LabVIEW

Graphical Programming

Better Productivity
LabVIEW is a highly productive graphical programming environment that combines easy-to-use graphical development with the flexibility of a powerful programming language. It offers an intuitive environment, tightly integrated with measurement hardware, for engineers and scientists to quickly produce solutions for data acquisition, data analysis, and data presentation.

Integrated Hardware
LabVIEW has built-in compatibility with hardware libraries for:
- GPIB/VXI/PCI/Computer-based instruments
- RS232/485 protocol
- Plug-in data acquisition
- Analog/digital/counter timer I/O
- Signal conditioning
- Distributed data acquisition
- Image acquisition and machine vision
- Motion control
- PLCs/data loggers

Powerful Analysis
LabVIEW features comprehensive analysis libraries that rival those of dedicated analysis packages. These libraries are complete with statistics, evaluations, regressions, linear algebra, signal generation algorithms, time and frequency-domain algorithms, windowing routines, and digital filters. See page 70 for more details.

Open Development Environment
With the open development environment of LabVIEW, you can connect or communicate to any other application through ActiveX, the Internet, DLLs (dynamic linked libraries), shared libraries, SQL (for databases), DataSocket, TCP/IP, DDE, and numerous other protocols.

Optimal Performance
All LabVIEW applications execute at compiled speed for optimal performance. With the LabVIEW Professional Development System or Application Builder, you can also build stand-alone executables for secure distribution to operator stations and the production floor.
LabVIEW
Competitive Advantage

Your Competitive Advantage with LabVIEW

Faster Development
LabVIEW accelerates development by a factor of 4 to 10 over traditional programming. With the modularity and hierarchical structure of LabVIEW, you can rapidly prototype, design, and modify systems in a short amount of time.

Better Investment
As application needs change, LabVIEW virtual instrumentation systems have the flexibility to be modified easily without the need for new equipment. Using a LabVIEW system, each user has access to a complete instrumentation laboratory at less than the cost of a single commercial instrument. LabVIEW is also cross-platform compatible, so that you can always port your systems to the best platform for you. And, National Instruments ensures backward compatibility, so VIs you develop today will be compatible with technologies tomorrow.

Easier Solutions
LabVIEW empowers engineers, scientists, and technicians to design and implement their own systems. Because the LabVIEW programming paradigm is very similar to standard flowchart notation, LabVIEW is extremely intuitive and easy to learn.

Complete Environment
LabVIEW has extensive acquisition, analysis, and presentation capabilities available within a single package, so you can seamlessly create a complete solution. In addition, LabVIEW features an optimized graphical compiler to maximize system performance. Thus, LabVIEW simplifies development and produces reusable code that executes at compiled execution speeds. LabVIEW can create true compiled, royalty-free, stand-alone executables that run on a target machine without a LabVIEW development system.

Simplified Tasks
Numerous LabVIEW add-on software packages simplify complex tasks such as sending data to the Internet, image acquisition, and database programming, by integrating these tools into the LabVIEW development environment.

Ensured Success
By using LabVIEW, you join a large community of successful users who take advantage of a variety of National Instruments programs, services, and support that are designed to make your solution a reality.
LabVIEW Resources
www.natinst.com/labview

Software
Evaluation software
Instrument drivers
Software updates/Beta software
Example programs
Measurement driver software and more...

Support
KnowledgeBase – searchable database of tips, common questions and more...
Application notes and white papers
LabVIEW Wishlist – On-line suggestion forum
On-line catalog and store, and more...

Events
Technical Seminar Series
LabVIEW user group meetings
Trade shows/Product demonstrations
NIWeek – Annual National Instruments developer conference

Training
Course schedules, descriptions, and registration information
Self-Paced training information
Certification Program, and more...

Independent Electronic User Forum
Subscribe: info-labview-request@pica.army.mil
Posts only: info-labview@pica.army.mil

Independent User FTP Site
ftp.pica.army.mil/pub/labview

The LabVIEW Library
LabVIEW For Everyone: Graphical Programming Made Easy Easier
Lisa Wells and Jeffrey Travis
Includes CD-ROM, sample LabVIEW software and hands-on activities to help the user progress from beginner to advanced.

LabVIEW Graphical Programming: Practical Applications in Instrumentation and Control
Gary W. Johnson • ISBN 0-07-032915-X,
In-depth, engineering-level guide to LabVIEW graphical programming. Includes sample software for creating instrumentation, data acquisition, automated test, imaging, sound/video, networking, and other measurement solutions. Includes CD-ROM.

LabVIEW Applications
Learn how LabVIEW is used in industrial automation, mathematics and simulation, image processing, quality management, and more. Includes CD-ROM.

LabVIEW Signal Processing
A practical, intuitive guide to LabVIEW signal processing and control system capabilities. Hands-on tasks include arbitrary waveform generation, signal separation, product cost prediction, and more. Includes CD-ROM.

LabVIEW Power Programming
Gary W. Johnson • ISBN 0-07-913666-4
A compilation of advanced programming techniques used by leading LabVIEW developers around the world, from LabVIEW applications in space to LabVIEW-based cryptography. Includes CD-ROM.

Joint Time-Frequency Analysis: Method and Application
Shie Qian and Dapang Chen
This book provides a practical, comprehensive introduction to joint time-frequency analysis with dozens of samples. Includes CD-ROM.

LabVIEW Technical Resource Newsletter
By LTR Publishing • www.ltrpub.com
Quarterly publication presenting power tips and techniques to novice and experienced LabVIEW users. Each issue also includes a disk of LabVIEW VIs and utilities that implements methods described in that issue.

See page 853 for ordering information and more details.
LabVIEW Applications
LabVIEW systems are implemented in test and measurement, as well as process monitoring and control applications throughout the world. These applications vary widely from transportation systems monitoring, to university laboratory classes; from automated parts testing to industrial process control.

Test and Measurement
LabVIEW has become an industry-standard development tool for test and measurement applications. With TestStand, graphical test programs, and the industry’s largest instrument driver library, you have a single, consistent development and execution environment for your entire system.

Process Control and Factory Automation
LabVIEW is well-suited for basic process monitoring and control applications. For larger industrial automation applications, we recommend BridgeVIEW, a specialized product in the LabVIEW family, designed specifically for the industrial automation world. Please see page 179 for details on the BridgeVIEW development environment.

Research and Analysis
The powerful LabVIEW analysis library provides everything you need in an analysis package integrated into the LabVIEW development environment. Scientists and researchers have used LabVIEW to analyze and compute real results for biomedical, aerospace and energy research applications, and in numerous other industries. The signal processing, filtering, windowing, and curve-fitting functions available are all listed on page 71. For specialized analysis, such as joint time-frequency analysis, wavelets, and digital filter design, LabVIEW offers the specially designed Signal Processing Toolset. See page 97 for information on the Signal Processing Toolset.

“Our LabVIEW-based in-vehicle data acquisition system has been a big hit with our customers. LabVIEW has provided the functionality, creative license, and tools to design systems that meet the cutting-edge requirements of our customers in the automotive industry.”

John Date, Vice President Engineering, Dateppli, Inc.
User Solutions Articles

The following chart lists just a few of the LabVIEW applications available. These articles describe complete LabVIEW applications spanning numerous industries and technologies, including the ones listed below. You can find a complete listing, and order or download the articles from the Internet or from our automated fax-on-demand system, or contact us for more information.

World Wide Web
www.natinst.com/labview

Fax-on-demand
(800) 329-7177 (U.S./Canada)

<table>
<thead>
<tr>
<th>Manufacturing and Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>360318A-01 Raychem Reduces Manufacturing Costs with Graphical Programming</td>
</tr>
<tr>
<td>360509A-01 Automating Chromium Waste Treatment with LabVIEW</td>
</tr>
<tr>
<td>360542A-01 LabVIEW-Controlled Next-Generation Gas Delivery System for Semiconductor Manufacturers</td>
</tr>
<tr>
<td>360643A-01 Automated Cell Tracking Engine Manufacturing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Automotive</th>
</tr>
</thead>
<tbody>
<tr>
<td>360544A-02 PC-Based Simulation and Monitoring of Automotive Electronic Control Modules</td>
</tr>
<tr>
<td>360567A-01 Real-Time Dynamometer Control with LabVIEW</td>
</tr>
<tr>
<td>360820A-01 LabVIEW Helps Ford Test Autos in Desert Heat, Automating Physical Testing At Ford</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>3604285-01 Measuring Music and More with LabVIEW</td>
</tr>
<tr>
<td>360509A-01 Using LabVIEW for Physiological Research</td>
</tr>
<tr>
<td>360704A-01 Test System Captures Heart Valve Sounds Using LabVIEW and DAQ Boards</td>
</tr>
<tr>
<td>360708A-01 LabVIEW—Our Choice for Cardiothoracic Research</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Automated Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>360331-01 Detecting Intermittent Rafts of 757 Aircraft Tap and Flat Controls During Thermal and Vibration Cycling</td>
</tr>
<tr>
<td>360432A-01 Simulation-Based Testing of Industrial Gas Turbine Control Systems Using LabVIEW and VXi</td>
</tr>
<tr>
<td>360433A-01 SO2 and LabVIEW Test Traulsen Refrigerators and Freezers</td>
</tr>
<tr>
<td>360508A-01 Using LabVIEW PID Controller to Assure Electronic Reliability Tests</td>
</tr>
<tr>
<td>360519A-01 Testing Submarine Sonar Systems with LabVIEW</td>
</tr>
<tr>
<td>N/A Arco Uses LabVIEW to Test Dashboard Destruction</td>
</tr>
<tr>
<td>N/A Dow Tests Creep in Polymer Plastics with LV/DAQ</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Telecommunications</th>
</tr>
</thead>
<tbody>
<tr>
<td>360537A-02 Detecting Signature Patterns in a Broadcast Message</td>
</tr>
<tr>
<td>360581A-31 AT&amp;T Monitors Remote Sites Using LabVIEW System</td>
</tr>
<tr>
<td>361054A-02 Developing a LabVIEW-Based, Enterprise-Wide Test Management System</td>
</tr>
</tbody>
</table>

“LabVIEW’s functional test design environment enables rapid development of cost-effective ATE solutions.”
Hugh W Williams, Test Equipment Design Leader
British Aerospace (Systems and Equipment) Limited – Base

“At CERN, LabVIEW is widely used by scientists and engineers. It does an excellent job in different fields, like testing modular instruments, controlling test benches, and monitoring power equipment.”
Fabio Soso, LabVIEW Software Administrator CERN, European Organization for Nuclear Research

<table>
<thead>
<tr>
<th>Monitoring and Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>360354A-01 Real-Time Control and Monitoring of a Bearing Test Stand with LabVIEW</td>
</tr>
<tr>
<td>360407-30 SO2 and LabVIEW Monitor Hydrogen-Powered Eureka Motor Bus</td>
</tr>
<tr>
<td>360409-01 LabVIEW Goes into Space Onboard Columbia Shuttle Mission</td>
</tr>
<tr>
<td>360496A-01 LabVIEW Delivers a Cross-Platform Interface for the York International Energy Management System</td>
</tr>
<tr>
<td>360706A-01 The Use of LabVIEW to Automate Commercial Irrigation</td>
</tr>
<tr>
<td>360771A-01 A Gas Sensor Control System in LabVIEW</td>
</tr>
<tr>
<td>360779A-01 Temperature Control for Measuring Electronic Circuits Using LabVIEW</td>
</tr>
<tr>
<td>360809A-01 High-Speed Remote Process Control with LabVIEW</td>
</tr>
<tr>
<td>360812A-01 Radio-Linked Environmental Monitoring and Display System Using LabVIEW</td>
</tr>
<tr>
<td>360817A-01 LabVIEW Controls Capture and Display of Four “Live” Video Images</td>
</tr>
<tr>
<td>360844A-01 LabVIEW-Based System Puts Dallas Transit on Track</td>
</tr>
<tr>
<td>360872A-01 Monitoring Magnetic Resonance Imaging Experiments with LabVIEW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>360498B-01 LabVIEW Helps Teach Physics Lab</td>
</tr>
<tr>
<td>360514A-01 Integrated Laboratory Instruction with LabVIEW—Adapting the LabVIEW Standard</td>
</tr>
<tr>
<td>360799A-01 Creating Curriculum-Wide Systems for Mechanical Engineering Labs</td>
</tr>
<tr>
<td>360802A-01 Teaching Instrumentation in the 21st Century with LabVIEW</td>
</tr>
<tr>
<td>360803A-01 LEGO Building Blocks and LabVIEW Teach Laboratory Skills</td>
</tr>
</tbody>
</table>
Draw Your Own Solution
With LabVIEW, you build VIs instead of writing programs. You quickly create front panel user interfaces, giving you the interactive control of your software system. To specify the functionality, you intuitively assemble block diagrams - a natural design notation for engineers and scientists.

Create the Front Panel
On the front panel of your VI, you place the controls and data displays for your system by choosing objects from the Controls palette, including numeric displays, meters, gauges, thermometers, tanks, LEDs, charts, graphs, and more. When your VI is complete, you can use the front panel to control your system - while the VI is running - by moving a slide, zooming in on a graph, entering a value from the keyboard, and more.

Construct the Graphical Block Diagram
To program the VI, you construct the block diagram without worrying about the many syntactical details of conventional programming. You select objects (icons) from the Functions palette and connect them with wires to pass data from one block to the next. These blocks range from simple arithmetic functions, to advanced acquisition and analysis routines, to network and file I/O operations.
Dataflow Programming
LabVIEW uses a patented dataflow programming model that frees you from the linear architecture of text-based languages. Because the execution order in LabVIEW is determined by the flow of data between blocks, and not by sequential lines of text, you can create diagrams that have simultaneous operations. Consequently, LabVIEW is a multitasking system - running multiple execution threads and multiple VIs.

Modularity and Hierarchy
LabVIEW VIs are modular in design, so any VI can run by itself or be used as part of another VI. You can even create an icon for your own VIs, so you can design a hierarchy of VIs and subVIs that you can modify, interchange, and combine with other VIs to meet your changing application needs.

Graphical Compiler
In many applications, execution speed is critical. LabVIEW is the only graphical programming system with a compiler that generates optimized code with execution speeds comparable to compiled C programs. With the built-in Profiler, you can even analyze and optimize time-critical sections of code. Consequently, you can increase your productivity with graphical programming without sacrificing execution speed.
The list below covers only part of the functionality available in the complete LabVIEW development system. Contact us for free fully functional LabVIEW Evaluation software, or complete a request form over the web at www.natinst.com/labview.

**Controls and Indicators**
- Buttons/switches/LEDs
- Slides/digital displays
- Gauges/dials/knobs
- Tanks/thermometers
- Graphs/charts
- Tables/arrays
- Intensity plots
- Menus/lists/rings
- Text boxes
- Decorations
- Custom controls, and more...

**Instrument Control**
- GPIB/CAMAC/VXI/PCI
- Serial/RS-232
- PLC
- More than 650 instrument drivers

**File I/O**
- Spreadsheet
- Binary/ASCII

**Open Connectivity**
- Internet
- SQL*
- DataSocket
- TCP/IP
- ActiveX/DDE

**Data Acquisition**
- DAQ Wizards
- Single point input/output
- Waveform acquisition/generation
- Image acquisition*
- Motion control*
- Signal conditioning
- Triggering/timing
- TTL/CMOS input/output
- Digital pattern generation
- Digital handshaking
- Pulse generation
- Event counting
- Edge detection
- Period and pulsewidth measurement, and more...

**Programming Structures**
- While loops/For loops
- Case structures
- Sequential structures

Acquire data, display, and write to file.
LabVIEW
Graphical Programming

Programming Fundamentals
Numeric computation
Boolean logic
Array/String manipulation
Time & Date functions
Multi-datatype structures
Custom subroutines

Signal Processing
Signal generation**
Signal processing**
Image processing*
Curve fitting
Windowing**
Filtering**
See page 70 for more details.

Math
Text-based formula nodes
Ordinary differential equations**
Optimization methods**
Root solving**
Gamma/Bessel/Jacobi/Beta and other functions**
Linear algebra
Statistics and more...
See page 70 for more details.

Visualization
3D plots**
Surface mesh/Contour plots**
Custom graphics/animation**

Optimization and Applications Management
Profiler for memory usage and execution time tracking
True compiled performance on all platforms
Multithreading
Source code control/Complexity metrics***
Hierarchy window
Print documentation set
Report generation**
Documentation for quality standards***

Debugging
Breakpoints
Probes/custom probes
Single-step mode
Execution highlighting
Help window
Online Help

* See LabVIEW Add-On Toolsets for details
** Included in the Full and Professional Development Systems
*** Included in the Professional Development System

Single Stepping
Execution Highlighting
Probe

National Instruments
Phone: (512) 794-0100 • Fax: (512) 683-8411 • info@natinst.com • www.natinst.com
LabVIEW Analysis

Built-in Analysis
With LabVIEW, you have the built-in analysis capabilities you need to eliminate noise, and to condition and transform the signal for your measurements.

Signal Processing Fundamentals
The following is a quick tutorial of some signal processing fundamentals to help you create your analysis applications.

Smoothing Windows
Smoothing windows are used in spectral analysis to reduce the spectral leakage that results from using the FFT on a block of discrete data called a time record. The underlying assumptions of the Fourier transform algorithm can create unwanted spikes or “spectral leakage” in the frequency domain transformed data. You can reduce the spectral leakage by selecting the correct smoothing window for your application.

Smoothing windows, such as the Blackman-Harris window, minimize the spectral leakage in signals acquired from a DAQ board. The dynamic signals are analyzed by magnitude/phase response, power spectrum, correlation, impulse response, and transfer function. Windowing functions reduce distortion in the spectra. LabVIEW windowing functions are specified on page 71.

Digital Filters
Digital filters are used to remove unwanted frequency components in a signal caused by noise effects between electrical components, or environmental effects such as a 60 Hz power supply. In addition to removing unwanted frequency components from signals, filters can be used to separate a signal into a frequency band of interest. LabVIEW has three types of filters – infinite impulse response (IIR), finite impulse response (FIR), and nonlinear filters. Digital filters have several advantages over analog filters – they are software programmable, do not drift with temperature or humidity or require precision components, and they have a superior performance-to-cost ratio.

Once you know the filter coefficients, you can easily create your own FIR and IIR filters with LabVIEW. Plus, you can interactively design digital filters using the Signal Processing Toolset (see page 97). The toolset can output the filter design so that you can implement the filter within LabVIEW.

Frequency Domain Transforms
Spectral analysis functions are typically used to calculate the frequency components of signals. Frequency content reveals information that is not available with traditional time domain analysis. The Fast Fourier Transform (FFT) is the most common transform, but other functions such as power spectrum, Hartley, and Hilbert transforms are also used.

For example, spectral analysis functions could be used for testing the strength of materials used in airplane propellers. A propeller blade is struck with a small hammer and the resulting vibration signal is detected with a strain gauge, and transformed into the frequency domain with the Power Spectrum function. The peaks in the spectrum and their decay rates are helpful in detecting failure modes in the propeller.

Measurement Functions
Functions for measuring total harmonic distortion (THD), impulse responses, frequency response, amplitude spectrum, cross spectrum, and power spectrum are part of LabVIEW. These functions make it easy to make complex analysis measurements using DAQ hardware.
LabVIEW Data Analysis and Math Libraries

Listed below are the Analysis libraries available for the LabVIEW Full Development System and the Professional Development System. For additional information on LabVIEW add-on analysis tools, please refer to our add-on software guide starting on page 74.

**Measurement**
- AC & DC Estimator
- Amp & Freq Estimate
- Amplitude and Phase Spectrum
- Auto Power Spectrum
- Cross Power Spectrum
- Harmonic Analyzer
- Impulse Response
- Network Functions (avg) Power & Frequency Estimate
- Scaled Time Domain Window
- Spectrum Unit Conversion
- Transfer Function

**Filters**
- Kaiser-Bessel Window
- Triangle Window
- Bessel Filter
- Butterworth Filter
- Cascade->Direct Coefficients
- Chebyshev Filter
- Elliptic Filter
- Equi-Ripple Filter
- FIR Filter
- FIR Narrowband Filter
- FIR Windowed Filter
- IIR Cascade Filter
- IIR Filter w/fth I.C.
- IIR Filter
- Inverse Chebyshev Filter
- Median Filter
- Parks-McClellan

**Signal Processing**
- AutoCorrelation
- Convolution
- Cross Power
- CrossCorrelation
- Decimate
- Deconvolution
- Derivative x(t)
- Fast Hilbert Transform
- Fast Hartley Transform
- Integral x(t)
- Inverse Real and Complex FFT
- Inverse Fast Hilbert Transform
- Inverse FHT
- Peak Finding
- Power Spectrum
- Pulse Parameters
- Real and Complex FFT
- Threshold Peak Detector
- Unwrap Phase
- Y[i]=Clip {X[i],} Y[i]=X[i-n]

**Statistics**
- 1D, 2D, and 3D ANOVA
- Chi Square Distribution
- Contingency Table
- erf(x) and erfc(x)
- F Distribution
- General Histogram
- Histogram
- Inv Chi Square Distribution
- Inv F Distribution
- Inv Normal Distribution
- Inv T Distribution
- Mean*
- Median*
- Mode*
- Moment about Mean
- MSE
- Normal Distribution
- Polynomial Interpolation
- Rational Interpolation
- RMS
- Spline Interpolant
- Spline Interpolation
- Standard Deviation*
- T Distribution
- Variance

**Linear Algebra**
- A x B*
- A x Vector*
- Determinant*
- Dot Product*
- Inverse Matrix*
- Linear Equations
- Normalize Matrix and Vector
- Outer Product*
- Peak
- Unit Vector
- LU Factorization
- Cholesky Factorization
- QR Factorization
- SVD Factorization
- Eigen Vectors and Eigen Values
- Matrix Condition Number
- Matrix Norm and Rank
- Pseudo Inverse Matrix
- Complex LU Factorization
- Complex Cholesky Factorization
- Complex QR Factorization
- Complex SVD Factorization
- Complex Inverse Matrix
- Complex Linear Equations
- Complex EigenVectors and Values
- Complex Determinant
- Complex Matrix Condition Number
- Complex Matrix Norm and Rank
- Complex Pseudo Inverse Matrix

**Curve Fitting**
- Exponential Fit
- General LS Linear Fit
- General Polynomial Fit
- Linear Fit
- Nonlinear Lev-Mar Fit
- 1D and 2D Linear Evaluation*
- 1D Polar to Rectangular
- 1D and 2D Transformation
- Sample to Rectangular*
- 1D Rectangular To Polar Normalize
- Polar To Rectangular
- Quick Scale 1D and 2D
- Rectangular To Polar
- Scale 1D and 2D
- Find Polynomial Roots

**Windowing**
- Blackman Window
- Blackman-Harris Window
- Cosine Tapered Window
- Exact Blackman Window
- Exponential Window
- Flat Top Window
- Force Window
- General Cosine Window
- Hamming Window
- Hanning Window

**Mathematics**
- Ordinary Differential Equations
- Euler Method
- Runge Kutta
- Cash Karp
- Linear Systems
- And more...
- Optimization
- Levenberg Marquardt
- Linear Programming
- Brent Derivative
- Downhill Simplex
- Root Solving
- Strum's Chain
- Newton Raphson
- Ridders
- Integration
- Differentiation
- Laplace Transform
- Wavelet Daubechies Transform

*Denotes Base Analysis VIs
LabVIEW Professional Development System

The LabVIEW Professional Development System (PDS) includes tools for developers of stand-alone applications as well as high-end, large-scale applications. These professional features particularly help developers who work in teams, users developing large suites of VIs, and programmers needing to adhere to stringent quality standards.

Stand-Alone Applications

You can create stand-alone executables from your VIs with a simple selection from the menu. The executable will run, but cannot be edited. Stand-alone applications are an efficient way to package and distribute proprietary VIs as turnkey systems and factory floor applications. Stand-alone applications execute at the same high performance rates as VIs in the development system.

No Licensing Fees

You may distribute stand-alone applications with no licensing fees. If you distribute executables using LabVIEW add-on tools, please consult the add-on tools section for additional licensing information.

Graphical Differencing

You can use the graphical differencing features to compare two LabVIEW applications to determine both the cosmetic and functional differences between them. You can compare two VIs or two hierarchies of VIs and clearly see the differences, making it easier for you to track changes in similar code.

Source Code Control

With the built-in source code control utilities, you can easily check your VIs out of a development project to begin development work, and later, check those VIs back in to the project, ensuring that no two developers modify a VI at the same time. In addition to regulating changes made to VIs, these source code control utilities also help you maintain version control of your applications. You can either take advantage of the built-in source code control utilities, or you can integrate with other standard source code control packages, such as Microsoft Visual SourceSafe. Contact National Instruments for a compatibility list of additional third-party source code control tools.

Complexity Measurements

When designing large suites of VIs or bidding on projects, it is often important to estimate the amount of time it will take to complete a project, as well as to determine the complexity of your application. You can use the code complexity utilities to examine the complexity of existing VIs and use that information to estimate the amount of development time needed to complete future projects.

Software Engineering with LabVIEW

The LabVIEW PDS includes a manual detailing how to apply software engineering practices to the development of LabVIEW applications. This information helps programmers design large applications and build organized, well-structured suites of VIs. These programming standards are useful for development teams to help ensure consistency of interfaces and structure throughout the application. Users at all experience levels will find the techniques in these standards to be useful in building high-quality LabVIEW applications.

Quality Standards

Large LabVIEW applications must often adhere to strict quality standards to achieve ISO 9000 and FDA approval, and adhere to internal regulations. The Professional Development System includes a discussion of the steps LabVIEW users must follow to meet such standards. Case studies of actual customer applications are discussed, and tips and techniques are presented.
<table>
<thead>
<tr>
<th>Feature</th>
<th>LabVIEW Professional Development System</th>
<th>LabVIEW Full Development System</th>
<th>LabVIEW Base Package†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controls and indicators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming structures and fundamentals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instrument control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data acquisition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>File I/O and report generation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Debugging</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multithreading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ActiveX†, TCP/IP, DDE†, DataSocket</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear algebra and array operations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability and statistics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curve fitting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fourier, Hilbert, and other transforms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amplitude/phase/power spectra</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pattern/noise generation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulse response</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak detectors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIR/FIR filters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Butterworth/Chebyshev and other nonlinear filters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windowing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interpolation algorithms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordinary differential equations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optimization algorithms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root solving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integration/differentiation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma/Bessel/( )jacobi and other functions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface mesh/contour plots</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Custom graphics and animation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report generation tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand-alone executables</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Create installation tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graphical differencing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source code control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity metrics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large project documentation tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software engineering with LabVIEW documentation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality and programming standards documentation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

†Available only for Windows platforms
## Add-On Software for LabVIEW
LabVIEW also offers additional tools specifically designed to help make your application development easier for specialized tasks. All of the following tools integrate seamlessly into LabVIEW so you can continue to work in a single, consistent, easy-to-use development environment.

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Add-On Toolset</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Test</td>
<td>Automated Test Toolset</td>
<td>TestStand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automated test sequencer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Access through multiple user profiles</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SQL database connectivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPC for quality control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete VI driver library</td>
</tr>
<tr>
<td>Enterprise Connectivity</td>
<td>Enterprise Connectivity Toolset</td>
<td>SQL database connectivity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPC for quality control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internet-enabled applications</td>
</tr>
<tr>
<td>PID and Fuzzy Logic Control</td>
<td>PID Control Toolset</td>
<td>PID control algorithms including autotuning, lead/lag, setramp calculations, and more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuzzy logic control algorithms including membership functions and defuzzification methods</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integration with NI-DAQ and DAQ hardware</td>
</tr>
<tr>
<td>System Simulation and Design</td>
<td>System Simulation and Design Toolset</td>
<td>Simulation and control of nonlinear systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Direct connection to National Instruments hardware</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ready-to-use control elements for PID, relays, filters, and more</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manager, synchronizer, and monitor for real-time behavior</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bode, Nyquist, and root locus plots</td>
</tr>
<tr>
<td>Advanced Signal Processing</td>
<td>Signal Processing Toolset</td>
<td>Joint time-frequency analysis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Digital filter design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wavelet and filter bank design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Third-octave analyzer and analysis libraries</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Super-resolution frequency analysis</td>
</tr>
<tr>
<td>Vision/Imaging</td>
<td>Vision Development Toolset</td>
<td>IMAQ Vision image processing libraries</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vision Builder</td>
</tr>
<tr>
<td>Motion Control</td>
<td>Motion Control Tools</td>
<td>Control National Instruments motion control boards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More than 300 powerful VIs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High-level examples</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Set-up file save-to-disk feature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Motion function libraries</td>
</tr>
</tbody>
</table>

For more details on the above add-on software tools, please refer to the LabVIEW Toolsets section beginning on page 86.
Instrument Drivers – The Key to Productive Test Development

Instrument drivers are the key to improving your test programming productivity. An instrument driver is a set of high-level, intuitive functions for controlling a GPIB, VXI, RS232/485, or computer-based instrument. The instrument driver functions handle the instrument command syntax, I/O interface protocol, data parsing, and scaling for you. LabVIEW has drivers for more than 650 instruments from all major instrument manufacturers.

Instrument drivers not only save you programming time and effort but also apply an important modular coding structure to your test programs. LabVIEW instrument drivers package instrument capabilities as a set of standard VIs. Each VI corresponds to a programmatic operation, such as configuring, reading from, writing to, and triggering the instrument. LabVIEW instrument drivers reduce your test program development time and simplify instrument control by eliminating the need to learn the complex, low-level programming protocol for each instrument.

The VXIplug&play Systems Alliance has endorsed LabVIEW instrument drivers as a core technology and a basis for industry standardization. LabVIEW is fully VXIplug&play compliant and can run all graphical and C-based instrument drivers that are VXIplug&play compliant. LabVIEW can automatically detect and load any VXIplug&play driver that is installed on your system.

IVI (Interchangeable Virtual Instruments)

IVI is a new architecture for building advanced instrument drivers. IVI instrument drivers are designed to handle the more rigorous requirements of production test systems for speed, flexibility, and long-term reusability. With IVI, you can build hardware and protocol-independent (GPIB, VXI, or RS-232) test programs, so you can preserve your investment in test software as your instruments and instrumentation platforms change. In addition to interchangeability, IVI drivers provide instrument simulation and high-speed state caching. See page 87 for more details on IVI instrument drivers.
LabVIEW Drivers for Industrial Automation

PLC and Device Servers
Some applications have real-time control needs or harsh environmental conditions that require use of PLCs or other devices. Our Industrial Automation Servers, described in detail on page 187, provide a standard programming interface to a range of PLCs, process controllers, analyzers, and industrial device networks. A device server is comprised of software components that perform basic I/O, provide the necessary communication protocol to exchange data and status information from a device, and manage the resources required for communications. For systems requiring continuous data updates from external devices as well as the remote control and resource management of multiple PLCs, and other factory-floor hardware and protocols, the Industrial Automation Servers combined with corresponding VI libraries provide an easy-to-use configurable interface between LabVIEW and BridgeVIEW, and numerous industrial automation devices.

Distributed I/O
LabVIEW also controls the National Instruments FieldPoint distributed I/O system, described on page 463, using the software server included free of charge. FieldPoint modules include discrete analog and digital I/O as well as RS-232/485 network modules.

These I/O modules mount onto either a screw terminal or spring terminal base. Adjacent terminal bases connect, forming a high-speed local bus, and mount directly onto a DIN rail or panel. FieldPoint features designed specifically for industrial automation include programmable power up, watchdog timers, a compact DIN rail package, and so on.

Industrial Communications Interfaces
National Instruments also offers industrial communications products to interface with networks such as FOUNDATION Fieldbus, PROFIBUS, CAN, and DeviceNet. In addition, RS232/485 serial interfaces for ISA, PCI, and PCMCIA provide standard connections to the PC from devices using those serial protocols. These products are programmable through LabVIEW VIs that communicate with driver level software. Please see page 806 for more information.

BridgeVIEW
For systems communicating with PLCs, National Instruments FieldPoint, or large numbers of channels of data acquisition, National Instruments recommends BridgeVIEW. BridgeVIEW begins with the LabVIEW development system and adds to it an event-driven engine that simplifies development of industrial monitoring, alarm management, and networking applications. BridgeVIEW combines the graphical programming language of LabVIEW with additional features for the industrial automation market. These additional features include OPC connectivity, security, and automation symbols. See page 179 for details on BridgeVIEW.

Table 1. National Instruments Industrial Communications Interfaces

<table>
<thead>
<tr>
<th>Industrial Communications Products</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT-DNET, PCMCIA-DNET, PCI-DNET</td>
<td>Interfaces to DeviceNet</td>
</tr>
<tr>
<td>AT-CAN, PCMCIA-CAN, PCI-CAN</td>
<td>Interfaces to CAN</td>
</tr>
<tr>
<td>AT-FBUS, PCMCIA-FBUS</td>
<td>Interfaces to FOUNDATION Fieldbus</td>
</tr>
<tr>
<td>PCI-485</td>
<td>Interfaces to PROFIBUS</td>
</tr>
</tbody>
</table>

Table 1. National Instruments Industrial Communications Interfaces
Localized Versions – Japanese, French, and German

Engineers and scientists, regardless of their primary language, conceptualize work in block diagrams, not text, so the programming methodology of LabVIEW matches this familiar style. Localized versions of LabVIEW give engineers and scientists from around the world a more natural and comfortable programming environment for developing applications in their native language. National Instruments offers versions of LabVIEW specifically for the Japanese, French, and German markets.


The LabVIEW German and French versions each currently feature translated documentation and software. They work with Windows NT/98/95/3.1. In addition, all LabVIEW development systems have built-in tools to help ease the process of translating applications from one language to another.

Worldwide Commitment to Success

National Instruments is committed to the continued success of LabVIEW programmers worldwide. These fully localized versions in German, French, and Japanese, with translated manuals and reference materials, will help more LabVIEW users develop faster and achieve success. The LabVIEW software environment that includes localized menus, virtual instrument (VI) libraries, dialog boxes, and numerous examples, eases development and optimizes performance.

For a free evaluation version or for ordering information, please contact your local National Instruments office.
## LabVIEW Cross-Platform Compatibility

### System Requirements

You can use LabVIEW on the operating system of your choice without sacrificing portability or reusability. The LabVIEW development system recompiles VIs on any of the platforms listed below so that you have the flexibility to work with the operating system that makes the most sense for your task, and still retain the ability to transfer and reuse VIs across your enterprise.

<table>
<thead>
<tr>
<th>Operating System</th>
<th>System Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Windows NT/98/95</strong></td>
<td>16 MB RAM, 32 MB recommended 486/DX, Pentium recommended For Windows NT users: Version 4.0, or later 85 MB disk space for full LabVIEW installation</td>
</tr>
<tr>
<td><strong>Mac OS (PowerPC)</strong></td>
<td>24 MB RAM Mac OS 7.12 or later 120 MB disk space for full LabVIEW installation</td>
</tr>
<tr>
<td><strong>Solaris</strong></td>
<td>32 MB RAM Solaris 2.4 or later XWindow System Software 75 MB disk space for full LabVIEW installation</td>
</tr>
<tr>
<td><strong>HP-UX</strong></td>
<td>32 MB RAM HP 9000 workstation, Model 700 Series HP-UX 10.0 or later HP-UX/CDE 75 MB disk space for full LabVIEW installation</td>
</tr>
</tbody>
</table>

Contact National Instruments for additional platform information.
### LabVIEW for Windows NT/98/95

<table>
<thead>
<tr>
<th>Development Systems</th>
<th>Part Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Development System (CD)</td>
<td>776670-03</td>
<td>73</td>
</tr>
<tr>
<td>Professional Development System (CD)</td>
<td>776678-03</td>
<td>73</td>
</tr>
<tr>
<td>Base Package (CD)</td>
<td>776671-03</td>
<td>73</td>
</tr>
<tr>
<td>Application Builder (3.5 in.)</td>
<td>776675-01</td>
<td>85</td>
</tr>
</tbody>
</table>

#### Add-On Software and Services
- Automated Test Toolset: 777868-03
- Enterprise Connectivity Toolset: 777871-03
- PID Control Toolset: 777874-03
- Vision Development Toolset: 777859-03
- Signal Processing Toolset: 777136-01
- System Simulation and Design Toolset: 777553-03
- Motion Control Tools
  - FlexMotion VIs: 777629-01
  - ValueMotion VIs: 777628-01
- Automation Symbols Toolkit: 777372-01

### LabVIEW for Mac OS

<table>
<thead>
<tr>
<th>Development Systems</th>
<th>Part Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Development System (CD)</td>
<td>776690-03</td>
<td>73</td>
</tr>
<tr>
<td>Professional Development System (CD)</td>
<td>776698-03</td>
<td>73</td>
</tr>
<tr>
<td>Application Builder (3.5 in.)</td>
<td>776695-01</td>
<td>85</td>
</tr>
</tbody>
</table>

#### Add-On Software
- Test Executive Toolkit: 776731-21
- Enterprise Connectivity Toolset: 777871-23
- PID Control Toolset: 777874-23
- IMAQ Vision: 777413-03
- Motion Control Tools
  - ValueMotion VIs: 777628-21
- Automation Symbols Toolkit: 777372-21

### LabVIEW for Sun

<table>
<thead>
<tr>
<th>Development Systems</th>
<th>Part Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Development System (CD)</td>
<td>776680-03</td>
<td>73</td>
</tr>
<tr>
<td>Professional Development System (CD)</td>
<td>776688-03</td>
<td>73</td>
</tr>
<tr>
<td>Application Builder</td>
<td>776685-01</td>
<td>85</td>
</tr>
</tbody>
</table>

#### Add-On Software
Contact your local National Instruments office for ordering information or visit [www.natinst.com/labview](http://www.natinst.com/labview)

### LabVIEW for HP-UX

<table>
<thead>
<tr>
<th>Development Systems</th>
<th>Part Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Development System (CD)</td>
<td>777010-03</td>
<td>73</td>
</tr>
<tr>
<td>Professional Development System (CD)</td>
<td>777018-03</td>
<td>73</td>
</tr>
<tr>
<td>Application Builder</td>
<td>777015-01</td>
<td>85</td>
</tr>
</tbody>
</table>

#### Add-On Software
Contact your local National Instruments office for ordering information or visit [www.natinst.com/labview](http://www.natinst.com/labview)

### LabVIEW for Concurrent PowerMAX

<table>
<thead>
<tr>
<th>Development Systems (DAT Tape)</th>
<th>Part Number</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Development System</td>
<td>777020-04</td>
<td>73</td>
</tr>
</tbody>
</table>

#### Add-On Software and Services
- Application Builder (DAT Tape): 777025-04
- PID and Automation Symbols Toolkit (DAT Tape): 776634-04

### LabVIEW Service and Support

#### Windows
- LabVIEW Software Subscription Program: 930000-02
- Basics I Training Course: 910013-xx
- Basics II Training Course: 910017-xx
- Advanced Modules Course: 910514-xx

#### Mac OS
- LabVIEW Software Subscription Program: 930000-01
- Basics I Training Course: 910013-xx
- Basics II Training Course: 910017-xx
- Advanced Modules Course: 910514-xx

#### Sun
- LabVIEW Software Subscription Program: 930000-03
- HP-UX LabVIEW Software Subscription Program: 930000-05

Part numbers listed denote single-user licenses. For multiuser licenses contact National Instruments.

*Please refer to Customer Education section to complete the part number.*