

What's New in Instrument Control

Agenda

- Bus Characteristics
 - GPIB, USB, PCI, PCI Express, Ethernet/LAN/LXI
- Hybrid Systems
- GPIB ENET/1000
 - NI Spy, GPIB Analyzer, Performance Tips
- IC SW 2011 Released
 - LabVIEW 2011
 - VISA 5.0
 - Instrument Drivers

Selecting an Instrument Control Bus

PXIExpress™

PCI



Fast Ethernet



GPIB



PCI 
EXPRESS™



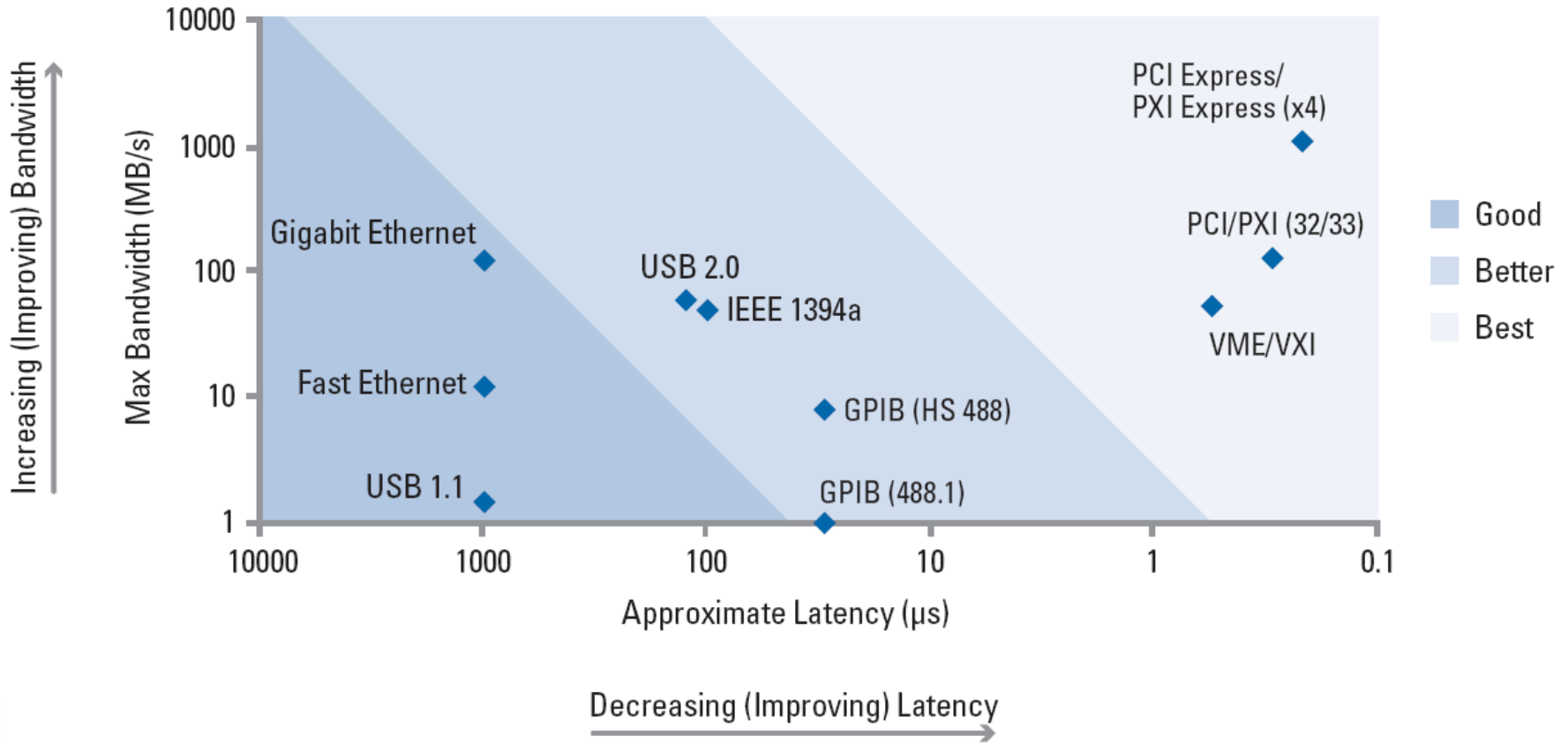
Gigabit Ethernet



VMEbus

CompactPCI®

Latency versus Bandwidth



GPIB/IEEE-488

HS488 Max Bandwidth: 8 MB/s
488.1 Max Bandwidth: 1.8 MB/s
Bandwidth Distribution: Shared
Bandwidth Rating: Good
Latency Rating: Better



- More than 30 years of compatibility
- Robust and reliable
- Widest industry adoption
- Largest installed base of instruments

- Ideal for:
 - Automating existing equipment
 - Hybrid systems
 - Systems requiring highly specialized instruments

USB

Max Bandwidth: 60 MB/s (Hi-Speed USB)

Bandwidth Distribution: Shared across all ports

Bandwidth Rating: Better

Latency Rating: Better

- PC ubiquity
- Simplest plug-and-play connectivity (autodetection)
- Ideal for:
 - Portable desktop and benchtop applications
 - Small, low-cost systems



Ethernet/LXI

1000BaseT Max Bandwidth: 125 MB/s

(Gigabit Ethernet)

100BaseT Max Bandwidth: 12.5 MB/s

(Fast Ethernet)

Bandwidth Distribution: Shared across network

Bandwidth Rating: Better

Latency Rating: Good



- Remote capabilities
- PC ubiquity
- LXI adds optional timing and triggering
 - Synchronization through IEEE 1588 (Class B)
 - Triggering support (Class A)
- Ideal for:
 - Distributed systems
 - Remote monitoring

PCI and PCI Express

PCI Express Bandwidth: (x1) 250 MB/s –
(x16) 4000 MB/s

PCI Express Bandwidth Distribution:
Dedicated per device

PCI Max Bandwidth: 132 MB/s

PCI Bandwidth Distribution: Shared

Bandwidth Rating: Best

Latency Rating: Best

- Best bandwidth and latency
- PC ubiquity
- Enables lower instrument cost
- Ideal for:
 - Useful when a PC is already in the system
 - Data-intensive systems



PXI and PXI Express

PXI Express Bandwidth: (x1) 250 MB/s –
(x8) 2000 MB/s

PXI Express Bandwidth Distribution:
Dedicated per device

PXI Max Bandwidth: 132 MB/s

PXI Bandwidth Distribution: Shared

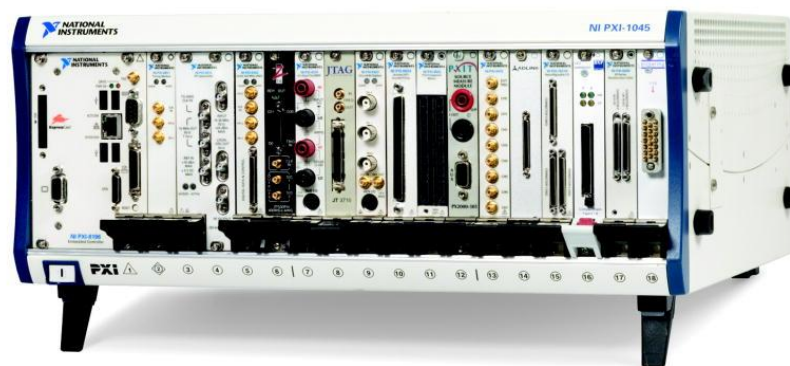
Bandwidth Rating: Best

Latency Rating: Best





Ideal for:

- High-performance systems
- Integration of several types of instruments
- Timing and synchronization

- Best bandwidth and latency
- Based on rugged CompactPCI physical standard
- Adds timing and synchronization to CompactPCI
 - Trigger bus
 - Star trigger
 - 10 or 100 MHz shared system clock



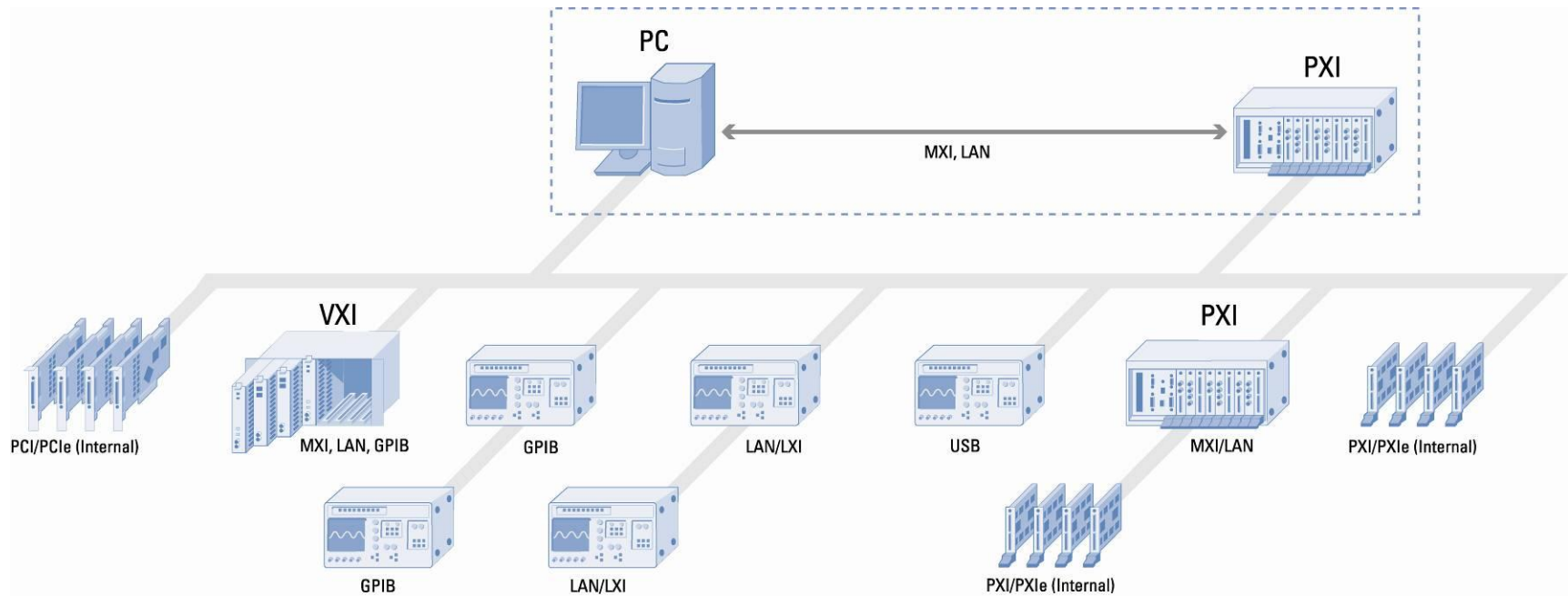
Bus Characteristics

Bus	Features	Application	Stats										
 <p>GPIB</p>	<ul style="list-style-type: none"> • More than 30 years of compatibility • Robust and reliable • Widest industry adoption 	<ul style="list-style-type: none"> • Automating existing equipment • Hybrid systems • Systems requiring highly specialized instruments 	<table border="0"> <tr> <td>Bandwidth</td> <td>1.8 / 8 MB/s</td> </tr> <tr> <td>Latency</td> <td>30 μs</td> </tr> <tr> <td>Cable Length</td> <td>20 m</td> </tr> <tr> <td>Setup Time</td> <td>Better</td> </tr> <tr> <td>Ruggedness</td> <td>Best</td> </tr> </table>	Bandwidth	1.8 / 8 MB/s	Latency	30 μ s	Cable Length	20 m	Setup Time	Better	Ruggedness	Best
Bandwidth	1.8 / 8 MB/s												
Latency	30 μ s												
Cable Length	20 m												
Setup Time	Better												
Ruggedness	Best												
 <p>USB</p>	<ul style="list-style-type: none"> • PC ubiquity • Auto-detectable 	<ul style="list-style-type: none"> • Portable desktop and benchtop applications • Small, low-cost systems 	<table border="0"> <tr> <td>Bandwidth</td> <td>60 MB/s</td> </tr> <tr> <td>Latency</td> <td>125 μs</td> </tr> <tr> <td>Cable Length</td> <td>5 m</td> </tr> <tr> <td>Setup Time</td> <td>Best</td> </tr> <tr> <td>Ruggedness</td> <td>Good</td> </tr> </table>	Bandwidth	60 MB/s	Latency	125 μ s	Cable Length	5 m	Setup Time	Best	Ruggedness	Good
Bandwidth	60 MB/s												
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Ruggedness	Good												
 <p>Ethernet/LXI</p>	<ul style="list-style-type: none"> • Remote capabilities • PC ubiquity • LXI adds optional timing and triggering 	<ul style="list-style-type: none"> • Distributed systems • Remote monitoring 	<table border="0"> <tr> <td>Bandwidth</td> <td>12.5 / 125 MB/s</td> </tr> <tr> <td>Latency</td> <td>1000 μs</td> </tr> <tr> <td>Cable Length</td> <td>100 m</td> </tr> <tr> <td>Setup Time</td> <td>Good</td> </tr> <tr> <td>Ruggedness</td> <td>Good</td> </tr> </table>	Bandwidth	12.5 / 125 MB/s	Latency	1000 μ s	Cable Length	100 m	Setup Time	Good	Ruggedness	Good
Bandwidth	12.5 / 125 MB/s												
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Cable Length	100 m												
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Ruggedness	Good												
 <p>PXI™</p>	<ul style="list-style-type: none"> • Based on rugged CompactPCI physical standard • Adds timing and synchronization to CompactPCI 	<ul style="list-style-type: none"> • High-performance systems • Integration of several types of instruments • Timing and synchronization 	<table border="0"> <tr> <td>Bandwidth</td> <td>250 / 4000 MB/s</td> </tr> <tr> <td>Latency</td> <td>0.7 μs</td> </tr> <tr> <td>Cable Length</td> <td>7 m</td> </tr> <tr> <td>Setup Time</td> <td>Better</td> </tr> <tr> <td>Ruggedness</td> <td>Best</td> </tr> </table>	Bandwidth	250 / 4000 MB/s	Latency	0.7 μ s	Cable Length	7 m	Setup Time	Better	Ruggedness	Best
Bandwidth	250 / 4000 MB/s												
Latency	0.7 μ s												
Cable Length	7 m												
Setup Time	Better												
Ruggedness	Best												

The Right Bus for Your Application

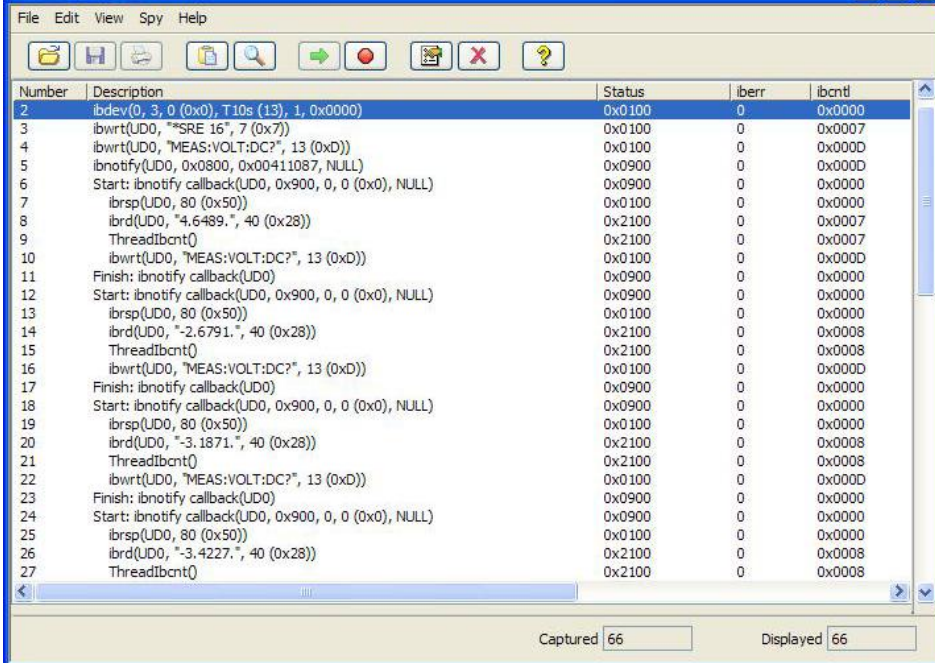
- No single bus technology solves all needs
 - GPIB → stand-alone instrument reuse, specialized instruments
 - PCI/PCI Express → best bandwidth and latency performance
 - PXI/PXI Express → best bandwidth and latency + timing and triggering
 - USB → autodetecting plug-and-play connectivity
 - Ethernet/LAN/LXI → distributed or remote systems
- Hybrid systems are often needed to integrate several technologies

Hybrid Systems Provide Flexibility



NI IO Trace - Driver Logging Utility

- Driver API logging utility for troubleshooting
- Captures low-level driver calls from a variety of NI drivers
 - DAQmx, NI-488.2, NI-VISA, NI-VXI, NI-Sync, NI Modular instruments
- Displays parameters and return values, timestamps and other information for each driver call
- Tool runs in parallel with your application and requires no code changes
- Features include logging to disk, Custom error actions and programmatic control from LabVIEW



The screenshot shows the NI IO Trace utility window. The window title is "NI IO Trace" and it has a menu bar with "File", "Edit", "View", "Spy", and "Help". Below the menu bar is a toolbar with icons for file operations, search, and execution. The main area is a table with the following columns: "Number", "Description", "Status", "iberr", and "ibcntl". The table contains 27 rows of data, showing various driver calls and their return values. At the bottom of the window, there are two input fields: "Captured" with the value "66" and "Displayed" with the value "66".

Number	Description	Status	iberr	ibcntl
2	ibdev(0, 3, 0 (0x0), T10s (13), 1, 0x0000)	0x0100	0	0x0000
3	ibwrt(UD0, "SRE 16", 7 (0x7))	0x0100	0	0x0007
4	ibwrt(UD0, "MEAS:VOLT:DC?", 13 (0xD))	0x0100	0	0x000D
5	ibnotfy(UD0, 0x0800, 0x00411087, NULL)	0x0900	0	0x000D
6	Start: ibnotfy callback(UD0, 0x900, 0, 0 (0x0), NULL)	0x0900	0	0x0000
7	ibrsp(UD0, 80 (0x50))	0x0100	0	0x0000
8	ibrd(UD0, "4.6489.", 40 (0x28))	0x2100	0	0x0007
9	ThreadIbcnt()	0x2100	0	0x0007
10	ibwrt(UD0, "MEAS:VOLT:DC?", 13 (0xD))	0x0100	0	0x000D
11	Finish: ibnotfy callback(UD0)	0x0900	0	0x0000
12	Start: ibnotfy callback(UD0, 0x900, 0, 0 (0x0), NULL)	0x0900	0	0x0000
13	ibrsp(UD0, 80 (0x50))	0x0100	0	0x0000
14	ibrd(UD0, "-2.6791.", 40 (0x28))	0x2100	0	0x0008
15	ThreadIbcnt()	0x2100	0	0x0008
16	ibwrt(UD0, "MEAS:VOLT:DC?", 13 (0xD))	0x0100	0	0x000D
17	Finish: ibnotfy callback(UD0)	0x0900	0	0x0000
18	Start: ibnotfy callback(UD0, 0x900, 0, 0 (0x0), NULL)	0x0900	0	0x0000
19	ibrsp(UD0, 80 (0x50))	0x0100	0	0x0000
20	ibrd(UD0, "-3.1871.", 40 (0x28))	0x2100	0	0x0008
21	ThreadIbcnt()	0x2100	0	0x0008
22	ibwrt(UD0, "MEAS:VOLT:DC?", 13 (0xD))	0x0100	0	0x000D
23	Finish: ibnotfy callback(UD0)	0x0900	0	0x0000
24	Start: ibnotfy callback(UD0, 0x900, 0, 0 (0x0), NULL)	0x0900	0	0x0000
25	ibrsp(UD0, 80 (0x50))	0x0100	0	0x0000
26	ibrd(UD0, "-3.4227.", 40 (0x28))	0x2100	0	0x0008
27	ThreadIbcnt()	0x2100	0	0x0008

Driver Logging API Support

- LabVIEW
- NI-488.2
- NI-VXI
- NI-VISA
- NI-DAQmx
- IviDmm
- IviScope
- IviSwitch
- IviFgen
- IviDCPwr
- IviPwrMeter
- IviSpecAn
- NI-DMM
- NI-SCOPE
- NI-SWITCH
- NI-FGEN
- NI-DCPower
- NI-RFSA
- NI-RDSG
- NI-CAN
- Switch Executive
- NI-Sync
- IviRFSigGen

GPIB Analyzer

- Powerful GPIB bus analysis and debugging tool
- Requires “+” boards for capturing
 - PCI-GPIB+, PCIe-GPIB+/LP
- Logs each line transition at a resolution of 50ns
- Special markers used for GPIB command messages
- ASCII and Hex representation of GPIB data lines

The screenshot shows the GPIB Analyzer software interface. The title bar reads "GPIB Analyzer - C:\Program Files\National Instruments\NI-488.2\Analyzer\sample.cap". The interface is divided into several sections:

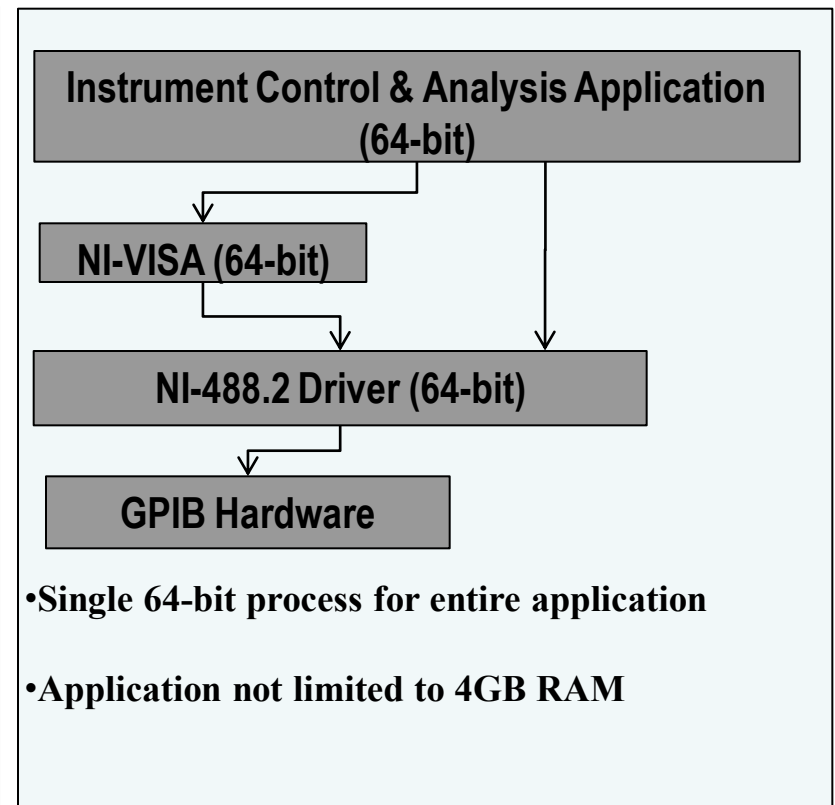
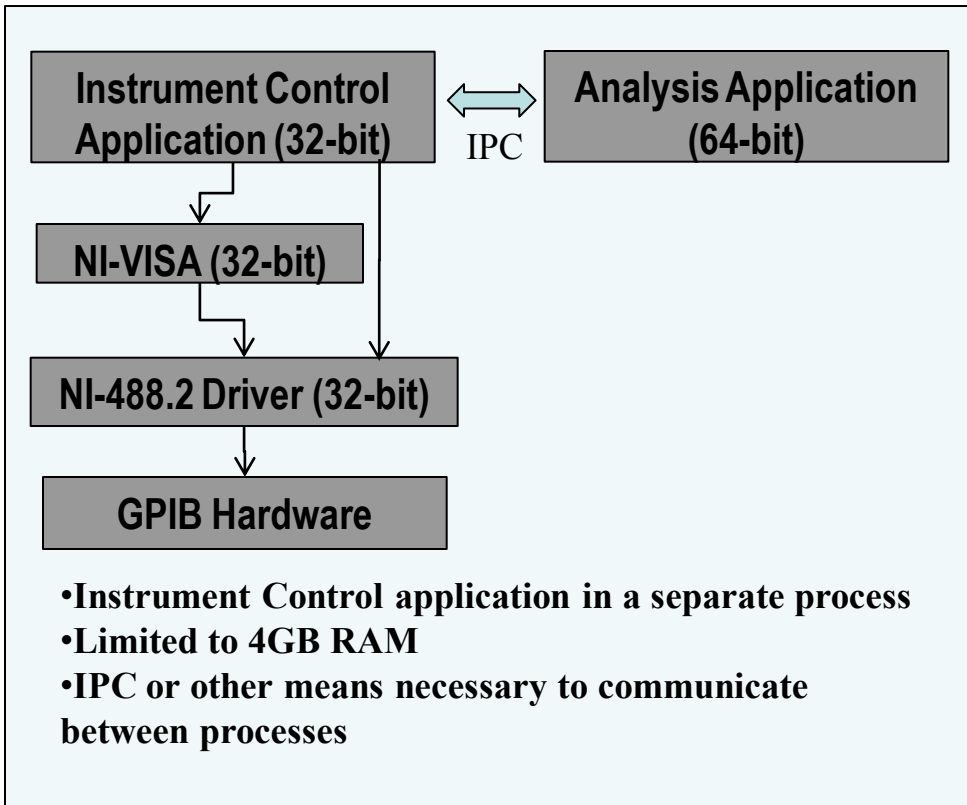
- Capture Settings:** Includes fields for Stimulus, Capture size (40000), Data Command Control, Handshake rate (None), and buttons for Find, Find Next, and Switch to Active Display.
- Markers & Statistics:** Includes fields for From (Begin), To (End), Go To (Begin), Number of capture events (52), Time elapsed (3s 487ms 208us), and Capture events per second (14.625).
- Display mode:** Set to Detailed.
- Data Table:** A table with columns for M, Timestamp (mi, s, ms, us, ns), Data (A, H, 87654321), Control (E, A, S, R, I, NR, ND, D), and various GPIB markers (EOI, IFC, REN, TAO, UNL, LA1, SDC, ATN, DAB, DAB, DAB, DAB, EOI, EOI, ATN, LAO, TAI, ATN, DAB, DAB, DAB, DAB, DAB, DAB).

M	Timestamp					Data	Control													
	mi	s	ms	us	ns		A	H	8	7	6	5	4	3		2	1	NR	ND	D
	0	0	0	0	50	F	46	01000110	0	1	0	0	0	1	0	0	0	0	EOI↑	IFC↑
	0	0	0	241	300	F	46	01000110	0	1	0	0	0	0	1	0	0	0	EOI↓	ATN↑
	0	0	0	3	400	F	46	01000110	0	1	0	1	0	0	0	1	0	0	IFC↓	REN↑
	0	0	2	539	900	@	40	01000000	0	1	0	1	0	0	0	1	1	TAO		
	0	0	0	134	400	?	3f	00111111	0	1	0	1	0	0	0	1	1	UNL		
	0	0	0	8	700	!	21	00100001	0	1	0	1	0	0	0	1	1	LA1		
	0	0	0	8	700	4	00000100	0	1	0	1	0	0	0	0	1	1	SDC		
	0	1	103	869	550	@	40	01000000	0	1	0	1	0	0	0	1	1	TAO		
	0	0	0	8	750	?	3f	00111111	0	1	0	1	0	0	0	1	1	UNL		
	0	0	0	235	0	!	21	00100001	0	1	0	1	0	0	0	1	1	LA1		
	0	0	0	88	200	@	40	01000000	0	0	0	1	0	0	0	1	0	0	ATN↓	
	0	0	0	92	650	*	2a	00101010	0	0	0	1	0	0	0	1	1	DAB		
	0	0	2	786	700	I	49	01001001	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	474	100	D	44	01000100	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	521	850	N	4e	01001110	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	521	800	?	3f	00111111	1	0	0	1	0	0	0	1	1	DAB	EOI↑	
	0	0	5	734	150	20	00100000	0	1	0	1	0	0	0	0	1	0	0	EOI↓	ATN↑
	0	0	0	38	300	?	3f	00111111	0	1	0	1	0	0	0	1	1	UNL		
	0	0	0	8	900	20	00100000	0	1	0	1	0	0	0	0	1	1	LAO		
	0	0	0	228	50	A	41	01000001	0	1	0	1	0	0	0	1	1	TAI		
	0	0	0	84	350	?	3f	00111111	0	0	0	1	0	0	0	1	0	0	ATN↓	
	0	0	59	864	700	F	46	01000110	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	260	350	L	4c	01001100	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	285	350	U	55	01010101	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	285	300	K	4b	01001011	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	285	350	E	45	01000101	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	285	300	,	2c	00101100	0	0	0	1	0	0	0	1	1	DAB		
	0	0	0	285	350	20	00100000	0	0	0	1	0	0	0	0	1	1	DAB		

64-bit Support

- Developer memory intensive instrument control applications for 64-bit OSs
- Development Environment support
 - LabVIEW
 - LabWindows/CVI, C/C++
 - Visual Studio .NET
- Driver support
 - NI-488.2
 - VISA

64-bit Support



GPIB-ENET/1000

GPIB-ENET/1000 Features

- Improved performance over the GPIB-ENET/100 (about 3x faster)
- **Compatible with existing GPIB-ENET/100 applications**
- **Links at 10Mbit, 100Mbit, and Gigabit speeds**
- DHCP, AutoIP, Link Local or static IP address assignment
- **Ethernet configuration through built-in webpage**
- **Supported on Windows XP, Windows Vista, and Windows 7**



Webpage Features

- Visibility and access to the GPIB-ENET/1000
- Change Network Settings
- Update firmware
- See the current status of the ENET
- Password protected

Network Configuration

General Settings

Hostname	<input type="text" value="NIENET14F40C4"/>
Static IP Configuration	<input type="checkbox"/>
IP Address	<input type="text" value="10.0.63.59"/>
Subnet Mask	<input type="text" value="255.255.255.0"/>
Default Gateway	<input type="text" value="10.0.63.1"/>
Primary DNS Server	<input type="text" value="130.164.12.8"/>
Secondary DNS Server	<input type="text" value="130.164.12.30"/>

Comment

64 characters remaining



Details

General

Model: GPIB-ENET/1000
Serial #: 14F40C4
Hostname: NIENET14F40C4
IP Address: 10.0.63.59
MAC Address: 00:80:2F:12:3A:B5

Firmware

Current Version: 1.0.0 | [Update](#)

Status

Device Status: Running
User Status:
You are not logged in | [Log In](#)

Feature comparison

GPIB-ENET/100	GPIB-ENET/1000
Up to 1.5 MB/s throughput	Up to 5.4 MB/s throughput, 3 times faster overall
Link speeds of 10Mbit and 100Mbit	Link speeds of 10Mbit, 100Mbit, and Gigabit
Use configuration utility to discover the device and change network settings	Use webpage to change network settings
	Compatible with existing GPIB-ENET/100 applications, just upgrade the driver!
	Additional locking allows use from multiple hosts at once

Instrument Control Software

Software and Hardware Integration



Graphical Development Environment

Communication Bus for Instrumentation

GPIB

USB

LXI

Serial

PXI

VXI



Programming with SCPI Commands

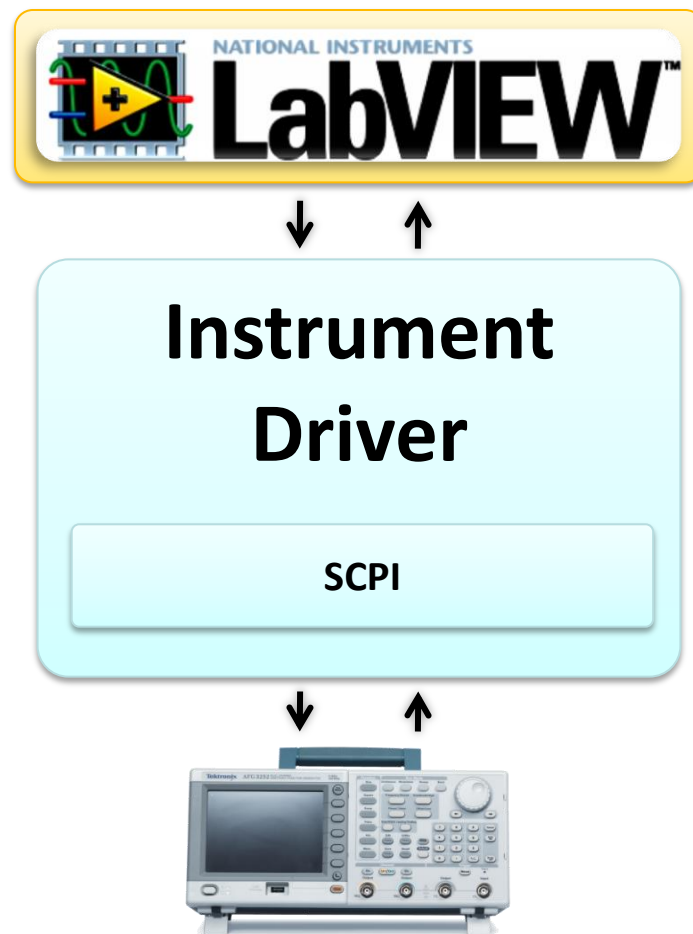
- Device Manuals
- Commands
- Bus
- More intense programming

Mnemonic	Group	Description
*IDN?	System Data	Identification query
*RST	Internal Operations	Reset
*TST?	Internal Operations	Self-test query
*OPC	Synchronization	Operation complete
*OPC?	Synchronization	Operation complete query
*WAI	Synchronization	Wait to complete
*CLS	Status and Event	Clear status
*ESE	Status and Event	Event status enable
*ESE?	Status and Event	Event status enable query
*ESR?	Status and Event	Event status register query
*SRE	Status and Event	Service request enable
*SRE?	Status and Event	Service request enable query
*STB?	Status and Event	Read status byte query

Instrument Driver API

Reduce development time

- No manual needed
- Abstraction of Bus communication protocols
- Fewer function calls
- Example code included



Instrument Driver Network

Industry's largest source of instrument drivers

ni.com/idnet

- 9,000+ Instrument Drivers
- Plug and Play, IVI, DLL
- NI Certified Drivers



Instrument Driver Network

Tektronix TPS 2012

Model Specifications

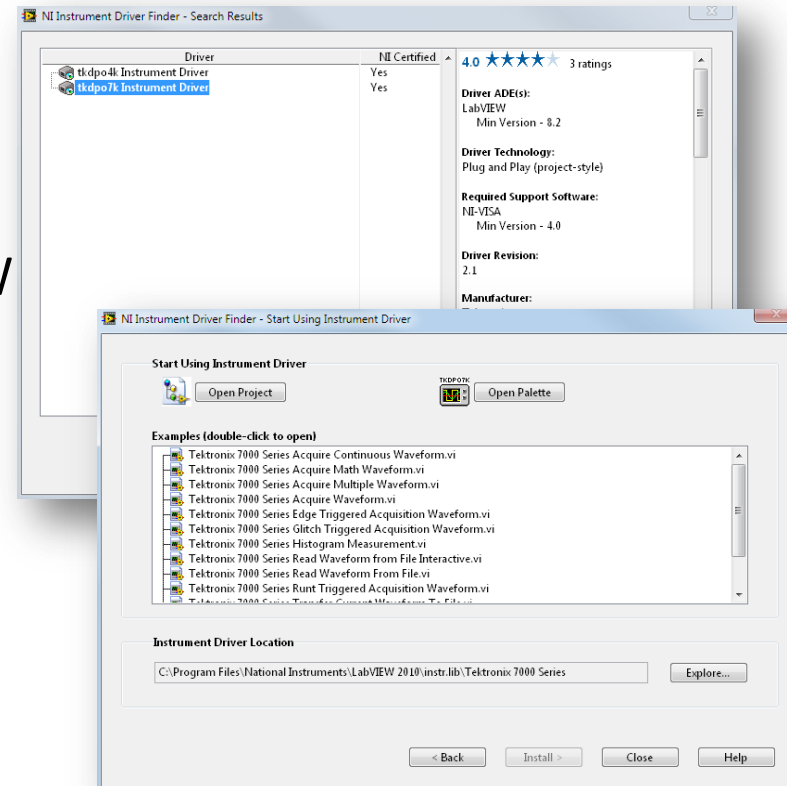
Manufacturer(s):	Tektronix
Instrument Model:	TPS 2012
Description:	Digital Oscilloscope
Instrument Family	TPS2000
Instrument Type(s):	Oscilloscope
Application Area(s):	Test and Measurement

Drivers Available For This Instrument Model

ADE	Driver Type	Interface(s)	NI Certified	Rating	
LabVIEW	Plug and Play (project-style)	IEEE 488.2 (GPIB) , USB , Serial	Yes	3.44	Go To Driver Page
LabVIEW	Plug and Play	IEEE 488.2 (GPIB) , USB , Serial	Yes	3.57	Go To Driver Page
LabVIEW LabWindows/CVI Measurement IVI Studio for Visual Studio	IVI	IEEE 488.2 (GPIB) , USB , Serial	Yes	3.48	Go To Driver Page

Finding Instrument Drivers

- IDFinder is launched with LabVIEW 2010
 - Download drivers from within LabVIEW
 - Auto install and refresh of LabVIEW palettes
 - Instrument specific examples
- Launching IDFinder
 - LabVIEW Getting Started Window
 - Measurement and Automation Explorer (MAX)
 - LabVIEW Toolbar Tools»Instrumentation



NI-VISA 5.1 Benefits to Customers

- Easier to find Instrument Drivers
 - Launch from MAX
- User control over size of NI-VISA on smaller RT targets
 - Select VISA passport requirement
- Better troubleshooting for writing custom USB drivers
- Support for updated VISA 5.0 industry specification

Summary

- New GPIB ENET/1000 – improved performance, web configuration
- LabVIEW – any instrument, any bus
- New Instrument control ‘ease of use’ features in LabVIEW 2011

ni.com/gettingstarted

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Getting Started with NI Products

Follow the steps below to install, set up, and configure your NI data acquisition (DAQ), NI CompactRIO, GPIB, or instrument control hardware and learn the basics of NI LabVIEW software.

- 1 Install Software and Drivers**

The first step to getting started is making sure you get the right software and drivers installed for your project.

[Start Here](#)
- 2 Connect and Set Up Hardware**

The next step is to physically connect and set up your hardware.

[Go](#)
- 3 Learn LabVIEW Basics**

Reading through this introduction to LabVIEW and graphical programming for beginners gives you the background you need to understand the many examples available.

[Go](#)
- 4 Begin Your Application**

View additional resources to help you develop your application, including video demonstrations and tutorials.

[Go](#)