new implantable VAD, Thoratec needed to test the reliability of the new device and to design new control algorithms that would later have to be programmed into a custom micro-controller circuit. In order to carry out these tasks, Thoratec Laboratories called upon Cal-Bay Systems, a system integrator and Alliance member in Northern California, to develop a control system using LabVIEW and National Instruments data acquisition hardware.

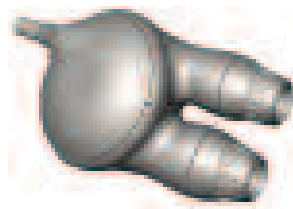


Figure 2. The new blood pump design required reliability testing in laboratory and field trials

Maintaining consistent control of the pump during long-term bench testing and field animal studies was essential. The system had to be robust, yet flexible. Typically, in this type of application, an embedded real-time control system is used to maintain precise closed loop control. But in this particular application, because the pump fill/empty cycle was in the order of one second, the control loop could vary slightly without causing the pump to skip a beat. We decided to implement this system with a regular PC and off-the-shelf hardware and software. The use of a PC-based virtual instrumentation system provided huge cost savings and allowed us to get the system up and running in a matter of days, not months.

The Hardware

After preliminary research and benchmarks were performed, we decided that one computer equipped with a National Instruments E-series data acquisition card would be used to control a bank of four pumps. Running two identical setups on Pentium III computers with Windows 98, we were able to maintain the 4 msec control loop cycle on eight separate pumps running in parallel without any problems.

We chose the PCI E-series card because it provided multiple functions such as digital and analog triggering for sampling the data and advanced counter/timer features for powering the proximity sensor. Later on, when the field validation testing was conducted, we switched to an equivalent DAQ card designed for a laptop and used the exact same software without modifications.

During actual running conditions, the proximity sensor is powered on for only a short period of time during each 4 ms cycle. This increases the lifetime of the sensor, but increases the complexity of the controller, which needs to supply a constant pulsing digital waveform (TTL) that turned the sensor on, triggered data sampling after a brief sensor "warm-up" period, and turned the sensor off every 4 ms cycle. When the design team wanted to implement this feature, we were able to deliver it easily thanks to the functionality of the E-series DAQ card. Using the general-purpose counters, we triggered the generation of two digital waveforms delayed in time. One was used to power the proximity sensor and the other was used to trigger the data acquisition shortly thereafter. The task of wiring the device was simplified by using the internal signal routing features of the DAQ card (PFI pins) to internally connect the output of the counter to the analog input start signal.

The Software

The LabVIEW programming environment was the clear choice for this project due to its ease of use and flexibility. The main challenge for this system (Figure 3) was to implement the new control algorithms and maintain control of the pump at a closed loop rate of 4 msec. Considering the fact that the fill/empty cycle of the pump runs at a rate of about once a second, the pump control loop times could vary slightly without causing the pump to skip a beat. In order to maintain this tight loop control, we utilized the advanced LabVIEW features.

First, the data was collected based on a trigger event, it was then passed to a routine that performed linearization and differentiation, and finally it went on to an analysis routine which performed the algorithm that determined when a digital I/O line should go high or low. This entire cycle had to be done within 4 milliseconds or less.

The general requirements of the software were very simple, but they had to be implemented in a very efficient manner. The analysis VI was configured to run on a separate thread at normal priority. We experimented with different priorities, but concluded that running two separate threads, one for the main VI and one for the algorithm subVI was the most efficient.

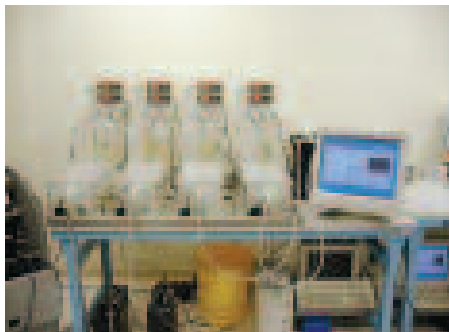


Figure 3. The control system ran four pumps uninterrupted for a period of over six months.

Saving data to disk greatly affected the timing of the control loop. The users only needed to collect data for a few pump cycles and they could turn it on or off when needed. In order to collect data for a few cycles and not affect the loop timing, we first buffered the data in a queue and then saved it all at once at the end of the collection period. This prevented processor-intensive hard drive access from corrupting the collected data.

Conclusion

This simple control and data acquisition system allowed Thoratec engineers to develop new control algorithms and to test the reliability of their new blood pump design. To date, all eight pumps have been operating for over six months, and the tests are ongoing. In addition, during field validation animal trials, this system controlled the pumps of two different test subjects for periods up to 45 consecutive days without interruption. Both the reliability testing bench system and the portable field test system proved to be stable and reliable. The studies done with this system provided valuable information for the FDA approval process. As a result of this and other studies, Thoratec received permission from the FDA to begin clinical trials on human subjects.

Category: Biomedical, Design Validation, R&D/Lab Automation

Products Used: LabVIEW, PCI-MIO-16E-4, DAQCard-MIO-16E-4

by Sorin Grama, Cal-Bay Systems, Inc.

in collaboration with Jason R. Weidman, Lead R&D Engineer, Thoratec Corporation, Eric T. Lee, Ph.D., R&D Engineer, Thoratec Corporation

Medical Stent Production Test

The Challenge

Automating a high volume production test for a medical device manufacturer that analyzes properties of a medical stent (a device that is placed in an artery to support the arterial walls) and increases existing test throughput by a factor of 10.

The Solution

Build an automated test system that tests 30 stents simultaneously by simulating the action of the medical device as it is inserted into the body, and measuring its expansion properties.



Production Test System for Medical Device Testing

Abstract

A stent is a spring-like device that is temperature sensitive. Compressed and supercooled, it is inserted into an artery, routed through the body and deployed at the point of an aneurysm, at which time it expands to its desired diameter and supports the walls of the artery. During production, it is necessary to ensure that the stents expand at the proper rate and to the proper size within extremely rigid specifications. Using LabVIEW, PXI, and SCXI, Cal-Bay Systems designed, developed, and implemented a fully automated, FDA approved test system for measuring and comparing the rate of expansion and the maximum expanded diameter of medical stents.

Introduction

The world of medical treatment is improving every day. Medical research and development is expanding rapidly. Devices that get inserted into the body to assist or sustain are becoming more widely used. In the case of an aneurysm, the walls of an artery become weakened and are susceptible to breakage. A device that supports the walls of the artery in the area of the aneurysm could prove to be invaluable. But how would one get such a device into an artery (some arteries are the diameter of a silver dollar) without disturbing the sensitive area and possibly causing a premature rupture?

A device called a stent is used to prop open and support an artery that is weakened by an aneurysm. A stent is a spring that starts out very small, compressed and supercooled, and is inserted into an artery at a convenient location (usually the inner thigh). The stent is then routed through the artery and deployed at the point of the aneurysm at which time it expands to its desired diameter and supports the walls of the artery. It is necessary to ensure that the stents expand at the proper rate and to the proper size within extremely rigid specifications. A mistake could be life threatening.

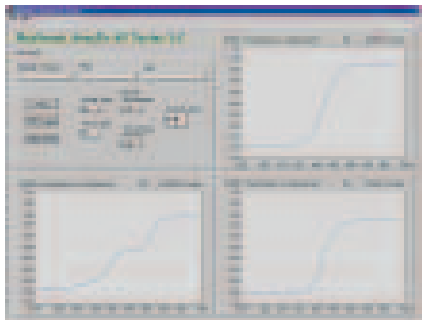


A stent (graft) inside an artery, supporting the arterial walls near an aneurysm

Cal-Bay Systems designed, developed, and implemented a fully automated test system, based on National Instruments PXI/SCXI hardware, for measuring and comparing the rate of expansion and the maximum expanded diameter of medical stents through a range of temperatures. This system replaced an older test system and provided a 10x increase in number of stents that are tested at one time.

The System

Using LabVIEW and National Instruments PXI/SCXI data acquisition hardware, Cal-Bay designed a state of the art production test system. The system was designed to test the expansion of 30 stents at one time, using LVDT's (linear variable displacement transducers) to determine the diameter of the stents as they are heated from a supercooled state to normal body temperature.



LabVIEW main screen for test system

A PC running a LabVIEW application collects the data and graphs expansion vs. temperature in real time for each stent under

test. The user is able to select up to three stents to view at one time. At the end of the test (when the test bath reaches body temperature), analysis is performed on the displacement curve to determine if the stents meet the desired specification. A report is generated for each test.

The software also controls the temperature of the test bath and a pneumatic valve that controls lowering the LVDT sensors onto the stents under test.

With the new test system 30 stents could be tested at one time, where only 3 stents were being tested simultaneously with the old system.

FDA Validation

The software for this test fixture required FDA validation, and using LabVIEW, an application was written to test every input and every output of the system, complete documentation of calculations, expected results and actual results was provided to the FDA.

Conclusion

Because of the success and popularity of medical stents in aiding aneurysm patients, and recent FDA approval, production of stents has skyrocketed. The automated test system developed by Cal-Bay Systems allows 30 stents to be tested at one time (an increase of 10x) and there are currently 5 production test systems in use.

Category: Manufacturing Functional Test, Manufacturing, Biomedical

Products Used: LabVIEW, NI-DAQ, SCXI 1100 Analog Input Module, PXI-1010 PXI chassis integrated with SCXI, PXI-6025E Multifunction I/O Card

by Dave Weisberg, Cal-Bay Systems, Inc.

Automating the Validation Process of New Implantable Insulin Pump Designs

The Challenge

Replacing tedious manual test procedures and visual inspections with automated systems for the validation of new mechanical and electrical designs of implantable insulin pumps.

The Solution

image acquisition, motion control and data acquisition cards, we implemented three test systems to validate the new pump designs. The systems replaced existing manual procedures and set the stage for large-volume production testing.

Abstract

An implantable ventricular assist device (VAD) is a pneumatically controlled device (pump) used to assist a patient's ailing heart until a donor heart becomes available for a transplant. A closed-loop control system had to be developed for use during reliability testing of a new pump design and to enable the fine-tuning of a new control algorithm. A laboratory version of the system controlled eight pumps, uninterruptedly, for a period of over six months while a portable version of the same system was used in field validation trials on animals. The LabVIEW software running on a laptop controlled a VAD that assisted the natural heart rhythm of a test subject for a period of up to 45 consecutive days.

The experiments conducted with this system provided critical data during the design verification and validation process for the new pump, thereby obtaining valuable information necessary for the FDA approval process. To date, Thoratec has received permission from the FDA to begin clinical trials on human subjects.

Introduction

All people, with or without diabetes, need insulin for two reasons: a background amount of insulin for normal functions of the body without food and a burst of insulin "on demand" when food is eaten. People without diabetes can trust that their pancreas will produce this insulin for them. People with diabetes need to take insulin as similar as possible to the way their pancreas would produce it if it could. In contrast with insulin injection therapy, insulin pump therapy delivers the insulin in the way the body would deliver it. Various types of insulin pumps are available on the market and today more than 150,000 people from around the world are controlling their diabetes with pump therapy. Implantable insulin pumps

(Figure 1), currently undergoing clinical trials in both the United States and Europe, are designed to deliver short, frequent pulses of insulin into the peritoneal cavity where it can be more rapidly and predictably absorbed. These new devices offer substantial advantages to diabetes patients who have difficulty maintaining consistent glucose control. Any new implantable pump designs must go through rigorous testing and validation processes to ensure consistent performance of the pumping mechanisms throughout the life of the device. Medtronic Minimed in Northridge, CA challenged Cal-Bay Systems with the task of automating three test procedures for a new implantable pump design.

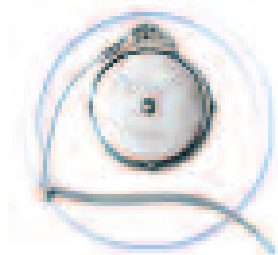


Figure 1. Implantable insulin pump

The three test procedures are:

1. stroke volume test – a long-term study of how the pump performs under typical or accelerated lifecycle conditions.
2. valve leakage test – a measurement of the amount of fluid leaked by the pump under the extremes of normal operating conditions.
3. reservoir pressure-volume test – a measurement of the variation of reservoir pressure over the full range of reservoir volume.

Stroke Volume Test

The long-term stroke volume tests system (Figure 2) was designed to measure the performance of the pump under typical operating conditions (37°C to simulate body temperature and continuous agitation to simulate body motion). Key parameters to be measured in tests lasting up to 24 months include the stroke volume of the pump (volume dispensed with each pulse), energy consumed and energy waveform characteristics.



Figure 2. Stroke volume test system uses PXI and FieldPoint to collect data and control temperatures

To address these requirements we used a PXI system with a combination of data acquisition cards. The triggering and synchronization features of these cards were key features in this application. A digital output pulse from the PXI-6070 card is used to actuate eight pumps at the same time. The stimulus signal is delayed by a counter which generates a trigger signal that starts the acquisition shortly after the stimulus. The end of the pump cycle is signaled by a falling edge on another signal which triggers yet another set of measurement to be taken. These last measurements are used in determining the pump energy and thus its relative health. To maintain the units at body temperature we used a FieldPoint control system with temperature input modules and pulse-width modulation output modules. A software control loop running on the embedded PXI controller maintained the temperature at a constant level. To date, two of these systems have been build and used to run a variety of long-term tests.

Valve Leakage Test

The valve leakage test is designed to measure the amount of fluid leaking back through a catheter into the pump and into the negative pressure reservoir. Negligible leakage occurs normally due to diffusion through the valve material and does not affect the safety of the patient, but larger amounts of leakage due to surface finish or mechanical alignment problems could lead to an under-delivery of insulin to the end of the catheter. Prior to automation, an operator would measure the movement of the meniscus in a small bore pipette using a small ruler. The problem with this approach is that the movement of the meniscus during the 15 minute test period is very small and so the operator required considerable experience to be able to detect liquid movement that could be measured.

We postulated that an image acquisition and processing system could perform this measurement faster and more reliably without operator intervention. To test this assumption we set up a simple prototype system that included an IMAQ PCI-1407 card, a camera with zoom lens and a backlighting system. We used NI IMAQ Vision to acquire and process images at regular intervals. The processing

is fairly simple: the program takes an initial snapshot of the setup and keeps it in memory. Subsequent images are compared with the initial image by using a subtraction algorithm, the result of which is proportional to the distance of travel. The valve leakage test system has proven to be an invaluable tool in the lab. It elegantly replaced the tedious and subjective visual inspection process and generates good quality data which requires no interpretation. To date, two of these valve leakage systems have been built and installed.

Reservoir Pressure-Volume Test

The reservoir pressure-volume test is designed to measure the variation of reservoir pressure over the full range of reservoir volume. This simulates the normal operating cycle as insulin is removed from the reservoir while it is being dispensed from the pump. The test is carried out by filling the reservoir with water at 37°C, measuring the reservoir pressure, removing small amounts of fluid from the reservoir with a syringe whilst repeating the reservoir pressure measurements. Prior to automation, the test was performed manually by an operator who changed the syringe plunger position using a crankshaft while recording the measurements on a piece of paper.

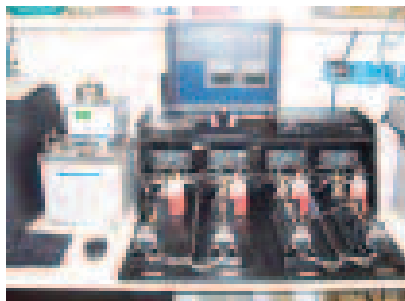


Figure 3. Reservoir pressure-volume test system uses motor actuated syringes to vary the pressure

This process was another good candidate for automation (Figure 3). To move the pistons, we used stepper motors driven by NI motion control hardware and to actuate the valves we used one of the new industrial digital I/O cards. To measure the piston distance of travel we initially specified a set of high-precision linear variable displacement transducers (LVDTs) normally used for this type of measurement, however, after some thought we realized that the distance can be measured just as accurately using a rotary encoder on the stepper motor. This idea saved considerable development time and money. We designed the system to be capable of measuring and controlling up to 4 pumps independently of each other. The system completely automates a manual process and will be validated for use on production testing.

Conclusion

All three systems described here demonstrate the power of PC-based automation. Using a wide range of tools such as data acquisition, image acquisition and motion control cards we were able to completely automate three manual processes and thereby increase test coverage and prepare for eventual deployment in high volume manufacturing.

Category: Biomedical

Products Used: LabVIEW 7.0, PXI-1042, 8-slot chassis with: PXI-8184 – embedded controller, PXI-6070 – data acquisition card, PXI-6025 – data acquisition card, PXI-6602 – counter/timer card, PXI-8420 – serial interface, FieldPoint system consisting of: FP-1000 – controller, FP-TC-120 – temperature module, FP-PWM-520 – pulse-width modulation module, IMAQ-1407 – image acquisition card, PCI-6527 – digital I/O card, PCI-7334 – 4-axis motion control card, NI-7604 – motion control driver

*by Sorin Grama, Cal-Bay Systems, Inc.
David Hezzell, Consultant Engineer, Medtronic, Inc.*

Cal-Bay Systems FlexATE™ -PMET

Patient Monitoring Equipment Test System

One Functional Tester to test your full Patient Monitoring product range

- Designed for companies wanting to reuse their test system to test multiple Patient Monitoring modules in design validation and production
- Designed for testing SpO2, NIBP, ECG, Temp monitors and analyzers
- Reduced system cost: Built around industry standard LabVIEW and TestStand software tools which lowers system cost
- Reduced test times: High performance PXI based measurement hardware improves test throughput
- Worldwide support: Installed, commissioned and supported by Cal-Bay Systems



The FlexATE™ -PMET Patient Monitoring Equipment test system from Cal-Bay Systems has been designed to provide the ideal solution for companies producing stand alone or modular Patient Monitoring Equipment.

Based around industry standard PXI hardware and configured using LabVIEW and TestStand, the FlexATE™-PMET can be configured for your specific test requirements quickly and easily making it ideally suited to both design validation and production test. The heart of the system is the multi interconnect which is permanently connected to the system hardware allowing new test fixtures to be configured easily without the need for rewiring, enabling faster product change-over between testing.

The easy to use, full function test system software provides the performance and flexibility required to test the most demanding of products. This increased flexibility means that the FlexATE™-PMET is ideally suited for testing most patient monitoring products including:

- SpO2 analyzers
- ECG Monitors
- NIBP Monitors
- Temperature Monitors

For further technical information or to find out if the FlexATE™-PMET system is the test system to satisfy your company's test requirements, please contact your nearest Cal-Bay office. Alternatively visit us at www.calbay.com

Cal-Bay Systems FlexATE™ -IDT

Implanted Device Functional Tester

The FlexATE™-IDT from Cal-Bay Systems, provides a “RiskFree” Test Solution for manufacturers of implanted medical devices including:

- Pacemakers
- Defibrillators
- Wireless telemetry devices
- Ambulatory recording devices
- Human body sensor simulation
- Surgical and treatment tools



System Benefits:

- FDA audited test solution
- “Gold standard” validation and calibration
- One tester for all product options
- Uses industry standard COTS products
- Built in Self Test Diagnostics

The FlexATE™-IDT has been designed to offer a single multiproduct test solution to companies designing, validating and testing medical devices. Based around high performance instrumentation hardware and industry standard software, the system is incredibly flexible and easy to use. It can be customized simply to your own specific needs, enabling you to obtain a customized solution to your test requirements for an off the shelf price.

Cal-Bay has supplied many leading medical device manufacturers with the FlexATE™-IDT Test System, and has undergone extensive FDA and other regulatory body auditing. This level of understanding means that we can help you develop a test process that will make it easier to obtain FDA approval for your medical device products.

The FlexATE™-IDT Test System comes fully tested, documented and supported removing any risk you have by developing a test solution inhouse.

To find out how we can help you solve your Medical Device Test needs contact sales@calbay.com or visit www.calbay.com

VIBRATION AND ROTATING MACHINERY ANALYSIS PRODUCTS

vibDaq Transient



vibDaq Continuous Monitoring



Saving Money and Increasing Productivity for Small
Business with ComponentWorks and Visual Basic



LabVIEW Brushless Servo Motor
Control System for Vibration Monitoring



Case History
Cocked/Misaligned Sleeve Bearing



FPGA-Based Tachometer Signal Acquisition
for Vibration Monitoring Applications

vibDaq

vibration monitoring systems

LabVIEW-based Vibration Solutions



vibDaq Transient

Designed to allow easy data collection and reporting for rotating machinery during transient events

- Track order magnitudes and phases during startup and coastdown
- Display overall magnitudes, gap voltages and much more

Plots generated from live or logged data in floating windows

- Supports Waveform, FFT, Waterfall, Bode, Polar, Orbit, Shaft Centerline, Trend and Feature Table plots

Event-based data logging

- Automatically log data to disk based upon user-defined triggers
- Configure independent logging criteria for vector data and waveform data

Easy-to-use configuration dialogs

- Save your settings to configuration files

Free offline plot viewer

- Allows for viewing of logged data files anywhere

Multiple National Instruments hardware platforms supported to best suit your application

- Professional Series is PXI-based for maximum performance (utilizes NI PXI-4472B DAQ cards)
- Portable Series is USB/cDAQ-based for simplicity and easy transportation (utilizes NI 9234, 9233 or 9215A DAQ cards)

National Instruments LabVIEW®-based application

- Utilizes advanced toolkits for even-angle resampling and order tracking
- Modular code base can be customized to meet the specific needs of your application

Supported probe types include:

- Proximity probes (Radial Vibration, Thrust Position or Tachometer)
- Accelerometers (with IEPE provided)
- Velocity probe
- Optical tachometer
- Other (any voltage output sensor within the input voltage range)

Hardware

	Portable Series	Professional Series
Channel Count	4 to 32	8 to 56
Acquisition Rate	Up to 51.2 kHz per channel	Up to 102.4 kHz per channel
Acquisition Method	Simultaneous	Simultaneous
Analog to Digital Resolution	24 bits	24 bits
Input Ranges	±5 volts	±10 volts or ±31.6 volts
Input Coupling	AC or DC	AC or DC
IEPE Power	Software selectable per channel	Software selectable per channel
Antialiasing Filter	Yes	Yes
Sensor Connections	BNC	SMB (SMB to BNC Cables Provided)

vibDaq

vibration monitoring systems

LabVIEW-based Vibration Solutions



vibDac Continuous Monitoring

Designed to view, log and analyze vibration data from rotating machinery

Plots generated from live or logged data in floating windows

- View any number of Waveform, FFT, Waterfall, Bode, Polar, Orbit, Shaft Centerline, Trend and Tabular Summary plots

Event-based data logging, with buffer for pre-event recording

- Automatically stream time domain data to disk based upon user-defined triggers

Easy-to-use configuration dialogs

- Save your data acquisition, logging, limit checking and view settings to configuration files

Remote client operation

- View live data being acquired on another system across your network

Integration of process data between test systems

- Send and receive data using OPC

Utilization of hardware and software from National Instruments

- COTS hardware is reliable and low-cost (NI PXI-4472B and NI PXI-7833R)
- LabVIEW®-based application utilizes advanced toolkits for even-angle resampling and order tracking
- Modular code base can be customized to meet the specific needs of your application

FPGA-based smart tachometer processing

- Automatically adjust to input signal characteristics in real time
- Samples tachometer waveforms at 200ks/sec for enhanced phase resolution

Supported probe types include:

- Proximity probes (radial vibration, thrust position)
- Accelerometers (with IEPE provided)
- Velocity probe
- Optical tachometer
- Other (any voltage output sensor within the input voltage range)

Hardware

Vibration Channels	8 to 48
Tachometer Channels	8
Acquisition Rate	Up to 102.4 kHz per channel
Acquisition Method	Simultaneous
Analog to Digital Resolution	24 bits
Input Ranges	± 10 volts or ± 31.6 volts
Input Coupling	AC or DC
IEPE Power	Software selectable per channel
Antialiasing Filter	Yes
Sensor Connections	SMB (SMB to BNC Cables Provided)

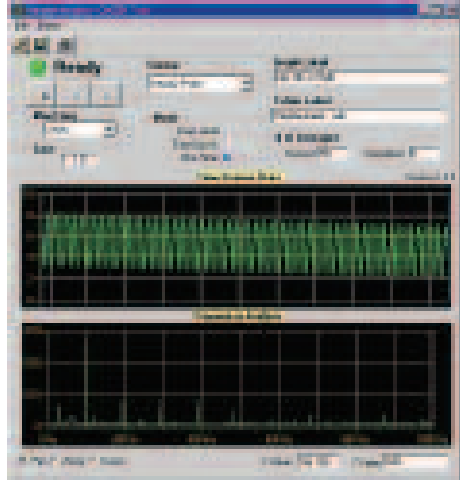
Saving Money and Increasing Productivity for Small Business with ComponentWorks and Visual Basic

The Challenge

Replacing an expensive spectrum analyzer with a flexible PC-Based solution that can present, analyze, print, and archive data while maintaining flexibility and ease of use for an untrained operator.

The Solution

A desktop PC powered by a VB/ComponentWorks application that acquires data at a programmable sample rate, allows the user to select from several analysis algorithms, displays data in a standard format, allows customized report generation, and archives and recalls all data.



Introduction

Pretech Inc. is a small business in Pleasant Hill, CA that provides civil engineering consulting. Their 8 employees work with customers to inspect manufacturing equipment and provide detailed maintenance reports. Acquiring vibration data and analyzing frequencies and harmonics allows Pretech staff to determine when a bearing or shaft is going to fail and how much "useful life" remains on each piece of equipment. They provide their customers with detailed reports indicating failure rates, maintenance schedules, and all fine points of their analysis.

Previous System

Pretech collects vibration data by wiring up acceleration sensors to each piece of equipment at their customer's site and using a data logger to store the raw data. One piece of equipment could have as many as 10 sensors (10 channels of data) being collected. Once the data had been logged, it would be brought back to their lab for analysis.

In the lab, they had a \$10,000 Tektronics Spectrum Analyzer with a single data input and several FFT and data smoothing analysis algorithms. They would replay the data back from the data logger and run it through the Spectrum Analyzer one channel at a time. The results would be recorded manually and entered into a spreadsheet. Each channel would be analyzed this way, one at a time, taking up to 15 minutes to analyze one channel. The spreadsheet would later be used to generate a graph that could be included in the customer report.

The Software

After doing a little research into PC-Based instrumentation, Pretech decided to replace their Tektronics scope with a PC-based system. They contacted Cal-Bay Systems, a local National Instruments Alliance member, to assist them in nailing down their requirements.

After several discussions a system was proposed that could collect 8 channels of data simultaneously, perform several different types of FFT analysis, incorporate multiple data smoothing and filtering algorithms, display data as it was being analyzed, archive all data to disk, and generate a completely customizable document that could be inserted directly into a customer report. The total cost for this system would be less than the cost of one Tektronics scope and it would be fully customizable and expandable. The biggest benefit of this system is that it reduces the amount of time it took to process and analyze data by a factor of 10. Pretech employees could now focus on their customers instead of their data.

System Configuration

The proposed system included a high speed PCI multi function DAQ card, Visual Basic as the software development environment, and ComponentWorks ActiveX controls for analysis and display. Pretech was most comfortable with Visual Basic because they knew that they could upgrade and maintain the software themselves if they needed to.

ComponentWorks ActiveX controls were a big part of this system. The ComponentWorks Analysis Library was used for all the data analysis, filtering, smoothing, and array manipulation. And the ComponentWorks Graph tools were used for data display with autoscaling, zoom, pan, modifiable grid lines, and logarithmic scale. The graph also offered cursor controls which allow the user to select any X-value on the graph and get the corresponding Y-value, which was perfect for determining the FFT amplitude at any given frequency. These features provided added functionality and capability to Pretech's data analysis capabilities.

The ComponentWorks Data Acquisition ActiveX controls handled data acquisition from the DAQ card and were used to implement triggering for time synchronous data collection. Programmable sample rates and buffers were also handled by ComponentWorks making the data acquisition portion of the application extremely straight forward.

The current setup allows for 8 channels of data to be sampled and analyzed at a time and in the future Pretech would like to move to a 16 channel system. The transition to higher channel count could be easily handled just by adding a second DAQ card.

LabVIEW Brushless Servo Motor Control System for Vibration Monitoring

The Challenge

To replace a standard 3 phase motor system that was driving a rotating shaft used for vibration and angular analysis of a turbine shaft. The original system used a Parvalux 3 phase motor driving the shaft via a belt drive. It would take up to 5 minutes to get up to it's full speed of 3000rpm and was prone to belt slippage. There was also no feedback to the operator of speed. The company wanted to be able to control the new motor accurately and vary ramp up speed, dwell time, deceleration time and the speed of the motor via a preset series of profiles.

The Solution

Using a combined 240V brushless servo control and motor device controlled via a LabVIEW program, the user was able to control the four profile parameters simply by entering timing and speed information. To find the where the shaft hit it's resonance frequency, i.e. the frequency where problems may occur on the shaft, the ramp up and deceleration times were set to 5 minutes each. When the speed of the system caused the shaft to hit this frequency, the run was restarted. They set the motor speed at the speed where resonance occurred. This gave them the opportunity of testing the shaft for an extended period at its resonant frequency. Because of this high level of motor control, they managed to get test results out significantly faster than they had done previously.

The System

The system software was developed using LabVIEW 8.20. The motor was controlled from a Laptop computer through the motor controllers RS232 port via a RS232-USB adaptor. The user interface was simple to operate and gave the users all of the control they required, including setting up the four profile parameters, viewing the profile on a graph and visualising the results coming back from the motor controller again via an on screen graph. The actual speed read back from the motor was shown via a digital indicator.



Conclusion

With the use of this state of the art motor control system, the company was able to test the effects of shaft vibration and potential failure significantly faster than before, and with much greater control.

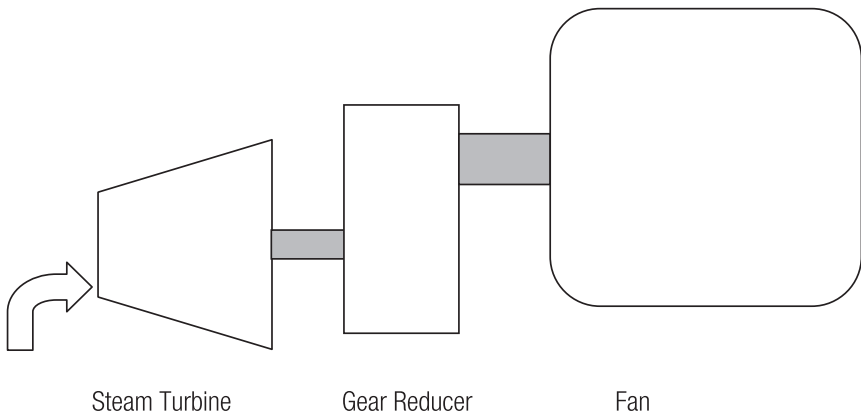
by Ian Crighton, Cal-Bay Systems Europe Ltd.

Case History

Cocked/Misaligned Sleeve Bearing

Introduction

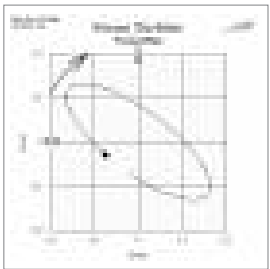
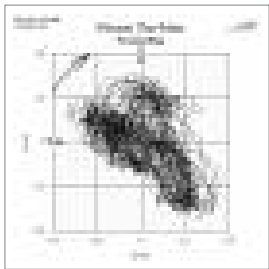
A steam turbine in a paper mill was recently overhauled. The turbine drives a forced draft fan for a boiler. After overhaul, the turbine was found to have high vibration on both ends of the turbine, with amplitudes of about 0.2 - 0.3 in/sec overall operating between 4600 and 5600 RPM. Maximum speed for the turbine is 5650 RPM. The layout is shown below:

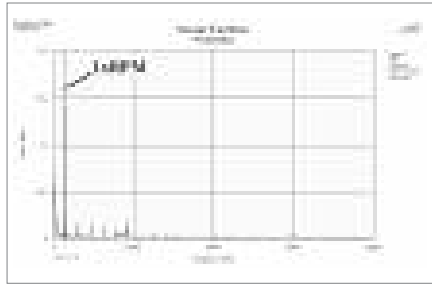
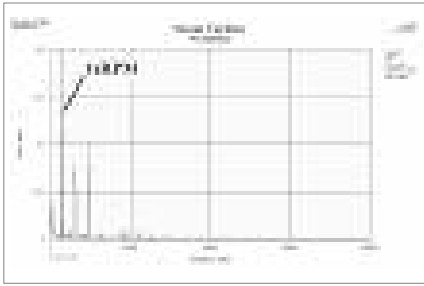


The steam inlet and thrust bearing are located on the outboard end of the turbine.

Measured Data

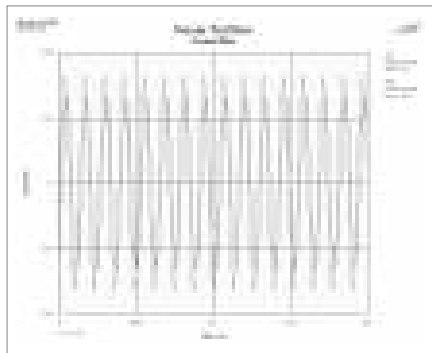
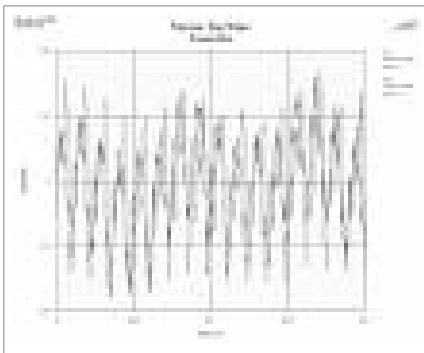
Accelerometers were mounted in the vertical, horizontal and axial positions on each of the bearing housings when this data was captured, with the signals integrated to velocity. The vibration on the turbine outboard was found to have predominant vibration at 1xRPM, with harmonics of running speed as shown in the attached FFT plots. The same data was displayed as raw orbits and orbits filtered at 1xRPM.





Analysis

The data indicated that the vertical and horizontal readings were pretty much in phase, with indications of a “preloaded” orbit that is typical of restricted motion in one direction.. This along with the presence of harmonic vibration 2x, 3x, 4x, etc. suggested that the outboard bearing liner may be cocked or not parallel with the journal. The drive end bearing also showed about 0.2 in/sec, with the vibration primarily at 1xRPM, but with the vertical and horizontal about 90° different phase.



Findings

Conversation with the mechanical contacts in the plant indicated that they had a lot of trouble installing and aligning the outboard bearing to the journal. Their comments strongly supported the likelihood that the bearing liner was not properly aligned to the journal.

by Ray Kelm, P.E. Category IV, Kelm Engineering. Email: ray@kelmengineering.com.

FPGA-Based Tachometer Signal Acquisition for Vibration Monitoring Applications

The Challenge

Develop a tachometer signal acquisition module to seamlessly integrate into a PXI-based vibration monitoring system. Provide the flexibility to connect a variety of sensor types in which signal frequency, amplitude, and DC offset may vary substantially. Avoid the use of expensive signal conditioning hardware while also minimizing processor loading during intensive vibration analysis and display.

The Solution

Utilizing National Instrument's R-series FPGA hardware alongside LabVIEW and the FPGA Module software, a solution was rapidly developed to address the requirements. The self-configuring algorithm automatically identifies input signal characteristics and provides reliable tachometer speed readings. Customized hardware is not necessary, and no additional load is introduced to the processor performing vibration analysis calculations.

Introduction

Tachometer signal acquisition requires converting pulse trains into a series of timestamps and speeds. Many tachometer sensors create pulses whose frequency varies with speed, but their amplitude, DC offset, and noise level may vary with changes in location, temperature, speed or other operating conditions. For example, proximity sensors are often used to measure rotational speed by detecting the location of a key cut into a rotating shaft. Small changes in the location of the rotating shaft with respect to the fixed proximity sensor have a significant impact on the DC value of the proximity sensor's signal. If a simple comparator is used to detect the pulses, the signal can be lost as the DC value changes.

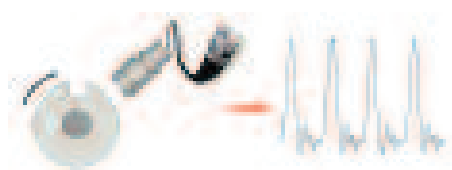


Figure 1. A typical tachometer configuration using a proximity sensor

One of the world's largest suppliers of natural gas compressors came to Cal-Bay Systems for help with the tachometer signal acquisition portion of their LabVIEW vibration monitoring and analysis system. This system continuously monitored vibration signals using PXI-4472 cards. Tachometer signals were acquired using a PXI-6602 counter card with comparators for front end signal conditioning. A MXI-4 interface was used to transfer vibration data to a dual-processor PC for analysis, display, and logging utilizing LabVIEW, the Sound and Vibration Toolkit (SVT), and the Order Analysis Toolkit (OAT). Since the software analyzed numerous vibration channels heavy processor loading was already a concern.

Incoming tachometer signals could originate from a variety of sensor types, with varying waveform shapes and properties. Existing solutions required custom hardware for tachometer signal processing. Costly, cumbersome, and inflexible, the hardware required manual configuration based upon signal properties. It could not adapt to different input signal types or to variations in DC offset and signal profile at runtime. Greater flexibility and accuracy were required.

FPGA-Based Solution

National Instrument's R Series Intelligent DAQ Devices were used to address the problem at hand. Field Programmable Gate Array (FPGA) hardware, in conjunction with LabVIEW and the FPGA Module, rapidly and intelligently processed the incoming signals while introducing zero additional processing load to the PC. The PXI-7833R module was chosen for this application. It seamlessly integrated with the existing PXI hardware, while providing analog signal acquisitions of up to eight independent tachometer signals at 200 kHz per channel. A three million gate FPGA chip provided plenty of parallel processing power to meet the goals of our application.

Algorithm

The output signal of most common tachometer sensors is a distorted AC waveform. Each of the PXI-7833's analog input channels were connected to an individual sensor, allowing the acquisition of 8 separate speeds. For each channel, high and low values of the input signal were tracked over time. Based upon these measurements a threshold value was calculated and used to detect pulses. Each pulse indicated that some portion of a rotation had been completed. Since the signal may have included additional noise, a hysteresis value was also determined and used for filtering. Threshold and hysteresis values were periodically updated to track changes in the DC value and offset of the tachometer signal. Incoming pulses were counted and used to determine the speed of the rotating shaft, which was correlated to other data using timestamps for vibration and order analysis.



Figure 2. Rapid calculation of threshold and hysteresis values compensate for signal variations

Conclusion

Using National Instruments FPGA hardware in conjunction with LabVIEW and the FPGA Module allowed for the rapid design, simulation, development, and testing of a tachometer signal acquisition and processing system. The hardware interfaced seamlessly with a PXI-based high-channel-count data acquisition system, adding no external hardware for processing. Performing all calculations on a PXI-7833R card meant that a PC used for vibration analysis was not additionally taxed with software-based tachometer signal processing. The number of available vibration input channels was not reduced, and sampling rates were not altered to meet the needs of tachometer signal acquisition. The system was highly scalable and re-usable. Processing algorithms were flexible enough to accept input from most common tachometer sensor types, and if more than eight channels were required additional FPGA card could be added to the system. Customer requirements for highly flexible and accurate detection of tachometer pulses for determining the speeds of rotating equipment were met and exceeded.

Category: Prototype/Test

Products Used: LabVIEWTM v8.2, LabVIEW FPGA Module v8.2, NI-DAQTM v8.3, PXI chassis, PXI-7833R Multifunction Reconfigurable I/O (RIO) card

by Daniel Hooks, N.D. "Buck" Smith, Adam Citarella, Cal-Bay Systems, Inc. United States

AEROSPACE, DEFENSE, & HIGH CHANNEL COUNT DATA ACQUISITION

Data Acquisition and Control System
for Testing Aerospace Fluidic Components



Enhancing Productivity in Microwave
Test with LabVIEW



Multi-Point Temperature Control System
for Simulated Space Environment



Honeywell Implements Distributed,
High-Channel-Count Data Acquisition System



FlexATE™ -HASS Reliability Tester



LabVIEW-based Control System for Aircraft Panels



Aircraft Actuator Life Cycle Testing



Ballistics Testing using PXI and LabVIEW
at US Army Yuma Proving Grounds

Data Acquisition and Control System for Testing Aerospace Fluidic Components

The Challenge

Collecting data from a few channels and controlling a few PID loops are the basic requirements for testing an aerospace fluidic device, such as a valve. But when the requirements are expanded to allow multiple devices to be tested in parallel, with over 120 channels of analog input being sampled continuously, 32 or more PID control loops running concurrently and various digital trigger events being analyzed in real-time, the task of developing such a test system becomes non-trivial. Add to this the requirement of monitoring and controlling multiple test setups in parallel over the network and you end up with a highly complex system.

The Solution

Using LabVIEW and LabVIEW Real-Time toolkit running on a PXI controller we developed a flexible test system that allows users to configure and run multiple test configurations in parallel using only one set of data acquisition and control hardware.

Introduction

Whittaker Controls is a leader in the design and manufacture of a broad range of fluid control devices and systems for both commercial and military aircraft, as well as various industrial applications. Their products regulate pneumatic (air), hydraulic (fluid) and fuel flows in aircraft systems and are used in virtually all Boeing and Airbus manufactured commercial aircraft.

Their on-site testing facility is used intensively to perform manufacturing, acceptance and qualification tests. A Daytronic System-10 test system was used for many years to perform these tests in a semi-automated fashion, but as the testing requirements became more complex and the system aged, it became necessary to replace it with a new, PC-based data acquisition and control system.

Cal-Bay Systems, Inc. developed a turnkey test system to replace the functionality of the existing test system while providing additional enhancements to increase the test throughput and the productivity of the entire test facility.

Requirements

A typical Automated Test Procedure (ATP) on a proportional valve involves the following steps:

1. Setting the valve to a known position.
2. Controlling one or more independent variables such as inlet/outlet pressures and temperatures.
3. After the conditions are stabilized, acquire data such as temperature, flow and pressure.
4. Repeat steps 1 through 3 at multiple valve positions.



Example of an Aircraft Valve

Whittaker Controls needed a complete turnkey system that allowed multiple operators to test up to six valves in parallel using six separate test cells similar to the ones shown in Figure 2. Because all sensors were terminated in one location, they wanted to use a centralized data acquisition & control computer to test all units.

A total of 120 analog input channels (thermocouples and pressures) had to be sampled continuously. Multiple digital I/O lines were needed to control the execution of a test sequence and to provide trigger points for data acquisition. Furthermore the system had to provide up to 32 PID control loops using voltage or current outputs.

The system had to be operated in either manual or automatic mode. In manual mode, the operator would setup the control parameters and then acquired the data at a push of a button. In automatic mode, the device test sequence was executed and data was collected without operator intervention. Other requirements included a system diagnostic, a system calibration and a report generation utility.

The Solution

The need for a centralized data acquisition and control unit was a key requirement, which determined a client/server architecture with one main computer performing the data acquisition & the PID control and multiple remote clients accessing the individual test setups for monitoring and control. The following diagram (Figure 3) shows the system architecture developed for this project.

Our hardware solution was based on the PXI platform for its ruggedness and the availability of multiple types of analog I/O and digital I/O hardware. We used the SCXI hardware to expand the number of channels and to provide signal conditioning to sensors such as thermocouples and flow meters. A PXI controller running LabVIEW Real-Time was selected as the main data acquisition and control engine. This controller, the workhorse of the system, communicates with the main operator PC through a dedicated TCP/IP connection.



Figure 3. Reservoir pressure-volume test system uses motor actuated syringes to vary the pressure

We based our software on the LabVIEW platform for its ease-of-use and tight integration with the hardware. In addition, the Real-Time Toolkit for LabVIEW enables us to run the control and acquisition program on the PXI controller as an embedded process without operating system overhead. With this, we can acquire over 120 channels of analog data at rates of up to 5000 samples/second and control up to 32 PID loops at update rates of 10 milliseconds

The main operator PC runs a dedicated LabVIEW program (Figure 4), which enables a user to configure, run and display the results of a test. A multi-tab display walks the user through a series of steps required to configure and run a test. These include:

1. Selecting the acquisition channels from the available pool of channels.
2. Configuring pseudo-channels which are calculated by entering complex mathematical formulas that combine multiple data acquisition channels.
3. Configuring the PID loops by specifying the process variable, the control output and the P, I and D parameters.
4. Creating a test sequence using a simple sequence editor to add/remove various test steps, such as: set digital output line, set analog output value, start PID loop, get data, wait etc.
5. Running a test in manual or automatic mode while viewing any selected channel data on a chart.

To allow multiple operators to configure and run tests at the same time, we decided to use the LabVIEW 6.1 Remote Panel feature. This is a new feature in LV 6.1 which made the remote operation easy to implement once the main software was developed and tested. Using only the Internet Explorer browser, any client PC on the network can connect to the main server PC and request to control and monitor of one of the six available test interfaces. With this feature, six different operators could use the system at the same time.

Conclusion

The system we delivered to Whittaker Controls is currently being validated. To date, we have run valve tests that involve multiple test cycles with a running time of over 6 hours. This software and hardware architecture is proving to be very robust while, at the same time, very flexible. We are finding that we could run test setups with capabilities beyond our original vision.

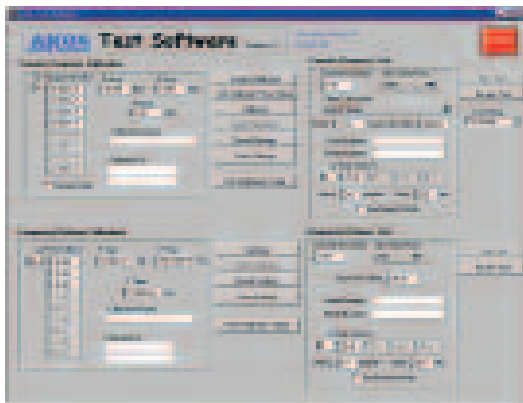
Enhancing Productivity in Microwave Test with LabVIEW

The Challenge

Test power transducers for military applications for linearity across a power range using multiple different frequencies. Calibrate system before every test, generate real time display, calculate slope and linearity, compare to spec values, and generate a detailed report.

The Solution

Using LabVIEW to control microwave instrumentation from Hewlett Packard and generate the desired power and frequency, acquire the appropriate data, analyze, plot and print the data using LabVIEW's analysis, graphing and reporting features.



Main screen for launching calibration and test programs

Introduction

Akon Inc, in San Jose, CA manufactures microwave transducers for military applications. They must adhere to strict specifications for acceptance; therefore it is necessary to perform rigid testing and analysis on every transducer. Two tests must be performed - Transfer Response test to test linearity across power levels and Frequency Flatness to test uniformity across multiple frequencies.

For the Transfer Response Test, the transducers must be tested over a range of power levels and must maintain linearity over that range. The transducer then must be tested over the same power range at multiple frequencies and multiple temperatures. So there are three variables that need to be controlled as the test is performed - power level, frequency, and temperature.

Before every test the power range at each frequency must be calibrated and the calibration must be stored and documented.

During each test the linearity must be calculated, and the actual data as well as the "acceptable" range must be plotted and stored. If data falls outside the acceptable range, the test fails. After each test the user has the option to graphically review all the data for that test by using a cursor to select a point and view the linearity at that point, each point can be reviewed graphically or tabularly to hone in on anomalies. A report can be printed, or the next device can be immediately tested.

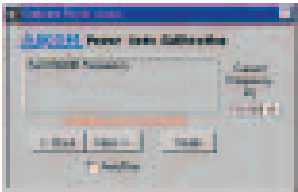
Since all data is stored, it can be recalled and analyzed at any time. Individual devices can be compared and plotted against each other to determine similarities and differences in response.

Software

The LabVIEW software was developed to ensure ease of use and maximize capabilities for the user. Calibration screens were designed as "Wizards" that offer a "Back" and "Next" button so the user could

go back to a certain point or procedure in the calibration if it were necessary.

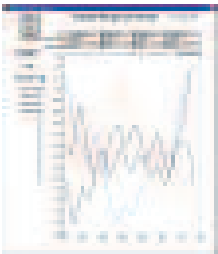
From the Main Screen (see figure above), users were able to save an recall calibrations and verify that calibrations were still valid by comparing expected data to known data and determining if the difference was less than a certain threshold. This allowed the user to avoid recalibrating if it weren't necessary. Also, a user could run a test or review a test. This allowed a simple straight forward, intuitive starting point for all tests. Each screen had a standard look and feel so as to keep operation consistent for the user.



Calibration "Wizard"

Reports

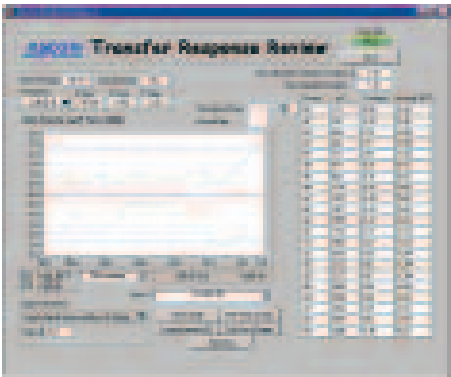
There were a total of 16 reports that could be generated by a calibration, a test, a comparison of multiple devices, a test review, or a calibration verification. The report functionality allows the user to print all data tabularly or graphically. If printed graphically the user could select between plotting the actual data or the linearity data (comparison of actual to desired data). The reporting VI's also allowed for multiple page reports and included a "scale to fit" option in case the user wanted to shrink all the data to fit on one page.



Report print preview

Instruments

The instruments used in this application were Hewlett Packard standard bench top instruments - an E-Series power meter, a synthesized sweeper, and Infinium scope, and a multimeter. The drivers were written for three of the instruments and were downloaded from the National Instruments web site. Slight modification was necessary to implement the full functionality of each of the drivers. The fourth driver was written from scratch in an afternoon. Once the drivers were written the application development was smooth and straightforward.



Analysis of test data comparing linearity of transducer across multiple frequencies

Conclusion

Cal-Bay Systems developed this test software for Akon in under 150 hours. Akon is using the software today to improve their manufacturing process and continue to impress their customers with the capabilities of their product and the professionalism of their testing process.

by Dave Weisberg, Cal-Bay Systems, Inc. National Instruments Alliance Member and Full Service Systems Integrator.

Multi-Point Temperature Control System for Simulated Space Environment

The Challenge

Upgrading the data acquisition and control systems for thermal vacuum chambers used to test satellite flight hardware.

Introduction

Lockheed Martin Space Systems Company (LMSSC) tests satellite flight hardware in thermal vacuum chambers (Figure 1). These systems simulate the rigors of space using a nitrogen-chilled chamber operating at 1×10^{-6} Torr vacuum.



Figure 1. Space Simulation Vacuum Chamber

After years of operation with an existing system that relied on unsupported, VAX-based hardware, Lockheed Martin needed a new system with improved test setup, operation, data logging, and hardware standardization. Additionally, the system had to be robust. The chambers are run 24/7 for extended periods, and any breakdown could compromise the flight hardware.

Lockheed Martin engineers worked with National Instruments to design a dual-chassis PXI-based system (Figure 2) that could control the thermal chambers and perform the necessary tests. Lockheed Martin then turned to Cal-Bay, Systems, Inc. to make their design a reality.

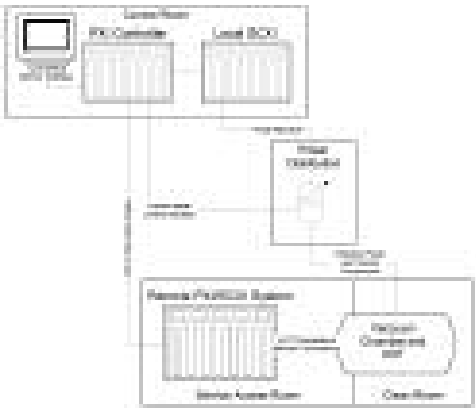


Figure 2. Overview of Thermal Vacuum System

System Description

The LMSSC thermal vacuum system consists of a high vacuum chamber lined with liquid nitrogen cold walls. Radiant solar heat is simulated using twelve resistive heaters operated through a power-distribution system. This power system has a serial interface that controls 12 stepper motor controllers.

These motors in turn control a series of autotransformers, which adjust power output to the heaters.

A PXI system is remotely located in the control room using fiber-optic MXI-3. The PXI controller executes the custom Cal-Bay LabVIEW application while serving the test data to engineering servers through NI DataSocket technology. A local SCXI chassis provides integration into the control room

power distribution control panel by measuring the voltage and current on each heating zone. The chamber pressure reading is also captured by the LabVIEW software for flight hardware safety protection.

System Performance

A key requirement for the new system was flexibility, which the former system lacked. This included the ability to change control loop feedback channels on the fly, as well as to adjust control modes--from temperature to power to voltage--on the fly. Furthermore, to avoid compromising the flight hardware, the system needed to automatically switch to backup feedback channels should the primary ones malfunction.

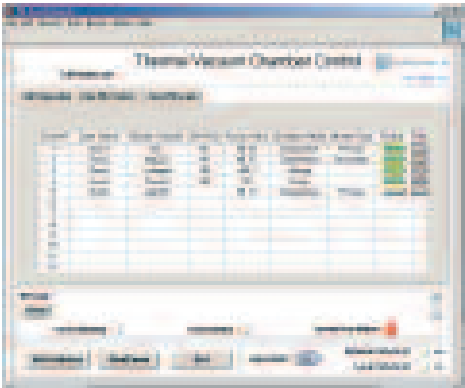


Figure 3. Main Software Front Panel

To complicate matters, a natural phenomenon called corona arcing occurs at specific pressures, when the dielectric of air ceases to prevent electrical conductivity between heaters and ground. Such a situation can cause electrical arcing capable of destroying flight hardware. By monitoring the system vacuum, the control software must override the power settings to eliminate any harmful electrical potential should vacuum reach the corona pressure.

Taking into account these needs, Cal-Bay developed a software solution that included elements of Cal-Bay's reusable test configuration utility. The Cal-Bay runtime DAQ engine was modified to support the advanced features of various operation modes and monitor types.

The new software allows monitoring and control of any of the 120+ feedback channels, including software configured pseudo channels. This single panel view, shown in Figure 3, gives the operator current operation information and the ability to modify it on the fly using the Edit feature.

Conclusion

With a combination of NI hardware and LabVIEW software, Lockheed Martin was able to realize a highly capable system. At approximately \$100 per channel, the hardware solution was not only competitive, but well below the cost of equivalent hardware from other vendors. By leveraging Cal-Bay's expertise and reusable LabVIEW code, the project was completed in only 4 man-months, rather than the 2 man-years originally estimated.

by Tim Dense, Project Manager, Cal-Bay Systems, Inc., and Manfred Diehl, Lockheed Martin Space Systems

Honeywell Implements Distributed, High Channel-Count Data Acquisition System

The Challenge

Developing a distributed, large-channel-count data acquisition system with real-time and historical data analysis capabilities from multiple remote display clients.

The Solution

Using the National Instruments LabVIEW Datalogging and Supervisory Control (DSC) Module 7.0 to implement a networked architecture that takes advantage of built-in DSC module features, saving weeks of custom software development time.

Requiring Dedicated Testing Facilities

Testing aircraft components such as turbines and generators requires dedicated test facilities that can subject the unit under test (UUT) to extreme pressures, temperatures, and other conditions similar to those encountered in real-life operating mode. Researchers initiate and monitor qualification tests from a control room, featuring multiple computer stations dedicated to specific tasks such as pressure and flow control, safety monitoring and simulation. During a test run, teams of engineers, technicians, and analysts work together to collect and analyze real-time and historical data from various subsystems. The atmosphere is similar to that of a space flight control room – everyone focuses on the UUT, but with a different perspective. A data acquisition system that acquires, displays, and records the critical test data is at the heart of this activity.

Designing a System to Present Data in Real Time

Honeywell Engines, Systems & Services in Torrance, California, challenged Cal-Bay Systems, Inc., with the task of implementing such a system. We were required to design a system that could collect more than 2,000 channels at sampling rates varying from 1 Hz to 100 Hz. In addition, the system had to make test data instantly available to six client PCs for display and on-the-fly analysis and collect every data point and store it to a central location where it could be available immediately for historical analysis using specialized software tools. In addition, the system needed to seamlessly switch back and forth between on-the-fly and historical data analysis.

Honeywell required a networked, distributed data acquisition hardware architecture to reduce the wiring throughout the test facility. The system had to interface to multiple Ethernet-based data acquisition devices. Besides collecting and logging data, the system needed to make the data available to a separate facility control computer, which would run the control loops for various pressure, flow, and temperature subsystems. Because of the real-time control requirement, the system had to publish the data to the control computer at a deterministic rate of 100 Hz using a real-time, dedicated network. Finally, this application required data integrity maintenance. The system could never duplicate a test run; therefore, it had to acquire all the channels and store them for postacquisition analysis.

Previously, engineers built data acquisition systems using various PC platforms, all of which had a concentrated architecture. The systems could acquire and display a very limited number of parameters. Engineers connected all instrumentation to a single PC, resulting in long wiring runs, which increased susceptibility to electromagnetic interference and physical damage. These systems were also limited to one data viewing station, which prevented multiple users from analyzing the incoming data in real time.

NI PXI, SCXI, and LabVIEW Real-Time Provide Results

We based our hardware design on the PXI platform for its ruggedness and multiple analog and digital I/O hardware offerings. We used the SCXI hardware to expand the channel number and provide signal conditioning to sensors such as thermocouples and flow meters. We selected a PXI controller running LabVIEW Real-Time as the main data acquisition engine. This controller communicates with a host PC through a real-time reflective memory interface. The host PC stores the data to a RAID disk array and, at the same time, makes it available to the client PCs for display.

We based our software on the LabVIEW platform for its ease of use and tight integration with the hardware. In addition, using LabVIEW Real-Time, we ran the control and acquisition program on the PXI controller as an embedded process without operating system overhead. With this system, we can deterministically acquire more than 2,000 channels of data and make them available to the control computer via the reflective memory ring. Normally, we would spend a year designing a system, such as this. However, using NI products, we completed our project in seven months, reducing development time by more than 40 percent.

Cal-Bay Systems FlexATE™ -HASS Reliability Tester

Designed specifically for HASS Reliability testing

- Monitors the health of 8 to 16 electronic devices in parallel when testing for failure due to vibration, shock and temperature
- Suited for testing any devices where high reliability is essential, including:
 - Defense electronics
 - Aerospace electronics
 - Telecomm Devices
 - High Reliability Audio/ Visual electronics
 - Computers and peripherals
- Significantly improves field MTBF, resulting in fewer field defects
- Individually controlled, fused and power for each DUT with integral current monitoring, along with Video and Audio signal monitoring for both analog and digital formats
- Worldwide support: Installed, commissioned and supported by Cal-Bay Systems or your preferred local system integration partner



*The FlexATE™-HASS
Reliability functional test
system from Cal-Bay Systems
has been designed to provide
the ideal solution for
companies performing
vibration and shock testing on
high reliability products.*

Based around industry standard COTS hardware and software , the FlexATE™-HASS tester can be configured quickly and easily, providing a flexible solution for testing multiple batches of devices for potential failure in harsh environments. The multi interconnect adaptor is permanently connected to the system hardware allowing new device fixtures to be configured easily without the need for rewiring, enabling faster change over between batches.

The easy to use, full function software provides simple to use GUI's (Graphical User Interface) which enable control and monitoring of the devices under test throughout the duration of the test. The results of each test are stored in a database for reference. This data can be exported to any SQL database for further analysis or data storage.

For further technical information or to find out if the FlexATE™-HASS Reliability Test System is the right functional test system to satisfy your company's HASS testing requirements, please contact your nearest Cal-Bay office. Alternatively visit us at www.calbay.com

LabVIEW-based Control Test System for Aircraft Panels

The Challenge

An industry leader in aircraft controls and panels needed an automated system to test several different DUTs on a single platform. The DUTs required both discrete and digital signal testing as well as an advanced GUI control to assist the operators during testing. The test system needed to be scalable and reconfigurable, as product changes and upgrades are always on the horizon.

The Solution

Use LabVIEW to create a test executive to quickly and efficiently step the user through the testing process. Make user interfaces and test functions reconfigurable so product updates and revisions are easily managed. Employ Intrastage to update configuration files and analyze test reports via the internet.

How we did it

LabVIEW 8.5 was used to create a comprehensive test executive capable of testing every signal type used. To dynamically select the correct test parameters, X-Controls were used to call appropriate test events in the test exec. The X-Controls, which represent the DUT under test, are preconfigured with all discrete and/or digital parameters needed to perform test. The panels being tested could have up to 20 DUT's per unit. Digital photos of the panels and DUTs were used to create custom user interfaces and controls.

Test Panel



Each control or button is considered a DUT.
A custom X-Control is created for each DUT.



By right clicking the DUT X-Control, the configuration panel seen below is displayed. Now each button can be configured with its own custom parameters. All parameters are saved to XML file. The Test Exec reads these parameters to perform appropriate test(s) and check limits.





During testing, the user is provided with a real-time data display and test system status.

To update test systems already deployed in the field, all test panel and X-Control parameters are written to a common .XML file. When the operator starts the test system, a dialog screen is used to select the Instrument to be tested. Once selected, the proper GUI is dynamically called and displayed on the screen. DUT parameters for that particular panel are then read from the XML file and loaded into the Test Exec queue. The test exec then sequences through each DUT until the entire panel is tested. The operator may also select individual DUTs to test.

Aircraft Actuator Life Cycle Testing

Products Used

LabVIEW
PCI-DAQ
cDAQ

The Challenge

To develop an automated PC based lifecycle test system to replace a traditional manual based system for lifecycle testing of aerospace actuators.

The Solution

By using PCI-DAQ for duty cycle simulation and cDAQ for sensor inputs we were able to produce a fully automated lifecycle test system powered by LabVIEW

Abstract

To test a new breed of electrical actuators, it was decided that automating the original manual process was required. This automation enabled the engineers to seed failures within the actuator to identify potential failure points. Previously the duty cycle to drive the actuator was a simple sine wave generated by a waveform generator. The amplitude was varied to excite the actuator to various levels within the operating window of the actuator. This was left to cycle for various periods of time until the device eventually failed. This typically took months.

The Measurements were taken from a number of sensors both internally within the actuator for measurement of motor temperature and externally for load, vibration and actuator response to the duty cycle.

Hardware

The new automated system was developed using LabVIEW. The hardware included a high speed PCI DAQ board to provide the duty cycle waveform and capture the higher speed measurements. To confirm the hysteresis characteristics of the actuator both the waveform output and the response output from an external LVDT were monitored simultaneously using two of the DAQ card analogue inputs. These were plotted on the main screen as an X-Y plot providing a visible indication of the hysteresis performance. The actuator power supplies were also monitored using SCC modules in the SCC-68 connector block.

An accelerometer was placed on the body of the actuator to enable analysis of the motor vibration. This was captured by a 9233 cDAQ card mounted in the cDAQ chassis. The vibration measurement was part of the analysis that helped predict the failure towards the end of the test cycle. A load cell with a charge amplifier was used to measure the load being applied to the actuator which itself was attached via a spring to a fixed mounting point on the test rig.

The actuator had an internally mounted thermocouple that was monitoring the motor temperature inside the device. This was monitored using a 9211 cDAQ card along with ambient temperature.

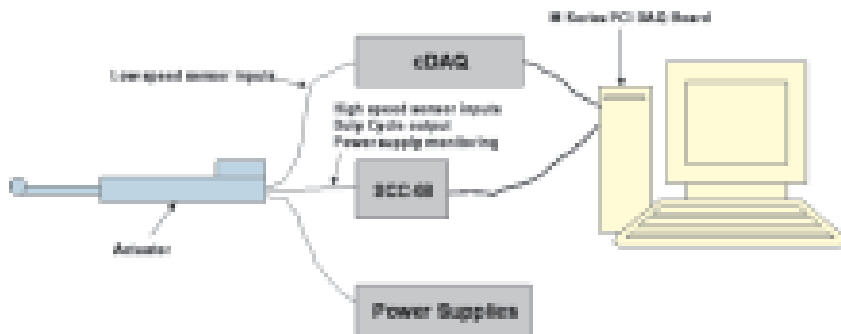


Figure 1: System overview

Software

One of the key benefits of using LabVIEW was the ability to create a number of duty cycles that represented more truthfully the operation of the actuator in the real world. Instead of just using a simple sine wave, a complex set of duty cycles were developed. These individual duty cycles were cycled one after the other and then repeated. Each duty cycle excited the actuator to a different level of extension, including one that set the actuator at full extension to really test it to its limits.

The software GUI also provided the operator with the ability to view all of the measurements on trend type charts as well as digital displays. All measured data was saved to file at one minute intervals for future analysis. A limit was placed on some of the strategic inputs that would identify when the device was close to failure; these included the vibration channel, current output from the power supply and internal temperature of the device. If any of these channels rose above the preset limit, the system started logging data at 10 second intervals for a period of ten minutes. If the inputs rose to a second higher level during this period, the system would shut down by turning off the power supplied to the actuator automatically. During this shutdown sequence, data was recorded and saved to disk at the full speed of the DAQ system to enable closer inspection of the data during post analysis of the failure. If the inputs stabilized then the test would continue as normal.

A number of actuators were seeded with potential issues such as grit in the gearing, cogs missing from the gearing etc. This was to check how these issues would affect long term performance.

Conclusion

The introduction of this LabVIEW based solution enabled the customer to test the actuators much more thoroughly than was previously possible. It also provided much better analysis of the actuator characteristics and performance in a significantly shorter time. For more about this solution, contact Ian Crighton of Cal-Bay Systems on 01793 538061.

Ballistics Testing using PXI and LabVIEW at US Army Yuma Proving Grounds

Lance Haag
VP Engineering
Cal-Bay Systems, Inc.

Overview:

Integrated Ballistics Data System

- Yuma ballistics testing mission profile
- Challenges to develop next generation system
 - Enable much faster setup, reduce errors and checking needed in enormously complex system
 - Radar, positioners, signal conditioning, digitizers, etc.
 - Coordinate many signals including weapon firing and signal generation for complementary systems
 - 3 different DAQ platforms with common software
 - Self test to detect setup errors, faulty equipment, etc.
- How did we do it? Solution presented ...

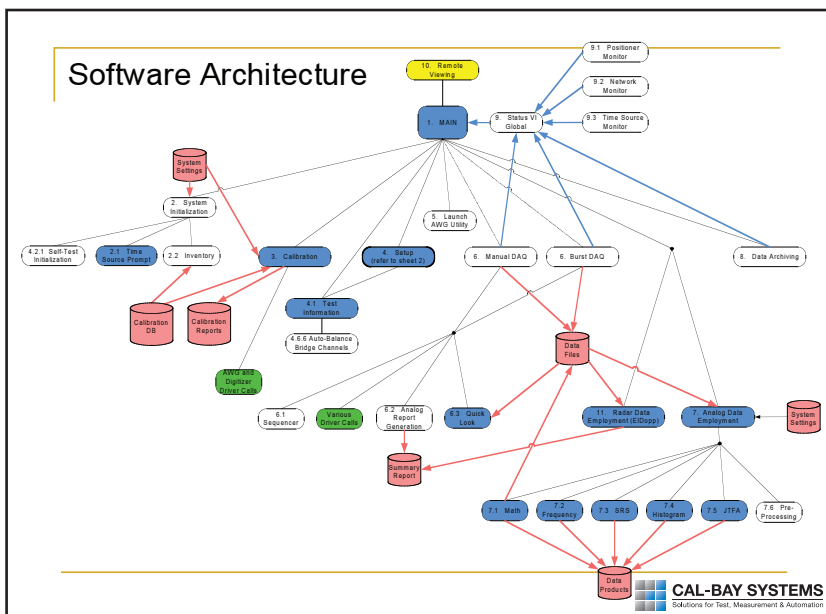
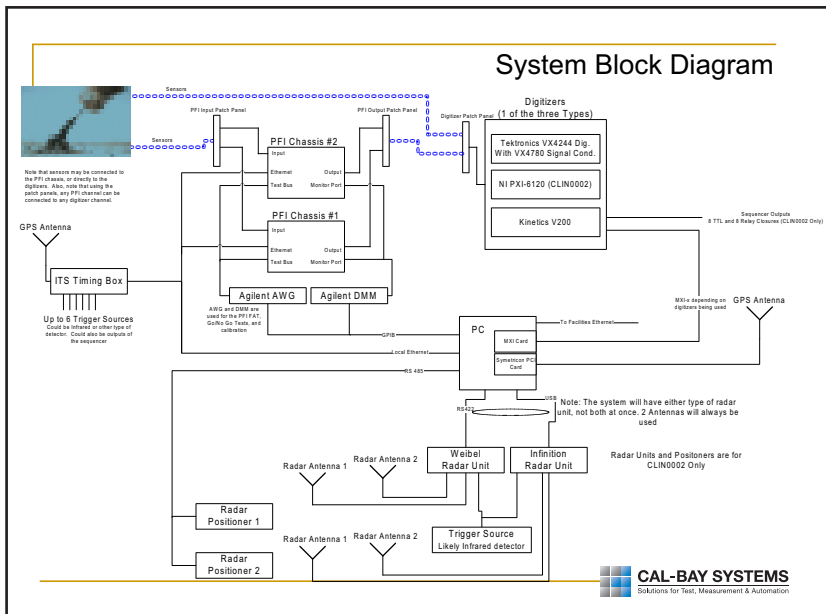
Yuma Test Mission



- USAYPG is one of several weapons proving grounds serving the US Armed Forces
- Facility is 1400 sq. miles
- Client Department Mission: Ballistics Testing
 - Weapons launch projectiles
 - Artillery, missiles, rockets, tank guns, etc.
 - Choreographed test events capture all data of interest

Project Attributes and Challenges

- Fixed price competitive bid with 60 pp SOW
- Cal-Bay wins against 5 other bidders, blessed with the “Winners curse”
 - Among lower bids meeting technical competence
 - Many scope boundary and technical feasibility issues to manage
 - Integrate equipment from several new vendors
 - 3 different digitizer platforms supported



Key Strategies

- Used off the shelf solutions for:
 - Remote Monitoring: Net Support Manager
 - NIST Traceable Signal Conditioner Calibration: Precision Filters FAT Software
- 3rd Party Collaboration
 - Great support from NI on Sequencer, multi-chassis triggering
 - Infinition Test Center API implemented per Cal-Bay spec
 - PFI software license on the backplane interface
- Staged Releases
- Give and Take with Customer



Elements Built by Cal-Bay

- Analog Channel Setup—major GUI design challenge, complex trigger modes
- Self Test channel by channel verification for high data validity
- Digitizer in-system calibration
- 3 simultaneous loops in DAQ
- Standalone
- Sequencer
- Many more . .



NI Solution Contribution

- LabVIEW 7.1 (This was the latest when project began 2 years ago)
- PXI-6120 S-Series Multifunction DAQ
 - 16 bit 4 channel 500 kSa/sec
 - Full analog and external triggering
- PXI-6602 Counter-Timer for the Sequencer
- GREAT support to optimize multi-module and multi-chassis triggering mode support



The System as-Built, in the Lab



Results

- First article SW and HW was accepted 18 months after contract start
- 6 additional systems have been delivered
- Additional development underway to speed up performance and implement 2nd round enhancements
- Moving toward mission readiness and fielding in 2008. More systems will be built then.
- Customer is VERY HAPPY



TELECOMM, RF & SEMICONDUCTOR

IBM Disk Drive Heads Get Put to the Test



PacBell Replaces Outdated Fade Analyzer
with FieldPoint 2000 Based Instrument



Production Test System for a High-Bandwidth
Optical Network Switch



A Bed of nails Tester/Calibrator Created From
LabVIEW and E-series DAQ



Silicon Valley Startup Uses BridgeVIEW and Fieldpoint
To Validate New Wafer Cleaning Technology



A Low-Cost, Expandable, PXI-Based Solution
for Mixed-Signal ASIC Test



FlexATE™ -RF Functional Test System

IBM Disk Drive Heads Get Put to the Test

Category

Manufacturing Functional Test
R&D Development
Semiconductor

Products Used

LabVIEW
NI-DAQ
PID Control Toolkit
3 PXI 6031 Multifunction I/O cards
3 PXI 6704 Analog Output Card
MXI-3 Bus Connectivity

The Challenge

Develop an automated test system for failure testing and stress testing of IBM disk drive read/write heads under extreme conditions of temperature, magnetic field, and varying current, that replaces an existing instrument-based system and provides 10x improvement in speed and performance.



Disk Head Test Fixture

The Solution

Using LabVIEW, PXI, and MXI 3 connectivity we developed an automated test system that provides high-speed data acquisition on multiple channels, controls three test environments and provides a detailed failure analysis report.

Abstract

IBM, the largest manufacturer of disk drive heads in the world, performs rigorous tests on their disk drive read/write heads to ensure their functionality and predict their failure rates. By measuring the resistance of the heads over a period of time in a controlled environment, they can predict the failure rates of the heads in the field. The data collected during this test is used to improve the average lifespan and durability of a read/write head. Cal-Bay Systems, Inc. developed a test system for IBM that incorporates PXI hardware and LabVIEW software to control temperature, magnetic field, and current while measuring and logging resistance data from 44 disk heads at once.

Introduction

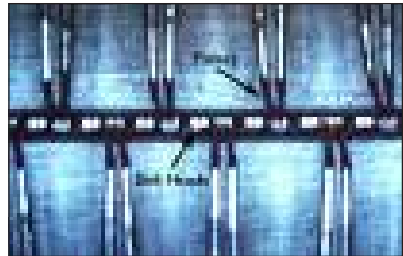
Disk drive head testing is a field once dominated by traditional GPIB instrumentation because of the accuracy and resolution requirements of the test. The draw back of using traditional GPIB instrumentation for this type of test is the speed at which data can be collected and the cost of the instrumentation. When IBM came to Cal-Bay Systems to design a next generation disk head tester, the requirements were simple: speed and accuracy. Cal-Bay designed a high-channel count system based on National Instruments PXI data acquisition cards and LabVIEW. In the end, the system not only met the requirements, but it completely blew them away.

Quantum Leaps in Performance and Accuracy

The previous generation disk head test system, that was custom designed for IBM, using traditional GPIB instruments, took eight minutes to collect a single set of resistance data from 44 disk heads (standard test lot), which resulted in a minimum of seven hours to run one cycle of a test. Most tests consist of anywhere from 5 to 15 cycles, therefore an entire test could take up to five days to complete. The next generation system, using PXI and MXI-3 is able to collect 44 channels of resistance data in less than one second while performing complex filtering and averaging algorithms, resulting in a one cycle test time of 3.6 minutes. The new system boasts total test time of less than one hour (compared to five days), less than 1% of the total test time of the previous-generation system. The gain in speed was not the only improvement for the system. The old system provided accuracy of 10 microvolts, which was adequate to achieve desired results at that time. With improvements in technology and manufacturing, the test requirements changed and IBM was looking for an improvement in the accuracy on the next generation system. The NI hardware selected for the job was able to provide IBM with a 2-microvolt accuracy, which dramatically improved the capability of the test. The main function performed by this particular test system is to accelerate the aging of the disk heads by exposing them to extreme conditions and determine the average life span and failure rate of the head. The head is exposed to extreme temperatures, varying magnetic fields, and a range of voltage excitations while performing precision resistance measurements. The PXI based system is able to maintain precise control of temperature, magnetic field, and 44 current loops all within a 100 ms loop time. Using LabVIEW, three independent control loops were running in parallel with the data collection. This allowed maximum flexibility and performance of the environmental conditions for the test.

Flexibility

Testing disk heads is no simple task. In order to measure precision resistance an excitation current is applied across the disk head and the voltage is recorded. Resistance is calculated by dividing the measured voltage by the excitation current. Because of the sensitivity to electro-static discharge, traditional current sources could potentially damage a disk head because of voltage build up. The PXI 6704 Analog Output Card provided the flexibility to switch between current output and voltage output, and therefore was selected as the hardware building block for this test system. Using the capabilities of this card, we were able to test both scenarios (current excitation and voltage excitation) and tune the system for maximum performance.

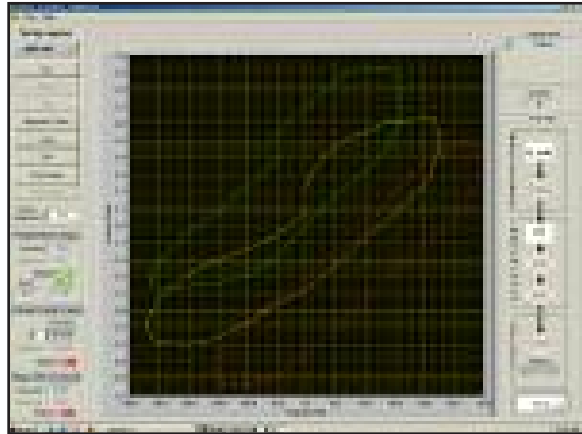


Disk Heads being tested (zoom 20x-actual head 1 mm diameter.)

Before the test is run, it is necessary to manually align the disk heads with test probes so that current can be applied and voltage can be measured. Alignment is currently done using a CCD camera with 20X zoom lens and micro thumbscrew adjustments to allow the user to line up the heads (which are 1 mm in diameter) manually with the test probes. Because of the expandable nature of the PXI platform and the diverse range of products offered by National Instruments, a future enhancement to the system could be the automation of the alignment process using a PXI-1408 image acquisition card and a PXI-7324 motion controller card, thus removing potential alignment issues and increasing the usability and reliability of the test fixture.

Software

Using LabVIEW, the system was designed for user-friendly operation. Simple configuration screens allow users the ability to configure all aspects of the test: temperature, magnetic field, variation and number of test cycles. While the test is being performed the LabVIEW application provides scalable real time graph displays of every channel with the ability to view up to five user-defined channels on the screen at one time for cross-channel



Disk Head Test Software Main Screen

data comparison. Reports are generated by integrating MS-Excel with LabVIEW using ActiveX. Each test generates detailed results that are saved using a standard IBM template. This allowed IBM to maintain the same format of reporting as the old generation system, avoiding the rewriting of many postprocess analysis routines. Having the data dynamically piped into Excel while the test is running also allows test data to be preserved in the case of a power failure or test interruption.

Conclusion

Using a combination of National Instrument hardware and software we proved that PC-Based instrumentation provides true improvements in performance, accuracy, and flexibility over traditional GPIB instrumentation. Minimizing test time from five days to one hour while increasing accuracy of the test by a factor of five, allows IBM to perform more rigorous testing of their disk drive heads and extract better information from their test data.

PacBell Replaces Outdated Fade Analyzer with FieldPoint 2000 Based Instrument

The Challenge

Replace and significantly update an existing analyzer that monitors the status of telecom transmission signals. Provide data logging capabilities and remote access in a compact, rugged form factor.

The Solution

Using LabVIEW/RT and the latest FieldPoint technology from National Instruments, Cal-Bay Systems was able to construct a compact, standalone data acquisition instrument capable of monitoring remote microwave transmission stations for 6 months between data downloads. We did it with the flexibility of a PC-based solution, without actually using a PC.

Introduction

PacBell, a wholly owned subsidiary of SBC Communications, provides telecommunications services in the United States and worldwide. Using microwave transmission towers, PacBell is able to transmit voice and data information over the airwaves. In certain areas, the use of this type of wireless transmission can be more cost effective than laying cable. Fine tuning the amplification of the microwave signal is important to ensure the quality of the transmission through changing environmental conditions, and when something goes wrong, it is imperative to have data to determine where a failure might have occurred.

PacBell uses a Fade Analyzer manufactured by *Oi Electric* in Yokohama, Japan, to monitor voltage signals from the amplifiers of microwave transmission towers (up to 14 signals per station). The analyzer converts voltage signals to a microwave decibel scale and logs them for retrieval at a later date. The conversion is achieved by a linear interpolation between calibrated data points, entered by an operator and stored as a look-up table (LUT). Each signal has a different calibration curve so the operator must enter an LUT for each transmission point being monitored. Typically, the analyzer is left, unattended in the field for up to 2 weeks. After monitoring, the analyzer is returned to the office to have the data retrieved.



Figure 1. Microwave Tower

The Requirements for a New System

The existing analyzer hardware had not been upgraded since the middle 1980's and PacBell was ready to take advantage of the advances in technology during the last 15 years. Cal-Bay Systems, Inc. of San Rafael, CA, a National Instrument Select Integrator, was contracted to develop an instrument that would duplicate the capabilities of the existing Fade Analyzer while adding user friendliness and several new features. The modifications included longer monitoring capability (the Fade Analyzer is only capable of 2 weeks), local and remote communications, simplified data retrieval, enhanced LUT downloading and the addition of environmental monitoring (temperature and humidity). The usability improvements included upgrading the existing 10-key – LED user interface of the Fade Analyzer to a remote control, menu driven terminal program.

Hardware

The instrument developed by Cal-Bay consists of an FP-2000 controller, two FP-AI-110 modules, a 33.6 Kbps modem and a 24V power supply. All these components are fully integrated into a standalone, compact NEMA-4 rated steel enclosure. 14 BNC connections on the front panel of the instrument (utilizing BNC panellets from National Instruments) provide a quick connect interface for voltage gain signals. And one 4-wire, twistlock connection provides an interface for the two environmental sensors. Connections for power, communications and environmental sensors are all in compliance with industry standards and fully removable for packaging and shipping.

A major goal of this project was to avoid the large footprint of a PC-based data acquisition system. Therefore the FP-2000 was utilized and we pushed the functionality to the limit. With LabVIEW/RT as the development platform, we believed we could leverage the FP-2000, not as a stand-alone controller, but as an embedded system capable of operating remotely for long periods of time. In order to achieve this, we needed to modify the standard FP- 2000 and generate software capable of handling large data sets and remote data transfer via modem and serial port.

We quickly realized that the onboard flash memory of the FP-2000 (11 MB) was not enough. We worked directly with National Instruments to have two FieldPoint 2000 units customized with 512 MB of flash memory. This solved our data storage challenge. The next step was to multiplex the FP-2000 onboard serial port to interface with an industry standard 56Kbps modem in addition to a local serial port. The system cannot use both protocols at the same time, so a port redirector was designed into the instrument and with the flick of a switch, the operator can switch between local and remote mode to upload the LUT data directly from a laptop or download acquired data from a remote field location.



Figure 2. The front panel presented the operator with easy access to the system

Software

LabVIEW/RT was chosen for this application as it allows stand-alone operation of the FP-2000 unit. Most of the real-time benefits of LabVIEW/RT were not utilized for this project. The instrument is designed to collect, store, and transmit data as its main functionality. Therefore, data is collected and averaged over a period of one minute, and stored in a circular database of 100,000 records. Once the database is filled, old data is overwritten with new data.

Since the FP-2000 does not include standard on-board file-transfer protocols for the serial port, Cal-Bay developed a protocol based on the industry standard Xmodem protocol. This facilitates the downloading of data and the uploading up LUT data via HyperTerminal (specifically requested by PacBell).

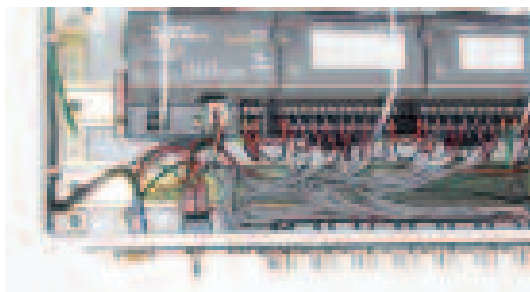


Figure 3. The FieldPoint hardware provided easy connectivity to the sensors

Conclusion

We started the development of this project with the goal of replacing an outdated analyzer with an elegant, compact solution based on NI products. By leveraging the capabilities of the new FP-2000 and the flexibility of LabVIEW/RT we were able to develop a data-logging instrument that is rich with features, compact, and capable of long-term operation in remote locations. The LabVIEW/RT-FieldPoint 2000 combination is a real boon to embedded systems developers.

National Instruments Products Used: FieldPoint, LabVIEW/RT

by Tim Dense, Project Manager - Cal-Bay Systems, Inc.

Production Test System for a High-Bandwidth Optical Network Switch

The Challenge

To test a telecom switch matrix you must verify that every interconnection meets the requirements for signal integrity and minimal loss. For example, a 64x64 switch matrix would require you to test 4096 different paths, one path at a time. Complex measurements are usually done for each path and, if done manually, it could take several days to test an entire matrix. This is a daunting task and an automated system is the only answer to speed up the process and make the testing efficient.

The Solution

Using PXI, TestStand and LabVIEW we developed a turnkey system that automated the testing of a telecom switch matrix and reduced the test time from a matter of days to just under a few hours.

Introduction

A telecom switch performs the basic function of routing incoming signals or phone calls from one place to another. It is a critical component that sits at the heart of any local phone exchange. TeraBurst Networks, an emerging Silicon Valley company, provides high-bandwidth switching solutions for next-generation optical networks. Their system provides a wavelength-level switching system based on an innovative RF & microwave frequency technology.

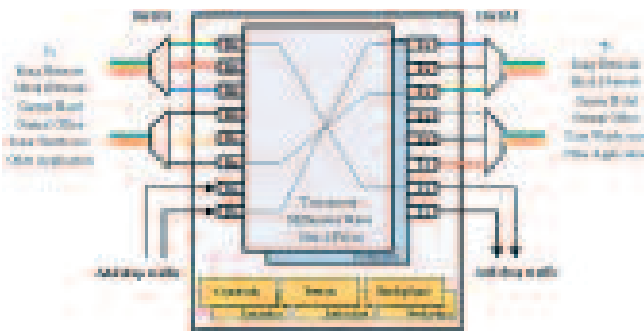


Figure 1. Block diagram of an optical network switch

Using a proprietary switching technology, the TeraBurst Networks products can switch signals from low frequencies around 60 MHz up to 40 GHz.

Cal-Bay Systems, Inc. in conjunction with TeraBurst Networks developed a turnkey production test system to test the RF performance of an NxN switch matrix. This flexible system proved to be as valuable for design verification as it was for production testing.

Requirements

TeraBurst Networks needed a complete turnkey system that automated a tedious manual testing process for the switch matrix component of their optical network switch solution. The system needed to test the RF performance of a signal path by measuring critical electrical parameters using a high-

bandwidth vector network analyzer instrument. Automated software had to be developed to control the switch matrix and instruct it to switch from one path to the next, get the measurements from the network analyzer and print a summary report of the paths that failed the design requirements for signal integrity.

Additionally, we needed to design an RF test fixture for inserting the device under test (DUT). This was a complex task given the fact that the fixture had to handle signals of very high frequency without introducing any distortions of its own. We also had to develop a complementary RF multiplexer to interface to the switch matrix and route the input and output signals from the network analyzer. Finally we had to integrate and build the system and deliver it as one complete solution.

The Solution

Our software solution was based on TestStand and LabVIEW. TestStand was the obvious choice for this production test system. It allowed us to build a test sequence that was both powerful and flexible. We used the built-in operator interface, the report generation module and limit checking modules available in TestStand rather than developing our own. This allowed us to concentrate on developing the test modules. Using the TestStand software was one of the main reasons the system was built on budget and delivered on time.

For the hardware, we decided to use the PXI platform for its compact size and reliability. A production test system needs to run with very little down time. The compact size is important for contract manufacturers who try to fit many testers on a production floor. In addition, the PXI hardware platform was easily integrated into our test rack. A block diagram of the system is shown in Figure 2.

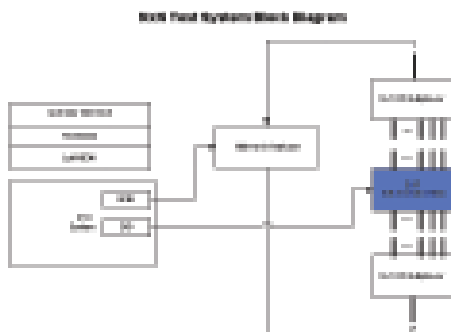


Figure 2. System block diagram

We used the GPIB interface to communicate with the Agilent network analyzer. We used the PXI-6533 as a high-speed, bi-directional digital I/O interface to communicate with the device under test. The PXI-6533 card has a tri-state feature which allows for bi-directional communication on the same port. The communication interface to the DUT was an 8-bit parallel interface with some handshaking lines. The interface allows a controller to command the switch to connect the different paths.

The 64x1 RF multiplexers were developed as separate instruments. An RF multiplexer, Figure 3, is a set of specialized electro-mechanical relays that operate at very high frequencies and route many input signals into one output signal or vice-versa. To operate the relays we used the FieldPoint DO-401 modules. We were able to integrate them nicely in a separate enclosure and control them via the serial

port like a standard instrument. We found that these RF multiplexers can be used in other projects where multiple signals had to be routed to one instrument.



Figure 3. 64x1 RF Multiplexer (18 GHz bandwidth)

To test the device we had to develop an RF test fixture. The test fixture allowed an operator to simply insert the device under test in a drawer. When the drawer was closed, TeraBurst's proprietary connection system engaged and connections were made to power the device and to connect it to a high-bandwidth backplane that routed the signals to the network analyzer via the RF multiplexers. The fixture, the hardware and the network analyzer all fit nicely in a standard 19" rack. The final system is shown in Figure 4.

The Challenges

The main challenges in this applications were all hardware related. We put a lot of thought and effort in the test fixture design and implementation. The communication with the DUT was tricky. We found out that the PXI-6533 card is the only product that could perform this task because of the need for bi-directional I/O lines that had to be switched on the fly.

The software was the easiest task and the main reason for it was the fact that we used TestStand which provided many useful components as built-in modules such as, operator interface, report generation and limit checking.



Figure 4. The complete, turnkey system

Conclusion

The system we delivered to TeraBurst Networks was very successful. Close cooperation between Cal-Bay and TeraBurst Networks assured that the systems were delivered on time and performed as expected. In the end, we delivered several similar systems to test the switch matrix and one to test the individual switching cards that make up a switch matrix. In the case of the switch matrix tester, we reduced the test time from days to just under a few hours. The systems proved to be invaluable tool for design engineers and test engineers alike.

Products Used: PXI, GPIB, FieldPoint, LabVIEW, TestStand

by Sorin Grama, Cal-Bay Systems, Inc.

A Bed of Nails Tester/Calibrator

Created From LabVIEW and E-series DAQ

The Challenge

Rapidly develop a tester/calibrator for an electronics package for mass flow controllers. Because of space limitations, the electronics were split into two circuit boards, designated “the DSP Board” and the “Analog Board”. The circuit boards were connected by two mating 30 pin connectors. The tester / calibrator needed to interface to two bed-of-nails fixtures to make the required measurements.

The Solution

A bed of nails fixture and interface box capitalizing on the measurement capabilities of E-series DAQ and ease of development with LabVIEW.

Introduction

Fugacity Corp. of Sparks, NV has introduced a new mass flow controller that uses pressure measurements made on each side of a flow restrictor to measure and control flow. To meet production goals they required an automated system that could verify operation of their circuit boards and measure the gains of the amplifiers.

Cal-Bay Systems was asked to design and fabricate a turnkey tester / calibrators to perform the test.

The Hardware

All of the tests were DC measurements. In most tests a DC voltage is applied to an amplifier circuit and its output voltage is measured. Gains are calculated from the results and stored in EEPROM in the electronics. One test required a duty cycle to be set as a pulse width modulated signal (PWM) and output to the electronics. This output drives a filter / amplifier circuit. The output of the amplifier / filter circuit was measured as a DC voltage, recorded and used to calibrate the PWM. Finally another series of tests required measurement of the various power supply voltages and the ADC reference voltage.

National Instruments E-series DAQ was the ideal measurement device for these tests. Fugacity already uses 16-bit E-series cards as an OEM component for one their products. The 16-bit resolution of the 6030 and 6052 made them the logical choice for the test systems.

The test fixture also needed to provide a +/- 15 volt power to the device under test and RS422 communication to the DUT. The interconnections between the E series card, the DUTs, the power supplies and an RS232-RS422 converter were packaged in an NI CA-1000 enclosure. The tester wiring was designed to allow one MIO board to connect to both fixtures via the CA-1000.



Figure 1. Solid Model of Bed of Nails Fixture



Figure 2. Bed of Nails Fixture and DUT

Most of Cal-Bay's hardware design effort went into the Bed of Nails fixtures. A manual, screw-driven slide was designed and fabricated to bring the boards down onto the nails. Spring loaded "pogo pin" contactors were used to take signals from contact points. For vias and pads a chisel type contactor was used. For pins, a socket type connector was used. Solid modeling software was used to design the fixture and verify tolerances.

The Software

One key requirement of the test software is to support automated data handling. It is desirable to run the tests on the boards as soon as possible after they are received from the contract manufacturer. Later when a set of boards is assembled, data from both tests must be loaded into EEPROM on the DSP board. A relational database was designed to store test and calibration measurements so that test data could be stored and retrieved by serial number. With LabVIEW's database connectivity toolkit, the database calls were tested and proven with a Microsoft Access database and later ported to a SQL Server database.

Another important requirement was to put the program into Flash memory on the DSP controller via a parallel port emulator. To automate this procedure under program control the venerable LabVIEW System Exec call was used. Separate calls were used to erase the flash and to write the program into it. Routines to parse the test output of the System Exec calls were used to create robust error handlers for these functions.

National Instruments E-series DAQ is the workhorses of modern data acquisition and control system, and Cal-Bay uses them whenever possible. Noise immunity was achieved with software by averaging blocks of voltage readings for each measurement. The simplicity and familiarity of the LabVIEW NI-DAQ calls made the measurement portion of the project a "no-brainer."

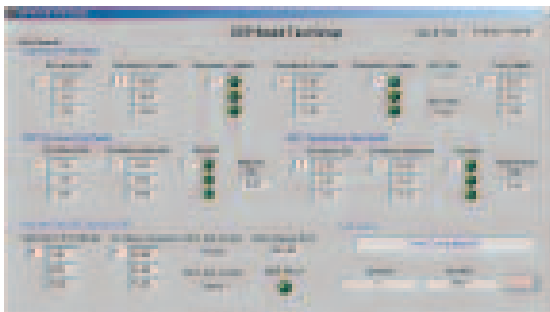


Figure 3. User interface for DSP board tester

Conclusion

LabVIEW, NI-DAQ and good mechanical design procedures can take the risk and time out of making functional testers for electronics.

Category: Manufacturing Functional Test

Products Used:; LabVIEW, PCI-6030E, CA-1000, Enterprise Connectivity Toolkit

by

William H White, Executive Vice President of R&D, Fugasity Corporation

Tim Dense, Project Manager, Cal-Bay Systems, Inc.

N.D. Buck Smith, Principal, Cal-Bay Systems, Inc.

Abdulla Ghouse, Project Manager, Soliton Automation

Silicon Valley Startup Uses BridgeVIEW and FieldPoint To Validate New Wafer Cleaning Technology

The Challenge

Precise and repeatable control of the high pressures and temperatures needed to reliably clean semiconductors using supercritical CO₂. The system had to be developed quickly and at minimal cost.

The Solution

Using BridgeVIEW and FieldPoint we were able to quickly put together a prototype for testing the new technology. Unique features of the BridgeVIEW software allowed us to develop the control software concurrent with the machine prototype development, thus shortening the time to market for this new technology.

Abstract

Proving a new technology can be a costly and time consuming endeavor. In today's fast paced technology landscape, startup companies are taking advantage of virtual instrumentation to drive down the cost and speed up the research and development of new technologies. The following paper describes a PC-based control system for a semiconductor wafer cleaning machine prototype. The prototype is based on a new technology which uses a combination of supercritical CO₂ and solvent chemistries as a replacement for aqueous based cleaning systems. The control system uses BridgeVIEW and FieldpPoint to create and monitor the high pressure environment required for precision cleaning.

The System

Supercritical Systems Inc. is a small semiconductor startup located in Fremont, California. The company is developing a cost-effective wafer cleaning technology that uses supercritical CO₂ and a small amount of co-solvent to remove process and etch residues.

The supercritical state of a liquid is truly a fourth state of matter- being neither liquid nor gas but embodying properties of both. In the case of CO₂, the supercritical point is reached at a temperature of 31 degC and pressure of 1069 psia. Supercritical CO₂ has the beneficial characteristics of flowing like a gas, but possessing the solvating power and inertial properties of a liquid. It is this ability to solvate and carry cleaning chemistries into the minute features of a semiconductor wafer that holds the promise for next generation cleaning technology.

To prove the effectiveness and repeatability of this new technology, the company designed and built a prototype wafer cleaning system. The machine (Figure 1) consists of a series of pumps and valves which direct CO₂ into a reactor. In the reactor the CO₂ is brought above the supercritical point by increasing pressure and temperature and a cleaning fluid is created with the addition of proprietary chemistries. This CO₂ cleaning fluid is then directed at and circulated over the wafer.

To help develop the process, the company needed to automate the monitoring and control of the entire system. They called on Cal-Bay Systems to help design the hardware and software for this system. Based on our experience with National Instruments products we were able to provide a cost-effective solution in a minimum amount of time.

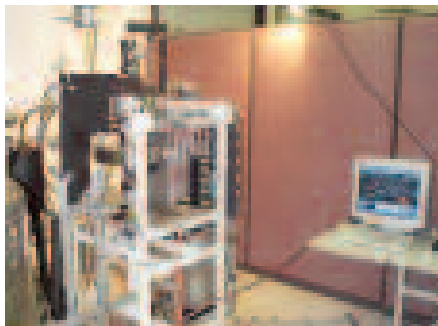


Figure 1. The prototype system with the controller PC next to it

The Requirements

In an industry where C++, real-time operating systems and VME-based control systems are the status quo, the idea of controlling a wafer cleaning machine with LabVIEW and PC-based instrumentation seemed quite adventurous. The system needed soft real-time control at 10 msec per cycle. We needed to control the temperature of the reactor within 0.5 deg C and maintain a constant pressure to within 50psi (a difficult task given the pressure cycling of the proprietary process). A total of 7 pressure transducers, 11 RTDs, 10 valves, 7 heaters and 4 pumps had to be monitored or controlled.

In case of an emergency, such as ruptured pipes or overpressure, the software had to quickly shut down the system. The customer wanted both a manual control and automatic control mode. In manual control the user could control any valves, pumps and heaters from a user-friendly interface yet not create a hazardous situation. In automatic mode, the software would ask the user for a recipe and then step through all the procedures involved in cleaning the wafer. In addition, they wanted us to develop the software at the same time they were building the system. We had to find a way to simulate the system inputs on the computer.

Hardware

Initially we thought of using LabVIEW and plug-in DAQ cards to monitor and control the system, but after further examination we recommended using BridgeVIEW software and FieldPoint hardware.

Using FieldPoint was an easy decision. National Instruments makes FieldPoint modules which are ideal for industrial applications such as this one. Most of the sensors had an analog output of 4-20 mA and all valves were on a 24 V circuit. We used the FP-RTD modules for monitoring the temperatures, the FP-AI-100 analog input modules for reading the pressures, the FP-DO digital output modules for controlling the valves, the FP-AO analog output modules for controlling the pumps and the FP-PWM modules for controlling the heaters (Figure 2). Later, we added a counter module for measuring the rotational speed of some of the hardware. A total of nine modules are being used. The FieldPoint modules communicate with the computer using RS-232. Initially we were concerned that the serial communication with the PC could be a bottleneck for this tight control loop. We found out that serial communication at 115 kbaud was fast enough to maintain our 10 msec control loop rate.

The FieldPoint modules provided easy connectivity to the sensors and, through the FieldPoint Explorer software, an easy configuration. Another reason we used FieldPoint was for the watchdog timer safety feature built into each module. In case of emergency or loss of power, we wanted the system to be quickly brought down to a shutdown state by commanding valves into safe states and turning off the heaters.



Figure 2. The Fieldpoint hardware provided easy connectivity to the sensors and valves

Software

BridgeVIEW has the flexibility of LabVIEW but offers additional features for industrial control applications and easy connectivity to FieldPoint hardware. The drawing card that made us select BridgeVIEW was the fact that it uses a separate engine and a database to collect and store the real-time and historical readings. This database can be accessed from multiple programs and acts as a global variable that stores all current pressures, temperatures and valve states. This allowed us to develop the manual and automatic interface, the emergency shutdown routine and the temperature PID control routine as separate programs that query this global database for the latest readings. Changes made by one routine can be instantaneously seen by the others. In addition, we could create so-called "memory tags" in BridgeVIEW to simulate I/O readings. This enabled us to develop the software (Figure 3) without actually being connected to the hardware. To test software response to changes in the state of the system, we developed a separate emulator program that stored realistic values in the database.

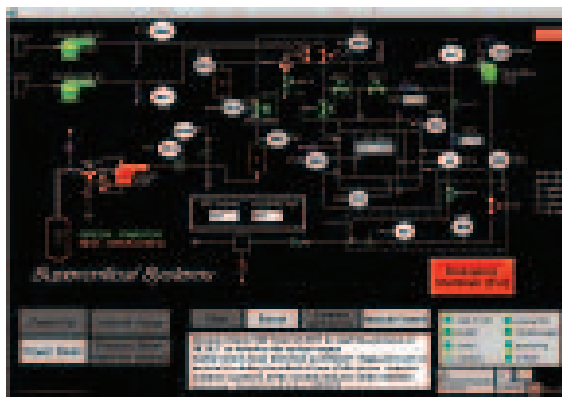


Figure 3. The front panel presented the operator with a clear image of the overall state of the system

We extensively tested the system response to emergency conditions generated by fluctuations in pressure and temperature.

The software was developed using classic LV state diagrams and event driven routines. We had to make sure that that we could easily step from one procedure to another. We used the queue VIs and

a main While loop as the execution engine. Each loop iteration removes the next task from the queue and executes it. The emergency shutdown routine was a critical component. It continuously monitored the pressures and temperatures and, if it detected a pressure drop of more than 100 psi, it initiated the shutdown state. The shutdown task was pushed into the main queue, but instead of being queued up like a normal event, it was placed at the front of the queue where it was immediately executed by the execution engine.

We quickly learned that the system was very stable and we could easily maintain the 10-msec control loop time. The Windows NT workstation is very stable and the FieldPoint power-down features along with the mechanical emergency features built into the system were enough to make it safe.

Conclusion

We started the development with many questions and no answers. Would the PC-based system be able to safely control such a machine? Could we develop the software without even seeing the hardware? Could we easily change the process steps? All these questions were answered with a resounding "Yes". The benefits of virtual instrumentation enabled us to develop a flexible prototype in a short amount of time. In the next phase of the project we will be integrating the software into a larger system compatible with the SECS/GEM protocol.

Category: Industrial Automation, R&D, Semiconductor

Products Used: BridgeVIEW, PID toolkit, FieldPoint

by Sorin Grama, Project Manager - Cal-Bay Systems, Inc.

A Low-Cost, Expandable, PXI-Based Solution for Mixed-Signal ASIC Test

The Challenge

Develop a flexible test system for characterizing new ASICs.

The Solution

A PXI-based system complete with software written in LabVIEW that allows for easy channel count expansion by leveraging NI's Synchronization and Memory Core architecture.

Abstract

Timely characterization and debug data is critical to getting new ASIC designs to market quickly. PXI instruments and LabVIEW enable custom characterization systems that would previously have been difficult to create quickly. We used several PXI-6552's to create a custom scan-chain test system, enabling rapid debug of an ASIC design.

Introduction

A fabless semiconductor startup challenged National Instruments and Cal-Bay Systems to develop a verification platform to test their mixed-signal ASICs. Debugging a new ASIC is an iterative process; test results may determine the requirements of the next test. Delays associated with running custom test protocols on traditional automated test equipment (ATE) at the foundry resulted in unacceptable delays in time to market. Placing the design validation test system in the hands of the design engineers allowed ASIC debug time to be reduced by a factor of 5.

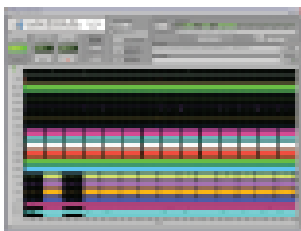


Figure 1. A screen shot of the controlling software designed by Cal-Bay for this project

After the initial test system was deployed test data showed that more channels would be needed to debug the ASIC design. The LabVIEW / PXI platform allows channel expansion by adding modular instruments which can be configured to work together as one instrument through the National Instruments' Synchronization and Memory Core.

Deep On-Board Memory, HW-Compare, and Low-Level Control via Bi-Directionality

Scan chain testing of ASICs allows designers to access many registers inside an ASIC via the Scan Chain interface which typically has only a few I/O pins. Scan chain testing requires the generation of millions of digital waveforms (stimulus) to the ASIC while at the same time acquiring and comparing the actual response of the ASIC to the expected response. An NI PXI-6652 card can be used for both generation and acquisition in Scan Chain tests. Each digital line of a PXI-6652 card has a Tri-State

capability allowing for this dual-mode operation. With Tri-State operation, the possible states associated with a digital line are not limited to the traditional 1 (drive High) and 0 (drive Low). For lines configured as inputs a comparison engine measures the ASIC's response to the given stimulus and compare this response to the expected value in hardware. These capabilities make it possible to manage the individual registers in the ASIC in a tightly controlled manner on a per-cycle basis. The PXI-6652 also allows the programmer to compensate for transmission line delays by applying a fixed delay to a selected list of channels. Finally, the ASIC test design is not limited to a single logic family, as programmable logic levels are allowed. All of these features make it possible to design a highly flexible and highly customized test for an ASIC.

Efficient and Effective Software Development with LabVIEW

The key requirement in this application was to allow test engineers to quickly define digital waveforms to generate and compare against. The customer had a desire to use text files to accomplish this task. As such, the system software used native LabVIEW File I/O libraries to read millions of 'vectors' from text files. Next, NI HSDIO driver libraries were utilized to implement the digital waveform generation and hardware compare features. Hardware compare functionality reduces the overhead associated with the comparison task allowing comparisons to be made on-the-fly with no coding or very little post-processing. Design engineers can review test results via intuitive waveform graph controls, text-based reports and mismatched vector displays. Displays of mismatched vectors permit design engineers to quickly 'drill down' into the large data sets.



Figure 2. The Scan Chain Tester setup user interface

NI's Synchronization and Memory Core allows for easy expandability

A main factor driving costs in Automated Test hardware is channel count. Generally speaking, more channels drive the cost of a data acquisition system higher. Adding more channels after the initial design may be expensive or impossible. National Instruments T-Clock Technology for Timing and Synchronization solves this problem by allowing multiple devices to be synchronized with minimum modification to existing hardware and software, giving the test design engineers the ability to add more channels seamlessly. Cal-Bay engineers were actually challenged to put this technology to use during this project. After the initial development phase was completed for 20 digital I/O channels, the customer expressed a desire to use the same software architecture with a total of 40 channels. This upgrade was completed flawlessly and in short order thanks to NI's Synchronization and Memory Core technology on the hardware front. On the software side, as the original software design employed principles of a modular architecture, addition of extra channels to the system was a relatively minor task.

Conclusions

- Per-Cycle bidirectional control of individual digital I/O lines coupled with features such as Tri-State operation, hardware comparison, programmable voltage level support, and channel time delay, make NI's PXI-655x family of modular instruments a formidable alternative to traditional high cost ATE's.
- LabVIEW native software libraries and free drivers that ship with NI's modular instruments reduce the time and risk associated with the usual software development process.
- NI's Synchronization and Memory Core technology allows for easily introducing additional digital I/O channels, seamlessly expanding the existing system in short order.

Category: Design R&D

Products Used: LabVIEW, PXI-6552 HSDIO cards, NI-HSDIO Driver Library with Hardware Compare support, NI-Digital Waveform Editor, MXI-4 [kit], PXI-1042 Chassis

FlexATE™ -RF

Functional Test System

Designed specifically for Functional Testing of RF devices

- Tests any RF devices up to 42GHz
- Suited for testing devices where a combination of general Functional Test and RF Test is required, including:
 - Defense Electronics
 - Aerospace Electronics
 - Telecomm Devices
 - Automotive Devices
- Based around industry standard COTS hardware and software for ease of maintenance and support
- Multi Point interconnect for quick product change
- Worldwide support: Installed, commissioned and supported by Cal-Bay Systems or your preferred local system integration partner



The FlexATE™-RF Functional Test System from Cal-Bay Systems has been designed to provide the ideal solution for companies requiring a combination of traditional functional test, combined with RF testing on high reliability products.

Based around industry standard COTS hardware and software, the FlexATE™-RF can be configured quickly and easily, providing a flexible solution for testing devices in a research, validation or production test environment. The multi interconnect adaptor is permanently connected to the system hardware allowing new device fixtures to be configured easily without the need for rewiring, enabling faster change over between product test.

The easy to use, full function software provides simple to use GUI's (Graphical User Interface) which enable control and monitoring of the devices under test throughout the duration of the test, ideal in a research environment. Alternatively the unit can be fully automated and optimised to deliver high throughput for production use. The results of each test are stored in a database for reference. This data can be exported to any SQL database for further analysis or data storage.

For further technical information or to find out if the FlexATE™-RF Functional Test System is the right solution to satisfy your company's RF testing requirements, please contact your nearest Cal-Bay office. Alternatively visit us at www.calbay.com

TEST DATA MANAGEMENT, ANALYSIS AND REPORT GENERATION PRODUCTS

IntraStage Overview Presentation



IntraStage Brochure

Overview of IntraStage

Test Data Management, simplified...

Patrick Kelly



IntraStage™ Organizes Test Data

**“Knowledge is a process of piling up facts;
wisdom lies in their simplification.”**

Martin H. Fischer

“Most test stations gather GigaBytes of data – waveforms, pass/fail results, tons of measurements. This data often exists in multiple files spread across several computers. When a report is needed, an engineer scrolls through the files for information and often spends hours manipulating data in Excel.

I thought that there had to be a better way, a way to simplify all of the piled up facts. So we created IntraStage.”

Tom Armes, Founder of IntraStage, Inc.



Why do Customers choose IS?

- 1) You may have a **variety of different data files**, some that are proprietary, others might be obsolete formats, and you are looking to standardize on something better...
- 2) Perhaps you have a **quality mandate using the Six Sigma methodology** and are looking for the best way to apply technology to your test data...
- 3) Or, as the test manager for your department, you are looking for ways to add more automation, **have better and more consistent reports** so that you can more easily analyze the data for root causes...



IntraStage: The Big Picture

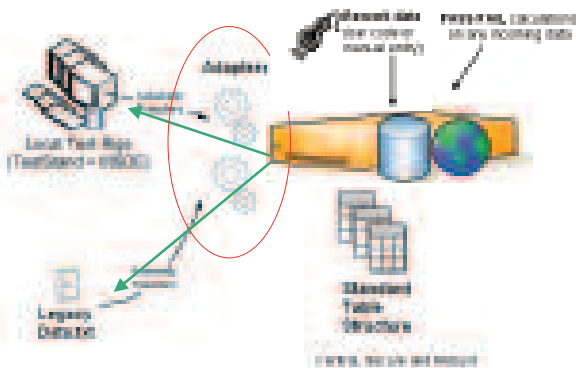


IntraStage in the Enterprise



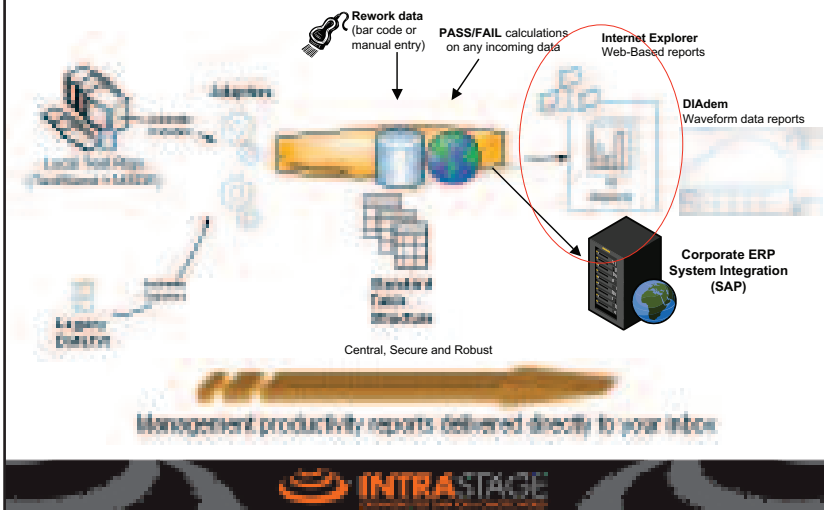
INTRASTAGE
ANALYSIS AND REPORT GENERATION PRODUCTS

IntraStage in the Enterprise



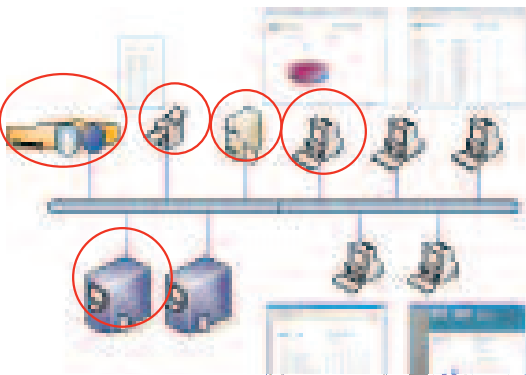
INTRASTAGE
ANALYSIS AND REPORT GENERATION PRODUCTS

IntraStage in the Enterprise



IntraStage on the Network

1. Test Stations logging to local database or text files
2. Automated data "pull" from IntraStage Server
3. Reports and data analysis available to clients via web interface
4. Reports can be printed or saved in a variety of electronic formats



What Clients Are Saying...

“We had a requirement from our biggest client to operate an SPC regime for many products shipped to them. We compared many of the products on the market and found that IntraStage met our needs while still costing thousands less than other products. IntraStage is now used to automatically collect test results from many different test stations and provides us with multiple types of detailed reports on a regular basis.”

R TYLER : TEST PROJECT ENGINEER –
(AEROSPACE INDUSTRY)



IntraStage™ Overview



- Six Sigma Device
- Data Acquired In Any Format
- Native Office Integration
- Built In Report Server
- Report Builder
- Alerts and Scheduled Reports
- Browser Based
- Zero Client Report Licensing

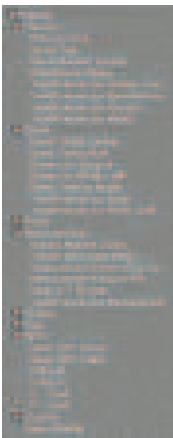


Customer Requirements

- **Centralize, Secure and Store all Test Data**
- **Track Process Capability for all Measurements**
 - Ex: Cp, Cpk, Six Sigma & SPC
- **Help Test Team to Prioritize Issues**
 - Ex: Dynamic, up-to-the-minute Pareto Charts
- **Feedback to Design Team**
 - Ex: Limit Changes, Re-Engineering, etc.
- **Easy-to-use Reporting, Scheduling & Alarms**
- **No Process Change on Existing Test Rigs**
- **Minimize Programming and DBA Needs**



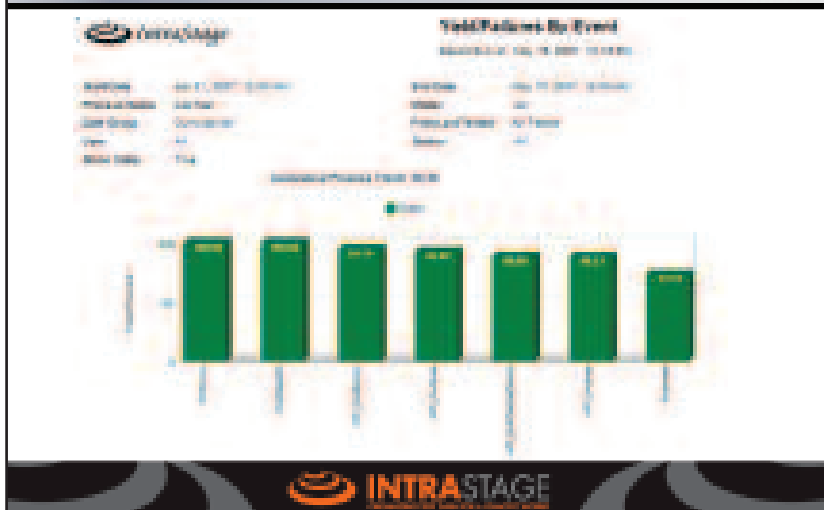
Reports Overview



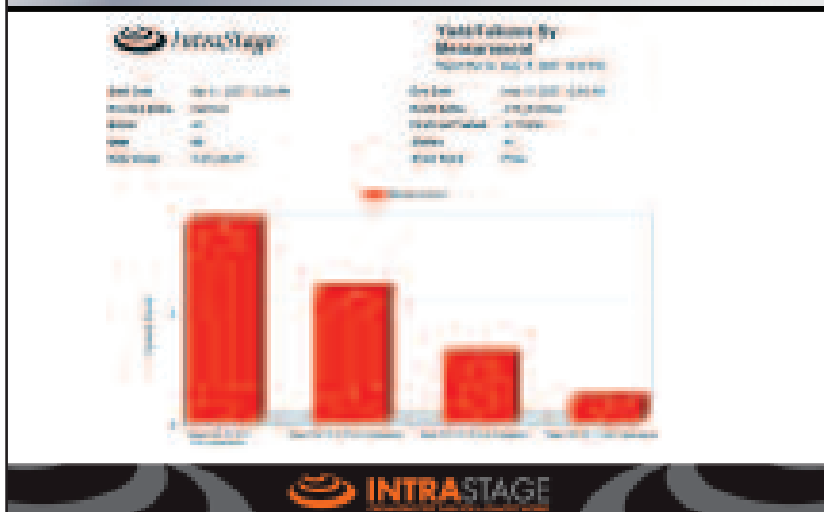
- **Standard Set of Reports Available**
- **Using the Report Builder:**
 - Create your own Reports
- **Using Query Builder:**
 - Create your own SQL queries to retrieve any data out of IntraStage
- **IntraStage Services Team:**
 - Can Build New, Custom Reports for you!



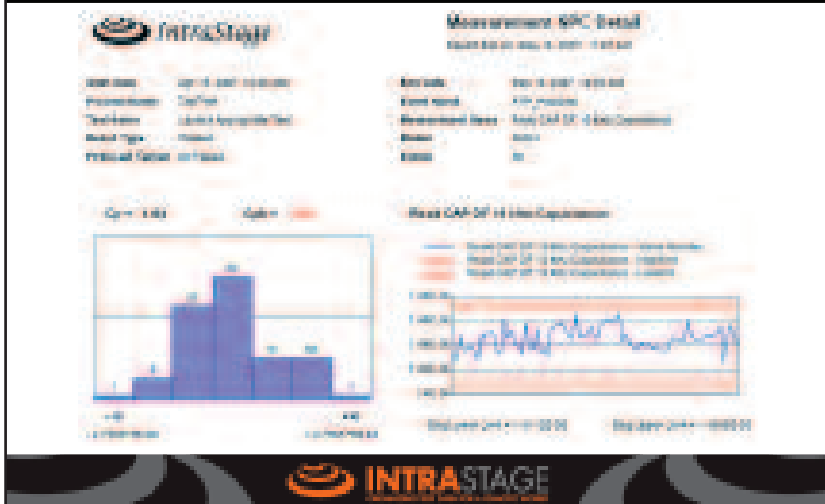
Yield by Event



Failures by Measurement



Capability, Distribution and Trend



Automated Information

- **Notifications**

- Receive E-mail notification when a certain condition is met (e.g. notification of measurement out of limit)

- **Subscriptions**

- Subscribe to a report, for e-mail delivery at specified intervals (e.g. SPC Measurement Table Report)

R/D and Lab Edition

- Device Verification Test Data
- Characterization Test Data
- Lots of tests LOOPED over:
 - Temperature, Voltage, Frequency, etc.
 - Often, for long time periods
- Low Volume of prototype designs
- IntraStage has the answer!



R/D Characterization Report



IntraStage deployment options

Lab Development

R/D Edition

- 1 Data source
- Unlimited Client report licenses

Test Dept usage

Green Belt Edition

- 10 Data source
- Unlimited Client report licenses

Site-wide usage

Black Belt Edition

- 50 Data source
- Unlimited Client report licenses
- 3 Client Licences (Choose any three of the following)
 - DIAdem (base Edition)
 - MiniTab 15
 - JMP 7 Corporate

Corporate usage

General Corporate Server

- Unlimited IntraStage Server Sources
- Unlimited Client report licenses
- Larger Server Hardware

Additional Data Source Licences can be purchased for these editions



SMOOTH

IntraStage seamlessly organizes and stores your data to a centrally secure location while you work, play, or sleep.

CONSISTENT

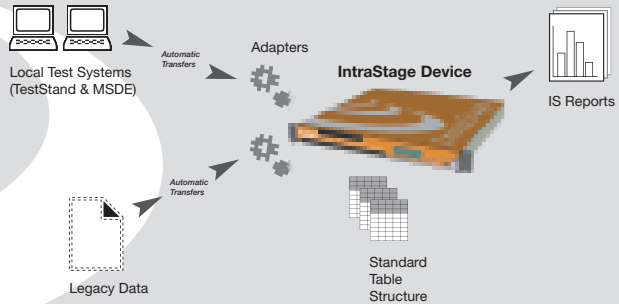
Your whole organization can finally have a standard, consistent 'look and feel' for test data reports.

RESULTS

You can make better decisions regarding process improvement or product reliability, having solid information at your fingertips.

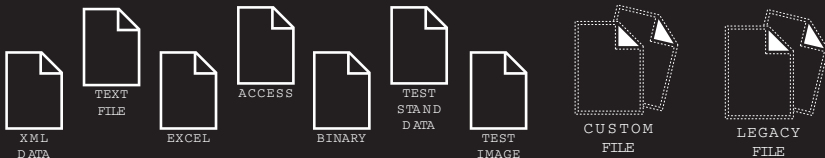
OVERVIEW

IntraStage elegantly imports data from anywhere in your enterprise on the schedule you specify, into a central and secure location. This data is then immediately available to any user who has access to the IntraStage system.



FILE TYPES

IntraStage can acquire data from just about any source. Whether it be from a well structured database or from a legacy tester outputting poorly structured text files, IntraStage will import this data on a schedule you specify.



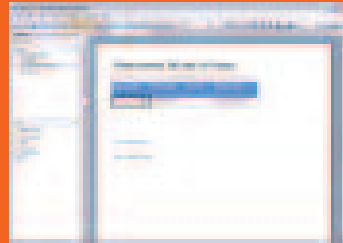
WEB BASED REPORTING

Base-of-use reports using a simple web browser to gain critical company information anytime. Unlimited client licenses allow companies to purchase this technology knowing the costs upfront.



BUILD, SHARE AND SCHEDULE

IntraStage easily allows users to create their own reports, publish these reports for sharing with co-workers and schedule these reports (as well as the built-in reports) to their inbox or file share for their Monday morning meeting.



R TYLER : TEST PROJECT ENGINEER - AEROSPACE

We had a requirement from our biggest client to operate an SFC regime for many products shipped to them. We compared many of the products on the market and found that IntraStage met our needs whilst still costing thousands less than other products. IntraStage is now used to automatically collect test results from many different test stations and provides us with multiple types of detailed reports on a regular basis.

TOM ARMES : FOUNDER

It is my firm belief that test data management should be no more difficult than managing music on my iPod™. I am consistently amazed that test data is strewn around most companies in some kind of known chaotic state ("because that's the way it has always been done").

This data disorder creates a serious lack of reliability, consistency, integrity and security with regards to any information attained. Building a product that eliminates these difficulties is the spirit behind the IntraStage device. With IntraStage, test data is now effortlessly gathered on the schedule specified and transformed and stored into useful information. The user is now empowered to create, share and schedule reports in a consistent and easy-to-use way. Companies can now make solid business decisions, based on reliable information straight from their Inbox.

So, go ahead and take off early on Friday! IntraStage will take care of your test data and email the critical report to you first thing Monday morning.

TECHNICAL SPECIFICATIONS

BUILT ON INDUSTRY PROVEN TECHNOLOGIES:

- Hardware: Industry standard server hardware from Dell and HP that have a proven record of performance, scalability and reliability.
- Software: IntraStage software is built to run on Microsoft Windows Server technology, SQL Server, SharePoint and .NET.
- This combination of technologies creates an "out of the box experience" with a true "plug and play" feel.

**Contact us to find out how Cal-Bay Systems
can help you develop a successful solution for
your Test, Measurement and Automation needs.**

Cal-Bay Systems, Inc. Headquarters

3070 Kerner Boulevard, Suite B
San Rafael, CA 94901
Phone: (415) 258-9400
Email: sales@calbay.com

Cal-Bay Systems, So. California Office

16 Technology Drive, Suite 160
Irvine, CA 92618
Phone: (415) 258-9400
Email: patrick@calbay.com

Cal-Bay Systems, Austin, Texas Office

Phone: (415) 526-8384
Email: guy@calbay.com

Cal-Bay Systems, SouthWest Office

1474 N. Cooper Rd, Suite 105-708
Gilbert, AZ 85233
Phone: (415) 526-8382
Email: kevin@calbay.com

Cal-Bay Systems, NorthWest Office

4957 Lakemont Blvd SE C-4, PMB 128
Bellevue, WA 98006
Phone: (503) 901-8719
Email: bphillips@calbay.com

Cal-Bay Atlantic (Maryland)

5272 River Road, Suite 510
Bethesda, MD 20816
Phone: (800) 230-0029
Email: sseiden@calbay.com

Cal-Bay Atlantic (Virginia)

11247 Raeburn Lane
Rixeyville, VA 22737
Phone: (800) 230-0029
Email: acollins@calbay.com

Cal-Bay Atlantic (New Jersey)

807 Summerfield Avenue, PO Box 110
Asbury Park, NJ 07712
Phone: (800) 230-0029
Email: jgoldberg@calbay.com

Cal-Bay Systems Europe Ltd

Suite 2, 13 Fairlawn
Linden, Swindon
UK, SN3 6ET
Phone: (0044) 1793 538061
Email: ian@calbay.com