Programmer Manual

Tektronix

TekVISA

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Preface

Who Should Read This Manual

This manual is both a reference and a tutorial. It is intended for use by Tektronix instrumentation end users and application programmers who wish to develop or modify

- VISA-compliant instrument driver software.
- Applications that use VISA-compliant instrument driver software.

About This Manual

This programming manual describes *TekVISA*, the Tektronix implementation of the *Virtual Instrument Software Architecture (VISA)* Library, an interface-independent software interface endorsed by the VXIplug&play Systems Alliance. The manual is organized as follows:

- The *Preface* and *Getting Started* sections briefly cover the audience and conventions for this guide, present overview concepts, summarize TekVISA features and applications, and explain how to configure TekVISA resources.
- The *Reference* section presents TekVISA operations, attributes, and events in alphabetical order.
  - The *Operations Summary* chapter summarizes the VISA operations implemented by Tektronix.
  - The *Operations* chapter describes each VISA operation including its syntax and sample usage.
  - The *Attributes Summary* chapter summarizes the VISA attributes implemented by Tektronix.
  - The *Attributes* chapter describes each VISA attribute including its syntax and usage.
  - The *Events* chapter describes each VISA event implemented by Tektronix including its syntax and usage.
- The *Programming Examples* section contains short programs that illustrate usage of VISA operations, attributes, and events to accomplish specific tasks.
- *Appendices* contain summary information for quick reference.

- The *VISA Data Type Assignments* appendix lists VISA data types in alphabetical order
- The *Completion and Error Codes* appendix lists operation completion codes and error codes in alphabetical order.

- *A Glossary* and *Index* appear at the end of the manual.

Conventions

This manual makes use of certain notational conventions and typefaces in distinctive ways, as summarized in Table i.

Table i: Table of Typographic Conventions

Typeface	Meaning	Example
italics	Used to introduce terms or to specify variables for which actual values should be substituted.	A common I/O library called the *Virtual Instrument Software Architecture (VISA)* The *requestedKey* will be copied into the user buffer referred to by the *accessKey*.
boldface	Used to emphasize important points or to denote exact characters to type or buttons to click in step-by-step procedures.	The **viFindRsrc**() operation matches an expression against the resources available for a particular interface. 1. Click **OK**.
NOTE	Used to call attention to notes or tips in text.	***NOTE***. *Read this carefully.*
<item1, item2, ...>	This notation is used to designate a variable list of one or more items separated by commas.	`viScanf (vi, readFmt, <arg1, arg2, ...>)`
`Code`	This font is used to designate blocks of code.	`*result = m_ViStatus;`
Menu > Submenu	This notation is used to designate a series of cascading menus. The example here means: from the File menu, choose Open.	1. Choose **File > Open**.

Related Manuals and Information

Refer to the following manuals for information regarding related products, manuals, and programming specifications.

- This programming manual resides in Adobe Acrobat format on the TekVISA Product Software CD.
- The *AD007 GPIB-LAN Adapter User Manual* (071-0245-01) provides related information if you are controlling your instrumentation from a remote PC over an Ethernet GPIB-LAN connection. This guide is located on the AD007 Product Software CD.
- The *TDS7000 Series Programmer Online Guide* and *TDS7000 Series Online Help* provide related information if you are using a TDS7000 Series Oscilloscope, which provides an open, Windows-based interface. These guides are located on the TDS7000 Product Software CD.
- The *TDS3000 Series Programmer Online Guide* and *TDS3000 Series Online Help* provide related information if you are using a TDS3000 Series Oscilloscope. These guides are on the TDS3000 Product Software CD.
- General information and specifications for Virtual Instrument Software Architecture (VISA) are available from the web site of the VXIplug&play System Alliance at http://www.vxipnp.org. The following documents relate to the Tektronix implementation of VISA:
  - *VISA Software Design Implementation*
  - *VPP-4.3: The VISA Library Revision 2.2.* This specification is intended to be used in conjunction with the VPP-3.X specifications including:
    - the *Instrument Drivers Architecture and Design Specification (VPP-3.1)*
    - the *Instrument Driver Functional Body Specification (VPP-3.2)*
    - the *Instrument Interactive Developer Interface Specification (VPP-3.3)*
    - the *Instrument Driver Programmatic Developer Interface Specification (VPP-3.4).*
    - the *Installation and Packaging Specification (VPP-6).*

    These related specifications describe the implementation details for specific instrument drivers used with specific system frameworks. VXIplug&play instrument drivers developed according to these specifications can be used in a wide variety of higher-level software environments as described in the *System Frameworks Specification (VPP-2).*

Contacting Tektronix

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Technical support	Email: techsupport@tektronix.com 1-800-833-9200, select option 3* 6:00 a.m. - 5:00 p.m. Pacific time

* **This phone number is toll free in North America. After office hours, please leave a voice mail message.**
Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices.

Getting Started

Getting Started

Product Description

Test and measurement applications require some kind of I/O library to communicate with test instrumentation. As a step toward industry-wide software compatibility, the VXI*plug&play* Systems Alliance developed a common I/O library called the *Virtual Instrument Software Architecture (VISA)*. VISA provides a common standard for software developers so that software from multiple vendors, such as instrument drivers, can run on the same platform.

An *instrument driver* is a library of functions that handles the details of controlling and communicating with a specific instrument such as a Tektronix oscilloscope. Instrumentation end users have been writing their own instrument drivers for years.

This manual describes *TekVISA*, the Tektronix implementation of the VISA Application Programming Interface (API). TekVISA is industry-compliant software, available with selected Tektronix instrument models, for writing (or drawing) interoperable instrument drivers in a variety of Application Development Environments (ADEs).

TekVISA implements a subset of Version 2.2 of the VISA specification for controlling GPIB and serial (RS-232) instrument interfaces locally or remotely via an Ethernet LAN connection. TekVISA provides the interface-independent functionality needed to control and access the embedded software of Tektronix test and measurement equipment in the following ways:

- Using virtual GPIB software running locally on Windows-based instrumentation such as TDS7000 and TDS/CSA8000 Series Oscilloscopes
- Using physical GPIB controller hardware
- Using asynchronous serial controller hardware
- Over a Local Area Network (LAN) that uses VXI-11 protocol and one of the following:
  - an AD007 LAN-to-GPIB adapter to GPIB controller hardware
  - A 10Base-T Ethernet connection together with virtual GPIB software running on Windows-based instrumentation such as TDS7000 and TDS/CSA8000 Series Oscilloscopes

Features and Benefits

TekVISA offers the following features and benefits:

- Improves ease of use for end users by providing a consistent methodology for using instrument drivers from a variety of vendors
- Provides language interface libraries for programmers using multiple Application Development Environments as shown in Figure 1–1, including:
  - Microsoft C/C++
  - Microsoft Visual Basic
  - LabVIEW graphics software using the G language
  - MATLAB analysis software
- Provides a Configuration utility for setting up additional VISA resources
- Allows software installation on any number of PCs

Applications and Connectivity Supported by TekVISA

TekVISA is beneficial in a variety of situations and applications:

- A single instrument driver can be used by multiple Application Development Environments.
- Instrument drivers from several vendors can be combined in a single user application.
- User programs running on Windows-based instrumentation (such as TDS7000 and TDS/CSA8000 Series Oscilloscopes) can use TekVISA to control instrument operation via a virtual GPIB software connection, without using any external GPIB hardware.
- User programs running on remote PCs networked toWindows-based instrumentation (such as TDS7000 and TDS/CSA8000 Series Oscilloscopes) can use TekVISA to control instrument operation via a virtual GPIB and VXI-11 software connection. No external GPIB-LAN hardware is needed. Only an Ethernet LAN connection is required.
- User programs connected locally or remotely to other non-Windows-based Tektronix instrumentation (such as TDS3000 Series Oscilloscopes) can use TekVISA to control instrument operation via a GPIB or serial (RS232) connection locally, or remotely via a Tektronix AD007 GPIB-LAN adapter.

Figures 1–1 and 1–2 illustrate the variety of software, local hardware, and network connections to embedded instrumentation supported by TekVISA.

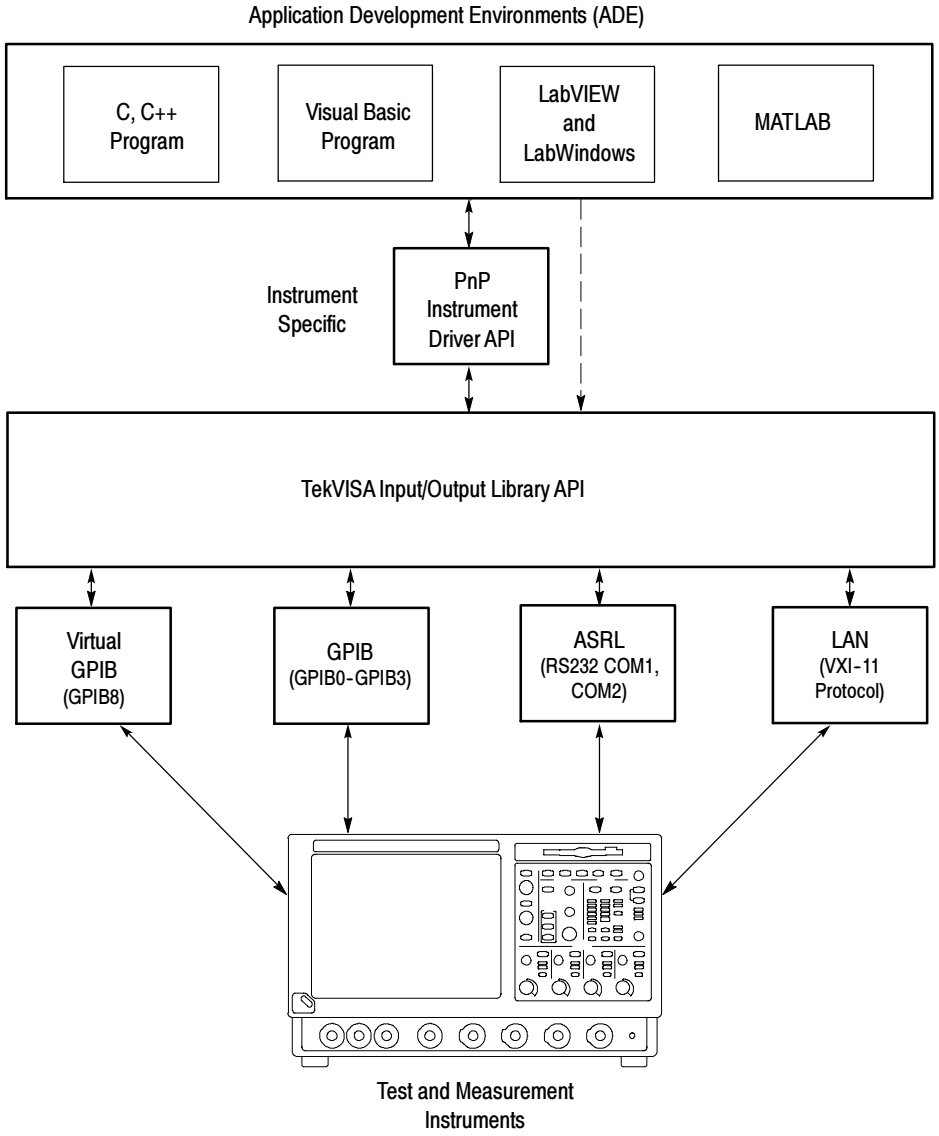


Figure 1-1: TekVISA Supports Multiple Development Environments

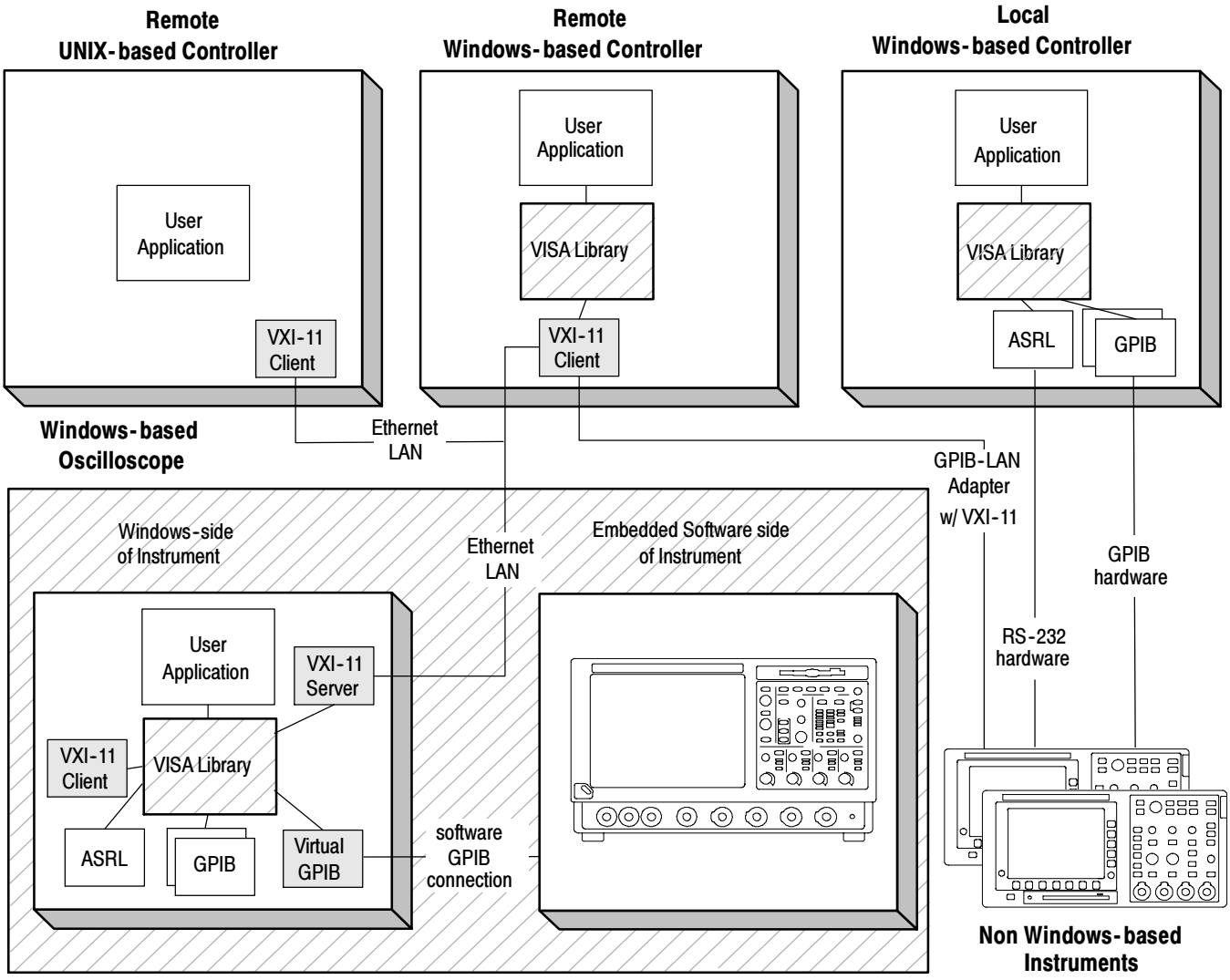


Figure 1-2: TekVISA Supports Local and Remote Connectivity

Terminology

The VISA specification introduces a number of new terms. Refer to the Glossary at the end of this manual for a complete list of terms and definitions. Some key terms are discussed in the following paragraphs and illustrated in Figure 1–3.

Resources, INSTR Resource, and Sessions

VISA defines an architecture consisting of many *resources* that encapsulate device functionality. In VISA, every defined software module is a resource. In general, the term *resource* is synonymous with the word *object* in object-oriented architectures. For VISA, resource more specifically refers to a particular implementation or *instance,* in object-oriented terms, of a *resource class,* which is the definition for how to create a particular resource.

A specialized type of resource class is a VISA *instrument control (INSTR) resource class*, which defines how to control a particular device. An INSTR resource class encapsulates the various operations for a particular device together (reading, writing, triggering, and so on) so that a program can interact with that device through a single resource. TekVISA supports two kinds of devices associated with the INSTR resource class: GPIB and ASRL (serial) devices.

Applications that use VISA can access device resources by opening *sessions* to them. A *session* is a communication path between a software element and a resource. Every session in VISA is unique and has its own life cycle. VISA defines a *locking mechanism* to restrict access to resources for special circumstances.

Operations, Attributes, and Events

After establishing a session, an application can communicate with a resource by invoking *operations* associated with the resource or by updating characteristics of resources called *attributes.* Some attributes depict the instantaneous state of the resource and others define changeable parameters that modify the behavior of resources. A VISA system also allows information exchange through *events*.

The Resource Manager

VISA *Resource Manager* is the name given to the part of VISA that manages resources. This management includes support for opening, closing, and finding resources; setting and retrieving resource attributes; generating events on resources; and so on.

The VISA Resource Manager provides access to all resources registered with it. It is therefore at the root of a subsystem of connected resources. Currently, one Resource Manager is available by default after initialization. This is called the *Default Resource Manager.* This identifier is used when opening resources, finding available resources, and performing other operations on device resources.

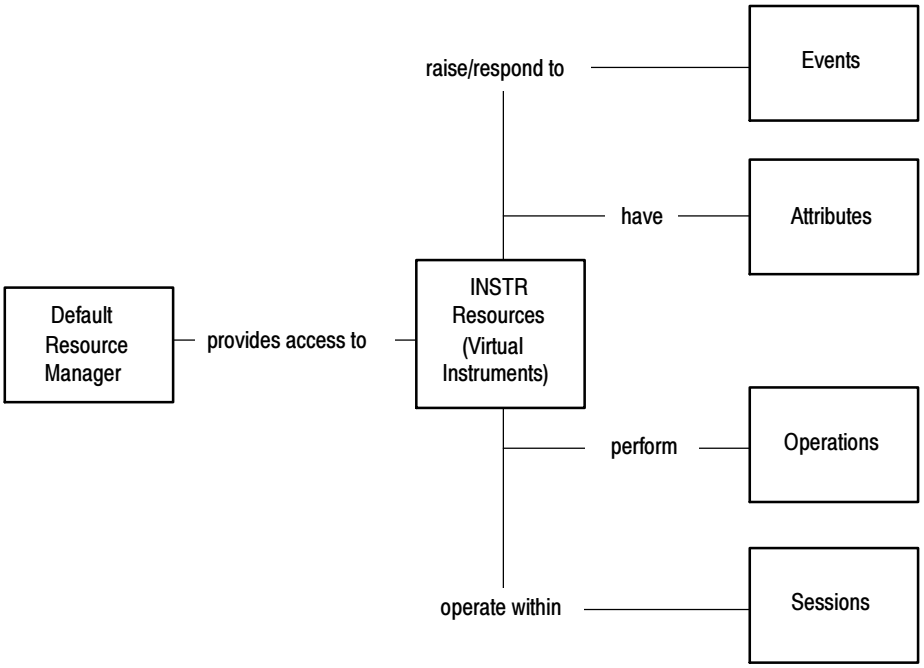


Figure 1- 3: Key VISA Terminology

Virtual Instruments and Virtual GPIB

A *virtual instrument* is a name given to the grouping of software modules (VISA resources with any associated or required hardware) to give the functionality of a traditional stand-alone instrument. Within VISA, a virtual instrument is the logical grouping of any of the VISA resources. TekVISA supports ASRL (serial) and GPIB virtual instruments, which work with accompanying RS-232 and GPIB hardware respectively.

In addition, TekVISA includes a specialized type of GPIB resource called *virtual GPIB*. User programs running on oscilloscopes with Windows-based instrumentation (such as TDS7000 Series Oscilloscopes), or running on a remote PC connected by LAN to such an instrument, can access the embedded instrument software by using a virtual GPIB software connection, without the need for any GPIB controller hardware or cables.

What You Need to Get Started

TekVISA Installation

VISA applications that communicate with Tektronix instrumentation should use TekVISA, the Tektronix version of VISA. You should install and configure TekVISA on each PC that communicates with Tektronix instrumentation using the VISA standard.

The software installation includes a utility to help you configure TekVISA resources. The VISA configuration utility allows you to detect GPIB and serial (ASRL) resource assignments, and to add or remove remote hosts (such as VXI-11 clients connected by Ethernet LAN or by an AD007 adapter and associated GPIB hardware).

***NOTE**. If you are connecting to a network just to print screen hardcopy data, you do not need to install or configure TekVISA software.*

TekVISA comes installed on current Tektronix MS-Windows oscilloscopes as part of the Product Software.

To install TekVISA software on a PC connected to your Tektronix oscilloscope, follow the steps shown below on Table 1–1.

Table 1-1: Installing TekVISA Software on a PC

Alternative Locations for Finding TekVISA Software	Instructions for Installing TekVISA Software on a PC
The product software CD for your MS-Windows oscilloscope	In your MS-Windows computer, select **Start > Run**, browse the CD to the TekVISA folder, and run setup.exe.
The TDSPCS1 OpenChoice PC Communications Software CD	Follow the instructions in the installation wizard.
The OpenChoice Solutions Software Developers' Kit CD	Click on the Developers' Kit browser button for **Software Drivers** and then for **TekVISA**
The current TekVISA installation download from the Tektronix web site	Unzip the downloaded file in a temporary directory of your choice and run setup.exe.

***NOTE**. If you have already installed TekVISA from an earlier version of the Tektronix Software Solutions CD or with Wavestar, you should uninstall that version first, and then reinstall TekVISA from the most recent source.*

The TekVISA Configuration Utility

Included with the TekVISA installation is the TekVISA configuration utility, which lets you find resource assignments and add or remove network hosts (instruments). Once an instrument is added to the TekVISA configuration, you can communicate with it by using a VISA compliant instrument driver.

To run the TekVISA configuration utility, you click on the TekVISA configuration icon in the system tray shown in Figure 1–4. Alternatively, you can select, **Start > Programs > TekVISA > TekVISA Configuration**.

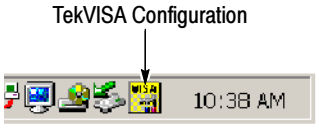


Figure 1-4: System Tray

Reference

Operations Summary

The following table summarizes Tektronix VISA operations by category.

Table 2-1: Table of VISA Operations by Category

Operation	Description	Page
Opening and Closing Sessions, Events, and Find Lists		
viOpenDefaultRM	Return a session to the Default Resource Manager	2-41
viOpen	Open a session to the specified resource	2-38
viClose	Close the specified session, event, or find list	2-12
Finding Resources		
viFindRsrc	Find a list of resources associated with a specified interface	2-24
viFindNext	Return the next resource from the find list	2-22
viParseRsrc	Parses a resource string to get the interface information	2-41
Setting and Retrieving Attributes		
viGetAttribute	Retrieve the state of an attribute for the specified session, event, or find list	2-31
viSetAttribute	Set the state of an attribute for the specified session, event, or find list	2-73
viStatusDesc	Retrieve a user-readable description of the specified status code	2-81
Reading and Writing Basic Data		
viWrite	Write data synchronously to a device from the specified buffer	2-100
viWriteAsync	Write data asynchronously to a device from the specified buffer	2-102
viRead	Read data synchronously from a device into the specified buffer	2-54
viReadAsync	Read data asynchronously from a device into the specified buffer	2-58
viTerminate	Terminate normal execution of an asynchronous read or write operation	2-82
Other Basic I/O Operations		
viClear	Clear a device	2-10
viAssertTrigger	Assert software or hardware trigger	2-5
viReadSTB	Read a status byte of the service request	2-63

Table 2-1: Table of VISA Operations by Category (Cont.)

Operation	Description	Page
Reading and Writing Formatted Data		
Formatted Buffer Operations		
viBufWrite	Write data synchronously to a device from the formatted I/O buffer	2-8
viBufRead	Read data synchronously from a device into the formatted I/O buffer	2-7
viSetBuf	Set the size of the formatted I/O and/or serial buffer(s)	2-74
viFlush	Manually flush the specified buffer(s)	2-29
Formatted Write Operations * (See Note)		
viPrintf	Format and write data to a device using a variable argument list	2-45
viVprintf	Format and write data to a device using a pointer to a variable argument list	2-87
viSPrintf	Format and write data to a user-specified buffer using a variable argument list	2-76
viVSPrintf	Format and write data to a user-specified buffer using a pointer to a variable argument list	2-94
Formatted Read Operations * (See Note)		
viScanf	Read and format data from a device using a variable argument list	2-65
viVScanf	Read and format data from a device using a pointer to a variable argument list	2-92
viSScanf	Read and format data from a user-specified buffer using a variable argument list	2-79
viVSScanf	Read and format data from a user-specified buffer using a pointer to a variable argument list	2-95
	Formatted Read/Write Operations * (See Note)	
viQueryf	Write and read formatted data to and from a device using a variable argument list	2-52
viVQueryf	Write and read formatted data to and from a device using a pointer to a variable argument list	2-89
Handling Events		
viEnableEvent	Enable notification of a specified event	2-17
viDisableEvent	Disable notification of the specified event using the specified mechanism	2-13
viDiscardEvents	Discard all pending occurrences of the specified events for the specified mechanism(s) and session	2-15
viWaitOnEvent	Wait for an occurrence of the specified event for a given session	2-97

Table 2-1: Table of VISA Operations by Category (Cont.)

Operation	Description	Page
Handling Events		
viInstallHandler	Install callback handler(s) for the specified event	2-32
viUninstallHandler	Uninstall callback handler(s) for the specified event	2-83
viEventHandler	Prototype for handler(s) to be called back when a particular event occurs	2-20
Locking and Unlocking Resources		
viLock	Obtain a lock on the specified resource	2-35
viUnlock	Relinquish a lock on the specified resource	2-85

Operations

The following Tektronix VISA operations are presented in alphabetical order.

viAssertTrigger (vi, protocol)

Usage Asserts a software trigger for a GPIB or serial device.

C Format ViStatus viAssertTrigger (ViSession *vi*, ViUInt16 *protocol*)

Visual Basic Format viAssertTrigger (ByVal *vi* As Long, ByVal *protocol* As Integer) As Long

Parameters

Table 2-2: viAssertTrigger() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
protocol	IN	Trigger protocol to use during assertion. Valid values are: VI_TRIG_PROT_DEFAULT

Return Values

Table 2-3: viAssertTrigger() Completion Codes

Completion Codes	Description
VI_SUCCESS	The specified trigger was successfully asserted to the device.

Table 2-4: viAssertTrigger() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_INV_PROT	The protocol specified is invalid.
VI_ERROR_TMO	Timeout expired before operation completed.

Table 2-4: viAssertTrigger() Error Codes (Cont.)

Error Codes	Description
VI_ERROR_RAW_WR_PROT_VIOL	Violation of raw write protocol occurred during transfer.
VI_ERROR_RAW_RD_PROT_VIOL	Violation of raw read protocol occurred during transfer.
VI_ERROR_INP_PROT_VIOL	Device reported an input protocol error during transfer.
VI_ERROR_BERRt	Bus error occurred during transfer.
VI_ERROR_LINE_IN_USE	The specified trigger line is currently in use.
VI_ERROR_NCIC	The interface associated with the given vi is not currently the controller in charge.
VI_ERROR_NLISTENERS	No Listeners condition is detected (both NRFD and NDAC are deasserted).
VI_ERROR_INV_SETUP	Unable to start operation because setup is invalid (due to attributes being set to an inconsistent state).

C Example

```
ViSession       rm, vi;
ViUInt16        val;
if (viOpenDefault(&rm) < VI_SUCCESS) return;
if (viOpen(rm, ”GPIB8::1::INSTR“, VI_NULL, VI_NULL, &vi)
   < VI_SUCCESS) return;
viAssertTrigger(vi, value);
viClose(rm);
```

Comments

The viAssertTrigger() operation will assert a software trigger as follows:

- For a GPIB device, the device is addressed to listen, and then the GPIB GET command is sent.
- For a serial device, if VI_ATTR_IO_PROT is VI_ASRL488, the device is sent the string “*TRG\n”. This operation is not valid for a serial device if VI_ATTR_IO_PROT is VI_NORMAL.
- For GPIB and serial software triggers, VI_TRIG_PROT_DEFAULT is the only valid protocol.

See Also

Basic Input/Output
VI_ATTR_IO_PROT

viBufRead (vi, buf, count, retCount)

Usage Reads data synchronously from a device into the formatted I/O buffer.

C Format ViStatus viBufRead (ViSession *vi*, ViPBuf *buf*, ViUInt32 *count*, ViPUInt32 *retCount*)

Visual Basic Format viBufRead (ByVal *vi* As Long, ByVal *buf* As String, ByVal *count* As Long, *retCount* As Long) As Long

Parameters

Table 2-5: viBufRead() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	OUT	Represents the location of a buffer to receive data from device.
count	IN	Number of bytes to be read.
retCount	OUT	Represents the location of an integer that will be set to the number of bytes actually transferred.

Return Values

Table 2-6: viBufRead() Completion Codes

Completion Codes	Description
VI_SUCCESS	The operation completed successfully and the END indicator was received (for interfaces that have END indicators).
VI_SUCCESS_TERM_CHAR	The specified termination character was read.
VI_SUCCESS_MAX_CNT	The number of bytes read is equal to count..

Table 2-7: viBufRead() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_TMO	Timeout expired before operation completed.
VI_ERROR_IO	An unknown I/O error occurred during transfer.

C Example

```
ViSession       rm, vi;
char            buffer[256];
if (viOpenDefault(&rm) < VI_SUCCESS) return;
if (viOpen(rm, "GPIB8::1::INSTR", VI_NULL, VI_NULL, &vi)
   < VI_SUCCESS) return;
if (viBufWrite(vi, (ViBuf) "*IDN?", 5, VI_NULL) < VI_SUCCESS)
   return;
viBufRead(vi, (ViBuf) buffer, sizeof(buffer), VI_NULL);
printf("%s\n", buffer);
viClose(rm);
```

Comments

The viBufRead() operation is similar to viRead() and does not perform any kind of data formatting. It differs from viRead() in that the data is read from the formatted I/O read buffer—the same buffer used by viScanf() and related operations—rather than directly from the device.

NOTE. *You can intermix this operation with viScanf(), but you should not mix it with viRead().*

Table 2-8: Special Value for retCount Parameter with viBufRead()

Value	Description
VI_NULL	If you pass this value, the number of bytes transferred is not returned. You may find this useful if you only need to know whether the operation succeeded or failed.

See Also

Reading and Writing Formatted Data
viBufWrite (*vi, buf, count, retCount*)

viBufWrite (vi, buf, count, retCount)

Usage

Writes data synchronously to a device from the formatted I/O buffer.

C Format

ViStatus viBufWrite(ViSession *vi*, ViBuf *buf*, ViUInt32 *count*, ViPUInt32 *retCount*)

Visual Basic Format

viBufWrite(ByVal *vi* As Long, ByVal *buf* As String, ByVal *count* As Long, *retCount* As Long) As Long

Parameters

Table 2-9: viBufWrite() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	OUT	Represents the location of a data block to be sent to the device
count	IN	Number of bytes to be written
retCount	OUT	Represents the location of an integer that will be set to the number of bytes actually transferred.

Return Values

Table 2-10: viBufWrite() Completion Codes

Completion Codes	Description
VI_SUCCESS	Operation completed successfully.

Table 2-11: viBufWrite() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_TMO	Timeout expired before operation completed. If this operation returns this message, the write buffer for the specified session is cleared.
VI_ERROR_INV_SETUP	Unable to start write operation because setup is invalid (due to attributes being set to an inconsistent state).
VI_ERROR_IO	An unknown I/O error occurred during transfer.

C Example

```
ViSession       rm, vi;
char            buffer[256];
if (viOpenDefault(&rm) < VI_SUCCESS) return;
if (viOpen(rm, "GPIB8::1::INSTR", VI_NULL, VI_NULL, &vi)
   < VI_SUCCESS) return;
if (viBufWrite(vi, (ViBuf) "*IDN?", 5, VI_NULL) < VI_SUCCESS)
   return;
viBufRead(vi, (ViBuf) buffer, sizeof(buffer), VI_NULL);
printf("%s\n", buffer);
viClose(rm);
```

Comments

The viBufWrite() operation is similar to viWrite() and does not perform any kind of data formatting. It differs from viWrite() in that the data is written to the formatted I/O write buffer—the same buffer used by viPrintf() and related operations—rather than directly to the device.

***NOTE**. You can intermix this operation with viPrintf(), but you should not mix it with viWrite().*

Table 2-12: Special Value for retCount Parameter with viBufWrite()

Value	Description
VI_NULL	If you pass this value, the number of bytes transferred is not returned. You may find this useful if you only need to know whether the operation succeeded or failed.

See Also

Reading and Writing Formatted Data
viBufRead (*vi, buf, count, retCount*)

viClear (vi)

Usage

Clears a device.

C Format

ViStatus viClear (ViSession *vi*)

Visual Basic Format

viClear (ByVal *vi* As Long) As Long

Parameters

Table 2-13: viClear() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.

Return Values

Table 2-14: viClear() Completion Codes

Completion Codes	Description
VI_SUCCESS	Operation completed successfully.

Table 2-15: viClear() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_TMO	Timeout expired before operation completed.
VI_ERROR_RAW_WR_PROT_VIOL	Violation of raw write protocol occurred during transfer.
VI_ERROR_RAW_RD_PROT_VIOL	Violation of raw read protocol occurred during transfer.
VI_ERROR_BERRt	Bus error occurred during transfer.
VI_ERROR_NCIC	The interface associated with the given vi is not currently the controller in charge.
VI_ERROR_NLISTENERS	No Listeners condition is detected (both NRFD and NDAC are deasserted).
VI_ERROR_INV_SETUP	Unable to start operation because setup is invalid (due to attributes being set to an inconsistent state).

C Example

```
ViSession          rm, vi;
if (viOpenDefault(&rm) < VI_SUCCESS) return;
if (viOpen(rm, ”GPIB8::1::INSTR“, VI_NULL, VI_NULL, &vi)
   < VI_SUCCESS) return;
viClear(vi);
viClose(rm);
```

Comments

The viClear() operation performs an IEEE 488.1–style clear of the device.

- For GPIB systems, the Selected Device Clear command is used.
- For a serial device, if VI_ATTR_IO_PROT is VI_ASRL488, the device is sent the string “*CLS\n”. This operation is not valid for a serial device if VI_ATTR_IO_PROT is VI_NORMAL.

***NOTE**. Invoking viClear() will also discard the read and write buffers used by the formatted I/O services for that session.*

See Also

Basic Input/Output
VI_ATTR_IO_PROT

viClose (vi)

Usage

Closes the specified session, event, or find list.

C Format

ViStatus viClose (ViObject *vi*)

Visual Basic Format

viClose (ByVal *vi* As Long) As Long

Parameters

Table 2-16: viClose() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session, event, or find list.

Return Values

Table 2-17: viClose() Completion Codes

Completion Codes	Description
VI_SUCCESS	Session, event, or find list closed successfully.
VI_WARN_NULL_OBJECT	The specified object reference is uninitialized. This message is returned if the value VI_NULL is passed to it.

Table 2-18: viClose() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_CLOS- ING_FAILED	Unable to deallocate the previously allocated data structures corresponding to this session or object reference.

C Example

```
ViSession          rm, vi;
if (viOpenDefault(&rm) < VI_SUCCESS) return;
if (viOpen(rm, ”GPIB8::1::INSTR“, VI_NULL, VI_NULL, &vi)
   < VI_SUCCESS) return;
viClose(vi);
viClose(rm);
```

Comments The viClose() operation closes a session, event, or a find list, and frees all data structures allocated for the specified vi.

See Also **Opening and Closing Sessions, Events, and Find Lists**
viOpen (*sesn, rsrcName, accessMode, timeout, vi*)
viOpenDefaultRM (*sesn*)

viDisableEvent (vi, eventType, mechanism)

Usage Disables notification of the specified event using the specified mechanism.

C Format ViStatus viDisableEvent (ViSession *vi*, ViEventType *eventType*, ViUInt16 *mechanism*)

Visual Basic Format viDisableEvent (ByVal *vi* As Long, ByVal *EventType* As Long, ByVal *mechanism* As Integer) As Long

Parameters

Table 2-19: viDisableEvent() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
eventType	IN	Logical event identifier.
mechanism	IN	Specifies event handling mechanisms to be disabled. The queuing mechanism is disabled by specifying VI_QUEUE, and the callback mechanism is disabled by specifying VI_HNDLR or VI_SUSPEND_HNDLR. It is possible to disable both mechanisms simultaneously by specifying VI_ALL_MECH.

Return Values

Table 2-20: viDisableEvent() Completion Codes

Completion Codes	Description
VI_SUCCESS	Event disabled successfully.
VI_SUCCESS_EVENT_DIS	Specified event is already disabled for at least one of the specified mechanisms.

Table 2-21: viDisableEvent() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_EVENT	Specified event type is not supported by the resource.
VI_ERROR_INV_MECH	Invalid mechanism specified.

C Example

```
ViSession rm, vi;

if ( viOpenDefaultRM(&rm) < VI_SUCCESS) return;
if (viOpen(rm, ”GPIB8::1::INSTR“, NULL, NULL, &vi) < VI_SUCCESS)
   return;
viEnableEvent(vi, VI_EVENT_SERVICE_REQ, VI_QUEUE, VI_NULL);

// Do some processing here

// Cleanup and exit
viDisableEvent(vi, VI_EVENT_SERVICE_REQ, VI_QUEUE);
viClose(vi);
viClose(rm);
```

Comments

The viDisableEvent() operation disables servicing of an event identified by *eventType* for the mechanisms specified in *mechanism*.

- This operation prevents new event occurrences from being added to the queue(s); however, event occurrences already existing in the queue(s) are not flushed. Use viDiscardEvents() if you want to discard events remaining in the queue(s).

Table 2-22: Special Values for eventType Parameter with viDisableEvent()

Value	Description
VI_ALL_ENABLED_EVENTS	Disable all events that were previously enabled. Allows a session to stop receiving all events.

Table 2-23: Special Values for mechanism Parameter with viDisableEvent()

Value	Description
VI_QUEUE	Disable this session from receiving the specified event(s) via the waiting queue. Stops the session from receiving queued events.
VI_HNDLR or VI_SUSPEND_HNDLR	Disable this session from receiving the specified event(s) via a callback handler or a callback queue. Specifying either VI_HNDLR or VI_SUSPEND_HNDLR stops applications from receiving callback events.
VI_ALL_MECH	Disable this session from receiving the specified event(s) via any mechanism. Disables both the queuing and callback mechanisms.

See Also

Handling Events
viEnableEvent (*vi, eventType, mechanism, context*)

viDiscardEvents (vi, eventType, mechanism)

Usage

Discards all pending occurrences of the specified events for the specified mechanism(s) and session.

C Format

ViStatus viDiscardEvents (ViSession *vi*, ViEventType *eventType*, ViUInt16 *mechanism*)

Visual Basic Format

viDiscardEvents (ByVal *vi* As Long, ByVal *EventType* As Long, ByVal *mechanism* As Integer) As Long

Parameters

Table 2-24: viDiscardEvents() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
eventType	IN	Logical event identifier.
mechanism	IN	Specifies event handling mechanisms to be discarded. The VI_QUEUE value is specified for the queuing mechanism and the VI_SUSPEND_HNDLR value is specified for pending events in the callback mechanism. To discard both mechanisms simultaneously, specify VI_ALL_MECH.

Return Values

Table 2-25: viDiscardEvents() Completion Codes

Completion Codes	Description
VI_SUCCESS	Event queue flushed successfully.
VI_SUCCESS_QUEUE_ EMPTY	Operation completed successfully, but queue was empty.

Table 2-26: viDiscardEvents() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_EVENT	Specified event type is not supported by the resource.
VI_ERROR_INV_MECH	Invalid mechanism specified.

C Example

```
// Cleanup and exit
status = viDiscardEvents(vi, VI_EVENT_SERVICE_REQ, VI_QUEUE);
```

Comments

The viDiscardEvents() operation discards all pending occurrences of the specified event types and mechanisms from the specified session.

- The discarded event occurrences are not available to a session at a later time.
- This operation does not apply to event contexts that have already been delivered to the application.

Table 2-27: Special Values for eventType Parameter with viDiscardEvents()

Value	Description
VI_ALL_ENABLED_EVENTS	Discard events of every type enabled for the given session. The information about all the event occurrences which have not yet been handled is discarded. This operation is useful to remove event occurrences that an application no longer needs.

Table 2-28: Special Values for mechanism Parameter with viDiscardEvents()

Value	Description
VI_QUEUE	Discard the specified event(s) from the waiting queue.
VI_HNDLR or VI_SUSPEND_HNDLR	Discard the specified event(s) from the callback queue.
VI_ALL_MECH	Discard the specified event(s) from all mechanisms.

See Also

Handling Events
viWaitOnEvent (*vi, inEventType, timeout, outEventType, outContext*)

viEnableEvent (vi, eventType, mechanism, context)

Usage

Enables notification of a specified event.

C Format

ViStatus viEnableEvent (ViSession *vi*, ViEventType *eventType*, ViUInt16 *mechanism,* viEventFilter *context*)

Visual Basic Format

viEnableEvent (ByVal *vi* As Long, ByVal *EventType* As Long, ByVal *mechanism* As Integer, ByVal *context* As Long) As Long

Parameters

Table 2-29: viEnableEvent() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
eventType	IN	Logical event identifier.
mechanism	IN	Specifies event handling mechanisms to be enabled. The queuing mechanism is enabled by specifying VI_QUEUE, and the callback mechanism is enabled by specifying VI_HNDLR or VI_SUSPEND_HNDLR. It is possible to enable both mechanisms simultaneously by specifying “bit-wise OR” of VI_QUEUE and one of the two mode values for the callback mechanism.
context	IN	VI_NULL

Return Values

Table 2-30: viEnableEvent() Completion Codes

Completion Codes	Description
VI_SUCCESS	Event enabled successfully.
VI_SUCCESS_EVENT_EN	Specified event is already enabled for at least one of the specified mechanisms.

Table 2-31: viEnableEvent() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_EVENT	Specified event type is not supported by the resource.
VI_ERROR_INV_MECH	Invalid mechanism specified. Returned if called with the *mechanism* parameter equal to the "bit-wise OR" of VI_SUSPEND_HNDLR and VI_HNDLR.
VI_ERROR_INV_CONTEXT	Specified event context is invalid.
VI_ERROR_HNDLR_NINS-TALLED	If no handler is installed for the specified event type, the request to enable the callback mechanism for the event type returns this error code. The session cannot be enabled for the VI_HNDLR mode of the callback mechanism.

C Example

```
ViSession rm, vi;

if ( viOpenDefaultRM(&rm) < VI_SUCCESS) return;
if (viOpen(rm, "GPIB8::1::INSTR", NULL, NULL, &vi) < VI_SUCCESS)
   return;
viEnableEvent(vi, VI_EVENT_SERVICE_REQ, VI_QUEUE, VI_NULL);

// Do some processing here

// Cleanup and exit
viDisableEvent(vi, VI_EVENT_SERVICE_REQ, VI_QUEUE);
viClose(vi);
viClose(rm);
```

Comments

The viEnableEvent() operation enables notification of an event identified by *eventType* for mechanisms specified in *mechanism*.

Table 2-32: Special Values for eventType Parameter with viEnableEvent()

Value	Description
VI_ALL_ENABLED_EVENTS	Switch all events previously enabled on this session to the callback mechanism specified in the *mechanism* parameter. Makes it easier to switch between the two callback mechanisms for multiple events.

Table 2-33: Special Values for mechanism Parameter with viEnableEvent()

Value	Description
VI_QUEUE	Enable this session to receive the specified event via the waiting queue. Events must be retrieved manually via the viWaitOnEvent() operation. Enables the specified session to queue events.
VI_HNDLR	Enable this session to receive the specified event via a callback handler, which must have already been installed via viInstallHandler(). Enables the session to invoke a callback function to execute the handler. Applications must install at least one handler to be enabled for this mode.
VI_SUSPEND_HNDLR	Enable this session to receive the specified event via a callback queue. Events will not be delivered to the session until viEnableEvent() is invoked again with the VI_HNDLR mechanism. Enables the session to receive callbacks, but invocation of the handler is deferred to a later time. Successive calls to this operation replace the old callback mechanism with the new callback mechanism.

- Event queuing and callback mechanisms operate independently. Enabling one mode does not enable or disable the other mode.
- If the mode is switched from VI_SUSPEND_HNDLR to VI_HNDLR for an event type,VISA will call installed handlers once for each event occurrence pending in the session (and dequeued from the suspend handler queue) before switching modes.
- A session enabled to receive events can start receiving them before the viEnableEvent() operation returns. In this case, the handlers set for an event type are executed before completion of the enable operation.

- If the mode is switched from VI_HNDLR to VI_SUSPEND_HNDLR for an event type, VISA will defer handler invocation for occurrences of the event type.
- If a session has events pending in its queue(s) and viClose() is invoked on that session, VISA will free all pending event occurrences and associated contexts not yet delivered to the application for that session.

See Also **Handling Events**
viDisableEvent (*vi, EventType, mechanism*)

viEventHandler (vi, eventType, context, userHandle)

Usage Prototype for handler(s) to be called back when a particular event occurs.

C Format ViStatus viEventHandler(ViSession *vi*, ViEventType *eventType*,
ViEvent *context*, ViAddr *userHandle*)

Visual Basic Format Not applicable

Parameters

Table 2-34: viEventHandler() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
eventType	IN	Logical event identifier.
context	IN	A handle specifying the unique occurrence of an event.
userHandle	IN	A value specified by an application that can be used for identifying handlers uniquely in a session for an event..

Return Values

Table 2-35: viEventHandler() Completion Codes

Completion Codes	Description
VI_SUCCESS	Event handled successfully.
VI_SUCCESS_NCHAIN	Event handled successfully. Do not invoke any other handlers on this session for this event.

C Example

```
ViStatus _VI_FUNCH ServiceReqEventHandler(ViSession vi, ViEventType
eventType, ViEvent event, ViAddr userHandle)
{
        printf("srq occurred\n");
        return VI_SUCCESS;
}

int main(int argc, char* argv[])
{
        ViSession rm, vi;
        ViStatus status;
        char    string[256];
        ViUInt32                retCnt;

        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        status = viOpen(rm, "GPIB8::1::INSTR", NULL, NULL, &vi);
        if (status < VI_SUCCESS) goto error;

        // Setup and enable event handler
        status = viInstallHandler(vi, VI_EVENT_SERVICE_REQ,
                                  ServiceReqEventHandler, NULL);
        if (status < VI_SUCCESS) goto error;
        status = viEnableEvent(vi, VI_EVENT_SERVICE_REQ,
                        VI_HNDLR, VI_NULL);
        if (status < VI_SUCCESS) goto error;

        // Do processing here


        // Cleanup and exit
        status = viDisableEvent(vi, VI_EVENT_SERVICE_REQ, VI_HNDLR);
        if (status < VI_SUCCESS) goto error;
        status = viUninstallHandler(vi, VI_EVENT_SERVICE_REQ,
                                    ServiceReqEventHandler, NULL);
        if (status < VI_SUCCESS) goto error;
        viClose(vi);
        viClose(rm);
```

Comments

viEventHandler() is the prototype for a user event handler that is installed with the viInstallHandler() operation. The user handler is called whenever a session receives an event and is enabled for handling events in the VI_HNDLR mode. The handler services the event and returns VI_SUCCESS on completion. Because each event type defines its own context in terms of attributes, refer to the appropriate event definition to determine which attributes can be retrieved using the *context* parameter.

- The VISA system automatically invokes the viClose() operation on the event context when a user handler returns. Because the event context must still be valid after the user handler returns (so that VISA can free it up), do not invoke the viClose() operation on an event context passed to a user handler. However, if the user handler will not return to VISA, call viClose() on the event context to manually delete the event object. This situation may occur when a handler throws a C++ exception in response to a VISA exception event.
- Normally, you should always return VI_SUCCESS from all callback handlers, since future versions or implementations of VISA may take actions based on other return values. However, if a specific handler does not want other handlers to be invoked for the given event for the given session, you should return VI_SUCCESS_NCHAIN. No return value from a handler on one session will affect callbacks on other sessions.

See Also **Handling Events**
viInstallHandler (***vi, eventType, handler, userHandle***)
viUninstallHandler (***vi, eventType, handler, userHandle***)

viFindNext (findList, instrDesc)

Usage Returns the next resource from the find list.

C Format ViStatus viFindNext(ViFindList *findList*, ViPRsrc *instrDesc[]*)

Visual Basic Format viFindNext (ByVal *findList* As Long, ByVal *instrDesc* As String) As Long

Parameters

Table 2-36: viFindNext() Parameters

Name	Direction	Description
findList	IN	Describes a find list. This parameter must be created by viFindRsrc().
instrDesc	OUT	Returns a string identifying the location of a device. Strings can then be passed to viOpen() to establish a session to the given device.

Return Values

Table 2-37: viFindNext() Completion Codes

Completion Codes	Description
VI_SUCCESS	Resource(s) found.

Table 2-38: viFindNext() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given findList does not support this operation.
VI_ERROR_RSRC_NFOUND	There are no more matches.

C Example

```
ViSession       rm, vi;
ViStatus status;
ViChar   desc[256], id[256], buffer[256];
ViUInt32        retCnt, itemCnt;
ViFindList      list;
ViUInt32        i;

// Open a default Session
status = viOpenDefaultRM(&rm);
if (status < VI_SUCCESS) goto error;

// Find all GPIB devices
status = viFindRsrc(rm, "GPIB?*INSTR", &list, &itemCnt, desc);
if (status < VI_SUCCESS) goto error;

for (i = 0; i < itemCnt; i++) {
        // Open resource found in rsrc list
        status = viOpen(rm, desc, VI_NULL, VI_NULL, &vi);
        if (status <  VI_SUCCESS) goto error;

        // Send an ID query.
        status = viWrite(vi, (ViBuf) "*idn", 5, &retCnt);
        if (status < VI_SUCCESS) goto error;

        // Clear the buffer and read the response
        status = viRead(vi, (ViBuf) id, sizeof(id), &retCnt);
        id[retCnt] = '\0';
        if (status < VI_SUCCESS) goto error;

        // Print the response
        printf("id: %s: %s\n", desc, id);

        // We're done with this device so close it
```

```
        viClose(vi);

        // Get the next item
        viFindNext(list, desc);
}

// Clean up
viClose(rm);
```

Comments The viFindNext() operation returns the next device found in the list created by viFindRsrc(). The list is referenced by the handle returned by viFindRsrc().

NOTE. *The size of the instrDesc parameter should be at least 256 bytes.*

See Also **Finding Resources**
viFindRsrc (*sesn, expr, findList, retcnt, instrDesc*)

viFindRsrc (sesn, expr, findList, retCount, instrDesc)

Usage Find a list of resources associated with a specified interface.

C Format ViStatus viFindRsrc(ViSession *sesn*, ViString *expr*,
ViPFindList *findList,* ViPUInt32 *retCount*, ViPRsrc *instrDesc[]*)

Visual Basic Format viFindRsrc (ByVal *sesn* As Long, ByVal *expr* As String, ByVal *findList* As Long, ByVal *retCount* As Long, ByVal *instrDesc* As String) As Long

Parameters

Table 2-39: viFindRsrc() Parameters

Name	Direction	Description
sesn	IN	Resource Manager session (should always be the Default Resource Manager for VISA returned from viOpenDefaultRM())
expr	IN	This is a regular expression followed by an optional logical expression. The grammar for this expression is given below.
findList	OUT	Returns a handle identifying this search session. This handle will be used as an input in viFindNext().

Table 2-39: viFindRsrc() Parameters (Cont.)

Name	Direction	Description
retCount	OUT	Number of matches.
instrDesc	OUT	Returns a string identifying the location of a device. Strings can then be passed to viOpen() to establish a session to the given device.

Return Values

Table 2-40: viFindRsrc() Completion Codes

Completion Codes	Description
VI_SUCCESS	Resource(s) found.

Table 2-41: viFindRsrc() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given sesn does not support this operation.
VI_ERROR_INV_EXPR	Invalid expression specified for search.
VI_ERROR_RSRC_NFOUND	Specified expression does not match any devices.

C Example

```
ViSession       rm, vi;
ViStatus status;
ViChar   desc[256], id[256], buffer[256];
ViUInt32        retCnt, itemCnt;
ViFindList      list;
ViUInt32        i;

// Open a default Session
status = viOpenDefaultRM(&rm);
if (status < VI_SUCCESS) goto error;

// Find all GPIB devices
status = viFindRsrc(rm, "GPIB?*INSTR", &list, &itemCnt, desc);
if (status < VI_SUCCESS) goto error;

for (i = 0; i < itemCnt; i++) {
        // Open resource found in rsrc list
        status = viOpen(rm, desc, VI_NULL, VI_NULL, &vi);
        if (status <  VI_SUCCESS) goto error;
```

```
            // Send an ID query.
            status = viWrite(vi, (ViBuf) "*idn?", 5, &retCnt);
            if (status < VI_SUCCESS) goto error;

            // Clear the buffer and read the response
            status = viRead(vi, (ViBuf) id, sizeof(id), &retCnt);
            id[retCnt] = '\0';
            if (status < VI_SUCCESS) goto error;

            // Print the response
            printf("id: %s: %s\n", desc, id);

            // We're done with this device so close it
            viClose(vi);

            // Get the next item
            viFindNext(list, desc);
}

// Clean up
viClose(rm);
```

Comments

The viFindRsrc() operation matches the value specified in *expr* with the resources available for a particular interface. On successful completion, this function returns the first resource found in the list (*instrDesc*).

NOTE. *The size of the instrDesc parameter should be at least 256 bytes.*

- This function also returns a count (*retcnt*) to indicate if more resources were found, and returns a handle to the list of resources (*findList*). This handle must be used as an input to viFindNext() and should be passed to viClose() when it is no longer needed.
- The *retcnt* and *findList* parameters can optionally be omitted if. only the first match is important and the number of matches is not needed.

Table 2-42: Special Value for retCount Parameter with viFindRsrc()

Value	Description
VI_NULL	If you pass this value, VISA does not return the number of matches.

Table 2-43: Special Value for findList Parameter with viFindRsrc()

Value	Description
VI_NULL	If you pass this value and the operation completes successfully, VISA does not return the findList handle and invokes viClose() on the handle instead.

- The search criteria specified in the *expr* parameter has two parts: a regular expression over a resource string, and an optional logical expression over attribute values. A regular expression is a string consisting of ordinary characters as well as special characters.

Table 2-44: Regular Expression Special Characters and Operators

Special Characters and Operators	Meaning
?	Matches any one character.
\	Makes the character that follows it an ordinary character instead of special character. For example, when a question mark follows a backslash (\?), it matches the ? character instead of any one character.
[list]	Matches any one character from the enclosed list. You can use a hyphen to match a range of characters.
[^list]	Matches any character not in the enclosed list. You can use a hyphen to match a range of characters.
*	Matches 0 or more occurrences of the preceding character or expression.
+	Matches 1 or more occurrences of the preceding character or expression.
exp|exp	Matches either the preceding or following expression. The or operator | matches the entire expression that precedes or follows it and not just the character that precedes or follows it. For example, ASRL|GPIB means (ASRL)|(GPIB), not ASR(L|G)PIB.
(exp)	Grouping characters or expressions.

- You use a regular expression to specify patterns to match in a given string. The regular expression is matched against the resource strings of resources known to the VISA Resource Manager.
- The viFindRsrc() operation uses a case-insensitive compare feature when matching resource names against the regular expression specified in *expr*. For example, calling viFindRsrc() with “GPIB?*INSTR” would return the same resources as invoking it with “gpib?*instr”.

Table 2-45: Examples of Regular Expression Matches

Regular Expression	Sample Matches
GPIB?*INSTR	Matches GPIB0::2::INSTR and GPIB1::1::1::INSTR.
GPIB[0-9]*::?*INSTR	Matches GPIB0::2::INSTR and GPIB1::1::1::INSTR..
GPIB[0-9]::?*INSTR	Matches GPIB0::2::INSTR and GPIB1::1::1::INSTR but not GPIB12::8::INSTR.
GPIB[^0]::?*INSTR	Matches GPIB1::1::1::INSTR but not GPIB0::2::INSTR or GPIB12::8::INSTR.
ASRL[0-9]*::?*INSTR	Matches ASRL1::INSTR but not GPIB0::5::INSTR.
ASRL1+::INSTR	Matches ASRL1::INSTR and ASRL11::INSTR but not ASRL2::INSTR.
?*INSTR	Matches all INSTR (device) resources.
?*	Matches all resources.

- If the resource string matches the regular expression, the attribute values of the resource are then matched against the expression over attribute values. If the match is successful, the resource has met the search criteria and gets added to the list of resources found.
- The optional attribute expression allows construction of flexible and powerful expressions with the use of logical ANDs, ORs and NOTs. Equal (==) and unequal (!=) comparators can be used compare attributes of any type, and in addition, other inequality comparators (>, <, >=, <=) can be used to compare attributes of numeric type. If the attribute type is ViString, a regular expression can be used in matching the attribute. Only global attributes can be used in the attribute expression.

Table 2-46: Examples That Include Attribute Expression Matches

Expr	Meaning
GPIB[0-9]*::?*::?*::INSTR {VI_ATTR_GPIB_SEC-ONDARY_ADDR > 0}	Find all GPIB devices that have secondary addresses greater than 0.
ASRL?*INSTR{VI_ATTR_ASRL_BAUD == 9600}	Find all serial ports configured at 9600 baud.
?*ASRL?*INSTR{VI_ATTR_MANF_ID == 0xFF6 && !(VI_ATTR_ASRL_LA == 0 || VI_ATTR_SLOT <= 0)}	Find all ASRL instrument resources whose manufacturer ID is FF6 and who are not logical address 0, slot 0, or external controllers.

See Also

Finding Resources
viFindNext (*findList, instrDesc*)

viFlush (vi, mask)

Usage

Manually flushes the specified buffer(s).

C Format

ViStatus viFlush (ViSession *vi*, ViUint16 *mask*)

Visual Basic Format

viFlush (ByVal *vi* As Long, ByVal *mask* As Integer) As Long

Parameters

Table 2-47: viFlush() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
mask	IN	Specifies the action to be taken with flushing the buffer.

Return Values

Table 2-48: viFlush() Completion Codes

Completion Codes	Description
VI_SUCCESS	Buffers flushed successfully.

Table 2-49: viFlush() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform read/write operation because of I/O error.
VI_ERROR_TMO	The read/write operation was aborted because timeout expired while operation was in progress.
VI_ERROR_INV_MASK	The specified mask does not specify a valid flush operation on read/write resource.

C Example

```
// Request the curve
status = viPrintf(vi, "CURVE?\n");
if (status < VI_SUCCESS) goto error;

// Always flush if a viScanf follows a viPrintf or
// viBufWrite.
status = viFlush(vi, VI_WRITE_BUF | VI_READ_BUF_DISCARD);
if (status < VI_SUCCESS) goto error;

// Get first char and validate
status = viScanf(vi, "%c", &c);
```

Comments

The value of mask can be one of the following flags:

Table 2-50: viFlush Values for mask Parameter

Flag	Meaning
VI_READ_BUF	Discard the read buffer contents. If data was present in the read buffer and no END-indicator was present, read from the device until encountering an END indicator (which causes the loss of data). This action resynchronizes the next viScanf() call to read a <TERMINATED RESPONSE MESSAGE>. (Refer to the IEEE 488.2 standard.)
VI_READ_BUF_DISCARD	Discard the read buffer contents (does not perform any I/O to the device).
VI_WRITE_BUF	Flush the write buffer by writing all buffered data to the device.
VI_WRITE_BUF_DISCARD	Discard the write buffer contents (does not perform any I/O to the device).
VI_ASRL_IN_BUF	Discard the receive buffer contents (same as VI_ASRL_IN_BUF_DISCARD).
VI_ASRL_IN_BUF_DISCARD	Discard the receive buffer contents (does not perform any I/O to the device)
VI_ASRL_OUT_BUF	Flush the transmit buffer by writing all buffered data to the device.
VI_ASRL_OUT_BUF_DISCARD	Discard the transmit buffer contents (does not perform any I/O to the device).

- It is possible to combine any of these read flags and write flags for different buffers by ORing the flags. However, combining two flags for the same buffer in the same call to viFlush() is illegal.
- Notice that when using formatted I/O operations with a serial device, a flush of the formatted I/O buffers also causes the corresponding serial communication buffers to be flushed. For example, calling viFlush() with VI_WRITE_BUF also flushes the VI_ASRL_OUT_BUF.

See Also

Reading and Writing Formatted Data
viSetBuf (*vi, mask, size*)

viGetAttribute (vi, attribute, attrState)

Usage

Retrieves the state of an attribute for the specified session, event, or find list.

C Format

ViStatus viGetAttribute(ViObject *vi*, ViAttr *attribute*,
ViAttrState *attrState*)

Visual Basic Format

viGetAttribute (ByVal *vi* As Long, ByVal *attribute* As Long, ByVal *attrState* As Long) As Long

Parameters

Table 2-51: viGetAttribute() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session, event, or find list.
attribute	IN	Session, event, or find list attribute for which the state query is made.
attrState	OUT	The state of the queried attribute for a specified resource. The interpretation of the returned value is defined by the individual resource.

Return Values

Table 2-52: viGetAttribute() Completion Codes

Completion Codes	Description
VI_SUCCESS	Session, event, or find list attribute retrieved successfully.

Table 2-53: viGetAttribute() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_ATTR	The specified attribute is not defined by the referenced session, event, or find list.

C Example

```
// Get VISA's vendors name, VISA Specification
// Version, and implementation version.
status = viGetAttribute(rm, VI_ATTR_RSRC_MANF_NAME, buffer);
if (status < VI_SUCCESS) goto error;
status = viGetAttribute(rm, VI_ATTR_RSRC_SPEC_VERSION,
                        &version);
if (status < VI_SUCCESS) goto error;
status = viGetAttribute(rm, VI_ATTR_RSRC_IMPL_VERSION,
                        &impl);
if (status < VI_SUCCESS) goto error;
```

Comments

tThe viGetAttribute() operation is used to retrieve the state of an attribute for the specified session, event, or find list.

- The output parameter *attrState* is of the type of the attribute actually being retrieved. For example, when retrieving an attribute defined as a ViBoolean, your application should pass a reference to a variable of type ViBoolean. Similarly, if the attribute is defined as being ViUInt32, your application should pass a reference to a variable of type ViUInt32.

See Also

Setting and Retrieving Attributes
viSetAttribute (*vi, attribute, attrState*)

viInstallHandler (vi, eventType, handler, userHandle)

Usage

Installs callback handler(s) for the specified event.

C Format

ViStatus viInstallHandler (ViSession *vi*, ViEventType *eventType*, ViHndlr *handler,* ViAddr *userHandle*)

Visual Basic Format

Not Applicable

Parameters

Table 2-54: viInstallHandler() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
eventType	IN	Logical event identifier.
handler	IN	Interpreted as a valid reference to a handler to be installed by a client application.
userHandle	IN	A value specified by an application that can be used for identifying handlers uniquely for an event type.

Return Values

Table 2-55: viInstallHandler() Completion Codes

Completion Codes	Description
VI_SUCCESS	Event handler installed successfully.

Table 2-56: viInstallHandler() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_EVENT	Specified event type is not supported by the resource.
VI_ER- ROR_INV_HNDLR_REF	The given handler reference is invalid.
VI_ERROR_HNDLR_NINS- TALLED	The handler was not installed. This may be returned if an application attempts to install multiple handlers for the same event on the same session.

C Example

```
ViStatus _VI_FUNCH ServiceReqEventHandler(ViSession vi, ViEventType eventType,
ViEvent event, ViAddr userHandle)
{
        printf("srq occurred\n");
        return VI_SUCCESS;
}

int main(int argc, char* argv[])
{
        ViSession rm, vi;
        ViStatus status;
        char      string[256];
        ViUInt32                retCnt;

        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        status = viOpen(rm, "GPIB8::1::INSTR", NULL, NULL,
                &vi);
        if (status < VI_SUCCESS) goto error;

        // Setup and enable event handler
        status = viInstallHandler(vi, VI_EVENT_SERVICE_REQ,
                                  ServiceReqEventHandler, NULL);
        if (status < VI_SUCCESS) goto error;
        status = viEnableEvent(vi, VI_EVENT_SERVICE_REQ,
                                VI_HNDLR, VI_NULL);
        if (status < VI_SUCCESS) goto error;

        // Do processing here


        // Cleanup and exit
        status = viDisableEvent(vi, VI_EVENT_SERVICE_REQ,
                                VI_HNDLR);
        if (status < VI_SUCCESS) goto error;
        status = viUninstallHandler(vi, VI_EVENT_SERVICE_REQ,
                                    ServiceReqEventHandler, NULL);
        if (status < VI_SUCCESS) goto error;
        viClose(vi);
        viClose(rm);
        return 0;
error:
        viStatusDesc(rm, status, string);
        fprintf(stderr, "Error: %s\n", (ViBuf) string);
        return 0;
}
```

Comments

The viInstallHandler() operation allows applications to install handlers on sessions. The handler specified in *handler* is installed along with any previously installed handlers for the specified event.

- You can specify a value in *userHandle* that is passed to the handler on its invocation. VISA identifies handlers uniquely using the handler reference and this value.
- VISA allows you to install multiple handlers for an event type on the same session. You can install multiple handlers through multiple invocations of the viInstallHandler() operation, where each invocation adds to the previous list of handlers. If more than one handler is installed for an event type, each handlers is invoked on every occurrence of the specified event(s). Handlers are invoked in Last In First Out (LIFO) order.

See Also

Handling Events
viUninstallHandler (*vi, eventType, handler, userHandle*)

viLock (vi, lockType, timeout, requestedKey, accessKey)

Usage

Obtains a lock on the specified resource.

C Format

ViStatus viLock(ViSession *vi*, ViAccessMode *lockType*, ViUInt32 *timeout,* ViKeyId *requestedKey*, ViPKeyId *accessKey[]*)

Visual Basic Format

viLock (ByVal *vi* As Long, ByVal *lockType* As Long, ByVal *timeout* As Long, ByVal *requestedKey* As String, ByVal *accessKey* As String) As Long

Parameters

Table 2- 57: viLock() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
lockType	IN	Specifies the type of lock requested, which can be either VI_EXCLUSIVE_LOCK or VI_SHARED_LOCK.
timeout	IN	Absolute time period (in milliseconds) that a resource waits to get unlocked by the locking session before returning this operation with an error.

Table 2-57: viLock() Parameters (Cont.)

Name	Direction	Description
requestedKey	IN	This parameter is not used and should be set to VI_NULL when *lockType* is VI_EXCLUSIVE_LOCK (exclusive locks). When trying to lock the resource as VI_SHARED_LOCK (shared), a session can either set it to VI_NULL, so that VISA generates an *accessKey* for the session, or the session can suggest an *accessKey* to use for the shared lock. Refer to the comments section below for more details.
accessKey	OUT	This parameter should be set to VI_NULL when *lockType* is VI_EXCLUSIVE_LOCK (exclusive locks). When trying to lock the resource as VI_SHARED_LOCK (shared), the resource returns a unique access key for the lock if the operation succeeds. This *accessKey* can then be passed to other sessions to share the lock.

Return Values

Table 2-58: viLock() Completion Codes

Completion Codes	Description
VI_SUCCESS	Specified access mode is successfully acquired.
VI_SUCCESS_NESTED_EXCLUSIVE	Specified access mode is successfully acquired, and this session has nested exclusive locks.
VI_SUCCESS_NESTED_SHARED	Specified access mode is successfully acquired, and this session has nested shared locks.

Table 2-59: viLock() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified type of lock cannot be obtained because the resource is already locked with a lock type incompatible with the lock requested. For example, this error is returned if a viLock() operation requesting a shared lock is invoked from a session that has an exclusive lock.
VI_ERROR_INV_LOCK_TYPE	The specified type of lock is not supported by this resource.
VI_ERROR_INV_ACCESS_KEY	The requestedKey value passed in is not a valid access key to the specified resource.
VI_ERROR_TMO	Specified type of lock could not be obtained within the specified timeout period.

C Example

```
ViSession       rm, vi;
char    string[256];
ViUInt32        retCnt;
int     i = 0;

if (viOpenDefaultRM(&rm) < VI_SUCCESS) return;
if (viOpen(rm, "GPIB8::1::INSTR", NULL, NULL, &vi) < VI_SUCCESS)
   return;

for (i = 1; i < 100; i++) {
        viLock(vi, VI_EXCLUSIVE_LOCK, VI_TMO_INFINITE, NULL,
NULL);
        if (viWrite(vi, (ViBuf) "ch1:scale?", 10, &retCnt)
           < VI_SUCCESS) return;
        if (viRead(vi, (ViBuf) string, 256, &retCnt)
           < VI_SUCCESS) return;
        printf("%d: scale %s", i, string);

        viUnlock(vi);
}
```

Comments

This operation is used to obtain a lock on the specified resource. The caller can specify the type of lock requested—exclusive or shared lock—and the length of time the operation will suspend while waiting to acquire the lock before timing out. This operation can also be used for sharing and nesting locks.

***NOTE**. If requesting a VI_SHARED_LOCK, the size of the accessKey parameter should be at least 256 bytes.*

- The *requestedKey* and the *accessKey* parameters apply only to shared locks. When using the lock type VI_EXCLUSIVE_LOCK, *requestedKey* and *accessKey* should be set to VI_NULL.
- VISA allows you to specify a key to be used for lock sharing through the use of the *requestedKey* parameter. Or, you can pass VI_NULL for *requestedKey* when obtaining a shared lock, in which case VISA will generate a unique access key and return it through *accessKey*. If you do specify a *requestedKey*, VISA will try to use this value for the *accessKey*. As long as the resource is not locked, VISA will use the *requestedKey* as the access key and grant the lock. When the operation succeeds, the *requestedKey* will be copied into the user buffer referred to by the *accessKey*.
- The session that gained a shared lock can pass the *accessKey* to other sessions for the purpose of sharing the lock. The session wanting to join the group of sessions sharing the lock can use the key as an input value to the *requestedKey* parameter. VISA will add the session to the list of sessions sharing the lock, as long as the *requestedKey* value matches the *accessKey*

value for the particular resource. The session obtaining a shared lock in this manner will then have the same access privileges as the original session that obtained the lock.

- You can obtain nested locks through this operation. To acquire nested locks, invoke the viLock() operation with the same lock type as the previous invocation of this operation. For each session, viLock() and viUnlock() share a lock count, which is initialized to 0. Each invocation of viLock() for the same session (and for the same *lockType*) increases the lock count. In the case of a shared lock, it returns with the same *accessKey* every time.

  When a session locks the resource a multiple number of times, you must invoke the viUnlock() operation an equal number of times in order to unlock the resource. That is, the lock count increments for each invocation of viLock(), and decrements for each invocation of viUnlock(). A resource is actually unlocked only when the lock count is 0.

See Also **Locking and Unlocking Resources**
viUnlock (*vi*)

viOpen (sesn, rsrcName, accessMode, timeout, vi)

Usage Opens a session to the specified resource.

C Format ViStatus viOpen(ViSession *sesn*, ViRsrc *rsrcname*, ViAccessMode *mode,* ViUInt32 *timeout*, ViPSession *vi*)

Visual Basic Format viOpen (ByVal *sesn* As Long, ByVal *rsrcName* As String,
ByVal *accessMode* As Long, ByVal *timeout* As Long, *vi* As Long) As Long

Parameters

Table 2-60: viOpen() Parameters

Name	Direction	Description
sesn	IN	Resource Manager session (should always be the Default Resource Manager for VISA returned from viOpenDefaultRM()).
rsrcName	IN	Unique symbolic name of a resource.
accessMode	IN	Specifies the mode(s) by which the resource is to be accessed: VI_EXCLUSIVE_LOCK and/or VI_LOAD_CONFIG. If the latter value is not used, the session uses the default values provided by VISA. Multiple access modes can be used simultaneously by specifying a "bit-wise OR" of the above values.

Table 2-60: viOpen() Parameters (Cont.)

Name	Direction	Description
timeout	IN	If the accessMode parameter requests a lock, then this parameter specifies the absolute time period (in milliseconds) that the resource waits to get unlocked before this operation returns an error; otherwise, this parameter is ignored.
vi	OUT	Unique logical identifier reference to a session.

Return Values

Table 2-61: viOpen() Completion Codes

Completion Codes	Description
VI_SUCCESS	Session opened successfully.
VI_SUCCESS_DEV_NPRE-SENT	Session opened successfully, but the device at the specified address is not responding.
VI_WARN_CONFIG_ NLOADED	The specified configuration either does not exist or could not be loaded; using VISA-specified defaults instead.

Table 2-62: viOpen() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_RSRC_ NAME	Invalid resource reference specified. Parsing error.
VI_ER-ROR_INV_ACC_MODE	Invalid access mode.
VI_ERROR_RSRC_NFOUND	Insufficient location information or resource not present in the system.
VI_ERROR_ALLOC	Insufficient system resources to open a session.
VI_ERROR_RSRC_BUSY	The resource is valid, but VISA cannot currently access it.
VI_ERROR_RSRC_LOCKED	Specified type of lock cannot be obtained because the resource is already locked with a lock type incompatible with the lock requested
VI_ERROR_TMO	A session to the resource could not be obtained within the specified timeout period.
VI_ERROR_LIBRARY_ NFOUND	A code library required by VISA could not be located or loaded.

C Example

```
// Open the GPIB device at primary address 1, GPIB board 8
status = viOpen(rm, "GPIB8::1::INSTR", VI_NULL, VI_NULL,
                &vi);
if (status < VI_SUCCESS) goto error;
```

Comments

The viOpen() operation opens a session to the specified resource. It returns a session identifier that can be used to call any other operations of that resource.

- The GPIB keyword can be used to establish communication with a GPIB device.
- The ASRL keyword is used to establish communication with an asynchronous serial device (such as RS-232).
- An address string must uniquely identify the resource. The following table shows the grammar for the address string and gives examples.
  - Optional string segments are shown in square brackets ([ ]).
  - The default value for the optional string segment *board* is 0.
  - The default value for the optional string segment *secondary address* is none.
  - Address strings are not case sensitive.

Table 2-63: Resource Address String Grammar and Examples with viOpen()

Grammar	Example	Description
GPIB[board] :: primary address [:: secondary address] [::INSTR]	GPIB::1::0::INSTR	A GPIB device at primary address 1 and secondary address 0 in GPIB interface 0.
ASRL [board][::INSTR]	ASRL1::INSTR	A serial device attached to interface ASRL1.

Table 2-64: Special Values for accessMode Parameter with viOpen()

Value	Description
VI_EXCLUSIVE_LOCK	Used to acquire an exclusive lock immediately upon opening a session; if a lock cannot be acquired, the session is closed and an error is returned.
VI_LOAD_CONFIG	Used to configure attributes to values specified by an external configuration utility.

See Also

Opening and Closing Sessions
viOpenDefaultRM (*sesn*)
viClose (*vi*)

viOpenDefaultRM (sesn)

Usage

Returns a session to the Default Resource Manager.

C Format

ViStatus viOpenDefaultRM(ViSession *sesn*)

Visual Basic Format

viOpenDefaultRM (ByVal *sesn* As Long) As Long

Parameters

Table 2-65: viOpenDefaultRM() Parameters

Name	Direction	Description
sesn	OUT	Unique logical identifier to a Default Resource Manager session.

Return Values

Table 2-66: viOpenDefaultRM() Completion Codes

Completion Codes	Description
VI_SUCCESS	Session to the Default Resource Manager resource created successfully

Table 2-67: viOpenDefaultRM() Error Codes

Error Codes	Description
VI_ERROR_SYSTEM_ ERROR	The VISA system failed to initialize.
VI_ERROR_ALLOC	Insufficient system resources to create a session to the Default Resource Manager resource.
VI_ERROR_INV_SETUP	Some implementation-specific configuration file is corrupt or does not exist.
VI_ERROR_LI- BRARY_NFOUND	A code library required by VISA could not be located or loaded.

C Example

```
// Open a default session
status = viOpenDefaultRM(&rm);
if (status < VI_SUCCESS) goto error;
```

Comments

The viOpenDefaultRM() function must be called before any VISA operations can be invoked.

- The first call to this function initializes the VISA system, including the Default Resource Manager resource, and also returns a session to that resource.
- Subsequent calls to this function return new and unique sessions to the same Default Resource Manager resource.
- When a Resource Manager session is closed, all find lists and device sessions opened with that Resource Manager session are also closed.

See Also

Opening and Closing Sessions
viOpen (*sesn, rsrcName, accessMode, timeout, vi*)
viClose (*vi*)

viParseRsrc (sesn, rsrcName, intfType, intfNum)

Usage Parses a resource string to get the interface information.

C Format ViStatus viParseRsrc(ViSession *sesn,*ViRsrc *rsrcName*, ViUint16 *intfType*, ViUInt *intfNum*)

Visual Basic Format viParseRsrc (ByVal *sesn* As Long, ByVal *rsrcName* As String, ByVal *intfType* As Integer, ByVal *intfNum* As Integer) As Long

Parameters

Table 2-68: viParseRsrc() Parameters

Name	Direction	Description
sesn	IN	Resource Manager session (should always be the Default Resource Manager for VISA returned from viOpenDefaultRM())
rsrcName	IN	Unique symbolic name of a resource.
intfType	OUT	Interface type of the given resource string.
intfNum	OUT	Board number of the interface of the given resource string.

Return Values

Table 2-69: viParseRsrc() Completion Codes

Completion Codes	Description
VI_SUCCESS	Resource string is valid

Table 2-70: viParseRsrc() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given session does not support this operation. For VISA, this operation is supported only by the Default Resource Manager session.
VI_ERROR_INV_ RSRC_NAME	Invalid resource reference specified. Parsing error.
VI_ERROR_RSRC_NFOUND	Insufficient location information or resource not present in the system.
VI_ERROR_ALLOC	Insufficient system resources to parse the string.

Table 2-70: viParseRsrc() Error Codes (Cont.)

Error Codes	Description
VI_ERROR_LIBRARY_NFOUND	A code library required by VISA could not be located or loaded.
VI_ERROR_INTF_NUM_NCONFIG	The interface type is valid but the specified interface number is not configured.

C Example

```
if (viOpenDefaultRM(&rm) < VI_SUCCESS) return;
if (viParseRsrc(rm,"GPIB8::1::INSTR", ifType, ifNum)) < VI_SUCCESS)
   return;
```

Comments

This operation parses a resource string to verify its validity. It should succeed for all strings returned by viFindRsrc() and recognized by viOpen(). This operation is useful if you want to know what interface a given resource descriptor would use without actually opening a session to it.

The values returned in intfType and intfNum correspond to the attributes VI_ATTR_INTF_TYPE and VI_ATTR_INTF_NUM. These values would be the same if a user opened that resource with viOpen() and queried the attributes with viGetAttribute().

***NOTE**. The size of the instrDesc parameter should be at least 256 bytes.*

- This function returns information determined solely from the resource string and any static configuration information (such as.INI files or the Registry).
- This function is case-insensitive when matching resource names against the name specified in *rsrcName*. Calling viParseRsrc() with "gpib8::1::instr" will produce the same results as invoking it with "GPIB 8::1::INSTR".

See Also

Finding Resources
viFindNext (*findList, instrDesc*)
viFindRsrc (*sesn, expr, findList, retcnt, instrDesc*)

viPrintf (vi, writeFmt, <arg1, arg2, ...>)

Usage Formats and writes data to a device using the optional variable-length argument list.

C Format ViStatus viPrintf (ViSession *vi*, ViString *writeFmt*, ...)

Visual Basic Format Not applicable

Parameters

Table 2-71: viPrintf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
writeFmt	IN	String describing the format for arguments.
<arg1, arg2, ...>	IN	Optional argument(s) the format string is applied to.

Return Values

Table 2-72: viPrintf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Parameters were successfully formatted.

Table 2-73: viPrintf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform write operation because of I/O error.
VI_ERROR_TMO	Timeout expired before write operation completed.
VI_ERROR_INV_FMT	A format specifier in the writeFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the writeFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
// Turn headers off, this makes parsing easier
status = viPrintf(vi, “header off\n”);
if (status < VI_SUCCESS) goto error;

// Get record length value
status = viQueryf(vi, ”hor:reco?\n“, ”%ld“, elements);
if (status < VI_SUCCESS) goto error;

// Make sure start, stop values for curve query match the
// full record length
status = viPrintf(vi, “data:start %d;data:stop %d\n”, 0,
                  (*elements)-1);
if (status < VI_SUCCESS) goto error;
```

Comments

The viPrintf() operation sends data to a device as specified by the format string (*writeFmt*). Before sending the data, the operation formats the argument characters as specified in the *writeFmt* string.

- The viWrite() operation performs the actual low-level I/O to the device. As a result, you should not use the viWrite() and viPrintf() operations in the same session.
- The *writeFmt* string can include regular character sequences, special formatting characters, and special format specifiers.
  - The regular characters (including white spaces) are written to the device unchanged.
  - The special characters consist of ‘ \’ (backslash) followed by a character.
  - The format specifier sequence consists of ‘%’ (percent) followed by an optional modifier (flag), followed by a format code.

Special Formatting Characters

Special formatting character sequences send special characters. The following table lists the special characters and describes what they send to the device.

Table 2-74: Special Characters used with viPrintf()

Formatting Character	Character Sent to Device
\n	Sends the ASCII LF character. The END identifier will also be automatically sent.
\r	Sends an ASCII CR character.
\t	Sends an ASCII TAB character.
\###	Sends the ASCII character specified by the octal value.

Table 2-74: Special Characters used with viPrintf() (Cont.)

Formatting Character	Character Sent to Device
\x##	Sends the ASCII character specified by the hexadecimal value.
\"	Sends the ASCII double-quote (") character.
\\	Sends a backslash (\) character.

Format Specifiers

The format specifiers convert the next parameter in the sequence according to the modifier and format code, after which the formatted data is written to the specified device. The format specifier takes the following syntax:

%[*modifiers*]*format code*

- *Modifiers* are optional codes that describe the target data.
- *Format code* specifies which data type the argument is represented in.
- In the following tables, a 'd' format code refers to all conversion codes of type integer ('d', 'i', 'o', 'u', 'x', 'X'), unless specified as %d only. Similarly, an 'f' format code refers to all conversion codes of type float ('f', 'e', 'E', 'g', 'G'), unless specified as %f only. Every conversion command starts with the % character and ends with a conversion character (*format code*). Between the % character and the *format code*, the following *modifiers* can appear in the sequence.

ANSI C Standard Modifiers

Table 2-75: ANSI C Standard Modifiers used with viPrintf()

Modifier	Supported with Format Code	Description
An integer specifying *field width*.	d, f, s format codes	This specifies the minimum field width of the converted argument. If an argument is shorter than the *field width*, it will be padded on the left (or on the right if the - flag is present). Special case: For the @H, @Q, and @B flags, the *field width* includes the #H, #Q, and #B strings, respectively. An asterisk (*) may be present in lieu of a *field width* modifier, in which case an extra *arg* is used. This *arg* must be an integer representing the *field width.*

Table 2-75: ANSI C Standard Modifiers used with viPrintf() (Cont.)

Modifier	Supported with Format Code	Description
An integer specifying *precision*.	d, f, s format codes	The *precision* string consists of a string of decimal digits. A . (decimal point) must prefix the *precision* string. The *precision* string specifies the following: a. The minimum number of digits to appear for the @1, @H, @Q, and @B flags and the i, o, u, x, and X format codes. b. The maximum number of digits after the decimal point in case of f format codes. c. The maximum numbers of characters for the string (s) specifier. d. Maximum significant digits for g format code. An asterisk (*) may be present in lieu of a *precision* modifier, in which case an extra *arg* is used. This *arg* must be an integer representing the *precision* of a numeric field.
An argument length modifier. h, l, L, z, and Z are legal values. (z and Z are not ANSI C standard modifiers.)	h (d, b, B format codes) l (d, f, b, B format codes) L (f format code) z (b, B format codes) Z (b, B format codes)	The argument length modifiers specify one of the following: a. The h modifier promotes the argument to a short or unsigned short, depending on the format code type. b. The l modifier promotes the argument to a long or unsigned long. c. The L modifier promotes the argument to a long double parameter. d. The z modifier promotes the argument to an array of floats. e. The Z modifier promotes the argument to an array of doubles.

Enhanced Modifiers to ANSI C Standards

Table 2-76: Enhanced Modifiers to ANSI C Standards used with viPrintf()

Modifier	Supported with Format Code	Description
A comma (,) followed by an integer *n*, where *n* represents the array size.	%d and %f only	The corresponding argument is interpreted as a reference to the first element of an array of size *n*. The first *n* elements of this list are printed in the format specified by the format code. An asterisk (*) may be present after the comma (,) modifier, in which case an extra *arg* is used. This *arg* must be an integer representing the array size of the given type.
@1	%d and %f only	Converts to an IEEE 488.2 defined NR1 compatible number, which is an integer without any decimal point (for example, 123).
@2	%d and %f only	Converts to an IEEE 488.2 defined NR2 compatible number. The NR2 number has at least one digit after the decimal point (for example, 123.45).
@3	%d and %f only	Converts to an IEEE 488.2 defined NR3 compatible number. An NR3 number is a floating point number represented in an exponential form (for example, 1.2345E-67).
@H	%d and %f only	Converts to an IEEE 488.2 defined <HEXADECIMAL NUMERIC RESPONSE DATA>. The number is represented in a base of sixteen form. Only capital letters should represent numbers. The number is of form #HXXX.., where XXX.. is a hexadecimal number (for example, #HAF35B)
@Q	%d and %f only	Converts to an IEEE 488.2 defined <OCTAL NUMERIC RESPONSE DATA>. The number is represented in a base of eight form. The number is of the form #QYYY.., where YYY.. is an octal number (for example, #Q71234).
@B	%d and %f only	Converts to an IEEE 488.2 defined <BINARY NUMERIC RESPONSE DATA>. The number is represented in a base two form. The number is of the form #BZZZ.., where ZZZ.. is a binary number (for example, #B011101001).

The following are the allowed *format code* characters. A format specifier sequence should include one and only one *format code*.

Standard ANSI C Format Codes

% Send the ASCII percent (%) character.

c Argument type: A character to be sent.

d Argument type: An integer.

Table 2-77: Modifiers used with Argument Types %, c, and d with viPrintf()

Modifier	Interpretation
Default functionality	Print an integer in NR1 format (an integer without a decimal point).
@2 or @3	The integer is converted into a floating point number and output in the correct format.
field width	Minimum field width of the output number. Any of the six IEEE 488.2 modifiers can also be specified with *field width*.
Length modifier l	*arg* is a long integer.
Length modifier h	*arg* is a short integer.
, *array size*	*arg* points to an array of integers (or long or short integers, depending on the length modifier) of size *array size*. The elements of this array are separated by *array size* - 1 commas and output in the specified format.

f Argument type: A floating point number.

Table 2-78: Modifiers used with Argument Type f with viPrintf()

Modifier	Interpretation
Default functionality	Print a floating point number in NR2 format (a number with at least one digit after the decimal point).
@1	Print an integer in NR1 format. The number is truncated.
@3	Print a floating point number in NR3 format (scientific notation). Precision can also be specified.
field width	Minimum field width of the output number. Any of the six IEEE 488.2 modifiers can also be specified with *field width*.
Length modifier l	*arg* is a double float.
Length modifier L	*arg* is a long double.
, *array size*	*arg* points to an array of floats (or doubles or long doubles, depending on the length modifier) of size *array size*. The elements of this array are separated by *array size* - 1 commas and output in the specified format.

s Argument type: A reference to a NULL-terminated string that is sent to the device without change.

Enhanced Format Codes

b Argument type: A location of a block of data.

Table 2-79: Modifiers used with Argument Types s and b with viPrintf()

Modifier	Interpretation
Default functionality	The data block is sent as an IEEE 488.2 <DEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA>. A count (long integer) must appear as a flag that specifies the number of elements (by default, bytes) in the block. A *field width* or *precision* modifier is not allowed with this format code.
* (asterisk)	An asterisk may be present instead of the count. In such a case, two *arg*s are used, the first of which is a long integer specifying the count of the number of elements in the data block. The second *arg* is a reference to the data block. The size of an element is determined by the optional length modifier (see below), and the default is byte width.
Length modifier h	*arg* points to an array of unsigned short integers (16 bits). The count corresponds to the number of words rather than bytes. The data is swapped and padded into standard IEEE 488.2 format, if native computer representation is different.
Length modifier l	*arg* points to an array of unsigned long integers. The count specifies the number of longwords (32 bits). Each longword data is swapped and padded into standard IEEE 488.2 format, if native computer representation is different.
Length modifier z	*arg* points to an array of floats. The count specifies the number of floating point numbers (32 bits). The numbers are represented in IEEE 754 format, if native computer representation is different.
Length modifier Z	*arg* points to an array of doubles. The count specifies the number of double floats (64 bits). The numbers will be represented in IEEE 754 format, if native computer representation is different.

B Argument type: A location of a block of data. The functionality is similar to b, except the data block is sent as an IEEE 488.2 <INDEFINITE LENGTH ARBITRARY BLOCK RESPONSE DATA>. This format involves sending an ASCII LF character with the END indicator set after the last byte of the block.

y Argument type: A location of a block of binary data.

Table 2-80: Modifiers used with Argument Types B and y with viPrintf()

Modifier	Interpretation
Default functionality	The data block is sent as raw binary data. A count (long integer) must appear as a flag that specifies the number of elements (by default, bytes) in the block. A field width or precision modifier is not allowed with this format code.
* (asterisk)	An asterisk may be present instead of the count. In such a case, two *arg*s are used, the first of which is a long integer specifying the count of the number of elements in the data block. The second *arg* is a reference to the data block. The size of an element is determined by the optional length modifier (see below), and the default is byte width.
Length modifier h	*arg* points to an array of unsigned short integers (16 bits). The count corresponds to the number of words rather than bytes. If the optional !ol byte order modifier is present, the data is sent in little endian format; otherwise, the data is sent in standard IEEE 488.2 format. The data will be byte swapped and padded as appropriate if native computer representation is different.
Length modifier l	*arg* points to an array of unsigned long integers (32 bits). The count specifies the number of longwords rather than bytes. If the optional !ol byte order modifier is present, the data is sent in little endian format; otherwise, the data is sent in standard IEEE 488.2 format. The data will be byte swapped and padded as appropriate if native computer representation is different.
Byte order modifier !ob	Data is sent in standard IEEE 488.2 (big endian) format. This is the default behavior if neither !ob nor !ol is present.
Byte order modifier !ol	Data is sent in little endian format.

- The END indicator is not appended when LF(\n) is part of a binary data block, as with %b or %B.
- For ANSI C compatibility, VISA also supports the following conversion codes for output codes: ‘i,’ ‘o,’ ‘u,’ ‘n,’ ‘x,’ ‘X,’ ‘e,’ ‘E,’ ‘g,’ ‘G’, and ‘p.’ For further explanation of these conversion codes, see the ANSI C Standard.

See Also

Reading and Writing Formatted Data
viScanf (*vi, readFmt, <arg1, arg2, ...>*)
viQueryf (*vi, writeFmt, readFmt, <arg1, arg2, ...>*)

viQueryf (vi, writeFmt, readFmt, <arg1, arg2,...>)

Usage

Writes and reads formatted data to and from a device using the optional variable-length argument list.

C Format ViStatus viQueryf (ViSession *vi*, ViString *writeFmt*, ViString read*Fmt*, ...)

Visual Basic Format Not Applicable

Parameters

Table 2-81: viQueryf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
writeFmt	IN	ViString describing the format of write arguments.
readFmt	IN	ViString describing the format of read arguments.
<arg1, arg2,...>	IN OUT	Optional argument(s) on which write and read format strings are applied.

Return Values

Table 2-82: viQueryf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Successfully completed the Query operation.

Table 2-83: viQueryf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform read/write operation because of I/O error.
VI_ERROR_TMO	Timeout occurred before read/write operation completed.
VI_ERROR_INV_FMT	A format specifier in the writeFmt or readFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier is not supported for current argument type.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
// Get the yoffset to help calculate the vertical values.
status = viQueryf(vi, "WFMOUTPRE:YOFF?\n", "%f", &yoffset);
if (status < VI_SUCCESS) goto error;

// Get the ymult to help calculate the vertical values.
status = viQueryf(vi, "WFMOutpre:YMULT?\n", "%f", &ymult);
if (status < VI_SUCCESS) goto error;
```

Comments

This operation provides a mechanism of "Send, then Receive" typical to a command sequence from a commander device. In this manner, the response generated from the command can be read immediately.

- This operation is a combination of the viPrintf() and viScanf() operations.
- The first *n* arguments corresponding to the first format string are formatted by using the *writeFmt* string, then sent to the device. The write buffer is flushed immediately after the write portion of the operation completes. After these actions, the response data is read from the device into the remaining parameters (starting from parameter *n*+1) using the *readFmt* string.

NOTE. Because the prototype for this function cannot provide complete type-checking, remember that all output parameters must be passed by reference.

See Also

Reading and Writing Formatted Data
viPrintf (*vi, writeFmt, <arg1, arg2, ...>*)
viScanf (*vi, readFmt, <arg1, arg2, ...>*)

viRead (vi, buf, count, retCount)

Usage

Reads data synchronously from a device into the specified buffer.

C Format

ViStatus viRead (ViSession *vi*, ViPBuf *buf*, ViUInt32 *count,* ViPUInt32 *retCount*)

Visual Basic Format

viRead (ByVal *vi* As Long, ByVal *buf* As String, ByVal *count* As Long, ByVal *retCount* As Long) As Long

Parameters

Table 2-84: viRead() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	OUT	Represents the location of a buffer to receive data from device.
count	IN	Number of bytes to be read.
retCount	OUT	Represents the location of an integer that will be set to the number of bytes actually transferred.

Return Values

Table 2-85: viRead() Completion Codes

Completion Codes	Description
VI_SUCCESS	The operation completed successfully and the END indicator was received (for interfaces that have END indicators).
VI_SUCCESS_TERM_CHAR	The specified termination character was read.
VI_SUCCESS_MAX_CNT	The number of bytes read is equal to count.

Table 2-86: viRead() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_TMO	Timeout expired before operation completed
VI_ER-ROR_RAW_WR_PROT_VIOL	Violation of raw write protocol occurred during transfer.
VI_ER-ROR_RAW_RD_PROT_VIOL	Violation of raw read protocol occurred during transfer.
VI_ERROR_OUTP_PROT_VIOL	Device reported an output protocol error during transfer.
VI_ERROR_BERRt	Bus error occurred during transfer.
VI_ERROR_INV_SETUP	Unable to start read operation because setup is invalid (due to attributes being set to an inconsistent state).
VI_ERROR_NCIC	The interface associated with the given vi is not currently the controller in charge.

Table 2-86: viRead() Error Codes (Cont.)

Error Codes	Description
VI_ERROR_NLISTENERS	No Listeners condition is detected (both NRFD and NDAC are deasserted).
VI_ERROR_ASRL_PARITY	A parity error occurred during transfer.
VI_ERROR_ASRL_FRAMING	A framing error occurred during transfer.
VI_ERROR_ASRL_OVER-RUN	An overrun error occurred during transfer. A character was not read from the hardware before the next character arrived.
VI_ERROR_IO	An unknown I/O error occurred during transfer.

C Example

```
if (viWrite(vi, (ViBuf) "*idn?", 5, VI_NULL) < VI_SUCCESS) return;
if (viRead(vi, (ViBuf), buffer, sizeof(buffer)-1, &retCnt)
   < VI_SUCCESS) return;
buffer[retCnt] = '\0'; // ensures null terminator in string
```

Comments

The viRead() operation synchronously transfers data. The data read is to be stored in the buffer represented by *buf*. This operation returns only when the transfer terminates. Only one synchronous read operation can occur at any one time.

- A viRead() operation can complete successfully if one or more of the following conditions were met (it is possible to have one, two, or all three of these conditions satisfied at the same time):
  - END indicator received.
  - Termination character read.
  - Number of bytes read is equal to count.

Condition 1: End Indicator Received

- If the following conditions are met, viRead() returns VI_SUCCESS regardless of whether the termination character is received or the number of bytes read is equal to count.
  - If an END indicator is received, and
  - VI_ATTR_SUPPRESS_END_EN is VI_FALSE.
- If either of the following conditions are met, viRead() will not terminate because of an END condition (and therefore will not return VI_SUCCESS). The operation can still complete successfully due to a termination character or reading the maximum number of bytes requested.
  - If VI_ATTR_SUPPRESS_END_EN is VI_TRUE

- If vi is a session to an ASRL INSTR resource, and VI_ATTR_ASRL_END_IN is VI_ASRL_END_NONE.

Condition 2: Termination Character Read

- If the following conditions are met, viRead() returns VI_SUCCESS_TERM_CHAR regardless of whether the number of bytes read is equal to count.
  - If no END indicator is received, and
  - the termination character is read, and
  - VI_ATTR_TERMCHAR_EN is VI_TRUE.
- Under the following condition, viRead() will not terminate because of reading a termination character (and therefore will not return VI_SUCCESS_TERM_CHAR). The operation can still complete successfully due to reading the maximum number of bytes requested.
  - If VI_ATTR_TERMCHAR_EN is VI_FALSE.
- If the following conditions are met, viRead() treats the value stored in VI_ATTR_TERMCHAR as an END indicator regardless of the value of VI_ATTR_TERMCHAR_EN.
  - If vi is a session to an ASRL INSTR resource, and
  - VI_ATTR_ASRL_END_IN is VI_ASRL_END_TERMCHAR.

Condition 3: Number of Bytes Read Equals Count

- If the following conditions are met, viRead() returns VI_SUCCESS_MAX_CNT.
  - If no END indicator is received, and
  - no termination character is read, and
  - the number of bytes read is equal to count.
- If you pass VI_NULL as the *retCount* parameter to the viRead() operation, the number of bytes transferred will not be returned. This may be useful if it is only important to know whether the operation succeeded or failed.

Table 2-87: Success Code Conditions for GPIB Interfaces with ViRead()

TRUE	FALSE	Success Code
END received	VI_ATTR_SUPPRESS_END_EN	VI_SUCCESS
VI_ATTR_TERM_CHAR_EN	END received	VI_SUCCESS_TERM_CHAR
max bytes requested received	END received	VI_SUCCESS_MAX_CNT

See Also

Reading and Writing Data
viWrite (*vi, buf, count, retCount*)

viReadAsync (vi, buf, count, jobId)

Usage

Reads data asynchronously from a device into the specified buffer.

C Format

ViStatus viReadAsync (ViSession *vi*, ViPBuf *buf*, ViUInt32 *count,* ViPJobId *jobId*)

Visual Basic Format

Not Applicable

Parameters

Table 2-88: viReadAsync() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	OUT	Represents the location of a buffer to receive data from device.
count	IN	Number of bytes to be read.
jobId	OUT	Represents the location of a variable that will be set to the job identifier of this asynchronous read operation.

Return Values

Table 2-89: viReadAsync() Completion Codes

Completion Codes	Description
VI_SUCCESS	Asynchronous read operation successfully queued.
VI_SUCCESS_SYNC	Read operation performed synchronously.

Table 2-90: viReadAsync() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_QUEUE_ERROR	Unable to queue read operation.

C Example

```
// rwwait.cpp
//
#include <stdio.h>
#include <string.h>
#include <windows.h>
#include ”visa.h“

// viReadAsync/viWriteAsync example -
// These commands can potentially decrease test time by allowing
// several read or write commands to happen in parallel.
int main(int argc, char* argv[])
```

```
{
        ViSession               rm, vi[2];
        ViJobId  jobid[2];
        ViStatus status;
        char     string[2][256];
        ViEventType             eventType[2];
        ViEvent event[2];
        int      i;

        // clear strings
        for (i = 0; i < 2; i++) {
                memset(string[i], 0, 256);
        }

        // Open the default RM
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;


        // Open multiple devices
        status = viOpen(rm, "GPIB0::1::INSTR", NULL, NULL, &vi[0]);
        if (status < VI_SUCCESS) goto error;

        status = viOpen(rm, "GPIB8::1::INSTR", NULL, NULL,
                  &vi[1]);
        if (status < VI_SUCCESS) goto error;

        // Enable waiting on the events
        for (i = 0; i < 2; i++) {
                status = viEnableEvent(vi[i], VI_EVENT_IO_COMPLETION,
                         VI_QUEUE, VI_NULL);
                if (status < VI_SUCCESS) goto error;
        }

        // Write commands to several devices (this allows
        // several writes to be done in parallel)
        for (i = 0; i < 2; i++) {
                status = viWriteAsync(vi[i],(ViBuf) "*idn?",
                        5, &jobid[i]);
                if (status < VI_SUCCESS) goto error;
        }

        // Wait for completion on all of the devices
        for (i = 0; i < 2; i++) {
                viWaitOnEvent(vi[i], VI_EVENT_IO_COMPLETION,
                 INFINITE, &eventType[i], &event[i]);
        }
```

```
        // Queue the read for all the devices (this allows
        // several reads to be done im parallel)
        for (i = 0; i < 2; i++) {
                status = viReadAsync(vi[i], (ViBuf) string[i],
                        256, &jobid[i]);
                if (status < VI_SUCCESS) goto error;
        }

        // Wait for all the reads to complete
        for (i = 0; i < 2; i++) {
                viWaitOnEvent(vi[i], VI_EVENT_IO_COMPLETION,
                  INFINITE, &eventType[i], &event[i]);
        }

        // Write out the *idn? strings.
        for (i = 0; i < 2; i++) {
                printf("%d: %s\n", i, string[i]);
        }

        // Cleanup and exit
        for (i = 0; i < 2; i++) {
                status = viDisableEvent(vi[i], VI_EVENT_IO_COMPLETION,
                        VI_QUEUE);
                if (status < VI_SUCCESS) goto error;
        }

        viClose(rm);
        return 0;
error:
        viStatusDesc(rm, status, string[0]);
        fprintf(stderr, "Error: %s\n", (ViBuf) string[0]);
        return 0;
}
```

Comments

The viReadAsync() operation asynchronously transfers data. The data read is to be stored in the buffer represented by *buf*. This operation normally returns before the transfer terminates.

- Before calling this operation, you should enable the session for receiving I/O completion events. After the transfer has completed, an I/O completion event is posted.
- The operation returns *jobId*, which you can use either
  - with viTerminate() to abort the operation, or
  - with an I/O completion event to identify which asynchronous read operation completed.

Table 2-91: Special Value for jobId Parameter with viReadAsync()

Value	Description
VI_NULL	Do not return a job identifier. This option may be useful if only one asynchronous operation will be pending at a given time.

- Since an asynchronous I/O request could complete before viReadAsync() returns, and the I/O completion event can be distinguished based on the job identifier, an application must be made aware of the job ID before the first moment that the I/O completion event could possibly occur. Setting *jobId* before the data transfer even begins ensures that an application can always match the *jobId* with the VI_ATTR_JOB_ID attribute of the I/O completion event.
- If multiple jobs are queued at the same time on the same session, an application can use the *jobId* to distinguish the jobs, as they are unique within a session.
- The viReadAsync() operation may be implemented synchronously, which could be done by using the viRead() operation. This means that an application can use the asynchronous operations transparently, even if a low-level driver supports only synchronous data transfers. If viReadAsync() is implemented synchronously and a given invocation is valid, it returns VI_SUCCESS_SYNC and all status information is returned in a VI_EVENT_IO_COMPLETION. Status codes are the same as those listed for viRead().
- The status code VI_ERROR_RSRC_LOCKED can be returned either immediately or from the VI_EVENT_IO_COMPLETION event.
- The contents of the output buffer pointed to by *buf* are not guaranteed to be valid until the VI_EVENT_IO_COMPLETION event occurs.
- For each successful call to viReadAsync(), there is one and only one VI_EVENT_IO_COMPLETION event occurrence.
- If the *jobId* parameter returned from viReadAsync() is passed to viTerminate() and a VI_EVENT_IO_COMPLETION event has not yet occurred for the specified *jobId*, the viTerminate() operation raises a VI_EVENT_IO_COMPLETION event on the given vi, and the VI_ATTR_STATUS field of that event is set to VI_ERROR_ABORT.

See Also

Asynchronous Read/Write
viWriteAsync (*vi, buf, count, jobId*)
viTerminate (*vi, degree, jobId*)

viReadSTB (vi, status)

Usage Reads a status byte of the service request.

C Format ViStatus viReadSTB (ViSession *vi*, ViPUInt16 *status*)

Visual Basic Format viReadSTB (ByVal *vi* As Long, ByVal *status* As Integer) As Long

Parameters

Table 2-92: viReadSTB() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to the session.
status	OUT	Service request status byte.

Return Values

Table 2-93: viReadSTB() Completion Codes

Completion Codes	Description
VI_SUCCESS	Operation completed successfully.

Table 2-94: viReadSTB() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_SRQ_ NOCCURRED	Service request has not been received for the session.
VI_ERROR_TMO	Timeout expired before operation completed
VI_ER-ROR_RAW_WR_PROT_VIOL	Violation of raw write protocol occurred during transfer.
VI_ER-ROR_RAW_RD_PROT_VIOL	Violation of raw read protocol occurred during transfer.
VI_ERROR_BERR	Bus error occurred during transfer.

Table 2-94: viReadSTB() Error Codes (Cont.)

Error Codes	Description
VI_ERROR_NCIC	The interface associated with the given vi is not currently the controller in charge.
VI_ERROR_NLISTENERS	No Listeners condition is detected (both NRFD and NDAC are deasserted).
VI_ERROR_INV_SETUP	Unable to start read operation because setup is invalid (due to attributes being set to an inconsistent state).

C Example

```
ViUInt16 stb;
viReadSTB(vi, &stb);
```

Comments

The viReadSTB() operation reads a service request status from a service requester (the message-based device). For example, on the IEEE 488.2 interface, the message is read by polling devices; for other types of interfaces, a message is sent in response to a service request to retrieve status information.

- For a serial device, if VI_ATTR_IO_PROT is VI_ASRL488, the device is sent the string "*STB?\n", and then the device's status byte is read.
- This operation is not valid for a serial device if VI_ATTR_IO_PROT is VI_NORMAL. In that case, viReadSTB() returns VI_ERROR_INV_SETUP.
- If the status information is only one byte long, the most significant byte is returned with the zero value.
- If the service requester does not respond in the actual timeout period, VI_ERROR_TMO is returned.

See Also

Status/Service Request
VI_ATTR_IO_PROT

viScanf (vi, readFmt, <arg1, arg2,...>)

Usage Reads and formats data from a device using the optional variable-length argument list.

C Format ViStatus viScanf (ViSession *vi*, ViString *readFmt*, ...)

Visual Basic Format Not Applicable

Parameters

Table 2-95: viScanf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
readFmt	IN	String describing the format for arguments.
<arg1, arg2,...>	OUT	Optional argument(s) into which the data is read and the format string is applied.

Return Values

Table 2-96: viScanf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Data was successfully read and formatted into arg parameter(s)

Table 2-97: viScanf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform read operation because of I/O error.
VI_ERROR_TMO	Timeout expired before read operation completed.
VI_ERROR_INV_FMT	A format specifier in the readFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the readFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
// Get first char and validate
status = viScanf(vi, "%c", &c);
if (status < VI_SUCCESS) goto error;
assert(c == '#');

// Get width of element field.
status = viScanf(vi, "%c", &c);
if (status < VI_SUCCESS) goto error;
        assert(c >= '0' && c <= '9');

// Read element characters
count = c - '0';
for (i = 0; i < count; i++) {
        status = viScanf(vi, "%c", &c);
        if (status < VI_SUCCESS) goto error;
        assert(c >= '0' && c <= '9');
}

// Read waveform into allocated storage
ptr = (double*) malloc(*elements*sizeof(double));

for (i = 0; i < *elements; i++) {
        status = viScanf(vi, "%c", &c);
        if (status < VI_SUCCESS) goto error;
        ptr[i] = (((double) c) - yoffset) * ymult;
}

return ptr;
```

Comments

The viScanf() operation receives data from a device, formats it by using the format string, and stores the resulting data in the *arg* parameter list.

- The viRead() operation is used for the actual low-level read from the device. As a result, you should not use the viRead() and viScanf() operations in the same session.

NOTE. Because the prototype for this function cannot provide complete type-checking, remember that all output parameters must be passed by reference.

- The format string can have format specifier sequences, white characters, and ordinary characters.
  - The white characters—blank, vertical tabs, horizontal tabs, form feeds, new line/linefeed, and carriage return—are ignored except in the case of %c and %[ ].
  - All other ordinary characters except % should match the next character read from the device.

- The format string consists of a %, followed by optional modifier flags, followed by one of the format codes in that sequence. It is of the form

  %[*modifier*]*format code*

  - where the optional *modifier* describes the data format,
  - while *format code* indicates the nature of data (data type).
- One and only one *format code* should be performed at the specifier sequence. A format specification directs the conversion to the next input *arg*. The results of the conversion are placed in the variable that the corresponding argument points to, unless the * assignment-suppressing character is given. In such a case, no *arg* is used and the results are ignored.
- The viScanf() operation accepts input until an END indicator is read or all the format specifiers in the *readFmt* string are satisfied. Thus, detecting an END indicator before the *readFmt* string is fully consumed will result in ignoring the rest of the format string. Also, if some data remains in the buffer after all format specifiers in the *readFmt* string are satisfied, the data will be kept in the buffer and will be used by the next viScanf() operation.
- When viScanf() times out, the next call to viScanf() will read from an empty buffer and force a read from the device. Notice that when an END indicator is received, not all arguments in the format string may be consumed. However, the operation still returns a successful completion code. The following two tables describe optional *modifiers* that can be used in a format specifier sequence.

ANSI C Standard Modifiers

Table 2-98: ANSI C Standard Modifiers used with viScanf()

Modifier	Supported with Format Code	Description
An integer specifying *field width*.	%s, %c, %[ ] format codes	It specifies the maximum *field width* that the argument will take. A '#' may also appear instead of the integer *field width*, in which case the next *arg* is a reference to the *field width*. This *arg* is a reference to an integer for %c and %s. The *field width* is not allowed for %d or %f.
A length modifier ('h,' 'l,' 'L,' 'z,' or 'Z'). z and Z are not ANSI C standard modifiers.	h (d, b format codes) l (d, f, b format codes) L (f format code) z (b format code) Z (b format code)	The argument length modifiers specify one of the following: a. The h modifier promotes the argument to be a reference to a short integer or unsigned short integer, depending on the format code. b. The l modifier promotes the argument to point to a long integer or unsigned long integer. c. The L modifier promotes the argument to point to a long double floats parameter. d. The z modifier promotes the argument to point to an array of floats. e. The Z modifier promotes the argument to point to an array of double floats.
*	All format codes	An asterisk (*) acts as the assignment suppression character. The input is not assigned to any parameters and is discarded.

Enhanced Modifiers to ANSI C Standards

Table 2-99: Enhanced Modifiers to ANSI C Standards used with viScanf()

Modifier	Supported with Format Code	Description
A comma (,) followed by an integer n, where n represents the array size.	%d and %f only	The corresponding argument is interpreted as a reference to the first element of an array of size n. The first n elements of this list are printed in the format specified by the format code. A number sign (#) may be present after the comma (,) modifier, in which case an extra arg is used. This arg must be an integer representing the array size of the given type.

Format Codes

ANSI C Format Codes

c Argument type: A reference to a character.

Table 2-100: Modifiers used with Argument Type c with viScanf()

Modifier	Interpretation
Default functionality	A character is read from the device and stored in the parameter. field width field width number of characters are read and stored at the reference location (the default field width is 1). No NULL character is added at the end of the data block.

***NOTE**. This format code does not ignore white space in the device input stream.*

d Argument type: A reference to an integer.

Table 2-101: Modifiers used with Argument Type d with viScanf()

Modifier	Interpretation
Default functionality	Characters are read from the device until an entire number is read. The number read may be in either IEEE 488.2 formats <DECIMAL NUMERIC PROGRAM DATA>, also known as NRf; flexible numeric representation (NR1, NR2, NR3...); or <NON-DECIMAL NUMERIC PROGRAM DATA> (#H, #Q, and #B).
field width	The input number will be stored in a field at least this wide.
Length modifier l	*arg* is a reference to a long integer.
Length modifier h	*arg* is a reference to a short integer. Rounding is performed according to IEEE 488.2 rules (0.5 and up).
, *array size*	*arg* points to an array of integers (or long or short integers, depending on the length modifier) of size *array size*. The elements of this array should be separated by commas. Elements will be read until either *array size* number of elements are consumed or they are no longer separated by commas.

f Argument type: A reference to a floating point number.

Table 2-102: Modifiers used with Argument Type f with viScanf()

Modifier	Interpretation
Default functionality	Characters are read from the device until an entire number is read. The number read may be in either IEEE 488.2 formats <DECIMAL NUMERIC PROGRAM DATA> (NRf) or <NON-DECIMAL NUMERIC PROGRAM DATA> (#H, #Q, and #B)
field width	The input number will be stored in a field at least this wide.

Table 2-102: Modifiers used with Argument Type f with viScanf() (Cont.)

Modifier	Interpretation
Length modifier l	*arg* is a reference to a double floating point number.
Length modifier L	*arg* is a reference to a long double number.
, *array size*	*arg* points to an array of floats (or double or long double, depending on the length modifier) of size *array size*. The elements of this array should be separated by commas. Elements will be read until either *array size* number of elements are consumed or they are no longer separated by commas.

s Argument type: A reference to a string.

Table 2-103: Modifiers used with Argument Type s with viScanf()

Modifier	Interpretation
Default functionality	All leading white space characters are ignored. Characters are read from the device into the string until a white space character is read.
field width	This flag gives the maximum string size. If the *field width* contains a number sign (#), two arguments are used. The first argument read is a pointer to an integer specifying the maximum array size. The second should be a reference to an array. In case of *field width* characters already read before encountering a white space, additional characters are read and discarded until a white space character is found. In case of # *field width*, the actual number of characters read are stored back in the integer pointed to by the first argument.

Enhanced Format Codes

b Argument type: A reference to a data array.

Table 2-104: Modifiers used with Argument Type b with viScanf()

Modifier	Interpretation
Default functionality	The data must be in IEEE 488.2 <ARBITRARY BLOCK PROGRAM DATA> format. The format specifier sequence should have a flag describing the *field width*, which will give a maximum count of the number of bytes (or words or longwords, depending on length modifiers) to be read from the device. If the *field width* contains a # sign, two arguments are used. The first *arg* read is a pointer to a long integer specifying the maximum number of elements that the array can hold. The second *arg* should be a reference to an array. Also, the actual number of elements read is stored back in the first argument. In the absence of length modifiers, the data is assumed to be of byte-size elements. In some cases, data might be read until an END indicator is read.
Length modifier h	*arg* points to an array of 16-bit words, and count specifies the number of words. Data that is read is assumed to be in IEEE 488.2 byte ordering. It will be byte swapped and padded as appropriate to native computer format.
Length modifier l	*arg* points to an array of 32-bit longwords, and count specifies the number of longwords. Data that is read is assumed to be in IEEE 488.2 byte ordering. It will be byte swapped and padded as appropriate to native computer format.
Length modifier z	*arg* points to an array of floats, and count specifies the number of floating point numbers. Data that is read is an array of 32-bit IEEE 754 format floating point numbers.
Length modifier Z	*arg* is a reference to a long double number.
, *array size*	*arg* points to an array of doubles, and the count specifies the number of floating point numbers. Data that is read is an array of 64-bit IEEE 754 format floating point numbers.

t Argument type: A reference to a string.

Table 2-105: Modifiers used with Argument Type t with viScanf()

Modifier	Interpretation
Default functionality	Characters are read from the device until the first END indicator is received. The character on which the END indicator was received is included in the buffer.
field width	This flag gives the maximum string size. If an END indicator is not received before *field width* number of characters, additional characters are read and discarded until an END indicator arrives. *#field width* has the same meaning as in %s.

T Argument type: A reference to a string.

Table 2-106: Modifiers used with Argument Type T with viScanf()

Modifier	Interpretation
Default functionality	Characters are read from the device until the first linefeed character (\n) is received. The linefeed character is included in the buffer.
field width	This flag gives the maximum string size. If a linefeed character is not received before *field width* number of characters, additional characters are read and discarded until a linefeed character arrives. *#field width* has the same meaning as in %s.

y Argument type: A location of a block of binary data.

Table 2-107: Modifiers used with Argument Type y with viScanf()

Modifier	Interpretation
Default functionality	The data block is read as raw binary data. The format specifier sequence should have a flag describing the *array size*, which will give a maximum count of the number of bytes (or words or longwords, depending on length modifiers) to be read from the device. If the *array size* contains a # sign, two arguments are used. The first argument read is a pointer to a long integer that specifies the maximum number of elements that the array can hold. The second argument should be a reference to an array. Also, the actual number of elements read is stored back in the first argument. In the absence of length modifiers, the data is assumed to be byte-size elements. In some cases, data might be read until an END indicator is read.
Length modifier h	The data block is assumed to be a reference to an array of unsigned short integers (16 bits). The count corresponds to the number of words rather than bytes. If the optional "!ol" modifier is present, the data read is assumed to be in little endian format; otherwise, the data read is assumed to be in standard IEEE 488.2 format. The data will be byte swapped and padded as appropriate to native computer format.
Length modifier l	The data block is assumed to be a reference to an array of unsigned long integers (32 bits). The count corresponds to the number of longwords rather than bytes. If the optional "!ol" modifier is present, the data read is assumed to be in little endian format; otherwise, the data read is assumed to be in standard IEEE 488.2 format. The data will be byte swapped and padded as appropriate to native computer format.
Byte order modifier !ob	The data being read is assumed to be in standard IEEE 488.2 (big endian) format. This is the default behavior if neither !ob nor !ol is present.
Byte order modifier !ol	The data being read is assumed to be in little endian format.

- For ANSI C compatibility, VISA also supports the following conversion codes for input codes: 'i,' 'o,' 'u,' 'n,' 'x,' 'X,' 'e,' 'E,' 'g,' 'G,' 'p,' '[...],' and '[^...].' For further explanation of these conversion codes, see the ANSI C Standard.

See Also

Reading and Writing Formatted Data
viPrintf (*vi, writeFmt, <arg1, arg2, ...>*)
viQueryf (*vi, writeFmt, readFmt, <arg1, arg2, ...>*)
VI_ATTR_RD_BUF_OPER_MODE

viSetAttribute (vi, attribute, attrState)

Usage

Sets the state of an attribute for the specified session, event, or find list.

C Format

ViStatus viSetAttribute(ViObject *vi*, ViAttr *attribute*, ViAttrState *attrState*)

Visual Basic Format

viSetAttribute (ByVal *vi* As Long, ByVal *attribute* As Long, ByVal *attrState* As Long) As Long

Parameters

Table 2-108: viSetAttribute() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
attribute	IN	Attribute for which the state is to be modified.
attrState	IN	The state of the attribute to be set for the specified resource. The interpretation of the individual attribute value is defined by the resource.

Return Values

Table 2-109: viSetAttribute() Completion Codes

Completion Codes	Description
VI_SUCCESS	Attribute value set successfully
VI_WARN_NSUP_ATTR_ STATE	Although the specified attribute state is valid, it is not supported by this implementation.

Table 2-110: viSetAttribute() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_ATTR	The specified attribute is not defined by the referenced session, event, or find list.

Table 2-110: viSetAttribute() Error Codes (Cont.)

Error Codes	Description
VI_ERROR_NSUP_ATTR_STATE	The specified state of the attribute is not valid, or is not supported as defined by the session, event, or find list.
VI_ERROR_ATTR_READONLY	The specified attribute is read-only.

C Example

```
// Set timeout to 5 seconds
status = viSetAttribute(vi, VI_ATTR_TMO_VALUE, 5000);
if (status < VI_SUCCESS) goto error;
```

Comments

The viSetAttribute() operation is used to modify the state of an attribute for the specified object.

- Both VI_WARN_NSUP_ATTR_STATE and VI_ERROR_NSUP_ATTR_STATE indicate that the specified attribute state is not supported.
  - A resource normally returns the error code VI_ERROR_NSUP_ATTR_STATE when it cannot set a specified attribute state.
  - The completion code VI_WARN_NSUP_ATTR_STATE is intended to alert the application that although the specified optional attribute state is not supported, the application should not fail. One example is attempting to set an attribute value that would increase performance speeds. This is different from attempting to set an attribute value that specifies required but nonexistent hardware, or a value that would change assumptions a resource might make about the way data is stored or formatted (such as byte order).

See Also

Setting and Retrieving Attributes
viGetAttribute (*vi, attribute, attrState*)

viSetBuf (vi, mask, size)

Usage

Sets the size of the formatted I/O and/or serial buffer(s).

C Format

ViStatus viSetBuf(ViSession *vi*, ViUInt16 *mask*,
ViUInt32 *size*)

Visual Basic Format

viSetBuf (ByVal *vi* As Long, ByVal *mask* As Integer, ByVal *size* As Long) As Long

Parameters

Table 2-111: viSetBuf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
mask	IN	Specifies the type of buffer.
size	IN	The size to be set for the specified buffer(s)

Return Values

Table 2-112: viSetBuf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Buffer size set successfully.
VI_WARN_NSUP_BUF	The specified buffer is not supported.

Table 2-113: viSetBuf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_ALLOC	The system could not allocate the buffer(s) of the specified size because of insufficient system resources.
VI_ERROR_INV_MASK	The system cannot set the buffer for the given mask.

C Example

```
viSetBuf(vi, VI_READ_BUF, 1024*10); // set buffer to 10K
```

Comments

The viSetBuf() operation changes the buffer size of the read and/or write buffer for formatted I/O and/or serial communication. The *mask* parameter specifies the buffer for which to set the size. The *mask* parameter can specify multiple buffers by bit-ORing any of the following values together.

Table 2-114: Flags used with Mask Parameter with viSetBuf()

Flag	Interpretation
VI_READ_BUF	Formatted I/O read buffer.
VI_WRITE_BUF	Formatted I/O write buffer.
VI_ASRL_IN_BUF	Serial communication receive buffer.
VI_ASRL_OUT_BUF	Serial communication transmit buffer.

- A call to viSetBuf() flushes the session's related read/write buffer(s). Although you can explicitly flush the buffers by making a call to viFlush(), the buffers are flushed implicitly under some conditions. These conditions vary for the viPrintf() and viScanf() operations.
- Since not all serial drivers support user-defined buffer sizes, VISA may not be able to control this feature. If an application requires a specific buffer size for performance reasons, but VISA cannot guarantee that size, we recommend you use some form of handshaking to prevent overflow conditions.

See Also **Reading and Writing Formatted Data**
viFlush (*vi, mask*)

viSPrintf (vi, buf, writeFmt, <arg1, arg2,...>)

Usage Formats and writes data to a user-specified buffer using an optional variable-length argument list.

C Format ViStatus viSPrintf (ViSession *vi*, ViPBuf *buf*,
ViString *writeFmt, ...*)

Visual Basic Format Not Applicable

Parameters

Table 2-115: viSPrintf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	OUT	Buffer where data is to be written.
writeFmt	IN	The format string to apply to arguments.
<arg1, arg2,...>	IN	Optional argument(s) on which the format string is applied. The formatted data is written to the specified buffer.

Return Values

Table 2-116: viSPrintf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Parameters were successfully formatted.

Table 2-117: viSPrintf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_INV_FMT	A format specifier in the writeFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the writeFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
#include <stdio.h>
#include <string.h>
#include <visa.h>
#include <stdarg.h>


// This example opens a specific GPIB device, sets the data start
// and stop locations and logs the command sent to c:\logfile.txt

int main(int argc, char* argv[])
{
        ViSession           rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        ViChar              buffer[256];
        const long          start = 1;
        const long          stop = 500;
        FILE*               log = fopen("C:\\logfile.txt", "w");

        // Open a default Session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Open the gpib device at primary address 1, gpib board 8
        status = viOpen(rm, "GPIB0::1::INSTR", VI_NULL, VI_NULL,
                &vi);
        if (status < VI_SUCCESS) goto error;
```

```
        status = viSPrintf(vi, (ViBuf) buffer, "data:start %d;
                        data:stop %d", start, stop);
        if (status < VI_SUCCESS) goto error;

        if (log != NULL)
                fprintf(log, "%s'n", buffer);

        status = viWrite(vi, (ViBuf) buffer, strlen(buffer),
                        VI_NULL);
        if (status < VI_SUCCESS) goto error;

        // Clean up
        if (log != NULL)
                fclose(log);

        viClose(vi); // Not needed, but makes things a bit more
                     // understandable
        viClose(rm);

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) {
                viClose(rm);
        }
        return 1;
}
```

Comments

The viSPrintf() operation is similar to viPrintf(), except that the output is not written to the device; it is written to the user-specified buffer. This output buffer will be NULL terminated.

- If this operation outputs an END indicator before all the arguments are satisfied, the rest of the *writeFmt* string is ignored and the buffer string is still terminated by a NULL.

See Also

Reading and Writing Formatted Data
viSScanf (*vi, readFmt, <arg1, arg2,...>*)

viSScanf (vi, buf, readFmt, <arg1, arg2,...>)

Usage Reads and formats data from a user-specified buffer using an optional variable-length argument list.

C Format ViStatus viSScanf (ViSession *vi*, ViPBuf *buf*,
ViString *readFmt, ...*)

Visual Basic Format Not Applicable

Parameters

Table 2-118: viSScanf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
readFmt	IN	String describing the format for arguments.
<arg1, arg2,...>	OUT	Optional argument(s) into which the data is read and to which the format string is applied.

Return Values

Table 2-119: viSScanf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Data was successfully read and formatted into arg parameter(s).

Table 2-120: viSScanf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform read operation because of I/O error.
VI_ERROR_TMO	Timeout expired before read operation completed.
VI_ERROR_INV_FMT	A format specifier in the readFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the readFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
#include <stdio.h>
#include <string.h>
#include <visa.h>
#include <stdarg.h>


// This example opens a specific GPIB device, and scans
// 10 comma-separated integers into a long array

int main(int argc, char* argv[])
{
        ViSession               rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        char                    buffer[256];
        long                    scanArray[10];
        ViChar                  *scanStr = ”0,1,2,3,4,5,6,7,8,9“;
        int                                     i;

        // Open a default Session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Open the gpib device at primary address 1, gpib board 8
        status = viOpen(rm, ”GPIB0::1::INSTR“, VI_NULL, VI_NULL,
                &vi);
        if (status < VI_SUCCESS) goto error;

        // Read a 10-element comma-separated array into a long array
        status = viSScanf(vi, (ViBuf) scanStr, “%,10d”, scanArray);
        if (status < VI_SUCCESS) goto error;

        for (i = 0; i < 10; i++) {
                printf(”%d “, scanArray[i]);
        }
        printf(”\n“);

        viClose(vi); // Not needed, but makes things a bit more
                // understandable
        viClose(rm);

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, ”failure: %s\n“, buffer);
        if (rm != VI_NULL) {
                viClose(rm);
        }
        return 1;
}
```

Comments The viSScanf() operation is similar to viScanf(), except that the data is read from a user-specified buffer rather than from a device.

See Also **Reading and Writing Formatted Data**
viSPrintf (*vi, writeFmt, <arg1, arg2,...>*)

viStatusDesc (vi, status, desc)

Usage Retrieves a user-readable description of the specified status code.

C Format ViStatus viStatusDesc (ViObject *vi*, ViStatus *status*,
ViString *desc*)

Visual Basic Format viStatusDesc (ByVal *vi* As Long, ByVal *status*
As Long, ByVal *desc* As String) As Long

Parameters

Table 2-121: viStatusDesc() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session, event, or find list.
status	IN	Status code to interpret.
desc	OUT	The user-readable string interpretation of the status code passed to the operation.

Return Values

Table 2-122: viStatusDesc() Completion Codes

Completion Codes	Description
VI_SUCCESS	Description successfully returned.
VI_WARN_UNKNOWN_ STATUS	The status code passed to the operation could not be interpreted.

C Example

```
// Report error
viStatusDesc(vi, status, buffer);
fprintf(stderr, ”failure: %s\n“, buffer);
```

Comments The viStatusDesc() operation is used to retrieve a user-readable string that describes the status code presented.

- If the string cannot be interpreted, the operation returns the warning code VI_WARN_UNKNOWN_STATUS. However, the output string *desc* is valid regardless of the status return value.

***NOTE**. The size of the desc parameter should be at least 256 bytes.*

See Also **Appendix B: Completion and Error Codes**

viTerminate (vi, degree, jobId)

Usage Terminates normal execution of an asynchronous read or write operation.

C Format ViStatus viTerminate(ViObject *vi*, ViUInt16 *degree*, ViJobId *jobId*)

Visual Basic Format Not Applicable

Parameters

Table 2-123: viTerminate() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to an object.
degree	IN	VI_NULL
jobId	IN	Specifies an operation identifier.

Return Values

Table 2-124: viTerminate() Completion Codes

Completion Codes	Description
VI_SUCCESS	Request serviced successfully.

Table 2-125: viTerminate() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_JOB_ID	Specified job identifier is invalid. This message is returned If the operation associated with the specified jobId has already completed.
VI_ERROR_INV_DEGREE	Specified degree is invalid.

C Example

```
viTerminate(vi, VI_NULL, jobid);
```

Comments

The vi Terminate() operation is used to request a session to terminate normal execution of an operation, as specified by the *jobId* parameter.

- The *jobId* parameter is a unique value generated from each call to an asynchronous operation.
- If a user passes VI_NULL as the *jobId* value to viTerminate(), VISA aborts the specified asynchronous operation and the resulting I/O completion event contains the status code VI_ERROR_ABORT.

See Also

Asynchronous Read/Write
viReadAsync (*vi, buf, count, jobId*)
viWriteAsync (*vi, buf, count, jobId*)

viUninstallHandler (vi, eventType, handler, userHandle)

Usage

Uninstalls callback handler(s) for the specified event .

C Format

ViStatus viUninstallHandler (ViSession *vi*, ViEventType *eventType*,
ViHndlr *handler,* ViAddr *userHandle*)

Visual Basic Format

Not Applicable

Parameters

Table 2-126: viUninstallHandler() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
eventType	IN	Logical event identifier.
handler	IN	Interpreted as a valid reference to a handler to be uninstalled by a client application.
userHandle	IN	A value specified by an application that can be used for identifying handlers uniquely in a session for an event.

Return Values

Table 2-127: viUninstallHandler() Completion Codes

Completion Codes	Description
VI_SUCCESS	Event handler successfully uninstalled.

Table 2-128: viUninstallHandler() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_EVENT	Specified event type is not supported by the resource.
VI_ERROR_INV_HNDLR_REF	Either the specified handler reference or the user context value (or both) does not match any installed handler.
VI_ERROR_HNDLR_NINSTALLED	A handler is not currently installed for the specified event.

C Example

```
// Cleanup and exit
status = viDisableEvent(vi, VI_EVENT_SERVICE_REQ, VI_HNDLR);
if (status < VI_SUCCESS) goto error;
status = viUninstallHandler(vi, VI_EVENT_SERVICE_REQ,
                            ServiceReqEventHandler, NULL);
if (status < VI_SUCCESS) goto error;
viClose(vi);
viClose(rm);
```

Comments

The viUninstallHandler() operation allows applications to uninstall handlers for events on sessions.

- Applications should also specify the value in the *userHandle* parameter that was passed while installing the handler. VISA identifies handlers uniquely using the handler reference and this value.
- All the handlers, for which the *handler* reference and the *userhandle* value matches, are uninstalled.

Table 2-129: Special Values for handler Parameter with viUninstallHandler()

Value	Description
VI_ANY_HNDLR	Causes the operation to uninstall all the handlers with the matching value in the *userHandle* parameter.

See Also

Handling Events
viInstallHandler (*vi, eventType, handler, userHandle*)

viUnlock (vi)

Usage

Relinquish a lock on the specified resource.

C Format

ViStatus viUnlock (ViSession *vi*)

Visual Basic Format

viUnlock (ByVal *vi* As Long) As Long

Parameters

Table 2-130: viUnlock() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.

Return Values

Table 2-131: viUnlock() Completion Codes

Completion Codes	Description
VI_SUCCESS	Lock successfully relinquished.
VI_SUCCESS_NESTED_EXCLUSIVE	Call succeeded, but this session still has nested exclusive locks.
VI_SUCCESS_NESTED_SHARED	Call succeeded, but this session still has nested shared locks.

Table 2-132: viUnlock() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_SESN_ NLOCKED	The current session did not have any lock on the resource.

C Example

```
ViSession       rm, vi;
char            string[256];
ViUInt32        retCnt;
int             i = 0;

if (viOpenDefaultRM(&rm) < VI_SUCCESS) return;
if (viOpen(rm, ”GPIB8::1::INSTR“, NULL, NULL, &vi) < VI_SUCCESS)
   return;

for (i = 1; i < 100; i++) {
        viLock(vi, VI_EXCLUSIVE_LOCK, VI_TMO_INFINITE, NULL,
         NULL);
        if (viWrite(vi, (ViBuf) ”ch1:scale?“, 10, &retCnt)
            < VI_SUCCESS) return;
        if (viRead(vi, (ViBuf) string, 256, &retCnt)
           < VI_SUCCESS) return;
        printf(”%d: scale %s“, i, string);

        viUnlock(vi);
}
```

Comments

This operation is used to relinquish the lock previously obtained using the viLock() operation.

See Also

Locking and Unlocking Resources
viLock (*vi, lockType, timeout, requestedKey, accessKey*)

viVPrintf (vi, writeFmt, params)

Usage Formats and writes data to a device using a pointer to a variable-length argument list.

C Format ViStatus viVPrintf (ViSession *vi*, ViString *writeFmt*, ViVAList *params*)

Visual Basic Format viVPrintf (ByVal *vi* As Long, ByVal *writeFmt* As String, ByVal *params* As Any) As Long

Parameters

Table 2-133: viVPrintf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
writeFmt	IN	The format string to apply to parameters in ViVAList
params	IN	A pointer to a variable argument list containing the variable number of parameters on which the format string is applied. The formatted data is written to the specified device.

Return Values

Table 2-134: viVPrintf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Parameters were successfully formatted.

Table 2-135: viVPrintf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform write operation because of I/O error.
VI_ERROR_TMO	Timeout expired before write operation completed.
VI_ERROR_INV_FMT	A format specifier in thewriteFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the writeFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
#include <stdio.h>
#include <string.h>
#include <visa.h>
#include <stdarg.h>

// My printf which always prepends the command with a header off
ViStatus MyPrintf(ViSession vi, ViString fmt, ...)
{
        ViStatus retval;
        ViVAList                args;

        viBufWrite(vi, (ViBuf) "header off", 10, VI_NULL);

        va_start(args, fmt);
        retval =  viVPrintf(vi, fmt, args);
        va_end(args);

        return retval;
}

int main(int argc, char* argv[])
{
        ViSession               rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        char                    buffer[256];
        long const              start = 1;
        long const              stop = 500;


        // Open a default Session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Open the gpib device at primary address 1, gpib board 8
        status = viOpen(rm, "GPIB0::1::INSTR", VI_NULL, VI_NULL,
                        &vi);
        if (status < VI_SUCCESS) goto error;

        status = MyPrintf(vi, "data:start %d;data:stop %d", start,
                          stop);
        if (status < VI_SUCCESS) goto error;

        viClose(vi); // Not needed, but makes things a bit more
                     // understandable
        viClose(rm);

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
```

```
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) {
                viClose(rm);
        }
        return 1;
}
```

Comments This operation is similar to viPrintf() except that *params* provides a pointer to a variable argument list rather than the variable argument list itself (with separate *arg* parameters).

See Also **Reading and Writing Formatted Data**
viVScanf (*vi, readFmt, params*)
viVQueryf(*vi, writeFmt, readFmt, params*)

viVQueryf (vi, writeFmt, readFmt, params)

Usage Writes and reads formatted data to and from a device using a pointer to a variable-length argument list.

C Format ViStatus viVQueryf (ViSession *vi*, ViString *writeFmt*, ViString *readFmt*,ViVAList *params*)

Visual Basic Format viVQueryf (ByVal *vi* As Long, ByVal *writeFmt* As String, ByVal read*Fmt* As String, ByVal *params* As Any) As Long

Parameters

Table 2-136: viVQueryf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
writeFmt	IN	The format string to apply to write parameters in ViVAList
readFmt	IN	The format string to apply to read parameters in ViVAList
params	IN OUT	A pointer to a variable argument list containing the variable number of write and read parameters. The write parameters are formatted and written to the specified device. The read parameters store the data read from the device after the format string is applied to the data.

Return Values

Table 2-137: viVQueryf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Successfully completed the Query operation.

Table 2-138: viVQueryf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform read/write operation because of I/O error.
VI_ERROR_TMO	Timeout expired before read/write operation completed.
VI_ERROR_INV_FMT	A format specifier in the writeFmt or readFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the writeFmt or readFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
#include <stdio.h>
#include <visa.h>
#include <stdarg.h>

// My own Queryf that flushes the write buffer before doing a query.
ViStatus MyQueryf(ViSession vi, ViString writeFmt, ViString readFmt, ...)
{
        ViStatus retval;
        ViVAList                args;

        // Make sure pending writes are written
        retval = viFlush(vi, VI_WRITE_BUF | VI_READ_BUF);
        if (retval < VI_SUCCESS) return retval;

        // Pass Query on to VISA
        va_start(args, readFmt);
        retval =  viVQueryf(vi, writeFmt, readFmt, args);
        va_end(args);

        return retval;
}
```

Comments This operation is similar to viQueryf() except that *params* provides a pointer to a variable argument list rather than the variable argument list itself (with separate *arg* parameters).

NOTE. Because the prototype for this function cannot provide complete type-checking, remember that all output parameters must be passed by reference.

See Also **Reading and Writing Formatted Data**
viVScanf (*vi, readFmt, params*)
viVPrintf(*vi, writeFmt, params*)

viVScanf (vi, readFmt, params)

Usage Reads and formats data from a device using a pointer to a variable-length argument list.

C Format ViStatus viVScanf (ViSession *vi*, ViString *readFmt*,ViVAList *params*)

Visual Basic Format viVScanf (ByVal *vi* As Long, ByVal read*Fmt* As String, ByVal *params* As Any) As Long

Parameters

Table 2-139: viVScanf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
readFmt	IN	The format string to apply to read parameters in ViVAList
params	OUT	A pointer to a variable argument list containing the variable number of parameters into which the data is read and the format string is applied.

Return Values

Table 2-140: viVScanf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Data was successfully read and formatted into arg parameter(s).

Table 2-141: viVScanf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_IO	Could not perform read operation because of I/O error.
VI_ERROR_TMO	Timeout expired before read operation completed.
VI_ERROR_INV_FMT	A format specifier in thereadFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the readFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
#include <stdio.h>
#include <visa.h>
#include <stdarg.h>

// My own Scan that flushes the write buffer before doing a query.
ViStatus MyScanf(ViSession vi, ViString readFmt, ...)
{
        ViStatus retval;
        ViVAList                args;

        // Make sure pending writes are written
        retval = viFlush(vi, VI_WRITE_BUF);
        if (retval < VI_SUCCESS) return retval;

        // Pass Query on to VISA
        va_start(args, readFmt);
        retval =  viVScanf(vi, readFmt, args);
        va_end(args);

        return retval;
}
```

Comments

This operation is similar to viScanf() except that *params* provides a pointer to a variable argument list rather than the variable argument list itself (with separate *arg* parameters).

NOTE. Because the prototype for this function cannot provide complete type-checking, remember that all output parameters must be passed by reference.

See Also

Reading and Writing Formatted Data
viVQueryf (*vi, writeFmt, readFmt, params*)
viVPrintf(*vi, writeFmt, params*)

viVSPrintf (vi, buf, writeFmt, params)

Usage Formats and writes data to a user-specified buffer using a pointer to a variable-length argument list.

C Format ViStatus viVSPrintf (ViSession *vi*, ViPBuf *buf*, ViString *writeFmt*, ViVAList *params*)

Visual Basic Format viVSPrintf (ByVal *vi* As Long, ByVal *buf* As String, ByVal *writeFmt* As String, ByVal *params* As Any) As Long

Parameters

Table 2-142: viVSPrintf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	OUT	Buffer where data is to be written.
writeFmt	IN	The format string to apply to parameters in ViVAList.
params	IN	A pointer to a variable argument list containing the variable number of parameters on which the format string is applied. The formatted data is written to the specified buffer.

Return Values

Table 2-143: viVSPrintf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Parameters were successfully formatted.

Table 2-144: viVSPrintf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_INV_FMT	A format specifier in the writeFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the writeFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
#include <stdio.h>
#include <string.h>
#include <visa.h>
#include <stdarg.h>

// My printf writes directly to the device (no buffering)
ViStatus MyPrintf(ViSession vi, ViString fmt, ...)
{
    ViStatus    retval;
    ViVAList    args;
    ViChar                          buffer[256];

     va_start(args, fmt);
     retval =  viVSPrintf(vi, (ViBuf) buffer, fmt, args);
     va_end(args);

     if (retval >= VI_SUCCESS) {
          retval = viWrite(vi, (ViBuf) buffer, strlen(buffer),
          VI_NULL);
     }

     return retval;
}
```

Comments

This operation is similar to viVPrintf() except that the output is not written to the device; it is written to the user-specified buffer. This output buffer is NULL terminated.

- If this operation outputs an END indicator before all the arguments are satisfied, the rest of the *writeFmt* string is ignored and the buffer string is still terminated by a NULL.

See Also

Reading and Writing Formatted Data
viVSScanf (*vi, buf, readFmt, params*)

viVSScanf (vi, buf, readFmt, params)

Usage

Reads and formats data from a user-specified buffer using a pointer to a variable-length argument list.

C Format

ViStatus viVSScanf (ViSession *vi*, ViPBuf *buf*, ViString *readFmt*, ViVAList *params*)

Visual Basic Format

viVSScanf (ByVal *vi* As Long, ByVal *buf* As String, ByVal *readFmt* As String, ByVal *params* As Any) As Long

Parameters

Table 2-145: viVSScanf() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	IN	Buffer from which data is read and formatted.
readFmt	IN	The format string to apply to parameters in ViVAList.
params	OUT	A pointer to a variable argument list with the variable number of parameters into which the data is read and to which the format string is applied.

Return Values

Table 2-146: viVSScanf() Completion Codes

Completion Codes	Description
VI_SUCCESS	Data was successfully read and formatted into arg parameter(s).

Table 2-147: viVSScanf() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_INV_FMT	A format specifier in the readFmt string is invalid.
VI_ERROR_NSUP_FMT	A format specifier in the readFmt string is not supported.
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.

C Example

```
#include <stdio.h>
#include <string.h>
#include <visa.h>
#include <stdarg.h>

// My scanf reads directly from the device (no buffering).
// The unscanned portions of the buffer will be lost.
ViStatus MyScanf(ViSession vi, ViString fmt, ...)
{
    ViStatus    retval;
    ViVAList    args;
    ViChar                          buffer[1024];

     retval = viRead(vi, (ViBuf) buffer, sizeof(buffer), VI_NULL);
     if (retval >= VI_SUCCESS) {
                va_start(args, fmt);
                retval =  viVSScanf(vi, (ViBuf) buffer, fmt, args);
                va_end(args);
     }

    return retval;
}
```

Comments

The viVSScanf() operation is similar to viVScanf() except that the data is read from a user-specified buffer rather than a device.

NOTE. Because the prototype for this function cannot provide complete type-checking, remember that all output parameters must be passed by reference.

See Also

Reading and Writing Formatted Data
viVSPrintf (*vi, buf, writeFmt, params*)

viWaitOnEvent (vi, inEventType, timeout, outEventType, outContext)

Usage

Waits for an occurrence of the specified event for a given session.

C Format

ViStatus viWaitOnEvent(ViSession *vi*, ViEventType *inEventType*, ViUInt32 *timeout,* ViPEventType *outEventType*,ViPEvent *outContext*)

Visual Basic Format

viWaitOnEvent (ByVal *vi* As Long, ByVal *inEventType* As Long, ByVal *timeout* As Long, ByVal *outEventType* As Long, ByVal *outcontext* As Long) As Long

Parameters

Table 2-148: viWaitOnEvent() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
inEventType	IN	Logical identifier of the event(s) to wait for.
timeout	IN	Absolute time period in time units that the resource shall wait for a specified event to occur before returning the time elapsed error. The time unit is in milliseconds.
outEventType	OUT	Logical identifier of the event actually received.
outContext	OUT	A handle specifying the unique occurrence of an event.

Return Values

Table 2-149: viWaitOnEvent() Completion Codes

Completion Codes	Description
VI_SUCCESS	Wait terminated successfully on receipt of an event occurrence. The queue is empty.
VI_SUCCESS_QUEUE_ NEMPTY	Wait terminated successfully on receipt of an event notification. There is still at least one more event occurrence of the type specified by inEventType available for this session.

Table 2-150: viWaitOnEvent() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_EVENT	Specified event type is not supported by the resource.
VI_ERROR_TMO	Specified event did not occur within the specified time period.
VI_ERROR_NENABLED	The session must be enabled for events of the specified type in order to receive them.

```
viWrite(vi, (ViBuf) "*CLS", 4, VI_NULL);
viWrite(vi, (ViBuf) ":ACQUIRE:STATE 1", 16, VI_NULL);
viwrite(vi, (ViBuf) "*OPC", 4, VI_NULL);
viWaitOnEvent(vi, VI_EVENT_SERVICE_REQ, 5000, &eventType, &context)
viReadSTB(vi, &stb)
```

Comments

The viWaitOnEvent() operation suspends the execution of a thread of an application and waits for an event of the type specified by *inEventType* for a time period specified by *timeout*.

- You can only wait for events that have been enabled with the viEnableEvent() operation. Refer to individual event descriptions for context definitions.
- viWaitOnEvent() removes the specified event from the event queue if one that matches the type is available. The process of dequeuing makes an additional space available in the queue for events of the same type.
- When the *outContext* handle returned from a successful invocation of viWaitOnEvent() is no longer needed, it should be passed to viClose().
- If a session's event queue becomes full and a new event arrives, the new event is discarded.
- The default value of VI_ATTR_MAX_QUEUE_LENGTH is 50.

Table 2-151: Special Values for inEventType Parameter with viWaitOnEvents()

Value	Description
VI_ALL_ENABLED_EVENTS	The operation waits for any event that is enabled for the given session.

Table 2-152: Special Values for timeout Parameter with viWaitOnEvents()

Value	Description
VI_TMO_INFINITE	The operation is suspended indefinitely.
VI_TMO_IMMEDIATE	The operation is not suspended; therefore, this value can be used to dequeue events from an event queue.

- The *outEventType* and *outContext* parameters are optional and can be VI_NULL.

Table 2-153: Special Values for outEventType Parameter with viWaitOnEvents()

Value	Description
VI_NULL	Used if the event type is known from the *inEventType* parameter.

Table 2-154: Special Values for outContext Parameter with viWaitOnEvents()

Value	Description
VI_NULL	Used if the *outContext* handle is not needed to retrieve additional information. If that case, VISA will automatically close the event context.

See Also

Handling Events
viDiscardEvents (*vi, event, mechanism*)

viWrite (vi, buf, count, retCount)

Usage

Writes data synchronously to a device from the specified buffer.

C Format

ViStatus viWrite (ViSession *vi*, ViBuf *buf*, ViUInt32 *count*, ViPUInt32 *retCount*)

Visual Basic Format

viWrite (ByVal *vi* As Long, ByVal *buf* As String, ByVal *count* As Long, ByVal *retCount* As Long) As Long

Parameters

Table 2-155: viWrite() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	IN	Represents the location of a data block to be sent to device.
count	IN	Number of bytes to be written.
retCount	OUT	Represents the location of an integer that will be set to the number of bytes actually transferred.

Return Values

Table 2-156: viWrite() Completion Codes

Completion Codes	Description
VI_SUCCESS	Transfer completed.

Table 2-157: viWrite() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_TMO	Timeout expired before operation completed.
VI_ER- ROR_RAW_WR_PROT_VIOL	Violation of raw write protocol occurred during transfer.
VI_ER- ROR_RAW_RD_PROT_VIOL	Violation of raw read protocol occurred during transfer.
VI_ERROR_INP_PROT_VIOL	Device reported an input protocol error during transfer.
VI_ERROR_BERR	Bus error occurred during transfer.
VI_ERROR_INV_SETUP	Unable to start write operation because setup is invalid (due to attributes being set to an inconsistent state).
VI_ERROR_NCIC	The interface associated with the given vi is not currently the controller in charge.
VI_ERROR_NLISTENERS	No Listeners condition is detected (both NRFD and NDAC are deasserted).
VI_ERROR_IO	An unknown I/O error occurred during transfer.

C Example

```
if (viWrite(vi, (ViBuf) “*idn?”, 5, VI_NULL) < VI_SUCCESS) return;
if (viRead(vi, (ViBuf) buffer, sizeof(buffer)-1, &retCnt)
   < VI_SUCCESS) return;
buffer[retCnt] = ’\0’; // ensure the string is null terminated
printf(”id: %s\n“, buffer);
```

Comments

The viWrite() operation synchronously transfers data. The data to be written is in the buffer represented by *buf*.

- This operation returns only when the transfer terminates.
- Only one synchronous write operation can occur at any one time.

Table 2-158: Special Value for retCount Parameter with viWrite()

Value	Description
VI_NULL	Do not return the number of bytes transferred. This may be useful if it is only important to know whether the operation succeeded or failed.

See Also **Reading and Writing Data**
viRead (*vi, buf, count, retCount*)

viWriteAsync (vi, buf, count, jobId)

Usage Writes data asynchronously to a device from the specified buffer.

C Format ViStatus viWriteAsync (ViSession *vi*, ViBuf *buf*, ViUInt32 *count*, ViPJobId *retCount*)

Visual Basic Format Not Applicable

Parameters

Table 2-159: viWriteAsync() Parameters

Name	Direction	Description
vi	IN	Unique logical identifier to a session.
buf	IN	Represents the location of a data block to be sent to device..
count	IN	Number of bytes to be written.
jobId	OUT	Represents the location of a variable that will be set to the job identifier of this asynchronous write operation.

Return Values

Table 2-160: viWriteAsync() Completion Codes

Completion Codes	Description
VI_SUCCESS	Asynchronous write operation successfully queued.
VI_SUCCESS_SYNC	Write operation performed synchronously.

Table 2-161: viWriteAsync() Error Codes

Error Codes	Description
VI_ERROR_INV_SESSION VI_ERROR_INV_OBJECT	The given session or object reference is invalid (both are the same value).
VI_ERROR_RSRC_LOCKED	Specified operation could not be performed because the resource identified by vi has been locked for this kind of access.
VI_ERROR_QUEUE_ERROR	Unable to queue write operation.

C Example

```
// rwwait.cpp
//
#include <stdio.h>
#include <string.h>
#include <windows.h>
#include ”visa.h“

// viReadAsync/viWriteAsync example -
// These commands can potentially decrease test time by allowing
// several read or write commands to happen in parallel.
int main(int argc, char* argv[])

{
        ViSession       rm, vi[2];
        ViJobId  jobid[2];
        ViStatus status;
        char    string[2][256];
        ViEventType     eventType[2];
        ViEvent event[2];
        int     i;

        // clear strings
        for (i = 0; i < 2; i++) {
                memset(string[i], 0, 256);
        }

        // Open the default RM
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;


        // Open multiple devices
        status = viOpen(rm, ”GPIB0::1::INSTR“, NULL, NULL, &vi[0]);
        if (status < VI_SUCCESS) goto error;

        status = viOpen(rm, ”GPIB8::1::INSTR“, NULL, NULL, &vi[1]);
        if (status < VI_SUCCESS) goto error;



        // Enable waiting on the events
        for (i = 0; i < 2; i++) {
                status = viEnableEvent(vi[i], VI_EVENT_IO_COMPLETION,
                        VI_QUEUE, VI_NULL);
                if (status < VI_SUCCESS) goto error;
        }
        // Write commands to several devices (this allows
        // several writes to be done in parallel)
        for (i = 0; i < 2; i++) {
                status = viWriteAsync(vi[i], (ViBuf) “*idn?”,
                        5, &jobid[i]);
```

```
            if (status < VI_SUCCESS) goto error;
        }

        // Wait for completion on all of the devices
        for (i = 0; i < 2; i++) {
            viWaitOnEvent(vi[i], VI_EVENT_IO_COMPLETION,
                    INFINITE, &eventType[i], &event[i]);
        }


        // Queue the read for all the devices (this allows
        // several reads to be done im parallel)
        for (i = 0; i < 2; i++) {
            status = viReadAsync(vi[i], (ViBuf) string[i], 256,
                                    &jobid[i]);
            if (status < VI_SUCCESS) goto error;
        }

        // Wait for all the reads to complete
        for (i = 0; i < 2; i++) {
            viWaitOnEvent(vi[i], VI_EVENT_IO_COMPLETION,
                    INFINITE, &eventType[i], &event[i]);
        }

        // Write out the *idn? strings.
        for (i = 0; i < 2; i++) {
            printf("%d: %s\n", i, string[i]);
        }

        // Cleanup and exit
        for (i = 0; i < 2; i++) {
            status = viDisableEvent(vi[i], VI_EVENT_IO_COMPLETION,
                    VI_QUEUE);
            if (status < VI_SUCCESS) goto error;
        }

        viClose(rm);
        return 0;
error:
        viStatusDesc(rm, status, string[0]);
        fprintf(stderr, "Error: %s\n", (ViBuf) string[0]);
        return 0;
}
```

Comments

The viWriteAsync() operation asynchronously transfers data. The data to be written is in the buffer represented by *buf*.

- This operation normally returns before the transfer terminates.
- Before calling this operation, you should enable the session for receiving I/O completion events. After the transfer has completed, an I/O completion event is posted.

- The operation returns a job identifier that you can use with either viTerminate() to abort the operation or with an I/O completion event to identify which asynchronous write operation completed.
- Since an asynchronous I/O request could complete before the vWriteAsync() operation returns, and the I/O completion event can be distinguished based on the job identifier, an application must be made aware of the job identifier before the first moment that the I/O completion event could possibly occur. Setting the output parameter *jobId* before the data transfer even begins ensures that an application can always match the *jobId* parameter with the VI_ATTR_JOB_ID attribute of the I/O completion event.
- If multiple jobs are queued at the same time on the same session, an application can use the *jobId* to distinguish the jobs, as they are unique within a session.
- The viWriteAsync() operation MAY be implemented synchronously, which could be done by using the viWrite() operation. This means that an application can use the asynchronous operations transparently even if a low-level driver only supports synchronous data transfers. If the viWriteAsync() operation is implemented synchronously and a given invocation of the operation is valid, the operation returns VI_SUCCESS_SYNC AND all status information is returned in a VI_EVENT_IO_COMPLETION.
- The status code VI_ERROR_RSRC_LOCKED can be returned either immediately or from the VI_EVENT_IO_COMPLETION event.
- For each successful call to viWriteAsync(), there is one and only one VI_EVENT_IO_COMPLETION event occurrence.

Table 2-162: Special Value for jobId Parameter with viWriteAsync()

Value	Description
VI_NULL	Do not return a job identifier. This option may be useful if only one asynchronous operation will be pending at a given time.

See Also

Asychronous Read/Write
viReadAsync (*vi, buf, count, jobId*)
ViTerminate (*vi, degree, jobId*)

Attributes

Attributes Summary

The following table summarizes Tektronix VISA attributes by category. Within categories, attributes appear in alphabetical order.

Table 3-1: Table of VISA Attributes by Category

Attribute	Description	Page
Resource Attributes		
VI_ATTR_MAX_QUEUE_LENGTH	Specifies the maximum number of events that can be queued at any time on the given session.	3-20
VI_ATTR_RM_SESSION	Specifies the session of the Resource Manager that was used to open this session.	3-22
VI_ATTR_RSRC_IMPL_VERSION	Resource version that uniquely identifies each of the different revisions or implementations of a resource.	3-22
VI_ATTR_RSRC_LOCK_STATE	The current locking state of the resource on the given session.	3-23
VI_ATTR_RSRC_MANF_ID	A value that corresponds to the VXI manufacturer ID of the manufacturer that created the VISA implementation.	3-23
VI_ATTR_RSRC_MANF_NAME	A string that corresponds to the VXI manufacturer name of the manufacturer that created the VISA implementation.	3-24
VI_ATTR_RSRC_NAME	The unique identifier for a resource.	3-24
VI_ATTR_RSRC_SPEC_VERSION	Resource version that uniquely identifies the version of the VISA specification to which the implementation is compliant.	3-25
VI_ATTR_USER_DATA	Data used privately by the application for a particular session.	3-29
Interface Attributes		
VI_ATTR_INTF_INST_NAME	Human-readable text describing the given interface.	3-17
VI_ATTR_INTF_NUM	Board number for the given interface.	3-18
VI_ATTR_INTF_TYPE	Specifies the interface type of the given session.	3-18
VI_ATTR_IO_PROT	Specifies which protocol to use, depending on the type of interface.	3-19
Serial Device Attributes		
VI_ATTR_ASRL_AVAIL_NUM	Shows the number of bytes available in the global receive buffer.	3-5
VI_ATTR_ASRL_BAUD	The baud rate of the interface.	3-5

Table 3-1: Table of VISA Attributes by Category (Cont.)

Attribute	Description	Page
Serial Device Attributes		
VI_ATTR_ASRL_CTS_STATE	Shows the current state of the Clear-to-Send (CTS) input signal.	3-6
VI_ATTR_ASRL_DATA_BITS	The number of data bits contained in each frame (5 to 8).	3-6
VI_ATTR_ASRL_DCD_STATE	Shows the current state of the Data Carrier Detect (DCD) input signal.	3-7
VI_ATTR_ASRL_DSR_STATE	Shows the current state of the Data Set Ready (DSR) input signal.	3-7
VI_ATTR_ASRL_DTR_STATE	Used to manually assert or unassert the Data Terminal Ready (DTR) output signal.	3-8
VI_ATTR_ASRL_END_IN	Indicates the method used to terminate read operations.	3-8
VI_ATTR_ASRL_END_OUT	Indicates the method used to terminate write operations.	3-9
VI_ATTR_ASRL_FLOW_CNTRL	Indicates the type of flow control used by the transfer mechanism.	3-10
VI_ATTR_ASRL_PARITY	The parity used with every frame transmitted and received.	3-11
VI_ATTR_ASRL_REPLACE_CHAR	Specifies the character to be used to replace incoming characters that arrive with errors (such as parity error).	3-11
VI_ATTR_ASRL_RI_STATE	Shows the current state of the Ring Indicator (RI) input signal.	3-12
VI_ATTR_ASRL_RTS_STATE	Used to manually assert or unassert the Request To Send (RTS) output signal.	3-12
VI_ATTR_ASRL_STOP_BITS	The number of stop bits used to indicate the end of a frame.	3-13
VI_ATTR_ASRL_XOFF_CHAR	Specifies the value of the XOFF character used for XON/XOFF flow control (both directions).	3-13
VI_ATTR_ASRL_XON_CHAR	Specifies the value of the XON character used for XON/XOFF flow control (both directions).	3-14
GPIB Device Attributes		
VI_ATTR_GPIB_PRIMARY_ADDR	Primary address of the GPIB device used by the given session.	3-15
VI_ATTR_GPIB_READDR_EN	Specifies whether to use repeat addressing before each read or write operation.	3-16
VI_ATTR_GPIB_SECONDARY_ADDR	Secondary address of the GPIB device used by the given session.	3-16

Table 3-1: Table of VISA Attributes by Category (Cont.)

Attribute	Description	Page
GPIB Device Attributes		
VI_ATTR_GPIB_UNADDR_EN	Specifies whether to unaddress the device (UNT and UNL) after each read or write operation.	3-17
Read/Write Attributes		
VI_ATTR_RD_BUF_OPER_MODE	Determines the operational mode of the read buffer.	3-21
VI_ATTR_SEND_END_EN	Specifies whether to assert END during the transfer of the last byte of the buffer.	3-26
VI_ATTR_SUPPRESS_END_EN	Specifies whether to suppress the END indicator termination.	3-27
VI_ATTR_TERMCHAR	Termination character.	3-27
VI_ATTR_TERMCHAR_EN	Flag that determines whether the read operation should terminate when a termination character is received.	3-28
VI_ATTR_WR_BUF_OPER_MODE	Determines the operational mode of the write buffer.	3-21
Event Attributes		
VI_ATTR_BUFFER	Contains the address of a buffer that was used in an asynchronous operation.	3-14
VI_ATTR_EVENT_TYPE	Unique logical identifier of the event.	3-15
VI_ATTR_JOB_ID	Contains the job ID of the asynchronous operation that has completed.	3-19
VI_ATTR_OPER_NAME	The name of the operation generating the event.	3-20
VI_ATTR_RET_COUNT	Contains the actual number of elements that were asynchronously transferred.	3-21
VI_ATTR_STATUS	Contains the return code of the asynchronous I/O operation that has completed or status code returned by an operation generating an error.	3-26
Miscellaneous Attributes		
VI_ATTR_TMO_VALUE	Minimum timeout value to use, in milliseconds.	3-28
VI_ATTR_TRIG_ID	Identifier for the current triggering mechanism.	3-29

Attributes

The following Tektronix VISA attributes are presented in alphabetical order.

VI_ATTR_ASRL_AVAIL_NUM

Usage Shows the number of bytes available in the global receive buffer.

Table 3-2: VI_ATTR_ASRL_AVAIL_NUM Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt32	0 to FFFFFFFFh	0	Read Only Global

Comments Applicable to serial devices.

See Also **Controlling the Serial I/O Buffers**
Setting and Retrieving Attributes

VI_ATTR_ASRL_BAUD

Usage The baud rate of the interface.

Table 3-3: VI_ATTR_ASRL_BAUD Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt32	0 to FFFFFFFFh	9600	Read/Write Global

Comments Applicable to serial devices. Although represented as an unsigned 32-bit integer so that any baud rate can be used, it usually requires a commonly used rate such as 300, 1200, 2400, or 9600 baud.

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_CTS_STATE

Usage Shows the current state of the Clear-to-Send (CTS) input signal.

Table 3-4: VI_ATTR_ASRL_CTS_STATE Attribute

Data Type	Range of Values	Default	Access Privilege
ViInt16	VI_STATE_ASSERTED VI_STATE_UNASSERTED VI_STATE_UNKNOWN	N/A	Read Only Global

Comments Applicable to serial devices.

See Also **Setting and Retrieving Attributes**
VI_ATTR_ASRL_FLOW_CNTRL
VI_ATTR_ASRL_RTS_STATE

VI_ATTR_ASRL_DATA_BITS

Usage The number of data bits contained in each frame (5 to 8).

Table 3-5: VI_ATTR_ASRL_DATA_BITS Attribute

Data Type	Range of Values	Default	Access Privilege
ViUint16	5 to 8	8	Read/Write Global

Comments Applicable to serial devices. The data bits for each frame are located in the low-order bits of every byte stored in memory.

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_DCD_STATE

Usage Shows the current state of the Data Carrier Detect (DCD) input signal.

Table 3-6: VI_ATTR_ASRL_DCD_STATE Attribute

Data Type	Range of Values	Default	Access Privilege
ViInt16	VI_STATE_ASSERTED VI_STATE_UNASSERTED VI_STATE_UNKNOWN	N/A	Read Only Global

Comments Applicable to serial devices. The DCD signal is often used by modems to indicate the detection of a carrier (remote modem) on the telephone line. The DCD signal is also known as *Receive Line Signal Detect* (RLSD).

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_DSR_STATE

Usage Shows the current state of the Data Set Ready (DSR) input signal.

Table 3-7: VI_ATTR_ASRL_DSR_STATE Attribute

Data Type	Range of Values	Default	Access Privilege
ViInt16	VI_STATE_ASSERTED VI_STATE_UNASSERTED VI_STATE_UNKNOWN	N/A	Read Only Global

Comments Applicable to serial devices.

See Also **Setting and Retrieving Attributes**
VI_ATTR_ASRL_FLOW_CNTRL
VI_ATTR_ASRL_DTR_STATE

VI_ATTR_ASRL_DTR_STATE

Usage Used to manually assert or unassert the Data Terminal Ready (DTR) output signal.

Table 3-8: VI_ATTR_ASRL_DTR_STATE Attribute

Data Type	Range of Values	Default	Access Privilege
ViInt16	VI_STATE_ASSERTED VI_STATE_UNASSERTED VI_STATE_UNKNOWN	N/A	Read/Write Global

Comments Applicable to serial devices.

See Also **Setting and Retrieving Attributes**
VI_ATTR_ASRL_FLOW_CNTRL
VI_ATTR_ASRL_DSR_STATE

VI_ATTR_ASRL_END_IN

Usage Indicates the method used to terminate read operations.

Table 3-9: VI_ATTR_ASRL_END_IN Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_ASRL_END_NONE VI_ASRL_END_LAST_BIT VI_ASRL_END_TERMCHAR	VI_ASRL_END_TERMCHAR	Read/Write Local

Comments Applicable to serial devices.

- If set to VI_ASRL_END_NONE, the read will not terminate until all of the requested data is received (or an error occurs).
- If set to VI_ASRL_END_LAST_BIT, the read will terminate as soon as a character arrives with its last bit set. For example, if VI_ATTR_ASRL_DATA_BITS is set to 8, the read will terminate when a character arrives with the 8th bit set.

- If set to VI_ASRL_END_TERMCHAR, the read will terminate as soon as the character in VI_ATTR_TERMCHAR is received.

See Also **Setting and Retrieving Attributes**
VI_ATTR_TERMCHAR

VI_ATTR_ASRL_END_OUT

Usage Indicates the method used to terminate write operations.

Table 3-10: VI_ATTR_ASRL_END_OUT Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_ASRL_END_NONE VI_ASRL_END_LAST_BIT VI_ASRL_END_TERMCHAR VI_ASRL_END_BREAK	VI_ASRL_END_NONE	Read/Write Local

Comments Applicable to serial devices.

- If set to VI_ASRL_END_NONE, the write will not append anything to the data being written.
- If set to VI_ASRL_END_BREAK, the write will transmit a break after all the characters for the write have been sent.
- If set to VI_ASRL_END_LAST_BIT, the write will send all but the last character with the last bit clear, then transmit the last character with the last bit set. For example, if VI_ATTR_ASRL_DATA_BITS is set to 8, the write will clear the 8th bit for all but the last character, then transmit the last character with the 8th bit set.
- If set to VI_ASRL_END_TERMCHAR, the write will send the character in VI_ATTR_TERMCHAR after the data being transmitted.

See Also **Setting and Retrieving Attributes**
VI_ATTR_TERMCHAR

VI_ATTR_ASRL_FLOW_CNTRL

Usage Indicates the type of flow control used by the transfer mechanism.

Table 3-11: VI_ATTR_ASRL_FLOW_CNTRL Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_ASRL_FLOW_NONE VI_ASRL_FLOW_XON_XOFF VI_ASRL_FLOW_RTS_CTS VI_ASRL_FLOW_DTR_DSR	VI_ASRL_FLOW_NONE	Read/Write Global

Comments Applicable to serial devices.

- If set to VI_ASRL_FLOW_NONE, the transfer mechanism does not use flow control, and buffers on both sides of the connection are assumed to be large enough to hold all data transferred.
- If set to VI_ASRL_FLOW_XON_XOFF, the transfer mechanism uses the XON and XOFF characters to perform flow control. It
  - controls input flow by sending XOFF when the receive buffer is nearly full.
  - controls the output flow by suspending transmission when XOFF is received.
- If set to VI_ASRL_FLOW_RTS_CTS, the transfer mechanism uses the RTS output signal and the CTS input signal to perform flow control. It
  - controls input flow by unasserting the RTS signal when the receive buffer is nearly full.
  - controls output flow by suspending the transmission when the CTS signal is unasserted.
  - In this case, the VI_ATTR_ASRL_RTS_STATE attribute is ignored when changed, but can be read to determine whether the background flow control is asserting or unasserting the signal.
- If set to VI_ASRL_FLOW_DTR_DSR, the transfer mechanism uses the DTR output signal and the DSR input signal to perform flow control. It
  - controls input flow by unasserting the DTR signal when the receive buffer is nearly full, and it

- controls output flow by suspending the transmission when the DSR signal is unasserted.

- This attribute can specify multiple flow control mechanisms by bit-ORing multiple values together. However, certain combinations may not be supported by all serial ports and/or operating systems.

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_PARITY

Usage The parity used with every frame transmitted and received.

Table 3-12: VI_ATTR_ASRL_PARITY Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_ASRL_PAR_NONE VI_ASRL_PAR_ODD VI_ASRL_PAR_EVEN VI_ASRL_PAR_MARK VI_ASRL_PAR_SPACE	VI_ASRL_PAR_NONE	Read/Write Global

Comments Applicable to serial devices.

- VI_ASRL_PAR_MARK means that the parity bit exists and is always 1.

- VI_ASRL_PAR_SPACE means that the parity bit exists and is always 0.

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_REPLACE_CHAR

Usage Specifies the character to be used to replace incoming characters that arrive with errors (such as parity error).

Table 3-13: VI_ATTR_ASRL_REPLACE_CHAR Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt8	0 to FFh	0	Read/Write Local

Comments Applicable to serial devices.

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_RI_STATE

Usage Shows the current state of the Ring Indicator (RI) input signal.

Table 3-14: VI_ATTR_ASRL_RI_STATE Attribute

Data Type	Range of Values	Default	Access Privilege
ViInt16	VI_STATE_ASSERTED VI_STATE_UNASSERTED VI_STATE_UNKNOWN	N/A	Read Only Global

Comments Applicable to serial devices. The RI signal is often used by modems to indicate that the telephone line is ringing.

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_RTS_STATE

Usage Used to manually assert or unassert the Request To Send (RTS) output signal.

Table 3-15: VI_ATTR_ASRL_RTS_STATE Attribute

Data Type	Range of Values	Default	Access Privilege
ViInt16	VI_STATE_ASSERTED VI_STATE_UNASSERTED VI_STATE_UNKNOWN	N/A	Read/Write Global

Comments Applicable to serial devices.

- When the VI_ATTR_ASRL_FLOW_CNTRL attribute is set to VI_ASRL_FLOW_RTS_CTS, this attribute is ignored when changed, but can be read to determine whether the background flow control is asserting or unasserting the signal.

See Also **Setting and Retrieving Attributes**
VI_ATTR_ASRL_FLOW_CNTRL
VI_ATTR_ASRL_CTS_STATE

VI_ATTR_ASRL_STOP_BITS

Usage The number of stop bits used to indicate the end of a frame.

Table 3-16: VI_ATTR_ASRL_STOP_BITS Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_ASRL_STOP_ONE VI_ASRL_STOP_ONE5 VI_ASRL_STOP_TWO	VI_ASRL_STOP_ONE	Read/Write Global

Comments Applicable to serial devices. The value VI_ASRL_STOP_ONE5 indicates one-and-one-half (1.5) stop bits.

See Also **Setting and Retrieving Attributes**

VI_ATTR_ASRL_XOFF_CHAR

Usage Specifies the value of the XOFF character used for XON/XOFF flow control (both directions).

Table 3-17: VI_ATTR_ASRL_XOFF_CHAR Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt8	0 to FFh	<Ctrl-S> (13h)	Read/Write Local

Comments Applicable to serial devices. If XON/XOFF flow control (software handshaking) is not being used, the value of this attribute is ignored.

See Also **Setting and Retrieving Attributes**
VI_ATTR_ASRL_FLOW_CNTRL
VI_ATTR_ASRL_XON_CHAR

VI_ATTR_ASRL_XON_CHAR

Usage Specifies the value of the XON character used for XON/XOFF flow control (both directions).

Table 3-18: VI_ATTR_ ASRL_XON_CHAR Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt8	0 to FFh	<Ctrl-Q> (11h)	Read/Write Local

Comments Applicable to serial devices. If XON/XOFF flow control (software handshaking) is not being used, the value of this attribute is ignored.

See Also
Setting and Retrieving Attributes
VI_ATTR_ASRL_FLOW_CNTRL
VI_ATTR_ASRL_XOFF_CHAR

VI_ATTR_BUFFER

Usage Contains the address of a buffer that was used in an asynchronous operation.

Table 3-19: VI_ATTR_BUFFER Attribute

Data Type	Range of Values	Default	Access Privilege
ViBuf	N/A	N/A	Read Only

Comments This attribute is used to check the buffer after event I/O completion.

See Also
Setting and Retrieving Attributes
Events
VI_EVENT_IO_COMPLETION

VI_ATTR_EVENT_TYPE

Usage Unique logical identifier of the event.

Table 3-20: VI_ATTR_EVENT_TYPE Attribute

Data Type	Range of Values	Default	Access Privilege
ViEventType	0 to FFFFFFFFh	N/A	Read Only

Comments .This attribute is used to identify one of the event types listed in the section on Events.

See Also **Setting and Retrieving Attributes**
Events

VI_ATTR_GPIB_PRIMARY_ADDR

Usage Primary address of the GPIB device used by the given session.

Table 3-21: VI_ATTR_GPIB_PRIMARY_ADDR Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	0 to 30	N/A	Read Only Global

Comments Applicable to GPIB devices. See the viOpen() operation for more information about the format for addressing GPIB devices.

See Also **Setting and Retrieving Attributes**
VI_ATTR_RSRC_NAME
viOpen()

VI_ATTR_GPIB_READDR_EN

Usage Specifies whether to use repeat addressing before each read or write operation.

Table 3-22: VI_ATTR_GPIB_READDR_EN Attribute

Data Type	Range of Values	Default	Access Privilege
Boolean	VI_TRUE VI_FALSE	VI_TRUE	Read/Write Local

Comments Applicable to GPIB devices.

See Also **Setting and Retrieving Attributes**
VI_ATTR_GPIB_UNADDR_EN

VI_ATTR_GPIB_SECONDARY_ADDR

Usage Secondary address of the GPIB device used by the given session.

Table 3-23: VI_ATTR_GPIB_SECONDARY_ADDR Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	0 to 30 VI_NO_SEC_ADDR	VI_NO_SEC_ADDR	Read Only Global

Comments Applicable to GPIB devices. See the viOpen() operation for more information about the format for addressing GPIB devices.

See Also **Setting and Retrieving Attributes**
VI_ATTR_RSRC_NAME
viOpen()

VI_ATTR_GPIB_UNADDR_EN

Usage Specifies whether to unaddress the device (UNT and UNL) after each read or write operation.

Table 3-24: VI_ATTR_GPIB_UNADDR_EN Attribute

Data Type	Range of Values	Default	Access Privilege
ViBoolean	VI_TRUE VI_FALSE	VI_FALSE	Read/Write Local

Comments Applicable to GPIB devices.

See Also **Setting and Retrieving Attributes**
VI_ATTR_GPIB_READDR_EN

VI_ATTR_INTF_INST_NAME

Usage Human-readable text describing the given interface.

Table 3-25: VI_ATTR_INTF_INST_NAME Attribute

Data Type	Range of Values	Default	Access Privilege
ViString	N/A	N/A	Read Only Global

Comments Applicable to GPIB and serial interfaces.

See Also **Setting and Retrieving Attributes**
VI_ATTR_INTF_NUM

VI_ATTR_INTF_NUM

Usage Board number for the given interface.

Table 3-26: VI_ATTR_INTF_NUM Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	0 to FFFFh	0	Read Only Global

Comments Applicable to GPIB and serial interfaces.

See Also **Setting and Retrieving Attributes**
VI_ATTR_INTF_NAME

VI_ATTR_INTF_TYPE

Usage Specifies the interface type of the given session.

Table 3-27: VI_ATTR_INTF_TYPE Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_INTF_GPIB VI_INTF_ASRL	N/A	Read Only Global

Comments Applicable to GPIB and serial interfaces.

See Also **Setting and Retrieving Attributes**

VI_ATTR_IO_PROT

Usage Specifies which protocol to use, depending on the type of interface.

Table 3-28: VI_ATTR_IO_PROT Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_NORMAL VI_HS488 VI_ASRL488	VI_NORMAL	Read/Write Local

Comments Choices depend of interface type:

- With GPIB interfaces, you can choose between normal and high-speed (HS488) data transfers.
- With serial interfaces, you can choose between normal and ASRL488-style transfers, in which case the viAssertTrigger(), viReadSTB(), and viClear() operations send 488.2-defined strings.

See Also
Setting and Retrieving Attributes
Controlling the Serial I/O Buffers
viAssertTrigger()
viReadSTB()
viClear()

VI_ATTR_JOB_ID

Usage Contains the job ID of the asynchronous operation that has completed.

Table 3-29: VI_ATTR_Job_ID Attribute

Data Type	Range of Values	Default	Access Privilege
ViJobID	N/A	NA	Read Only

Comments This attribute is used to check the job ID after event I/O completion

See Also
Setting and Retrieving Attributes
Events
VI_EVENT_IO_COMPLETION

VI_ATTR_MAX_QUEUE_LENGTH

Usage Specifies the maximum number of events that can be queued at any time on the given session.

Table 3-30: VI_ATTR_MAX_QUEUE_LENGTH Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt32	1h to FFFFFFFFh	50	Read/Write Local

Comments If the number of pending occurrences exceeds the value specified in this attribute, the lowest-priority events are discarded. This attribute is

- Read/Write until viEnableEvent() is called for the first time on a session
- Read Only after viEnableEvent() is called for the first time on a session

See Also **Setting and Retrieving Attributes**
viEnableEvent()

VI_ATTR_OPER_NAME

Usage The name of the operation generating the event.

Table 3-31: VI_ATTR_OPER_NAME Attribute

Data Type	Range of Values	Default	Access Privilege
ViString	N/A	N/A	Read Only

Comments This attribute is used to check the operation name that generated an event, typically an exception. For example, for an exception generated from the viLock() operation, VI_ATTR_OPER_NAME would contain the string "viLock".

See Also **Setting and Retrieving Attributes**
Events
VI_EVENT_EXCEPTION

VI_ATTR_RD_BUF_OPER_MODE

Usage Determines the operational mode of the read buffer.

Table 3-32: VI_ATTR_RD_BUF_OPER_MODE Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_FLUSH_ON_ACCESS VI_FLUSH_DISABLE	VI_FLUSH_DISABLE	Read/Write Local

Comments When the operational mode is set to

- VI_FLUSH_DISABLE (default), the buffer is flushed only on explicit calls to viFlush().
- VI_FLUSH_ON_ACCESS, the buffer is flushed every time a viScanf() operation completes.

See Also **Setting and Retrieving Attributes**
viScanf()

VI_ATTR_RET_COUNT

Usage Contains the actual number of elements that were asynchronously transferred.

Table 3-33: VI_ATTR_RET_COUNT Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt32	0 to FFFFFFFFh	N/A	Read Only

Comments This attribute is used to check the return count after event I/O completion.

See Also **Setting and Retrieving Attributes**
VI_EVENT_IO_COMPLETION

VI_ATTR_RM_SESSION

Usage Specifies the session of the Resource Manager that was used to open this session.

Table 3-34: VI_ATTR_RM_SESSION Attribute

Data Type	Range of Values	Default	Access Privilege
ViSession	N/A	N/A	Read Only Local

Comments The value of this attribute for the Default Resource Manager is VI_NULL.

See Also **Setting and Retrieving Attributes**

VI_ATTR_RSRC_IMPL_VERSION

Usage Resource version that uniquely identifies each of the different revisions or implementations of a resource.

Table 3-35: VI_ATTR_RSRC_IMPL_VERSION Attribute

Data Type	Range of Values	Default	Access Privilege
ViVersion	0 to FFFFFFFFh	N/A	Read Only Global

Comments The value of this attribute is defined by the individual manufacturer and increments the total version value on subsequent revisions. The value of sub-minor versions is non-zero only for pre-release versions (beta). All officially released products have a sub-minor value of zero.

Table 3-36: ViVersion Description for VI_ATTR_RSRC_IMPL_VERSION

Bits 31 to 20	Bits 19 to 8	Bits 0 to 7
Major Number	Minor Number	Sub-minor Number

See Also **Setting and Retrieving Attributes**

VI_ATTR_RSRC_LOCK_STATE

Usage The current locking state of the resource on the given session.

Table 3-37: VI_ATTR_RSRC_LOCK_STATE Attribute

Data Type	Range of Values	Default	Access Privilege
ViAccessMode	VI_NO_LOCK VI_EXCLUSIVE_LOCK VI_SHARED_LOCK	VI_NO_LOCK	Read Only Global

Comments The resource can be unlocked, locked with an exclusive lock, or locked with a shared lock.

See Also **Setting and Retrieving Attributes**
Locking and Unlocking Resources

VI_ATTR_RSRC_MANF_ID

Usage A value that corresponds to the VXI manufacturer ID of the manufacturer that created the VISA implementation.

Table 3-38: VI_ATTR_RSRC_MANF_ID Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	0 to 3FFFh	N/A	Read Only Global

Comments The manufacturer of TekVISA is Tektronix.

See Also **Setting and Retrieving Attributes**

VI_ATTR_RSRC_MANF_NAME

Usage A string that corresponds to the VXI manufacturer name of the manufacturer that created the VISA implementation.

Table 3-39: VI_ATTR_RSRC_MANF_NAME Attribute

Data Type	Range of Values	Default	Access Privilege
ViString	N/A	N/A	Read Only Global

Comments The manufacturer of TekVISA is Tektronix.

See Also **Setting and Retrieving Attributes**

VI_ATTR_RSRC_NAME

Usage The unique identifier for a resource.

Table 3-40: VI_ATTR_RSRC_NAME Attribute

Data Type	Range of Values	Default	Access Privilege
ViRsrc	N/A	N/A	Read Only Global

Comments For the Default Resource Manager, the value of this attribute is "", the empty string.

- The value of this attribute must be compliant with the address structure presented in the following table. See the viOpen() description for examples.
  - Optional string segments are shown in square brackets ([ ]).
  - The default value for the optional string segment *board* is 0.
  - The default value for the optional string segment *secondary address* is none.
  - Address strings are not case sensitive.

Table 3-41: Resource Address String Grammar

Interface	Syntax
ASRL	ASRL[board][::INSTR]
GPIB	GPIB[board]:: primary address[:: secondary address][::INSTR]

See Also **Setting and Retrieving Attributes**
viOpen()

VI_ATTR_RSRC_SPEC_VERSION

Usage Resource version that uniquely identifies the version of the VISA specification to which the implementation is compliant.

Table 3-42: VI_ATTR_RSRC_SPEC_VERSION Attribute

Data Type	Range of Values	Default	Access Privilege
ViVersion	0 to FFFFFFFFh	00200000h	Read Only Global

Comments This current implementation is compliant with Version 2.0 of the VISA Specification.

Table 3-43: ViVersion Description for VI_ATTR_RSRC_SPEC_VERSION

Bits 31 to 20	Bits 19 to 8	Bits 0 to 7
Major Number	Minor Number	Sub-minor Number

See Also **Setting and Retrieving Attributes**

VI_ATTR_SEND_END_EN

Usage Specifies whether to assert END during the transfer of the last byte of the buffer.

Table 3-44: VI_ATTR_SEND_END_EN Attribute

Data Type	Range of Values	Default	Access Privilege
Vi Boolean	VI_TRUE VI_FALSE	VI_TRUE	Read/Write Local

Comments Applicable to GPIB and serial devices.

See Also
Setting and Retrieving Attributes
Basic Input/Output
Reading and Writing Formatted Data

VI_ATTR_STATUS

Usage Contains the return code of the asynchronous I/O operation that has completed or status code returned by an operation generating an error.

Table 3-45: VI_ATTR_STATUS Attribute

Data Type	Range of Values	Default	Access Privilege
ViStatus	N/A	N/A	Read Only

Comments This attribute is used to check the return code after event I/O completion or the status code after an exception event.

See Also
Setting and Retrieving Attributes
Handling Events
VI_EVENT_IO_COMPLETION
VI_EVENT_EXCEPTION

VI_ATTR_SUPPRESS_END_EN

Usage Specifies whether to suppress the END indicator termination.

Table 3-46: VI_ATTR_SUPPRESS_END_EN Attribute

Data Type	Range of Values	Default	Access Privilege
ViBoolean	VI_TRUE VI_FALSE	VI_FALSE	Read/Write Local

Comments If this attribute is set to

- VI_TRUE, the END indicator does not terminate read operations.
- VI_FALSE, the END indicator terminates read operations.

See Also **Setting and Retrieving Attributes**
viRead()

VI_ATTR_TERMCHAR

Usage Termination character.

Table 3-47: VI_ATTR_TERMCHAR Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt8	0 to FFh	0Ah (linefeed)	Read/Write Local

Comments When the termination character is read and VI_ATTR_TERMCHAR_EN is enabled during a read operation, the read operation terminates.

See Also **Setting and Retrieving Attributes**
Basic Input/Output
Reading and Writing Formatted Data
VI_ATTR_TERMCHAR_EN
VI_ATTR_ASRL_END_IN
VI_ATTR_ASRL_END_OUT
viRead()

VI_ATTR_TERMCHAR_EN

Usage Flag that determines whether the read operation should terminate when a termination character is received.

Table 3-48: VI_ATTR_TERMCHAR_EN Attribute

Data Type	Range of Values	Default	Access Privilege
ViBoolean	VI_TRUE VI_FALSE	VI_FALSE	Read/Write Local

Comments When the termination character is read and VI_ATTR_TERMCHAR_EN is enabled during a read operation, the read operation terminates.

See Also **Setting and Retrieving Attributes**
Basic Input/Output
Reading and Writing Formatted Data
VI_ATTR_TERMCHAR
viRead()

VI_ATTR_TMO_VALUE

Usage Minimum timeout value to use, in milliseconds.

Table 3-49: VI_ATTR_TMO_VALUE Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt32	VI_TMO_IMMEDIATE 1 to FFFFFFFEh VI_TMO_INFINITE	2000	Read/Write Local

Comments A timeout value of

- VI_TMO_IMMEDIATE means that operations should never wait for the device to respond.
- VI_TMO_INFINITE disables the timeout mechanism.

See Also **Setting and Retrieving Attributes**

VI_ATTR_TRIG_ID

Usage Identifier for the current triggering mechanism.

Table 3-50: VI_ATTR_TRIG_ID Attribute

Data Type	Range of Values	Default	Access Privilege
ViInt16	VI_TRIG_SW	VI_TRIG_SW	Read/Write Local

Comments Applicable to GPIB and serial devices.

See Also **Setting and Retrieving Attributes**
viAssertTrigger()

VI_ATTR_USER_DATA

Usage Data used privately by the application for a particular session.

Table 3-51: VI_ATTR_USER_DATA Attribute

Data Type	Range of Values	Default	Access Privilege
ViAddr	N/A	N/A	Read/Write Local

Comments This data is not used by VISA for any purposes and is provided to the application for its own use.

See Also **Setting and Retrieving Attributes**

VI_ATTR_WR_BUF_OPER_MODE

Usage Determines the operational mode of the write buffer.

Table 3-52: VI_ATTR_WR_BUF_OPER_MODE Attribute

Data Type	Range of Values	Default	Access Privilege
ViUInt16	VI_FLUSH_ON_ACCESS VI_FLUSH_WHEN_FULL	VI_FLUSH_WHEN_FULL	Read/Write Local

Comments When the operational mode is set to

- VI_FLUSH_WHEN_FULL (default), the buffer is flushed when an END indicator is written to the buffer, or when the buffer fills up.
- VI_FLUSH_ON_ACCESS, the write buffer is flushed under the same conditions, and also every time a viPrintf() operation completes.

See Also **Setting and Retrieving Attributes**
Basic Input/Output
Reading and Writing Formatted Data
viPrintf()

Events

Events

The following event types are presented in alphabetical order.

VI_EVENT_EXCEPTION

Usage Notification that an error condition has occurred during an operation invocation.

Table 4-1: VI_EVENT_EXCEPTION Related Attributes

Event Attribute	Description
VI_ATTR_EVENT_TYPE	Unique logical identifier of the event. Value = VI_EVENT_EXCEPTION.
VI_ATTR_STATUS	Status code returned by the operation generating the error.
VI_ATTR_OPER_NAME	The name of the operation generating the event.

See Also **Exception Handling**
Generating an Error Condition

VI_EVENT_IO_COMPLETION

Usage Notification that an asynchronous operation has completed.

Table 4-2: VI_EVENT_IO_COMPLETION Related Attributes

Event Attribute	Description
VI_ATTR_EVENT_TYPE	Unique logical identifier of the event. Value = VI_EVENT_IO_COMPLETION.
VI_ATTR_STATUS	Return code of the asynchronous I/O operation that has completed.
VI_ATTR_JOB_ID	The job ID of the asynchronous operation that has completed.
VI_ATTR_BUFFER	The address of a buffer that was used in an asynchronous operation.
VI_ATTR_RET_COUNT	The actual number of elements that were asynchronously transferred.
VI_ATTR_OPER_NAME	The name of the operation generating the event.

See Also **Asynchronous Read/Write**
viReadAsync()
viWriteAsync

VI_EVENT_SERVICE_REQ

Usage Notification that a service request was received from the device.

Table 4-3: VI_EVENT_SERVICE_REQ Related Attributes

Event Attribute	Description
VI_ATTR_EVENT_TYPE	Unique logical identifier of the event. Value = VI_EVENT_SERVICE_REQ.

See Also **Status/Service Request**

Examples

Programming Examples

Introduction

The programming examples discussed here illustrate methods you can use to control the oscilloscope using VISA. All the program examples assume that the device descriptor is GPIB8::1::INSTR. The sample programs include:

SIMPLE.CPP — illustrates opening and closing a session

SIMPLEFINDRSRC.CPP — illustrates finding resources using regular expressions

FINDRSRCATTRMATCH.CPP — illustrates finding resources using attribute matching

ATTRACCESS.CPP — illustrates getting and setting attributes

RWEXAM.CPP — illustrates basic input/output

FORMATIO.CPP — illustrates formatted input/output

BUFFERIO.CPP — demonstrates the performance effect of resizing the formatted I/O buffers

SRQWAIT.CPP — illustrates event handling using the queuing mechanism

SRQ.CPP — illustrates event handling using the callback mechanism

EXLOCKEXAM.CPP — illustrates exclusive locking of resources

SHAREDLOCK.CPP — illustrates shared locking of resources

The sample programs were written in Microsoft Visual C ++ 6.0. If you wish to develop code, you will need to compile and link using two Visual C++ files: *visa32.lib* and *visa.h*. If you have TekVISA (or any version of VISA) installed on your computer, these files can be found in the *C:\vxipnp\win95* directory, regardless of whether you are using Windows 95 or a later version of Windows (such as Windows 98 or ME). If you are using Windows NT or 2000, the files can be found in the *C:\vxipnp\winnt* directory.

- The *visa32.lib* file is located in the *\lib\Msc* subdirectory of the *C:\vxipnp\win95* or *C:\vxipnp\winnt* directory.
- The *visa.h* file is located in the *\include* subdirectory of the *C:\vxipnp\win95* or *C:\vxipnp\winnt* directory.

For more information about TekVISA installation and packaging, refer to the *Getting Started* chapter of this book, and the README.HTML file that

accompanies the TekVISA installation software on the Product Software CD for your Series of Tektronix Oscilloscope.

Compiling and Linking Examples

***NOTE**. Some project examples in this chapter have already been configured and compiled on the accompanying CD.*

To make an executable for any of the files (for example, a project named SIMPLE), perform the following steps:

1. Install TekVISA if necessary.
2. Install Visual C++ if necessary.
3. If necessary, copy the programming example files to your hard disk.
4. Set up a project for each example. The example below creates a new project for the SAMPLE example program.
   a. Invoke Visual C++.
   b. From the **File** menu, select **New.**
   c. From the **Projects** tab, Choose **Win32 Console Application**.
   d. Select the directory where you want to store the project, give the project a name, for example, *Simple*, and click **OK**.
   e. Select **An Empty Project,** click **Finish** and **OK**.
   f. From the **Project** menu, select **Add to Project > Files...** , navigate to the folder where you stored the *Simple.cpp* source file, select it, and click **OK**.
5. From the **Project** menu, select **Settings.**
6. Select **All Configurations** in the **Settings for** combo box.
7. From the **C/C++** tab:
   a. Choose the **Precompiled Headers** category and select **Not using precompiled headers**.
   b. Choose the **Preprocessor** category and under the heading **Additional Include directories**, type **c:\vxipnp\win95\include** (or **c:\vxipnp\winNT\include** if you are running under Windows NT)
8. From the **Link** tab:

a. Choose the **General** category and under the heading **Object/library modules**, add **visa32.lib** to the list of files in the text entry box.

b. Choose the **Input** category and under the heading **Additional library path**, type **c:\vxipnp\win95\lib\msc** and click **OK**.

9. To compile and link your sample program, choose **Build** from the **Build** menu or press **F7**.

10. To run the sample program, choose **Execute** from the **Build** menu or press **Ctrl+F7**.

Opening and Closing Sessions

The *VISA Resource Manager* assigns unique resource addresses and IDs and provides access to resources registered with it. Currently, one such manager is available by default to a VISA application after initialization—the *Default Resource Manager*. The Default Resource Manager is used when finding available resources, opening resources, and performing other operations at the resource level.

- Applications use the **viOpenDefaultRM**() function to get access to the Default Resource Manager. This function must be called before any VISA operations can be invoked.
  - The first call to this function initializes the VISA system, including the Default Resource Manager resource, and returns a session to that resource.
  - Subsequent calls to this function return unique sessions to the same Default Resource Manager resource.
- After opening the Default Resource Manager, applications use the **viOpen**() operation to get access to a particular instrument resource. This operation opens a session to a device resource that is uniquely identified by an address string. TekVISA supports the following address string grammar syntax for GPIB and serial devices:
  - GPIB*[board]::primaryaddress[::secondaryaddress][::*INSTR*]*
  - ASRL*[board][::*INSTR*]*

  where brackets [ ] enclose optional fields, the default board is 0, and the default secondary address is None. For example, GPIB8 refers to the GPIB INSTR device on board 0 at primary address 8.
- Once an application has opened a session to a VISA resource using some of the services in the VISA Resource Manager, it can use **viClose**() to close that session and free up all the system resources associated with it. The VISA

system is also responsible for freeing up all associated system resources whenever an application becomes dysfunctional.

- IF the **viClose**() operation is invoked on a session returned from **viOpenDefaultRM**(), all VISA sessions opened with the corresponding Default Resource Manager session are also closed.

SIMPLE.CPP Example

The following C++ example, **SIMPLE.CPP**, opens the Default Resource Manager, opens a session to a GPIB device, queries the device, and then closes the session to the GPIB device and closes the session to the Default Resource Manager. Note that the first Close() operation is optional and not really necessary, since closing the Default Resource Manager also closes any sessions opened with it.

```
#include <visa.h>
#include <stdio.h>
#include <memory.h>

// This example opens a specific GPIB device, does an *idn query
// and prints the result.

int main(int argc, char* argv[])
{
        ViSession       rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        ViChar          buffer[256];
        ViUInt32        retCnt;

        // Open a default session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Open the GPIB device at primary address 1, GPIB board 8
        status = viOpen(rm, “GPIB8::1::INSTR”, VI_NULL, VI_NULL,
                        &vi);
        if (status < VI_SUCCESS) goto error;

        // Send an ID query.
        status = viWrite(vi, (ViBuf) ”*idn?“, 5, &retCnt);
        if (status < VI_SUCCESS) goto error;

        // Clear the buffer and read the response
        memset(buffer, 0, sizeof(buffer));
        status = viRead(vi, (ViBuf) buffer, sizeof(buffer), &retCnt);
        if (status < VI_SUCCESS) goto error;

        // Print the response
        printf(”id: %s\n“, buffer);

        // Clean up
```

```
        viClose(vi); // Not needed, but makes things a bit more
                     // understandable
        viClose(rm); // Closes resource manager and any sessions
                     // opened with it

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) {
                viClose(rm);
        }
        return 1;
}
```

Figure 5-1: SIMPLE.CPP Example

Finding Resources

The VISA Resource Manager resource gives applications the ability to search a VISA system for a resource in order to establish a communication link to it. Applications can request this service by using the **viFindRsrc**() and **viFindNext**() operations.

- The **viFindRsrc**() operation matches an expression against the resources available for a particular interface. The search is based on a resource address string that uniquely identifies a given resource in the system. Search criteria can include a *regular expression* matched against the address strings of available resources, and an optional *attribute expression* involving logical comparisons of attribute values. If the match is successful, **viFindRsrc**() returns a handle to a *find list* as well as the first resource found in the list, along with a count to indicate if more matching resources were found for the designated interface. The find list handle must be used as an input to **viFindNext**().
- The **viFindNext** () operation receives the find list handle created by **viFindRsrc**() and returns the next device resource found in the list.
- When the find list handle is no longer needed, it should be passed to **viClose**(). The **viClose**() operation is used not only to close sessions, but also to free find lists returned from the **viFindRsrc**() operation, as well as events returned from the **viWaitOnEvent**() operation.

Using Regular Expressions

A *regular expression* is a string used for pattern matching against the resource address strings known to the VISA Resource Manager. The expression can include regular characters as well as wildcard characters such as ?. Given a

regular expression as input, the **viFindRsrc**() operation compares it to a resource string or list of strings, and returns a list of one or more strings that match the regular expression.

SIMPLEFINDRSRC.CPP Example

The following C++ example, **SIMPLEFINDRSRC.CPP**, opens the Default Resource Manager, finds all available GPIB devices, opens a session to the first one, prints its response to an ID query, closes the session, finds the next one, and so on for all GPIB devices found. At the end of the example, the program closes the session to the Default Resource Manager.

```
#include <visa.h>
#include <stdio.h>
#include <memory.h>

// This example cycles through all GPIB devices and prints out
// each instrument's response to an *idn? query.

int main(int argc, char* argv[])
{
        ViSession       rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        ViChar          desc[256], id[256], buffer[256];
        ViUInt32        retCnt, itemCnt;
        ViFindList      list;
        ViUInt32        i;

        // Open a default session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Find all GPIB devices
        status = viFindRsrc(rm, "GPIB?*INSTR", &list, &itemCnt,
                                desc);
        if (status < VI_SUCCESS) goto error;

        for (i = 0; i < itemCnt; i++) {
                // Open resource found in rsrc list
                status = viOpen(rm, desc, VI_NULL, VI_NULL, &vi);
                if (status <  VI_SUCCESS) goto error;

                // Send an ID query.
                status = viWrite(vi, (ViBuf) "*idn?", 5, &retCnt);
                if (status < VI_SUCCESS) goto error;

                // Clear the buffer and read the response
                memset(id, 0, sizeof(id));
                status = viRead(vi, (ViBuf) id, sizeof(id), &retCnt);
                if (status < VI_SUCCESS) goto error;

                // Print the response
```

```
                printf("id: %s: %s\n", desc, id);

                // We're done with this device so close it
                viClose(vi);

                // Get the next item
                viFindNext(list, desc);
        }

        // Clean up
        viClose(rm);

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) {
                viClose(rm);
        }
        return 1;
}
```

Figure 5-2: SIMPLEFINDRSRC.CPP Example

Using Attribute Matching

If the resource string matches the regular expression, the attribute values of the resource are then matched against an *optional attribute expression* if one exists. This expresson can include the use of logical ANDs, ORs and NOTs. Equal (==) and unequal (!=) comparators can be used to compare attributes of any type, and other inequality comparators (>, <, >=, <=) can be used to compare attributes of numeric type. If the attribute type is ViString, a regular expression can be used in matching the attribute. Only global attributes can be used in the attribute expression.

FINDRSRCATTRMATCH.CPP Example

The following C++ example, **FINDRSRCATTRMATCH.CPP**, opens the Default Resource Manager, finds all GPIB devices with primary addresses between 1 and 5, then cycles through the find list and, for each found device, opens a session, print its response to an ID query, and closes the session. At the end of the example, the program closes the session to the Default Resource Manager.

```
#include <visa.h>
#include <stdio.h>
#include <memory.h>

// This example cycles through all GPIB devices with primary address
```

```
// between 1 and 5 and prints out each instrument's response to an
// *idn? query.


int main(int argc, char* argv[])
{
        ViSession       rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        ViChar          desc[256], id[256], buffer[256];
        ViUInt32        retCnt, itemCnt;
        ViFindList      list;
        ViUInt32        i;

        // Open a default session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Find all GPIB devices
        status = viFindRsrc(rm, "GPIB?*INSTR\
                                {VI_ATTR_GPIB_PRIMARY_ADDR >= 1\
                                 && VI_ATTR_GPIB_PRIMARY_ADDR <= 5}",
                                 &list, &itemCnt, desc);
        if (status < VI_SUCCESS) goto error;

        for (i = 0; i < itemCnt; i++) {
                // Open resource found in rsrc list
                status = viOpen(rm, desc, VI_NULL, VI_NULL, &vi);
                if (status <  VI_SUCCESS) goto error;

                // Send an ID query.
                status = viWrite(vi, (ViBuf) "*idn?", 5, &retCnt);
                if (status < VI_SUCCESS) goto error;

                // Clear the buffer and read the response
                memset(id, 0, sizeof(id));
                status = viRead(vi, (ViBuf) id, sizeof(id), &retCnt);
                if (status < VI_SUCCESS) goto error;

                // Print the response
                printf("id: %s: %s\n", desc, id);

                // We're done with this device so close it
                viClose(vi);

                // Get the next item
                viFindNext(list, desc);
        }

        // Clean up
        viClose(rm);
```

```
        return 0;


error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) {
                viClose(rm);
        }
        return 1;
}
```

Figure 5- 3: FINDRSRCATTRMATCH.CPP Example

Setting and Retrieving Attributes

Resources have attributes associated with them. Some attributes depict the instantaneous state of the resource and some define changeable parameters that can be used to modify the behavior of the resources. VISA defines operations for retrieving and modifying the value of individual resource attributes.

Retrieving Attributes

The VISA operation for retrieving the value of an attribute is **viGetAttribute**().

Setting Attributes

The VISA operation for modifying the value of an attribute is **viSetAttribute**().

ATTRACCESS.CPP Example

The following C++ example, **ATTRACCESS.CPP**, opens the Default Resource Manager, gets some information about the VISA implementation, then opens a session to a particular GPIB device (the GPIB INSTR device on board 8 at primary address 1), sets the timeout to 5 seconds, queries the device ID, and prints the results. At the end of the example, the program closes the sessions to the device and to the Default Resource Manager.

In this example, the program uses the **viGetAttribute**() operation to retrieve VISA implementation information. Specifically, the program consults the VI_ATTR_RSRC_MANF_NAME, VI_ATTR_RSRC_SPEC_VERSION, and VI_ATTR_RSRC_IMPL_VERSION attribute values to obtain the VISA Manufacturer name, the VISA specification version it supports, and the VISA implementation version.

In this example, the program uses the **viSetAttribute**() operation to set the timeout to 5 seconds. Specifically, the program sets the VI_ATTR_TMO_VALUE to 5000 milliseconds, which corresponds to 5 seconds.

```
#include <visa.h>
#include <stdio.h>
#include <memory.h>

// This example gets some info about the VISA implementation,
// opens a specific GPIB device, sets the timeout to 5 seconds, and
// does an *idn query then prints the result.

int main(int argc, char* argv[])
{
        ViSession       rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        ViChar          buffer[256];
        ViUInt32        retCnt;
        ViVersion       version = 0, impl = 0;

        // Open a default session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Get and print VISA's vendors name, VISA Specification
        // Version, and implementation version.
        status = viGetAttribute(rm, VI_ATTR_RSRC_MANF_NAME, buffer);
        if (status < VI_SUCCESS) goto error;
        status = viGetAttribute(rm, VI_ATTR_RSRC_SPEC_VERSION,
                                &version);
        if (status < VI_SUCCESS) goto error;
        status = viGetAttribute(rm, VI_ATTR_RSRC_IMPL_VERSION,
                                &impl);
        if (status < VI_SUCCESS) goto error;
        printf("VISA Manufacturer Name: %s, supports %x spec,
                %x implementation version\n", buffer, version, impl);

        // Open the GPIB device at primary address 1, GPIB board 8
        status = viOpen(rm, "GPIB8::1::INSTR", VI_NULL, VI_NULL,
                        &vi);
        if (status < VI_SUCCESS) goto error;

        // Set timeout to 5 seconds
        status = viSetAttribute(vi, VI_ATTR_TMO_VALUE, 5000);
        if (status < VI_SUCCESS) goto error;

        // Send an ID query.
        status = viWrite(vi, (ViBuf) "*idn?", 5, &retCnt);
        if (status < VI_SUCCESS) goto error;

        // Clear the buffer and read the response
        memset(buffer, 0, sizeof(buffer));
        status = viRead(vi, (ViBuf) buffer, sizeof(buffer), &retCnt);
        if (status < VI_SUCCESS) goto error;
```

```
        // Print the response
        printf("id: %s\n", buffer);

        // Clean up
        viClose(vi); // Not needed, but makes things a bit more
                     // understandable
        viClose(rm);

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) {
                viClose(rm);
        }
        return 1;
}
```

Figure 5- 4: ATTRACCESS.CPP Example

Basic Input/Output

The VISA INSTR resource provides a program with Basic Input/Output services to

- Send blocks of data to a device
- Request blocks of data from a device
- Send the device clear command to a device
- Trigger a device
- Find information about a device's status

Reading and Writing Data

The *Basic Input/Output Services* allow devices associated with an INSTR resource to read and write data synchronously or asynchronously. The resource can receive and send data in the native mode of the associated interface, or in any alternate mode supported by the interface.

The *VISA Write Service* lets a program send blocks of data from an *explicit user-specified buffer* to the device. The device can interpret the data as necessary—for example, as messages, commands, or binary encoded data. Setting the appropriate attribute modifies the data transmittal method and other features such as whether to send an END indicator with each block of data.

The *VISA Read Service* lets a program request blocks of data from the device. The data is returned in an *explicit, user-specified buffer*. How the returned data is interpreted depends on how the device has been programmed. For example, the information could be messages, commands, or binary encoded data. Setting the appropriate attribute modifies the data transmittal method and other features such as the termination character.

Synchronous Read/Write

The basic synchronous I/O operations are **viRead**() and **viWrite**().

Extract from SIMPLE.CPP Example

The following extract from the **SIMPLE.CPP** example highlights the synchronous read/write portions of that example. Here, the program sends a 5-byte ID query (*idn?) to a GPIB device using a user-specified buffer, then clears the buffer for readability and reads the device's ID response from the same buffer.

```
// Send an ID query.
status = viWrite(vi, (ViBuf) "*idn?", 5, &retCnt);
if (status < VI_SUCCESS) goto error;

// Clear the buffer and read the response
memset(buffer, 0, sizeof(buffer));
status = viRead(vi, (ViBuf) buffer, sizeof(buffer), &retCnt);
if (status < VI_SUCCESS) goto error;

// Print the response
printf("id: %s\n", buffer);
```

Figure 5-5: Read/Write Extract from SIMPLE.CPP Example

RWEXAM.CPP Example

In the following **RWEXAM.CPP** example, the program sends a 5-byte ID query (*idn?) to a GPIB device using a user-specified buffer, then reads the device's ID response from the same buffer. In this case, unlike the previous example the buffer is not cleared before it is read.

```
#include <stdio.h>
#include "visa.h"

int main(int argc, char* argv[])
{
        ViSession       rm, vi;
        ViStatus status;
        char            string[256];
        ViUInt32        retCnt;

        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        status = viOpen(rm, "GPIB8::1::INSTR", NULL, NULL, &vi);
        if (status < VI_SUCCESS) goto error;
```

```
        status = viWrite(vi, (ViBuf) "*idn?", 5, &retCnt);
        if (status < VI_SUCCESS) goto error;

        status = viRead(vi, (ViBuf) string, 256, &retCnt);
        if (status < VI_SUCCESS) goto error;

        printf("*idn response %s\n", string);

        viClose(vi);
        viClose(rm);
        return 0;
error:
        viStatusDesc(rm, status, string);
        fprintf(stderr, "Error: %s\n", (ViBuf) string);
        return 0;
}
```

Figure 5-6: RWEXAM.CPP Example

Asynchronous Read/Write

Any INSTR resources can have asynchronous, non-blocking operations associated with them. The basic asynchronous I/O operations are **viReadAsync**() and **viWriteAsync**(). These operations are invoked just like other operations. However, instead of waiting for the actual job to be done, they simply register the job to be done and return immediately. When I/O is complete, an event is generated to indicate the completion status.

Before beginning an asynchronous transfer, you must enable the session for the I/O completion event using the **viEnableEvent**() operation. After the transfer, you can use the **viWaitOnEvent**() operation to wait for the VI_EVENT_IO_COMPLETION event.

If you want to abort such an asynchronous operation after a specified time period, use **viTerminate**() with the unique job ID returned from the session of the operation to be aborted. If a VI_EVENT_IO_COMPLETION event has not yet occurred for the specified *jobId*, the **viTerminate**() operation raises a VI_EVENT_IO_COMPLETION event.

Clear

The *VISA Clear Service* lets a program send the device clear command to the device it is associated with. The action that the device takes depends on the interface to which it is connected. For a GPIB device, this amounts to sending the IEEE 488.1 SDC (04h) command. For a serial device, the string "*CLS\n" is sent if 488-style protocol is being used.

Invoking a **viClear**() operation on a device resource not only resets the hardware, it also flushes the formatted I/O read buffer (applies it to the hardware) and discards the contents of the formatted I/O write buffer used by the *Formatted I/O Services* for that session.

Trigger

The *VISA Trigger Service* provides monitoring and control access to the trigger of the device associated with the resource. Specifically, the **viAssertTrigger()** operation handles assertion of software triggers for GPIB and serial devices.

Status/Service Request

The *VISA Status/Service Request Service* allows a program to service requests made by other requesters in a system, and can procure device status information. Your program can determine if an event is a service request by using the **viGetAttribute()** operation to get the value of the VI_ATTR_EVENT_TYPE attribute. A related activity is to use the **viWaitOnEvent()** operation to wait on the VI_EVENT_SERVICE_REQUEST event. You can then use the **viReadSTB()** operation to manually obtain device status information by reading the status byte of the service request. For example, you might read this byte to determine which GPIB device among several possibilities is making the request. If the resource cannot obtain the status information from the requester in the timeout period, it returns a timeout.

Reading and Writing Formatted Data

NOTE. *In version 1.1 and earlier versions of TekVISA, the operations described in this section return the value* ***NOT IMPLEMENTED.***

Buffering can improve performance and throughput by making it possible to transfer large blocks of data to and from devices at certain times. The *Formatted I/O Services* support formatting and intermediate buffering in two ways:

NOTE. These distinctions are analogous to the differences in syntax between the formatted I/O operation **fprint()** (implicit buffering held by a file pointer) and buffered I/O operation **sprint()** (explicit user-specified buffering) in the ANSI C /C++ languages.

- The TekVISA *formatted I/O operations* write to an implicit write buffer and read from an implicit read buffer associated with a virtual instrument. These operations include **viPrintf()**, **viScanf()**, **viQueryf()**, and the related *variable list operations* (**viVPrintf()**, **viVScanf()**, and **ViVQueryf()**). In this document, these implicit buffers that are held by a file pointer are called the *formatted I/O buffers*.

  The related operations **viSetBuf()**, **viBufRead()**, **viBufWrite()**, and **viFlush()** can also act on these implicit buffers to set the buffer size, read and write segments of the buffer, and flush the contents (by applying them to the hardware in the case of the read buffer, or discarding them in the case of the write buffer).

Invoking a **viClear**() operation on a device resource not only resets the hardware, it also flushes the formatted I/O read buffer (applies it to the hardware) and discards the contents of the formatted I/O write buffer used by the *formatted I/O operations* for that session.

- The TekVISA *buffered I/O operations* write formatted information to and read it from *explicit user-supplied buffers* that you provide. These operations include **viSPrintf**(), **viSScanf**() and the related *variable list operations* (**viVSPrintf**(), and **viVSScanf**()).

  The related operations **viBufRead**() and **viBufWrite**() can also act on these explicit buffers to read data segments from a device into a user-supplied buffer, and write data segments from a user-supplied buffer to a device.

Since all of these operations actually use the **viWrite**() and **viRead**() operations to perform low-level I/O to and from the device, you are discouraged from mixing the **viWrite**() and **viRead**() *basic I/O operations* with *formatted I/O* and/or *buffered I/O operations* in the same session. If you do mix these operations, you must be careful to flush buffers correctly when moving between operations. Figure 5-7 illustrates the various types of formatted read/write operations supported by VISA.

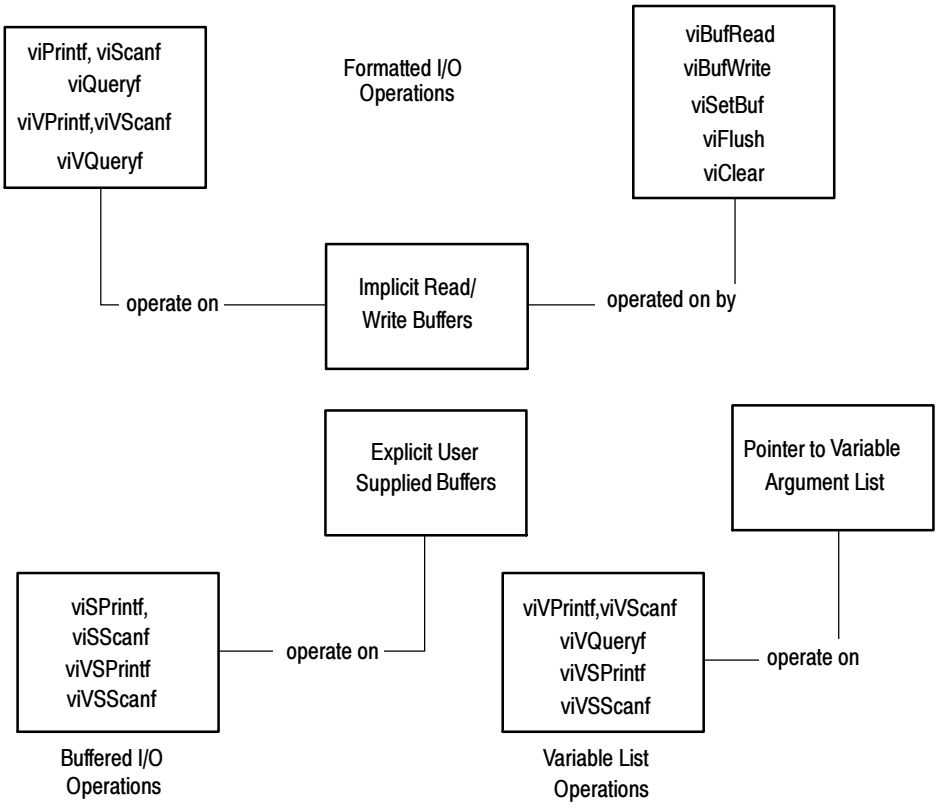


Figure 5-7: Types of Formatted Read/Write Operations

Formatted I/O Operations

The TekVISA *formatted I/O operations* write to an implicit write buffer and read from an implicit read buffer associated with a virtual instrument. Usage of these operations is illustrated in the following example.

FORMATIO.CPP Example

The following C++ example, **FORMATIO.CPP**, includes a main program that opens the Default Resource Manager, opens a session to the GPIB device with primary address 1 on board 8, calls the **ReadWaveform**() function to get header and waveform data from a Tektronix TDS scope, then writes the response to the standard output, and closes the session. At the end of the example, the program closes the session to the Default Resource Manager.

To review the use of Tektronix TDS scope commands and formatted I/O operations in more detail:

1. The **`header off`** command sent using the **viPrintf**() operation causes the oscilloscope to omit headers on query responses, so that only the argument is returned. The **`\n`** format string sends the ASCII LF character and END identifier.

2. The **hor:reco?** query sent using the **viQueryf**() operation asks the oscilloscope for the current horizontal record length and receives the response.The **\n** format string sends the ASCII LF character and END identifier. The **%ld** modifier and format code specify that the argument is a long integer.

3. The **data:start %d;data:stop %d\n** commands sent using the **viPrintf**() operation set the starting data point to 0 and the ending data point to the record length - 1 for the waveform transfer that will be initiated later using a CURVE? query. The **%d** format codes specify that the arguments are integers. The **\n** format string sends the ASCII LF character and END identifier.

4. The **WFMOUTPRE:YOFF?\n** query sent using the **viQueryf**() operation asks the oscilloscope for the vertical offset (YOFF) and receives the response. This information is needed to convert digitizing units to vertical units (typically volts) in order to scale the data. The **%f** format code specifies that the argument is a floating point number. The **\n** format string sends the ASCII LF character and END identifier.

5. The **WFMOutpre:YMULT?\n** query sent using the **viQueryf**() operation asks the oscilloscope for the vertical scale factor (YMULT) per digitizing level (also called the Y multiple) vertical multiplier and receives the response. This information is needed to convert digitizing units to vertical units (typically volts) in order to scale the data. The **%f** format code specifies that the argument is a floating point number. The **\n** format string sends the ASCII LF character and END identifier.

6. The **DATA:ENCDG RIBINARY;WIDTH 1\n** command sent using the **viPrintf**() operation sets the data format for the waveform transfer to binary using signed integer data-point representation, with the most significant byte transferred first. The DATA:WIDTH command sets the number of bytes to transfer to one byte per data point. The **\n** format string sends the ASCII LF character and END identifier.

   In binary format, the waveform is formatted as:

   #<*a*><*bbb*><*data*><*newline*>

   where:

a =	the number of *b* bytes
bbb =	the number of bytes to transfer
data =	the curve data
newline =	a single-byte new-line character at the end

7. The **CURVE?\n** query sent using the **viPrintf**() operation asks the oscilloscope to transfer the waveform. The **\n** format string sends the ASCII LF character and END identifier. Since the waveform could easily exceed the size of the formatted I/O read buffer, a **viQueryf**() is not being used here.

Instead, we want to split up the write (**viPrintf**()) and read (**viScanf**()) operations, rather than combining them in a single query.

8. The `viFlush(vi, VI_WRITE_BUF | VI_READ_BUF_DISCARD)` operation performs two combined tasks before getting the oscilloscope's response to the CURVE? query. It transfers the contents of the formatted I/O write buffer (in this case, the CURVE? query) to the oscilloscope, and discards the contents of the formatted I/O read buffer.This flushing operation should always be performed before a **viScanf**() operation that follows a **viPrintf**() or **viBufWrite**() operation, to guarantee that flushing occurs.

9. The first `viScanf(vi, "%c", &c)` operation reads the first character of the waveform response from the oscilloscope. The `%c` format code specifies that the argument is a character. This character is expected to be #.

10. The second `viScanf(vi, "%c", &c)` operation reads the next character of the waveform response from the oscilloscope. This character specifies the width of the next field, which contains the number of bytes of waveform data to transfer, and is expected to be between 0 and 9.

11. The third `viScanf(vi, "%c", &c)` operation reads the characters that represent the number of bytes to transfer. The result of the previous scan is used as the counter in the FOR loop. Each character read is expected to be between 0 and 9.

12. The program uses the results of the previous scan to allocate the right size for an array of double-word floating-point numbers that will contain the waveform. Then the fourth `viScanf(vi, "%c", &c)` operation reads the waveform itself, using the result of the previous scan as the counter in the FOR loop. The **viScanf**() operation accepts input until an END indicator is read or all the format specifiers in the format string are satisfied.

13. The `ptr[i] = (((double) c) - yoffset) * ymult;` calculation converts the waveform data results from string data into a numerical array of double-word floating point numbers, and also converts the data from digitizing units into vertical units (typically volts in the case of waveform data).

```
#include <visa.h>
#include <stdio.h>
#include <stdlib.h>
#include <assert.h>

// This function reads the currently selected waveform and returns
// it as an array of doubles.
double* ReadWaveform(ViSession vi, long* elements) {
        ViStatus status;
        float           yoffset, ymult;
        ViChar          buffer[256];
        ViChar          c;
```

```
        long            count, i;
        double* ptr = NULL;

        assert(elements != NULL);

        status = viSetAttribute(vi, VI_ATTR_WR_BUF_OPER_MODE,
VI_FLUSH_ON_ACCESS);
        status = viSetAttribute(vi, VI_ATTR_RD_BUF_OPER_MODE,
VI_FLUSH_ON_ACCESS);

        // Turn headers off, this makes parsing easier
        status = viPrintf(vi, "header off\n");
        if (status < VI_SUCCESS) goto error;

        // Get record length value
        status = viQueryf(vi, "hor:reco?\n", "%ld", elements);
        if (status < VI_SUCCESS) goto error;

        // Make sure start, stop values for curve query match the
        // full record length
        status = viPrintf(vi, "data:start %d;data:stop %d\n", 0,
                        (*elements)-1);
        if (status < VI_SUCCESS) goto error;

        // Get the yoffset to help calculate the vertical values.
        status = viQueryf(vi, "WFMOUTPRE:YOFF?\n", "%f", &yoffset);
        if (status < VI_SUCCESS) goto error;

        // Get the ymult to help calculate the vertical values.
        status = viQueryf(vi, "WFMOutpre:YMULT?\n", "%f", &ymult);
        if (status < VI_SUCCESS) goto error;

        // Request 8-bit binary data on the curve query
        status = viPrintf(vi, "DATA:ENCDG RIBINARY;WIDTH 1\n");
        if (status < VI_SUCCESS) goto error;

        // Request the curve
        status = viPrintf(vi, "CURVE?\n");
        if (status < VI_SUCCESS) goto error;

        // Always flush if a viScanf follows a viPrintf or
        // viBufWrite.
        status = viFlush(vi, VI_WRITE_BUF | VI_READ_BUF_DISCARD);
        if (status < VI_SUCCESS) goto error;

        // Get first char and validate
        status = viScanf(vi, "%c", &c);
        if (status < VI_SUCCESS) goto error;
        assert(c == '#');

        // Get width of element field.
```

```
        status = viScanf(vi, "%c", &c);
        if (status < VI_SUCCESS) goto error;
        assert(c >= '0' && c <= '9');

        // Read element characters
        count = c - '0';
        for (i = 0; i < count; i++) {
                status = viScanf(vi, "%c", &c);
                if (status < VI_SUCCESS) goto error;
                assert(c >= '0' && c <= '9');
        }

        // Read waveform into allocated storage
        ptr = (double*) malloc(*elements*sizeof(double));

        for (i = 0; i < *elements; i++) {
                status = viScanf(vi, "%c", &c);
                if (status < VI_SUCCESS) goto error;
                ptr[i] = (((double) c) - yoffset) * ymult;
        }

        status = viFlush(vi, VI_WRITE_BUF | VI_READ_BUF_DISCARD);
        if (status < VI_SUCCESS) goto error;

        return ptr;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (ptr != NULL) free(ptr);
        return NULL;
}


// This program reads a waveform from a Tektronix
// TDS scope and writes the floating point values to
// stdout.
int main(int argc, char* argv[])
{
        ViSession       rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        ViChar          buffer[256];
        double*         wfm = NULL;
        long            elements, i;

        // Open a default session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Open the GPIB device at primary address 1, GPIB board 8
```

```
        status = viOpen(rm, "GPIB8::1::INSTR", VI_NULL, VI_NULL,
                        &vi);
        if (status < VI_SUCCESS) goto error;

        // Read waveform and write it to stdout
        wfm = ReadWaveform(vi, &elements);
        if (wfm != NULL) {
            for (i = 0; i < elements; i++) {
                printf("%f\n", wfm[i]);
            }
        }

        // Clean up
        if (wfm != NULL) free(wfm);
        viClose(vi); // Not needed, but makes things a bit more
                     // understandable
        viClose(rm);

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) viClose(rm);
        if (wfm != NULL) free(wfm);
        return 1;
}
```

Figure 5-8: FORMATIO.CPP Example

Resizing the Formatted I/O Buffers

The VISA system provides separate formatted I/O read and write buffers that you can modify using the **viSetBuf**() operation. Use of these buffers is illustrated in the following example.

BUFFERIO.CPP Example

The following C++ example, **BUFFERIO.CPP**, demonstrates the performance effect of resizing the formatted I/O buffers. In this example as in the **FORMATIO.CPP** example, the main program opens the Default Resource Manager, opens a session to the GPIB device with primary address 1 on board 8, and calls the **ReadWaveform**() function to get header and waveform data from a Tektronix TDS scope.

In this case, before calling the **ReadWaveform**() function, the program starts a FOR loop that sets the read buffer size to 10, 100, 1000, and 10000 to show the effect of buffer sizes on performance. Each time through the loop, the program initializes a benchmark start time, calls the **ReadWaveform**() function five times to read segments of the waveform, and then writes the buffer size and the time required to read the buffer. After printing all the benchmark numbers for

comparison, the program closes the session to the oscilloscope and closes the session to the Default Resource Manager.

```
#include <visa.h>
#include <stdio.h>
#include <stdlib.h>
#include <assert.h>
#include <time.h>

// This function reads the currently selected waveform and returns
// it as an array of doubles.
double* ReadWaveform(ViSession vi, long* elements) {
.
. (same as FORMATIO Example)
.

        return ptr;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (ptr != NULL) free(ptr);
        return NULL;
}


// This program shows the performance effect of sizing buffers
// with buffered I/O.
int main(int argc, char* argv[])
{
        ViSession
rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        ViChar          buffer[256];
        double* wfm = NULL;
        long            elements, i;
        ViUInt32        bufferSize = 10;
        unsigned long   start, total;

        // Open a default session
        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        // Open the GPIB device at primary address 1, GPIB board 8
        status = viOpen(rm, "GPIB8::1::INSTR", VI_NULL, VI_NULL,
                        &vi);
        if (status < VI_SUCCESS) goto error;

        // Try buffer sizes 10, 100, ..., 10000 to show effect
        // of buffer sizes on performance.
```

```
        for (bufferSize = 10; bufferSize <= 10000; bufferSize *= 10)
        {
                // Set new buffer size
                viSetBuf(vi, VI_READ_BUF, bufferSize);

                // Get Start time for benchmark
                start = time(NULL);

                // Loop several times
                for (i = 0; i < 5; i++) {
                        wfm = ReadWaveform(vi, &elements);
                }

                // Print results
                total = time(NULL) - start;
                printf("bufSize %d, time %3.1fs\n", bufferSize,
                   ((double) total)/5.0);
        }

        // Clean up
        if (wfm != NULL) free(wfm);
        viClose(vi); // Not needed, but makes things a bit more
                     // understandable
        viClose(rm);

        return 0;

error:
        // Report error and clean up
        viStatusDesc(vi, status, buffer);
        fprintf(stderr, "failure: %s\n", buffer);
        if (rm != VI_NULL) viClose(rm);
        if (wfm != NULL) free(wfm);
        return 1;
}
```

Figure 5- 9: BUFFERIO.CPP Example

Flushing the Formatted I/O Buffer

The formatted I/O write buffer is maintained by the formatted I/O write operations—**viPrintf(), viVPrintf(),** and **viBufWrite**(). Flushing a write buffer immediately sends any queued data to the device. To explicitly flush the write buffer, you can call the **viFlush**() operation with a write flag set.

The formatted I/O read buffer is maintained by the formatted I/O read operations— **viScanf**(), **viVScanf**(), and **viBufRead**(). Flushing a read buffer discards the data in the read buffer. This guarantees that the next call to **viScanf**() (or a related buffered read operation) reads data directly from the device rather than from queued data in the read buffer. To explicitly flush the read buffer, you can call the **viFlush**() operation with a read flag set.

Although you can explicitly flush the buffers by calling the **viFlush**() operation, the buffers are flushed implicitly under some conditions. These conditions vary for the **viPrintf**() and **viScanf**() operations.

The write buffer is flushed automatically under the following conditions:

- When an END-indicator character is sent.
- When the buffer is full.
- In response to a call to **viSetBuf**() with the VI_WRITE_BUF flag set.

Invoking a **viClear**() operation on a device resource also flushes the read buffer and discards the contents of the write buffer used by the formatted I/O operations for that session. At such a time, any ongoing operation through the read/write port must be aborted.

Refer back to the **FORMATIO.CPP** example for sample usage of the **viPrintf**(), **viScanf**(), **viQueryf**(), and **viFlush**() operations with Tektronix TDS oscilloscopes.

Buffered I/O Operations

A *buffered I/O write operation* writes formatted data to an explicit user-specifed buffer, while a buffered I/O read operation reads formatted data from an explicit user-specified buffer. These operations include **viSPrintf**(), **viSScanf**() and the related *variable list operations* (**viVSPrintf**(), and **viVSScanf**()).

The related operations **viBufRead**() and **viBufWrite**() can also act on these explicit buffers to read data segments from a device into a user-supplied buffer, and write data segments from a user-supplied buffer to a device.

Variable List Operations

The VISA *variable list operations* use a pointer argument to a variable argument list, rather than the variable list itself as the argument. The VISA variable list operations include **viVPrintf**, **viVSPrintf**, **viVScanf**, **viVSScanf**, and **viVQueryf**. These operations are identical in operation to their ANSI C/C++ counterpart versions of variable list operations. Please refer to a C programming manual for more information.

Controlling the Serial I/O Buffers

You can use the **viSetBuf**() operation to control the sizes of the serial communication receive and transmit buffers. By resizing these buffers, you can realize performance improvements for serial device communication comparable to those derived from resizing the formatted I/O buffers. Refer to the section entitled **Resizing the Formatted I/O Buffers** for an example illustrating buffer resizing.

Handling Events

An *event* is a means of communicating between a VISA resource and its applications. Typically, events occur because a condition requires the attention of applications.

VISA provides two independent mechanisms for an application to receive events: *queuing* and *callback handling*. The queuing and callback mechanisms are suitable for different programming styles:

- The *queuing* mechanism is generally useful for non-critical events that do not need immediate servicing. To receive events using the queuing mechanism, an application must invoke the **viWaitOnEvent()** operation. All of the occurrences of a specified event type are placed in a session-based event queue. There is one event queue per event type per session. The application can receive the event occurrences later by dequeuing them with the **viWaitOnEvent()** operation.
- The *callback* mechanism is useful when immediate responses are needed. To receive events using the callback mechanism, an application must install a callback handler using the **viInstallHandler()** operation. The application is called directly by invoking a handler function that the application installed prior to enabling the event. The callback handler is invoked on every occurrence of the specified event.

By default, a session is not enabled to receive any events by either mechanism. Since these mechanisms work independently of each other, both can be enabled at the same time. An application can enable either or both mechanisms using the **viEnableEvent()** operation. The callback handling mechanism can be enabled for one of two modes: *immediate callback* or *delayed callback queuing*. The **viEnableEvent()** operation is also used to switch between the two callback modes. The **viDisableEvent()** operation is used to disable either or both mechanisms, regardless of the current state of the other.

When an application receives an event occurrence via either mechanism, it can determine information about the event by invoking **viGetAttribute()** on that event. When the application no longer needs the event information, it must call **viClose()** on that event. The **viClose()** operation is used not only to close sessions, but also to free events returned from the **viWaitOnEvent()** operation.

Queueing Mechanism

Applications can use the *queuing* mechanism in VISA to receive events only when it requests them. An application retrieves the event information by using the **viWaitOnEvent()** operation. If the specified event(s) exist in the queue, these operations retrieve the event information and return immediately. Otherwise, the application thread is blocked until the specified event(s) occur or until the timeout expires, whichever happens first. When an event occurrence unblocks a thread, the event is not queued for the session on which the wait operation was invoked.

Once a session is enabled for queuing, all the event occurrences of the specified event type are queued. When a session is disabled for queuing, any further event occurrences are not queued, but event occurrences that were already in the event queue are retained. The retained events can be dequeued at any time using the **viWaitOnEvent()** operation. An application can explicitly clear (flush) the event queue for a specified event type using the **viDiscardEvents()** operation.

SRQWAIT.CPP Example

The following C++ example, **SRQWAIT.CPP**, demonstrates event handling using the queuing mechanism. The program begins by opening the Default Resource Manager and opening a session to the GPIB device with primary address 1 on board 8. Next the program enables notification of the VI_EVENT_SERVICE_REQ event.

The program then uses a series of **viWrite()** operations to send Tektronix TDS scope commands to set up the instrument. These commands do the following:

1. The **`:DATA:ENCDG RIBINARY;SOURCE CH1;START 1;STOP 500;WIDTH 2`** commands do the following:
   - **a.** Set the data format for the waveform transfer to binary using signed integer data-point representation, with the most significant byte transferred first.
   - **b.** Set the data source to channel 1.
   - **c.** Set the starting data point to 0 and the ending data point to 500 for the waveform transfer that will be initiated later.
   - **d.** Set the number of bytes to transfer to two bytes per data point.
2. The **`:ACQUIRE:STOPAFTER SEQUENCE;REPET 0;STATE 0;MODE SAMPLE`** commands tell the oscilloscope to:
   - **a.** Acquire a single sequence (equivalent to pressing SINGLE from the front panel).
   - **b.** Disable repetitive mode (equivalent to setting Equivalent Time Auto/Off in the Acquisition control window).
   - **c.** Stop acquisition (equivalent to pressing STOP from the front panel)
   - **d.** Set the acquisition mode to sample (equivalent to selecting HORIZONTAL/ACQUISITION from the HORIZ/ACQ menu and then choosing SAMPLE from the Acquisition Mode group box.
3. The **`DESE 1;*ESE 1;*SRE 32`** commands and the **`*CLS`** command tell the oscilloscope to:

a. Set registers to await an Operation Complete (OPC) event (bit 1) in the event queue. This event is summarized in the Event Status Bit(ESB) of the Status Byte Register.

b. Set the Event Status Bit (bit 5) to await a Service Request (SRQ).

c. Clear the event registers.

4. In the For loop, the **`:ACQUIRE:STATE 1`** command starts acquisition and is equivalent to pressing the front panel RUN button or setting the state to ON.

5. The **`*OPC`** command generates the Operation Complete message in the Standard Event Status Register (SESR) and generates a Service Request (SRQ) when all pending operations complete. This allows programmers to synchronize operation of the oscilloscope with their application program.

After using the **viWaitOnEvent**() operation to wait for an SRQ event to occur, the program prints a success or faiilure message, uses the **viDisableEvent**() operation to disable the VI_EVENT_SERVICE_REQ event, closes the session to the oscilloscope, and closes the session to the Default Resource Manager.

```
// srqwait.cpp :Defines the entry point for the console application.
//
#include <stdio.h>
#include <string.h>
#include <windows.h>
#include ”visa.h“

int main(int argc, char* argv[])
{
      ViSession      rm, vi;
      ViStatus       status;
      char           string[256];
      ViUInt32       retCnt;
      int              i;
      ViUInt16       stb;
      ViEventType    eventType = 0;
      ViEvent        context = 0;

      status = viOpenDefaultRM(&rm);
      if (status < VI_SUCCESS) goto error;

      status = viOpen(rm, ”GPIB8::1::INSTR“, NULL, NULL, &vi);
      if (status < VI_SUCCESS) goto error;

      status = viEnableEvent(vi, VI_EVENT_SERVICE_REQ, VI_QUEUE,
                                    VI_NULL);
      if (status < VI_SUCCESS) goto error;

      // Setup instrument
      status = viWrite(vi, (ViBuf)
```

```
        ":DATA:ENCDG RIBINARY;SOURCE CH1;START 1;STOP 500;WIDTH 2",
                    56, &retCnt);
    if (status < VI_SUCCESS) goto error;
    status = viWrite(vi, (ViBuf)
        ":ACQUIRE:STOPAFTER SEQUENCE;REPET 0;STATE 0;MODE
SAMPLE",
                        55, &retCnt);
    if (status < VI_SUCCESS) goto error;
    status = viWrite(vi, (ViBuf) "DESE 1;*ESE 1;*SRE 32", 21,
                        &retCnt);
    if (status < VI_SUCCESS) goto error;

    // Do cause some srqs
    for (i = 0; i < 100; i++) {
        status = viWrite(vi, (ViBuf) "*CLS", 4, &retCnt);
        if (status < VI_SUCCESS) goto error;
        status = viWrite(vi, (ViBuf) ":ACQUIRE:STATE 1", 16,
                            &retCnt);
        if (status < VI_SUCCESS) goto error;
        status = viWrite(vi, (ViBuf) "*OPC", 4, &retCnt);
        if (status < VI_SUCCESS) goto error;
        status = viWaitOnEvent(vi, VI_EVENT_SERVICE_REQ,
                                5000, &eventType, &context);
        if (status >= VI_SUCCESS) {
            printf("(%d) Received SRQ\n", i);
            viClose(context);
        } else {
            viStatusDesc(vi, status, string);
            printf(
                        "(%d) viWaitOnEvent Failed - \"%s\"\n",
                        string);
        }
        viReadSTB(vi, &stb);
    }

    // Cleanup and exit
    status = viDisableEvent(vi, VI_EVENT_SERVICE_REQ, VI_QUEUE);
    if (status < VI_SUCCESS) goto error;

    viClose(vi);
    viClose(rm);
    return 0;
error:
    viStatusDesc(rm, status, string);
    fprintf(stderr, "Error: %s\n", (ViBuf) string);
    return 0;
}
```

Figure 5- 10: SRQWAIT.CPP Example

Callback Mechanism

Applications can use the *callback* mechanism by installing handler functions that can be called back when a particular event type is received. The **viInstallHandler()** operation can be used to install handlers to receive specified event types. The handlers are invoked on every occurrence of the specified event, once the session is enabled for the callback mechanism. One handler must be installed before a session can be enabled for sensing using the callback mechanism.

VISA allows applications to install multiple handlers for an event type on the same session. Multiple handlers can be installed through multiple invocations of the **viInstallHandler()** operation, where each invocation adds to the previous list of handlers. If more than one handler is installed for an event type, each of the handlers is invoked on every occurrence of the specified event(s). VISA specifies that the handlers are invoked in Last In First Out (LIFO) order.

When a handler is invoked, the VISA resource provides the *event context* as a parameter to the handler. The *event context* is filled in by the resource. Applications can retrieve information from the *event context* object using the **viGetAttribute()** operation.

An application can supply a reference to any application-defined value while installing handlers. This reference is passed back to the application as the *userHandle* parameter to the callback routine during handler invocation. This allows applications to install the same handler with different application-defined *event contexts*.

For example, an application can:

- install a handler with a fixed *event context* value **0x1** on a session for an event type.
- install the same handler with a different *event context* value, for example **0x2**, for the same event type.

The two installations of the same handler are different from one another. Both handlers are invoked when the event of the given type occurs. However, in one invocation, the value passed to *userHandle* is **0x1** and in the other it is **0x2**. Thus, event handlers are uniquely identified by a combination of the *userHandle* handler address and the user *event context*. This identification is particularly useful when different handling methods need to be done depending on the user context data. Refer to **viEventHandler(),** an event service handler procedure prototype, for more information about writing an event handler.

An application may install the same handler on multiple sessions. In this case, the handler is invoked in the context of each session for which it was installed.

The callback mechanism of a particular session can be in one of three different states: *handling*, or *suspended handling*, or *disabled*.

- When a session transitions to the *handling* state, the callback handler is invoked for all the occurrences of the specified event type.

- When a session transitions to the *suspended handling* state, the callback handler is not invoked for any new event occurrences, but occurrences are kept in a suspended handler queue. The handler is invoked later, when a transition to the handling state occurs.

  In the *suspended handling* state, a maximum of the VI_ATTR_MAX_QUEUE_LENGTH number of event occurrences are kept pending. If the number of pending occurrences exceeds the value specified in this attribute, the lowest-priority events are discarded. An application can explicitly clear (flush) the callback queue for a specified event type using the **viDiscardEvents**() operation.

- When a session transitions to the *disabled* state, the session ignores any new event occurrences, but any pending occurrences are retained in the queue.

SRQ.CPP Example

The following C++ example, **SRQ.CPP**, demonstrates event handling using the callback mechanism. This example first defines a handler function called **ServiceReqEventHandler**, which simply prints a message that a service request occurred and returns successfully. The main program begins by opening the Default Resource Manager and opening a session to the GPIB device with primary address 1 on board 8. Next the program installs the **ServiceReqEventHandler** callback handler for the VI_EVENT_SERVICE_REQ event, and then enables notification of the VI_EVENT_SERVICE_REQ event.

The program then uses a series of **viWrite**() operations to send Tektronix TDS scope commands that do the following:

1. The `:RECALL:SETUP FACTORY` and `:SELECT:CH1 1;CH2 0;CH3 0;CH4 0` commands reset the instrument to factory settings and select four channels.
2. The `:DATA:ENCDG RIBINARY;SOURCE CH1;START 1;STOP 500;WIDTH 2` commands do the following:
   a. Set the data format for the waveform transfer to binary using signed integer data-point representation, with the most significant byte transferred first.
   b. Set the data source to channel 1.
   c. Set the starting data point to 0 and the ending data point to 500 for the waveform transfer that will be initiated later.
   d. Set the number of bytes to transfer to two bytes per data point.
3. The `:ACQUIRE:STOPAFTER SEQUENCE;REPET 0;STATE 0;MODE SAMPLE` commands tell the oscilloscope to:
   a. Acquire a single sequence (equivalent to pressing SINGLE from the front panel).

b. Disable repetitive mode (equivalent to setting Equivalent Time Auto/Off in the Acquisition control window).

c. Stop acquisition (equivalent to pressing STOP from the front panel)

d. Set the acquisition mode to sample (equivalent to selecting HORIZONTAL/ACQUISITION from the HORIZ/ACQ menu and then choosing SAMPLE from the Acquisition Mode group box.

4. The **`DESE 1;*ESE 1;*SRE 32`** commands and the **`*CLS`** command tell the oscilloscope to:

a. Set registers to await an Operation Complete (OPC) event (bit 1) in the event queue. This event is summarized in the Event Status Bit(ESB) of the Status Byte Register.

b. Set the Event Status Bit (bit 5) to await a Service Request (SRQ).

c. Clear the event registers.

5. The **`:ACQUIRE:STATE RUN`** command starts acquisition and is equivalent to pressing the front panel RUN button.

6. The **`*OPC`** command generates the Operation Complete message in the Standard Event Status Register (SESR) and generates a Service Request (SRQ) when all pending operations complete. This allows programmers to synchronize operation of the oscilloscope with their application program.

After waiting long enough for an SRQ event to occur, the program disables the VI_EVENT_SERVICE_REQ event, uninstalls the **ServiceReqEventHandle** handler, closes the session to the oscilloscope, and closes the session to the Default Resource Manager.

```
// srq.cpp : Defines the entry point for the console application.
//
#include <stdio.h>
#include <string.h>
#include <windows.h>
#include ”visa.h“

ViStatus _VI_FUNCH ServiceReqEventHandler(ViSession vi, ViEventType
eventType, ViEvent event, ViAddr userHandle)
{
        printf(”srq occurred\n“);
        return VI_SUCCESS;
}

int main(int argc, char* argv[])
{
        ViSession       rm, vi;
        ViStatus status;
```

```
char            string[256];
ViUInt32        retCnt;

status = viOpenDefaultRM(&rm);
if (status < VI_SUCCESS) goto error;

status = viOpen(rm, ”GPIB8::1::INSTR“, NULL, NULL, &vi);
if (status < VI_SUCCESS) goto error;

// Setup and enable event handler
status = viInstallHandler(vi, VI_EVENT_SERVICE_REQ,
                          ServiceReqEventHandler, NULL);
if (status < VI_SUCCESS) goto error;
status = viEnableEvent(vi, VI_EVENT_SERVICE_REQ, VI_HNDLR,
                       VI_NULL);
if (status < VI_SUCCESS) goto error;

// Setup instrument
status = viWrite(vi, (ViBuf) ”:RECALL:SETUP FACTORY“, 21,
                 &retCnt);
if (status < VI_SUCCESS) goto error;
status = viWrite(vi, (ViBuf) ”:SELECT:CH1 1;CH2 0;CH3 0;CH4
                 0“, 31, &retCnt);
if (status < VI_SUCCESS) goto error;
status = viWrite(vi, (ViBuf) ”:DATA:ENCDG RIBINARY;SOURCE
                 CH1;START 1;STOP 500;WIDTH 2“, 56, &retCnt);
if (status < VI_SUCCESS) goto error;
status = viWrite(vi, (ViBuf) ”:ACQUIRE:STOPAFTER
                 SEQUENCE;REPET 0;STATE 0;MODE SAMPLE“, 55,
                 &retCnt);
if (status < VI_SUCCESS) goto error;
status = viWrite(vi, (ViBuf) ”DESE 1;*ESE 1;*SRE 32“, 21,
                 &retCnt);
if (status < VI_SUCCESS) goto error;

// Do a single acq
status = viWrite(vi, (ViBuf) ”*CLS“, 4, &retCnt);
if (status < VI_SUCCESS) goto error;
status = viWrite(vi, (ViBuf) ”:ACQUIRE:STATE 1“, 16,
                 &retCnt);
if (status < VI_SUCCESS) goto error;
status = viWrite(vi, (ViBuf) ”*OPC“, 4, &retCnt);
if (status < VI_SUCCESS) goto error;

// Wait around long enough for srq event to occur
::Sleep(10000);

// Cleanup and exit
status = viDisableEvent(vi, VI_EVENT_SERVICE_REQ, VI_HNDLR);
if (status < VI_SUCCESS) goto error;
status = viUninstallHandler(vi, VI_EVENT_SERVICE_REQ,
```

```
                                        ServiceReqEventHandler, NULL);
        if (status < VI_SUCCESS) goto error;
        viClose(vi);
        viClose(rm);
        return 0;
error:
        viStatusDesc(rm, status, string);
        fprintf(stderr, "Error: %s\n", (ViBuf) string);
        return 0;
}
```

Figure 5-11: SRQ.CPP Example

Exception Handling

NOTE. *In version 1.1 and earlier versions of TekVISA, support for exception handling is* ***NOT IMPLEMENTED*****.**

In VISA, exceptions are defined as events, and *exception handling* takes place using the *callback* mechanism. Each error condition defined by operations of resources can cause *exception events*. When an error occurs, normal execution of that session operation halts. The operation notifies the application of the error condition by raising an exception event (event type VI_EVENT_EXCEPTION). Raising the exception event invokes the application-specified exception callback routine(s) installed for the particular session, based on whether this exception event is currently enabled for the given session. The notification includes the cause of the error. Once notified, the application can tell the VISA system the action to take, depending on the error's severity.

Exception handling uses the same operations as those used for general event handling. Your application can install a callback handler that is invoked on an error. This installation can be done using the **viInstallHandler()** operation on a session. Once a handler is installed, a session can be enabled for exception event using the **viEnableEvent()** operation. The exception event is like any other event in VISA, except that the *queuing* and *suspended handling* mechanisms are not allowed.

When an error occurs for a session operation, the exception handler is executed synchronously; that is, the operation that caused the exception blocks until the exception handler completes its execution. When invoked, the exception handler can check the error condition and instruct the exception operation to take a specific action. For example:

- The handler can instruct the exception operation to continue normally (returning the indicated error code) or to not invoke any additional handlers (in the case of handler nesting).

- A given implementation may choose to provide implementation-specific return codes for users' exception handlers, and may take alternate actions based on those codes.
- A vendor-specific return code from an exception handler might cause the VISA implementation to close all sessions for the given process and exit the application.

NOTE. *Using vendor-specific return codes makes an application incompatible with other implementations.*

Generating an Error Condition on Asynchronous Operations

One situation in which an exception event will not be generated is in the case of asynchronous operations. If the error is detected after the operation is posted (that is, once the asynchronous portion has begun), the status is returned normally via the I/O completion event (type IO_COMPLETION_EVENT). However, if an error occurs before the asynchronous portion begins (that is, the error is returned from the asynchronous operation itself), then the exception event will still be raised. This deviation is because asynchronous operations already raise an event when they complete, and this I/O completion event may occur in the context of a separate thread previously unknown to the application. In summary, a single application event handler can easily handle error conditions arising from both exception events and failed asynchronous operations.

Locking and Unlocking Resources

Applications can open multiple sessions to a resource simultaneously and access the resource through the different sessions concurrently. However, an application accessing a resource might want to restrict other applications or sessions from accessing the same resource. For example, an application might need sole access to a resource in order to perform a sequence of writes. VISA defines a locking mechanism to restrict resource access in such special circumstances. The **viLock**() operation is used to acquire a lock on a resource and the **viUnlock**() operation is used to relinquish the lock.

The VISA locking mechanism enforces arbitration of access to resources on a per-session basis. If a session locks a resource, operations invoked on the resource through other sessions are either serviced or returned with an error, depending on the operation and the type of lock used.

If a VISA resource is not locked by any of its sessions, all sessions have full privilege to invoke any operation and update any global attributes. Sessions are not required to have locks to invoke operations or update global attributes. However, if some other session has already locked the resource, attempts to update global attributes or execute certain operations will fail.

Locking Types and Access Privileges

VISA defines two different types of locks: *exclusive locks* and *shared locks*.

- If a session has an *exclusive lock* to a resource, other sessions cannot modify global attributes or invoke operations, but can still get attributes. Locking a resource restricts access from other sessions and prevents other sessions from acquiring an exclusive lock. In the case where an exclusive lock is acquired, locking a resource guarantees that operations do not fail because other sessions have acquired a lock on that resource.
- *Shared locks* are similar to exclusive locks in terms of access privileges, but can still be shared between multiple sessions. If a session has a shared lock to a resource, it can perform any operation and update any global attribute in that resource, unless some other session has an exclusive lock. Other sessions with shared locks can also modify global attributes and invoke operations. A session that does not have a shared lock will lack this capability.

The VI_ATTR_RSRC_LOCK_STATE attribute specifies the current locking state of a resource on a given session.

In TekVISA, only INSTR resource operations are restricted by the locking scheme. Also, not all operations are restricted by locking. Some operations may be permitted even when there is an exclusive lock on a resource. Likewise, some global attributes may not be read when there is any kind of lock on the resource. These exceptions, when applicable, are mentioned in the descriptions of individual operations and attributes in the Reference part of this manual.

EXLOCKEXAM.CPP Example

The following C++ example, **EXLOCKEXAM.CPP**, demonstrates exclusive locking of a resource. In this example, if a -l is typed on the command line when the executable is invoked, the lockflag is set to TRUE. The program then opens the Default Resource Manager and opens a session to the GPIB device with primary address 1 on board 8. Next the program opens a FOR loop that will iterate 100 times.

Each time through the loop, if lockflag is TRUE, the program uses the **vilock()** operation toset an exclusive lock on the device for an infinite period of time. The program then uses a series of **viWrite()** and **viRead()** operations to send and receive Tektronix TDS scope commands and responses as follows:

1. The `:ch1:scale?` command queries the oscilloscope for the vertical scale of channel 1. Sending this command is equivalent to selecting Vertical Setup from the Vertical menu and then viewing the Scale. The program reads the response from the scope and then prints it, along with the number of times the program has been through the FOR loop.

2. The **`:ch1:position?`** command queries the oscilloscope for the vertical position setting for channel 1. This command is equivalent to selecting Position from the Vertical menu.vertical Position/Scale of channel 1. The program reads the response from the scope and then prints it, along with the number of times the program has been through the FOR loop.

Each time through the loop, the program unlocks the device using the **viUnlock()** operation. Once the program exits the FOR loop, it closes the session to the oscilloscope, and closes the session to the Default Resource Manager.

```
#include <stdio.h>
#include <stdlib.h>
#include ”visa.h”

int main(int argc, char* argv[])
{
        ViSession       rm = VI_NULL, vi = VI_NULL;
        ViStatus status;
        char            string[256];
        ViUInt32        retCnt;
        int             i = 0;
        bool            lockflag = false;
        bool            bLockState = false;

        if (argc == 2 && argv[1][0] == ’-’ && argv[1][1] == ’l’) {
                lockflag = true;
        }

        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        status = viOpen(rm, ”GPIB8::1::INSTR”, NULL, NULL, &vi);
        if (status < VI_SUCCESS) goto error;

        for (i = 1; i < 100; i++) {
                if (lockflag) {
                        viLock(vi, VI_EXCLUSIVE_LOCK, VI_TMO_INFINITE,
                                NULL, NULL);
                        bLockState = true;
                }
                status = viWrite(vi, (ViBuf) ”ch1:scale?”, 10, &retCnt);
                if (status < VI_SUCCESS) goto error;
                status = viRead(vi, (ViBuf) string, 256, &retCnt);
                if (status < VI_SUCCESS) goto error;
                printf(”%d: scale %s”, i, string);

                status = viWrite(vi, (ViBuf) ”ch1:position?”, 13, &retCnt);
                if (status < VI_SUCCESS) goto error;
                status = viRead(vi, (ViBuf) string, 256, &retCnt);
```

```
                if (status < VI_SUCCESS) goto error;
                printf("%d: position %s", i, string);

                if (lockflag) {
                        viUnlock(vi);
                        bLockState = false;
                }
        }

        viClose(vi);
        viClose(rm);
        return 0;

error:
        viStatusDesc(rm, status, string);
        fprintf(stderr, "Error: %s\n", (ViBuf) string);
        if (bLockState && vi != VI_NULL)
                viUnlock(vi);
        if (vi != VI_NULL)
                viClose(vi);
        if (rm != VI_NULL)
                viClose(rm);
        return 0;
```

Figure 5-12: EXLOCKEXAM.CPP Example

Testing Exclusive Locking

You can see for yourself how exclusive locking works by running two instances of the program as follows:

1. Bring up an MS-DOS Prompt window, change to the directory where the EXLOCKEXAM.EXE file is located, and type:

   EXLOCKEXAM -l

***NOTE**. Be sure to type l for locked, not the number 1.*

2. Before you press **Enter**, bring up another MS-DOS Prompt window, change to the same directory, and type

   EXLOCKEXAM

3. Now press **Enter** in each window in quick succession.

   The locked instance runs and prints correctly, while the unlocked instance exits with an error.

4. Try running the programs again with both instances having the -l lock switch, or try running them with neither having the -l lock switch, to see the possibilities.

If you run two instances with the -l option, both will run correctly. If you run two instances at once without the -l option, they will not work correctly (and will terminate with an error).

Lock Sharing

Because the VISA locking mechanism is session-based, multiple threads sharing a session that has locked a resource have the same access privileges to that resource. Some applications, however, with separate sessions to a resource might want all those sessions to have the same privilege as the session that locked the resource. In other cases, there might be a need to share locks among sessions in different applications. Essentially, sessions that acquire a lock to a resource may share the lock with other sessions they select, and exclude access from other sessions.

VISA defines a *shared lock* type that gives exclusive access privileges to a session, along with the discretionary capability to share these exclusive privileges. A session can acquire a shared lock on a resource to get exclusive access privileges to it. When sharing the resource using a shared lock, the **viLock**() operation returns an *accessKey* that can be used to share the lock. The session can then share this lock with any other session by passing around the *accessKey*.

Before other sessions can access the locked resource, they need to acquire the lock by passing the *accesskey* in the *requestedKey* parameter of the **viLock**() operation. Invoking **viLock**() with the same key will register the new session to have the same access privilege as the original session. The session that acquired the access privileges through the sharing mechanism can also pass the access key to other sessions for resource sharing. All the sessions sharing a resource using the shared lock should synchronize their accesses to maintain a consistent state of the resource.

VISA provides the flexibility for applications to specify a key to use as the *accessKey*, instead of VISA generating the *accessKey*. Applications can suggest a key value to use through the *requestedKey* parameter of the **viLock**() operation. If the resource was not locked, the resource will use this *requestedKey* as the *accessKey*. If the resource was locked using a shared lock and the *requestedKey* matches the key with which the resource was locked, the resource will grant shared access to the session. If an application attempts to lock a resource using a shared lock and passes VI_NULL as the *requestedKey* parameter, VISA will generate an *accessKey* for the session.

A session seeking to share an exclusive lock with other sessions needs to acquire a shared lock for this purpose. If it requests an exclusive lock, no valid access key will be returned. Consequently, the session will not be able to share it with any other sessions. This precaution minimizes the possibility of inadvertent or malicious access to the resource.

Acquiring an Exclusive Lock While Owning a Shared Lock

When multiple sessions have acquired a shared lock, VISA allows one of the sessions to acquire an exclusive lock along with the shared lock it is holding. That is, a session holding a shared lock could also acquire an exclusive lock using the **viLock**() operation. The session holding both the exclusive and shared lock will have the same access privileges that it had when it was holding the shared lock only. However, this would prevent other sessions holding the shared lock from accessing the locked resource. When the session holding the exclusive lock releases the resource using the **viUnlock**() operation, all the sessions (including the one that had acquired the exclusive lock) will again have all the access privileges associated with the shared lock. This is useful when multiple sessions holding a shared lock must synchronize. This can also be used when one of the sessions must execute in a critical section.

In the reverse case in which a session is holding an exclusive lock only (no shared locks), VISA does not allow it to change to a shared lock.

Nested Locks

VISA supports *nested locking*. That is, a session can lock the same VISA resource multiple times for the same lock type. Unlocking the resource requires an equal number of invocations of the **viUnlock**() operation. A resource can be actually unlocked only when the lock count is 0.

Each session maintains a separate lock count for each type of lock. Repeated invocations of the **viLock**() operation for the same session will increase the appropriate lock count, depending on the type of lock requested. In the case of a shared lock, nesting **viLock**() calls will return with the same *accessKey* every time. In case of an exclusive lock, **viLock**() will not return any *accessKey*, regardless of whether it is nested or not.

A session does not need to pass in the access key obtained from the previous invocation of **viLock**() to gain a nested shared lock on the resource. However, if an application does pass in an access key when nesting on shared locks, it must be the correct one for that session.

SHAREDLOCK.CPP Example

The following C++ example, **SHAREDLOCK.CPP**, demonstrates acquiring an exclusive lock while holding a shared lock, and also illustrates nested locking. In this example, the program opens the Default Resource Manager and opens a session to the GPIB device with primary address 1 on board 8. The program then uses the **vilock**() operation to establish a shared lock on the device for an infinite period of time, with “mykey” defined as the key to the lock. A shared lock allows other applications that use the same key to have access to the specified resource. Next the program opens a FOR loop that will iterate 100 times.

Each time through the loop, the program uses the **vilock**() operation toset an exclusive lock on the device for an infinite period of time. This lock is nested inside the shared lock on the resource. The program then uses a series of

viWrite() and **viRead**() operations to send and receive Tektronix TDS scope commands and responses as follows:

1. The **`:ch1:scale?`** command queries the oscilloscope for the vertical scale of channel 1. Sending this command is equivalent to selecting Vertical Setup from the Vertical menu and then viewing the Scale. The program reads the response from the scope and then prints it, along with the number of times the program has been through the FOR loop.

2. The **`:ch1:position?`** command queries the oscilloscope for the vetical position setting for channel 1. This command is equivalent to selecting Position from the Vertical menu.vertical Position/Scale of channel 1. The program reads the response from the scope and then prints it, along with the number of times the program has been through the FOR loop.

Each time through the loop, the program unlocks the exclusive lock on the device using the **viUnlock**() operation, and sleeps long enough for a cooperating program that shares the lock to execute. Once the program exits the FOR loop, it unlocks the outer shared lock on the device using the **viUnlock**() operation, closes the session to the oscilloscope, and closes the session to the Default Resource Manager.

```
#include <stdio.h>
#include <stdlib.h>
#include ”visa.h”
#include <windows.h>
#include <signal.h>

ViSession          rm = VI_NULL, vi = VI_NULL;

int main(int argc, char* argv[])
{
        ViStatus status;
        char               string[256];
        ViUInt32           retCnt;
        int                i = 0;

        status = viOpenDefaultRM(&rm);
        if (status < VI_SUCCESS) goto error;

        status = viOpen(rm, ”GPIB8::1::INSTR”, VI_NULL, VI_NULL, &vi);
        if (status < VI_SUCCESS) goto error;

        // A shared lock only allows other applications that use the same
        // key to have access to the specified resource.
        viLock(vi, VI_SHARED_LOCK, VI_TMO_INFINITE, ”mykey”, VI_NULL);

        for (i = 1; i < 100; i++) {
                viLock(vi, VI_EXCLUSIVE_LOCK, VI_TMO_INFINITE,
                        VI_NULL, VI_NULL);
```

```
                status = viWrite(vi, (ViBuf) "ch1:scale?", 10, &retCnt);
                if (status < VI_SUCCESS) goto error;
                status = viRead(vi, (ViBuf) string, 256, &retCnt);
                if (status < VI_SUCCESS) goto error;
                printf("%d: scale %s", i, string);

                status = viWrite(vi, (ViBuf) "ch1:position?", 13, &retCnt);
                if (status < VI_SUCCESS) goto error;
                status = viRead(vi, (ViBuf) string, 256, &retCnt);
                if (status < VI_SUCCESS) goto error;
                printf("%d: position %s", i, string);
                viUnlock(vi);
                ::Sleep(1000);
        }

        // Clean up and exit
        viUnlock(vi);
        viClose(vi);
        viClose(rm);
        return 0;
error:
        // Print error info
        viStatusDesc(rm, status, string);
        fprintf(stderr, "Error: %s\n", (ViBuf) string);

        // Clean up
        if (vi != VI_NULL) {
                // clear all remaining locks
                while (viUnlock(vi) >= VI_SUCCESS)
                        ;
                viClose(vi);
        }
        if (rm != VI_NULL)
                viClose(rm);
```

Figure 5- 13: SHAREDLOCK.CPP Example

Testing Shared Locking

You can see for yourself how shared locking works by running two instances of the program as follows:

1. Bring up an MS-DOS Prompt window, change to the directory where the SHAREDLOCK.EXE file is located, and type:

   SHAREDLOCK

2. Before you press **Enter**, bring up another MS-DOS Prompt window, change to the same directory, and type

   SHAREDLOCK

3. Now press **Enter** in each window in quick succession.

The two instances with the shared lock cooperate and work together, taking turns sequentially while the other one sleeps.

4. Now try running the EXLOCKEXAM exclusive locking example with the -l switch, while one or more instances of the SHAREDLOCK program are running.

   The EXLOCKEXAM program will wait until all instances of the SHAREDLOCK program have completed before it can access the resource.

Building a Graphical User Interface

The VISAAPIDemo example incorporates a number of TekVISA operations and illlustrates their use in a C++ program with a graphical user interface.

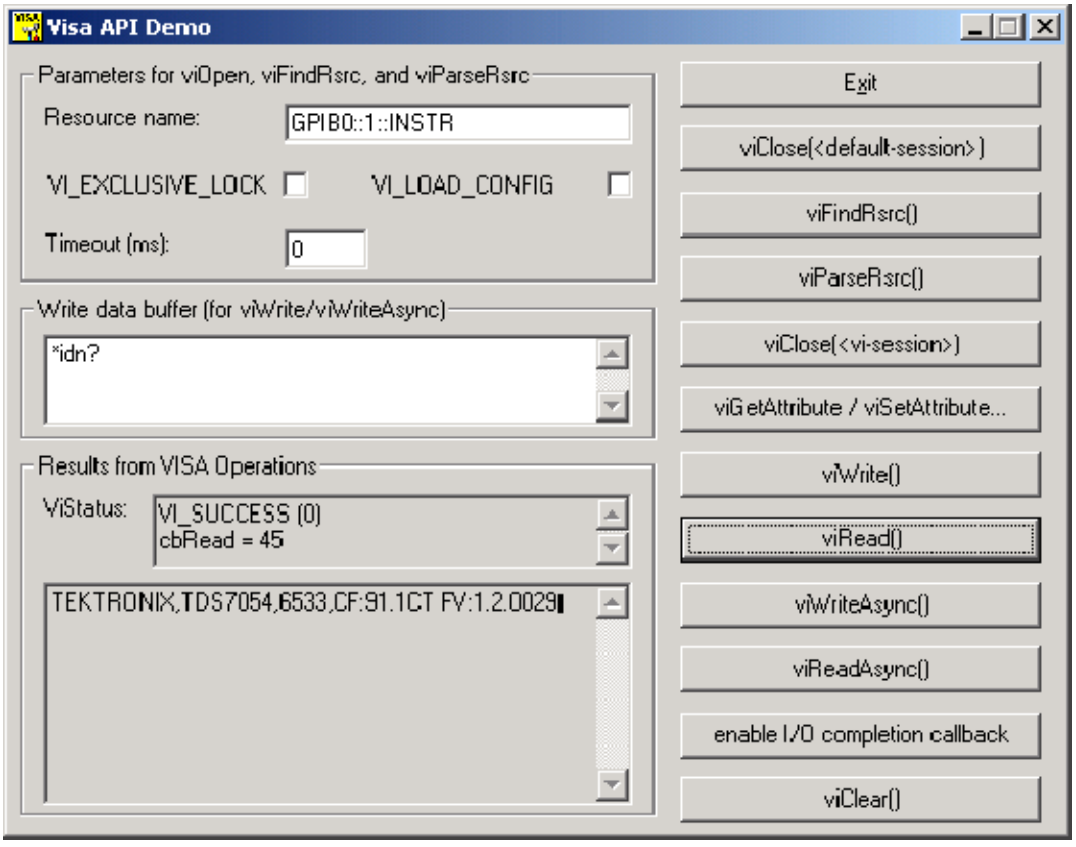
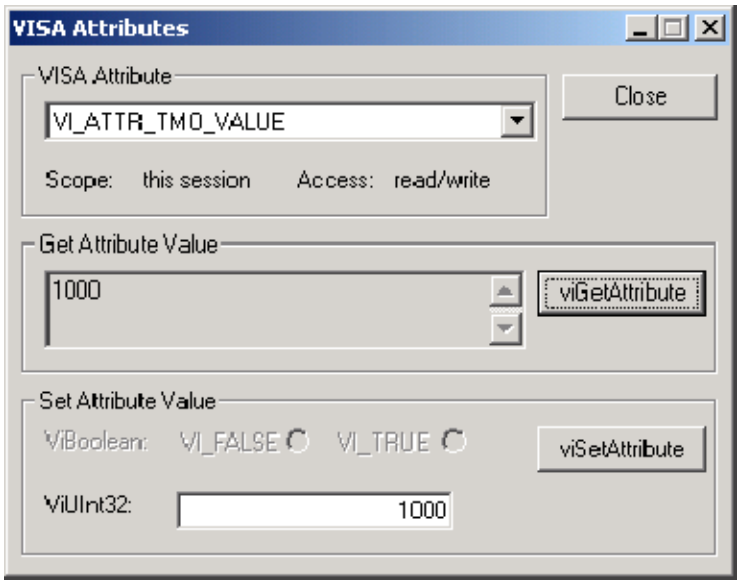
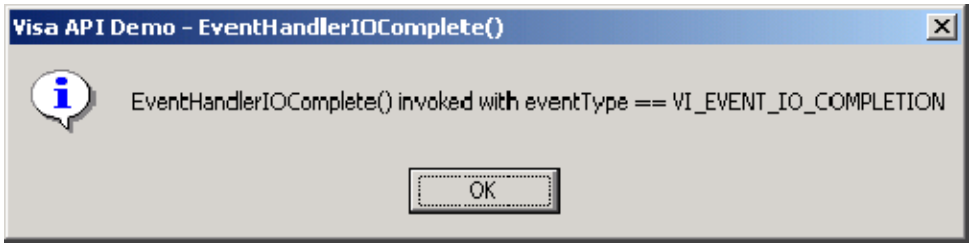


Figure 5-14: VISAAPIDemo Graphical User Interface

When the viGetAttribute/viSetAttribute... button is pressed, the following dialog box appears:



When the enable I/O completion button is pressed, the following confirmation box appears:



The source code for this example can be found on your CD. The following figure illlustrates the control toolbar and various windows used in building this example in Visual C++.

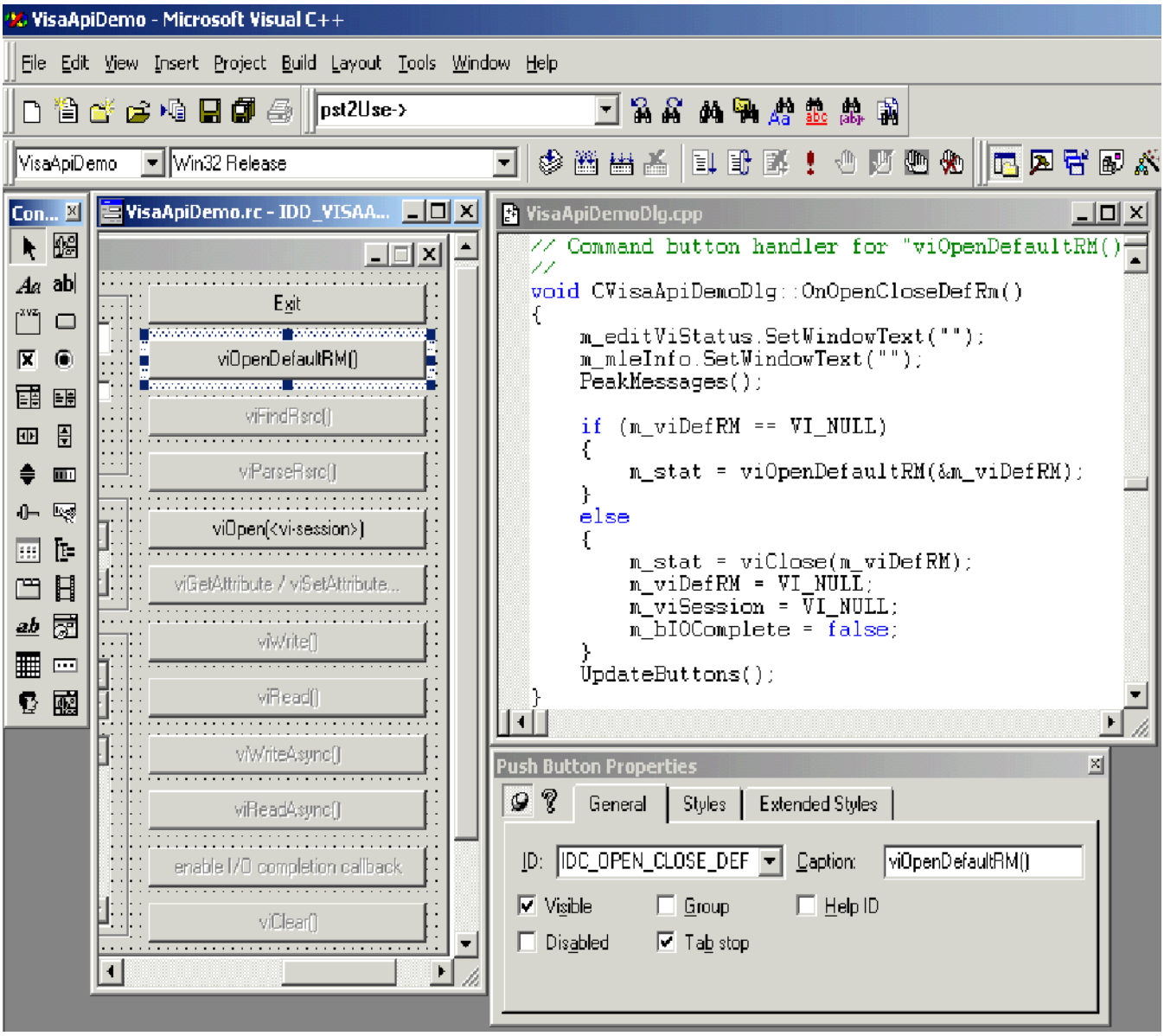


Figure 5-15: C++ Controls Toolbar and Form, Code, and Properties Windows

Appendices

Appendix A: VISA Data Type Assignments

Tables A–1 and A–2 give the type assignments for ANSI C and Visual Basic for each generic VISA data type. Although ANSI C types can be defined in a header file, Visual Basic types cannot.

Table A–1 lists those types that are both used and exported by direct users of VISA (such as instrument drivers). Table A–2 lists types that may be used but not exported by such users. For example, end–users would see the types specified in A–1 exported by a VXI Plug&Play instrument driver; however, end users would not see the types specified in Table A–2.

Thus, if you are writing a program using the VISA API, you will see the data types in both tables. However, if you are writing a program using a VXI Plug&Play instrument driver API, you will only see the data types in Table A–1.

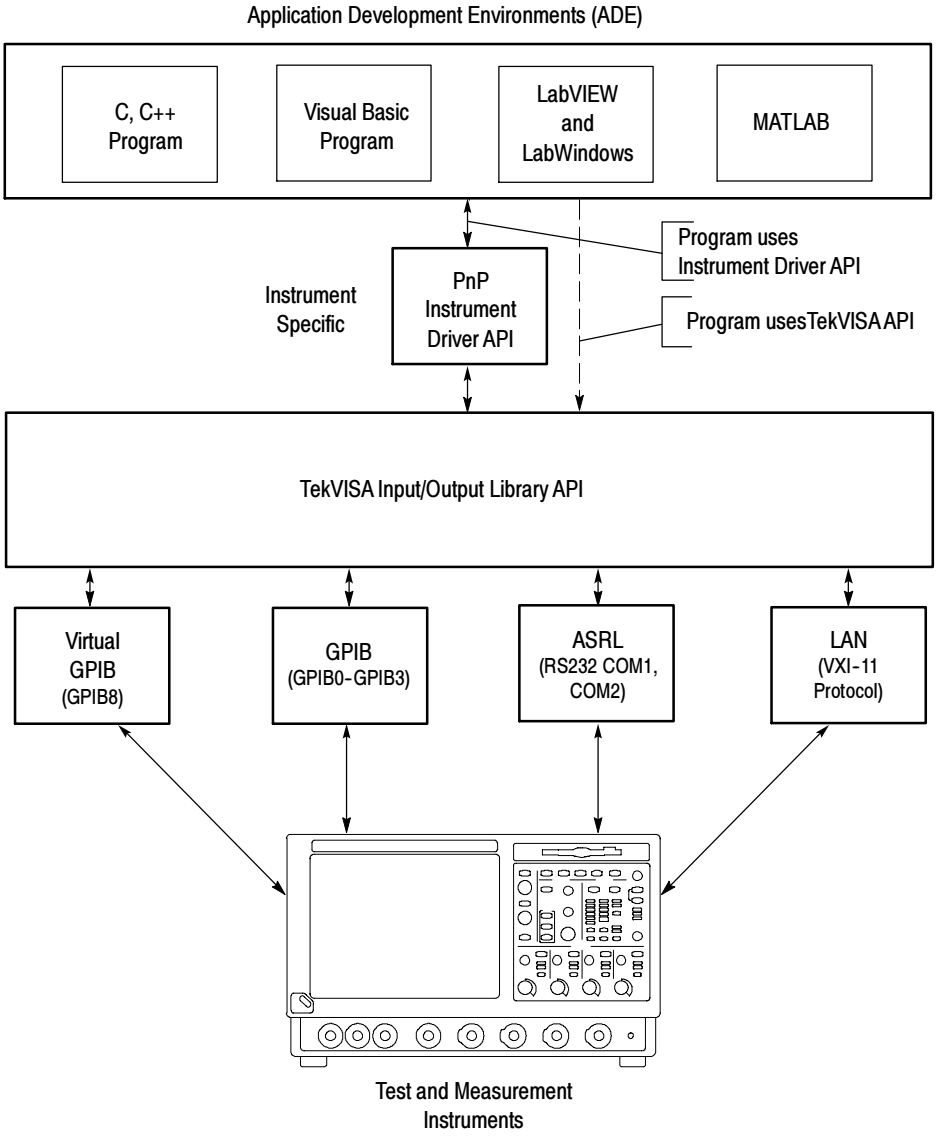


Figure A-1: Your Program Can Use the Instrument Driver API or VISA API

Table A-1: Type Assignments for VISA and Instrument Driver APIs

VISA Data Type	C / Visual Basic Bindings	Description
ViUInt32	unsigned long Long	A 32-bit unsigned integer.
ViPUInt32	ViUInt32 * N/A	The location of a 32-bit unsigned integer.
ViAUInt32	ViUInt32[] N/A	An array of 32-bit unsigned integers.

Table A-1: Type Assignments for VISA and Instrument Driver APIs (Cont.)

VISA Data Type	C / Visual Basic Bindings	Description
ViInt32	signed long Long	A 32-bit signed integer.
ViPInt32	ViInt32 * N/A	The location of a 32-bit signed integer.
ViAInt32	ViInt32[] N/A	An array of 32-bit signed integers.
ViUInt16	unsigned short Integer	A 16-bit unsigned integer.
ViPUInt16	ViUInt16 * N/A	The location of a 16-bit unsigned integer.
ViAUInt16	ViUInt16[] N/A	An array of 16-bit unsigned integers.
ViInt16	signed short Integer	A 16-bit signed integer.
ViPInt16	ViInt16 * N/A	The location of a 16-bit signed integer.
ViAInt16	ViInt16[] N/A	An array of 16-bit signed integers.
ViUInt8	unsigned char Integer/Byte	An 8-bit unsigned integer.
ViPUInt8	ViUInt8 * N/A	The location of an 8-bit unsigned integer.
ViAUInt8	ViUInt8[] N/A	An array of 8-bit unsigned integers.
ViInt8	signed char Integer/Byte	An 8-bit signed integer.
ViPInt8	ViInt8 * N/A	The location of an 8-bit signed integer.
ViAInt8	ViInt8[] N/A	An array of 8-bit signed integers.
ViAddr	void * Long	A type that references another data type, in cases where the other data type may vary depending on a particular context.
ViPAddr	ViAddr * N/A	The location of a ViAddr.
ViAAddr	ViAddr[] N/A	An array of type ViAddr.
ViChar	char Integer/Byte	An 8-bit integer representing an ASCII character.

Table A-1: Type Assignments for VISA and Instrument Driver APIs (Cont.)

VISA Data Type	C / Visual Basic Bindings	Description
ViPChar	ViChar * N/A	The location of a ViChar.
ViAChar	ViChar[] N/A	An array of type ViChar.
ViByte	unsigned char Integer/Byte	An 8-bit unsigned integer representing an extended ASCII character.
ViPByte	ViByte * N/A	The location of a ViByte.
ViAByte	ViByte[] N/A	An array of type ViByte.
ViBoolean	ViUInt16 Integer	A type for which there are two complementaryvalues: VI_TRUE and VI_FALSE.
ViPBoolean	ViBoolean * N/A	The location of a ViBoolean.
ViABoolean	ViBoolean[] N/A	An array of type ViBoolean.
ViReal32	float Single	A 32-bit single-precision value.
ViPReal32	ViReal32 * N/A	The location of a 32-bit single-precision value.
ViAReal32	ViReal32[] N/A	An array of 32-bit single-precision values.
ViReal64	double Double	A 64-bit double-precision value.
ViPReal64	ViReal64 * N/A	The location of a 64-bit double-precision value.
ViAReal64	ViReal64[] N/A	An array of 64-bit double-precision values.
ViBuf	ViPByte String	The location of a block of data.
ViPBuf	ViPByte String	The location to store a block of data.
ViABuf	ViBuf[] N/A	An array of type ViBuf.
ViString	ViPChar String	The location of a NULL-terminated ASCII string.
ViPString	ViPChar String	The location to store a NULL-terminated ASCII string.

Table A-1: Type Assignments for VISA and Instrument Driver APIs (Cont.)

VISA Data Type	C / Visual Basic Bindings	Description
ViAString	ViString[] N/A	An array of type ViString.
ViRsrc	ViString String	A ViString type that is further restricted to adhere to the addressing grammar for resources as described in Table 2-63.
ViPRsrc	ViString String	The location to store a ViRsrc.
ViARsrc	ViRsrc[] N/A	An array of type ViRsrc.
ViStatus	ViInt32 Long	A defined type that contains values corresponding to VISA-defined Completion and Error termination codes.
ViPStatus	ViStatus * N/A	The location of a ViStatus.
ViAStatus	ViStatus[] N/A	An array of type ViStatus.
ViVersion	ViUInt32 Long	A defined type that contains a reference to all information necessary for the architect to represent the current version of a resource.
ViPVersion	ViVersion * N/A	The location of a ViVersion.
ViAVersion	ViVersion[] N/A	An array of type ViVersion.
ViObject	ViUInt32 Long	The most fundamental VISA data type. It contains attributes and can be closed when no longer needed.
ViPObject	ViObject * N/A	The location of a ViObject.
ViAObject	ViObject[] N/A	An array of type ViObject.

Table A-1: Type Assignments for VISA and Instrument Driver APIs (Cont.)

VISA Data Type	C / Visual Basic Bindings	Description
ViSession	ViObject Long	A defined type that contains a reference to all information necessary for the architect to manage a communication channel with a resource.
ViPSession	ViSession * N/A	The location of a ViSession.
ViASession	ViSession[] N/A	An array of type ViSession.
ViAttr	ViUInt32 Long	A type that uniquely identifies an attribute.
ViConstString	const ViChar * String	A ViString type that is guaranteed to not be modified by any driver.

Table A-2: Type Assignments for VISA APIs Only

VISA Data Type	C / Visual Basic Bindings	Description
ViAccessMode	ViUInt32 Long	A defined type that specifies the different mechanisms that control access to a resource.
ViPAccessMode	ViAccessMode * N/A	The location of a ViAccessMode.
ViBusAddress	ViUInt32 Long	A type that represents the system dependent physical address.
ViPBusAddress	ViBusAddress * N/A	The location of a ViBusAddress.
ViBusSize	ViUInt32 Long	A type that represents the system dependent physical address size.
ViAttrState	ViUInt32 Long	A value unique to the individual type of an attribute.
ViPAttrState	void * Any	The location of a ViAttrState.

Table A-2: Type Assignments for VISA APIs Only (Cont.)

VISA Data Type	C / Visual Basic Bindings	Description
ViVAList	va_list Any	The location of a list of a variable number of parameters of differing types.
ViEventType	ViUInt32 Long	A defined type that uniquely identifies the type of an event.
ViPEventType	ViEventType * N/A	The location of a ViEventType.
ViAEventType	ViEventType * N/A	An array of type ViEventType.
ViPAttr	ViAttr * N/A	The location of a ViAttr.
ViAAttr	ViAttr * N/A	An array of type ViAttr.
ViEventFilter	ViUInt32 Long	A defined type that specifies filtering masks or other information unique to an event.
ViFindList	ViObject Long	A defined type that contains a reference to all resources found during a search operation.
ViPFindList	ViFindList * N/A	The location of a ViFindList.
ViEvent	ViObject Long	A defined type that encapsulates the information necessary to process an event.
ViPEvent	ViEvent * N/A	The location of a ViEvent.
ViKeyId	ViString String	A defined type that contains a reference to all information necessary for the architect to manage the association of a thread or process and session with a lock on a resource.
ViPKeyId	ViPString String	The location of a ViKeyId.
ViJobId	ViUInt32 Long	A defined type that contains a reference to all information necessary for the architect to encapsulate the information necessary for a posted operation request.

Table A-2: Type Assignments for VISA APIs Only (Cont.)

VISA Data Type	C / Visual Basic Bindings	Description
ViPJobId	ViJobId * N/A	The location of a ViJobId.
ViHndlr	ViStatus (*) (ViSession, ViEventType, ViEvent, ViAddr) N/A	A value representing an entry point to an operation for use as a callback.

Appendix B: Completion and Error Codes

The following Tektronix VISA completion and error codes are presented in alphabetical order within category.

Table B-1: Completion Codes

Code	Description
VI_SUCCESS_DEV_NPRESENT	The session opened successfully, but the device at the specified address is not responding.
VI_SUCCESS_EVENT_EN	The specified event is already enabled for at least one of the specified mechanisms.
VI_SUCCESS_EVENT_DIS	The specified event is already disabled for at least one of the specified mechanisms.
VI_SUCCESS_MAX_CNT	The number of bytes read is equal to count.
VI_SUCCESS_NCHAIN	Event handled successfully. Do not invoke any other handlers on this session for this event.
VI_SUCCESS_NESTED_EXCLUSIVE	The specified access mode is successfully acquired, and this session has nested exclusive locks.
VI_SUCCESS_NESTED_SHARED	The specified access mode is successfully acquired, and this session has nested shared locks.
VI_SUCCESS_QUEUE_EMPTY	The operation completed successfully, but queue was empty.
VI_SUCCESS_QUEUE_NEMPTY	Wait terminated successfully on receipt of an event notification. There is still at least one more event occurrence of the type specified by inEventType available for this session.
VI_SUCCESS_SYNC	Read or write operation performed synchronously.
VI_SUCCESS_TERM_CHAR	The specified termination character was read.
VI_WARN_CONFIG_NLOADED	The specified configuration either does not exist or could not be loaded; using VISA-specified defaults instead.
VI_WARN_NSUP_ATTR_STATE	Although the specified attribute state is valid, it is not supported by this implementation.
VI_WARN_NSUP_BUF	The specified buffer is not supported.
VI_WARN_NULL_OBJECT	The specified object reference is uninitialized. This message is returned if the value VI_NULL is passed to it.
VI_WARN_UNKNOWN_STATUS	The status code passed to the operation could not be interpreted.

Table B-2: Error Codes

Code	Description
VI_ERROR_ALLOC	The system could not allocate a formatted I/O buffer because of insufficient system resources.
VI_ERROR_ASRL_FRAMING	A framing error occurred during transfer.
VI_ERROR_ASRL_OVER-RUN	An overrun error occurred during transfer. A character was not read from the hardware before the next character arrived.
VI_ERROR_ASRL_PARITY	A parity error occurred during transfer.
VI_ERROR_ATTR_READON-LY	The specified attribute is read-only.
VI_ERROR_BERR	Bus error occurred during transfer.
VI_ERROR_CLOS-ING_FAILED	Unable to deallocate the previously allocated data structures corresponding to this session or object reference.
VI_ERROR_HNDLR_ NINSTALLED	If no handler is installed for the specified event type, the request to enable the callback mechanism for the event type returns this error code. The session cannot be enabled for the VI_HNDLR mode of the callback mechanism.
VI_ERROR_INP_PROT_VIOL	Device reported an input protocol error during transfer.
VI_ERROR_INV_ACCESS_ KEY	The requestedKey value passed in is not a valid access key to the specified resource.
VI_ERROR_INV_ACC_ MODE	Invalid access mode.
VI_ERROR_INV_CONTEXT	Specified event context is invalid.
VI_ERROR_INV_DEGREE	Specified degree is invalid.
VI_ERROR_INV_EVENT	Specified event type is not supported by the resource.
VI_ERROR_INV_EXPR	Invalid expression specified for search.
VI_ERROR_INV_FMT	A format specifier in the writeFmt string is invalid.
VI_ERROR_INV_HNDLR_ REF	Either the specified handler reference or the user context value (or both) does not match any installed handler.
VI_ERROR_INV_JOB_ID	Specified job identifier is invalid. This message is returned If the operation associated with the specified jobId has already completed.
VI_ERROR_INV_LOCK_ TYPE	The specified type of lock is not supported by this resource.
VI_ERROR_INV_MASK	The system cannot set the buffer for the given mask.
VI_ERROR_INV_MECH	Invalid mechanism specified.
VI_ERROR_INV_OBJECT VI_ERROR_INV_SESSION	The given session or object reference is invalid (both are the same value).
VI_ERROR_INV_PROT	The protocol specified is invalid.

Table B-2: Error Codes (Cont.)

Code	Description
VI_ERROR_INV_RSRC_NAME	Invalid resource reference specified. Parsing error.
VI_ERROR_INV_SETUP	Some implementation-specific configuration file is corrupt or does not exist.
VI_ERROR_IO	An unknown I/O error occurred during transfer.
VI_ERROR_LIBRARY_NFOUND	A code library required by VISA could not be located or loaded.
VI_ERROR_LINE_IN_USE	The specified trigger line is currently in use.
VI_ERROR_NCIC	The interface associated with the given vi is not currently the controller in charge.
VI_ERROR_NENABLED	The session must be enabled for events of the specified type in order to receive them.
VI_ERROR_NLISTENERS	No Listeners condition is detected (both NRFD and NDAC are deasserted).
VI_ERROR_NSUP_ATTR	The specified attribute is not defined by the referenced session, event, or find list.
VI_ERROR_NSUP_ATTR_STATE	The specified state of the attribute is not valid, or is not supported as defined by the session, event, or find list.
VI_ERROR_NSUP_FMT	A format specifier in the writeFmt string is not supported.
VI_ERROR_NSUP_OPER	The given vi does not support this operation.
VI_ERROR_OUTP_PROT_VIOL	Device reported an output protocol error during transfer.
VI_ERROR_RAW_WR_PROT_VIOL	Violation of raw write protocol occurred during transfer.
VI_ERROR_RAW_RD_PROT_VIOL	Violation of raw read protocol occurred during transfer.
VI_ERROR_RSRC_BUSY	The resource is valid, but VISA cannot currently access it.
VI_ERROR_RSRC_LOCKED	Specified type of lock cannot be obtained because the resource is already locked with a lock type incompatible with the lock requested
VI_ERROR_RSRC_NFOUND	There are no more matches.
VI_ERROR_SESN_NLOCKED	The current session did not have any lock on the resource.
VI_ERROR_SRQ_NOCCURRED	Service request has not been received for the session.
VI_ERROR_SYSTEM_ERROR	The VISA system failed to initialize.
VI_ERROR_TMO	Timeout expired before write operation completed.

Glossary

The following are some specialized terms used within this document.

Address
A string (or other language construct) that uniquely locates and identifies a resource. VISA defines an ASCII-based grammar that associates strings with particular physical devices or interfaces and VISA resources.

ADE
Application Development Environment

API
Application Programmers Interface. The direct interface that an end user sees when creating an application. The VISA API consists of the sum of all of the operations, attributes, and events of each of the VISA Resource Classes.

Attribute
A value within a resource that reflects a characteristic of the operational state of a resource.

Bus Error
An error that signals failed access to an address. Bus errors occur with low-level accesses to memory and usually involve hardware with bus mapping capabilities. For example, non-existent memory, a non-existent register, or an incorrect device access can cause a bus error.

Communication Channel
The same as *Session*. A communication path between a software element and a resource. Every communication channel in VISA is unique.

Controller
A device that can control another device(s) or is in the process of performing an operation on another device.

Device
An entity that receives commands from a controller. A device can be an instrument, a computer (acting in a non-controller role), or a peripheral (such as a plotter or printer). In VISA, the concept of a device is generally the logical association of several VISA resources.

GPIB (General Purpose Interface Bus)
An interconnection bus and protocol that allows you to connect multiple instruments in a network under the control of a controller. Also known as IEEE 488 bus. It transfers data with eight parallel data lines, five control lines, and three handshake lines.

Instrument
A device that accepts some form of stimulus to perform a designated task, test, or measurement function. Two common forms of stimuli are message passing and register reads and writes. Other forms include triggering or varying forms of asynchronous control.

Interface
A generic term that applies to the connection between devices and controllers. It includes the communication media and the device/controller hardware necessary for cross-communication.

Instrument Driver
Library of functions for controlling a specific instrument

LabVIEW
Graphical programming ADE for Windows, Windows NT, and Sun operating systems

LabWindows/CVI
C-based ADE for the Windows and Sun operating systems

LLB
LabVIEW VI library

NI-488
National Instruments GPIB interface software

NI-VXI
National Instruments VXIbus interface software

Operation
An action defined by a resource that can be performed on a resource.

Oscilloscope
An instrument for making a graph of two factors. These are typically voltage versus time.

Process
An operating system component that shares a system's resources. A multi-process system is a computer system that allows multiple programs to execute simultaneously, each in a separate process environment. A single-process system is a computer system that allows only a single program to execute at a given point in time.

Register
An address location that either contains a value that is a function of the state of hardware or can be written into to cause hardware to perform a particular action or to enter a particular state. In other words, an address location that controls and/or monitors hardware.

Resource Class
The definition for how to create a particular resource. In general, this is synonymous with the connotation of the word class in object-oriented architectures. For VISA Instrument Control Resource Classes, this refers to the definition for how to create a resource that controls a particular capability of a device.

Resource or Resource Instance
In general, this term is synonymous with the connotation of the word object in object-oriented architectures. For VISA, resource more specifically refers to a particular implementation (or instance in object-oriented terms) of a Resource Class. In VISA, every defined software module is a resource.

Session
The same as *Communication Channel*. A communication path between a software element and a resource. Every communication channel in VISA is unique.

SRQ
IEEE 488 Service Request. This is an asynchronous request from a remote GPIB device that requires service. A service request is essentially an interrupt from a remote device. For GPIB, this amounts to asserting the SRQ line on the GPIB.

Status Byte
A byte of information returned from a remote device that shows the current state and status of the device. If the device follows IEEE 488 conventions, bit 6 of the status byte indicates if the device is currently requesting service.

Template Function
Instrument driver subsystem function common to the majority of VXI-plug&play instrument drivers.

Top-level Example
A high-level test-oriented instrument driver function. It is typically developed from the instrument driver subsystem functions.

Virtual Instrument
A name given to the grouping of software modules (in this case, VISA resources with any associated or required hardware) to give the functionality of a traditional stand-alone instrument. Within VISA, a virtual instrument is the logical grouping of any of the VISA resources. The VISA Instrument Control Resources Organizer serves as a means to group any number of any type of VISA Instrument Control Resources within a VISA system.

VI
LabVIEW program or Virtual Instrument

Virtual GPIB

A special type of GPIB resource that creates a software connection between the embedded instrument software and the Windows software on a Tektronix Windows-based oscilloscope, without the need for any GPIB controller hardware or cables.

VISA

Virtual Instrument Software Architecture. The architecture consists of two main VISA components: the VISA Resource Manager and the VISA Instrument Control Resources.

VISA Instrument Control Resources

This is the name given to the part of VISA that defines all of the device-specific resource classes. VISA Instrument Control Resources encompass all defined device and interface capabilities for direct, low-level instrument control.

VISA Resource Manager

This is the name given to the part of VISA that manages resources. This management includes support for opening, closing, and finding resources; setting attributes, retrieving attributes, and generating events on resources; and so on.

VISA Resource Template

This is the name given to the part of VISA that defines the basic constraints and interface definition for the creation and use of a VISA resource. All VISA resources must derive their interface from the definition of the VISA Resource Template.

VTL

VISA Transition Library.

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