DIAdem™

Data Acquisition and Visualization

NATIONAL
INSTRUMENTS™

Worldwide Technical Support and Product Information

`ni.com`

Worldwide Offices

Visit `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

National Instruments Corporate Headquarters

11500 North Mopac Expressway   Austin, Texas 78759-3504   USA   Tel: 512 683 0100

For further support information, refer to the *Technical Support and Professional Services* appendix. To comment on National Instruments documentation, refer to the National Instruments Web site at `ni.com/info` and enter the Info Code `feedback`.

Important Information

Warranty

The media on which you receive National Instruments software are warranted not to fail to execute programming instructions, due to defects in materials and workmanship, for a period of 90 days from date of shipment, as evidenced by receipts or other documentation. National Instruments will, at its option, repair or replace software media that do not execute programming instructions if National Instruments receives notice of such defects during the warranty period. National Instruments does not warrant that the operation of the software shall be uninterrupted or error free.

A Return Material Authorization (RMA) number must be obtained from the factory and clearly marked on the outside of the package before any equipment will be accepted for warranty work. National Instruments will pay the shipping costs of returning to the owner parts which are covered by warranty.

National Instruments believes that the information in this document is accurate. The document has been carefully reviewed for technical accuracy. In the event that technical or typographical errors exist, National Instruments reserves the right to make changes to subsequent editions of this document without prior notice to holders of this edition. The reader should consult National Instruments if errors are suspected. In no event shall National Instruments be liable for any damages arising out of or related to this document or the information contained in it.

EXCEPT AS SPECIFIED HEREIN, NATIONAL INSTRUMENTS MAKES NO WARRANTIES, EXPRESS OR IMPLIED, AND SPECIFICALLY DISCLAIMS ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CUSTOMER'S RIGHT TO RECOVER DAMAGES CAUSED BY FAULT OR NEGLIGENCE ON THE PART OF NATIONAL INSTRUMENTS SHALL BE LIMITED TO THE AMOUNT THERETOFORE PAID BY THE CUSTOMER. NATIONAL INSTRUMENTS WILL NOT BE LIABLE FOR DAMAGES RESULTING FROM LOSS OF DATA, PROFITS, USE OF PRODUCTS, OR INCIDENTAL OR CONSEQUENTIAL DAMAGES, EVEN IF ADVISED OF THE POSSIBILITY THEREOF. This limitation of the liability of National Instruments will apply regardless of the form of action, whether in contract or tort, including negligence. Any action against National Instruments must be brought within one year after the cause of action accrues. National Instruments shall not be liable for any delay in performance due to causes beyond its reasonable control. The warranty provided herein does not cover damages, defects, malfunctions, or service failures caused by owner's failure to follow the National Instruments installation, operation, or maintenance instructions; owner's modification of the product; owner's abuse, misuse, or negligent acts; and power failure or surges, fire, flood, accident, actions of third parties, or other events outside reasonable control.

Copyright

Under the copyright laws, this publication may not be reproduced or transmitted in any form, electronic or mechanical, including photocopying, recording, storing in an information retrieval system, or translating, in whole or in part, without the prior written consent of National Instruments Corporation.

National Instruments respects the intellectual property of others, and we ask our users to do the same. NI software is protected by copyright and other intellectual property laws. Where NI software may be used to reproduce software or other materials belonging to others, you may use NI software only to reproduce materials that you may reproduce in accordance with the terms of any applicable license or other legal restriction.

End-User License Agreements and Third-Party Legal Notices

You can find end-user license agreements (EULAs) and third-party legal notices in the following locations:

- Notices are located in the `<National Instruments>\_Legal Information` and `<National Instruments>` directories.
- EULAs are located in the `<National Instruments>\Shared\MDF\Legal\license` directory.
- Review `<National Instruments>\_Legal Information.txt` for more information on including legal information in installers built with NI products.

Trademarks

DIAdem, LabVIEW, National Instruments, NI, ni.com, the National Instruments corporate logo, and the Eagle logo are trademarks of National Instruments Corporation. Refer to the *Trademark Information* at `ni.com/trademarks` for other National Instruments trademarks.

Other product and company names mentioned herein are trademarks or trade names of their respective companies.

Members of the National Instruments Alliance Partner Program are business entities independent from National Instruments and have no agency, partnership, or joint-venture relationship with National Instruments.

Patents

For patents covering National Instruments products/technology, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your media, or the *National Instruments Patent Notice* at `ni.com/patents`.

Export Compliance Information

Refer to the *Export Compliance Information* at `ni.com/legal/export-compliance` for the National Instruments global trade compliance policy and how to obtain relevant HTS codes, ECCNs, and other import/export data.

WARNING REGARDING USE OF NATIONAL INSTRUMENTS PRODUCTS

(1) NATIONAL INSTRUMENTS PRODUCTS ARE NOT DESIGNED WITH COMPONENTS AND TESTING FOR A LEVEL OF RELIABILITY SUITABLE FOR USE IN OR IN CONNECTION WITH SURGICAL IMPLANTS OR AS CRITICAL COMPONENTS IN ANY LIFE SUPPORT SYSTEMS WHOSE FAILURE TO PERFORM CAN REASONABLY BE EXPECTED TO CAUSE SIGNIFICANT INJURY TO A HUMAN.

(2) IN ANY APPLICATION, INCLUDING THE ABOVE, RELIABILITY OF OPERATION OF THE SOFTWARE PRODUCTS CAN BE IMPAIRED BY ADVERSE FACTORS, INCLUDING BUT NOT LIMITED TO FLUCTUATIONS IN ELECTRICAL POWER SUPPLY, COMPUTER HARDWARE MALFUNCTIONS, COMPUTER OPERATING SYSTEM SOFTWARE FITNESS, FITNESS OF COMPILERS AND DEVELOPMENT SOFTWARE USED TO

Contents

Chapter 4
Visualizing Data and Operating Facilities

Chapter 5
Working with Packet Processing

Chapter 6
Monitoring Processes with the Alarm System

Chapter 7
The Basics of Process Measuring and Control Technology with DIAdem

Appendix A
Executing Measurements Automatically

Appendix B
Technical Support and Professional Services

Index

About This Manual

This manual, *NI DIAdem: Acquiring and Visualizing Data*, explains how to create block diagrams for solving measurement tasks and how to design visualizations.

The first chapter describes how you create a block diagram step by step, without measurement hardware. You select a data source, display instruments and operating instruments and define a condition to control when the data is saved.

The second chapter describes how to configure measurement hardware and to register the hardware in DIAdem. You can use one of the interfaces that DIAdem supports, to communicate with external measurement devices.

The third chapter describes how to select a block for each function, and how to connect the blocks to suit the task. DIAdem distinguishes between data buses, control buses, system buses, packet buses, alarm buses, and text buses, each of which transports different signals. You can save and import partial tasks of a block diagram as a subdiagram block.

The fourth chapter describes the visualization associated with the block diagram and explains the available display and operating functions. In DIAdem VISUAL you position the display instruments and the input instruments and you group the instruments on VISUAL pages. In DIAdem DAC you connect display blocks to create event-related visualizations.

The fifth chapter describes how to use packet processing in order to acquire data in packets, to process the data, and to show the data in a 3D display. With packet processing you can increase the throughput, use special measurement hardware, or use manual display instruments which you can operate during a measurement.

The sixth chapter describes the alarm system that you use to monitor processes by generating alarms, displaying alarms, sending alarms in e-mails, and recording alarms. The user can delete the alarms as soon as the cause has been found and eliminated.

The seventh chapter describes the basics of digital data acquisition and discusses topics such as the resolution, the measurement range, and the sampling rate. The chapter also describes the measurement modes available in DIAdem.

Conventions

The following conventions are used in this manual:

<>	Angle brackets indicate a key you press to perform a function, for example, <Ctrl> for the control key.
»	The » symbol leads you through nested menu items and dialog box options to a final action. The settings **Help»Examples** instruct you to open the **Help** menu and select the menu item **Examples**.

📝	This icon denotes a note, which alerts you to important information.
bold	Bold text denotes items that you must select or click in DIAdem, such as menu items and dialog box options. Parameters are also in bold type.
italic	Italic text denotes variables, emphasis, cross-references, or an introduction to important concepts.
`monospace`	Text in this font denotes text or characters that you should enter from the keyboard, such as sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, folders, programs, subprograms, subroutines, device names, functions, operations, commands, variables, controls, events, methods, filenames and extensions, and code excerpts.
`monospace bold`	Bold text in this font denotes the messages and responses that the computer automatically outputs to the screen.

Related Documentation

For more information on DIAdem, refer to the following documentation:

- *Getting Started with NI DIAdem*

  You can use this DIAdem manual to familiarize yourself with DIAdem features and how to use them. The manual includes exercises for mining, analyzing, presenting data, and combining several steps into a script.

- *NI DIAdem: Data Mining, Analysis, and Report Generation*

  This DIAdem manual explains the structure of DIAdem and how to use DIAdem to mine data, to run analyses, to create reports, and to combine all functions in a script.

- *DIAdem Help*, which you open by selecting **Help»Contents**, or <F1>.

  The DIAdem help offers you procedures and dialog box help for each panel, as well as references to functions, commands, and variables for programmers.

- *NI DataFinder Server Edition: Search Engine for Technical Data*

  This manual describes how you use the DataFinder server to index data files in networks. Users connect DIAdem with a DataFinder server to search for the indexed data.

1

Getting Started with DIAdem DAC

With DIAdem DAC and DIAdem VISUAL you acquire data, control processes, and visualize data. In DIAdem DAC you create block diagrams to acquire measurement values and to process and output the measurement values during the measurement. In DIAdem VISUAL you design the visualization to display the acquired and calculated measurement values and to influence the measurement with input instruments.

DIAdem is the interactive National Instruments software for finding and managing technical data, for mathematically and graphically-interactively analyzing data, and for presenting data in reports. In a uniform environment, DIAdem offers a unique combination of tools that are tailored to the requirements of technicians, engineers, and scientists. All tools can be adjusted to your requirements and can be automated in scripts.

Acquiring Measurement Data

In DIAdem DAC you select functions blocks from the various function groups and connect them with signal buses, to create block diagrams. The measurement data is transferred from data sources to processing blocks, display instruments, and output blocks.

To create a block diagram with a simulated signal source, complete the following steps:

📝 **Note** You can substitute simulation signals later with measured data.

1. Select **DIAdem DAC**.
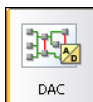
2. Click **New Block Diagram**.

3. Click **Simulation Inputs** on the group bar.

4. Click **Function Generator** in this function group.

5. Click **Display Instruments** on the group bar.

6. Click **Numeric Display** in this function group.

DIAdem inserts every new block in the top left corner of the workspace in DIAdem DAC.

7. Drag the **Digits1** block to the right of the **Generator1** block.

8. Click the output on the right side of the **Generator1**. Left-click and and drag the green bus to the input on the left side of the **Digits1** block. As soon as OK appears on the cursor, you can release the mouse button.

The data source and the display instrument are now linked with a green data bus similar to Figure 1-1.

Figure 1-1. Block Diagram with Function Generator and Digits Display
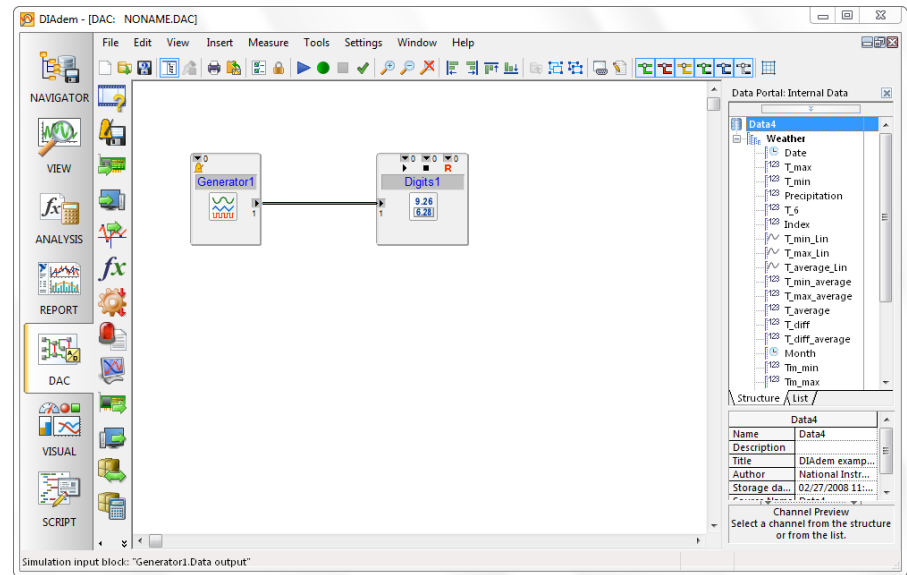
9.   Click **Start Display** on the toolbar.

DIAdem opens the DIAdem VISUAL panel and displays the simulated sine values in Digits display.

10.   Click **Stop Measurement**.

Saving Measurement Data

Until now you have displayed the signal values, but the values are not yet saved. To document processes and to check results, DIAdem must save measurement values.

To save the measurement data, complete the following steps.

1.   Select **DIAdem DAC**.
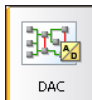
2.   Click **System** on the group bar.

3.   Click **Save Data with Trigger** in this function group.

4.   Position the **Save1** block below the Digits display.
5.   Click the green data bus and drag the bus to the data input of the Save block as shown in Figure 1-2.
6.   Double-click the **Save1** block.

   a.   Select **Parameters**.
   b.   Enter 1000 as the **Number of values**.
   c.   Click **OK**.

7. Click **Start Measurement**.

DIAdem stops the measurement as soon as 1,000 values are saved.

8. Select **DIAdem DAC**.
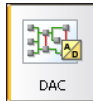
The new channels `Time1` and `Generator1_1` are now visible in the default group of the Data Portal.

Figure 1-2. Extended Block Diagram with Data Storage
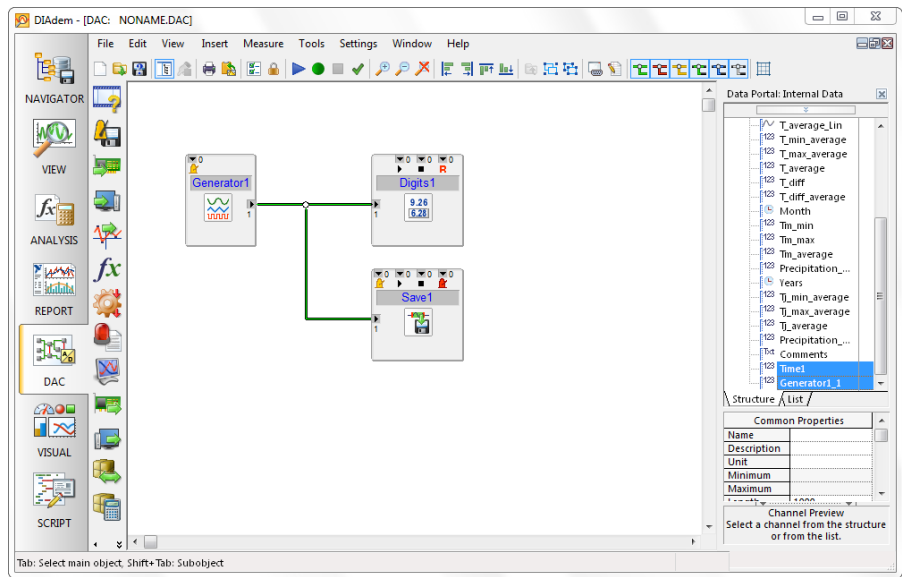
Monitoring Measurement Signals

In control blocks you define conditions for monitoring and controlling measurements.

To save measurement values in relation to a condition, complete the following steps.

1. Click **Simulation Inputs** on the group bar.

2. Click **Slider Control** in this function group.

3. Position the **Slider1** block below the Generator.

4. Click **Control** on the group bar.

5. Click **Window** in this function group.

6. Position the **Window1** block next to the Slider control.

7. Drag a green bus from the output on the Slider control to the input on the Window condition.

8. Double-click the **Window1** block.

   a. Enter the lower limit –5 and the upper limit 5 in the signal list, as shown in Figure 1-3.

   b. Select Window exit as the **Window Type**.

Figure 1-3. Setting the Window Condition
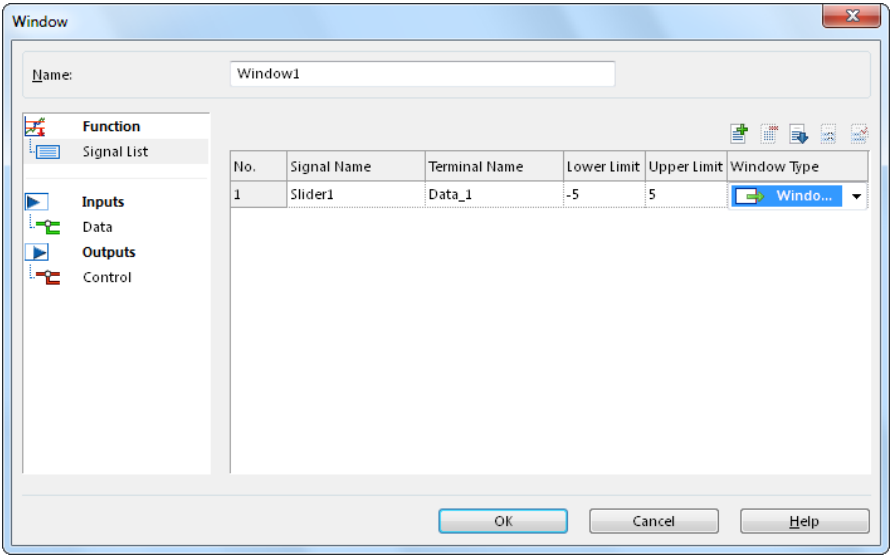
    c.   Click **OK**.

9.   Click the data bus between the **Slider1** block and the **Window1** block, and drag a new bus to the green bus between the **Generator1** block and the **Digits1** block.

    The 2 at the input of the numeric display indicates that two signals now reach the block on this data bus.

10.   Drag a bus from the output at the lower edge of **Window1** to the input with the triangle at the top edge of the **Save1** block, as shown in Figure 1-4.

    This creates a red control bus that DIAdem uses to trigger data storage. Always connect control buses at the top or at the bottom of a block.

Figure 1-4. Extended Block Diagram with Slider Control and Window Condition

Storage Display

To display when the storage starts complete the following steps.

1. Click **Display Instruments** on the group bar.

2. Click **Graphics** in this function group.

3. Position the graphic to the right of the **Save1** block.

4. Click the red control bus above **Save1** and drag the control bus to the input with the triangle at the upper edge of the **Graphics1** block, as shown in Figure 1-5.
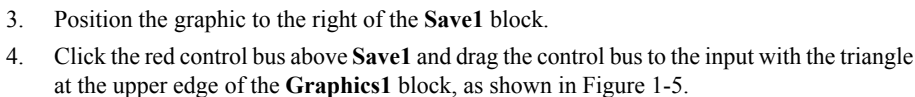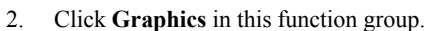
Figure 1-5. Extended Block Diagram with a Storage Display
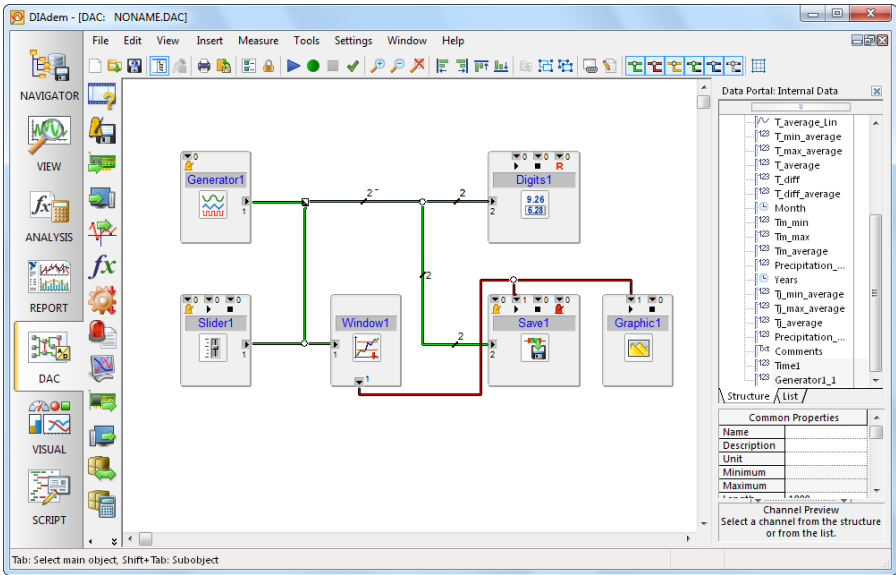
Visualizing Measurements

You can arrange the input instruments and display instruments, which are integrated in the block diagram, in DIAdem VISUAL and you can configure each instrument individually.

To design the visualization complete the following steps.

1. Select **DIAdem VISUAL**.

The three instruments Slider Control, Numeric Display, and Graphic are staggered at the top left of the display area of DIAdem VISUAL.

2. Select the three instruments.

3. Click **Align Horizontal Intervals** and then **Center Horizontally**.

4. Click into the workspace to deselect it.

5. Double-click the empty display instrument **Graphic1**.

    a. Select **Parameters**.

    b. Click **Browse** and load the file `Saving.jpg`.

    c. Enable **Keep aspect ratio**.

    d. Click **OK**.

6. Click **Start Measurement**.

7. Drag the slider control up and down.

    As soon as the slider control leaves the specified window range of `-5` to `5`, DIAdem starts saving the measurement values and displaying the ongoing saving process as shown in Figure 1-6.

    Figure 1-6. Visualization with Input Instruments and Display Instruments
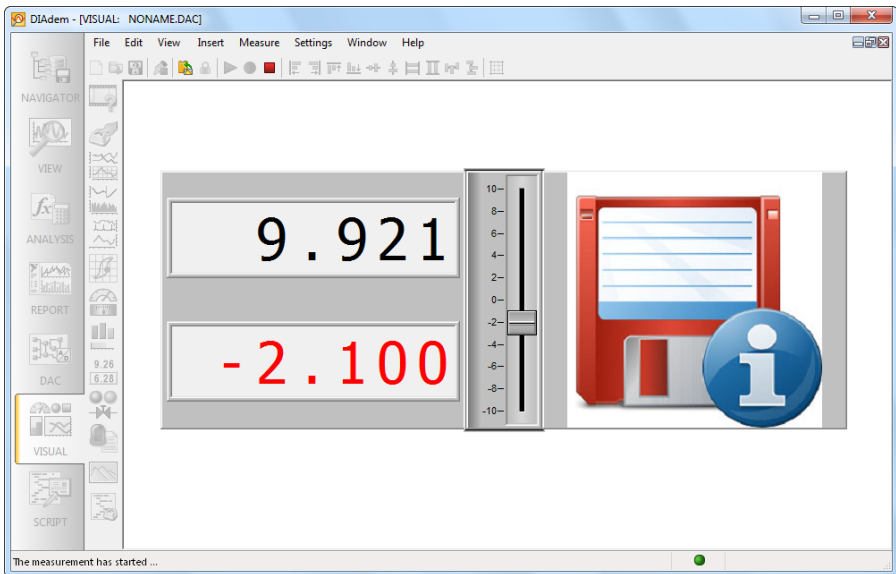
8. Click **Stop Measurement** or wait until DIAdem measures the specified 1,000 values and saves the values in new channels in the Data Portal.

9. Click **Save Block Diagram As** to save the block diagram.

2

Installing Measurement Hardware and Communicating via Interfaces

To use DIAdem for measurements and open and closed-loop control, you need a measurement acquisition board that you can plug into the computer, or an external measurement device that you connect to the computer via an interface. You use the associated driver to access the measurement hardware. The function groups for the inputs and outputs contain blocks with prepared functions for connecting hardware and communicating via interfaces.

Installing Measurement Hardware

After you have installed the plug-in board on the computer or have connected an external measurement device through USB, the operating system prompts you to install the driver of the hardware manufacturer after the computer starts. Next you register the associated DIAdem driver, which communicates with the hardware driver, in DIAdem DAC. You can then assign driver functions to function groups in DIAdem DAC.

Installing the Hardware Drivers

Install DIAdem and the driver libraries supplied with your hardware and register the installed hardware on the operating system.

To use hardware from National Instruments, install the driver library *NI-DAQmx* and the Measurement & Automation Explorer (short NI MAX) where you configure the device parameters and the channel parameters of the hardware. You open NI MAX in the Windows Start menu. NI MAX lists the installed hardware and software from National Instruments in a tree view. Double-click **Devices and Interfaces** to display the installed acquisition boards and connected measurement devices. If you select an item, NI MAX displays the board properties. Click **Self-Test** to test the hardware. Click **Test Panels** to check the board functions.

To access National Instruments hardware with DIAdem, you create channels in NI MAX for all the required inputs and outputs. In DIAdem, you use the channel names specified in NI MAX to access these channels. To create a global NI-DAQmx channel, right-click **Data Neighborhood** in the tree and select **New** from the context menu. Select **Global NI-DAQmx Virtual Channel**. The Channel Wizard guides you through the configuration and specifies the measurement mode and the terminal. NI MAX lists all the virtual channels in the **Data Neighborhood** branch of the tree hierarchy as shown in the following figure. A wizard helps you define a two-point calibration on the **Calibration** tab. Scaling data delays data acquisition, which means that the channels are no longer real-time. To acquire data in real time, you can scale the measured values later in DIAdem, instead of in NI MAX.

Figure 2-1. Creating a NI-DAQmx Channel in the Measurement & Automation Explorer (NI MAX)
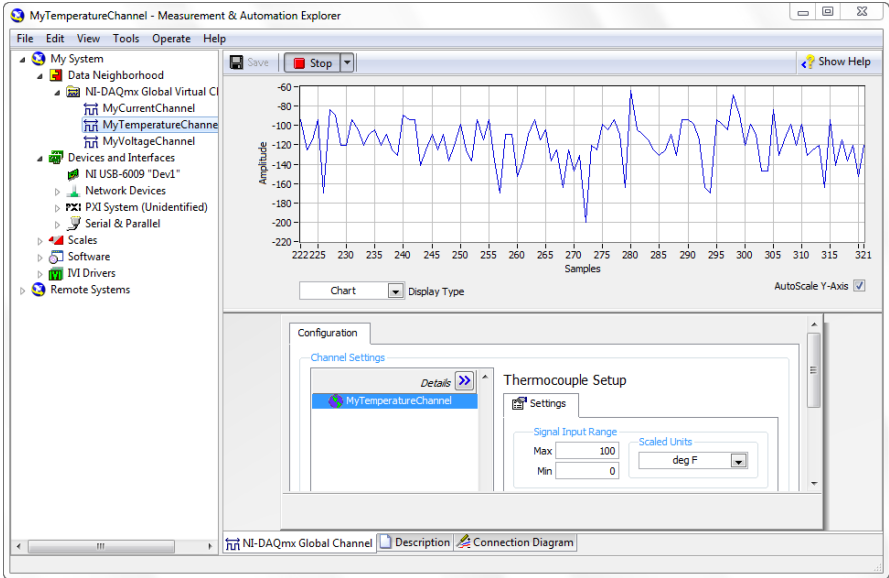
Registering and Configuring DIAdem Drivers

The DIAdem driver links the driver library of the manufacturer to DIAdem DAC. DIAdem drivers are in DLLs (DLL: Dynamic Link Library), which you register in DIAdem by selecting **Settings»Options»Extensions»GPI Extensions**. Click **Default** to check whether the DLL that is required for your hardware is already registered in DIAdem. Click **Add** to load an additional DLL. You can obtain the DIAdem driver and the driver library from the hardware manufacturer.

The DLL GfSnidaq.dll is required for communication between the driver library NI-DAQmx and DIAdem, and is registered by default, which means that the associated driver block is already in the driver inputs and driver outputs. To use the channels that are defined in NI MAX for data acquisition, open the **Driver Inputs** function group and click **NI-DAQmx Driver**. Double-click the block to open the block dialog box and select the channels you want.

Figure 2-2. Using NI-DAQmx Channels in DIAdem
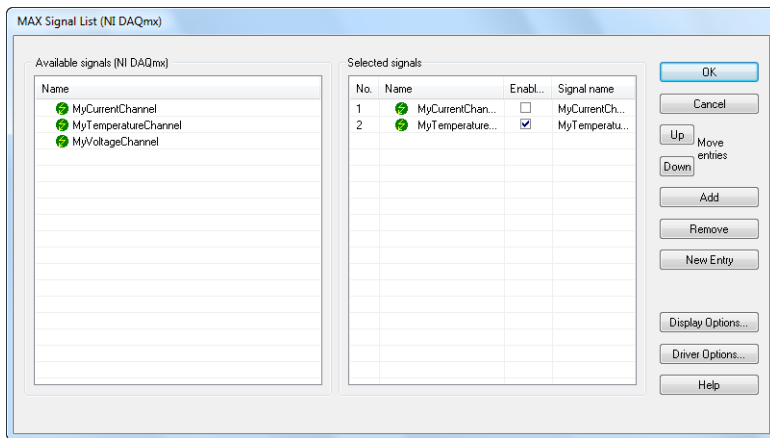
After the registration of most DIAdem drivers in DIAdem DAC, you must select **Settings»Single Point Processing»Driver Function Groups** to specify which functions the driver offers for acquisition and output. This is not necessary for the NI-DAQmx driver. Here you can add, delete, and configure DIAdem drivers, signal inputs, signal outputs, and processing functions that the driver executes on the measurement hardware. Double-click a registered device to open the list of supported driver functions and click **Options** to change the parameters of the driver function selected in the list. Make sure that the device parameters such as the base address or the input voltage range are the same as the settings on the measurement hardware.

You usually use Plug&Play to specify system resources such as base address, IRQs, or DMA channels. The operating system and the hardware that is already installed ensure that the new hardware is integrated correctly. If you specify the system resources the hardware requires manually, ensure that no other application uses this resource.

Note Usually you can only access installed hardware with different applications such as two DIAdem versions or with DIAdem and LabVIEW alternately and not simultaneously. National Instruments hardware recognizes this type of conflict at the driver level and displays an error message.

In the function groups **Driver inputs**, **Driver outputs**, and **Processing** DIAdem displays the registered driver functions. DIAdem saves the registered driver functions in the desktop file.

If you change the predefined settings or the assignments in the driver function groups later, the driver block settings in the block diagram remain unchanged. DIAdem saves the settings of the driver blocks included in a block diagram, in the block diagram. If you use different hardware, you can replace the driver blocks in the block diagram with the driver inputs and driver outputs from the new hardware. To do this, drag and drop the driver blocks of the new hardware onto the

blocks you want to replace in the block diagram. If possible, the settings of the previous blocks are used in the new blocks.

Communicating via Interfaces

You communicate with external measurement devices, which are connected to the computer via an interface, either directly via the OPC driver or the CAN driver, or indirectly via a control file or a VBS script.

Using OLE for Process Control

DIAdem can communicate via the OPC (OLE for Process Control) interface as the OPC client with each OPC server that is registered on the computer, and can access either local measurement hardware or, via an OPC server, hardware that is located on the network. This enables you to connect DIAdem to field bus systems and the associated hardware. DIAdem DAC can provide multiple access to one OPC server and can access several OPC servers simultaneously.

Open the dialog box of the OPC block to register OPC servers, which are either on the same computer or on another computer in the network. When the OPC servers are registered, you can select the signals to be measured in the OPC Browser. In OPC applications the signals are called items. Drag and drop the signals into the signal list. You configure the communication on the tabs **Parameters** and **OLE**.

Using NI-XNET

With the NI-XNET driver, DIAdem can acquire and output data with the NI-XNET hardware. The NI-XNET hardware supports CAN (Controller Area Network), LIN (Local Interconnect Network), and FlexRay. Although the individual network types have a number of differences, NI-XNET offers an API (Application Programming Interface) that allows all three network types to be accessed with similar functions.

A database file in Field Bus Exchange format (FIBEX) describes the network (Cluster) and the transferred data packages (Frames). Every frame contains several signals which contain the actual measurement data. The DIAdem driver accesses the signals defined in the FIBEX file directly through the NI-XNET-API. Frames and signals are referenced through their names. DIAdem does not support the direct access to the raw data of the frames.

The dialog boxes in the NI-XNET driver provide a signal selection with signals to be acquired or output. In the dialog boxes of the Bus configuration you specify the clusters and specify some of the network settings not defined in the FIBEX file. First, select a bus configuration or load a database file to create a bus configuration. One bus configuration can apply in several DIAdem blocks. Then select the signals available in the cluster for DIAdem to read or write. You can acquire and output up to 255 signals in a DIAdem DAC block.

Using CAN Drivers

The Controller Area Network driver from National Instruments (NI-CAN) transfers data to and from DIAdem via interface boards. To connect DIAdem to CAN, select **Settings»Single Point Processing»Interfaces»CAN Bus** and configure the CAN interface, and establish CAN channels, for example, in the Measurement & Automation Explorer. Branch to **My System» Data Neighborhood»CAN Channels** in NI MAX, and click **Create Message** on the function bar. Select the created CAN message and click **Create Channel** on the function bar. Then you configure the CAN channels.

The CAN block in DIAdem uses the channel names to access the CAN channels. Double-click the block to open the block dialog box and select the channels you want.

Using ECU Measurement and Calibration Toolkit Driver

The NI ECU Measurement and Calibration Toolkit is used for acquiring data from Engine Control Units (ECUs).

The CAN Calibration Protocol (CCP) or Universal Measurement and Calibration Protocol (XCP) is used for executing the measurement data acquisition and calibration of Electronic Control Units (ECU). CCP is a protocol for measuring and calibrating ECU data and is based on CAN. XCP is a generalized version of the CCP. You can use the definitions of an A2L file to access the controller data. The A2L files are based on the ASAM-MCD 2MC standard.

You must first install the NI ECU Measurement and Calibration Toolkit to use the ECU Measurement and Calibration Toolkit driver with DIAdem.

Using Control File Drivers

You can use the control file driver to access external measurement devices in DIAdem via the RS-232 interface or General Purpose interface Bus (GPIB). This communication is based on a simply-structured text file in which a communication protocol for linking devices is defined. Use the `Example.atr` control file as an example.

A control file consists of the measurement preparations, the actual measurement, and the post-measurement action, as shown in the following figure. The Init procedure starts the communication with the measurement device and the Start procedure starts a measurement. During the measurement, DIAdem calls the Input procedure for data input, and the Output procedure for data output, cyclically in the specified measurement clock. The Stop procedure stops the measurement and the DeInit procedure resets the measurement device.

Figure 2-3. Structure of a Control File
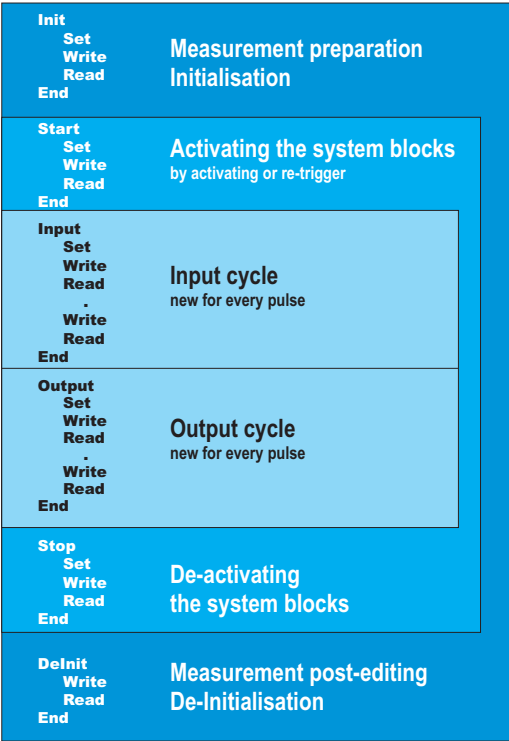
You can use several control file driver blocks in one block diagram, and you can address several external devices in one control file.

The interface monitor on the toolbar guides you through an interactive dialog box with external devices via the serial interfaces COM1 to COM9 and via GPIB (DIN IEC 625 or IEEE 488). You can send character strings to a device and read the replies on the screen. The interface monitor is useful for testing and commissioning programmable measurement devices and for programming control files. In the hexadecimal display mode, you can see all the control characters the device sends.

Using Script Drivers

The Script driver uses Visual Basic Script (VBS) to acquire, process, and output data with external devices. You can use VBS for complex tasks such as test sum calculations, which you cannot execute with the control file driver. The GFSUDI communication layer communicates with the interfaces RS-232, GPIB, and TCP/IP, to exchange data with external devices, as the following figure shows. If you use VBS, you can access other program modules such as ActiveX components.

Figure 2-4. External Devices Can Communicate with DIAdem via VBScript
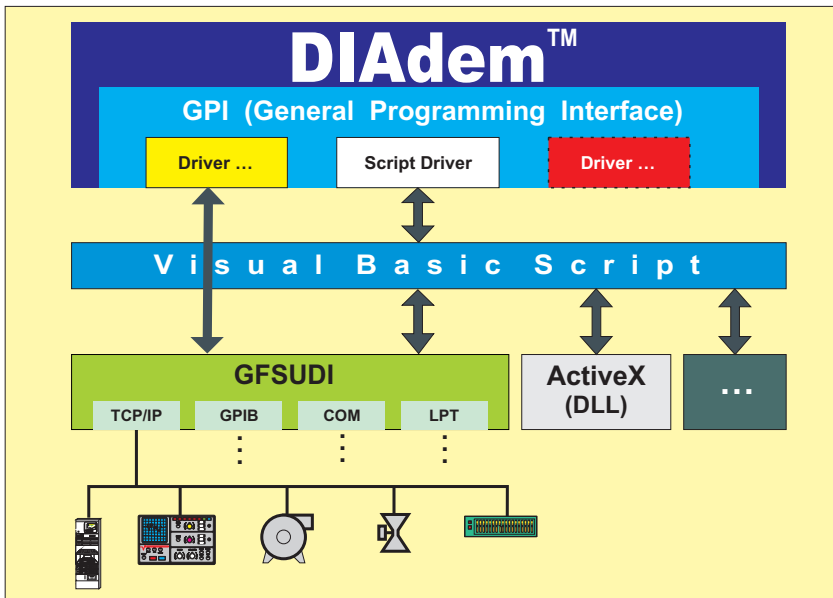
In the Script block you specify the inputs, outputs, and the script. To create a script, click **Script Template**. DIAdem opens a wizard where you select the interface and specify the script functions. DIAdem creates a template, which you can edit in DIAdem SCRIPT.

3

The Block Diagram Describes the Measurement Task

In DIAdem DAC you create block diagrams in order to acquire, to process, to visualize, and to output measurement values. For each function you select a block from a function group, position the block in the workspace, and connect the block to other blocks. Double-click a block to configure the block in dialog boxes.

Creating Block Diagrams

You start a block diagram on the left with a data source, for example, a driver input from the installed hardware, use blocks for scaling and processing, and the data ends in the display instruments on the right. The data in the block diagram does not always flow from left to right, but it always flows from block outputs to block inputs.

A simple block diagram consists of a data source and a display instrument. If you want to use an inbuilt National Instruments measurement board as the data sourc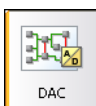e, click **NI-DAQ Driver** in the **Driver Inputs** function group. Then open the **Display Instruments** function group and click **Curve**. DIAdem inserts the blocks in the top left-hand corner of the workspace. Position the Curve display block to the right of the driver block. Click the data output on the right edge of the driver block and drag the crosshair to the data input on the left edge of the Curve display. Click the data input of the Curve display as soon as **OK** appears next to the crosshair. DIAdem connects the two blocks with a green data bus. Double-click the **NI-DAQ** driver block and select the signals to be displayed, from the channels defined in the Measurement & Automation Explorer.

To display the measurement values, click **Start Display** on the toolbar. DIAdem switches to the VISUAL panel and displays the selected signals as curves. To stop the display, click **Stop Measurement** on the toolbar. You also can press <Esc> to abort a measurement.

If you use a block to save the measurement values in the block diagram, you must click **Start Measurement** so that DIAdem can visualize measurement values and can save the measurement values in the Data Portal or in a file. To save the measurement values without visualizing them,

select **Measure»Measurement (Without Display)**. In the Save block you specify where to save the data and also the maximum number of measurement values to be saved. Select **Measure» Last Measurement Status** to see how long the last measurement with data storage took and how many values DIAdem saved. Before starting a measurement, DIAdem checks the block diagram and displays corrupt connections and settings. Use the **Check Block Diagram** function to reveal errors when you create block diagrams.

To create and test a block diagram independently of the measurement hardware, open the function group **Simulation Inputs** first, and use the blocks **Random**, **Noise**, or **Function Generator** as data sources. You also can use input instruments, data files, data channels of the Data Portal and calculation results from processing blocks as hardware-independent data sources. In the second step you exchange the simulation blocks for driver blocks. To replace a block, drop the driver input onto the simulation input in the block diagram. DIAdem replaces the simulation block with the driver block and transfers the common settings, such as the block name and the number of signals.

Connecting Blocks with Buses to Create a Block Diagram

The task determines which block you select and how you connect the blocks in a block diagram. You can connect blocks to blocks, blocks to buses, and buses to buses. If you click an output or an input terminal on a block, the beginning of the new bus appears with a crosshair at the tip. Click a bus and press the left mouse button to create a new bus. Drag the crosshair over an input terminal or a bus that is the same color, until DIAdem displays **OK** at the crosshair. After a mouse click, DIAdem creates the connection. If DIAdem displays a crossed out crosshair, you cannot connect the blocks.

If you drag a bus away from another bus, DIAdem displays the branch as a circle. When you join two buses, DIAdem displays a small square at the input node. The black triangles in the square indicate which buses deliver signals.

If the block diagram is very complex, DIAdem might continue the bus in the background. Then the bus ends with a black point which displays the name of the bus, for example, D11 for the eleventh data bus. At a different position in the block diagram, a second black point appears with the same name, D11, from which DIAdem continues the bus.

Buses Differ According to the Signals They Transport

DIAdem distinguishes the connections between data buses, control buses, system buses, packet buses, alarm buses, and text buses. Each bus type transports different signals. You only can connect buses and block terminals that are the same type, for example, you cannot connect data buses to control buses. To distinguish between the various buses, DIAdem displays each type of bus in a different color. Single point processing buses are monochrome and packet processing buses have two colors. Refer to Chapter 5, *Working with Packet Processing*, for more information on single point processing and packet processing.

DIAdem organizes the different bus types in separate display layers. To keep a block diagram clear and easy to understand, and to make it easier to make connections, you can hide the layers using the symbols on the toolbar or in the **View** menu. A block diagram can contain up to six layers:

- The system layer contains the yellow system buses, which transport clock rate information between the blocks.
- The control layer contains the red control buses, which transfer conditions, and activate, deactivate, or reset blocks.
- The data layer contains the green data buses, which transfer analog signals or digital signals, depending on the data source.
- The packet layer contains the green and black packet buses, which transport data packets.
- The alarm layer contains the blue and black alarm buses, which transport alarm information.
- The text layer contains the gray and black text buses, which transport text information.

The blocks have different input terminals and output terminals. Data leaves a block on the right side of the block and reaches a block on the left side of the block. This also applies for data packets, alarms, and texts. You connect the control buses and system buses on the horizontal edges of the block: the inputs at the top and the outputs at the bottom. Control blocks can have several control inputs and control outputs. Display instruments and manual input instruments have the control inputs **Start**, **Stop**, or **Reset** which enable, disable, or reset the visualization. Packet blocks can have several data input and data output terminals.

Buses Contain Multiple Signals

All the buses between the blocks transport multiple signals. For example, a green data bus between two blocks can transport the measured values from 20 sensors. If you connect the signal from another sensor to this data bus, the data bus contains 21 sensor signals after the input node. DIAdem displays the number of transported signals along the bus and at the input terminals and the output terminals.

Double-click a bus to obtain a list of the signals transported in the bus. The bus dialog box lists the names of the block outputs and the names of the signals. If blocks enter more than one signal, double-click the block name to open the list.

You specify in the block diagram dialog boxes how many signals the block creates or processes. For example, to increase the number of signals generated by a function generator, click the **List Length** button in the **Signal list** in the dialog box of the function generator. Increase the number of outgoing signals to five, for example. After you close the dialog box, the function generator displays the number five at the data output terminal. If you connect a Curve display, the display instrument shows five curves underneath each other. By default DIAdem enables the checkbox **Automatically increasing** in the list length of the display block, so that the display instruments automatically displays all connected signals.

> **Note**   For the driver inputs, the list length must be the same as the number of terminals on the installed hardware.

You can disable signals in data sources, data outputs, and some process functions, without changing the signal list. To do so, open, for example, the signal list in the dialog box of the function generator. Click the checkbox in the fifth row of the **Enabled** column to disable the fifth channel. When you close the dialog box, the number five is still on the Curve display bus. However, if you start a display, the display instrument displays only four curves. If you change the list length, the sequence of the signals changes. If you disable signals, the sequence of the signals remains unchanged. Therefore you do not need to adjust the rest of the block diagram when you separate and then reconnect it.

Select the data signals to be processed by the block in the block dialog box. For example, to disconnect signals at the curve display, click **Inputs»Data**. DIAdem displays a list with the five connected signals. Select a signal and click **Disconnect signal**. You can select several non-consecutive signals to disconnect them all simultaneously. DIAdem deletes the signal names in the row of disconnected signals and displays in the neighboring column a disconnected plug. When you close the input dialog box, the number four appears at the data input terminal.

To re-connect a data signal, you must click the empty field of the signal name. Open the selection list and select a data signal. If you want to connect several signals in one step, select all the data inputs you want to connect. Click **Connect Signals** to open a list with the names of the connected blocks. When you double-click a block name, DIAdem displays a list of signals you can choose from.

Combining Subtasks into Subblock Diagrams

The more blocks you insert and connect in a block diagram, the more complex the block diagram becomes. To keep the block diagram easy to understand, you can group sections of the task into subblock diagrams. A subblock diagram looks like a block with signal inputs and signal outputs. You can include other subblock diagrams in a subblock diagram and in this way, establish a hierarchy with several levels. You can export subblock diagrams to reuse the task sections in other block diagrams.

To create a subblock diagram, you select the blocks and the buses that you want to group together, and click **Group Subblock Diagram** on the toolbar. DIAdem packs the blocks and the buses into one subblock diagram block and creates inputs and outputs for the buses to the blocks outside the subblock diagram. Double-click to open a subblock diagram. In the following figure, you recognize the open subblock diagram by the surrounding terminal bars for importing and exporting the various types of signals. You can move and extend the terminal bars to enlarge the workspace of the subblock diagram.

Subblock Diagram with the Terminal Bars of the Various Bus Types
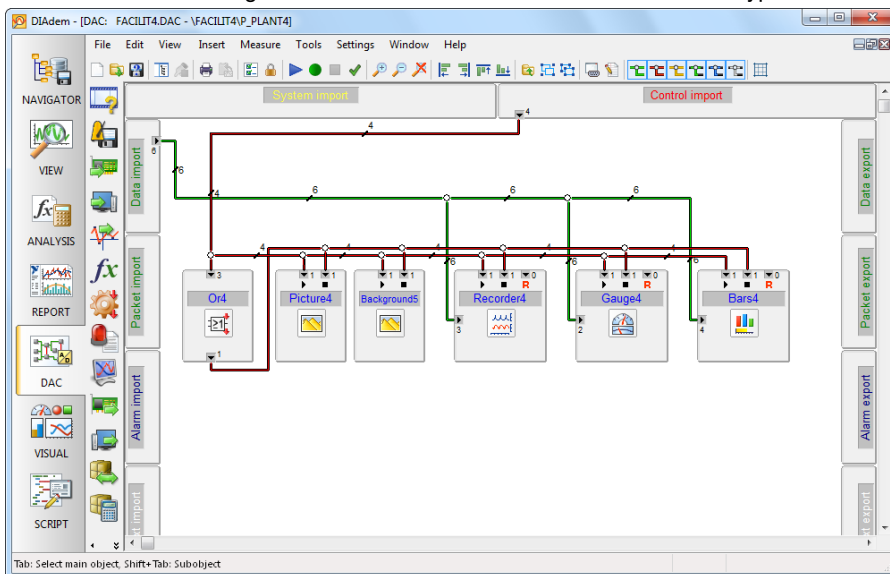
You use the connection bars to connect blocks inside the subblock diagram to blocks outside the subblock diagram. Double-click the terminal fields at the edges of the subblock diagram to open the dialog boxes with lists of the imported or exported signals. You can add or delete connections in these dialog boxes. If you add a new import connection for data, the respective import field of the subblock diagram receives another connection. The subblock diagram contains another data input terminal where you can connect more signals. If you add export connections, DIAdem also generates the respective terminals in the subblock diagram and in the subblock diagram block. You only can delete terminals if no signal buses are connected to these terminals in the subblock diagram or in the subblock diagram block.

Click the **Close Subblock Diagram** button on the toolbar to display the subblock diagram again as a single block in the main block diagram. To integrate the blocks of a subblock diagram in a block diagram, select the subblock diagram block and click **Ungroup Subblock Diagram** on the toolbar. Before you ungroup a subblock diagram, you must connect each import and export terminal inside and outside the subblock diagram with buses that are the same length as the list length, otherwise DIAdem will not be able to completely unpack the subblock diagram.

You can save a subblock diagram as a file in order to reuse partial solutions for other tasks. Open the subblock diagram and select **File»Save Subblock Diagram**. To save a brief description of a subblock diagram, click **Block Diagram Parameters** on the toolbar. DIAdem saves block diagrams with the filename extension `.dac` and subblock diagrams with the filename extension `.sub` in the same file format. You also can load a block diagram as a subblock diagram and use a subblock diagram as a template for a block diagram. Select **File»Load Subblock Diagram** to import subblock diagrams. After you have selected the file name, DIAdem imports the subblock

diagram without changing the global settings such as the default system clock, interfaces, data storage, and measurement parameters, of the main block diagram.

Editing Block Diagrams

In the DIAdem DAC workspace you can select and position one or more blocks. Use the alignment functions and the grid, which you activate on the toolbar, to position the blocks in relation to each other. When you move the blocks, DIAdem reconnects the buses. To move buses separately from the blocks in the block diagram, move branches and input nodes. Press <Del> to delete selected objects. To delete a bus between two blocks, for example, select the bus and press <Del>. To deselect all objects, click anywhere in the worksheet, or press the <Esc> key.

If you move a block to the right or down over the edge of the workspace, you move the visible section of the block diagram. Use the scroll bars to move the visible section anywhere in the workspace. To view the entire workspace, click **Zoom Out**. To enlarge a section of the block diagram overview, click **Zoom In**. DIAdem displays a cursor with a rectangle, which you use to specify the section you want. You can use this function repeatedly until you have the view you want. You can now click **Zoom Out** to undo the zoom step by step and click **Zoom Off** to restore the normal view.

In complex block diagrams, you can select **Edit»Find** to search for blocks and signals. When DIAdem finds a block, you can open the block properties and terminals from the search dialog box. At the same time, DIAdem selects the block in the block diagram.

You can prevent changes being made in block diagrams in DIAdem DAC. To do so, click **Lock Editing** on the toolbar. DIAdem saves this setting with the block diagram. However, you can still change the parameters for the display and input instruments in DIAdem VISUAL.

In the DIAdem DAC settings you specify the maximum size of the block diagram and the display of the block diagram editor. Select **Settings»Options»DAC»Measurement Kernel** to specify the maximum number of blocks and signals for one block diagram. Select **Settings»Options» DAC»Block Diagram** to change the background colors, the block display, the bus layers, and the labels for the blocks and buses.

Select **Settings»Single Point Processing»Default System Clock** to specify the basic sampling rate for the block diagram. DIAdem sets the default system clock for all blocks for which you do not set a clock signal. Use system clock blocks in the block diagram to assign a clock rate that is different to the default system clock to individual blocks. The blocks that are not connected to the System Clock block continue to work with the default system clock. If you use several system clock blocks, you can create subsystems that have different sampling rates. The settings you set in the system clock block specifies whether only the DAC kernel controls the measurement, or whether the kernel and the measurement hardware control the measurement together. Refer to *Different DIAdem Measurement Modes* in Chapter 7, *The Basics of Process Measuring and Control Technology with DIAdem*, for more information about the measurement modes.

If you also use packet blocks in a block diagram, select **Settings»Packet Processing»Default System Clock** to specify the sampling rate of the packet blocks. Refer to Chapter 5, *Working with Packet Processing*, for more information on single point processing and packet processing.

In a block diagram file with the filename extension `.dac`, you save the blocks, the buses, the hardware settings, the interfaces in DIAdem, the system settings, and the visualization settings. If you use a graphic for visualization, DIAdem saves the filename including the path, in the block diagram. Select **Settings»Options»DAC** to save a block diagram in ANSI format instead of in Unicode. With DIAdem 10.2 and earlier versions you only can load block diagrams that were saved in ANSI format.

Enter a short description of the block diagram in the **Block Diagram Parameters**. In the block diagram parameters you can also include user commands so that you can use functions you defined in a script, before and after a block diagram check and before and after a measurement. Select **Settings»Options»Extensions»User Commands** and register script files that contain user commands, for DIAdem to add the user commands contained in the files to the collection of commands. Refer to Appendix A, *Executing Measurements Automatically*, for more information about scripts for DIAdem DAC. Refer to Chapter 6, *Automating Work Sequences*, in the DIAdem manual *Data Mining, Analysis, and Report Generation*, for general information about creating scripts.

DIAdem DAC Function Groups

DIAdem provides an extensive library of functions as blocks for signal acquisition, processing, and visualization. These blocks are arranged by category in the DIAdem DAC function groups:

- System
- Driver inputs and outputs
- Simulation inputs and outputs
- Scaling
- Processing
- Control
- Display instruments

  Refer to *DIAdem VISUAL Function Groups* in Chapter 4, *Visualizing Data and Operating Facilities*, for a description of the display instruments.

- Alarm system

  Refer to *Alarm System Functions* in Chapter 6, *Monitoring Processes with the Alarm System*, for a description of the alarm functions.

- Packet processing

  Refer to *Packet Processing Functions* in Chapter 5, *Working with Packet Processing*, for a description of the packet function.

> 📝 **Note**   The NI License Manager only enables DAC functions included in your DIAdem license. DAC functions that are not included in your DIAdem license are dimmed in the corresponding function groups. To use these DAC functions you must obtain a license for a different DIAdem edition.

System Function Group

The function group **System** includes the blocks **Save Data**, **Save Data with Trigger**, and **Save in Variables**, for saving measured values. The blocks **Save Data** and **Save Data with Trigger** save channel group properties and channel properties with the measured values, in the Data Portal or to a file.

To save measured values in relation to events, you can define a start trigger and a stop trigger in the system block **Save Data with Trigger**, and you can define consecutive triggers in the system block **Trigger Sequence**. For the start trigger and the stop trigger you can define a pre-range and a post-range, to save the measured values that come directly before or after a trigger. For each trigger sequence you can define a data reduction, to save only the first value, the minimum, the maximum, or the arithmetic mean, of the specified interval. Select **Settings»Options»DAC» Measurement Kernel»Triggers** to change the maximum number of trigger sequences in a block.

Use the **System Clock** to create subsystems with different sampling rates. DIAdem sets the default system clock for all blocks for which you do not set a clock signal. The measurement mode you set in the system clock block specifies whether only the DAC kernel controls the measurement, or whether the kernel and the measurement hardware control the measurement together. To make settings for the default system clock select **Settings»Single Point Processing»Default System Clock**.Refer to *Different DIAdem Measurement Modes* in Chapter 7, *The Basics of Process Measuring and Control Technology with DIAdem*, for more information about the measurement modes.

Driver Inputs and Driver Outputs

The function groups **Driver Inputs** and **Driver Outputs** include functions for registered measurement hardware and interface functions. Use the function group **Driver Inputs** to insert signal acquisition blocks into a block diagram. Use the function group **Driver Outputs** to insert signal output blocks into a block diagram.

Both function groups contain blocks for the interfaces XNET, CAN, OPC, DDE, and device drivers. With the **NI-XNET driver**, DIAdem can acquire and output data with the NI-XNET hardware. NI-XNET supports CAN (Controller Area Network), LIN (Local Interconnect Network), and FlexRay. The driver inputs contain the **ECU driver**, which uses the NI ECU Measurement and Calibration Toolkit to acquire data from the Engine Control Units (ECU). The **NI-CAN Driver** (Controller Area Network) enables access to signals via the CAN bus and the **NI-DAQmx-driver** enables access to the National Instruments hardware that you define in the Measurement & Automation Explorer, which is the National Instruments device configurator. With the **OPC Driver** (OLE for Process Control), DIAdem can communicate as an OPC client with any OPC servers registered on your computer. With the **DDE Driver** (Dynamic Data

Exchange), you can establish a client/server link via DDE. DIAdem uses the **Script Driver** to communicate, VBS based, with external measurement devices via the interfaces RS-232, GPIB, and TCP/IP. DIAdem uses the **Control File Driver** to communicate with external measurement devices on the basis of ASCII control files, via the RS-232 interface or the GPIB bus.Refer to Chapter 2, *Installing Measurement Hardware and Communicating via Interfaces*, for more information on how to register measurement hardware in DIAdem or how to access external devices via interfaces.

Simulation Inputs and Simulation Outputs

The function groups **Simulation Inputs** and **Simulation Outputs** include functions for generating signals without measurement hardware. You can use simulation blocks to create and to test block diagrams without hardware, and you can later replace the data sources with hardware blocks.

The function group **Simulation Inputs** includes the blocks **Random**, **Noise**, and **Function Generator**, for generating continuous signals. You operate the input instruments **Switch**, **Push Button**, **Slider Control**, **Dial**, **Radio Button**, and **Numeric Input** in DIAdem VISUAL using the mouse or the keyboard, to generate signals interactively. You can manually trigger control signals in relation to conditions. The blocks **Read Channel from Data Portal**, **Read Channel from DAT File**, and **Read Channel from DAT Measurement File**, read data from the Data Portal or from a data file that can originate from a measurement that has finished or is still running.

To display the date and time during a measurement, use the **Absolute Time** with a digital display. Because DIAdem displays the time in seconds since the year zero, you must enter the digital date display in days, hours, seconds, and milliseconds, for example, in the format `#dd hh:nn:ss.ffff`. Use the **Date** block if you want to display only the day, the month, or the year of the current date, and use the **Time** block to display the current hour, minute, or second. In the connected digital display, you do not specify a time format to display the date or the hour, you specify the number of decimal places, for example, `dddd` for the date. You use the **Stopwatch** to measure the duration of events in seconds, by starting, stopping, and resetting the stopwatch with control signals.

You use the **Counter** to simulate a counter component that has a control input `Clock Release`, which starts counting synchronously with the system clock, and a control input `Reversion`, which changes the counting direction. The **Buffer Monitor** monitors the filling of the measurement value buffer to give you an idea of the load the measurement subjects the computer to.

The function group **Simulation Outputs** includes the **Loudspeaker**, which outputs measured values as acoustic signals to the computer loudspeakers. Use the **Execute Application** block to start other applications in relation to events. Use the **Open Application** block to display and to hide executing programs on the screen.

Scaling Function Group

The **Scaling** function group includes blocks for converting the incoming signals from the measurement hardware into the measured physical quantities. Scaling blocks convert, for example, the voltage recorded on temperature sensors into the original measured temperature, with the unit degrees Celsius.

Linear Scaling scales signals linear, using the linear equation `ax+b`, and **Two-Point Scaling** scales signals using two specified points. You can execute a calibration measurement to determine the two points. Use **Free Linearization via Table** to create a value table and use **Free Linearization via Channels** to specify channel pairs from the Data Portal which specify the interpolation points for any non-linear scalings. DIAdem uses an interpolation to calculate the scaled signal values between the between data points. Use the **Offset Correction** function to subtract a constant from the measurement values.

The **PT100 Linearization** calculates the temperature from the measured resistance. The **Thermo Linearization** block calculates the temperature from the voltage measured on a thermocouple. If you execute external pre-amplification, DIAdem can convert the incoming voltage values to the voltage range on the thermocouple used, so that the linearization function processes the measured values correctly.

Processing Function Group

The function group **Processing** includes blocks for calculating data signals and controlling processes.

In the processing block **Formula** you define formulas for connecting data signals to control signals, in the same way as in the DIAdem Calculator. You can execute comparison operations and Boolean operations in the formula, for example. However you cannot execute VBS commands. As the formula result, DIAdem outputs data signals such as the power, calculated from the current and the voltage. The **Signal Copy** creates as many copies of the input signal as the block has data outputs. However, the **Signal Multiplexer**, which is controlled by the selection input, groups measured values from several input signals, into one data signal. You use the block **Control Signal–>Data Signal** to convert control signals into data signals, for example, to visualize the status of control signals. The processing block supplies data signals with the values 0 and 1.

Use the **PID Controller**, the **Two-Point Controller**, or the **Three-Point Controller** to calculate actuating values from the difference between the reference values and the actual value. In the non-linear blocks **Two-Point Controller** and **Three-Point Controller**, you can specify a hysteresis by entering different values for the on and off levels. With the **PID Controller** you must ensure that the proportional part, the integral part, and the differential part correspond, to ensure good control behavior.

Use the **Bit Bundling** block to bundle up to 32 single-bit signals into one 32-bit signal, and the **Bit Extraction** block to divide a signal with up to 32 bits, into single-bit signals. The processing block **Mean of N Signals** calculates the arithmetic mean of all the input signals and the

processing block **Floating Mean** calculates the floating mean for each signal at an interval that you specify. The processing blocks **Binary Code->Gray Code** and **Gray Code->Binary Code** convert measured values from binary code to Gray code and vice versa.

Create your own processing functions in scripts, to use the functions in the processing block **VBS Script** in block diagrams. You also can create function libraries (DLLs) which you register via **Settings»Options»Extensions»GPI Extensions** in DIAdem and provide in this function group via **Settings»Single Point Processing»Driver Function Groups**.

Control Function Group

The function group **Control** includes blocks for monitoring data signals, system signals, and control signals. DIAdem generates control impulses when data signals exceed thresholds, for example, or when periods of time elapse, or when a key is pressed. Control signals have the value 1 if a condition is true and the value 0 if a condition is not true. Use control signals to start or to stop the storage of measured values, to switch display instruments on and off, or to adjust the sampling rate during the measurement.

To add an inverted block output to the control blocks, enable the setting **Inverted outputs** for the control outputs.

Use the control block **Window**, **Slope**, and **Signal Alteration** to monitor data signals. The **Window** generates a control impulse when data signals enter or leave a specified value range. The **Slope** block checks whether data signals exceed a threshold in the ascending or the descending direction, and the **Signal Alteration** block monitors the difference between consecutive values.

In the control block **Formula** you define formulas for connecting data signals to control signals and for outputting control signals as the formula result, in the same way as in the DIAdem Calculator. You can execute comparison operations and Boolean operations in the formula, for example. However you cannot execute VBS commands. When you use formula blocks, remember that DIAdem processes predefined conditions, such as the Window block, faster than formulas.

The **Push Button**, the **Radio Button**, and the **Checkbox** create a control impulse if the user presses a specified function key or selects the respective button in DIAdem VISUAL. With the Start and Stop control inputs, you can block and release the operation of the three input instruments in relation to events. The **Time** block realizes an on/off delay or generates a periodic control impulse, and the **Absolute Time** generates a time condition with the date and time.

Use the control blocks **AND** and **OR** to execute operations on control signals, and use the **NOT** block to invert a control signal. The **Impulse Delay** control block forwards a control signal, with a delay, as an impulse.

The Mono Flop and the Flip Flops work the same as the electrical engineering components. The **Mono Flop** is a single-shot circuit that outputs a control signal for a specific hold time, as soon as a control impulse arrives at the set input. The **RS Flip Flop** and the **JK Flip Flop** are bi-stable

circuits that, after a control impulse, continue to output a control signal at the set input until a new control impulse arrives at a reset input. The **Switch** is similar to the RS flip flop, but DIAdem monitors only one control input: only the reset condition for a set switch and only the set condition for a switch that is not set.

Use the control blocks **System Clock Status**, **Trigger Sequence Status**, and **Number of Values** to monitor system signals. The **System Clock Status** checks the status of a system clock and the **Trigger Sequence Status** checks the status of a trigger sequence of a system clock rate. You can use this control information to start other clock systems or trigger sequences consecutively. The control block **Number of Values** generates a control impulse after a specific number of clock cycles.

4

Visualizing Data and Operating Facilities

You use DIAdem VISUAL to design the visualization of block diagrams that you create with DIAdem DAC. When a measurement starts, DIAdem automatically switches to DIAdem VISUAL to display measurement data, open or closed loop control data, or monitoring data. The display and input instruments can be positioned freely and pictures and audio files used, allowing you to design all kinds of appropriate visualizations for your task.

Creating a Visualization

When you create the block diagram in DIAdem DAC, you select, configure, and connect the blocks and decide which display instruments show which signals. In DIAdem VISUAL you then design the visualization by arranging and configuring the display instruments and the input instruments. You save the definition of the visualization with the block diagram. You also can add display instruments and input instruments from the function groups in DIAdem VISUAL. With each instrument you add, you also add a block to the block diagram in DIAdem DAC, where you connect data buses, control buses, and system buses to the block.

For example, to display the data of the **NI-DAQ** driver input as curves on a recorder, open the **Recorder Display** function group in DIAdem VISUAL and click the **Horizontal Recorder Display** button. DIAdem inserts the display instrument in the top left corner of the workspace. Move and resize the recorder display to position the display instrument. Double-click the instrument and select the y-scaling, specify the frame and background, and display the axis labeling and a legend in order to edit the instrument. To connect data to the display instrument, open DIAdem DAC and connect the data input of the **Recorder** block to the data output of the **NIDAQ-In** block.

To display the measurement values, click **Start Display** on the toolbar. DIAdem displays the connected and active signals as curves. To stop the display, click **Stop Measurement** on the toolbar. While a measurement is running, you cannot move or edit the instruments, you only can operate the input instruments in the workspace and click **Stop** on the toolbar. In DIAdem VISUAL you can not only start a block diagram, you also can load it and save it.

Use the full-screen mode to hide the DIAdem VISUAL user interface and display the workspace contents on the entire screen. Press <Ctrl-U> for the full-screen mode. Then press <Ctrl-F5> to start a measurement. Hit the <Esc> key to stop the measurement. Press <Ctrl-U> to disable the full-screen mode. You can neither enable nor disable the full screen mode while a measurement is running.

Editing a Visualization

You can position display instruments, input instruments, and graphics anywhere in the visible workspace. However, you cannot move instruments over the edge of the screen as you can in DIAdem DAC, because the DIAdem VISUAL workspace is limited to the visible area. Enable the grid to position instruments exactly next to each other or above one another.

When you select an instrument, DIAdem marks the instrument with a dashed frame and small squares in the corners and at the sides. Move the squares at the sides to change the width and the height. Drag the squares at the corners to resize the instrument while maintaining the proportions. Press <Ctrl> at the same time, to change the size but keep the center.

You can select several instruments and move and resize them together. You can use the alignment functions to align selected instruments to each other and to align the size of the objects. The dashed frame is the reference point for DIAdem. To align three instruments evenly spaced underneath each other, click the **Align Vertical Intervals** button on the toolbar. If the selection frame is smaller than the total height of all three instruments, DIAdem positions the instruments underneath each other with the edges touching, without changing the height of each instrument. If you position an instrument incorrectly, or if you use the wrong alignment function, press <Ctrl-Z> to undo steps.

If you cannot select an instrument with the mouse in the workspace, because the instrument is hidden by another instrument, click the instrument which is on top, and select **Edit»Outline** to make the hidden instrument visible. To edit hidden instruments, select one instrument after another with the <Tabulator>. DIAdem displays the selected instrument in the foreground.

The display instruments and the input instruments have a predefined value range of ±10. You can change the value range separately for each signal in the block dialog box. In the dialog boxes for the display instruments **Curve**, **Recorder**, **Wiper, and Spike** you can select automatic y-scaling so that DIAdem sets the value range according to the incoming measurement values.

You can prevent changes being made in visualizations in DIAdem VISUAL. To do so, click **Lock Editing** on the toolbar. DIAdem saves this setting with the block diagram. However, the visualization block parameters can still be changed in DIAdem DAC.

Working with VISUAL Pages

Position instruments you want to view simultaneously when the display starts next to each other or one above the other without one instrument concealing the other. However, if you want to change the display in relation to an event, arrange the instruments so that they are stacked on top of each other and only reveal the instrument you need. The conditions which you define in the

control blocks determine when DIAdem displays which instrument. If you connect a control bus to the start input of the curve display, DIAdem does not show this display instrument until the condition at the start input is true.

To make it easier to select display instruments and input instruments in complex block diagrams, which makes it easier to edit the visualization, you can group instruments together into VISUAL pages. You can display, hide, and lock VISUAL pages for editing. To define VISUAL pages in DIAdem VISUAL, select **View»Page Management**. Then you must assign a VISUAL page to each instrument in the block dialog box under **Frame**. To hide a group while you edit the visualization screen, click **View** and disable the appropriate VISUAL page.

By default, each subblock diagram uses its own VISUAL page, which has the same name as the subblock diagram. To assign another VISUAL page to a subblock diagram, open the subblock diagram in DIAdem DAC and select **Block Diagram Parameters»VISUAL Page** on the toolbar. To assign a different VISUAL page to an instrument of the subblock diagram select select the new VISUAL page in the block dialog box.

Visualization Settings

To specify basic visualization properties, select **Settings»Block Diagram Parameters»Visualization**. You specify whether DIAdem hides deactivated display instruments during the measurement, and select the VISUAL background color. DIAdem saves the sizes and positions of the instruments in relation to the workspace, to automatically adjust the visualization to different screen sizes or changed window sizes. For identical display of the sizes and positions of instruments on any screen, specify the display area for the visualization, for example, as 800×600. DIAdem then shows the same visualization screen, regardless of the screen resolution.

DIAdem VISUAL Function Groups

DIAdem provides various display and input instruments. These functions are arranged by category in the DIAdem VISUAL function groups:

- Manual input
- Curve display
- Wiper and spike display
- Recorder display
- XY displays
- Gauge displays
- Bar displays
- Alphanumeric displays
- Binary and status displays
- Alarm system display

Refer to *Alarm System Functions* in Chapter 6, *Monitoring Processes with the Alarm System* for a description of the display instruments of the alarm system.

• Graphics

DIAdem DAC includes blocks for displaying measurement values in the function group **Display Instruments** and the blocks for the manual instruments in the function group **Simulation Inputs**.

Manual Input Instruments

The function group **Simulation Inputs** includes the instruments **Switch**, **Push Button**, **Radio Button**, **Slider Control**, **Dial**, and **Numeric Input**, which you can use to create data signals manually. In DIAdem DAC use the **Push Button**, the **Radio Button**, or the **Checkbox** from the **Control** function group to create a control impulse manually. You can operate the manual input instruments with the mouse, the keyboard, or with a data signal. After you enable remote control in the dialog box, the block receives another control input and data input. The additional data signal does not control the manual input instrument unless there is an active control signal at the remote control input. You cannot control manual instruments manually and via a data input at the same time.

You use the arrow keys on the keyboard to operate the **Slider Control** and the **Dial**, and you use an assigned function key to operate the **Switch** and the **Push Button**. Select the settings for a **Radio Button** and **Checkbox** either with the arrow keys and the enter key, or with the function keys. For **Numeric Entry** you enter numbers on the keyboard and press <Enter>. If you enter a value that is outside the set value range, DIAdem uses the corresponding limit value instead.

Curve Display, Recorder Display, Wiper Display, and Spike Display

The function groups **Display Curves**, **Recorder Display**, and **Wiper and Spike Display** include display instruments that display signals as time-related curves.

Use the **Display Curves** function group to display signals as time-related curves, which DIAdem plots from left to right. The Curve display deletes when the curve reaches the end of the window, refreshes, and re-plots from the left.

Use **Recorder Display** to display signals as a continuous horizontal curve from right to left, or as a vertical curve from the top to the bottom. The recorder displays the signals as curves as if they were recorded on paper by a needle on a roller.

Use the **Wiper** to display signals as continuous time-related curves, and use the **Spike** display instrument to display signals as vertical lines over the time axis. In both of these display instruments, a vertical line moves across the instrument from left to right and deletes and re-plots the curve. Wiper and Spike display, for example, display the values measured in the last ten seconds. In this case the current values are to the left of the vertical line and the previous values are to the right of the line. This enables you to see signal changes as soon as they occur.

With these display instruments, you can display all the curves in one axis system or each curve in a separate axis system. Grid lines, legends, and warning and alarm ranges make it easier to monitor the signals. To scale the time axis you specify a time segment, which DIAdem labels with the measurement time, with the current time, or with a fixed scale. To scale the y-axis, you can choose between a scale with the percentages of the display area, and a scale with the physical values. Specify the value range in the signal list; otherwise DIAdem specifies the range automatically. If you select automatic scaling, you can specify a minimum range, a fixed range, or an automatic scaling with peak hold.

If you enable the setting **Allow manual changes to the value range**, you can change the y-scaling interactively during a measurement. To do so, position the cursor over the y-axis scale and turn the mouse wheel when a double-arrow appears at the cursor. Rotate the mouse wheel to expand or to shrink the scale. If you position the cursor at the center of the axis, you modify the scale at both ends of the axis. If you position the cursor at the lower end or the upper end of the axis, you scale the axis at the selected end, while the opposite end remains fixed. Of course, you also can move the section. At the end of the measurement DIAdem restores the original value range.

XY Display

Use **XY Display** to display the relation between two signals as an xy-curve. The display instrument plots a curve or moves a symbol, such as a circle or a triangle, across the display area.

To scale the x-axis and the y-axis, you can choose between a scale with the percentages of the display area, and a scale with the physical values. Grid lines, legends, and warning and alarm ranges facilitate signal monitoring.

Gauge Display

The function group **Gauge Display** includes display instruments such as the **Tachometer**, **Analog Instruments**, and **Cylinder Tachometers**, to display the current signal values with pointers. The **Analog Instrument** uses a quadrant, the **Gauge Display** uses a semicircle, and the **Tacho Display** uses a three-quarter circle as the scale that the gauge moves in. You can modify the size and position of the scale for the gauge and for the tachometer.

In **Cylinder Tachometer** display, the scale moves, not the pointer. DIAdem can move the cylinder vertically or horizontally and display the pointer as a line or as a double arrow. You specify the scale on the cylinder as a percentage that is the size of the visible segment of the value range.

Use the **Polar Display** to display the x-values and the y-values of a signal in a polar axis system. The x-values contain the angles around which the pointer rotates and the y-values contain the amplitudes that specify the length of the pointer.

The Cylinder tachometer displays a separate display instrument for each signal, whereas you can display all the signals in each of the other gauge displays. You can choose between a scale with

the percentages of the display area, and a scale with the physical values. Legends and warning and alarm ranges make it easier to monitor the signals.

Bar Display

Use the **Bar Displays** to display the current signal values as horizontal or vertical bars. By default DIAdem plots bars from the bottom edge of the instrument to the current value. If the value range is ±10, DIAdem plots a bar from -10 to -3 for the value -3. The reference line specifies whether the bars display on one side or on both sides of the axis. To differentiate the positive and negative values set the reference point to 50% in the middle of the symmetrical value range. If the values are positive, DIAdem plots the vertical bar upwards. If the values are negative, DIAdem plots them downwards.

The bar displays of the **Container** specify the filling level in different-shaped containers. The level corresponds to the current measured value. You can choose between three cylindrical forms and one round form or a graphic for the selected container. To do this, select a graphic file in the dialog box of the container, and specify the transparency color. The graphic area which displays the bar must have the transparency color.

You can choose between a scale with the percentages of the display area, and a scale with the physical values. A color change in the bars indicates that the limit values have been exceeded.

Alphanumeric Display

The **Alphanumeric Display** function group includes the digital displays **Digits** and **Table**, for numeric display of the current signal values. You can manually enter the numeric format and the font, and you can use color changes to indicate when limits are exceeded.

Use **Message Display** to display events visually or acoustically. DIAdem reads the messages from a text file and displays each measured value in a separate line. Instead of text, DIAdem can also display graphics and play audio files. To display graphics, enter @graphic in the first line of the text file and enter the paths with the graphic files in the subsequent lines. To run audio files, you must enter @sound and the audio files instead. To combine graphics with audio files, use two Message blocks in the block diagram.

Use **Text** to display a description or instructions in relation to an event. DIAdem has static text and dynamic text. Dynamic text contains formula expressions and variables that DIAdem periodically updates. You can double-click to open the text editor, for example, to enter @@CurrTime@@ for the current time display.

Binary and Status Display

The instruments in the function group **Binary and Status Display** do not show measured values, they divide the measurement range into two or more states.

Use the binary displays **Valve** and **Switch** to display an opening or closing valve or switch. If you select the **Rectangle** or the **Light** instead, a color change indicates whether the signal is inside or outside the display range.

Use the **Status** display to differentiate between several states with colors, graphics, and audio files. The status display, for example, can display the various work steps of a press such as opening the car roof or the deformation of a component.

Use the **Color Matrix**, for example, to show the temperature distribution on a workpiece. The temperature sensors must be positioned in a regular grid on the workpiece. The color palette that you define as the value range determines the color shading for the signals in DIAdem.

Graphics

Use the function group **Graphics** to integrate a picture of the test rig, the company logo, or a video, in the visualization. To integrate graphics in the customary formats and videos in the AVI file format and the MPEG file format, select **Load Graphics**. If you load a graphic or a video, DIAdem creates a link to the file. DIAdem saves the link with the path definition in the block diagram. If you want to use the block diagram on another computer, you must also copy the graphic or the video to the computer.

The following figure shows how the icons on the buttons on the left edge make switching between components easy. The large graphic on the right of the visualization shows the part of the plant to which the measurement values are assigned.

Figure 4-1. Monitoring a Facility at Four Critical Points

5
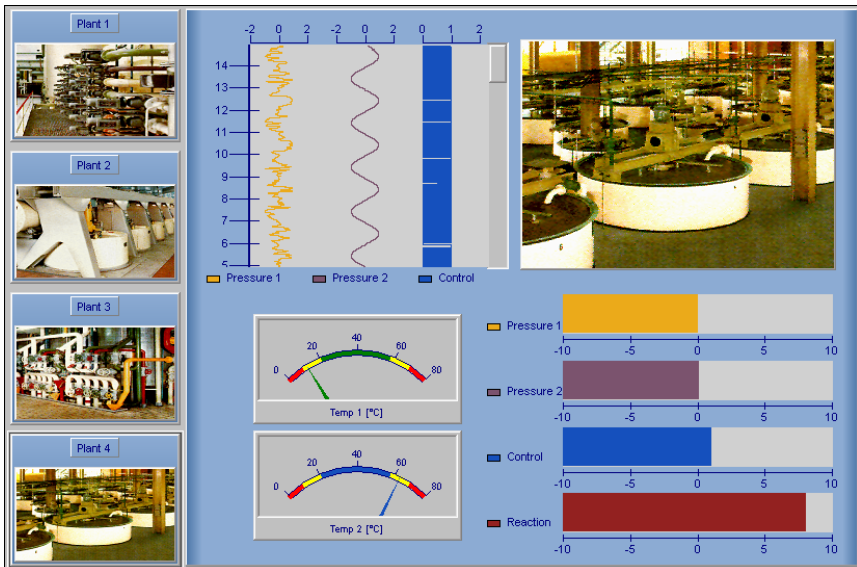
Working with Packet Processing

DIAdem provides two different methods for measuring and visualizing data: single point processing and packet processing. In single point processing, the measurement kernel controls the timing for point-by-point data acquisition, processing, and output. In packet processing, DIAdem handles the data in packets. The data flow controls the processes, which means that a function block must process an entire data packet before the subsequent function blocks can start to process the packet. You can combine single point processing and packet processing in one block diagram, for example, to execute an online FFT in the packet section and to use the maximum values of the frequency analysis for control in the single point section.

Processing Single Values

In single point processing, the measurement kernel controls all functions. This centralized control decides when DIAdem executes which functions, and controls the sampling rates, triggers, and conditions. The measurement kernel requests values from the device drivers or forwards values to device drivers for output, and displays the values on the screen. At any point in time, the current acquired or calculated value is at each function block.

In single point processing, data acquisition is executed in hardware clock or software clock. This enables you to execute long-term measurements and fast measurements. You can use plug-in boards to execute open and closed loop control without a signal processor.

Refer to *Different DIAdem Measurement Modes* in Chapter 7, *The Basics of Process Measuring and Control Technology with DIAdem*.

Single point processing is especially suitable for the following operations:

• Measurement data acquisition with individual moderate sampling rates

• Long term measurements

• Event-controlled data acquisition

• Open and closed control tasks with moderate real-time requirements

Processing Data Packets

In packet processing, DIAdem does not process single values separately: DIAdem groups the single values into packets that pass through each of the processing steps consecutively. As soon as a data packet arrives, DIAdem forwards the data packet to the first processing function. The function processes, visualizes, saves, duplicates, or rejects the values and transfers the resulting data packet to the next processing function.

The data packet flow works like a letter shoot. The data packets go physically from one function to the next. The reduced amount of administration effort increases the data throughput compared to single point processing. Each function works automatically as soon as a data packet arrives. This makes it possible to execute calculations such as Fourier analyses, which require a certain number of values simultaneously.

The measured values are acquired in data packets with data flow control. The measurement hardware determines which additional functions you have, for example, processing mathematical functions or complex testing tasks with short response times to boards with signal processors, which reduces the computing load during processing.

Packet processing is especially suitable for the following operations:

- Data acquisition with high data throughput

- Fast online visualization

- Complex online mathematical functions

- Using special hardware features

Using Packet Functions in the Block Diagram

Packet processing has its own functions for signal processing, signal analysis, visualization, signal acquisition, and signal output. To combine single values and data packets in one block diagram, use the **Pack** block, which groups single values into data packets, and the **Unpack** block, which divides the data packets into separate values.

For example, to display a signal from the single point **NI-DAQ** driver input defined in the block diagram as a waterfall diagram, open the function group **Signal Processing (Packet Processing)** and click the **Pack** button. Position the packet block below the existing block diagram and connect the green data bus that is connected to the driver input, to the data input on the **Pack** block. Double-click this block to specify the number of values in one data packet in the block dialog box.

To display the data packets as a waterfall diagram, open the function group **Display and I/O (Packet Processing)** and click **Oscilloscope (3D Display)**. Position the Oscilloscope block next to the Pack block and connect both packet blocks. DIAdem connects the two packet blocks with a green and black packet bus. Together with the Oscilloscope block, DIAdem displays a new window which you can position anywhere on the screen, not just in the DIAdem VISUAL workspace.

When you start a measurement, the window displays axes and measurement curves as soon as the oscilloscope block receives data. The Oscilloscope window displays the curve of the current data packet in the foreground and the curves of the old data packets in the background, which creates a three-dimensional waterfall display. While a measurement is running, you can move the window around on the screen and you can modify the display of the measured values using the menus or the toolbar in the window. Click **Stop Measurement** on the toolbar to stop the measurement.

Unlike the display instruments in single point processing, the display of the windows is specified only in the menus or on the toolbar, and the functions of the input instruments are specified in the shortcut menus. In the dialog box of these packet blocks you only make settings concerning the data flow. In DIAdem VISUAL you have no access to the packet processing display windows and input instruments.

Unlike the single point processing function blocks, which distinguish between data buses and control buses, you connect packet buses to the control inputs, not control buses. DIAdem monitors the packet buses to check whether the condition is true.

Block Size and Sampling Rate Determine the Data Packet Flow

Packet processing transports data packets from one packet block to the next in the block diagram. Data packets are generated by hardware inputs, input instruments from packet processing, or the Pack block. DIAdem does not forward a data packet to the subsequent packet block until the data packet is completely filled with data. The subsequent packet block does not work until all the block inputs have data packets and the block outputs are vacant.

How many values a data packet contains depends on the size of the block. The maximum block size depends on the measurement hardware you use. Most packet blocks leave the block size unchanged during processing. Several packet blocks output data packets with a smaller block size, for example, the FFT data packets are half the size of the incoming data packets.

The packet processing driver blocks deliver data packets whose data originates from several channels used on the hardware. Multi-channel data packets generate the statistics function and the **Merge** packet block which combines several data packets from several packet buses. The packet blocks **Oscilloscope**, **File-I/O**, **Relay Switch**, **Arithmetic**, **Copy**, **Voltmeter**, and **Protocol list** can process multi-channel data packets. DIAdem arranges the data of the individual channels in multi-channel data packets value-wise. DIAdem first enters all first values, then all second values, and so on, into one data packet. The number of channels a data packet contains is indicated at the beginning of the multi-channel data packet.

The size of the data packets and the sampling rate determine the processing speed, which in turn determines the data flow in the block diagram. The sampling rate determines how fast DIAdem generates data or requests data from the data acquisition board. The response time in the block diagram depends on the ratio between the block size and the sampling rate. A data acquisition block that is to measure 100 values at a sampling rate of 100 Hertz, can return only one data packet per second. All packet blocks whose dialog boxes do not specify block size or sampling rate, use the default settings.

If you select **Settings»Packet Processing»Default System Clock** you can specify the packet call clock as well as the block size and the sampling rate. The packet call clock is the rate at which DIAdem calls the packet blocks. At every call, DIAdem checks whether a packet block is prepared for work. A packet block can work if all block inputs contain data packets and no

data packet is blocking the block outputs. As long as a packet block is working, the packet block ignores the packet call clock.

Packet Processing Functions

All the packet processing functions in DIAdem DAC are grouped by category into four function groups.

- Signal processing (packet processing)
- Signal analysis (packet processing)
- Display and I/O (packet processing)
- Driver (packet processing)

The **Complete Selection** button in the function group **Signal Processing (Packet Processing)** contains other packet functions that you can use in your block diagram.

> **Note**   The NI License Manager only provides the packet functions if your license contains packet processing. If not, the buttons in the alarm function groups are dimmed. To use the packet functions you might have to obtain a license for a different DIAdem edition.

Packet Functions for Signal Processing

The function group **Signal Processing (Packet Processing)** includes the functions **Unpack** and **Pack**, for combining packet processing with single point processing. The **Unpack** packet block divides the data packets of a packet bus into single values and outputs the single values to a data bus in single point processing. The **Pack** packet block combines values from one data bus in single point processing and outputs the data packets to a packet bus.

You use the **Merge** packet block to combine data packets from several packet buses to a new multi-channel data packet. The packet size and the sampling frequency of one-channel data packets must correspond. You use the **Manager** packet block to select channels from multi-channel data packets. To create single-channel data packets, enter only one channel in the channel list. This packet block forwards the unaltered input signal together with the selected channels.

Use the **Multiplexing** packet block to output data packets from several data inputs in alternating order from a block output, and the **Demultiplexing** packet block to output data packets from one input signal to several block outputs in alternating order. The signal at the control input specifies which input DIAdem uses for the multiplexer or which output for the demultiplexer.

The **Relay Switch** packet block works as an on/off switch or as a toggle switch, to interrupt data packet transport or to assign the transport to two block outputs. The signal at the control input controls the relay switch. The **Trigger** packet block outputs data packets in relation to events, and DIAdem monitors whether the data signal or a second signal overshoot thresholds. The Trigger block rejects all data packets before the event.

You use the **Ignore** packet block to reduce the amount of incoming data. The Ignore block can reject values, change packet sizes, or output specified sections of data depending on a control signal. The **Replicator** packet block repeatedly outputs a data packet, for example, for recurring use of a data packet with set points or comparative data, or to synchronize data signals that have seldom and irregularly incoming data packets with fast data signals. You use the **Offset Register** packet block to reduce the block size by dividing large data packets into smaller subpackets.

You use the scaling functions to convert values, for example, to display the values in a different unit. **Linear Scaling** uses a linear equation with a factor and an offset for calculations, whereas **2-Point Scaling** uses two points to determine the linear equation. **Thermo Linearization** converts the voltages measured with thermocouples and with PT100 resistance into temperatures. **Multi-Point Scaling** scales data with a non-linear calibration curve, which the packet block reads at a second data input. To change the calibration dynamically, you can exchange the calibration curve during the measurement.

Use the **Clock** packet block with the single point block **System Clock** to change the packet call rate in the block diagram. Use the packet block **Stop** to stop the block diagram packet blocks or the complete measurement after a specified number of data packets.

Packet Functions for Signal Analysis

The function group **Signal Analysis (Packet Processing)** includes the packet block **Formula Parser**, which executes mathematical functions on data packets from several packet buses, with a specified formula. DIAdem calculates the data packets of each block input value-by-value and outputs the results in a data packet that is the same size as the first data input.

You use the **Averaging** packet block to calculate the arithmetic mean or the floating mean for entire data packets or for sections of the data packets and you use the **Counter** packet block to count measured values, data packets, or time ranges. The **Statistics** packet block calculates characteristic statistical values for data packets and the **Online Classification** block specifies the frequency distributions for the measured values in the data packets. DIAdem divides the data packets into classes, and counts how many measured values each class contains.

The function group **Signal Analysis (Packet Processing)** includes functions such as fast Fourier transform (FFT) and Third/Octave Analysis, which you use to monitor frequency sections of oscillations during measurements. The **FFT** block transfers signals from the time domain to the frequency domain, the **Inverse FFT** block reverts signals from the frequency domain to the time domain, and the **FFT of Two Time Signals** analyzes two signals with a common time channel, by calculating cross spectra and transfer functions. You use the **Third/Octave Analysis** to check the frequency distribution in the signal for frequency domains, not for individual frequencies. To do this, the third/octave analysis sums up the amplitude values of an FFT in standardized logarithmic frequency intervals.

With the **Digital Filters** packet block, you can attenuate or amplify selected frequency ranges of a time-related signal. You can choose from a selection of filter types such as lowpass, bandpass, and bandstop filter, which you use as IIR filters and FIR filters. The following figure shows the results from the IIR filters Butterworth and Chebyshev.

Figure 5-1. Signals Filtered with Different Digital Filters Displayed in the Oscilloscope
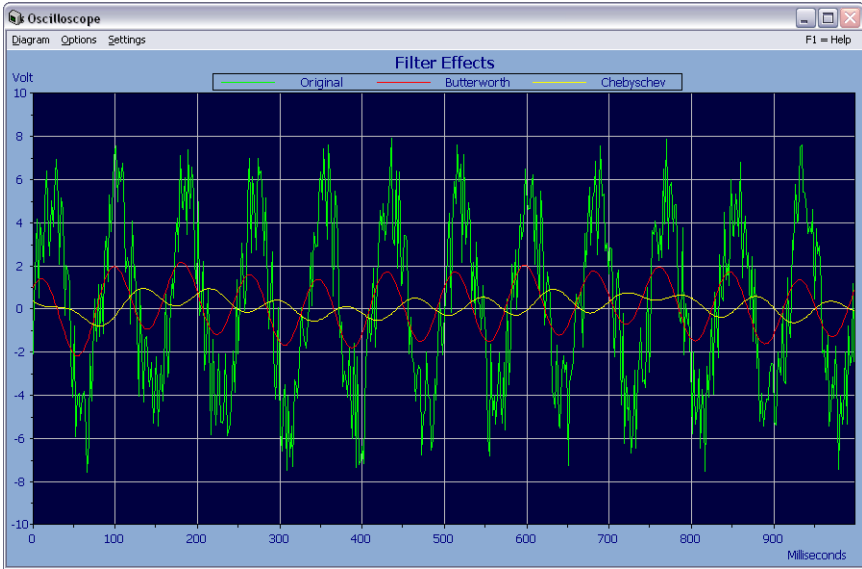
Packet Functions for Display and File Access

The **Display and I/O** (Packet Processing) function group includes the oscilloscope and the voltmeter for visualizing data packets, and packet blocks for manual input and output of data packets. These blocks have their own windows, which you can configure separately and position anywhere on the screen.

The **Oscilloscope** displays data packets as curves, bars, or spikes. You can display the chronological profile of signals as a three-dimensional surface or in recorder display. You use the menus and the toolbar in the display window to specify the appearance of the display, which you also can change during measurements.

Click **Cursor** on the toolbar to show two cursor lines for measuring curve profiles and the cursor window. You can move the cursor lines with the mouse during the measurement and enlarge the range between the two cursor lines. The cursor window shows, for example, the point numbers and the x-values and the y-values, of both cursors.

The **Voltmeter** block displays measured values with gauges, digital instruments, horizontal or vertical bars, and text. If the voltmeter contains multi-channel data packets, the window displays a separate instrument for each data channel. Use the shortcut menu of the display window to

specify the display mode for the incoming signals and to show the warning and alarm limits, the drag indicator, and the trend display.

The **Generator** packet block generates signals such as sine signals and noise signals. The **Manual Input** blocks generate data packets with a slider control, a dial, a switch, a push button, or a bit switch. You use the shortcut menu of the instrument to specify the instrument display. If you generate several signals with a manual input instrument, DIAdem displays an input instrument for each channel in the display window. Manual input generates data blocks that have a block size of 1. Use the bit switch to output integer data values and use the slider control and the dial to output any data values. Use the push button and the switch to output control signals. The Push Button and the Switch blocks return the value 0 when they are off and the value 5 when they are on, whereas the slider control, the dial, and the bit switch output the set value.

The **Data Write** packet block saves measured data in the Data Portal and the **Data Read** packet block reads data from the Data Portal, for example, as the reference channel. The **File I/O** packet block writes data to files and reads data from files. In the window of the **File Player** you read consecutive data packets or overlapping data packets forwards and backwards in data files. You use the packet blocks **Network Server** and **Network Client** to exchange data packets between DIAdem installations on a network.

Packet Functions for Data Acquisition and Output

The function group **Driver (Packet Processing)** includes the functions of the packet sound driver **Sound Input**, which acquires signals with the sound board in the computer, and **Sound Output**, which emits signals on the computer loudspeakers. For more driver functions, register the packet driver of the measurement hardware after selecting **Settings»Options»Extensions» GPI Extensions**. For the acquisition, output, and processing driver functions, select **Settings» Packet Processing»Driver Function Group**.

Refer to *Installing Measurement Hardware* in Chapter 2, *Installing Measurement Hardware and Communicating via Interfaces*, for more information about registering DIAdem drivers.

Complete Selection of Packet Functions

If you open the **Signal Processing (Packet Processing)** function group and click **Complete Selection**, you get packet functions that are not contained in the function groups. Use the **Scaling** packet block to convert data packets into a different physical unit using a linear characteristic curve. Specify the characteristic curve with two points.

Use the **Level Calculation** packet block to calculate characteristic values for describing surrounding noise, from a time-related acoustic signal. You use the **Protocol List** to create and to print a list of the first value of each data packet in the protocol window. The **Copy** block outputs the data packets of an input signal on several packet buses simultaneously. The **Buffer** block collects data to output large data packets. The **Timer** block outputs control signals time-related, and the **Trigger Finder** also monitors a data channel in multi-channel data packets, to output a control signal.

6

Monitoring Processes with the Alarm System

You use the alarm system to monitor whether signals overshoot or undershoot limits. Define limits in two stages to trigger alarms with increasing priorities of importance. DIAdem displays the alarms continuously on the screen. You can record and comment on alarms online as they occur. The alarm log can function as an operation report that DIAdem sends straight to those in charge so they are informed about alarms that occur.

📝 **Note** The NI License Manager only provides the alarm functions if your license contains the alarm system. If not, the buttons in the alarm function groups are dimmed. To use the alarm system you might have to obtain a license for a different DIAdem edition.

The following figure shows how the alarm generator monitors measured values from connected packet buses. If limit values are exceeded, the alarm generator displays alarms in the alarm table on the screen. To record the alarms in a file or to send them in an e-mail, DIAdem converts the alarm information into text. With each alarm, the alarm generator also outputs numeric data packets with the status of the alarms.

Figure 6-1. Alarm System Structure
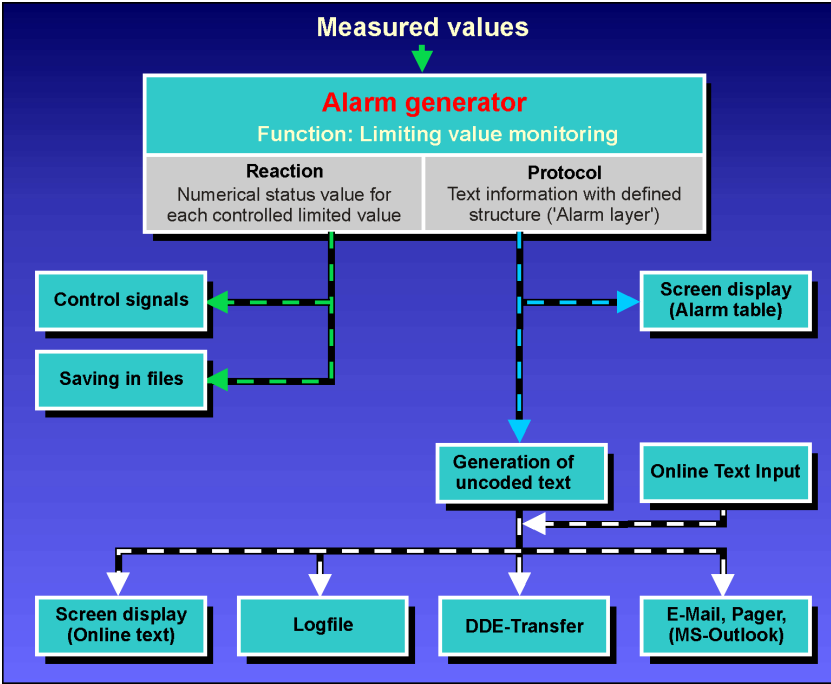
The alarm blocks are packet blocks and and control the incoming measurement values in the data packets with data. The alarm generator does not work until a data packet arrives at the input, and the subsequent alarm table does not work until an alarm packet arrives from the alarm generator. The alarm generator monitors the green and black packet buses and outputs alarms on the blue and black alarm buses. DIAdem transports text on the gray and black text buses.

Defining Alarms

The alarm generator is the central function block in the alarm system. The measurement values to be monitored arrive in a packet bus at the alarm block, where you specify the alarm conditions. You confirm alarms in the alarm table which displays the alarms of the alarm generator.

For example, to use the alarm system to monitor signals from the **NI-DAQ** driver input, which is already defined in the block diagram, open the function group **Alarm System** and click the **Alarm Generator** button shown here. Position the alarm block below the packet block **Pack** and connect the green and black packet bus to the data input E on the alarm generator block. Double-click the alarm generator to open the dialog box where you define alarms and change the default settings.

Then click the **Alarm Table** button in the same function group and position this alarm block to the right of the alarm generator. Connect output A on the alarm generator to input E in the alarm table. DIAdem connects the two alarm blocks with a blue and black alarm bus.

Select DIAdem VISUAL to position the display instrument for the alarm table in the DIAdem VISUAL workspace. Click **Start Display** on the toolbar to display the alarms. As soon as the measured values exceed the limit specified in the alarm generator, the alarm table shows an alarm with a time stamp and a description, in each row. As soon as the limit is no longer exceeded, DIAdem deletes the alarm from the alarm table.

Note You should match the block size of the data packets you want to monitor, with the acquisition rate. If the block is substantially larger than the acquisition rate in Hertz, the alarm generator waits a long time for the data packet that is to be monitored. If, on the other hand, the block size is much smaller than the acquisition rate, the alarm generator has to monitor many small data packets.

Specifying Alarm Attributes

In the alarm generator you specify the alarm attributes to define alarms. DIAdem differentiates between static and dynamic attributes as shown in the figure. You specify static attributes when you configure the alarm system. DIAdem determines the dynamic attributes during runtime. Static attributes are, for example, the name and number of the channel that is to be monitored, or the limit, the delay, or the comment. Dynamic attributes are the time stamp, the current measured value, or the alarm status. DIAdem manages the five attributes alarm group, alarm type, priority, quit level, and alarm status for all blocks, so that alarms can be filtered with these global parameters, and colors and graphics can be assigned to the alarms for visualization.

Figure 6-2. Static and Dynamic Attributes Describe Alarms
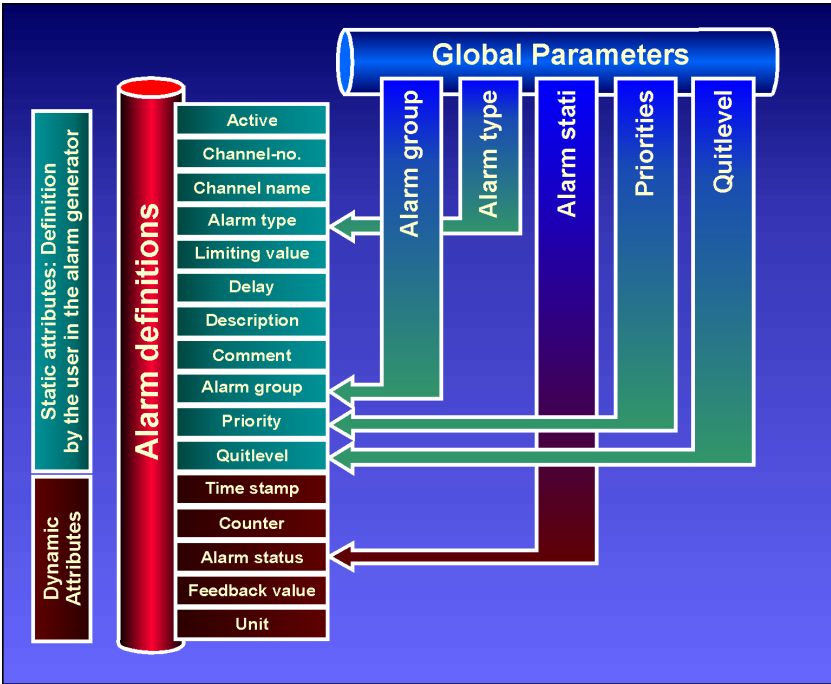
If a limit value is exceeded, DIAdem combines the attributes to a formatted data packet, the alarm, and transports this data packet in alarm buses to the alarm table and to the alarm/text convertor.

During a measurement, you can confirm alarms that occur in the alarm table, for example, if it was a false alarm or if the cause of the alarm was rectified during the measurement. DIAdem then changes the alarm status. For this purpose, you connect output A on the alarm table in the block diagram to input T on the alarm generator. You must also click the **Display** button in the alarm table dialog box and enable the **Display button for alarm confirmation** checkbox.

Creating Protocols

To record the alarms in a file or to send them in an e-mail, DIAdem must convert the alarms into text. To do this, use the alarm block **Alarm–>Text** and connect this block to the alarm bus. In the dialog box of the alarm/text convertor, you select the alarm attributes that you want DIAdem to forward to the subsequent protocol blocks on the text bus. DIAdem creates a format string that consists of the appropriate variables, which are indicated by the @ characters, and text.

The following format string records for each alarm the time stamp, the alarm counter, the name, the measured value that caused the alarm, the alarm type, the limit, and the current alarm status:

```
@PKALTIMESTAMP@ @PKALCOUNTER@ @PKALNAME@
(@PKALVALUE@ @PKALTYPE@: @PKALREFVALUE@)—@PKALSTATE@
```

You can record alarms in three ways. To display the text for each alarm immediately on the screen, use the **Dynamic Text Display** shown in the following figure. To save the text for later inspection, use the **Logfile**. To send an e-mail with the alarm details, use the **Text Output Outlook**.

Figure 6-3. Visualization with Alarm Table, Text Display, and Buttons for Confirming Alarms
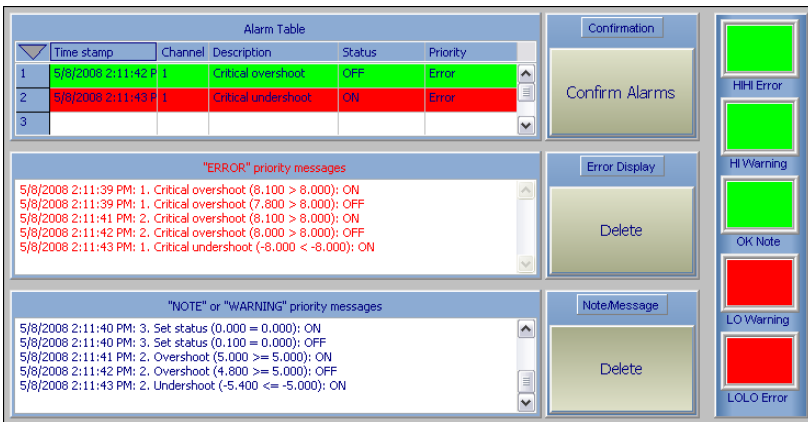
Setting Up User Management

With the alarms system you can confirm limit overshoots in the alarm table. The system administrator provides the necessary rights in user accounts in the user management system, so that only authorized users can confirm alarms. DIAdem saves the user accounts in an encrypted file with the filename extension `.adm` and saves the access rights with the block diagram. Each time a measurement starts, DIAdem checks whether the user that is logged on has the rights required to confirm the alarms.

To set up or modify user accounts or user rights, select **Settings»Alarm System»User Management**. To log on as the administrator, you must first enter the user name `administrator` and the password `diadem`. You can enter the text in uppercase or lowercase because DIAdem is not case-sensitive here.

To change the standard password, click **Password**. To open the user management, click **Register**. In the user management you create new user accounts, change access data of user accounts, and grant or revoke rights. Click **Save** to create a new ADM file. Click **OK** to save the settings in the current ADM file and to close the user management. Select **Settings»Alarm System»User Log On/Log Off** to log off.

Alarm System Functions

The function group **Alarm System** includes all the functions you need to define, generate, display, and record alarms and to send alarms as e-mails.

Use the **Alarm Generator** to define alarms and to monitor data packets for limit overshoots. Use the **Alarm Table** to display or to confirm alarms output by the alarm generator. Use the alarm block **Log User On/Off** to allow the users registered in the user management to log on and off during measurements.

The alarm block **Alarm–>Text** outputs selected alarm attributes via text buses, which the alarm block **Dynamic Text Display** displays on the screen and which the alarm block **Logfile** saves in a text file. Use the alarm block **Text Input** to enter comments from the keyboard during measurements, and to display the comments in a separate window in DIAdem VISUAL. If you display the button for confirming the text input, this alarm block displays the comment on the text bus.

Use the **Text Multiplexer** to combine the alarm texts from the converter with the comments, and to forward them in alternating order to the subsequent alarm blocks, on a text bus. Use the **Alarm Multiplexer** to combine alarms from various alarm buses. Alarm blocks can process only data packets from an alarm bus or a text bus.

Use the block **Text Output Outlook** to send alarm text as e-mails with Microsoft Outlook. For DIAdem to establish an OLE connection to MS Outlook, you must install MS Outlook and set it up as an active e-mail program. Use the block **Text Output DDE** to transfer alarm texts via the DDE (Dynamic Data Exchange) interface with fax software, e-mail software, or paging software, or to archive the packets in a database. You enter the DDE server as the recipient of the alarm texts.

Use the alarm blocks **Alarm Server** and **Alarm Client** to exchange alarms, and the alarm blocks **Text Server** and **Text Client** to exchange alarm texts between DIAdem installations on one network.

7

The Basics of Process Measuring and Control Technology with DIAdem

For computer-based data acquisition of measured signals you need to be aware of the phenomena involved in a measurement chain, so that you can choose and set the individual components correctly in order to minimize or avoid errors. This chapter gives you a brief outline of the basics of process measuring and control technology, and describes the measurement modes and sampling rates that are available in DIAdem.

Computer-Based Signal Acquisition

The following figure shows the basic processes involved in the acquisition of temperature measurement values with DIAdem DAC. The top display solves the task with a data acquisition measurement plugin and the bottom display solves the task with an external measurement device connected to the computer via a digital interface such as GPIB or USB.

Figure 7-1. Temperature Measurement Using a Plug-In Board or an Interface
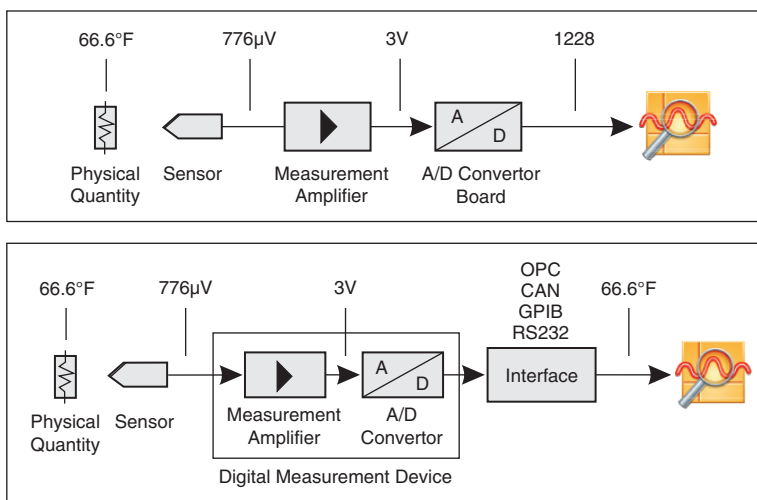
For measured value acquisition, sensors first convert the physical quantities, which are to be measured, into voltage or current. This creates, for example, a temperature-related voltage at a

thermocouple. The sensor signals are then transferred to a measurement amplifier and converted into numeric values for the computer, using an A/D convertor. The A/D convertor converts the continuous, analog signal into measured values that are time-discrete and amplitude-discrete. DIAdem can reconvert the measured values into the original physical quantities or save the values for later offline analyses.

Communication with Measurement Hardware

DIAdem DAC communicates with the measurement hardware via the DIAdem drivers, which are available for many different kinds of measurement hardware. If no driver is available for a specific measurement hardware, you can use a DLL-based driver interface to create and implement the driver for DIAdem yourself.

In most cases, DIAdem automatically provides the capabilities of the supported hardware when you load the device driver. You only need to specify the settings in the configuration dialog box to specify the base settings for the measurement hardware.

Refer to Chapter 2, *Installing Measurement Hardware and Communicating via Interfaces* for more information on how to register measurement hardware in DIAdem or how to access external devices via interfaces.

Parameters for A/D Conversion

The following sections provide a rough overview of the most important factors which impact the digitalized signals.

Measurement mode

If a measurement system is unilaterally grounded, all inputs are connected to one grounding point, which means single ended. Use this system for voltages <1 Volt, for short signal cables (<4 m), and if all the input channels are grounded, at the same point.

In all other cases, use a differential measurement system, where each input has its own reference potential. A differential system basically has two important advantages compared to a single-ended system: ground circuits cannot cause measurement errors, and most disturbances that affect both measurement cables of a signal are suppressed. On the other hand, unilaterally grounded systems have twice as many measurement channels.

Resolution

An analog signal is digitized into a discrete signal. The amplitude of the signal is represented in discrete steps, which results in a digitization error called the quantization error.

The number of bits the A/D convertor uses determines the number of steps the analog signal is digitized with. The resolution is better, the quantization errors decline, and the smallest measurable change decreases in relation to the increase in numbers of steps. A 3-bit A/D convertor, for example, divides its input voltage range into $2^3 = 8$ stages. A binary or digital code between `000` and `111` represents the eight subsections.

The following figure shows a 5 kHz sine oscillation digitized by a 3-bit A/D convertor. The digital signal does not adequately represent the original signal, because the convertor does not have enough digital subsections. If you increase the resolution to 16 bits, to increase the number of subsections in the A/D convertor from 8 (2^3) to 65536 (2^{16}), you achieve a precise representation of the analog signal.

Figure 7-2. Resolution of a 3-Bit and a 16-Bit A/D Convertor
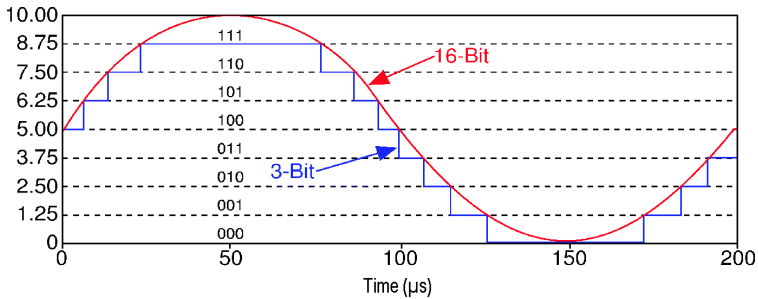
Measurement Range and Gain

The measurement range refers to the minimum and the maximum analog signal levels that the A/D converter can digitize. Many devices have selectable measurement ranges (usually from 0 to 10 Volt or from –10 to 10 Volt), so you can adjust the range of the A/D convertor to the signal range. This makes optimal use of the available resolution for an exact signal measurement.

In the following figure, the 3-bit A/D convertor in the left diagram (1) has 8 digital subsections in the measurement range from 0 to 10 Volt. However, if you select the measurement range –10 to 10 Volt, as shown in diagram (2), the same A/D convertor divides the 20 V measurement range into eight subsections. The lowest measurable voltage change increases from 1.25 to 2.5 Volts, which means the right diagram displays the signal considerably less precisely.

Figure 7-3. How the Measurement Range Affects Precision: (1) 0 to 10 Volt, (2) –10 to 10 Volt
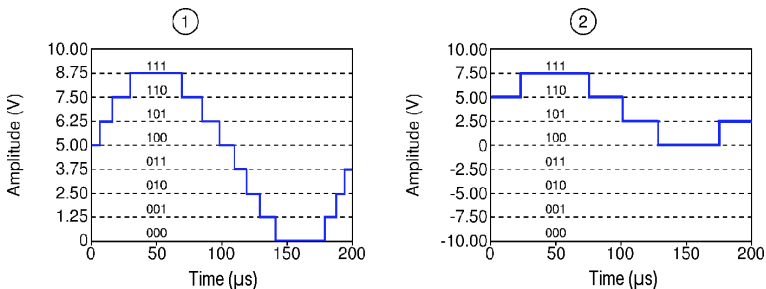
The amplification factor includes all amplifications and attenuation that affect a signal before the signal is digitized. If you adjust the amplification factor to the signal level, you make the best use of the resolution of an A/D convertor. Therefore, it is just as important to set the correct amplification as it is to set the right measurement range.

Sampling Rate

We have shown that digital signals have discrete steps to display the amplitudes, and we have described how to minimize the resulting quantization errors. However, we have not taken into account the fact that after A/D conversion, the signal is no longer continuous along the time axis. This is due to the fact that the signal is sampled only at specific times, and the samples are stored as numbers. Random sampling never gives an exact representation of the data.

The more frequent the samples, the more precisely you can reconstruct the original analog signal as a series of digital numeric values. However, this greatly increases the required sampling rate, especially for high-frequency signals, which in turn results in increasingly large amounts of data per unit of time.

This correlation results in the following requirement: you need a sampling rate that meets the requirements with as few samples as possible.

According to the Nyquist theory, the sampling rate should be at least twice as high as the highest frequency in the signal. The digitized signal then contains enough information to resolve, for example, the frequencies of the acquired signal after a transformation to the frequency domain (FFT). However, as shown in the following figure, this does not in any way provide an exact reconstruction of the signal profile. Neither the exact signal form nor the amplitude heights can be reconstructed for all points in time.

Figure 7-4. How a Low Sampling Rate Affects Data Acquisition
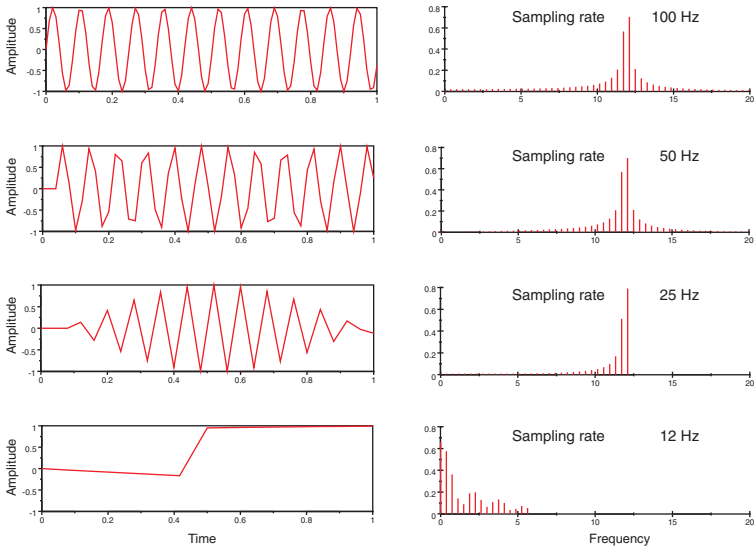
As this figure shows, a multiple of the Nyquist frequency is necessary if you want to display the correct shape of the signal as well as the frequency.

Anti-Aliasing Filter

If the sampling rate is lower than the sampling rate determined according to the Nyquist theory, an effect called Aliasing occurs. This effect causes digitized signal forms or signal frequency parts that are essentially different from the actual analog signal (alias frequencies). The data generated by undersampling display frequency contents that are substantially lower than the original signal, as shown in two examples in the following figure.

Figure 7-5. Aliasing Effects Caused by Undersampling a Signal
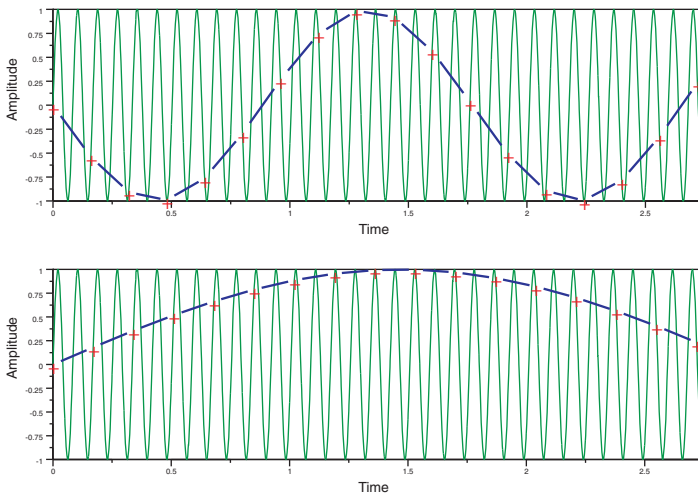
You cannot distinguish between these apparent signal sections of the digitized signal and the real signal frequencies. Therefore, you cannot correct errors caused by aliasing.

If you cannot attain the sampling frequency that is required to measure a signal, or if the highest frequency in the signal is unknown, you must filter the analog signal with lowpass filters (anti-aliasing filters) before the A/D conversion. Alternatively, you can increase the sampling frequency by using other measurement hardware or a different type of measurement.

According to the Nyquist criterion, an appropriate lowpass filter must only let through signals that have frequencies lower than half the sampling rate used for the A/D conversion. In this case, filters that have very steep slopes are most suitable.

Note Do not confuse anti-aliasing filters with digital filters on the digital side after the A/D convertor.

Unwanted noise distorts the analog signal before the signal is converted into a digital signal. You can limit external influences by using suitable signal conditioning such as filtering and amplification before digitization. Another way to reduce noise distortion is to oversample the signal, which means using a higher sampling rate for the data acquisition and then averaging the digitized values.

Computer-Based Signal Output

With the right hardware, DIAdem can output acquired data, generated data, and calculated data, as voltage or current. You can use analog or digital outputs to control processes with DIAdem, or to create closed loops with control blocks.

The following figure shows the signal output for temperature control. DIAdem converts the actuating variable, which is determined by comparing the room temperature and the set point, into the manipulated variable for the heating valve. DIAdem transfers a numeric value to the D/A convertor, on a plug-in board for example, which outputs the proportional voltage. A power stage transfers the voltage to the heating valve. Assuming the set temperature is 20 °C, the heating valve opens wider and releases more hot water into the heating system.

Figure 7-6. Temperature Control with a Plug-In Board
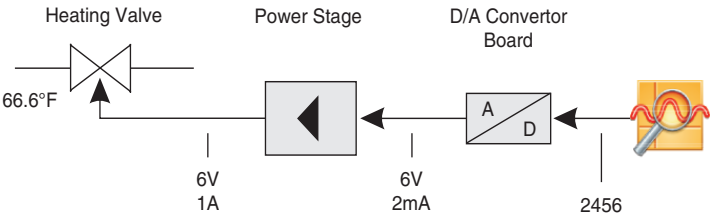
Measurement Acquisition with Interrupts

The computer has interrupt mechanisms for reacting to events such as keyboard entries. These mechanisms prevent constant keyboard entry requests. If a relevant event occurs, the computer processor receives an interrupt request. The processor then interrupts its current program and processes the function associated with the event. DIAdem uses this mechanism to acquire data, to execute calculations, and to output set values at the clock times set by the user, and undisturbed by other programs.

Because the processor first has to save the status of the current program when an interrupt request arrives, there is a delay between the arrival of an interrupt and the interrupt actually being processed. This delay is called *latency time*. For periodic processes, such as data acquisition and open and closed loop control, each sampling step has a different latency time, because the latency time depends on the current status of the processor when the interrupt occurs: A measurement that is executed with 100 Hertz over a period of 1 second, results in 100 different

values for the latency time. The difference between the minimum latency time and the maximum latency time is called the *jitter*. The jitter thus indicates the degree of the periodicity of the clock times.

What jitter level is acceptable depends on the particular task at hand. In visualization tasks, tests have shown that delays of up to 100 Milliseconds are not actually perceived as delays. Therefore, it is acceptable for an alarm light to respond with a delay of up to 100 Milliseconds after the time the alarm occurs. On the other hand, the periods between the output times have to be precise in digital closed loop control. The output time is the time when the D/A convertor is accessed to output the manipulated variable. If the controller output is to be made with 1 Kilohertz and the periodicity error of the output time is less than 5%, the maximum valid jitter is 100 Microseconds.

Different DIAdem Measurement Modes

DIAdem differentiates between the measurement types software clock and hardware clock which you select in the system clock block. DIAdem and Windows generate the rate for the software clock and the measurement hardware generates the rate for the hardware clock. DIAdem supports the measurement modes HighSpeed measurement, DMA measurement, and Disk measurement, for earlier measurement hardware. DIAdem offers the hardware clock to execute these tasks on modern measurement hardware.

The standard DIAdem clock is the software clock, which fully supports the entire range of DIAdem functions. In the **Software Clock** measurement mode, the DAC kernel controls the complete measurement procedure. You can use the software clock in Windows timing, Multicore timing, or soft timing. Specifies that DIAdem automatically sets the best possible timing for the computer hardware and the measurement hardware. To specify the timing in DIAdem DAC, select **Settings»Single Point Processing»Measurement Parameters»Timer**. If you select soft timing or multicore timing, you can execute only one measurement. If you select Windows timing, you can execute several measurements.

When DIAdem measures with several system clocks, DIAdem uses in the software clock the lowest common multiple of the single sampling rates as the total sampling rate. If the total sampling rate is too high, DIAdem tries to adjust the single sampling rates. If the DAC kernel cannot find a solution for the computer and the measurement hardware used, DIAdem aborts the measurement preparations.

In the **Hardware clock** mode, the measurement hardware generates the clock and the DAC kernel controls the measurement. This measurement mode supports the entire range of DIAdem functions with a few limitations, which include not being able to output signals in the hardware clock.

Software Clock with Windows Timing

If you set software clock with Windows timing, DIAdem uses the computer multimedia timer for the clock rate. In this measurement mode you can process analog and digital signals and execute measurements with nearly every hardware and a number of different devices. The Windows timing allows channel sampling rates of up to 1 kilohertz and latency times of a few milliseconds.

You can use Windows timing to execute measurements with different sampling rates simultaneously on one measurement hardware. DIAdem requests the measurement values from the hardware at a clock rate that Windows generates. DIAdem processes the measured values, displays the results, and outputs signals. Other programs might require the operating system and prevent an accurate clock rate. The deviations can be in the millisecond range. You can reduce these deviations if you do not execute other processes on the computer at the same time.

For most process measurement and control tasks, Windows timing is completely adequate for clock rate generation, which is why most hardware drivers support only this type of timing. For time-critical processes that require more precise reaction times, you must use Software clock with Multicore timing or soft timing.

Software Clock with Windows Timing

If DIAdem runs in the software clock mode together with Multicore timing, DIAdem uses a processor exclusively and with top priority to generate the base clock. DIAdem uses this base clock to process the measurements defined in the block diagram, on other processors. Multicore timing achieves sampling rates above 1 kilohertz and better latency times than Windows timing. If the computer is suitable, Windows timing drivers support also Multicore timing. Multicore timing under Windows 7 and Windows Vista provides the best timing in the software clock.

Multicore timing is neither available on computers with only one processor nor on computers with a logical duplication, for example, with the Hyper-Threading technology from Intel.

Software Clock with Soft Timing

In Software clock with Soft timing, the DAC kernel uses real hardware interrupts to control the clock rate. Measurements in Soft timing maintain the clock rate much more accurately than measurements in Windows timing. A measurement with soft timing supports all the DIAdem functions that are also available in Windows timing. Ask your hardware manufacturer whether your measurement hardware driver supports this type of timing.

Soft timing is not available under Windows 7 and Windows Vista. If you use Windows 7 and Windows Vista and the performance in Windows timing is not sufficient, you can use a computer which supports multicore timing.

With Soft timing an extremely accurate internal PC timer generates signals, which immediately interrupt all Windows functions to run DIAdem measurements and to maintain the clock rate as accurately as possible. During this interruption, DIAdem runs only operations that are time-critical, to avoid delaying Windows functions for too long. That is why drivers do not use

soft timing for hardware access via interfaces that have long reaction times, for example, via the serial interface. Screen display or measured data storage are not time-critical processes and are executed outside an interruption.

Hardware Clock

In the Hardware clock measurement mode, timers on the measurement hardware generate the clock rate. Use the Hardware clock to acquire data at high sampling rates. The maximum clock rate nearly always reaches the specified maximum sampling rate of the measurement hardware. You can generally only use the Hardware clock with analog inputs, because digital inputs usually work with no clock rate on the hardware and thereby do not support the hardware clock.

The Hardware clock achieves very high sampling rates. During the measurement preparations, DIAdem transfers the specified sampling rate and the channel list to the measurement hardware and then starts the measurement. The measured data first goes into the measurement hardware buffer. The data is read from this buffer at regular intervals and forwarded to DIAdem. Data output has first priority, because the device buffer is limited. DIAdem buffers the data again if the data is not processed immediately. This computer buffer can expand to several Megabytes for very fast measurements.

The Hardware clock delivers data that is acquired at a guaranteed high-speed sampling rate. However, processing is always slightly delayed, because the data can never be read from the buffer in real time. In many applications, it is irrelevant whether data is displayed or saved a few milliseconds slower, as long as the end-result and the time reference are correct. However, if immediate reactions are required during the measurement, the delay can lead to unacceptable results.

Because digital signals cannot be recorded in the Hardware clock, the signals must be measured parallel in the Software clock. This can lead to delays, because the timers on the computer and the measurement hardware cannot be synchronized at the start of or during the measurement. Because two timers never start at exactly the same time and never run at exactly the same speed, the times in the time channels are not exactly the same after a measurement. The deviation usually amounts to a few milliseconds.

A

Executing Measurements Automatically

You use scripts to automate recurring work sequences such as starting a measurement and then evaluating the saved measurement values. You create scripts in the script editor in DIAdem SCRIPT.

Use the panel-specific object commands and variables to access the blocks of a block diagram in a script. DAC blocks are the central DAC objects; subobjects are signal connections at DAC blocks and subblock diagrams and labelling of display and manual input instruments. How you access objects in DIAdem DAC is not typical for VBS. You must first open the main object and then the subobject, make your changes, and then close the objects in the reverse order.

Use the `SchemeLoad` command to load a block diagram. Use the commands `DACObjOpen` and `DACObjClose` to configure a DAC block. In the `DACObjOpen` command you enter the object name to open this object and to then change the object properties. The following script loads the `Example.dac` block diagram and the `BlPinSigCountSet` command sets the number of terminals at the signal input of the `Bars` DAC block to `21`.

```
Call SchemeDel()
Call SchemeLoad("Example")
Call DACObjOpen("Bars")
 Call DACObjOpen("Display data")
  Call BlPinSigCountSet(21)
 Call DACObjClose("Display data")
Call DACObjClose("Bars")
```

To add the object access to the script double-click the block to open the dialog box and press <Ctrl-Shift-A>. Switch to DIAdem SCRIPT and press <Ctrl-V> to paste the contents of the clipboard into the script. The script editor displays the commands with the object names and the variable assignments from the dialog box that was open.

To open a DAC object, you need the name of the object. If you select a block of the block diagram on the screen, DIAdem displays the name of the DAC block in the status bar. When you click a block terminal, DIAdem displays the name of the main DAC object and the name of the DAC subobject, separated by a point, in the status bar.

B

Technical Support and Professional Services

Log in to your National Instruments `ni.com` User Profile to get personalized access to your services. Visit the following sections of `ni.com` for technical support and professional services:

- **Support**—Technical support at `ni.com/support` includes the following resources:
  - **Self-Help Technical Resources**—For answers and solutions, visit `ni.com/support` for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on. Registered users also receive access to the NI Discussion Forums at `ni.com/forums`. NI Applications Engineers make sure every question submitted online receives an answer.
  - **Standard Service Program Membership**—This program entitles members to direct access to NI Applications Engineers via phone and email for one-to-one technical support, as well as exclusive access to eLearning training modules at `ni.com/elearning`. All customers automatically receive a one-year membership in the Standard Service Program (SSP) with the purchase of most software products and bundles including NI Developer Suite. NI also offers flexible extended contract options that guarantee your SSP benefits are available without interruption for as long as you need them. Visit `ni.com/ssp` for more information.

    For information about other technical support options in your area, visit `ni.com/services`, or contact your local office at `ni.com/contact`.

- **Training and Certification**—Visit `ni.com/training` for training and certification program information. You can also register for instructor-led, hands-on courses at locations around the world.

- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit `ni.com/alliance`.

You also can visit the Worldwide Offices section of `ni.com/niglobal` to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

Index