Spectrum IVI driver

for M2i, M3i, M4i, M4x, M2p cards, digitizerNETBOX generatorNETBOX

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IVI Driver

The IVI Foundation is an open consortium founded in 1998 to promote standards for programming test instruments. Composed primarily of instrument manufacturers, end-users, software vendors, and system integrators, the Foundation strives to create specifications that govern the development of instrument drivers.

-> http://IVIfoundation.org

About IVI

The IVI standards define an open driver architecture, a set of instrument classes, and shared software components. Together these provide critical elements needed for instrument interchangeability.

Benefits

IVI offers several benefits to measurement system designers:

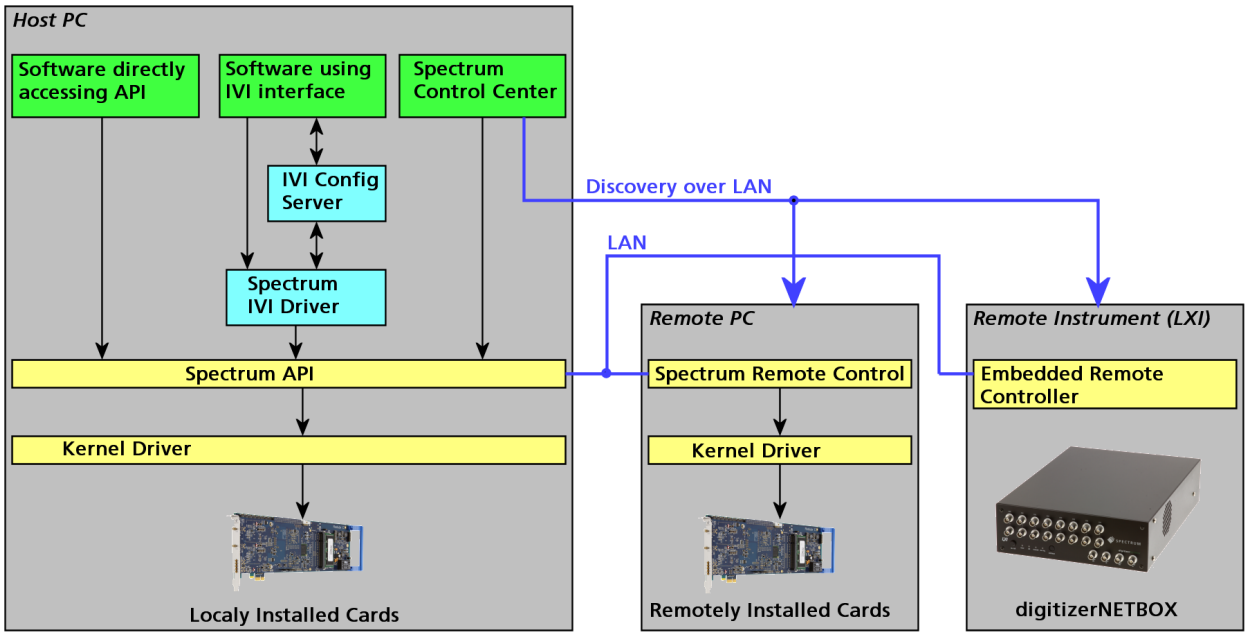
- IVI's defined Application Programming Interfaces (APIs) standardize common measurement functions reducing the time needed to learn a new IVI instrument.
- Instrument simulation allows developers to run code without an instrument. This feature reduces the need for sometimes scarce measurement hardware resources and it can simplify testing of measurement applications.
- IVI drivers feature enhanced ease of use in popular Application Development Environments. IVI's standard APIs, combined with IVI driver wrappers where appropriate, provide fast, intuitive access to driver functions.
- IVI drivers provide for interchangeability. Interchangeability reduces the time and effort needed to integrate measurement devices into new or existing systems

Interchangeability

Systems designed with IVI drivers enjoy the benefits of standardized code that can be interchanged into other systems. This code also supports interchange of measurement devices – helping to prevent hardware obsolescence. Interchangeability is supported on three levels: The IVI architecture specifications allow architectural interchangeability – that is a standard driver architecture that can be reused. The class specifications provide syntactic interchangeability which supports instrument exchange with minimal code changes. The highest level of interchangeability is achieved by using the IVI signal specifications.

General Concept of the Spectrum IVI driver

The Spectrum IVI driver is based on the standard Spectrum API and can be used with any Spectrum products specified below in the supported hardware chapter. The Spectrum products to be accessed with the IVI driver can be locally installed data acquisition cards, remotely installed data acquisition cards or remote LXI instruments like a digitizerNETBOX or generatorNETBOX.



Supported Spectrum Hardware

All Spectrum analog data acquisition hardware based on the SPCM driver structure is supported by the IVI driver. There is only one IVI driver for all hardware.

Supported data acquisition card families:

- M2i.20xx and M2i.20xx-exp family
- M3i.21xx and M3i.21xx-exp family
- M4i.22xx-x8 and M4x.22xx-x4 family
- M2i.30xx and M2i.30xx-exp family
- M2i.31xx and M2i.31xx-exp family
- M3i.32xx and M3i.32xx-exp family
- M2i.40xx and M2i.40xx-exp family
- M3i.41xx and M3i.41xx-exp family
- M4i.44xx-x8 and M4x.44xx-x4 family
- M2i.46xx and M2i.46xx-exp family
- M2i.47xx and M2i.47xx-exp family
- M3i.48xx and M3i.48xx-exp family
- M2i.49xx and M2i.49xx-exp family
- M2p.59xx-x4
- M2i.60xx and M2i.60xx-exp family
- M4i.66xx-x8 and M4x.66xx-x4 family

Supported digitizerNETBOX families

- DN2.20x-xx family
- DN2.22x-xx and DN6.22x-xx family
- DN2.44x-xx and DN6.44x-xx family
- DN2.46x-xx and DN6.46x-xx family
- DN2.49x-xx and DN6.49x-xx family
- DN2.59x-xx and DN6.59x-xx family

Supported generatorNETBOX families

- DN2.60x-xx family
- DN2.66x-xx and DN6.66x family

IVI Compliance

General information on the Spectrum IVI driver:

IVI class specification version	Version 3.3
IVI-C interface	supported
IVI-COM interface	supported
IVI.NET interface	not supported

The following IVI classes are supported by different instrument types:

IVI Class	Supported by Spectrum hardware	IVI specific driver function prefix
IVIScope	Supported by all digitizerNETBOX devices and analog data acquisition cards listed above	SpecScope_
IVIDigitizer	Supported by all digitizerNETBOX devices and analog data acquisition cards listed above	SpecDigitizer_
IVIFgen	Supported by all generatorNETBOX devices and analog data generator cards listed above	SpecFGen_

Supported Operating Systems

32 bit operating systems	64 bit operating systems
Winodws 7	Windows 7
Windows 8	Windows 8
Windows 10	Windows 10

Supported Standard Driver Features

Feature	Supported	Description of the Feature
State caching	yes standard feature of the API which is permanently active	To minimize the number of I/O calls needed to configure an instrument to a new state, IVI specific drivers may implement state caching. IVI specific drivers can choose to implement state caching for all, some, or none of the instrument settings. If the user enables state caching and the IVI specific driver implements caching for hardware configuration attributes, driver functions perform instrument I/O when the current state of the instrument settings is different from what the user requests.
Range checking	yes standard feature of the API which is permanently active	If range checking is enabled, an IVI specific driver checks that input parameters are within the valid range for the instrument.
Instrument Status Checking	yes standard feature of the API which is permanently active	If instrument status checking is enabled, an IVI specific driver automatically checks the status of the instrument after most operations. If the instrument indicates that it has an error, the driver returns a special error code. The user then calls the Error Query function to retrieve the instrument specific error code from the instrument.
Multithread Safety	yes	IVI drivers are multithread safe. Multithread safety means that multiple threads in the same process can use the same IVI driver session and that different sessions of the same IVI driver can run simultaneously on different threads.
Simulation	yes	If simulation is enabled, an IVI specific driver does not perform instrument I/O, and the driver creates simulated data for output parameters. This allows the user to execute instrument driver calls in the application program even though the instrument is not available.

IVIScope Supported Class Capabilities

Feature	Supported	Description of Feature
IVIScopeBase	yes	Base Capabilities of the IVIScope specification. This group includes the capability to acquire waveforms using edge triggering.
IVIScopeInterpolation	no	Extension: IVIScope with the ability to configure the oscilloscope to interpolate missing points in a waveform.
IVIScopeTVTrigger	no	Extension: IVIScope with the ability to trigger on standard television signals.
IVIScopeRuntTrigger	no	Extension: IVIScope with the ability to trigger on runts.
IVIScopeGlitchTrigger	no	Extension: IVIScope with the ability to trigger on glitches.
IVIScopeWidthTrigger	no	Extension: IVIScope with the ability to trigger on a variety of conditions regarding pulse widths.
IVIScopeAcLineTrigger	no	Extension: IVIScope with the ability to trigger on zero crossings of a network supply voltage.
IVIScopeWaveformMeas	no	Extension: IVIScope with the ability to calculate waveform measurements, such as rise time or frequency.
IVIScopeMinMaxWaveform	no	Extension: IVIScope with the ability to acquire a minimum and maximum waveforms that correspond to the same time range.
IVIScopeProbeAutoSense	no	Extension: IVIScope with the ability to automatically sense the probe attenuation of an attached probe.
IVIScopeContinuous Acquisition	no	Extension: IVIScope with the ability to continuously acquire data from the input and display it on the screen.
IVIScopeAverage Acquisition	no	Extension: IVIScope with the ability to create a waveform that is the average of multiple waveform acquisitions.
IVIScopeSampleMode	no	Extension: IVIScope with the ability to return the actual sample mode.
IVIScopeTrigger Modifier	no	Extension: IVIScope with the ability to modify the behavior of the triggering subsystem in the absence of a expected trigger.
IVIScopeAutoSetup	no	Extension: IVIScope with the automatic configuration ability.

IVIDigitizer Supported Class Capabilities

Feature	Supported	Description of Feature
IVIDigitizerBase	yes	Base Capabilities of the IVIDigitizer specification. This group includes the capability to acquire waveforms using edge triggering.
IVIDigitizerMultiRecordAcquisition	yes	Extension: IVIDigitizer with the ability to do multi-record acquisitions.
IVIDigitizerBoardTemperature	no	Extension: IVIDigitizer with the ability to report the temperature of the digitizer.
IVIDigitizerChannelFilter	no	Extension: IVIDigitizer with the ability to control the channel input filter frequency.
IVIDigitizerChannelTemperature	no	Extension: IVIDigitizer with the ability to report the temperature of indIVIdual digitizer channels.
IVIDigitizerTimeInterleavedChannels	no	Extension: IVIDigitizer with the ability to combine two or more input channels to achieve higher acquisitions rates and/or record lengths.
IVIDigitizerDataInterleavedChannels	no	Extension: IVIDigitizer with the ability to interleave the data from two or more input channels, usually to create complex (I/Q) data.
IVIDigitizerReferenceOscillator	no	Extension: IVIDigitizer with the ability to use an external reference oscillator.
IVIDigitizerSampleClock	yes	Extension: IviDigitizer with the ability to use an external sample clock.
IVIDigitizerSampleMode	no	Extension: IVIDigitizer with the ability to control whether the digitizer is using real-time or equivalent-time sampling.
IVIDigitizerSelfCalibration	yes	Extension: IVIDigitizer with the ability to perform self calibration.
IVIDigitizerDownconversion	no	Extension: IVIDigitizer with the ability to do frequency translation or downconversion in hardware.
IVIDigitizerArm	no	Extension: IVIDigitizer with the ability to arm on positive or negative edges.
IVIDigitizerMultiArm	no	Extension: IVIDigitizer with the ability to arm on one or more sources.
IVIDigitizerGlitchArm	no	Extension: IVIDigitizer with the ability to arm on glitches.
IVIDigitizerRuntArm	no	Extension: IVIDigitizer with the ability to arm on runts.
IVIDigitizerSoftwareArm	no	Extension: IVIDigitizer with the ability to arm acquisitions.
IVIDigitizerTVArm	no	Extension: IVIDigitizer with the ability to arm on standard TV signals.
IVIDigitizerWidthArm	no	Extension: IVIDigitizer with the ability to arm on a variety of conditions regarding pulse widths.
IVIDigitizerWindowArm	no	Extension: IVIDigitizer with the ability to arm on signals entering or leaving a defined voltage range.
IVIDigitizerTriggerModifier	no	Extension: IVIDigitizer with the ability to perform an alternative triggering function in the event that the specified trigger event doesn't occur.
IVIDigitizerMultiTrigger	yes	Extension: IVIDigitizer with the ability to trigger on one or more sources.
IVIDigitizerPretriggerSamples	yes	Extension: IVIDigitizer with the ability to specify a number of samples to fill up the data buffer with pre-trigger data.
IVIDigitizerTriggerHoldoff	no	Extension: IVIDigitizer with the ability to specify a length of time after the digitizer detects a trigger during which the digitizer ignores additional triggers.
IVIDigitizerGlitchTrigger	no	Extension: IVIDigitizer with the ability to trigger on glitches.
IVIDigitizerRuntTrigger	no	Extension: IVIDigitizer with the ability to trigger on runts.
IVIDigitizerSoftwareTrigger	no	Extension: IVIDigitizer with the ability to trigger acquisitions.
IVIDigitizerTVTrigger	no	Extension: IVIDigitizer with the ability to trigger on standard television signals.
IVIDigitizerWidthTrigger	no	Extension: IVIDigitizer with the ability to trigger on a variety of conditions regarding pulse widths.
IVIDigitizerWindowTrigger	yes	Extension: IVIDigitizer with the ability to trigger on signals entering or leaving a defined voltage range.

IVIFGen Supported Class Capabilities

Feature	Supported	Description of Feature
IviFgenBase	yes	Base Capabilities.
IviFgenArbFrequency	no	Extension: IVIFgen with the ability to generate arbitrary waveforms with user-defined sample rate.
IviFgenArbWfm	yes	Extension: IVIFgen with the ability to generate user-defined arbitrary waveforms.
IviFgenArbSeq	no	Extension: IVIFgen with the ability to generate of arbitrary sequences
IviFgenBurst	no	Extension: IVIFgen with the ability to generate discrete numbers of waveform cycles.
IviFgenInternalTrigger	no	Extension: IVIFgen with the ability to use internally generated triggers
IviFgenModulateAM	no	Extension: IVIFgen with the ability to apply amplitude modulation to an output signal
IviFgenModulateFM	no	Extension: IVIFgen with the ability to apply frequency modulation to an output signal
IviFgenSoftwareTrigger	no	Extension: IVIFgen with the ability to generate signals based on software triggers
IviFgenStdFunc	yes	Extension: IVIFgen with the ability to generate standard waveforms
IviFgenTrigger	no	Extension: IVIFgen with the ability to use user-definable trigger sources

Find more Information on IVI

The official IVI foundation webpage offers a lot of additional information on setup and programming of the IVI drivers using different environments.

General Information on IVI

->http://ivifoundation.org

The website of the IVI foundation offers several documents and detailed explanations for the useage of IVI drivers and the benefits.

IVI Getting Started Guides and Videos

-> http://ivifoundation.org/resources/default.aspx

In here you find getting started guides and videos for different environments:

- Using IVI with Visual C++
- Using IVI Visual C# and Visual Basic .NET
- Using IVI with LabVIEW
- Using IVI with LabWindows/CVI
- Using IVI with MATLAB
- Using IVI with Measure Foundry
- Using IVI with Visual Basic 6.0
- Using IVI with Keysight VEE Pro

Installation

Installer

The Spectrum IVI Driver Installer is shipped as an executable containing all IVI related software parts. There is only one installer for both 32 bit and 64 bit environments. The insaller automatically detects the components that are necessary to install.

Please be sure to have the latest drivers available. You find the current driver archieves on the Spectrum webpage www.spectrum-instrumentation.com available for download.

Shared Components

To improve users' experience when they combine drivers and other software from various vendors, it is important to have some key software components common to all implementations. In order to accomplish this, the IVI Foundation provides a standard set of shared components that must be used by all compliant drivers and ancillary software. These components provide services to drivers and driver clients that need to be common to all drivers, for instance, the administration of system-wide configuration.

The IVI shared components are available directly at the IVI Foundation homepage www.ivifoundation.org. Please download the lates version of the IVI shared components there.

The IVI Shared Component installer creates a directory structure to house the IVI Shared Components as well as IVI drivers themselves. The root of this directory structure is referred to as the IVI install directory [IVIInstallDir] and is typically located under [program files]\IVI Foundation\IVI.

Installation Procedure

Please stick to this installation order to avoid any problems with the drivers:

Spectrum Card locally installed

- Install card into the system as described in the hardware manual
- Start the system and let Windows install the hardware driver from CD or from your download folder
- Install the Spectrum Control Center
- Install the IVI shared components from www.ivifoundation.org
- Install the IVI driver package

Spectrum Card remotely installed

- Install card into the remote system as described in the hardware manual
- Start the remote system and let Windows install the hardware driver from CD or from your download folder
- Install the Spectrum Remote Package onto the remote PC as described in the manual
- Install the Spectrum Control Center on the host system
- Setup the remote connection inside the Control Center as described in the hardware manual
- Install the IVI shared components from www.ivifoundation.org
- Install the IVI driver package on the host system

Spectrum digitizerNETBOX/generatorNETBOX remotely controlled

- Connect the digitizerNETBOX/generatorNETBOX to your LAN or directly to your host PC
- Install the Spectrum Control Center on the host system
- Setup the remote connection inside the Control Center as described in the hardware manual
- Install the IVI shared components from www.ivifoundation.org
- Install the IVI driver package on the host system

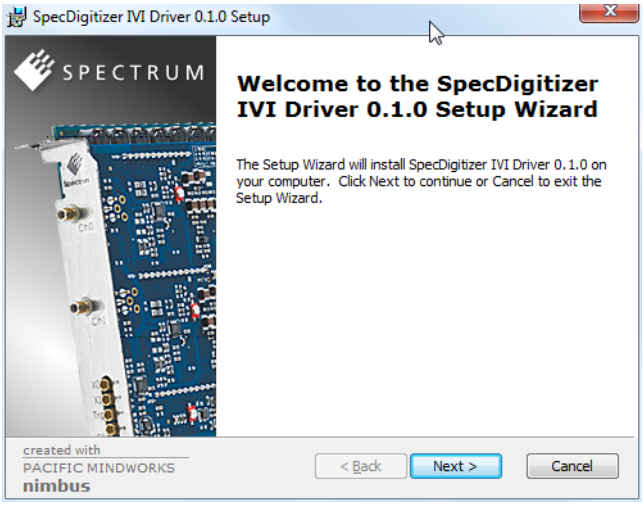
No Spectrum hardware available, only simulated cards

- Install the Spectrum Control Center on the system
- Setup one or more demo cards inside the Spectrum Control Center
- Install the IVI shared components from www.ivifoundation.org
- Install the IVI driver package on the host system

Installation of the IVI driver package

Please start the installation by doubleclicking the install file

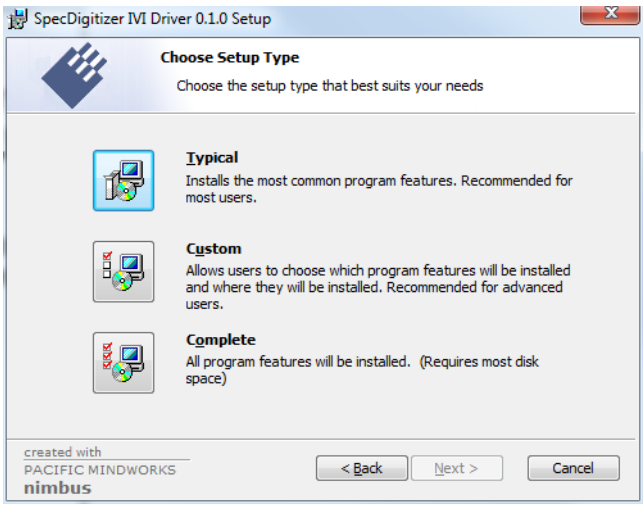
There is one installer for the IVI scope class driver and one installer for the IVI digitizer class driver. You may install one of them or both.



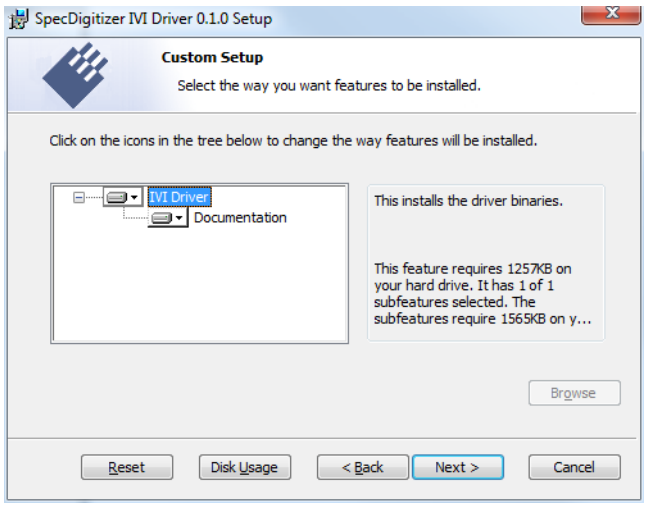
Select the setup type for the installation:

- Typical setup will install the most common program features
- Custom setup allows user to choose which program features will be installed.
- Complete setup will install all prgra, features.

Typical and Complete setup runs without any further user interaction and install the needed components of the driver.



The custom setup allows users to deselect certain parts of the driver package



Configuration Store

General Information

The IVI Configuration Server is the run-time module that is responsible for providing system database services to IVI based measurement system applications. Specifically, it provides system initialization and configuration information. The IVI Configuration Server is used by several of the IVI compliant modules. For instance, the Configuration Server indicates which physical instrument and IVI driver will be used by a particular application to provide a particular measurement capability.

Since a typical system intermixes instruments and drivers from multiple vendors this system configuration service needs to be accessed in a vendor independent fashion. Therefore, the IVI Configuration Server is an IVI shared component (that is, the code is owned by the IVI Foundation). The IVI Configuration Server is provided by the IVI Foundation because the architecture requires a single Configuration Server be installed on any system, therefore having a single shared implementation eliminates potential conflicts from divergent implementations.

The IVI Configuration Server is a single executable and one or more XML configuration stores (databases) made up of the following basic components:

- The physical database (known as the configuration store). A physical configuration store is a single XML file. APIs are available to read and write the data to arbitrary files, thus providing complex applications with the ability to directly manage system configurations.
- The API (and its implementation) used to read information from the configuration store(s). The IVI modules typically use this API when they are instantiated and configured.
- The API (and its implementation) to write information to the configuration store(s). This API is typically used by GUI or other applications that set up the initial configuration.
- The API (and its implementation) used to bind an instance of the Configuration Server code to a particular copy of the configuration information stored on a system. This includes appropriate algorithms for gaining access to the master configuration store.

Repeated Capabilities

In many instruments there are capabilities that are duplicated either identically or very similarly across the instrument. Such capabilities are called repeated capabilities. The IVI class-compliant APIs represent repeated capabilities by a parameter that indicates which instance of the duplicate capability this function is intended to access. The IVI C APIs include this parameter as an additional parameter to function calls.

The IVI Configuration Server provides a way for software modules to publish the functionality that is duplicated and the strings that the software module recognizes to access the repeated capabilities. The IVI Configuration Server also provides a way for the client to supply aliases for the physical identifiers recognized by the drivers.

The Spectrum IVI driver for example uses the channel index as repeated capability allowing to give channel names as an identifier.

IVI-C

Necessary Driver Files

The following driver files are installed with the Spectrum IVI driver installer and can be used to write own programs for the supported IVI classes. The location and installed files depend on the used Windows system

File Name	Path	Description
IviVisaType.h	[Program Files]\IVI\include\	Definition of VISA types
SpecScope.h	[Program Files]\IVI\Include\	Spectrum Header file for IVI Scope class
SpecDigitizer.h	[Program Files]\IVI\Include\	Spectrum Header file for IVI Digitizer class
SpecFgen.h	[Program Files]\IVI\Include\	Spectrum Header file for IVI Function Generator class
SpecScope.lib	[Program Files\IVI\Lib\msc\	Library for Microsoft Visual C++ for Spectrum IVI Scope driver
SpecDigitizer.lib	[Program Files\IVI\Lib\msc\	Library for Microsoft Visual C++ for Spectrum IVI Digitizer driver
SpecFgen.lib	[Program Files\IVI\Lib\msc\	Library for Microsoft Visual C++ for Spectrum IVI FGen driver

Setup Visual Studio

To run the Spectrum IVI-C drivers your Visual Studio project needs the following steps:

- Add the include path [Program Files]\IVI\include to the project includes
- Add the matching library e.g. „SpecScope.lib“ to the project itself

For more information on the setup please see the getting started guide „Using IVI with Visual C++“ at the IVI foundation homepage:
http://ivifoundation.org/resources/default.aspx

Sessions

When using an IVI-C driver, an application program creates and initializes an instrument driver session in a single call to the Initialize function. The application program closes and destroys the instrument driver session by calling the Close function.

IVI-C drivers use unique integer handles of type ViSession to identify an instrument driver session. The Initialize function returns the handle that application programs use to reference the instrument driver session in subsequent calls to instrument driver functions.

```
ViSession session;
ViStatus status;
status = IviScope_InitWithOptions("/dev/spcm0", VI_FALSE, VI_TRUE, "", &session);
status = IviScope_close(session);
```

If a logical name has been given for that device inside the configuration store, the initialization will like:

```
ViSession session;
ViStatus status;
status = IviScope_InitWithOptions("MySpectrumDigitizer", VI_FALSE, VI_TRUE, "", &session);
status = IviScope_close(session);
```

Interchangeability

Interchangeability for IVI-C drivers is achieved through IVI-C class drivers. An application program makes calls to an IVI-C class driver, which, in turn, dynamically loads the IVI-C class-compliant specific driver that the user specifies in the IVI configuration store. The IVI-C class driver communicates through the IVI-C specific driver to control the instrument.

By using the IVI-C class driver API in the application program, the user can interchange IVI-C specific instrument drivers and corresponding instruments without affecting test code. When using an IVI-C class driver, the user designates which IVI-C specific driver to use by specifying a logical name. The user may configure the logical name in the IVI configuration store.

Complete Example

A simple working example for a single Spectrum card using the IVI scope class will look like:

```
// no error checking in example to keep it short

#include "SpecScope.h"

int main ()
    {
    ViSession vi;

    ViStatus viErr = IviScope_init ("/dev/spcm0", VI_FALSE, VI_TRUE, &vi);

    // setup clock to 1 MHz
    ViInt32 lMemsize = 16 * 1024; // 16kS
    viErr = IviScope_ConfigureAcquisitionRecord (vi, 1.0 / 1000000, lMemsize, 0);

    // setup channel 0: +/-1 V, 1 MOhm, DC, no offset
    ViConstString sChannel = "CHANNEL0";
    viErr = IviScope_ConfigureChannel (vi, sChannel, 2.0, 0, IVISCOPE_VAL_DC, 1, VI_TRUE);
    viErr = IviScope_ConfigureChanCharacteristics (vi, sChannel, 1000000, 100000000);

    // external trigger, positive edge
    viErr = IviScope_ConfigureEdgeTriggerSource (vi, IVISCOPE_VAL_EXTERNAL, 0, IVISCOPE_VAL_POSITIVE);

    // get waveform, timeout 5 seconds,
    ViReal64 adWaveformArray[16384];
    ViInt32 lActualPoints = 0;
    ViReal64 dInitialX = 0;
    ViReal64 dXIncrement = 0;
    viErr = IviScope_ReadWaveform (vi, sChannel, lMemsize, 5000, adWaveformArray,
                                   &lActualPoints, &dInitialX, &dXIncrement);

    viErr = IviScope_close (vi);
    return 0;
    }
```