USER GUIDE

LabVIEW™ DataPlugin SDK

Contents

An Introduction to the LabVIEW DataPlugin SDK 1
- DataPlugin Overview 1
- LabVIEW DataPlugin Types 3

Creating DataPlugins with LabVIEW 5
- LabVIEW Project Folders 5
- Debugging and Testing Your LabVIEW DataPlugin 7
- Adapting the LabVIEW Project Build 7
- Converting a 32-Bit LabVIEW DataPlugin to a 64-Bit LabVIEW DataPlugin 9

Constraints 10
- Channel Length Limitation 10
- Supported Data Types and Conversions 10
- Name Conventions 11
- Supported LabVIEW Versions 12

Worldwide Support and Services 13

An Introduction to the LabVIEW DataPlugin SDK

The LabVIEW DataPlugin SDK enables you to create DataPlugins from scratch using 100% LabVIEW G-code. The SDK also enables you to create an installer in order to install the new DataPlugin on any Windows computer.

Visit `ni.com/dataplugins` for the list of all freely downloadable DataPlugins and for more information about DataPlugins.

Visit `ni.com/tdm` for more information about the TDM data model, the TDM file format, and associated TDM tools.

Visit the following web sites for more information about these related software packages:

- LabVIEW: `ni.com/labview`
- DIAdem: `ni.com/diadem`
- DataFinder Server Edition: `ni.com/datafinder`

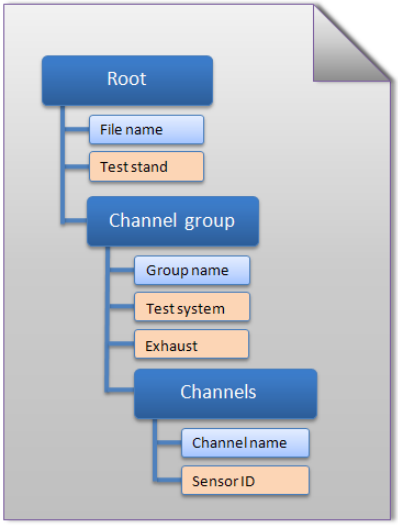
NATIONAL INSTRUMENTS™

DataPlugin Overview

A DataPlugin is encapsulated code that understands how to read and to interpret the data contained in a specific data file format by mapping it to the TDM data model. The TDM data model arranges the data in root element, channel groups, and channels.

The TDM data model has the following structure:

Figure 1. TDM Data Model



Initially DataPlugins could only be created by using C++ or VBScript programming languages, but the LabVIEW DataPlugin SDK gives you, the LabVIEW programmer, the ability to create DataPlugins using LabVIEW.

DataPlugins created with the LabVIEW DataPlugin SDK can only read data. This is the case for most DataPlugins publicly posted at `ni.com/dataplugins`.

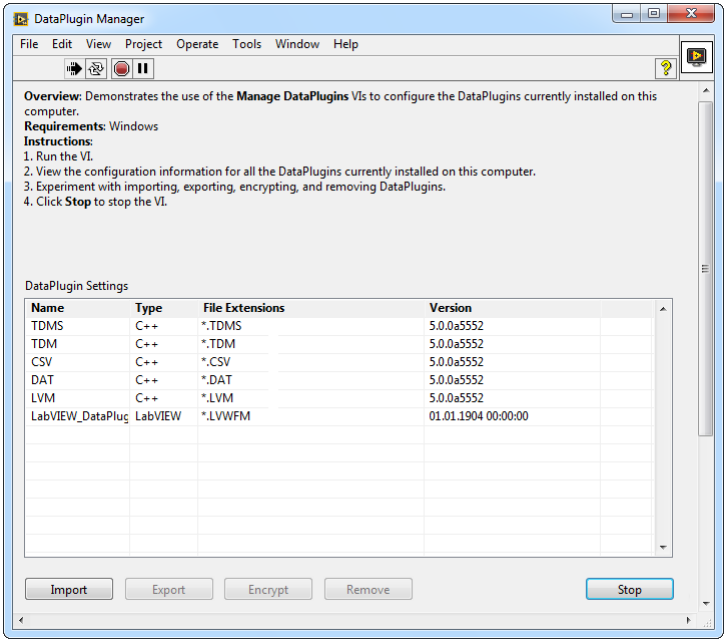
DataPlugins "plug into" a software layer called USI (Universal Storage Interface), which installs with LabVIEW, DIAdem, and DataFinder Server Edition. Once a new DataPlugin is registered on a computer, any installed LabVIEW, DIAdem, or DataFinder application on that computer is able to use that newly registered DataPlugin to load data files in the file format the new DataPlugin supports. In LabVIEW this happens via a set of Express VIs called the "Storage VIs." In DIAdem the DataPlugin can be used by simply interactively dragging a data file of the supported file format from the NAVIGATOR window into the Data Portal, or alternatively, by using commands like DataFileLoad() in a DIAdem script. The DataFinder uses the DataPlugin for indexing the files of this specific file format.

The main advantage of creating a DataPlugin with the LabVIEW DataPlugin SDK is to leverage LabVIEW G-code to give new file format reading capability to DIAdem and/or the DataFinder.

When the LabVIEW DataPlugin installer runs, no record of it appears in “Add and Remove Programs,” instead the DataPlugin is registered with the USI layer it “plugs into.” You may run the LabVIEW DataPlugin installer as many times as you want, and each time the DataPlugin registered with USI is simply updated. So to install a newer version of the DataPlugin on top of an older version, you just run the newer LabVIEW DataPlugin installer on that computer. To get an overview of the installed DataPlugins use the “DataPlugin Settings” dialog box in DIAdem or DataFinder Server Edition. Use the same dialog box to uninstall LabVIEW DataPlugins.

In LabVIEW you can use the Storage VIs to enumerate, register, or deregister DataPlugins.

Figure 2. Overview of Installed DataPlugins



Note The LabVIEW DataPlugin example projects contain a **For testing** project folder with a VI you can use to debug your LabVIEW DataPlugin from within LabVIEW, without needing to first build the DataPlugin DLL and installer. Refer to *LabVIEW Project Folders* for further information on DataPlugins.

LabVIEW DataPlugin Types

There are two types of LabVIEW DataPlugins, One-Shot and On-Demand. You need to choose between implementing a One-Shot or an On-Demand DataPlugin based on the structure of the data file and your level of LabVIEW programming experience, as described below.

One-Shot DataPlugins

The one-shot DataPlugin, is the simplest. The one-shot DataPlugin has one callback VI that you program, `Your Code Here.vi`. This VI is called exactly once any time the DataPlugin is used. The one-shot DataPlugin passes all the descriptive information (meta-data, group and channel hierarchy) as well as all the data values for all the channels. This type of DataPlugin agrees well with the way LabVIEW programmers are used to operating, because the VI runs exactly once when loading data with the DataPlugin.

On-Demand DataPlugins

The on-demand DataPlugin is more complicated and less comfortable for the LabVIEW programmer, but in general this is still the right choice for very large data files. The on-demand DataPlugin has two callbacks, the `Your Code Here_meta.vi` which is called exactly once any time the DataPlugin runs, and the `Your Code Here_raw.vi` which can be called one or more times but is only called when data values are requested. The `Your Code Here_meta.vi` declares on-demand data channels which specify, for example, the data type, name, length, descriptive properties, but which contain no data values. Then the `Your Code Here_raw.vi` is called individually for each on-demand data channel.

One-Shot versus On-Demand DataPlugins

The advantages of the one-shot DataPlugin are that it is simple to program and often loads all the values from all the channels faster than an on-demand DataPlugin. The one-shot DataPlugin is an excellent choice when the data files you need to load are always small enough to fit in RAM. If it only takes a few seconds to load all the values of all the channels, this is the way to go. If, though, you know that some or most of your data files will be too big to load into RAM, then you should seriously consider the more complicated on-demand DataPlugin. Note that when loading data values into DIAdem, the values are always converted to DBLs in DIAdem's internal memory (not the case for LabVIEW), so in that case you should estimate your file's effective size in DBLs when determining if it fits in RAM.

The downside to the one-shot DataPlugin is that you load all the data values any time the DataPlugin is called. If the DataPlugin is being called by the DataFinder in order to index the file (which needs only the descriptive information), this takes much longer than necessary because the one-shot DataPlugin loads all the data values even though they are not needed in that case.

In case of the on-demand DataPlugin when the DataFinder is indexing the file, the on-demand DataPlugin only returns the descriptive information—it does not waste unnecessary time reading all the data values.

If the One-Shot DataPlugin is being called by DIAdem to load only 1 out of 200 channels, it loads the data much slower, because it is loading all the data values for all 200 channels, even though only the data values for 1 channel were requested. Similarly, if only the first 100 values from a 100 million value long data channel are being requested, the one-shot DataPlugin loads all 100 million values anyway and then only returns the first 100 of them.

On the other hand, if your data file contains 20 channels, and an on-demand DataPlugin is called to load all the data values from all 20 channels, the `Your Code Here_raw.vi` is called 20 times, once for each separate on-demand channel. If you are dealing with a binary file that has excellent random access, and you know exactly at which byte position each channel starts, this does not slow you down at all. If, however, you have a datalog file with an array of clusters where each cluster has 20 elements, this causes you to read the file 20 times in order to load all the data values from all the channels. This is how the one-shot DataPlugin can be faster if you can fit your data file into RAM (including LabVIEW copies and DataPlugin copies). At that point you have to weigh how much virtual memory will slow you down versus the inefficiency of loading the file multiple times.

Another distinction of on-demand DataPlugins and on-demand channels is that the data values are in general loaded in buffers. When an on-demand DataPlugin is called to load all the data from a given on-demand channel, the DataPlugin engine usually calls the `Your Code Here_raw.vi` multiple times to load the data values buffer by buffer for that channel. The DataPlugin engine decides what buffer size to use and how many times to call the `Your Code Here_raw.vi`, so you neither have to worry about that nor can you affect the buffer size yourself. This is why the `Your Code Here_raw.vi` has “Offset” and “Count” inputs, so that the DataPlugin engine can tell you which data buffer to load from the requested channel. This also means that when the on-demand DataPlugin is called to load the first 100 values from a 100,000 value on-demand channel, that the DataPlugin can very efficiently just load the needed values and not have to process all 100,000 unnecessarily. Again, for very large files with a data file format that offers excellent random access, this is an ideal fit.

ASCII files, however, are particularly bad for the on-demand DataPlugins, because in order to forward the file cursor to the correct “Offset” position, you have to parse all the endline characters in the file up to that point, and this you must do all over again for every successive buffer read. In this particular case you might want to think of using VBS DataPlugins as they provide built-in optimized on-demand ASCII (and binary) readers.

One more scenario where on-demand DataPlugins shine (provided a file format with reasonable random access) is when the DataPlugin is called to load all the values from only one channel out of, for example, 200. In this case you can read the whole file much faster and only store data in LabVIEW memory from one channel instead of all 200. Furthermore there is the advantage that you do not unnecessarily load data values when only descriptive information is being requested.

In summary, the type of DataPlugin you choose depends partly on your file format, partly on your average file size relative to RAM, and partly on your typical loading/indexing use cases.

Creating DataPlugins with LabVIEW

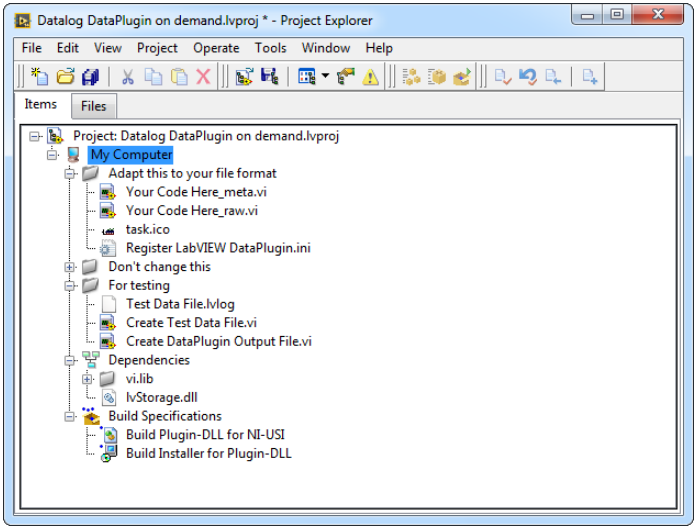
In this chapter you will learn how to adapt predefined LabVIEW projects, how to test your DataPlugin, and how to set the DataPlugin parameters.

LabVIEW Project Folders

LabVIEW DataPlugins are built by adapting predefined LabVIEW projects to your specific needs. Use the Project Explorer to load such a predefined project.

You can also access these examples by browsing to the folder **LabVIEW»Examples»FileIO» DataPlugins**.

Figure 3. LabVIEW Project Layout for On-Demand DataPlugins



The LabVIEW project folder **Adapt this to your file format** contains your actual file-format-specific source code to read the data from the particular data file that your DataPlugin supports. In the one-shot case this is the `Your Code Here.vi`, while in the on-demand case this is both the `Your Code Here_meta.vi` and the `Your Code Here_raw.vi`. You should adapt the code in this project folder from one of the LabVIEW DataPlugin examples, since the input and output terminals of these VIs must remain the same for the rest of the DataPlugin architecture to call your VIs correctly. Refer to *LabVIEW DataPlugin Types* for information about the correct DataPlugin type, and thus the correct example project to start with.

This project folder also includes a required `Register LabVIEW DataPlugin.ini` file, which you need to edit in order to match the expected file extension, programming name of the DataPlugin, associated DataPlugin icon file, and so on. The optional `.ico` file that is associated

with the DataPlugin is the last resource file in this project folder. Refer to *Adapting the LabVIEW Project Build* for further information.

The LabVIEW project folder **Don't change this** contains several files which comprise the heart of the LabVIEW DataPlugin architecture and should never be edited nor deleted in your DataPlugin project.

The LabVIEW project folder **For testing** contains several completely optional files which should be useful to you in debugging and testing your DataPlugin. Refer to *Debugging and Testing Your LabVIEW DataPlugin* for further information.

The LabVIEW project folder **Dependencies** contains files or file references which need to be included in the built source distribution that goes in the installer—in general you should not need to change anything by hand here. The list of included VIs begins with all the `vi.lib` files used in your project. Any additionally included subVIs can show up here, and any included DLLs, such as the `lvStorage.dll` (always) or the `lvanlsis.dll` also appear here.

The LabVIEW project folder **Build Specifications** contains the configurations for creating the DataPlugin DLL and for building the LabVIEW DataPlugin installer. All the LabVIEW code in the DataPlugin is built into the DataPlugin DLL, and the installer orchestrates the installation of the DataPlugin DLL and a few other resource files, as well as the subsequent registration of the DataPlugin with the host computer. In general you should not need to change anything in the DataPlugin DLL configuration, except perhaps the target name of the DLL. The DataPlugin installer is another matter. Refer to *Adapting the LabVIEW Project Build* for further information.

Debugging and Testing Your LabVIEW DataPlugin

The LabVIEW project folder **For testing** contains several completely optional files which should be useful to you in testing your DataPlugin.

The first of these is an example `Test Data File.xxxxx` for you to try to load with the DataPlugin code. This is useful to you only if you are getting familiar with LabVIEW DataPlugin architecture and using one of the examples without any edits. It is a good practice, though, to add a sample data file to this project folder so that you or others have an easy way to test/edit the source code later on.

The second file is a `Create Test Data File.vi` with which you can create additional test data files with different types of data and/or different file sizes. Again, this is only useful in the unedited examples, and here you should only include one for your DataPlugin if you happen to have it handy.

The third file is a `Create DataPlugin Output File.vi`, which enables you to test your DataPlugin code, prior to building and running the DataPlugin installer and while still in LabVIEW. This VI simulates the way the DataPlugin architecture calls the `Your Code Here.vi` you edited, and then displays the resulting loaded data in a pop-up, interactive VI. You should use this VI to debug your code, prior to building the installer, so that you can use LabVIEW debugging to identify the source of any errors or incorrect data loading. Feel free to look at this VI's block diagram to gain a clearer understanding of what the DataPlugin architecture is doing with your code.

Use the `Data File Viewer.vi` in the **File I/O»Storage VIs/DataPlugins** palette to test the built and installed DataPlugin from within LabVIEW.

Note If you have installed LabVIEW 64-bit, you will create 64-bit DataPlugins. You cannot use this DataPlugin with a 32-bit version of LabVIEW, but you can create 32-bit DataPlugins with a 32-bit LabVIEW and the LabVIEW DataPlugin SDK.

Adapting the LabVIEW Project Build

In this section you will learn how to set the DataPlugin parameters such as the DataPlugin name and the supported file extensions. Additionally you will learn how to change the build configuration.

DataPlugin Parameterization

To personalize your LabVIEW DataPlugin, you need to edit the content of the `Register LabVIEW DataPlugin.ini` from the **Adapt this to your file format** project folder. Below is the content of the `Register LabVIEW DataPlugin.ini` file in the LabVIEW DataPlugin example "Datalog DataPlugin on demand."

```
[LVDataPluginDatalog]
Name = LVDataPluginDatalog
FileExtension = *.lvlog
PluginFileName = LabVIEWDataPluginDatalog.dll
IconFileName = Datalog.ico
```

The first line sets the `Name` of the DataPlugin, as it is listed in the USI configuration file and how it shows up in the user dialog boxes in DIAdem and the DataFinder. It is also the programmatic name of the DataPlugin for LabVIEW VIs and DIAdem scripts. You just need to make sure you pick a user-friendly name that is different from all other DataPlugins which might be on your target host computers.

The `FileExtension` of the DataPlugin is the default file extension or extensions that are associated with this DataPlugin in DIAdem and the DataFinder. Multiple extensions can be specified by using semicolon as a separator between each extension.

Note Please note that DataPlugins with wildcards as extensions, for example `*.*` or `*.lv?og`, are not used by DataFinder for indexing.

The `PluginFileName` of the DataPlugin is the name of the DataPlugin DLL—make sure it matches the name listed in the DataPlugin DLL configuration dialog box as well as the name in the installer configuration dialog box.

The `IconFileName` of the DataPlugin is the `.ico` file which is associated with your DataPlugin—make sure this matches the actual name of the icon file in the **Adapt this to your file format** project folder. If you choose to take the default DataPlugin icon, you can end this line with the "=" sign. You also need to change the name of the associated `.ico` file in the

Source Files»Destination View to match your actual icon file, or else delete the icon file from the **Source Files»Destination View** if you choose not to have one.

Note To create your own icon files you must use an appropriate graphics program, for example you could buy Axialis IconWorkshop (`http://www.axialis.com`). The icon size should be 16 × 16 pixels.

Build Configuration

The DataPlugin DLL configuration does not require changes, because it always builds the DLL starting with the DataPlugin architecture code in the **Don't change this** project folder, which you never need to edit. You will, however, probably choose to change the target name of the DataPlugin DLL to better reflect the name of your particular DataPlugin. You should similarly change the **Product Information»Product Name** in the installer configuration.

The DataPlugin installer includes the resulting DataPlugin DLL as well as the `Register LabVIEW DataPlugin.exe` from the **Don't change this** project folder and the `Register LabVIEW DataPlugin.ini` plus any associated icon file from the **Adapt this to your file format** project folder. If you change the name of the DataPlugin DLL in the DLL build configuration, you have to make corresponding name changes to the resulting `.dll`, `.h`, `.ini`, `.lib` files in the **Source Files»Destination View**.

You may want to remove the "NI LabVIEW Run-Time Engine" from the "Additional Installers" section to reduce the size of the resulting installer. If you do this, you are assuming that all the clients that will ever install your DataPlugin will previously and separately have installed the same LabVIEW Run-Time Engine version that the DataPlugin is using. In general it is safer to include the LabVIEW Run-Time Engine in the DataPlugin installer.

Something else you do not need to change but should be aware of, is that the last step of your DataPlugin installer kicks off an additional installer called `Register LabVIEW DataPlugin.exe`, which is located in the **Don't change this** project folder. This additional installer must be selected to run in the "Advanced" section of the installer configuration, because this is what registers the DataPlugin with the host computer after the DataPlugin has successfully installed onto the host computer.

Converting a 32-Bit LabVIEW DataPlugin to a 64-Bit LabVIEW DataPlugin

In order to use an existing 32-bit DataPlugin in a 64-bit version of LabVIEW, the DataPlugin must be converted to 64-bit. To convert your 32-bit LabVIEW DataPlugin to 64-bit, complete the following steps:

1. Install a 64-bit version of LabVIEW.

   The version number of LabVIEW does not necessarily need to match the version of DIAdem being used. For example, it does not matter that you are using LabVIEW 2014 to compile the DataPlugin and DIAdem 2015 to use it. The DataPlugin will call in to the LabVIEW Run-Time Engine installed on the computer.

2. Install the correct version of the LabVIEW DataPlugin SDK.

   You can find the LabVIEW DataPlugin SDK here:
   `http://www.ni.com/example/31016/en/`
3. Open your existing LabVIEW 32-bit DataPlugin project in LabVIEW 64-bit.
4. Open the 64-bit version of the LabVIEW example that was used as the template for your 32-bit LabVIEW DataPlugin. Make sure to use the correct example, either one-shot or on-demand.
5. Replace the Register LabVIEW DataPlugin.exe in your 32-bit DataPlugin Project with the one included in the 64-bit LabVIEW example.
6. Rebuild your DataPlugin.

Constraints

In this chapter you will learn which data types DataPlugins support, and which channel length limitation and name conventions you have to consider.

Channel Length Limitation

DataPlugins currently can only declare channels to have a length from 0 to 2^{31}. If you pass more than 2^{31} values to a DataPlugin channel, the DataPlugin throws an error.

Supported Data Types and Conversions

You can import the following data types with a DataPlugin:

`Time, U8, I8, I16, U16, I32, U32, I64, U64, SGL, DBL`

Only the following data types are natively supported by DataPlugins:

`Time, U8, I16, I32, SGL, DBL`

All other data types are type converted when passed to the DataPlugin. The final converted type can depend on which VI you use to pass the data to the DataPlugin.

If you use the standard `Write Data.vi` express VI from the Storage VI palette, the following type conversions automatically occur:

Table 1. Write Data Conversions

Original Format	Direction	Converted Format
I8	→	I16
U16	→	I32
U32	→	I32
I64	→	DBL Waveform
U64	→	DBL Waveform

If you are reading U32, U64, or I64 data, you should use the `Write Channel Values.vi` instead (see below).

If you use instead the `Write Channel Values.vi` (which you can find in the Datalog example project), the following type conversions automatically occur:

Table 2. Write Channel Values Conversions

Original Format	Direction	Converted Format
I8	→	I16
U16	→	I32
U32	→	DBL
I64	→	DBL
U64	→	DBL

Note Even here the 64 bit integer conversions still in some cases result in loss of data, so if you are dealing with digital ports, for example, you might want to map a U64 into four separate U16 DataPlugin channels (which would automatically be converted to I32 internally).

Note None of the following data types are supported at all in DataPlugins: Booleans, Clusters, extended data types, or arrays of greater dimensionality than 1D.

Name Conventions

All channel groups within a LabVIEW DataPlugin and all channels within a specific channel group should have a unique name. The same applies to custom properties added to the file, channel group or channel level.

Additionally some characters may not be used in names. Please find below a table listing those special characters.

Table 3. Forbidden Characters in Names

Area of Usage	Forbidden Characters
File names (Data set names)	`\ / : * ? < > | ".`
Channel group names	`/ * ? ' [ ]`
Channel names	`/ * ? ' [ ]`
Property names	`. : , ; ' \ @ < > # [ ] % ( ) { } | * ? = ! " ^ $ & + - /` and a space

The following property names for file have a special meaning in the TDM data model: `author`, `datestring`, `datetime`, `description`, `name`, `mime_type`, `registertxt1`, `registertxt2`, `registertxt3`, `timestring`, `title`, `wf_create_time`.

The following property names for file are reserved for internal use: `channelgroups`, `children`, `environment`, `external_references`, `id`, `instance_attributes`, `objecttype`, `parent`, `registercomments`, `version`, `version_date`.

The following property names for channel groups have a special meaning in the TDM data model: `description`, `measurement_begin`, `measurement_end`, `mime_type`, `name`, `registertxt1`, `registertxt2`, `registertxt3`.

The following property names for channel groups are reserved for internal use: `channels`, `children`, `equipments`, `external_references`, `id`, `index`, `instance_attributes`, `measurement_quantities`, `objecttype`, `parent`, `root`, `sequences`, `submatrices`, `test`, `units_under_test`, `version`, `version_date`.

The following property names for channels have a special meaning in the TDM data model: `description`, `displaytype`, `maximum`, `mime_type`, `minimum`, `monotony`, `name`, `novaluekey`, `registerint1`, `registerint2`, `registerint3`, `registerint4`, `registerint5`, `registerint6`, `registertxt1`, `registertxt2`, `registertxt3`, `registerval1`, `registerval2`, `registerval3`, `registerval4`, `registerval5`, `registerval6`, `unit_string`, `wf_increment`, `wf_samples`, `wf_start_offset`, `wf_start_time`, `wf_xnametype`, `wf_xunit_string`.

The following property names for channels are reserved for internal use: `average`, `channel`, `children`, `datatype`, `deletebehaviour`, `dimension`, `empty`, `external_references`, `flagkey`, `group`, `groupindex`, `id`, `implicit_increment`, `implicit_start`, `instance_attributes`, `internal_params`, `internal_res1`, `internal_res2`, `interpolation`, `is_scaled_by`, `length`, `lengthmax`, `local_columns`, `measurement`, `number`, `objecttype`, `parent`, `quantity`, `rank`, `representation`, `scales`, `sourcedatafilename`, `sourcedatafilepath`, `sourcegenparam1`, `sourcegenparam2`, `sourcehandle`, `sourceinstancekey`, `sourcename`, `sourceparentname`, `sourcerepresentation`, `sourcetype`, `sourcevalue`, `standard_deviation`, `status`, `type_size`, `unit`, `valuetype`, `version`, `version_date`, `waveform`, `writeprotection`.

Supported LabVIEW Versions

DataPlugins have been supported in LabVIEW Storage VIs since LabVIEW 2010. In earlier versions DataPlugins could be used by a work around.

Note Use a DataPlugin built with the LabVIEW DataPlugin SDK only with the same LabVIEW version with which you created this DataPlugin.

The same applies if this DataPlugin is used together with the LabVIEW DataFinder Toolkit.

Worldwide Support and Services

The National Instruments website is your complete resource for technical support. At ni.com/support you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

Visit ni.com/services for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit ni.com/register to register your National Instruments product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world. For telephone support in the United States, create your service request at ni.com/support or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the Worldwide Offices section of ni.com/niglobal to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

372601J-01 Jun18