PCIS-DASK

Data Acquisition Software Development Kit

For NuDAQ PCI-bus Cards, Windows NT/98/2000

User’s Guide

CONTENTS

How to Use This Manual

This manual is to help you use the PCIS-DASK software driver for NuDAQ PCI-bus data acquisition cards. The manual describes how to install and use the software library to meet your requirements and help you program your own software applications. It is organized as follows:

- Chapter 1, "Introduction to PCIS-DASK" describes the hardware and language support of PCIS-DASK.
- Chapter 2, "The Fundamentals of Building Windows NT/98 Applications with PCIS-DASK" describes the fundamentals of creating PCIS-DASK applications in Windows NT and Windows 98.
- Chapter 3, "PCIS-DASK Utilities" describes the utilities PCIS-DASK provides.
- Chapter 4, "PCIS-DASK Overview" describes the classes of functions in PCIS-DASK and briefly describes each function.
- Chapter 5, "PCIS-DASK Application Hints" provides the programming schemes showing the function flow of that PCIS-DASK performs analog I/O and digital I/O.
- Chapter 6, "Continuous Data Transfer in PCIS-DASK" describes the mechanism and techniques that PCIS-DASK uses for continuous data transfer.
- Chapter 7, "Sample Programs" describes some sample programs in the software package.

1

Introduction to PCIS-DASK

1.1 About the PCIS-DASK Software

PCIS-DASK is a software development kit for NuDAQ PCI-bus data acquisition cards. It contains a high performance data acquisition driver for developing custom applications under Windows NT, Windows 98 and Windows 2000 environments.

The memory and data buffer management capabilities free developers from dealing with there complex issues. That is, PCIS-DASK is constructed to provide a simple programming interface in communication with the NuDAQ PCI-bus data acquisition cards. The easy-to-use functions provided by PCIS-DASK allow a programmer to use the features of the card in a high level way.

Using PCIS-DASK also makes you take advantage of the power and features of Microsoft Win32 System for your data acquisition applications, including running multiple applications and using extended memory. Also, using PCIS-DASK under Visual Basic environment makes it easy to create custom user interfaces and graphics.

In addition to the software drivers, some sample programs are provided for your reference to save a lot of programming time and get some other benefits as well.

1.2 PCIS-DASK Hardware Support

ADLink will periodically upgrade PCIS-DASK for new NuDAQ PCI-bus data acquisition cards and NuIPC CompactPCI cards. Please refer to *Release Notes* for the cards that the current PCIS-DASK actually supports. The following cards are those which PCIS-DASK supports currently or will support in the near future:

- PCI-6208A : 8-channel 16-bit current output card
- PCI-6208V/16V : 8/16-channel 16-bit voltage output card
- PCI-6308A : Isolated 8-channel voltage and current output card
- PCI-6308V : Isolated 8-channel voltage output card
- PCI-7200/cPCI-7200 : high-speed 32-bit digital I/O card with bus mastering DMA transfer capability
- PCI-7230/cPCI-7230 : 32-channel isolated digital I/O card
- PCI-7233/PCI-7233H : Isolated 32 channels DI card with COS detection
- PCI-7234 : 32-channel isolated digital output card
- PCI-7248/cPCI-7248 : 48-bit digital I/O card
- cPCI-7249R : 3U CompactPCI 48 parallel digital I/O card
- PCI-7250 : 8 relay output and 8 isolated input card
- cPCI-7252 : 8 relay output and 16 isolated input card
- PCI-7296 : 96-bit digital I/O card
- PCI-7300A/cPCI-7300A : 40 Mbytes/sec Ultra-high speed 32 channels digital I/O card with bus mastering DMA transfer supporting scatter gather technology
- PCI-7396 : High driving capability 96 channels DIO card
- PCI-7432/cPCI-7432 : 32 isolated channels DI & 32 isolated channels DO card

- PCI-7433/cPCI-7433 : 64 isolated channels DI card
- PCI-7434/cPCI-7434 : 64 isolated channels DO card
- cPCI-7432R : Isolation 32 Digital Inputs & 32 Digital Outputs with Rear I/O
- cPCI-7433R : Isolation 64 Digital Inputs Module with Rear I/O
- cPCI-7434R : Isolation 64 Digital Outputs Module with Rear I/O
- PCI-8554 : 16-CH Timer/Counter & DIO card
- PCI-9111 : advanced multi-function card
- PCI-9112/cPCI-9112 : advanced multi-function card with bus mastering DMA transfer capability
- PCI-9113 : 32 isolated channels A/D card
- PCI-9114 : 32-channel high gain multi-function card
- PCI-9118 : 333KHz high speed multi-function card with bus mastering DMA transfer capability
- PCI-9812/10 : 20MHz Ultra-high speed A/D card with bus mastering DMA transfer capability
- cPCI-9812/10 : 20MHz Ultra-high speed A/D card with bus mastering DMA transfer capability

1.3 PCIS-DASK Language Support

PCIS-DASK is DLL (Dynamic-Link Library) version for using under Windows NT, Window 98 and Windows 2000. It can work with any Windows programming language that allows calls to a DLL, such as Microsoft Visual C/C++ (4.0 or above), Borland C++ (5.0 or above), or Microsoft Visual Basic (4.0 or above), etc. PCIS-DASK also provides a PCIS-DASK function prototype file, Dask.pas for use with Borland Delphi 2.*x* (32-bit) or above.

2

The Fundamentals of Building WindowsNT/98/2000 Applications with PCIS-DASK

2.1 Creating a Windows NT/98/2000 PCIS-DASK Applications Using Microsoft Visual C/C++

To create a data acquisition application using PCIS-DASK and Microsoft Visual C/C++, follow these steps after entering Visual C/C++:

step 1. Open the project in which you want to use PCIS-DASK. This can be a new or existing project

step 2. Include header file DASK.H in the C/C++ source files that call PCIS-DASK functions. DASK.H contains all the function declarations and constants that you can use to develop your data acquisition application. Incorporate the following statement in your code to include the header file.

#include “DASK.H”

step 3. Build your application.

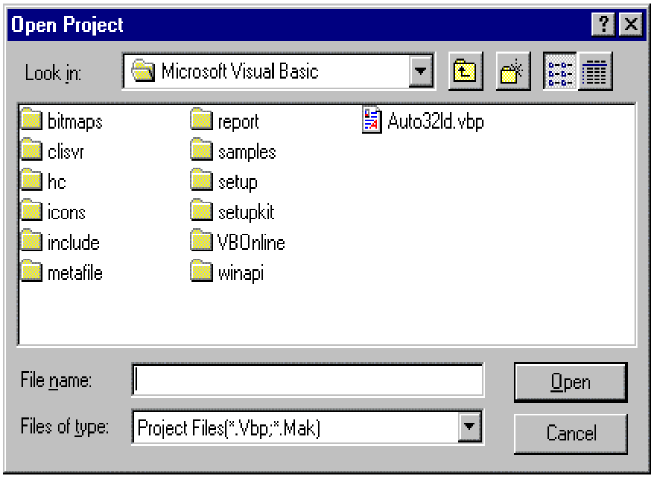
Setting the appropriate compile and link options, then build your application by selecting the Build command from Build menu (Visual C/C++ 4.0). Remember to link PCIS-DASK's import library, PCI-DASK.LIB.

2.2 Creating a Windows NT/98/2000 PCIS-DASK Applications Using Microsoft Visual Basic

To create a data acquisition application using PCIS-DASK and Visual Basic, follow these steps after entering Visual Basic:

step 1. Open the project in which you want to use PCIS-DASK. This can be a new or existing project

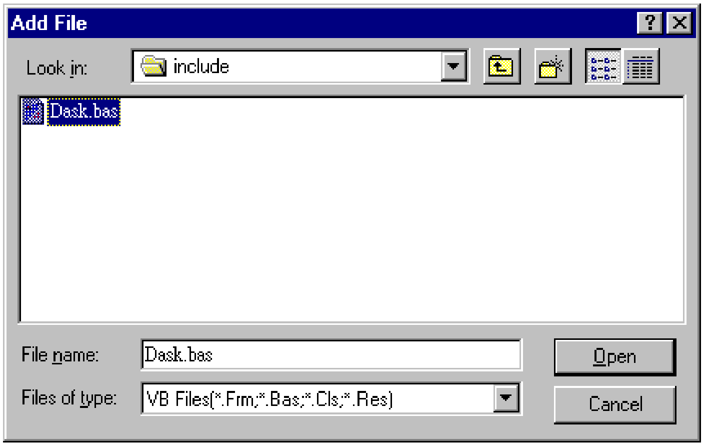
Open a new project by selecting the New Project command from the File menu. If it is an existing project, open it by selecting the Open Project command from the File menu. Then the Open Project dialog box appears.



Changed directory to the place the project file located. Double-click the project file name in the File Name list to load the project.

step 2. Add file DASK.BAS into the project if this file is not included in the project. This file contains all the procedure declarations and constants that you can use to develop your data acquisition application.

From the File menu, select the Add File command. The Add File window appears, displaying a list of files in the current directory.



Select DASK.BAS from the Files list by double clicking on it. If you can't find this file in the list, make sure the list is displaying files from the correct directory. By default, DASK.BAS is installed in C:\ADLink\PCI-DASK\INCLUDE.

step 3. Design the interface for the application.

To design the interface, you place the desired elements, such as command button, list box, text box, etc., on the Visual Basic form. These are standard controls from the Visual Basic Toolbox. To place a control on a form, you just move pointer to Toolbox, select the desired control and draw it on the form. Or you can double-click the control icon in the Toolbox to place it on the form.

step 4. Set properties for the controls.

To view the property list, click the desired control and then choose the Properties command from the View menu or press F4, or you can also click the Properties button on the toolbar.

step 5. Write the event code.

The event code defines the action you want to perform when an event occurs. To write the event code, double-click the desired control or form to view the code module and then add code you want. You can call the functions that declared in the file DASK.BAS to perform data acquisition operations.

step 6. Run your application.

To run the application, choose Start from the Run menu, or click the Start icon on the toolbar (you can also press F5).

step 7. Distribute your application.

Once you have finished a project, you can save the application as an executable (.EXE) file by using the Make EXE File command on the File menu. And once you have saved your application as an executable file, you've ready to distribute it. When you distribute your application, remember also to include the PCIS-DASK's DLL and driver files. These files should be copied to their appropriate directory as section 1.4.1 described.

3

PCIS-DASK Utilities

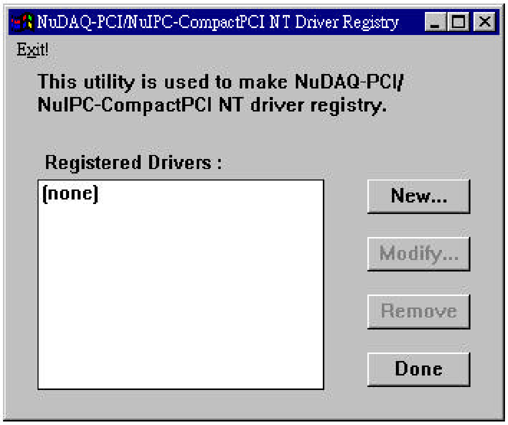
This chapter introduces the tools that accompanied with the PCIS-DASK package.

3.1 NuDAQ Registry/Configuration utility (PciUtil)

PciUtil is used for the users to ***register*** PCIS-DASK drivers (Windows NT4 only), ***remove*** installed drivers (Windows NT4 only), and ***set/modify*** the allocated buffer sizes of AI, AO, DI and DO. The default location of this utility is <InstallDir>\Util directory.

[PciUtil in Windows NT]

The *PciUtil* main window is shown as the following window. If any PCIS-DASK/NT driver has been registered, it will be shown on the *Registered Driver* list.

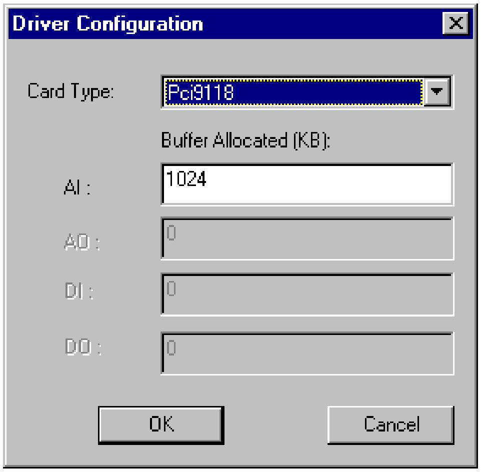

NuDAQ-PCI/NuIPC-CompactPCI NT Driver Registry

This utility is used to make NuDAQ-PCI/
NuIPC-CompactPCI NT driver registry.

Registered Drivers :

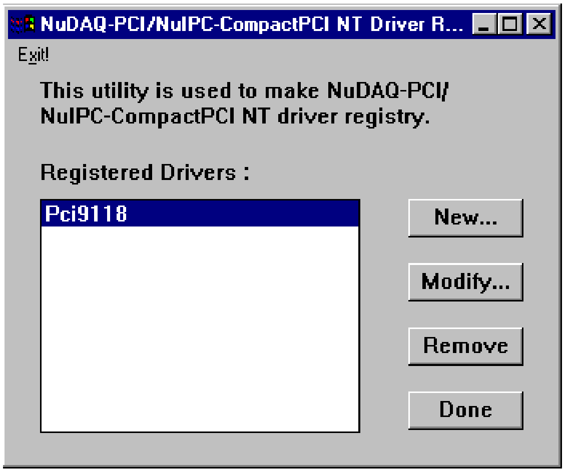
[none]

To register one of PCIS-DASK drivers, click " New ..." button and a *Driver Configuration* window appears.



In this window, users can select the driver you want to register and input the parameters in the box corresponding to AI, AO, DI, or DO for the requirement of your applications. The " Buffer Allocated" of AI, AO, DI, DO represent the sizes of contiguous Initially Allocated memory for continuous analog input, analog output, digital input, digital output respectively. Its unit is KB, i.e. 1024 bytes. Device driver will try to allocate these sizes of memory at system startup time. The size of initially allocated memory is the maximum memory size that DMA or Interrupt transfer can be performed. It will induce an unexpected result in that DMA or Interrupt transfer performed exceeds the initially allocated size.

After the device configurations of the driver you select is finished, click " OK" to register the driver and return to the *PciUtil* main window. The driver you just registered will be shown on the registered driver list as the following figure:

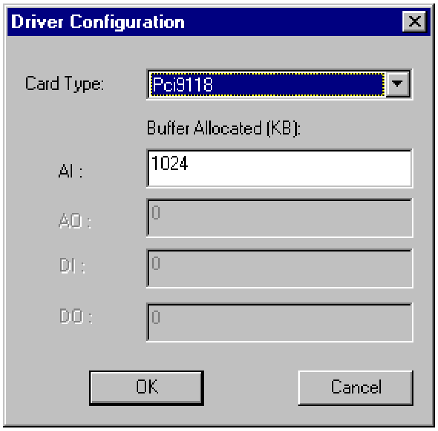

Exit!

This utility is used to make NuDAQ-PCI/ NuIPC-CompactPCI NT driver registry.

Registered Drivers :

Pci9118

Using *PciUtil* to ***change the buffer allocated settings*** of one of the PCIS-DASK drivers, select the driver from the *Registered Driver* list and click "Modify ..." button and then a "Driver Configuration" window is shown as below.


Driver Configuration

Card Type: Pci9118

Buffer Allocated (KB):

AI : 1024

AO : 0

DI : 0

DO : 0

Inside the allocated buffer size fields of AI, AO, DI and DO are the originally set values. Type the value in the box corresponding to AI, AO, DI, or DO according to the requirement of your applications, and then click "OK" button.

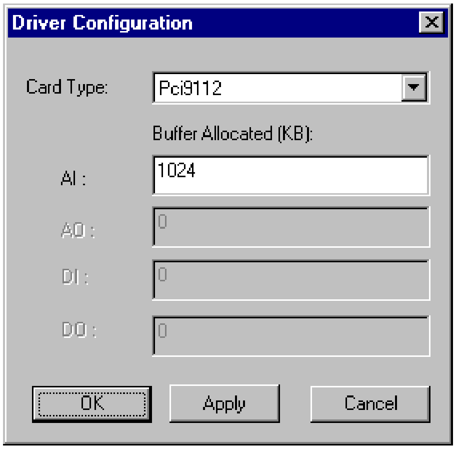
To ***remove*** a registered driver, select the driver from the *Registered Driver* list in The *PciUtil* main window and click "Remove" button. The selected driver will be deleted from the registry table.

[PciUtil in Windows 98]

This utility is used to ***set/modify*** the allocated buffer sizes of AI, AO, DI and DO. The allocated buffer sizes of AI, AO, DI, DO represent the sizes of contiguous Initially Allocated memory for continuous analog input, analog output, digital input, digital output respectively. Its unit is page *KB*, i.e. 1024 bytes. Device driver will try to allocate these sizes of memory at system startup time. The size of initially allocated memory is the maximum memory size that DMA or Interrupt transfer can be performed. It will induce an unexpected result in that DMA or Interrupt transfer performed exceeds the initially allocated size.

The "Driver Configuration" window is shown as below.

Using *PciUtil* to ***change the buffer allocated settings*** of one of the PCIS-DASK drivers, select the driver from the *Card Type*


Driver Configuration

Card Type: Pci9112

Buffer Allocated (KB):

AI : 1024

AO : 0

DI : 0

DO : 0

combo box.

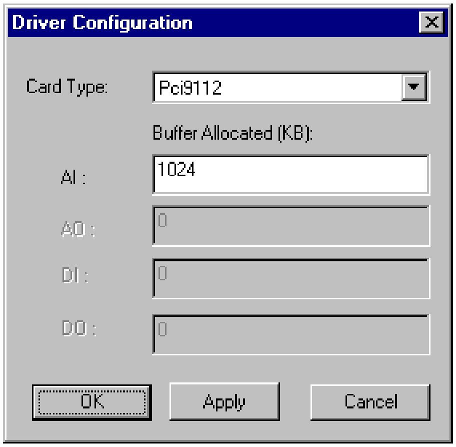
Inside the allocated buffer size fields of AI, AO, DI and DO are the originally set values. Type the value in the box corresponding to AI, AO, DI, or DO according to the requirement of your applications, and then click "Apply" button.

[PciUtil in Windows 2000]

This utility is used to ***set/modify*** the allocated buffer sizes of AI, AO, DI and DO. The allocated buffer sizes of AI, AO, DI, DO represent the sizes of contiguous Initially Allocated memory for continuous analog input, analog output, digital input, digital output respectively. Its unit is page *KB*, i.e. 1024 bytes. Device driver will try to allocate these sizes of memory at system startup time. The size of initially allocated memory is the maximum memory size that DMA or Interrupt transfer can be performed. It will induce an unexpected result in that DMA or Interrupt transfer performed exceeds the initially allocated size.

The "Driver Configuration" window is shown as below.

Using *PciUtil* to ***change the buffer allocated settings*** of one of the PCIS-DASK drivers, select the driver from the *Card Type combo box*.


Driver Configuration

Card Type: Pci9112

Buffer Allocated (KB):

AI : 1024

AO : 0

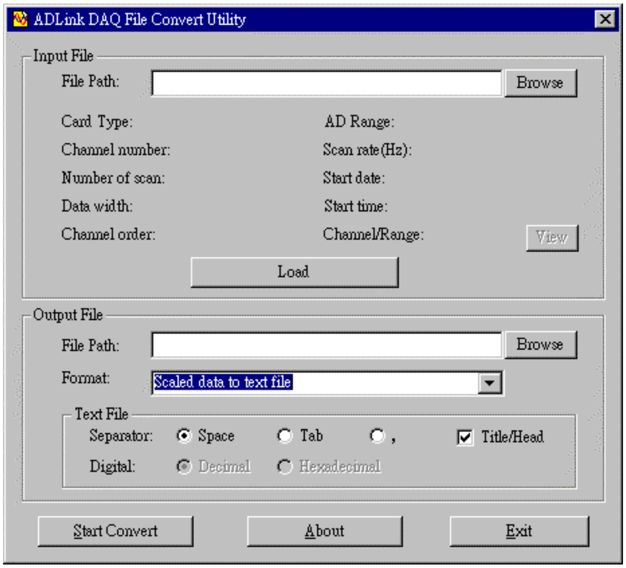
DI : 0

DO : 0

Inside the allocated buffer size fields of AI, AO, DI and DO are the originally set values. Type the value in the box corresponding to AI, AO, DI, or DO according to the requirement of your applications, and then click "Apply" button.

3.2 PCIS-DASK Data File Converter utility (DAQCvt)

The data files, generated by the PCIS-DASK functions performing continuous data acquisition followed by storing the data to disk, is written in binary format. Since a binary file can' t be read by the normal text editor and can' t be used to analyze the accessed data by Excel, PCIS-DASK provides a convenient tool *DAQCvt* to convert the binary file to the file format read easily. The default location of this utility is <InstallDir>\Util directory. The *DAQCvt* main window is as the following figure:


ADLink DAQ File Convert Utility

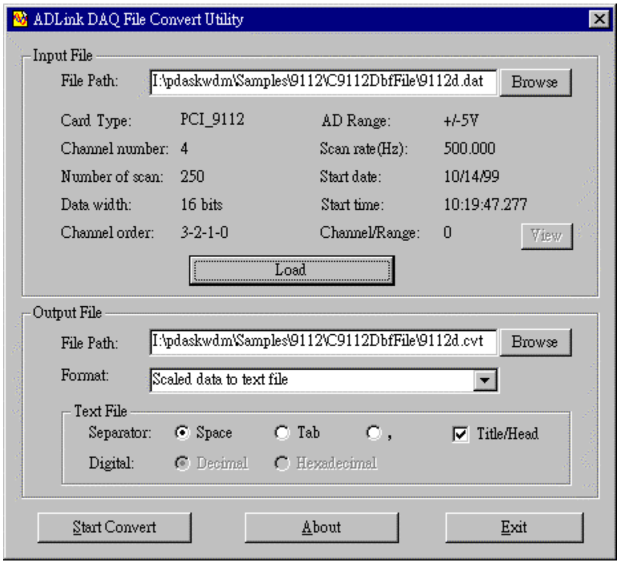
Input File
File Path:
Card Type:
AD Range:
Channel number:
Scan rate(Hz):
Number of scan:
Start date:
Data width:
Start time:
Channel order:
Channel/Range:

Output File
File Path:
Format: Scaled data to text file

Text File
Separator: [✓ Space] Tab ,
[✓ Title/Head]
Digital: [✓ Decimal] Hexadecimal

The *DAQCvt* main window includes two frames. The upper frame, *Input File frame* is used for the source data file and the lower frame is used for the destination file.

To **load the source binary data file**, type the binary data file name in *File Path* field or click *Browser* button to select the source file from *Input File frame*, and then click *Load* button. As the file is loaded, the information related to the data file, e.g. *data* *type*, *data width*, *AD Range*, ..etc., are shown in the corresponding fields in " Input File" frame, and the default converted data file path and format are also listed as the figure below.


ADLink DAQ File Convert Utility

Input File
File Path: I:\pdaskwdm\Samples\9112\C9112DbfFile\9112d.dat
Card Type: PCI_9112
AD Range: +/-5V
Channel number: 4
Scan rate(Hz): 500.000
Number of scan: 250
Start date: 10/14/99
Data width: 16 bits
Start time: 10:19:47.277
Channel order: 3-2-1-0
Channel/Range: 0

Output File
File Path: I:\pdaskwdm\Samples\9112\C9112DbfFile\9112d.cvt
Format: Scaled data to text file
Text File
Separator: [✓ Space] Tab ,
[✓ Title/Head]
Digital: [✓ Decimal] Hexadecimal

The default **destination file** with a *.cvt* extension is located in the same directory as the source one. To change the default setting, type the file path you wish or click the *Browser* button from *Output File* frame to select the destination file location.

DAQCvt provides three types of data format conversion.

Scaled data to text file :

The data in hexadecimal format is scaled to engineering unit (voltage, ample, ..etc) according to the card type, data width and data range and then written to disk in text file format. This type is available for the data accessed from continuous AI operation only.

Scaled data to binary file (float) :

The data in hexadecimal is scaled to engineering unit (voltage, ample, ..etc) according to the card type, data width and data range and then written to disk in binary file format. This type is available for the data accessed from continuous

AI operation only.

Binary codes to text file :

The data in hexadecimal format or converted to a decimal value is written to disk in text file format. If the original data includes channel information, the raw value will be handled to get the real data value. This type is available for the data accessed form continuous AI and DI operations.

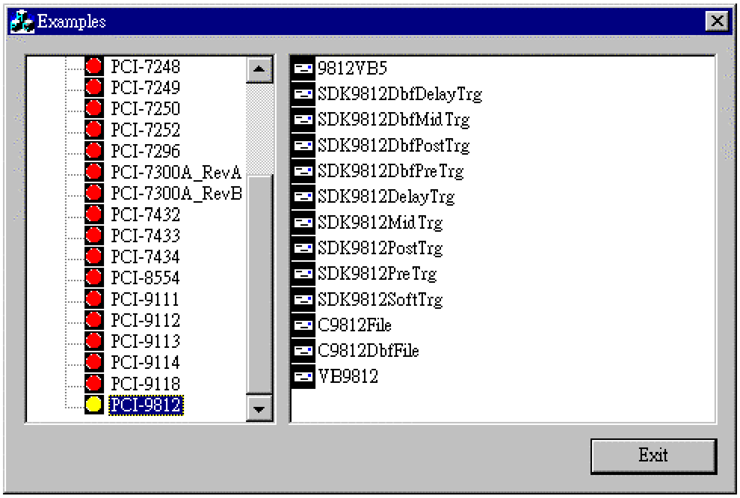
The data separator in converted text file is selectable among *space*, *comma* and *Tab*.

If you want to add title/head which includes the card type information at the beginning of file, check the "Title/Head" box.

After setting the properties (File Path, Format, ..etc) related to the converted file, you can push *Start Convert* button from the *Output File* frame to perform the file conversion.

3.3 PCIS-DASK Sample Programs Browser (Examples.exe)

PCIS-DASK provides a sample program browser, ***Examples.exe***, for you to view and execute the sample programs that PCIS-DASK package includes. The default location of this utility is <InstallDir>\Samples directory. After *Examples.exe* utility is running, select the device you wish to operate from the device list in the left frame, and then double click the icon of the sample you wish to execute to run this sample program.

Examples
PCI-7248
PCI-7249
PCI-7250
PCI-7252
PCI-7296
PCI-7300A_RevA
PCI-7300A_RevB
PCI-7432
PCI-7433
PCI-7434
PCI-8554
PCI-9111
PCI-9112
PCI-9113
PCI-9114
PCI-9118
PCI-9812
9812VB5
SDK9812DbfDelayTrg
SDK9812DbfMidTrg
SDK9812DbfPostTrg
SDK9812DbfPreTrg
SDK9812DelayTrg
SDK9812MidTrg
SDK9812PostTrg
SDK9812PreTrg
SDK9812SoftTrg
C9812File
C9812DbfFile
VB9812
Exit

4

PCIS-DASK Overview

This chapter describes the classes of functions in PCIS-DASK and briefly describes each function.

PCIS-DASK functions are grouped to the following classes:

- **General Configuration Function Group**
- **Analog Input Function Group**
  - Analog Input Configuration functions
  - One-Shot Analog Input functions
  - Continuous Analog Input functions
  - Asynchronous Analog Input Monitoring functions
- **Analog Output Function Group**
- **Digital Input Function Group**
  - Digital Input Configuration functions
  - One-Shot Digital Input functions
  - Continuous Digital Input functions
  - Asynchronous Digital Input Monitoring functions
- **Digital Output Function Group**
  - Digital Output Configuration functions
  - One-Shot Digital Output functions
  - Continuous Digital Output functions
  - Asynchronous Digital Output Monitoring functions
- **Timer/Counter Function Group**
- **DIO Function Group**
  - Digital Input/Output Configuration function
  - Dual-Interrupt System Setting function

4.1 General Configuration Function Group

Use these functions to initializes and configures data acquisition card.

Register_Card	Initializes the hardware and software states of an NuDAQ PCI-bus data acquisition card. Register_Card must be called before any other DASK library functions can be called for that card.
Release_Card	Tells DASK library that this registered card is not used currently and can be released. This would make room for new card to register.

4.2 Analog Input Function Group

4.2.1 Analog Input Configuration Functions

AI_9111_Config	Informs PCIS-DASK library of the trigger source and trigger mode selected for the analog input operation of PCI9111. You must call this function before calling function to perform continuous analog input operation of PCI9111.
AI_9112_Config	Informs PCIS-DASK library of the trigger source selected for the analog input operation of PCI9112. You must call this function before calling function to perform continuous analog input operation of PCI9112.
AI_9113_Config	Informs PCIS-DASK library of the trigger source selected for the analog input operation of PCI9113. You must call this function before calling function

	to perform continuous analog input operation of PCI9113.
AI_9114_Config	Informs PCIS-DASK library of the trigger source selected for the analog input operation of PCI9114. You must call this function before calling function to perform continuous analog input operation of PCI9114.
AI_9118_Config	Informs PCIS-DASK library of the trigger source, trigger mode, input mode, and conversion mode selected for the analog input operation of PCI9118. You must call this function before calling function to perform continuous analog input operation of PCI9118.
AI_9812_Config	Informs PCIS-DASK library of the trigger source, trigger mode, and trigger properties selected for the analog input operation of PCI9812. You must call this function before calling function to perform continuous analog input operation of PCI9812.
AI_InitialMemoryAllocated	Gets the actual size of analog input memory that is available in the device driver.

4.2.2 One-Shot Analog Input Functions

AI_ReadChannel	Performs a software triggered A/D conversion (analog input) on an analog input channel and returns the value converted (unscaled).

AI_VReadChannel	Performs a software triggered A/D conversion (analog input) on an analog input channel and returns the value scaled to a voltage in units of volts.
AI_VoltScale	Converts the result from an AI_ReadChannel call to the actual input voltage.

4.2.3 Continuous Analog Input Functions

AI_ContReadChannel	Performs continuous A/D conversions on the specified analog input channel at a rate as close to the rate you specified.
AI_ContScanChannels	Performs continuous A/D conversions on the specified *continuous* analog input channels at a rate as close to the rate you specified. This function is only available for those cards that support auto-scan functionality.
AI_ContReadMultiChannels	Performs continuous A/D conversions on the specified analog input channels at a rate as close to the rate you specified. This function is only available for those cards that support auto-scan functionality.
AI_ContReadChannelToFile	Performs continuous A/D conversions on the specified analog input channel at a rate as close to the rate you specified and saves the acquired data in a disk file.

AI_ContScanChannelsToFile	Performs continuous A/D conversions on the specified *continuous* analog input channels at a rate as close to the rate you specified and saves the acquired data in a disk file. This function is only available for those cards that support auto-scan functionality.
AI_ContReadMultiChannelsToFile	Performs continuous A/D conversions on the specified analog input channels at a rate as close to the rate you specified and saves the acquired data in a disk file. This function is only available for those cards that support auto-scan functionality.
AI_ContVScale	Converts the values of an array of acquired data from an continuous A/D conversion call to the actual input voltages.
AI_ContStatus	Checks the current status of the continuous analog input operation.

4.2.4 Asynchronous Analog Input Monitoring Functions

AI_AsyncCheck	Checks the current status of the asynchronous analog input operation.
AI_AsyncClear	Stops the asynchronous analog input operation.

AI_AsyncDblBufferMode	Enables or Disables double buffer data acquisition mode.
AI_AsyncDblBufferHalfReady	Checks whether the next half buffer of data in circular buffer is ready for transfer during an asynchronous double-buffered analog input operation.
AI_AsyncDblBufferTransfer	Copies half of the data of circular buffer to user buffer. You can execute this function repeatedly to return sequential half buffers of the data.

4.3 Analog Output Function Group

4.3.1 Analog output Configuration Functions

AO_6208A_Config	Informs PCIS-DASK library of the current range selected for the analog output operation of PCI6208A. You must call this function before calling function to perform current output operation.
AO_6308A_Config	Informs PCIS-DASK library of the current range selected for the analog output operation of PCI6308A. You must call this function before calling function to perform current output operation.
AO_6308V_Config	Informs PCIS-DASK library of the polarity (unipolar or bipolar) that the output channel is configured for the analog output and the reference

	voltage value selected for the analog output channel(s) of PCI6308V. You must call this function before calling function to perform current output operation.
AO_9111_Config	Informs PCIS-DASK library of the polarity (unipolar or bipolar) that the output channel is configured for the analog output of PCI9111. You must call this function before calling function to perform voltage output operation.
AO_9112_Config	Informs PCIS-DASK library of the reference voltage value selected for the analog output channel(s) of PCI9112. You must call this function before calling function to perform voltage output operation.

4.3.2 One-Shot Analog Output Functions

AO_WriteChannel	Writes a binary value to the specified analog output channel.
AO_VWriteChannel	Accepts a voltage value, scales it to the proper binary value and writes a binary value to the specified analog output channel.
AO_VoltScale	Scales a voltage to a binary value.

4.4 Digital Input Function Group

4.4.1 Digital Input Configuration Functions

DI_7200_Config	Informs PCIS-DASK library of the trigger source and trigger properties selected for the digital input operation of PCI7200. You must call this function before calling function to perform continuous digital input operation of PCI7200.
DI_7300A_Config/ DI_7300B_Config	Informs PCIS-DASK library of the trigger source and trigger properties selected for the digital input operation of PCI7300A Rev.A or PCI7300A Rev.B. You must call this function before calling function to perform continuous digital input operation of PCI7300A Rev.A or PCI7300A Rev.B.
DI_InitialMemoryAllocated	Gets the actual size of digital input DMA memory that is available in the device driver.

4.4.2 One-Shot Digital Input Functions

DI_ReadLine	Reads the digital logic state of the specified digital line in the specified port.
DI_ReadPort	Reads digital data from the specified digital input port.

4.4.3 Continuous Digital Input Functions

DI_ContReadPort	Performs continuous digital input on the specified digital input port at a rate as close to the rate you specified.

DI_ContReadPortToFile	Performs continuous digital input on the specified digital input port at a rate as close to the rate you specified and saves the acquired data in a disk file.
DI_ContStatus	Checks the current status of the continuous digital input operation.

4.4.4 Asynchronous Digital Input Monitoring Functions

DI_AsyncCheck	Checks the current status of the asynchronous digital input operation.
DI_AsyncClear	Stops the asynchronous digital input operation.
DI_AsyncDblBufferMode	Enables or Disables double buffer data acquisition mode.
DI_AsyncDblBufferHalfReady	Checks whether the next half buffer of data in circular buffer is ready for transfer during an asynchronous double-buffered digital input operation.
DI_AsyncDblBufferTransfer	Copies half of the data of circular buffer to user buffer. You can execute this function repeatedly to return sequential half buffers of the data.

4.5 Digital Output Function Group

4.5.1 Digital Output Configuration Functions

DO_7200_Config	Informs PCIS-DASK library of the trigger source and trigger properties selected for the digital input operation of PCI7200. You must call this function before calling function to perform continuous digital output operation of PCI7200.
DO_7300A_Config/ DO_7300B_Config	Informs PCIS-DASK library of the trigger source and trigger properties selected for the digital input operation of PCI7300A Rev.A or PCI7300A Rev.B. You must call this function before calling function to perform continuous digital output operation of PCI7300A Rev.A or PCI7300A Rev.B.
EDO_9111_Config	Informs PCIS-DASK library of the mode of EDO channels of PCI9111.
DO_InitialMemoryAllocated	Gets the actual size of digital output DMA memory that is available in the device driver.

4.5.2 One-Shot Digital Output Functions

DO_WriteLine	Sets the specified digital output line in the specified digital output port to the specified state. This function is only available for those cards that support digital output read-back functionality.
DO_WritePort	Writes digital data to the specified digital output port.
DO_ReadLine	Reads the specified digital output line in the specified digital output port.

DO_ReadPort	Reads digital data from the specified digital output port.

4.5.3 Continuous Digital Output Functions

DO_ContWritePort	Performs continuous digital output on the specified digital output port at a rate as close to the rate you specified.
DO_ContStatus	Checks the current status of the continuous digital output operation.
DO_PGStart	Performs pattern generation operation.
DO_PGStop	Stops pattern generation operation.

4.5.4 Asynchronous Digital Output Monitoring Functions

DO_AsyncCheck	Checks the current status of the asynchronous digital output operation.
DO_AsyncClear	Stops the asynchronous digital output operation.

4.6 Timer/Counter Function Group

CTR_Setup	Configures the selected counter to operate in the specified mode.
CTR_Read	Reads the current contents of the selected counter.
CTR_Clear	Sets the output of the selected counter to the specified state.
CTR_8554_ClkSrc_Config	Sets the counter clock source.

CTR_8554_CK1_Config	Sets the source of CK1.
CTR_8554_Debounce_Config	Sets the debounce clock.

4.7 DIO Function Group

4.7.1 Digital Input/Output Configuration Functions

DIO_PortConfig	This function is only used by the Digital I/O cards whose I/O port can be set as input port or output port. This function informs PCIS-DASK library of the port direction selected for the digital input/output operation. You must call this function before calling functions to perform digital input/output operation.

4.7.2 Dual-Interrupt System Setting Functions

DIO_SetDualInterrupt	Controls two interrupt sources of Dual Interrupt system.
DIO_SetCOSInterrupt	Sets the ports used for COS interrupt detection.
DIO_INT1_EventMessage	Controls the interrupt sources of INT1 of Dual Interrupt system and notifies the user's application when an interrupt event occurs. The notification is performed through a user-specified callback function or the Windows PostMessage API.
DIO_INT2_EventMessage	Controls the interrupt sources of INT2 of Dual Interrupt system and notifies the user's application when an interrupt event occurs.

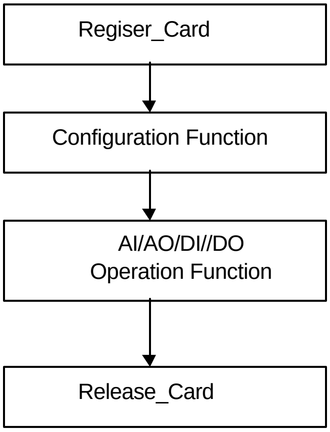
The notification is performed through a user-specified callback function or the Windows PostMessage API.

5

PCIS-DASK Application Hints

This chapter provides the programming schemes showing the function flow of that PCIS-DASK performs analog I/O and digital I/O.

The figure below shows the basic building blocks of a PCIS-DASK application. However, except using Register_Card at the beginning and Release_Card at the end, depending on the specific devices and applications you have, the PCIS-DASK functions comprising each building block vary.



The programming schemes for analog input/output and digital input/output are described individually in the following sections.

5.1 Analog Input Programming Hints

PCIS-DASK provides two kinds of analog input operation — nonbuffered single-point analog input readings and buffered continuous analog input operation.

The nonbuffered single-point AI uses software polling method to read data from the device. The programming scheme for this kind of AI operation is described in section 5.1.1.

The buffered continuous analog input uses interrupt transfer or DMA transfer method to transfer data from device to user's buffer. The maximum number of count in one transfer depends on the size of initially allocated memory for analog input in the driver. The driver allocates the memory at system boot time (in Window NT) or Windows startup time (in Window 98). We recommend the applications use *AI_InitialMemoryAllocated* function to get the size of initially allocated memory before performing continuous AI operation.

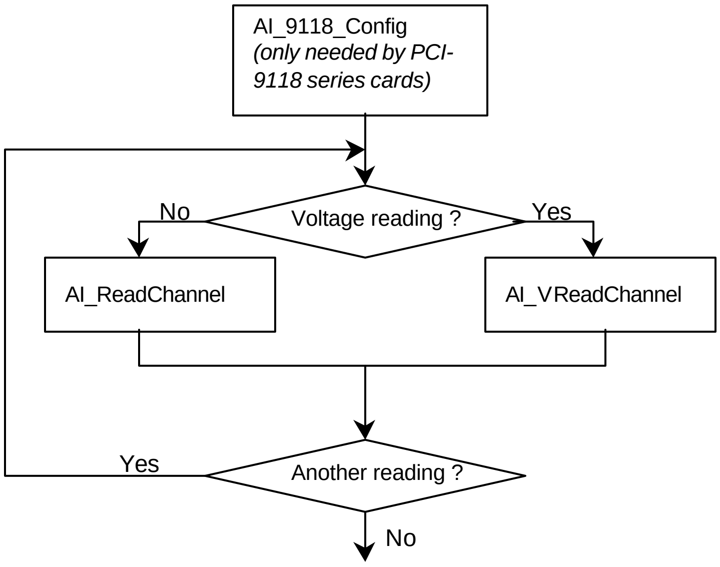
The buffered continuous analog input includes:

- synchronous continuous AI
- non-triggered non-double-buffered asynchronous continuous AI
- non-triggered double-buffered asynchronous continuous AI
- triggered non-double-buffered asynchronous continuous AI
- triggered double-buffered asynchronous continuous AI

They are described in section 5.1.2 to 5.1.6 section respectively. About the special consideration and performance issues for the buffered continuous analog input, please refer to the *Continuous Data Transfer in PCIS-DASK* chapter for the details.

5.1.1 One-Shot Analog input programming Scheme

This section described the function flow typical of nonbuffered single-point analog input readings. While performing one-shot AI operation, most of the cards (except PCI-9118 series cards) don' t need to include AI configuration step at the beginning of your application.

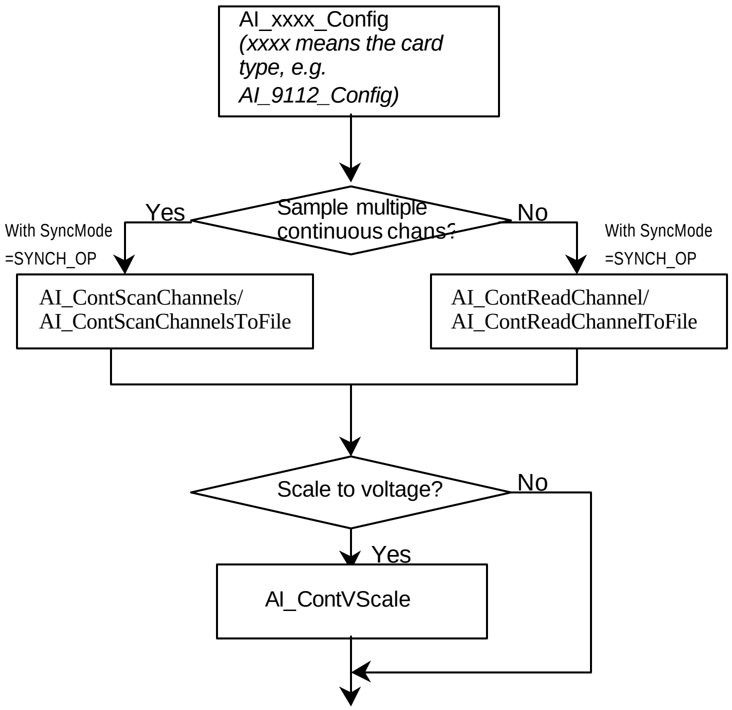


[Example Code Fragment]

```
card = Register_Card(PCI_9118, card_number);
          …
AI_9118_Config(card,Input_Signal|Input_Mode,0,0,0);
AI_ReadChannel(card, channelNo, range, &analog_input[i]);
          …
Release_Card(card);
```

5.1.2 Synchronous Continuous Analog input programming Scheme

This section described the function flow typical of synchronous analog input operation. While performing continuous AI operation, the AI configuration function has to be called at the beginning of your application. In addition, for synchronous AI, the *SyncMode* argument in continuous AI functions has to be set as *SYNCH_OP.*


AI_xxxx_Config
(xxxx means the card type, e.g. AI_9112_Config)
Sample multiple continuous chans?
Yes
No
With SyncMode =SYNCH_OP
With SyncMode =SYNCH_OP
AI_ContScanChannels/ AI_ContScanChannelsToFile
AI_ContReadChannel/ AI_ContReadChannelToFile
Scale to voltage?
No
Yes
AI_ContVScale

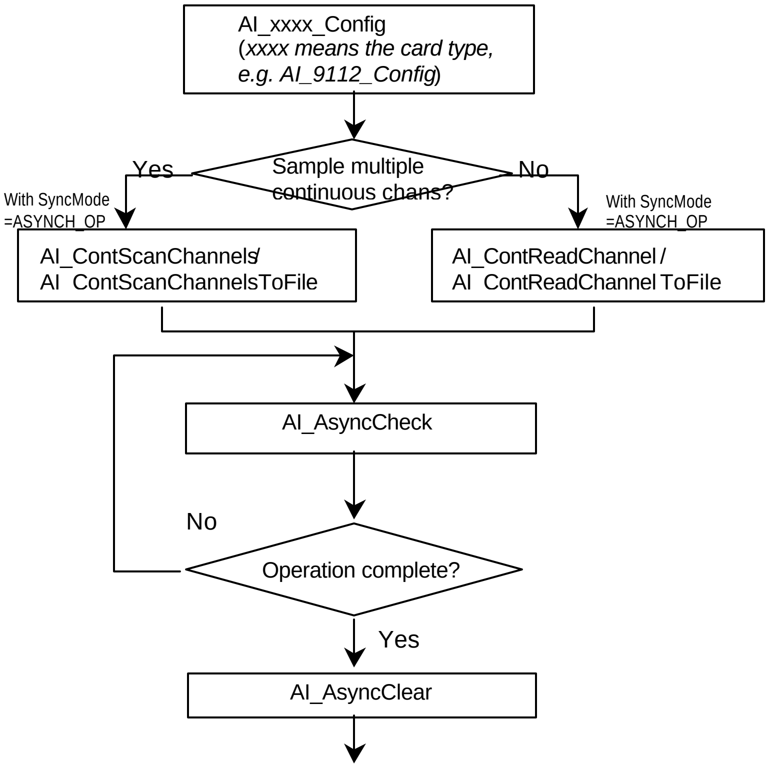
[Example Code Fragment]

```
card = Register_Card(PCI_9112, card_number);
          …
```

```
AI_9112_Config(card,TRIG_INT_PACER);
AI_ContScanChannels (card, channel, range, ai_buf, data_size,
(F64)sample_rate, SYNCH_OP); or
AI_ContReadChannel(card, channel, range, ai_buf, data_size,
(F64)sample_rate, SYNCH_OP)
                …
Release_Card(card);
```

5.1.3 Non-Trigger Non-double-buffered Asynchronous Continuous Analog input programming Scheme

This section described the function flow typical of non-trigger, non-double-buffered asynchronous analog input operation. While performing continuous AI operation, the AI configuration function has to be called at the beginning of your application. In addition, for asynchronous AI, the *SyncMode* argument in continuous AI functions has to be set as *ASYNCH_OP.*

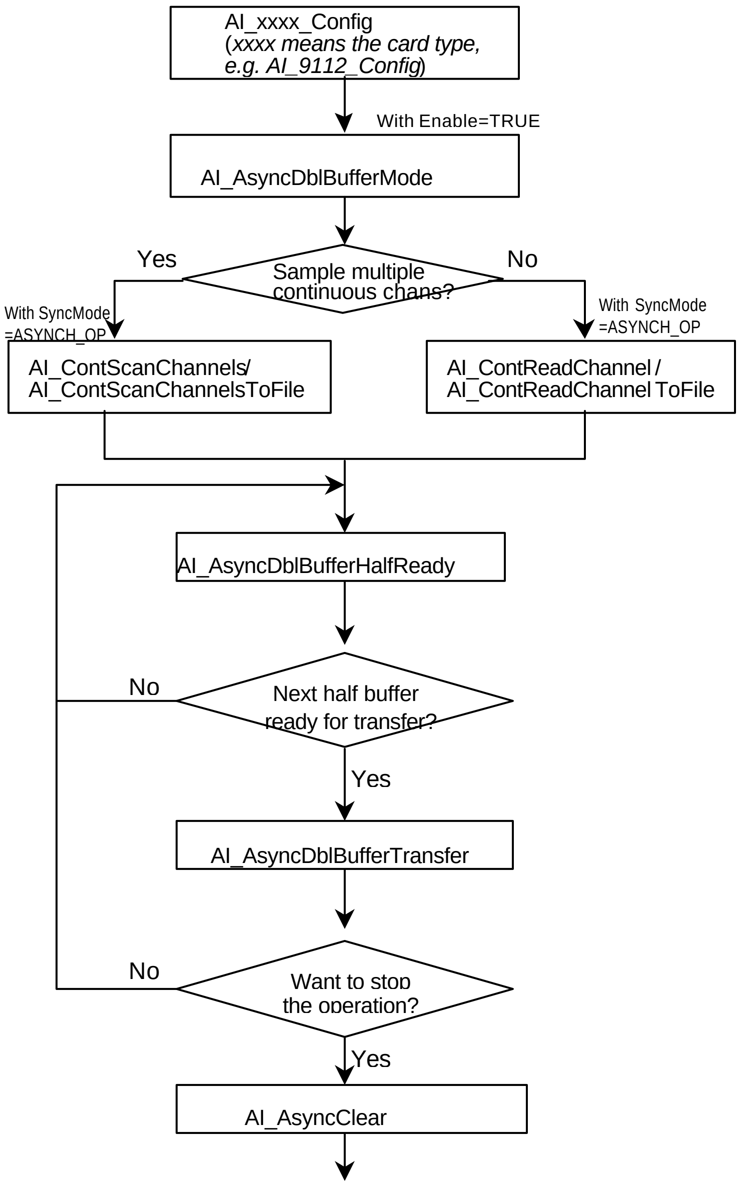

AI_xxxx_Config
(*xxxx means the card type, e.g. AI_9112_Config*)
Sample multiple continuous chans?
Yes
No
With SyncMode =ASYNCH_OP
With SyncMode =ASYNCH_OP
AI_ContScanChannels/ AI_ContScanChannelsToFile
AI_ContReadChannel / AI_ContReadChannel ToFile
AI_AsyncCheck
No
Operation complete?
Yes
AI_AsyncClear

[Example Code Fragment]

```
card = Register_Card(PCI_9112, card_number);
              …
AI_9112_Config(card,TRIG_INT_PACER);
AI_AsyncDblBufferMode (card, 0); //non-double-buffered AI
AI_ContScanChannels (card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP); or
AI_ContReadChannel(card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP)
do {
      AI_AsyncCheck(card, &bStopped, &count);
} while (!bStopped);

AI_AsyncClear(card, &count);
 …
Release_Card(card);
```

5.1.4 Non-Trigger Double-buffered Asynchronous Continuous Analog input programming Scheme

This section described the function flow typical of non-trigger, double-buffered asynchronous analog input operation. While performing continuous AI operation, the AI configuration function has to be called at the beginning of your application. For asynchronous AI, The *SyncMode* argument in continuous AI functions has to be set as *ASYNCH_OP.* In addition, double-buffered AI operation is enabled by setting *Enable* argument of *AI_AsyncDblBufferMode* function to 1. To learn more about double buffer mode, please refer to section 5.2 *Double-Buffered AI/DI Operation* for the details.

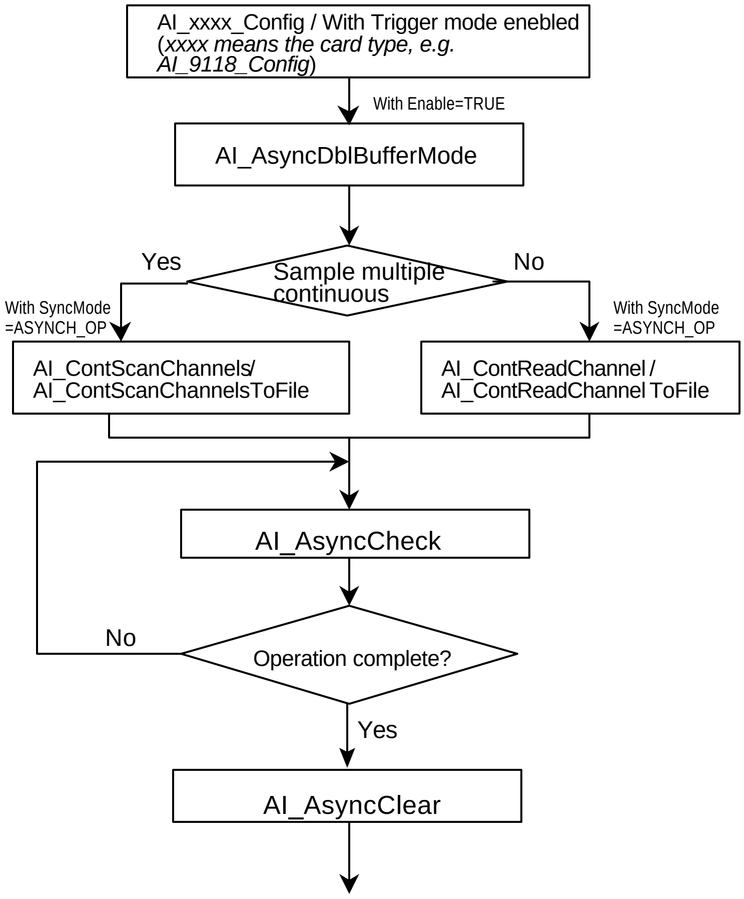

AI_xxxx_Config
(*xxxx means the card type, e.g. AI_9112_Config*)
With Enable=TRUE
AI_AsyncDblBufferMode
Sample multiple continuous chans?
Yes
No
With SyncMode =ASYNCH_OP
With SyncMode =ASYNCH_OP
AI_ContScanChannels/ AI_ContScanChannelsToFile
AI_ContReadChannel / AI_ContReadChannel ToFile
AI_AsyncDblBufferHalfReady
Next half buffer ready for transfer?
No
Yes
AI_AsyncDblBufferTransfer
Want to stop the operation?
No
Yes
AI_AsyncClear

[Example Code Fragment]

```
card = Register_Card(PCI_9112, card_number);
              …
AI_9112_Config(card,TRIG_INT_PACER);
AI_AsyncDblBufferMode (card, 1); // Double-buffered AI
AI_ContScanChannels (card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP); or
AI_ContReadChannel(card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP)
do {
     do {
         AI_AsyncDblBufferHalfReady(card, &HalfReady, &fstop);
     } while (!HalfReady);

     AI_AsyncDblBufferTransfer(card, ai_buf);
     …
} while (!clear_op);

AI_AsyncClear(card, &count);
…
Release_Card(card);
```

5.1.5 Trigger Mode Non-double-buffered Asynchronous Continuous Analog input programming Scheme

This section described the function flow typical of trigger mode double-buffered asynchronous analog input operation. A trigger is an event that occurs based on a specified set of conditions. An interrupt mode or DMA-mode Analog input operation can use a trigger to determinate when acquisition stop. The trigger mode data acquisition programming is almost the same as the non-trigger mode asynchronous analog input programming. Using PCIS-DASK to perform trigger mode data acquisition, the *SyncMode* of continuous AI should be set as *ASYNCH_OP*.


AI_xxxx_Config / With Trigger mode enebled (*xxxx means the card type, e.g. AI_9118_Config*)
With Enable=TRUE
AI_AsyncDblBufferMode
Sample multiple continuous
Yes
No
With SyncMode =ASYNCH_OP
With SyncMode =ASYNCH_OP
AI_ContScanChannels/ AI_ContScanChannelsToFile
AI_ContReadChannel / AI_ContReadChannel ToFile
AI_AsyncCheck
Operation complete?
No
Yes
AI_AsyncClear

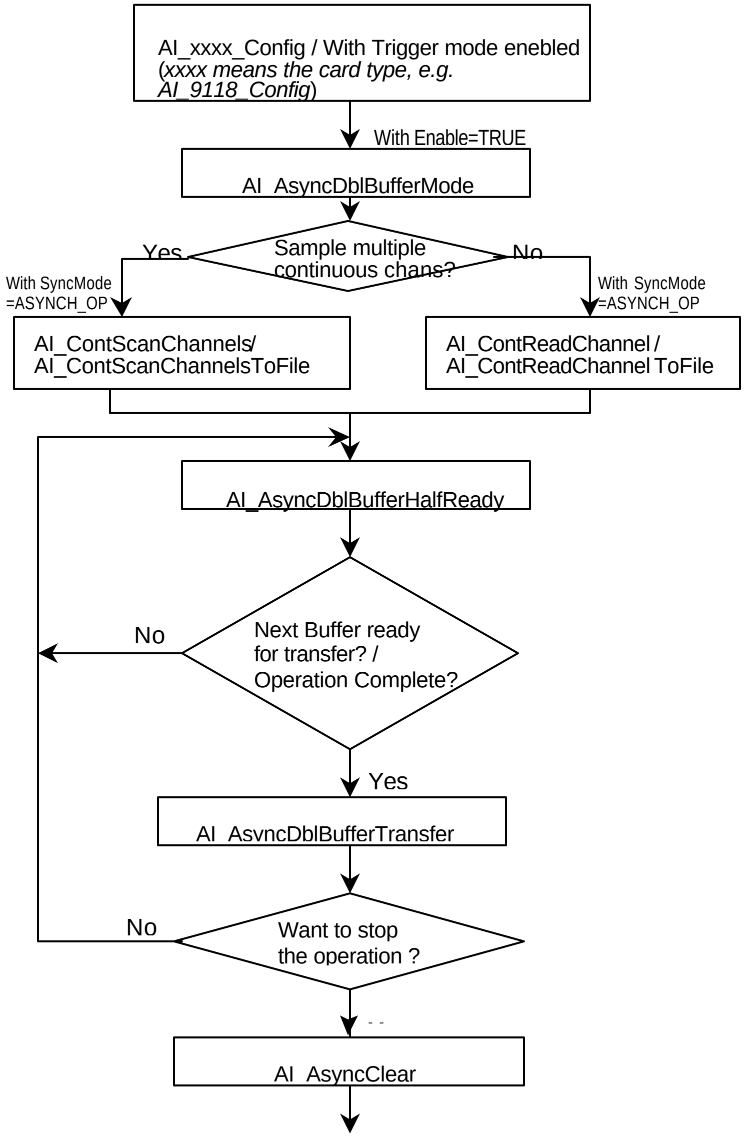
[Example Code Fragment]

card = Register_Card(PCI_9118, card_number);
…
AI_9118_Config(card, P9118_AI_BiPolar|P9118_AI_SingEnded, P9118_AI_DtrgPositive|P9118_AI_EtrgPositive| ***P9118_AI_AboutTrgEn****, 0, postCount)*
AI_AsyncDblBufferMode (card, 0); //non-double-buffered AI

```
AI_ContScanChannels (card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP); or
AI_ContReadChannel(card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP)
do {
      AI_AsyncCheck(card, &bStopped, &count);
} while (!bStopped);

AI_AsyncClear(card, &count);
 …
Release_Card(card);
```

5.1.6 Trigger Mode Double-buffered Asynchronous Continuous Analog input programming Scheme

This section described the function flow typical of trigger mode double-buffered asynchronous analog input operation. A trigger is an event that occurs based on a specified set of conditions. An interrupt mode or DMA-mode Analog input operation can use a trigger to determinate when acquisition stop. The trigger mode data acquisition programming is almost the same as the non-trigger mode asynchronous analog input programming. Using PCIS-DASK to perform trigger mode data acquisition, the *SyncMode* of continuous AI should be set as *ASYNCH_OP*. In addition, double-buffered AI operation is enabled by setting *Enable* argument of *AI_AsyncDblBufferMode* function to 1. To learn more about double buffer mode, please refer to section 5.2 *Double-Buffered AI/DI Operation* for the details.


AI_xxxx_Config / With Trigger mode enebled
(xxxx means the card type, e.g. AI_9118_Config)
With Enable=TRUE
AI_AsyncDblBufferMode
Sample multiple continuous chans?
Yes
No
With SyncMode =ASYNCH_OP
With SyncMode =ASYNCH_OP
AI_ContScanChannels/ AI_ContScanChannelsToFile
AI_ContReadChannel / AI_ContReadChannel ToFile
AI_AsyncDblBufferHalfReady
Next Buffer ready for transfer? / Operation Complete?
No
Yes
AI_AsyncDblBufferTransfer
Want to stop the operation ?
No
AI_AsyncClear

[Example Code Fragment]

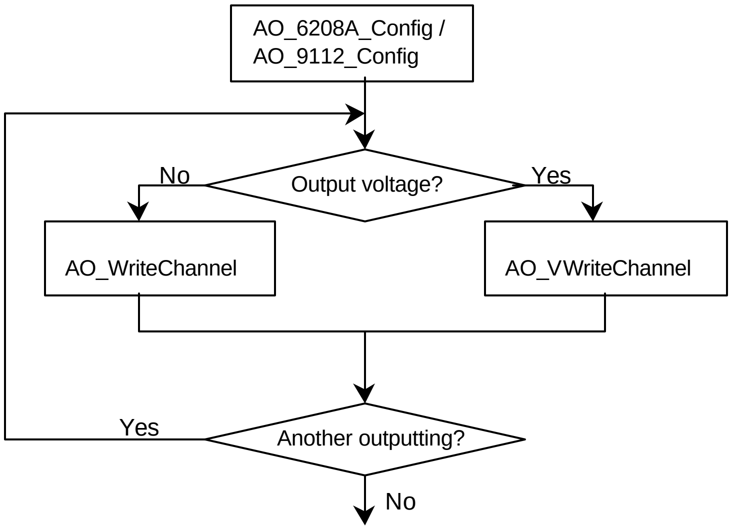
```
card = Register_Card(PCI_9118, card_number);
                …
AI_9118_Config(card,P9118_AI_BiPolar|P9118_AI_SingEnded,
P9118_AI_DtrgPositive|P9118_AI_EtrgPositive|
P9118_AI_AboutTrgEn,0,postCount)
AI_AsyncDblBufferMode (card, 1);  Double-buffered AI
AI_ContScanChannels (card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP); or
AI_ContReadChannel(card, channel, range, ai_buf, data_size,
(F64)sample_rate, ASYNCH_OP)
do {
    do {
        AI_AsyncDblBufferHalfReady(card, &HalfReady, &fstop);
    } while (!HalfReady && !fstop);

    AI_AsyncDblBufferTransfer(card, ai_buf);
    …
} while (!clear_op && !fstop);

AI_AsyncClear(card, &count);
AI_AsyncDblBufferTransfer(card, ai_buf);
…
Release_Card(card);
```

5.2 Analog Output Programming Hints

This section described the function flow typical of single-point analog output conversion. While performing the following operation, the AO configuration function has to be called at the beginning of your application:

a. Use PCI-6208A, PCI-6308A to perform current output

b. Use the analog output function that can convert a voltage value to a binary value and then write it to device, the AO configuration function has to be called at the beginning of your application.



[Example Code Fragment]

```
card = Register_Card(PCI_6208A, card_number);
          …
AO_6208A_Config(card, P6208_CURRENT_4_20MA);
AO_WriteChannel(card, chan, out_value);
          …
Release_Card(card);
```

5.3 Digital Input Programming Hints

PCIS-DASK provides two kinds of digital input operation — nonbuffered single-point digital input operation and buffered continuous digital input operation.

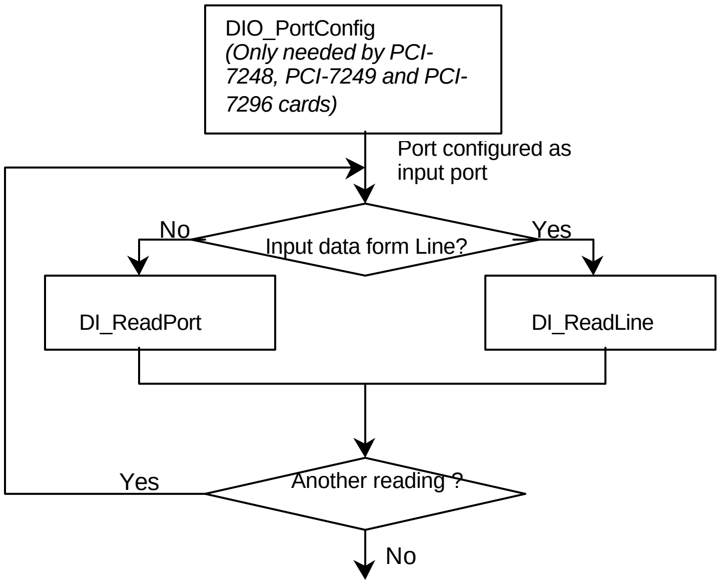
The nonbuffered single-point DI uses software polling method to read data from the device. The programming scheme for this kind of DI operation is described in section 5.3.1.

The buffered continuous DI uses DMA transfer method to transfer data from device to user's buffer. The maximum number of count in one transfer depends on the size of initially allocated memory for digital input in the driver. The driver allocates the memory at system boot time (in Window NT) or Windows startup time (in Window 98). We recommend the applications use *DI_InitialMemoryAllocated* function to get the size of initially allocated memory before performing continuous DI operation.

The buffered continuous analog input includes synchronous continuous DI, non-double-buffered asynchronous continuous DI and double-buffered asynchronous continuous DI. They are described in section 5.3.2 to 5.3.4 section respectively. About the special consideration and performance issues for the buffered continuous digital input, please refer to the *Continuous Data Transfer in PCIS-DASK* chapter for the details.

5.3.1 One-Shot Digital input programming Scheme

This section described the function flow typical of non-buffered single-point digital input readings. While performing one-shot DI operation, the devices whose I/O port can be set as input or out put port (PCI-7248 and PCI7296) need to include port configuration function at the beginning of your application.

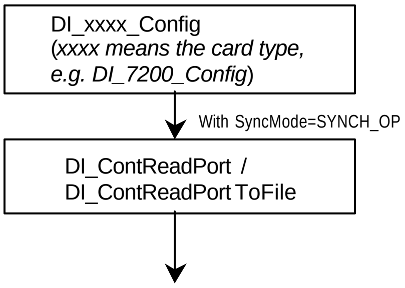


[Example Code Fragment]

```
card = Register_Card(PCI_7248, card_number);
//port configured
DIO_PortConfig(card ,Channel_P1A, INPUT_PORT);
DIO_PortConfig(card, Channel_P1B, INPUT_PORT);
DIO_PortConfig(card, Channel_P1CL, INPUT_PORT);
DIO_PortConfig(card, Channel_P1CH, INPUT_PORT);
//DI operation
DI_ReadPort(card,  Channel_P1A, &inputA);
...
Release_Card(card);
```

5.3.2 Synchronous Continuous Digital input programming Scheme

This section described the function flow typical of synchronous digital input operation. While performing continuous DI operation, the DI configuration function has to be called at the beginning of your application. In addition, for synchronous DI, the *SyncMode* argument in continuous DI functions has to be set as *SYNCH_OP.*

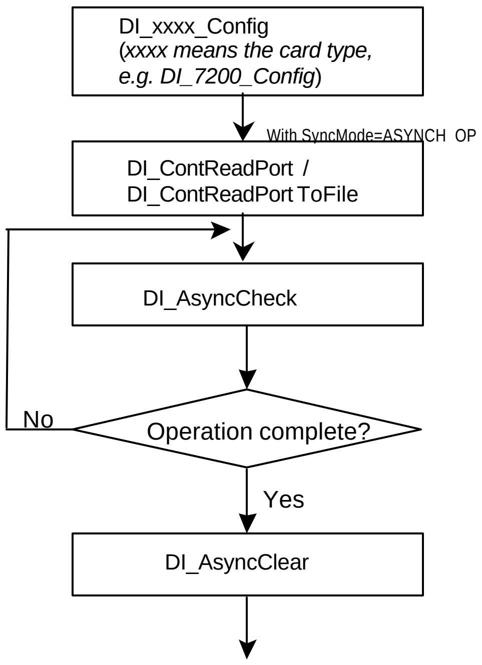


[Example Code Fragment]

card = Register_Card(PCI_7200, card_number);
…
DI_7200_Config(card,TRIG_INT_PACER, DI_NOWAITING, DI_TRIG_FALLING, IREQ_FALLING);
DI_AsyncDblBufferMode (card, 0); //non-double-buffered mode
DI_ContReadPort(card, 0, pMem, data_size, (F64)sample_rate, SYNCH_OP)
…
Release_Card(card);

5.3.3 Non-double-buffered Asynchronous Continuous Digital input programming Scheme

This section described the function flow typical of non-double-buffered asynchronous digital input operation. While performing continuous DI operation, the DI configuration function has to be called at the beginning of your application. In addition, for asynchronous DI operation, the *SyncMode* argument in continuous DI functions has to be set as *ASYNCH_OP.*



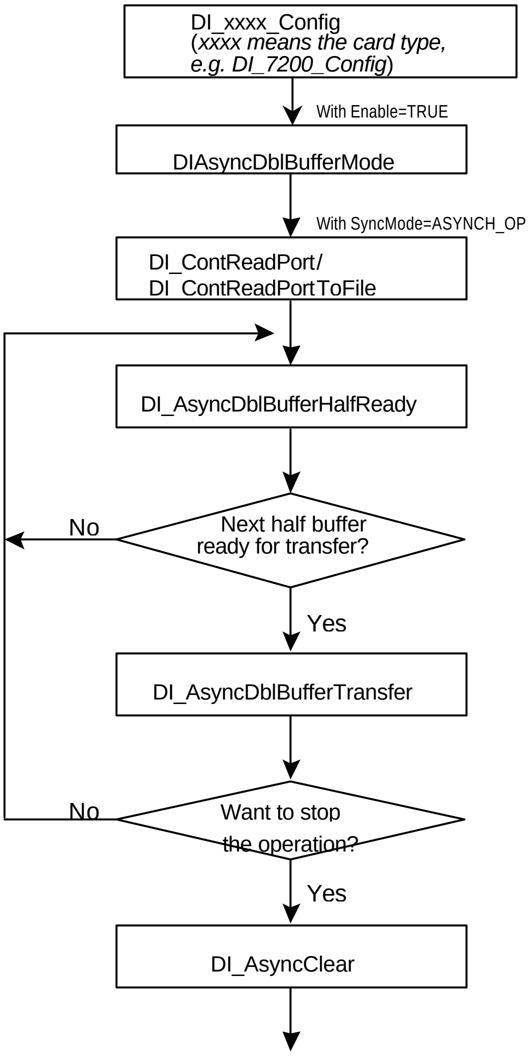
[Example Code Fragment]

card = Register_Card(PCI_7200, card_number);
…

```
DI_7200_Config(card,TRIG_INT_PACER, DI_NOWAITING,
DI_TRIG_FALLING, IREQ_FALLING);
DI_AsyncDblBufferMode (card, 0); // non-double-buffered mode
DI_ContReadPort(card, 0,  pMem,  data_size,  (F64)sample_rate,
ASYNCH_OP)
do {
      DI_AsyncCheck(card, &bStopped, &count);
} while (!bStopped);

DI_AsyncClear(card, &count);
 …
Release_Card(card);
```

5.3.4 Double-buffered Asynchronous Continuous Digital input programming Scheme

This section described the function flow typical of double-buffered asynchronous digital input operation. While performing continuous DI operation, the DI configuration function has to be called at the beginning of your application. For asynchronous DI, the *SyncMode* argument in continuous DI functions has to be set as *ASYNCH_OP.* In addition, double-buffered AI operation is enabled by setting *Enable* argument of *DI_AsyncDblBufferMode* function to 1. To learn more about double buffer mode, please refer to the *Double-Buffered AI/DI operation* section for the details.


DI_xxxx_Config
(xxxx means the card type, e.g. DI_7200_Config)
With Enable=TRUE
DIAsyncDblBufferMode
With SyncMode=ASYNCH_OP
DI_ContReadPort/
DI_ContReadPortToFile
DI_AsyncDblBufferHalfReady
No
Next half buffer ready for transfer?
Yes
DI_AsyncDblBufferTransfer
No
Want to stop the operation?
Yes
DI_AsyncClear

[Example Code Fragment]

card = Register_Card(PCI_7200, card_number);

```
            …
DI_7200_Config(card,TRIG_INT_PACER, DI_NOWAITING,
DI_TRIG_FALLING, IREQ_FALLING);
DI_AsyncDblBufferMode (card, 1); // Double-buffered mode
DI_ContReadPort(card, 0,  pMem,  data_size,  (F64)sample_rate,
ASYNCH_OP)
do {
     do {
         DI_AsyncDblBufferHalfReady(card, &HalfReady);
     } while (!HalfReady);

   DI_AsyncDblBufferTransfer(card, pMem);

} while (!clear_op);

DI_AsyncClear(card, &count);
…
Release_Card(card);
```

5.4 Digital Output Programming Hints

PCIS-DASK provides three kinds of digital output operation — nonbuffered single-point digital output operation, buffered continuous digital output operation and pattern generation.

The nonbuffered single-point DO uses software polling method to write data to the device. The programming scheme for this kind of DO operation is described in section 5.4.1.

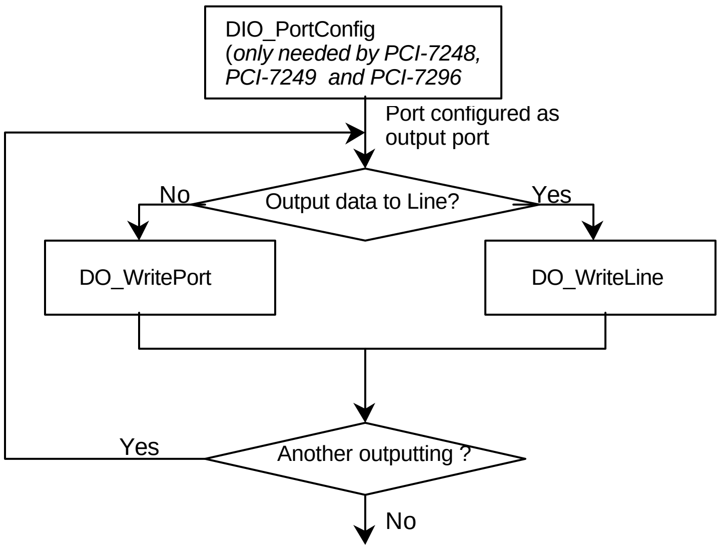
The buffered continuous DO uses DMA transfer method to transfer data from user's buffer to device. The maximum number of count in one transfer depends on the size of initially allocated memory for digital output in the driver. The driver allocates the memory at system boot time (in Window NT) or Windows startup time (in Window 98). We recommend the applications use *DO_InitialMemoryAllocated* function to get the size of initially allocated memory before start performing continuous DO operation.

The buffered continuous digital output includes synchronous continuous DO and asynchronous continuous DO. They are described in section 5.4.2 and 5.4.3 section individually. About the special consideration and performance issues for the buffered continuous digital output, please refer to the *Continuous Data Transfer in PCIS-DASK* chapter for the details.

The Pattern Generation DO outputs digital data pattern repeatedly at a predetermined rate. The programming scheme for this kind of DO operation is described in section 5.4.4.

5.4.1 One-Shot Digital output programming Scheme

This section described the function flow typical of non-buffered single-point digital output operation. While performing one-shot DO operation, the cards whose I/O port can be set as input or out put port (PCI-7248, PCI7249 and PCI-7296) need to include port configuration function at the beginning of your application.

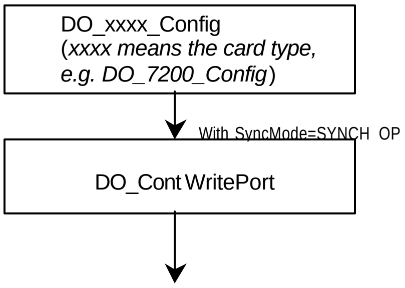


[Example Code Fragment]

```
card = Register_Card(PCI_7248, card_number);
//port configured
DIO_PortConfig(card ,Channel_P1A, OUTPUT_PORT);
DIO_PortConfig(card, Channel_P1B, OUTPUT_PORT);
DIO_PortConfig(card, Channel_P1CL, OUTPUT_PORT);
DIO_PortConfig(card, Channel_P1CH, OUTPUT_PORT);
//DO operation
DO_WritePort(card, Channel_P1A, outA_value);
…
Release_Card(card);
```

5.4.2 Synchronous Continuous Digital output programming Scheme

This section described the function flow typical of synchronous digital output operation. While performing continuous DO operation, the DO configuration function has to be called at the beginning of your application. In addition, for synchronous DO operation, the *SyncMode* argument in continuous DO functions for synchronous mode has to be set as *SYNCH_OP.*

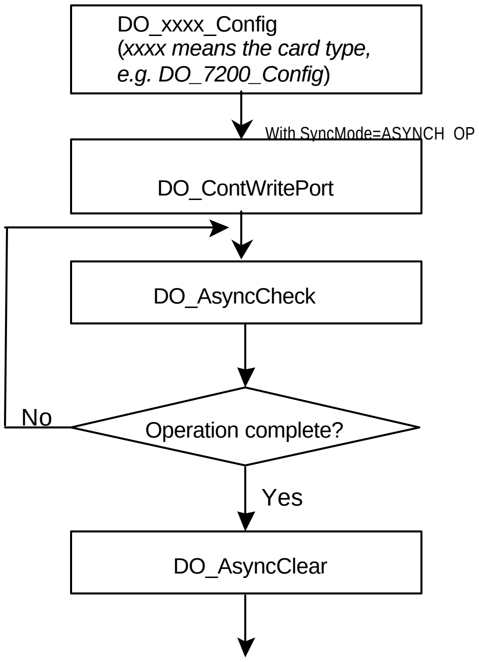


[Example Code Fragment]

card = Register_Card(PCI_7200, card_number);
…
DO_7200_Config(card, TRIG_INT_PACER, OREQ_DISABLE, OTRIG_LOW);
DO_AsyncDblBufferMode (card, 0); //non-double-buffered mode
DO_ContWritePort(card, 0, DoBuf, count, 1, (F64)sample_rate, SYNCH_OP);
…
Release_Card(card);

5.4.3 Asynchronous Continuous Digital output programming Scheme

This section described the function flow typical of asynchronous digital output operation. While performing continuous DO operation, the DO configuration function has to be called at the beginning of your application. In addition, for asynchronous DO operation, the *SyncMode* argument in continuous DO functions for asynchronous mode has to be set as *ASYNCH_OP.*



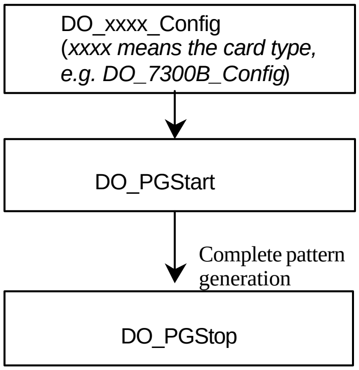
[Example Code Fragment]

card = Register_Card(PCI_7200, card_number);
…
DO_7200_Config(card, TRIG_INT_PACER, OREQ_DISABLE, OTRIG_LOW);

```
DO_ContWritePort(card, 0, DoBuf, count, 1, (F64)sample_rate,
ASYNCH_OP);
do {
      DO_AsyncCheck(card, &bStopped, &count);
} while (!bStopped);

DO_AsyncClear(card, &count);
 …
Release_Card(card);
```

5.4.4 Pattern Generation Digital output programming Scheme

This section described the function flow typical of pattern generation for digital output. While performing pattern generation of DO, the DO configuration function has to be called at the beginning of your application.


DO_xxxx_Config
(*xxxx means the card type, e.g. DO_7300B_Config*)
DO_PGStart
Complete pattern generation
DO_PGStop

[Example Code Fragment]

card = Register_Card(PCI_7300A_RevB, card_number);
…
DO_7300B_Config (card, 16, TRIG_INT_PACER, P7300_WAIT_NO, P7300_TERM_ON, 0, 0x40004000);
//start pattern generation
***DO_PGStart** (card, out_buf, 10000, 5000000);*
…
//stop pattern generation
***DO_PGStop** (card);*
Release_Card(card);

5.5 Interrupt Event Message Programming Hints

PCIS-DASK provides two methods to perform interrupt occurrence notification for NuDAQ DIO cards that have dual interrupt system.

The Event Message method handles event notification through user-defined callbacks and/or the Windows Message queue (for VB5, through user-defined callbacks only). When a user-specified interrupt event occurs, PCIS-DASK calls the user-defined callback (if defined) and/or puts a message into the Windows Message queue, if you specified a window handle. After receiving the message, the user's application can carry out the appropriate task.

The event message mechanism is easy and safe in Windows 98 and NT systems; however, the time delay between the event and notification is highly variable and depends largely on how loaded your system is. In addition, if a callback function is called, succeeding events will not be handled until your callback has returned. If the time interval between interrupt events is smaller than the time taken for callback function processing, the succeeding interrupt events will not be handled. Therefore this mechanism is not suitable for the frequent interrupt occurrence condition.

The Event Status checking and waiting method handles interrupt event status checking through Win32 wait functions, such as WaitForSingleObject or WaitForMultipleObjects. This method is useful for the situation that the interrupt event occurs very often, and the applications written in the language that doesn't support function pointers (e.g. VB4).

1. Through user-defined callbacks and the Windows Message queue

[Example Code Fragment]

card = Register_Card(PCI_7230, card_number);

*//INT1 event notification is through **window message***
DIO_INT1_EventMessage (card, INT1_EXT_SIGNAL, hWnd, WM_INT, NULL);

```
//INT2 event notification is through a callback function
DIO_INT2_EventMessage (card, INT2_EXT_SIGNAL, hWnd,
NULL, (void *) cbfn);
…
//window message handling function
long PASCAL MainWndProc(hWnd, message, wParam,
lParam)
{
  switch(message) {
   …
  case WM_INT: //interrupt event occurring message
   …
  break;
   …
 case WM_DESTROY:
   //Disable interrupts
   DIO_INT1_EventMessage (card, INT1_DISABLE,
   hMainWnd, NULL, NULL);
   DIO_INT2_EventMessage (card, INT2_DISABLE,
   hMainWnd, NULL, NULL);
   //Release card
   if (card >= 0) Release_Card(card);
   PostQuitMessage(0);
break;
…
 }
}
…
//call back function
LRESULT CALLBACK cbfn()
{
   …
}
```

2. Through a Win32 wait function

[Example Code Fragment]

```
card = Register_Card(PCI_7230, card_number);
```

```
   DIO_SetDualInterrupt(card, INT1_EXT_SIGNAL,
                              INT2_EXT_SIGNAL, hEvent);
   …
   //wait for  INT1 event
   if (WaitForSingleObject(hEvent[0], INFINITE) ==
                              WAIT_OBJECT_0) {
           ResetEvent(hEvent[0]);
           ……
   }
   ….
//wait for  INT2 event
if (WaitForSingleObject(hEvent[1], INFINITE) ==
                              WAIT_OBJECT_0) {
           ResetEvent(hEvent[1]);
           ……
}
….
if (card >= 0) Release_Card(card);
```

6

Continuous Data Transfer in PCIS-DASK

The continuous data transfer functions in PCIS-DASK input or output blocks of data to or from a plug-in NuDAQ PCI device. For input operations, PCIS-DASK must transfer the incoming data to a buffer in the computer memory. For output operations, PCIS-DASK must transfer outgoing data from a buffer in the computer memory to the NuDAQ PCI device. This chapter describes the mechanism and techniques that PCIS-DASK uses for continuous data transfer and the considerations for selecting the continuous data transfer mode (sync. or async., double buffered or not, triggered or non-triggered mode).

6.1 Continuous Data Transfer Mechanism

PCIS-DASK uses two mechanisms to perform the continuous data transfer. The first one, interrupt transfer, transfers data through the interrupt mechanism. The second one is to use the DMA controller chip to perform a hardware transfer of the data. Whether PCIS-DASK uses interrupt or DMA depends on the device. If the device support both of these two mechanisms, PCIS-DASK decides on the data transfer method that typically takes maximum advantage of available resources. For example, PCI-9112 supports interrupt and DMA for data transfers. The DMA data transfer is typically faster, so PCIS-DASK takes advantage of it. PCI-9111 supports FIFO Half-Full and EOC interrupt transfer modes. PCIS-DASK takes FIFO Half-Full interrupt transfer mode, because the CPU is interrupted do data transfer only when the FIFO becomes half-full.

6.2 Double-Buffered AI/DI Operation

PCIS-DASK uses double-buffering techniques in its driver software for continuous input of large amounts of data.

6.2.1 Double Buffer Mode Principle

The data buffer for double-buffered continuous input operation is a circular buffer logically. It is logically divided into two equal halves. The double-buffered input begins when device starts writing data into the first half of the circular buffer (Figure 6-1a). After device begins writing to the second half of the circular buffer, you can copy the data from the first half into the transfer buffer (user buffer) (Figure 6-1b). You now can process the data in the transfer buffer according to application needs. After the board has filled the second half of the circular buffer, the board returns to the first half buffer and overwrites the old data. You now can copy the second half of the circular buffer to the transfer buffer (Figure 6-1c). The data in the transfer buffer is again available for process. The process can be repeated endlessly to provide a continuous stream of data to your application (Figure 6-1d).

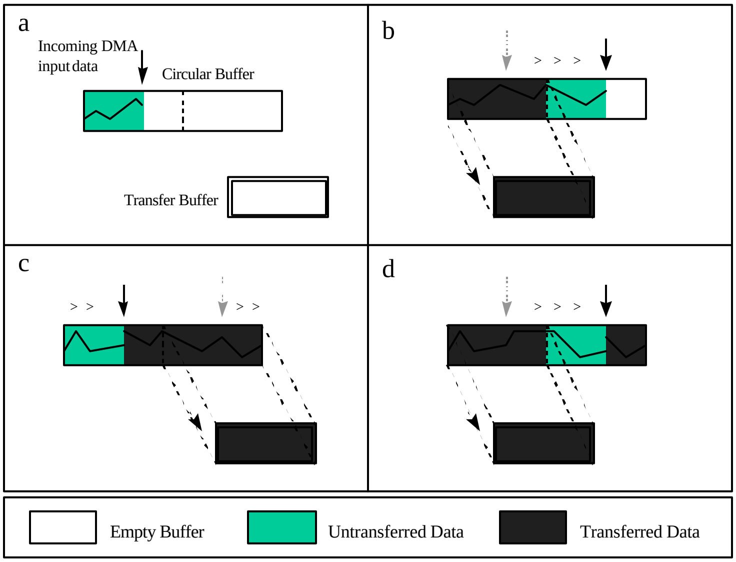


Figure 7-1

The PCIS-DASK double buffer mode functions were designed according to the principle described above. If you use **`AI_AsyncDblBufferMode/DI_AsyncDblBufferMode`** to enable double buffer mode, the following continuous AI/DI function will perform double-buffered continuous AI/DI. You can call **`AI_AsyncDblBufferHalfReady/DI_AsyncDblBufferHalfReady`** to check if data in the circular buffer is half full and ready for copying to the transfer buffer. Then you can call **`AI_AsyncDblBufferTransfer/DI_AsyncDblBufferTransfer`** to copy data from the ready half buffer to the transfer buffer.

Single-Buffered Versus Double-Buffered Data Transfer

Single-buffered data transfer is the most common method for continuous data transfer. In single-buffered input operations, a fixed number of samples are acquired at a specified rate and transferred into user' s buffer. After the user' s buffer stores the data, the application can analyze, display, or store the data to the hard disk for later processing. Single-buffered operations are relatively simple to implement and can usually take advantage of the full hardware speed of the device. However, the major disadvantage of single-buffered operation is that the maximum amount of data that can be input at any one time is limited to the amount of initially allocated memory allocated in driver and the amount of free memory available in the computer.

In double-buffered operations, as mentioned above, the data buffer is configured as a circular buffer. Therefore, unlike single-buffered operations, double-buffered operations reuse the same buffer and are able to input or output an infinite number of data points without requiring an infinite amount of memory. However, there exits the undesired result of data overwritten for double-buffered data transfer. The device might overwrite data before PCIS-DASK has copied it to the transfer buffer. Another data overwritten problem occurs when an input device overwrites data that PCIS-DASK is simultaneously copying to the transfer buffer. Therefore, the data must be processed by the application at least as fast as the rate at which the device is reading data. For most of the applications, this requirement depends on the speed and efficiency of the computer system and programming language.

Hence, double buffering might not be practical for high-speed input applications.

6.3 Trigger Mode Data Acquisition for Analog Input

A trigger is an event that occurs based on a specified set of conditions. An interrupt mode or DMA-mode analog input operation can use a trigger to determinate when acquisition stops or starts.

PCIS-DASK also provides two buffering methods for trigger mode AI – double-buffering and single-buffering. However, the single buffer in trigger mode AI is different from that in non-trigger mode AI. It is a circular buffer just like that in double buffer mode but the data stored in the buffer can be processed only when the continuous data reading is completed. The buffer will be reused until the data acquisition operation is completed. Therefore, to protect the data you want to get from being overwritten, the size of the single buffer should be the same as or larger than the amount of data you wish to access. For example, if you want to perform single-buffered middle-trigger AI with PCI-9812, and the amount of data you want to collect before and after the trigger event are 1000 and 3000 respectively, the size of single buffer is at least 4000 in order to get all the data you want to collect. Since the data are handled after the input operation is completed, the desired data loss problem hardly occurs.

Since PCIS-DASK uses asynchronous AI to perform trigger mode data acquisition, the *SyncMode* of continuous AI should be set as *ASYNCH_OP*.

7

Sample Programs

There are several sample programs provided in this software diskette. They could help you to program your own applications by using PCIS-DASK easily. The brief descriptions of these programs are specified as follows:

SDK6208V	D/A conversion of PCI-6208V/16V Visual C/C++ Program
SDK6208A	D/A conversion of PCI-6208A Visual C/C++ Program
VB6208	D/A conversion of PCI-6208A Visual Basic Program
VB6216	D/A conversion of PCI-6208V/16V Visual Basic Program
SDK7200Wave	Digital input of PCI-7200/cPCI-7200 through DMA transfer Visual C/C++ Program
SDK7200DbfWav	Double buffer mode digital input of PCI-7200/cPCI-7200 through DMA transfer Visual C/C++ Program
VB7200Dma	Digital input of PCI-7200/cPCI-7200 through DMA transfer Visual Basic Program
SDK7200HdSk	HandShanking mode digital input of PCI-7200/cPCI-7200 through DMA transfer Visual C/C++ program
SDK7230	D/I, and D/O of PCI-7230/cPCI-7230 Visual C/C++ Program

SDK7230Int	D/I, and D/O of PCI-7230/cPCI-7230 through Interrupt operation Visual C/C++ Program
SDK7230DbEvt	D/I, and D/O of PCI-7230/cPCI-7230 through Interrupt operation (Dual Interrupt Events) Visual C/C++ Program
VB7230	D/I, and D/O of PCI-7230/cPCI-7230 Visual Basic Program
SDK7234	D/O of PCI-7234 Visual C/C++ Program
VB7234	D/O of PCI-7234 Visual Basic Program
SDK7248	D/I, and D/O of PCI-7248/cPCI-7248 Visual C/C++ Program
SDK7248Int	D/I, and D/O of PCI-7248/cPCI-7248 through Interrupt operation Visual C/C++ Program
SDK7248DbEvt	D/I, and D/O of PCI-7248/cPCI-7248 through Interrupt operation (Dual Interrupt Events) Visual C/C++ Program
VB7248	D/I, and D/O of PCI-7248/cPCI-7248 Visual Basic Program
SDK7250	D/I, and D/O of PCI-7250/51 Visual C/C++ Program
VB7250	D/I, and D/O of PCI-7250/51 Visual Basic Program
SDK7252	D/I, and D/O of cPCI-7252 Visual C/C++ Program
VB7252	D/I, and D/O of cPCI-7252 Visual Basic Program
SDK7296	D/I, and D/O of PCI-7296 Visual C/C++ sample program
SDK7296Int	D/I, and D/O of PCI-7296 through Interrupt operation Visual C/C++ Program
SDK7296DbEvt	D/I, and D/O of PCI-7296 through Interrupt operation (Dual Interrupt Events) Visual C/C++ Program

VB7296	D/I, and D/O of PCI-7296 Visual Basic Program
SDK7300Wave	Digital input of PCI-7300A_Rev.A/cPCI-7300A_Rev.A through DMA transfer Visual C/C++ Program
SDK7300Wave	Digital input of PCI-7300A_Rev.B/cPCI-7300A_Rev.B through DMA transfer Visual C/C++ program
SDK7432	D/I, and D/O of PCI-7432/cPCI-7432 Visual C/C++ sample program
SDK7432Int	D/I, and D/O of PCI-7432/cPCI-7432 through Interrupt operation Visual C/C++ Program
SDK7432DbEvt	D/I, and D/O of PCI-7432/cPCI-7432 through Interrupt operation (Dual Interrupt Events) Visual C/C++ Program
VB7432	D/I, and D/O of PCI-7432/cPCI-7432 Visual Basic Program
SDK7433	D/I of PCI-7433/cPCI-7433 Visual C/C++ sample program
SDK7433Int	D/I of PCI-7433/cPCI-7433 through Interrupt operation Visual C/C++ Program
SDK7433DbEvt	D/I of PCI-7433/cPCI-7433 through Interrupt operation (Dual Interrupt Events) Visual C/C++ Program
VB7433	D/I of PCI-7433/cPCI-7433 Visual Basic Program
SDK7434	D/O of PCI-7434/cPCI-7434 Visual C/C++ sample program
VB7434	D/O of PCI-7434/cPCI-7434 Visual Basic Program
SDK8554	Timer/counter of PCI-8554 Visual C/C++ sample program
SDKEventCnt	Event counter of PCI-8554 Visual C/C++ sample program
VB8554	Timer/counter of PCI-8554 Visual Basic Program

SDK9111	A/D conversion, D/A conversion, D/I, and D/O of PCI9111 Visual C/C++ Program
SDK9111Int	Analog input of PCI-9111 through Interrupt operation Visual C/C++ Program
SDK9111DbfPreTrg	Pre-trigger with Double buffer mode analog input of PCI-9111 through Interrupt operation Visual C/C++ Program
SDK9111SpreTrg	Pre-trigger with Double buffer mode analog input of PCI-9111 through Interrupt operation Visual C/C++ Program
VB9111	A/D conversion, D/A conversion, D/I, and D/O of PCI9111 Visual Basic Program
VB9111Int	Analog input of PCI-9111 through Interrupt operation Visual Basic Program
VB9111PreTrg	Pre-trigger with Double buffer mode analog input of PCI-9111 through Interrupt operation Visual Basic Program
VB9111Scan	Autoscan Analog input of PCI-9111 Visual Basic Program
SDK9112	A/D conversion, D/A conversion, D/I, and D/O of PCI9112/cPCI-9112 Visual C/C++ program
SDK9112DMA	Analog input of PCI-9112/cPCI-9112 through DMA data transfer Visual C/C++ Program
SDK9112DbfDma	Double buffer mode analog input of PCI-9112/cPCI-9112 through DMA data transfer Visual C/C++ sample program
VB9112	A/D conversion, D/A conversion, D/I, and D/O of PCI9112/cPCI-9112 Visual Basic Program

VB9112DbfDma	Double buffer mode analog input of PCI-9112/cPCI-9112 through DMA data transfer Visual Basic Program
SDK9113	A/D conversion, D/A conversion, D/I, and D/O of PCI9113 Visual C/C++ Program
SDK9113Int	Analog input of PCI-9113 through Interrupt operation Visual C/C++ Program
SDK9113DbfDma	Double buffer mode analog input of PCI-9113 through DMA data transfer Visual C/C++ sample program
VB9113	A/D conversion, D/A conversion, D/I, and D/O of PCI9113 Visual Basic Program
VB9113Int	Analog input of PCI-9113 through Interrupt operation Visual Basic Program
VB9113Scan	Autoscan Analog input of PCI-9113 Visual Basic Program
SDK9114	A/D conversion, D/A conversion, D/I, and D/O of PCI9114 Visual C/C++ Program
SDK9114Int	Analog input of PCI-9114 through Interrupt operation Visual C/C++ Program
VB9114	A/D conversion, D/A conversion, D/I, and D/O of PCI9114 Visual Basic Program
VB9114Int	Analog input of PCI-9114 through Interrupt operation Visual Basic Program
VB9114Scan	Autoscan Analog input of PCI-9114 Visual Basic Program
SDK9118	A/D conversion, D/A conversion, D/I, and D/O of PCI9118 Visual C/C++ Program

SDK9118DbfAboutTrg	About trigger with Double buffer mode analog input of PCI-9118 through DMA data transfer Visual C/C++ Program
SDK9118BurstDma	Analog input of PCI-9118 through Burst Mode DMA data transfer Visual C/C++ Program
SDK9118DbfDma	Double buffer mode analog input of PCI-9118 through DMA data transfer Visual C/C++ Program
SDK9118HRDbfDma	Double buffer mode analog input of PCI-9118HR through DMA data transfer Visual C/C++ Program
SDK9118ScanDma	Autoscan Analog input of PCI-9118 through DMA data transfer Visual C/C++ Program
SDK9118HRScanDma	Autoscan Analog input of PCI-9118HR through DMA data transfer Visual C/C++ Program
SDK9118DbfPreTrg	Pre-trigger with Double buffer mode analog input of PCI-9118 through DMA data transfer Visual C/C++ Program
SDK9118DbfPostTrg	Post trigger with Double buffer mode analog input of PCI-9118 through DMA data transfer Visual C/C++ sample program
SDK9118AboutTrg	About trigger with Single buffer mode analog input of PCI-9118 through DMA data transfer Visual C/C++ Program
SDK9118HRAboutTrg	About trigger with Single buffer mode analog input of PCI-9118HR through DMA data transfer Visual C/C++ Program
SDK9118PostTrg	Post trigger with Single buffer mode analog input of PCI-9118 through DMA data transfer Visual C/C++ Program

VB9118	A/D conversion, D/A conversion, D/I, and D/O of PCI9118 Visual Basic Program
VB9118AboutTrg	About trigger with Single buffer mode analog input of PCI-9118 through DMA data transfer Visual Basic Program
VB9118PostTrg	Post trigger with Single buffer mode analog input of PCI-9118 through DMA data transfer Visual Basic sample program
VB9118Dma	Analog input of PCI-9118 through DMA data transfer Visual Basic Program
VB9118HRDma	Analog input of PCI-9118HR through DMA data transfer Visual Basic Program
SDK9812SoftTrg	Software trigger with Single buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
SDK9812PreTrg	Pre-trigger with Single buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
SDK9812PostTrg	Post trigger with Single buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
SDK9812MidTrg	Middle trigger with Single buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
SDK9812DelayTrg	Delay trigger with Single buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program

SDK9812DbfMidTrg	Middle trigger with Double buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
SDK9812DbfPreTrg	Pre-trigger with Double buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
SDK9812DbfPostTrg	Post trigger with Double buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
SDK9812DbfDelayTrg	Delay trigger with Double buffer mode analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual C/C++ Program
VB9812	Analog input of PCI-9812/cPCI-9812 through DMA data transfer Visual Basic Program

Note 1: ADLink will periodically upgrades PCIS-DASK to add support for new NuDAQ PCI-bus data acquisition cards and NuIPC CompactPCI cards and the additional sample programs for the new devices will be included. Please refer to *Release Notes* for the card types that the current release of PCIS-DASK actually supports.

Note 2: PCIS-DASK provides a sample program browser, ***Examples.exe***, for you to view and execute the sample programs that PCIS-DASK package includes. The default location of this utility is <InstallDir>\Samples directory. After *Examples.exe* utility is running, you can double click the icon of the sample you wish to execute to execute this sample program.

7.1 Sample Programs Development Environment

7.1.1 Visual Basic Sample Programs

There are several Visual Basic sample programs provided for each card in this software package. The following files are included in each sample program (Using VB9112DMA as an example):

- VB project file --- VB9112D.VBP
- VB form files --- VB9112D.FRM
- Executable file --- VB9112D.EXE

You must have 32-bit Microsoft Visual Basic 4.0 Professional Edition or above to deal with these sample programs. Please refer to Visual Basic Manual or related reference books to get the information about how to use Visual Basic 4.0.
If you don't install 32-bit Microsoft Visual Basic 4.0, but want to execute the VB sample programs, please install "*VB4 Runtime*" package first. The *VB4 Runtime* package includes the required library and DLL files to run the VB sample programs. You can find this package in the root directory of "*ADLink All-In-One Compact Disc*" CD or from the setup main window of this CD. After the installation of *VB4 Runtime* package, the VB4 samples can be executed on the system with no VB4 installed.
PCIS-DASK includes another kind of samples, Microsoft C/C++ sample programs, which will be described in the next section. The C/C++ samples provide the similar functions as those provided by VB samples. Preferably, they can be run directly and don't need to install any additional package. So, if you just want to test the PCIS-DASK package, please use Microsoft C/C++ sample programs.

7.1.2 Microsoft C/C++ Sample Programs

We provide several Microsoft C/C++ sample programs for each card in this package. The following files are included in each sample program (Using SDK7200WAV as an example):

- C source file --- 7200WAV.C

- Workspace file --- 7200WAV.MDP
- Resource script file --- 7200WAV.RC, RESOURCE.H
- Make file --- 7200WAV.MAK
- Executable file --- 7200WAV.EXE

You can use any editor or Microsoft Visual C++ 4.0 to view or modify these source files. However, to build the executable 7200WAV.EXE, you must have Microsoft Visual C++ 4.0 or above. Please refer to Visual C++ Manual or related reference books to get the information about how to use Visual C++.

7.2 Execute Sample Programs

To run the sample programs, please follow these steps:

step 1. Open the sample program
You can use Microsoft Visual C++ 4.0 or Visual Basic 4.0 to open and execute the sample programs. Or you can run the executable files directly.

step 2. Option Setting
According to your requirements, select the testing functions, e.g. A/D, D/A, etc., testing channels, sampling rate and transfer count, etc.

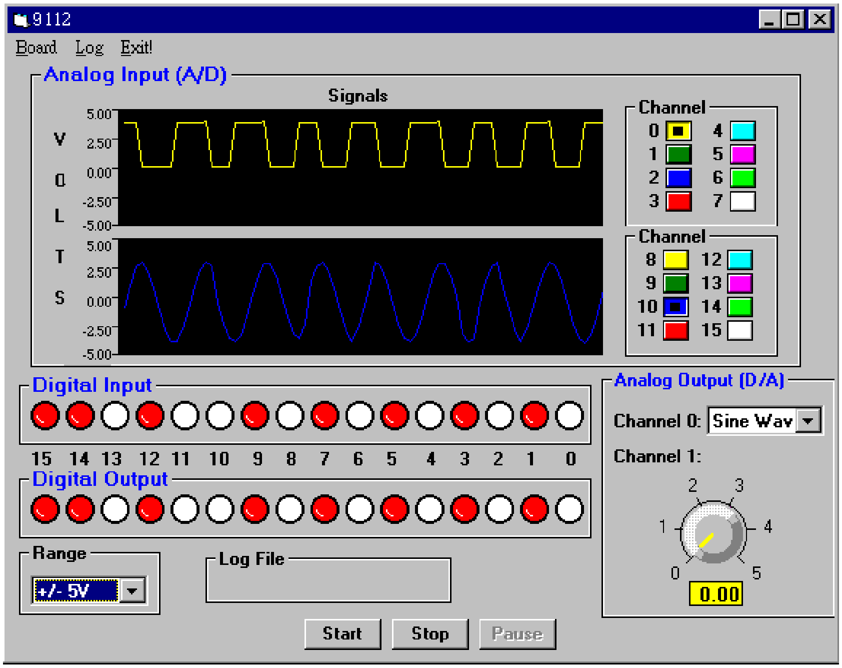
step 3. Push “start” button to run the program.

7.3 The Detailed Descriptions of these Sample Programs

There are four kinds of sample programs provided in this software package. The descriptions of these three types are the following (Using the screens of VB 9112, SDK 9112DMA, SDK 9112CDMA and SDK 9118 DbfPreTrg as the figure examples) :

7.3.1 A/D conversion, D/A conversion, D/I, and D/O

This kind of samples is used to demonstrate how to use PCIS-DASK to operate software trigger with program polling data mode and Read/Write data from digital input/output channels on PCI-9112. The main screen of this kind of programs is shown below (Figure 7.2):



Range: +/- 5V

Channel 0: Sine Wav

0.00

Figure 7.2

Analog Input (A/D) : This is used to show the results of A/D conversion. You can select the Input channels (allows multiple channels) and the input range (gain) you want to test from the main screen.

Analog output (D/A): This is used to show the results of D/A conversion. Turning the turner to set the output voltage. You can also choose the output waveform (sine or square).

D/I and D/O: This is used to show the results of Read/Write data from/to digital input/output channels. To set the output value, click the channel lights. The red light means " on" and the white light means " off" .

7.3.2 Data I/O through DMA Data Transfer or Interrupt operation

This kind of programs is used to demonstrate how to use PCIS-DASK to operate data I/O through DMA data transfer or Interrupt operation. The main screen of this kind of programs is shown below (Figure 7.3):

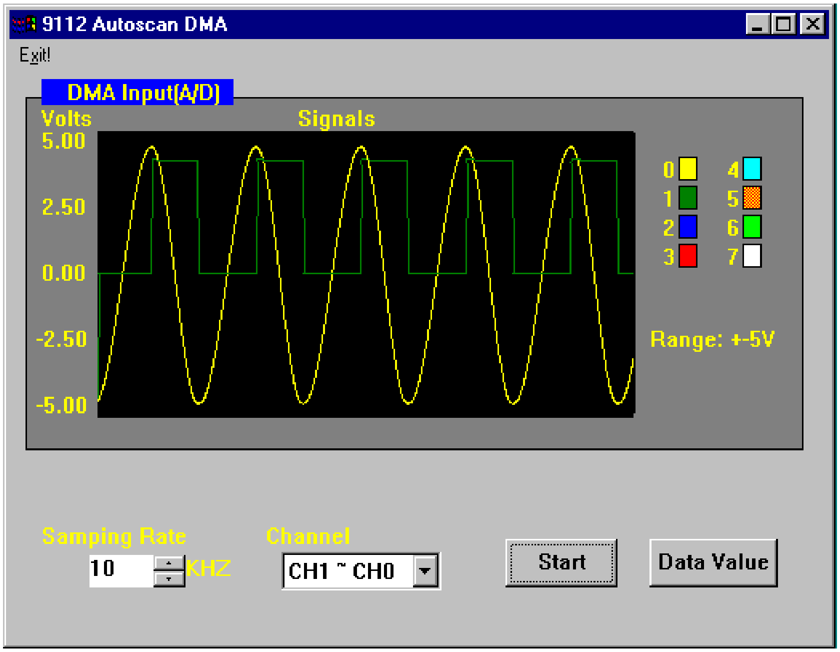
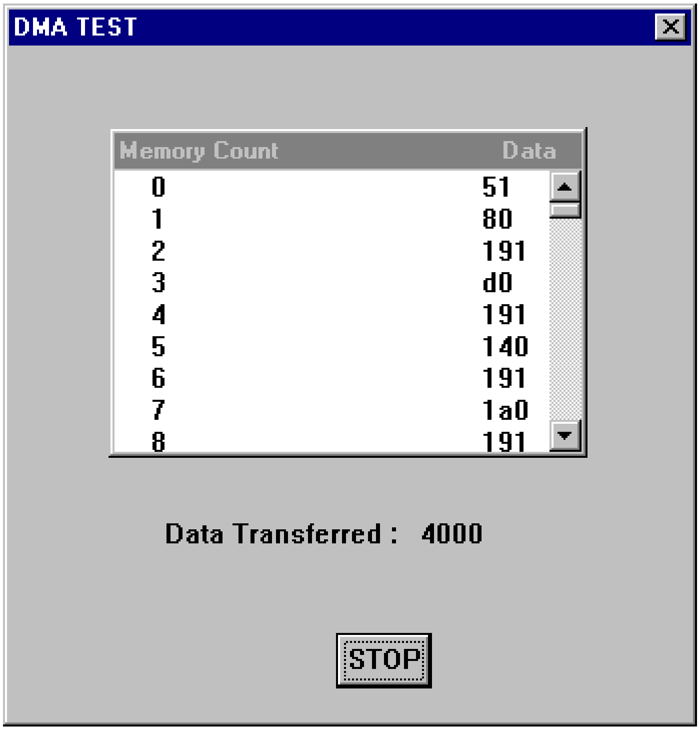


Figure 7.3

In this kind of programs you can select Input channels, Input range (PCI-7200 does not have these two options), sampling rate, and data size (transfer count) as you wish. To view the input data, push "Data Value" button in the main screen as data transfer is finished (Figure 7.4).



```
Memory Count        Data
0                   51
1                   80
2                   191
3                   d0
4                   191
5                   140
6                   191
7                   1a0
8                   191
```

Data Transferred :   4000

Figure 7.4

7.3.3 Double buffer mode data I/O through DMA transfer or Interrupt operation

This kind of programs is used to demonstrate how to use PCIS-DASK to operate double-buffered data I/O through DMA transfer or Interrupt operation. The screen of this kind of programs is shown below (Figure 7.5) :

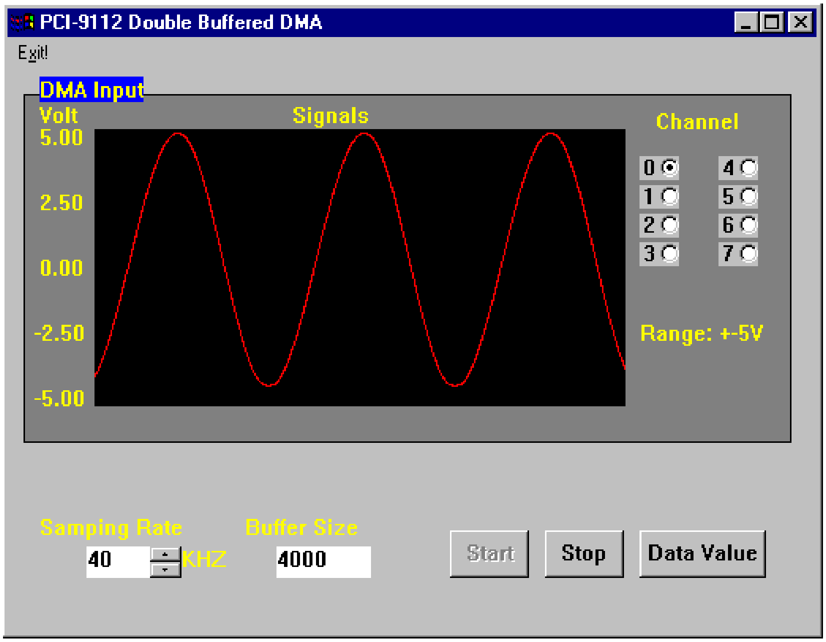
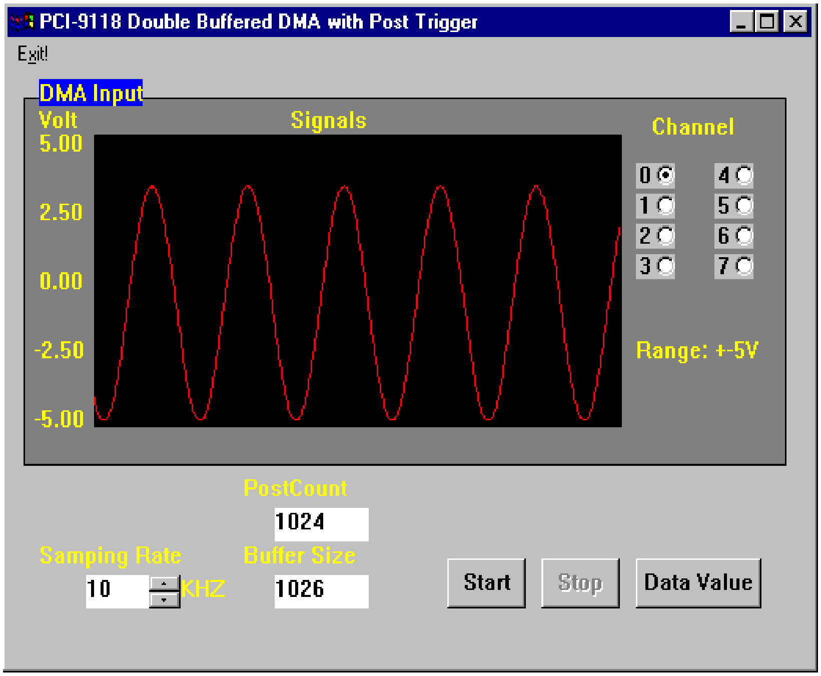


Figure 7.5

In this kind of programs you can select Input channel, input range (PCI-7200 does not have this two options), sampling rate, and data size (transfer count) as you wish. To view the input data, push “Data Value” button in the main screen after you stop the double-buffered operation.

7.3.4 Trigger Mode Data I/O through DMA Data Transfer or Interrupt operation

This kind of programs is used to demonstrate how to use PCIS-DASK to operate Trigger Mode data I/O through DMA data transfer or Interrupt operation. Except an additional input item, *postCount*, the running steps and the main screen of this kind of programs (Figure 7.6) are almost the same as those mentioned in section 7.3.2 (For Single-Buffer Mode) or section 7.3.3 (For Double-Buffer Mode). Please refer to these two sections for the details. This additional item, *postCount* , represents *the number of data accessed after a specific trigger event* or *the counter value for deferring to access data after a specific trigger event*. Please refer to the description of AI configuration functions (*AI_9111_Config, AI_9118_Config, AI_9812_Config*) for the details.



Range: +-5V

PostCount: 1024

Samping Rate: 10 KHZ

Buffer Size: 1026

Figure 7.6

Note: Except VB9812, all the trigger mode data acquisition sample programs use ***external digital trigger source*** to provide trigger signal. Please refer to the user's manuals of these cards you want to operate for the detailed description of trigger mode data acquisition.