LabVIEW

Overview
National Instruments LabVIEW delivers the best way to acquire, analyze, and present data. LabVIEW is a graphical development environment that helps you quickly build data acquisition, instrumentation and control systems, boosting productivity and saving development time. With LabVIEW, you quickly create user interfaces for interactive control of your software system. To specify your system functionality, you simply assemble block diagrams – a natural design notation for scientists and engineers. The tight integration of LabVIEW with measurement hardware facilitates rapid development of data acquisition and control, analysis, and presentation solutions. LabVIEW contains powerful built-in measurement analysis and a graphical compiler for optimum performance. LabVIEW is available for Windows 2000/NT/Me/9x/XP, Mac OS, Linux, and Sun Solaris, and offers three different development system options.

Faster Development
LabVIEW graphical development is four to 10 times faster than other programming methods. With the modularity and hierarchical structure of LabVIEW, you can prototype, design, and modify systems in a short amount of time. You also can reuse LabVIEW code easily and quickly in other applications.

Better Investment
Using a LabVIEW system, you have access to a complete measurement and automation system at less than the cost of a single commercial instrument. In addition, user-configurable LabVIEW systems are flexible enough to adapt to technology changes, resulting in a better long-term investment.

LabVIEW
• Intuitive, industry-standard graphical development environment
• Integrate a wide variety of I/O with more than 1,500 instrument drivers from over 100 vendors
• Lower development costs through rapid development
• Powerful, built-in measurement analysis
• Compiled for faster performance

LabVIEW Real-Time Module
• Graphical development for real-time control and reliability

LabVIEW Datalogging and Supervisory Control Module
• Graphical development for monitoring and distributed applications
• Networked system management tools

LabVIEW Vision Development Module
• Graphical development for high-level machine vision and image processing

LabVIEW Add-On Software
• Report Generation for Microsoft Office
• Enterprise Connectivity
• Application Builder
• PID Control
• Signal Processing
• Sound and Vibration
• Order Analysis
• Database Connectivity

Operating Systems
• Windows 2000/NT/XP/Me/9x
• Mac OS
• Sun Solaris
• Linux
• Real-Time (see page 56)

Optimal Performance
All LabVIEW applications execute at compiled speed for optimal performance. With the LabVIEW Professional Development System or Application Builder, you can build stand-alone executables or dynamic link libraries (DLLs) to securely distribute your code or to call LabVIEW code from other programming environments.

Open Development Environment
With the open development environment of National Instruments LabVIEW, you can connect to other applications through .NET, ActiveX, the Web, XML, IrDA, DLLs, shared libraries, SQL, DataSocket, TCP/IP, and numerous other methods. Use LabVIEW to quickly create networked measurement and automation systems that integrate the latest technologies in Web publishing and remote data sharing. LabVIEW also has driver libraries available for plug-in data acquisition, signal conditioning, serial, GPIB, VXI, PXI, instruments, image acquisition, and motion control.

*Visit ni.com/mac for the latest Mac OS information.
In addition to the LabVIEW development systems, National Instruments offers a variety of add-on modules and toolsets that extend the functionality of LabVIEW. These tools save you valuable development time, and help you efficiently solve your application challenges.

LabVIEW Data Logging and Supervisory Control Module
The NI LabVIEW Data Logging and Supervisory Control Module offers tools to help you monitor your distributed systems. Designed to let you focus on acquiring data, the LabVIEW Data Logging and Supervisory Control Module has many built-in tools to increase your productivity. These tools include automatic data logging, full alarm management and event logging, and real-time and historical trending. The module includes a networked database which features built-in security and OPC connectivity. Designing a distributed system is now easier than ever. See page 53 for more information.

LabVIEW Real-Time Module
For applications that require real-time performance, National Instruments offers LabVIEW Real-Time. LabVIEW Real-Time downloads standard LabVIEW code to a dedicated hardware target running a real-time operating system independent from Windows. See page 56 for more information.

LabVIEW Vision Development Module
The LabVIEW Vision Development Module is for scientists, automation engineers, and technicians who are developing LabVIEW machine vision and scientific imaging applications. The LabVIEW Vision Development Module includes IMAQ Vision, a library of vision functions, and IMAQ Vision Builder, an interactive environment for vision applications. Unlike any other vision products, IMAQ Vision Builder and IMAQ Vision work together to simplify vision software development so that you can rapidly apply vision to your measurement and automation applications. See page 58 for more information.

LabVIEW Toolsets
For specialized measurement and automation applications, National Instruments offers a wide range of add-on software tools to speed your system development. The table below lists these tools:

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Countless Applications

Engineers and scientists implement NI LabVIEW applications in many industries worldwide, including automotive, telecommunications, aerospace, semiconductor, electronic design and production, process control, biomedical, and others. Applications cover all phases of product development from design to production. By using LabVIEW throughout your organization, you can efficiently share information and applications, helping boost productivity.

Test and Measurement

LabVIEW is an industry-standard development tool for test and measurement applications. LabVIEW-based test programs, also deliver the industry’s largest instrument driver library, giving you a consistent development and execution environment for your entire system.

Process Control and Factory Automation

In process control and factory automation applications, many engineers look to LabVIEW for the high-speed, high-channel-count measurement and control. For large, sophisticated industrial automation and control applications, the LabVIEW family includes the LabVIEW Datalogging and Supervisory Control Module which is designed specifically for monitoring large numbers of I/O points, communicating with industrial controllers and networks, and providing PC-based control.

Machine Monitoring and Control

LabVIEW is ideal for machine monitoring and predictive maintenance applications that need deterministic control, vibration analysis, vision and image processing, and motion control. With the LabVIEW platform of products, including the LabVIEW Real-Time Module for real-time deterministic control and the LabVIEW Datalogging and Supervisory Control Module, you can create powerful machine monitoring and control applications quickly and accurately.

Research and Analysis

The built-in LabVIEW measurement analysis library provides everything you need in an analysis package. Scientists and researchers use LabVIEW to analyze and compute real results for research applications in the biomedical, aerospace, and energy industries, among others. Some of the available functions for signal generation and processing, digital filtering, windowing, curve-fitting, and limit mask testing are listed on page 73.

For specialized analysis, such as joint time-frequency analysis, wavelets, and model-based spectral analysis, LabVIEW offers the specially designed Signal Processing Toolset. See page 94 for more information.

Sound and Vibration

National Instruments also offers two toolsets that extend LabVIEW for applications involving measurement of sound, vibration, and other dynamic signals. The first is the Sound and Vibration Toolset, which enhances LabVIEW with features such as fractional-octave analysis (compliant with ANSI and IEC standards), level measurements, engineering unit tracking, and weighting filters (A, B, C, and custom). The second toolset for sound and vibration measurement is the Order Analysis Toolset. Built on a patent-pending algorithm, the software extends LabVIEW with tools for analysis, extraction, and tracking of harmonic orders – signal components that are related to the running speed of mechanical devices with rotating components.

"LabVIEW made it possible to shorten development time because it facilitates easy changing and creation of the front panel. The value of using LabVIEW was proven by this development project, and we plan to use it to develop other test and measurement systems."
– Tsuneo Kimura, PE Dept., 2nd Power Section, Toyota Motor Corp.
LabVIEW Graphical Development

Draw Your Own Solution
With National Instruments LabVIEW, you build a graphical program called a virtual instrument (VI) instead of writing a text-based program. You quickly create a front panel user interface that gives you interactive control of your system. To add functionality to the user interface, 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 selecting objects such as numeric displays, meters, gauges, thermometers, tanks, LEDs, charts, and graphs. When you complete and run your VI, you use the front panel to control your system whether you move a slide, zoom in on a graph, or enter a value with the keyboard.

Construct the Graphical Block Diagram
To program the VI, you construct the block diagram without worrying about the syntactical details of text-based programming languages. To build a block diagram, select objects (icons) and connect them with wires to transfer data among block diagram objects. These objects include simple arithmetic functions, advanced acquisition and analysis routines, network and file I/O operations, and more.
LabVIEW Graphical Development

Dataflow Programming
NI LabVIEW uses a patented dataflow programming model that frees you from the linear architecture of text-based programming languages. Because the execution order in LabVIEW is determined by the flow of data between nodes and not by sequential lines of text, you can create block diagrams that execute multiple operations in parallel. Consequently, LabVIEW is a multitasking system capable of running multiple execution threads and multiple VIs in parallel.

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

Compiled Execution
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. You even can use the LabVIEW profiler to analyze and optimize time-critical operations. Thus, LabVIEW increases your productivity without sacrificing execution speed.
LabVIEW Graphical Development

The following list covers only part of the functionality available in the complete LabVIEW development system. Contact National Instruments for FREE, fully functional NI LabVIEW evaluation software, or complete a request form on the Web at ni.com/labview.

Controls and Indicators
Buttons/switches/LEDs
Slides/digital displays
Gauges/dials/knobs
Tanks/thermometers
Graphs/charts (analog and digital)
Tables/arrays
Intensity plots
Menus/lists/rings
Text boxes
Decorations
ActiveX controls
Tip strips
Tab dialog boxes
Tab controls

File I/O
Spreadsheet
Binary/ASCII
Datalogging

Open Connectivity
Internet/Networking
Databases
NI DataSocket
TCP/IP
UDP
.NET/ActiveX
DLLs/shared libraries
AppleEvents/named pipes
MATLAB**
XML
IrDA

Instrument Control
GPIB/CAMAC
VXI/PXI
Serial
Industrial devices
More than 1500 instrument drivers

Data Acquisition and Control Configuration
DAQ Solution Wizard
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

Remotely control your LabVIEW application over the Web with no programming

Automatic Program Generation with the NI-DAQ Solution Wizard
LabVIEW Graphical Development

Programming Structures
- While Loops/For Loops
- Case structures
- Sequence structures
- Event structures

Programming Fundamentals
- Numeric computations
- Boolean logic
- Array/string manipulation
- Time and date functions
- Multi-data type structures
- Custom subroutines

Waveform Measurements
- DC/rms**
- Single-tone analysis**
- Harmonic distortion analysis**
- SINAD analysis**
- Power and cross-power spectra**
- Frequency response**
- Power spectral density**
- Limit mask testing**
- Pulse and transition

Visualization
- 3D surface, line, and contour plots**
- Custom graphics(animation)**

Math
- Text-based formula nodes**
- Ordinary differential equations**
- Optimization methods**
- Root solving**
- Gamma/Bessel/Jacobi/Beta and other functions**
- Linear algebra
- Probability and statistics

Signal Processing
- Signal generation**
- Image processing*
- Curve fitting**
- Windowing**
- Filtering**
- Point-by-point and array-based**

Optimization and Applications Management
- True compiled performance on all platforms
- Profiling of memory usage and execution speed***
- Multithreading
- Source code control/complexity metrics***
- Hierarchy window
- Full printed and online documentation set
- Advanced report generation**
- Documentation for quality standards***

Debugging
- Breakpoints
- Probes/custom probes
- Single-stepping modes
- Execution highlighting
- Graphical differencing tools***

* Included in the LabVIEW Vision Development Module
** Included in the Full and Professional Development Systems
*** Included in the Professional Development System
LabVIEW Measurement Analysis and Digital Signal Processing

Built-In Measurement Analysis and Digital Signal Processing
With National Instruments LabVIEW, you have the built-in digital signal processing, analysis, and visualization capabilities you need for your measurement applications.

High-level measurement analysis tools simplify development of applications that require common measurement analysis routines such as spectral analysis, filtering, and statistics. At the same time, you have the flexibility to construct custom analysis algorithms using lower-level tools such as linear algebra, FFT, and curve fitting.

The following describes a few highlights of the measurement analysis capabilities of LabVIEW. Visit ni.com/analysis for a complete list and more details; a partial listing appears on page 51.

Complex Measurements Made Easy
Despite the complexity of the underlying algorithms that implement these functions, you will find LabVIEW analysis capabilities easy to use. For example, a set of built-in measurement functions uses the waveform data type to accept real-world, time-domain signal inputs directly from DAQ hardware and reports results ready for charting, graphing, or additional stages of signal processing.

Measurements and Mathematics
NI LabVIEW includes a variety of other measurement analysis tools. Examples include curve fitting, signal generation, peak detection, and probability and statistics. Measurement analysis functions can determine signal characteristics such as DC/rms levels, total harmonic distortion (THD/SINAD), impulse response, frequency response, and cross-power spectrum. Using LabVIEW, you can also deploy numerical tools for solving differential equations, optimization, root finding, and other mathematical problems. In addition, you can extend these built-in capabilities by entering MathWorks MATLAB scripts directly in your LabVIEW programs.

For charting and graphing, you can rely on the built-in LabVIEW 2D and 3D visualization tools. 2D tools include features such as autoscaling X and Y ranges, reconfigurable attributes (point/line styles, colors, and more), and cursors. Microsoft Windows users can employ OpenGL-based 3D graphs and then dynamically rotate, zoom, and pan these graphs with the mouse.

LabVIEW Add-On Toolsets for Analysis
For additional signal processing and analysis functionality, see these other National Instruments toolsets:
- Sound and Vibration Toolset (see page 68)
- Order Analysis Toolset (see page 69)
- Signal Processing Toolset (see page 70-71)
LabVIEW Measurement Analysis
and Digital Signal Processing

LabVIEW Data Analysis and Math Libraries
Listed below are the analysis tools available for LabVIEW.
For additional information on LabVIEW add-on tools for analysis, please refer to our add-on software guide on page 44 or visit ni.com/analysis

Measurement
Waveform-Based**
- Averaged DC rms and cycle average and rms
- Pulse transition (rise, slew, overshoot, ...)
- Pulse width/period/duty
- Pulse amplitude and levels
- Signal noise and distortion (SINAD) analyzer
- Harmonic distortion analyzer
- Cross spectra
- Sine tone measurement
- FFT Spectrum
- Frequency response function
- Power spectrum
- Power spectral density

Array-Based
- AC and DC Estimator
- Amp and frequency estimate
- Amp and phase spectrum
- Auto power spectrum
- Cross power spectrum
- Harmonic analyzer
- Impulse response
- Network functions (avg)
- Power and frequency estimate
- Power spectrum
- Scaled time-domain window
- Spectrum unit conversion
- Transfer function

Signal Monitoring/Triggering
Waveform-Based**
- Basic level trigger detection
- Limit testing
- Limit specification
- Limit specification by function
- Waveform peak detection

Array-Based
- Peak detection
- Pulse parameters
- Threshold peak detector

Signal Generation
Waveform-Based**
- Basic multitone
- Basic multitone with amplitudes
- Function generator
- Formula waveform
- Triangle waveform
- Square waveform
- Sine waveform
- Multitone generator
- Uniform white noise
- Gaussian white noise
- Arbitrary wave
- Chirp pattern
- Impulse pattern
- Periodic random noise
- Ramp pattern
- Sawtooth wave
- Sinc pattern
- Sine pattern
- Sine wave
- Square wave
- Triangle wave
- Uniform white noise
- Gaussian white noise

Windowing
Waveform/Array-Based
- Blackman
- Blackman-Harris
- Cosine tapered
- Exact Blackman
- Exponential
- Flat top
- Force
- General cosine
- Hamming
- Hanning
- Kaiser-Bessel
- Triangle

Digital Filters
Waveform-Based**
- FIR/IIR
- Array-Based
- Bessel
- Butterworth
- Cascade
- Chebyshew
- Elliptic
- Equiripple
- FIR/IIR
- Inverse Chebyshew
- Median
- Parks-McClellan

Statistics
- 1D, 2D, and 3D ANOVA
- Chi square distribution
- Contingency table
- Erf(x) and erfc(x)
- F distribution
- T distribution
- General histogram
- Histogram
- Inverse chi square
- Distribution
- Inverse F distribution
- Inverse normal distribution
- Inverse T distribution
- Mean*
- Median*
- Mode*
- Moment about mean
- Mean squared error (MSE)
- Normal distribution
- Polynomial interpolation
- Rational interpolation
- Root mean square (rms)
- Spline interpoint/interpolation
- Standard deviation*
- Variance

Signal Processing
Auto correlation
Convolution
Cross power
Cross correlation
Decimate
Deconvolution
Derivative x(t)
Fast Hilbert transform
Fast Hartley transform
Integral x(t)
FFT/Inverse FFT (Re + Im)
Inverse fast Hilbert Transform
Unwrap phase
Y[i]=Clip[X[i]]
Y[i]=X[i-n]

Curve Fitting
Exponential fit
General least squares linear fit
General polynomial fit
Linear fit
Nonlinear Lev-Mar fit
1D and 2D linear evaluation*
1D and 2D polynomial evaluation*
Numeric integration
Polynomial to rect/Rect to polar
Scale 1D/2D
Find polynomial roots

Linear Algebra
- Real/Complex A X B*
- Real/Complex A X vector*
- Determinant*
- Dot product*
- Inverse matrix*
- Linear equations
- Normalize matrix/vector
- Outer product*
- Trace
- Unit vector
- LU factorization
- Cholesky factorization
- QR factorization
- SVD factorization
- Eigenvectors/Eigenvalues
- Matrix condition number
- Matrix norm and rank
- Pseudoinverse matrix
- Complex factorization
- Complex inverse matrix
- Complex linear equations
- Complex eigenvectors/values
- Complex determinant
- Complex matrix condition number
- Complex matrix norm and rank
- Complex pseudoinverse matrix
- Complex dot product
- Complex outer product
- Complex vector norm
- Generate special matrix
- Test positive definite matrix

Mathematics/Numerical Methods
- Ordinary differential equations
- Optimization
- Root solving

*Denotes VIs that are shipped with the Base package of LabVIEW for Windows 2000/NT/XP/Me/9x.
**Waveform VIs input a time-domain signal and output a scaled measurement.
LabVIEW Development Systems

Development System Options
National Instruments offers a number of NI LabVIEW development systems and programming tools to help you build professional applications. Choose from any of three development system options to meet the demands of your application.

LabVIEW Professional Development System
The NI LabVIEW Professional Development System includes all the functionality of the Full Development system and adds tools to facilitate the development of high-end, sophisticated instrumentation systems for developers working in teams, users developing large suites of VIs, or programmers needing to adhere to stringent quality standards. The Professional Development System also includes the LabVIEW Application Builder for building stand-alone executables and shared libraries (DLLs) and for creating distribution kits* (see page 59 for more details on LabVIEW Application Builder). In addition, the development system furnishes source code control tools and offers utilities for quantitatively measuring the complexity of your applications. Additionally, it includes graphical differencing tools to help debug multiple versions of VIs.

LabVIEW Full Development System
The NI LabVIEW Full Development System contains all of the functionality of the Base Package and adds all of the tools you need to develop instrumentation systems. It includes GPIB, VISA, VXI, RS-232, DAQ, and instrument driver libraries for data acquisition and instrument control. The measurement analysis libraries add digital signal processing, measurement analysis functions, and a myriad of linear algebra and mathematical functions. The development system also provides functions for direct access to DLLs, .NET/ActiveX, and other external code. Other features of the system include Web server and publishing tools, advanced report generation tools, the ability to call MATLAB scripts*, 3D surface, line, and contour graphs*, and custom graphics and animation.

LabVIEW Base Package*
Use the NI LabVIEW Base Package, the minimum LabVIEW configuration, for developing basic data acquisition, instrument control, and data presentation applications.

Debug License for LabVIEW
If you deploy LabVIEW applications, including LabVIEW tests for use with TestStand, the debug license allows you to install the LabVIEW development system on the target machines so you can step into your test code for complete test debugging. This license cannot be used for program development.

NI Developer Suite
NI Developer Suite is the complete, comprehensive LabVIEW package and subscription program that bundles the LabVIEW Professional Development System and a wide range of add-on LabVIEW toolsets. You will receive quarterly updates with latest versions of our software for a year, keeping you current with the latest powerful, industry-standard software at your fingertips.

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<th>NI LabVIEW Base Package*</th>
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<td>✓</td>
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</tr>
<tr>
<td>Programming structures and fundamentals</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Instrument control</td>
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<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Data acquisition</td>
<td>✓</td>
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<td>✓</td>
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<tr>
<td>Image acquisition and motion control</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>File I/O and simple report generation</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Debugging</td>
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</tr>
<tr>
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<td>✓</td>
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</tr>
<tr>
<td>Web publishing tools</td>
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<tr>
<td>ActiveX*, TCP/IP, UDP, DataSocket</td>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Translation tools</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Signal processing/analysis**</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Call HiQ and MATLAB scripts*</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Custom graphics and animation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Advanced report generation tools</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Stand-alone executables and shared libraries (DLLs)</td>
<td>✓</td>
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<tr>
<td>Application and shared library deployment tools*</td>
<td>✓</td>
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<tr>
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<tr>
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<tr>
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<tr>
<td>Large project documentation tools</td>
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<tr>
<td>Printed documentation on software engineering with LabVIEW</td>
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<td>Printed documentation on quality and programming standards</td>
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*Available only on Windows platforms.  **Go to ni.com/analysis for a complete list of functions.
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### LabVIEW Service and Support Software Subscription Service

- **Windows 2000/NT/XP/Me/9x** (930000-02) .. 18
- **Mac OS** (930000-02) .. 18
- **Linux** (930000-02) .. 18
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### Training

- **Basics I Training Course** (910013-xx†) .. 761
- **Basics II Training Course** (910017-xx†) .. 761
- **Advanced Performance and Communication Course** (910514-xx†) .. 761
- **Advanced Application Development** (910607-01) .. 762
- **Data Acquisition and Signal Conditioning** (910010-01) .. 762

NI Developer Suite offers many of these products bundled with other NI software tailored for test or control applications. See page 39 for more information.

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

†Please refer to the Training Services section to complete the part number.

*Visit [ni.com/mac](https://ni.com/mac) for the latest Mac OS information.