

# NI DIAdem™

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### NI Services

# About This Manual

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You can use this manual to familiarize yourself with DIAdem functions and how to use them. Each chapter describes a DIAdem panel.

This manual contains exercises for finding, analyzing, and presenting data, and for automating each step of the process. These short exercises make it easier for you to get started with DIAdem. At the end of each chapter there is a summary of the most important contents.

## Related Documentation

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

- *DIAdem Help*

You can open the DIAdem Help in every dialog box with the **Help** button, or in the menu **Help»Content**, or with <F1>. The DIAdem Help offers procedures and dialog box help for each panel, and references for programmers.

The introduction to the DIAdem help explains the structure of DIAdem and how to use DIAdem to find data, to run analyses, to create reports, and to combine all functions in a script.

- *SystemLink TDM Help*

With SystemLink TDM, you handle data and evaluations centrally on a server.

SystemLink TDM has applications for data indexing, data preparation, and analysis automation. The client user uses Data Navigation to navigate and search in indexed data and Data Analysis to check shared automation tasks.

With DIAdem as your developing environment, you can create and test analysis scripts and automated report generation.

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# Introduction to DIAdem

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 standardized environment, DIAdem offers a unique combination of tools that are tailored to the requirements of technicians, engineers, and scientists. You can adjust all the tools to your tasks and automate them in scripts, which reduce evaluation time substantially.

The DataFinder enables you to find test data quickly and easily, and to identify corresponding data. Using DataFinder does not require a database or IT support, but is ready to use immediately after installing DIAdem.

## Working with DIAdem

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DIAdem groups related functions in panels. Use the panel bar that is on the left of the DIAdem screen to switch panels. Each panel provides all the tools for one of the following tasks:

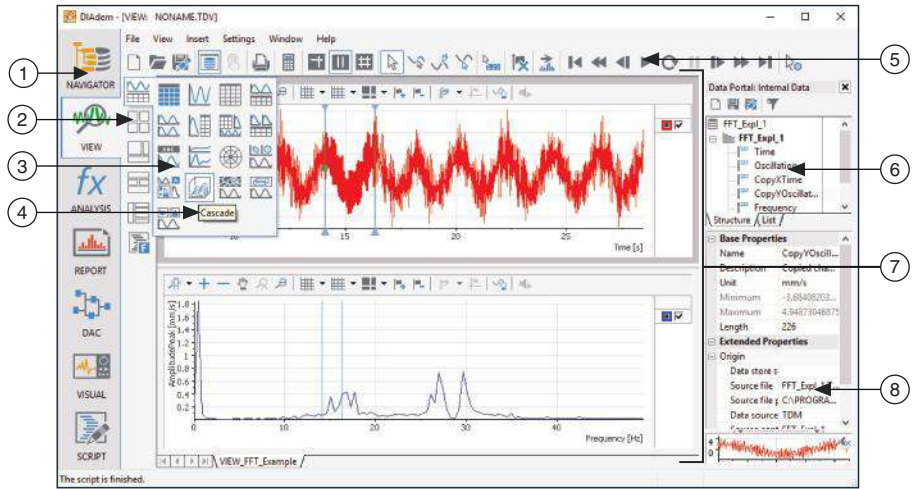
- Use DIAdem NAVIGATOR to find, to load, and to manage data. Use the DataFinder to search for data on your computer and in the network, and to navigate through the found data files and databases. You load the data into the Data Portal so that all DIAdem panels can work with the data, which is organized in channels.
- Use DIAdem VIEW to view, to analyze, and to edit data as curves in axis systems. In channel tables you can edit and delete the data as values and enter new data. You synchronize videos or the map display of a test drive with data. They represent 3D data in two-dimensional contour areas.
- Use DIAdem ANALYSIS to analyze data mathematically. You can apply predefined standard mathematical functions, including basic mathematics, curve fitting, signal analysis, and statistics. The dialog boxes for these standard functions guide you through the calculation, so you do not have to enter a formula. You select the input data and the settings. Use the DIAdem Calculator to define and calculate your own formulas.
- Use DIAdem REPORT to document data and present results. In 2D and 3D axis systems, you display your data as curves, bar diagrams, and surfaces. In 2D and 3D tables, you list channel contents. You can label your report with comments and text and illustrate the report with graphics and formulas.
- Use DIAdem SCRIPT to automate tasks in a script, which combines several work steps for recurring sequences such as standard calculations and serial evaluations. Scripts, which you can record interactively, use the functions of all DIAdem panels. You can add program structures and dialog boxes to scripts in the integrated script editor.



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

When you select a panel, the user interface changes so that you can quickly access the functions you want. Each DIAdem panel has, as shown in Figure 1-1, its own group bar to the right of the panel bar. Open a group bar, click a function group, and select a function. The workspace also changes with the DIAdem panel and displays a folder hierarchy or a worksheet. The toolbars and the context menus contain frequently used functions, which DIAdem also adapts to the selected panel.

**Figure 1-1. The Elements of the DIAdem User Interface**



- |                                    |                                 |
|------------------------------------|---------------------------------|
| 1 Panel bar                        | 5 DIAdem VIEW toolbar           |
| 2 Group bar                        | 6 Data Portal                   |
| 3 Function group                   | 7 DIAdem VIEW workspace         |
| 4 Tooltip of the selected function | 8 Properties in the Data Portal |

# Introduction Screen

When you launch DIAdem, the DIAdem introduction screen appears.

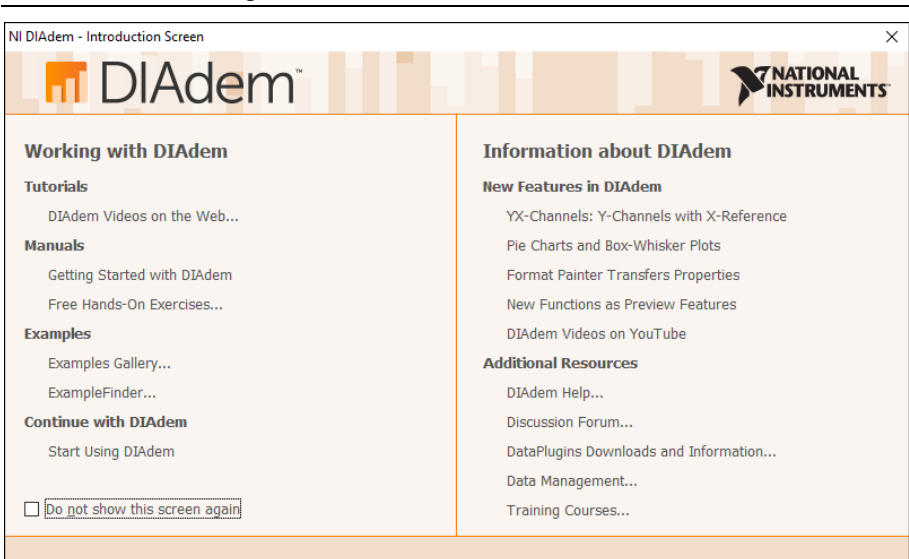
Visit NI's DIAdem channel on YouTube to learn how to use DIAdem. Short videos show how to present data in a report, how to synchronize measurement data with a video of the experiment, or how to automate the many steps of an interactive evaluation.

Open the Examples Gallery to load and run examples in DIAdem or to use them as templates for your own applications. The table of contents of the ExampleFinder contains procedures which are step-by-step instructions for the solution of certain tasks.



**Note** If the introduction screen does not appear when DIAdem launches, select **Help»Introduction** to open the introduction screen.

**Figure 1-2.** The DIAdem Introduction Screen



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## Finding Data

Use DIAdem NAVIGATOR to find, to load, and to manage data. Use DataFinder to search for data on your computer and in the network, and to navigate through the found data files and databases. You load the data into the Data Portal so that all DIAdem panels can work with the data, which is organized in channels.

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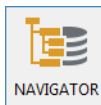
## Mining Data

Use the **Quick Search** to search for a term if you do not know whether the property belongs to a file, a group, or a channel. Use the **Advanced Search** to combine multiple search conditions and describe exactly what properties you are looking for.

## Executing a Quick Search

To find data with a **Quick Search**, complete the following steps.

1. Select **DIAdem NAVIGATOR**.



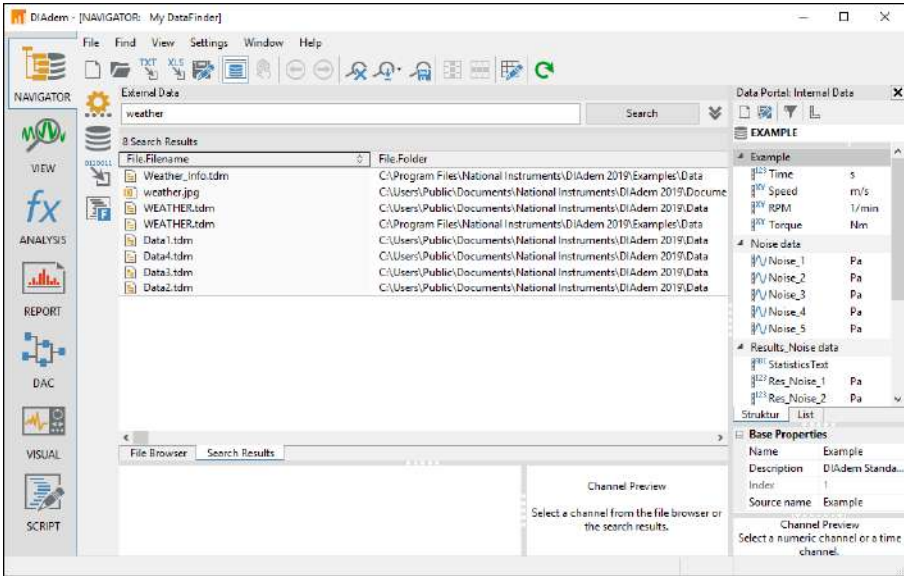
The file browser in the NAVIGATOR panel offers external data in a tree structure.

2. In the search input area, type `Weather` to find all data sets that contain the term `Weather`.
3. Click **Search**.

Search

In the quick search DIAdem does not distinguish whether the data set contains the term as the name or the property of a file, of a channel group, or of a channel. DIAdem displays all files containing the term `Weather` or compound terms such as `Weather data` in the **search results**, as shown in Figure 2-1.

**Figure 2-1.** Search Results of the Quick Search



## Executing an Advanced Search

To narrow down the results of the Quick Search with an **Advanced Search**, complete the following steps.

1. Click the **Advanced Search** button to specify the search result more precisely, as shown in Figure 2-2.



2. In the **Level** column of the first row, click **File** and select `Group`.
  - a. Click `<Enter a property>` in the **Property** column of the first row and select `Name`.
  - b. Click the button with the three dots at the end of the first line. DIAdem lists the names of all the groups found.
  - c. Double-click the group name `Weather`.

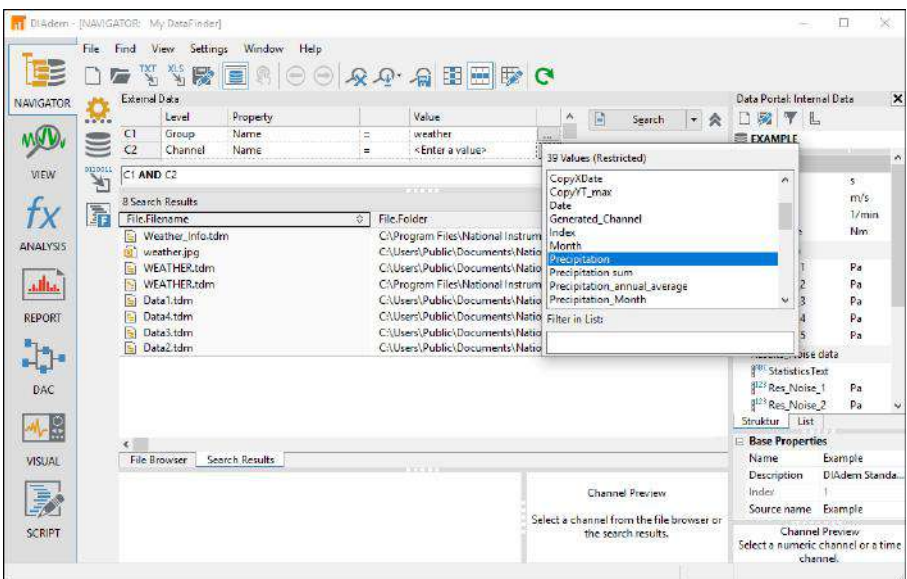


**Note** If the list does not contain the term `Weather`, DIAdem has not yet indexed all sample files. Select **Settings»MyDataFinder»Configure»Indexer»StartNow** to start indexing.

Define another search condition in the second row to specify the search more accurately.

3. In the **Level** column of the second row, click **File** and select `Channel`.
  - a. Click **<Enter a property>** in the **Property** column of the second row and select `Name`.
  - b. Click the button with the three dots at the end of the second row. DIAdem lists the names of all the found channels, as shown in Figure 2-2.
  - c. Double-click the channel name `Precipitation`.

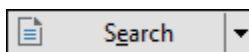
**Figure 2-2.** Selection List with the Channel Names of the Indexed Data



As you can see in the logical operations line below the search conditions, DIAdem connects several search conditions with the **AND** operator by default.

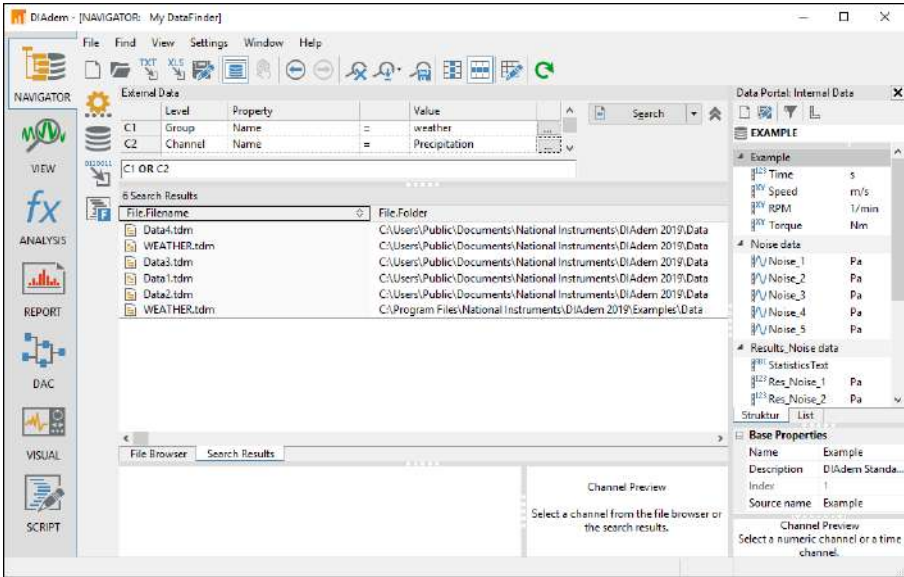
4. Replace **AND** with **OR** in the logical operations line for the following operation:
 

C1 OR C2
5. Click **Search**.



DIAdem displays the **Search Results** as shown in Figure 2-3. Each of the files found contains either a group called `Weather` or a channel called `Precipitation`.

**Figure 2-3.** Search Results of the Advanced Search



## Browsing in Data Sets

Complete the following steps to open data files in the file browser in order to inspect search results.

1. In the search results, right-click the `Data1.tdm` file.
2. Select **Display in File Browser** from the context menu.

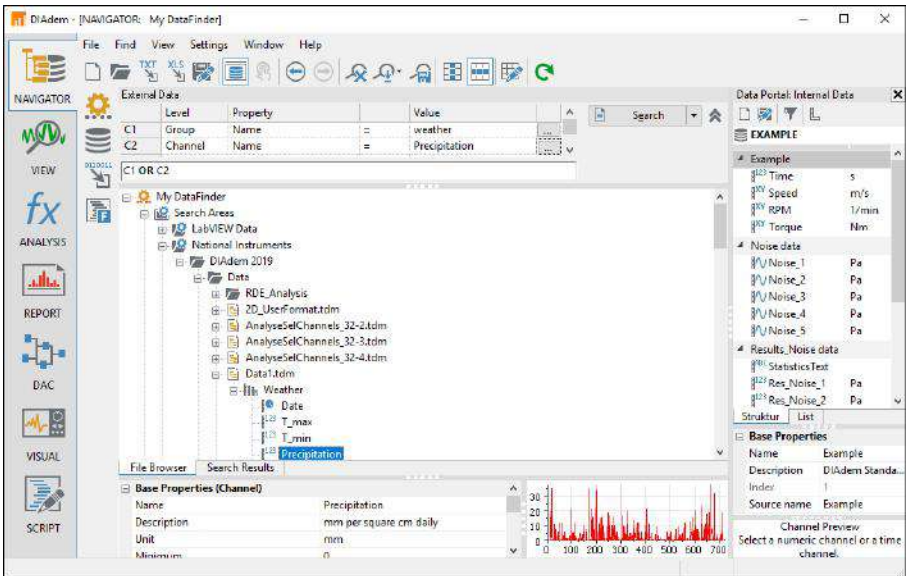
DIAdem switches from the search results to the file browser and displays the file `Data1.tdm` in the tree view.

3. Click the plus sign in front of the file icon.
4. Click the plus sign in front of the `Weather` channel group icon.
5. Click the `Precipitation` channel.

DIAdem lists all the channel groups and channels that are contained in a file, in a tree structure. You can browse the folders and files down to channel level if the data format allows you to browse. For more information about the selected file, channel group, or channel, refer to the **Properties** window below the **File Browser**, as shown in Figure 2-4. If you select a

channel, the channel preview to the right of the properties display shows the channel data as a curve.

**Figure 2-4.** Browsing the Found Files in the File Browser



## Loading and Managing Data

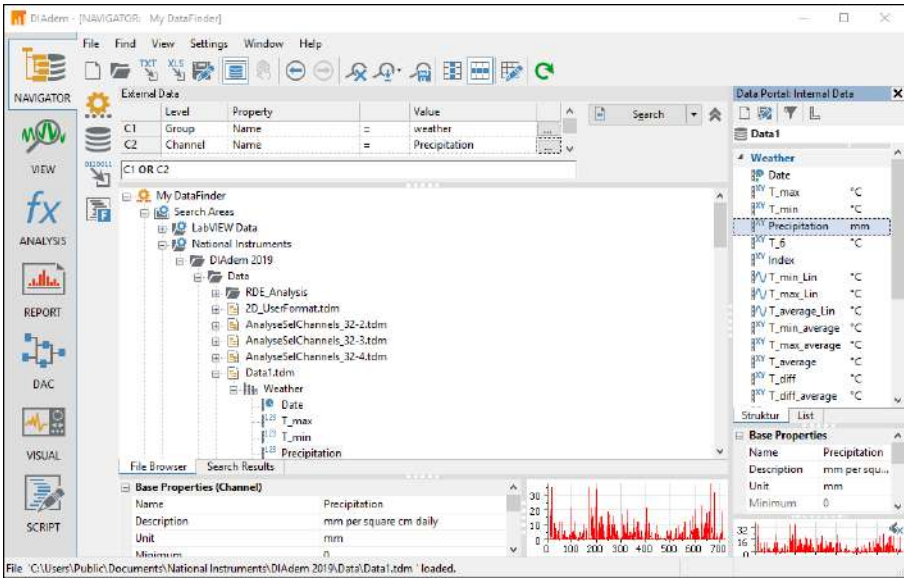
If you want to work with the data you found, you must load the data into the Data Portal. To load data and to remove unnecessary data, complete the following steps.

1. Click **Delete Internal Data** on the toolbar.
2. In the file browser, click the `Weather` channel group to select that channel group.

3. Drag and drop the selected channel group into the Data Portal.

The Data Portal displays the new channel group `Weather` with all channels, as shown in Figure 2-5. If you select a channel, the channel preview of the Data Portal displays the channel data as a curve.

**Figure 2-5.** Loading Data from the File Browser to the Data Portal



**Note** If you modify data in the Data Portal, DIAdem does not automatically save these changes. The changes are executed only in the memory and not in the data file from which you loaded the data. This enables you to experiment with data without modifying the original data.

## Saving Data

In the Data Portal, click **Save** to overwrite the `Data1.tdm` file with the current data from the Data Portal. To save the data of the Data Portal in another location under a different name, carry out the following steps.

4. In the `National Instruments` folder, navigate to the `DIAdem Data` folder.
5. Select the `Weather` channel group in the Data Portal.
6. Drag and drop the `Weather` channel group onto the `Data` folder.
7. Enter `Weather data` in the **Save As** file name dialog box.
8. Change the file type to `National Instruments TDM Files (*.tdm)`.
9. Click **Save**.



# Summary

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The summary provides an overview of the topics discussed in this chapter. It also includes additional information.

## DataFinder

In the search input area of the DataFinder, you enter search conditions to find your data. You can also drag and drop properties from the properties display of the Data Portal or of the file browser into the search input area. In the logical operations line, you connect the search conditions with AND and OR and use parentheses to specify queries more precisely. DIAdem lists the files found in the search areas on the **Search Results** tab.

## SystemLink TDM

SystemLink TDM's DataFinder instances index data files on the network and allow multiple DIAdem users to access common search areas simultaneously. You can enable security settings and use archiving systems.

## Search Areas

Search areas are folders of the file system, which the DataFinder indexes. Select **Settings»MyDataFinder»Configure** to modify the search areas of the DataFinder.

## File Browser

The **File Browser** displays the files of the search areas in a tree structure. Right-click the empty space of the file browser to open the context menu and hide or show the folders of the local file system in a separate tree.

## Internal Data in the Data Portal

DIAdem manages internal data in the Data Portal, which is visible in all panels. In all DIAdem panels you work with the channels of the internal data and their descriptive information.

DIAdem saves result data in the Data Portal. You can display and edit the channel contents in DIAdem VIEW.



**Tip** To highlight multiple channels in the Data Portal without using the <Shift> or <Ctrl> keys, click the icons next to the channel name. DIAdem displays a cursor with a plus sign.

## Channel groups

Channel groups contain channels and descriptive properties of the channel groups. Use different channel groups to organize your data. You can define a channel group as a default group, for example, to automatically group together all the calculation results from DIAdem ANALYSIS. DIAdem displays the group name of the default group in bold type.

## Channels

Channels contain data series which you either measured, loaded from an external data set, or calculated with DIAdem. DIAdem distinguishes numeric channels, xy-channels, waveform

channels, time channels, and text channels. Numeric channels contain numeric values, waveform channels contain numeric values and the associated x-channel, time channels contain time values, and text channels contain text.

## Properties

Properties are information about the data, which DIAdem saves with the data series in a TDM file. The data set properties contain the name of the author and the storage date, the channel group properties contain the name of the measurement and comments, and the channel properties contain the data type and the channel unit. In addition to the standard properties, you can create your own custom properties for the data set, the channel group, and the channel. DIAdem displays the properties in the properties displays of the file browser and of the Data Portal.

## Units Catalog

The channel unit is a special channel property because you can organize the channel units in the units catalog. Use the units catalog to assign a physical quantity and a unit to measurement values, for example, the quantity speed and the unit kilometers per hour. If you assign the unit mile per hour from the units catalog to the speed channel, DIAdem can convert the channel values.

# Viewing and Evaluating Data

Use DIAdem VIEW to view, to analyze, and to edit data as curves in axis systems. In channel tables you can edit and delete the data as values and enter new data. You synchronize videos or the map display of a test drive with data.

## Viewing Curves

To view the loaded data set in an axis system, complete the following steps.

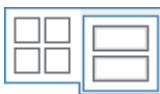


**Note** If you did not complete the exercise in the previous chapter, delete the current data from the Data Portal and load the `Data1.tdm` data set from the DIAdem Data folder. You can find this folder in the DIAdem NAVIGATOR file browser in the **National Instruments** search area.

1. Select **DIAdem VIEW**.



2. Click **New Layout**.
3. Open the function group **Regular Worksheet Partitions** and select **Two Areas**.

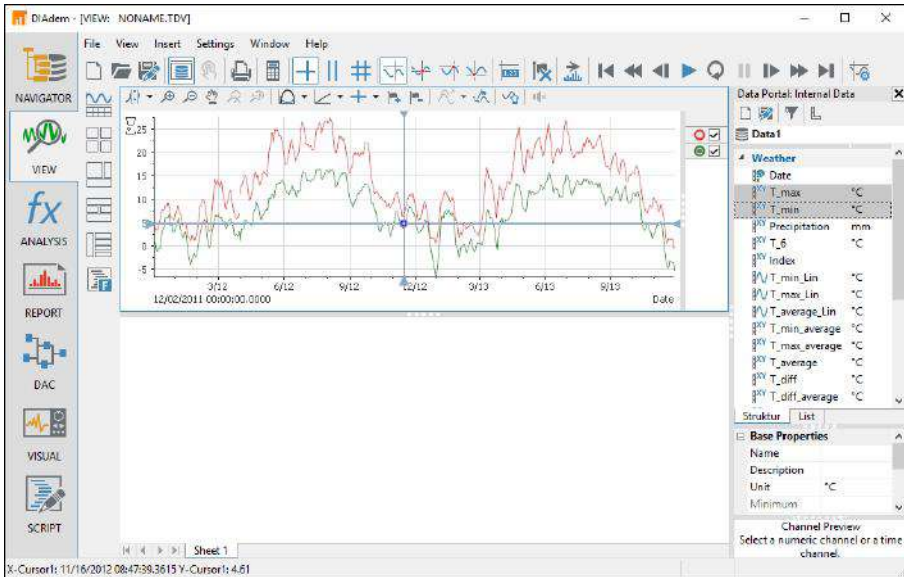


**Note** Each panel has its own group bar on the left. When you click a button on the group bar, DIAdem opens the function group where you can select a function.

4. In the Data Portal, select the numeric channels  $T_{max}$  and  $T_{min}$  by clicking the symbol in front of the channel name. The cursor changes its color and displays a plus sign.
5. Drag and drop the two channels selected in the Data Portal into the upper worksheet area.
6. Select **2D Axis System** in the selection dialog box.

DIAdem displays the axis system, as shown in Figure 3-1.

**Figure 3-1.** Viewing Temperature Data as Curves



**Note** If you select multiple numeric channels in the Data Portal and drag them into an axis system, DIAdem assigns the first selected channel to the x-axis. If you select only one channel, DIAdem uses the index to display a numeric channel, and uses the x-channel to display an xy-channel and a waveform channel.

## Editing Curves

In DIAdem VIEW you can measure curves, and copy, delete, and interpolate curve sections. Use the curve cursor, the maximum values cursor, or the minimum values cursor on the DIAdem VIEW toolbar to measure a curve. To edit curve sections, use the flag functions on the axis system toolbar. The functions on the toolbar of the axis system influence the curves in the associated axis system, whereas the functions on the DIAdem VIEW toolbar influence all areas.

## Measuring Curves

To follow the curve points with the curve cursor in an axis system, complete the following steps.

1. Click **Curve Cursor** on the tool bar.
2. Click the axis system and move the curve cursor along the curve.

DIAdem displays the x-values and the y-values of the curve points in a tooltip next to the crosshair cursor that follows the cursor.

- Click the red circle in the legend at the right edge of the axis system to select the other curve as the leading curve.



**Note** You can use the second check box next to the curve symbol to hide and show the curve in the axis system.

DIAdem displays the coordinates of the new leading curve in the tooltip.

## Copying Curve Sections

To select a curve section and to copy the data of the curve section into the Data Portal, complete the following steps.

- Click **Band Cursor** on the toolbar.
- At the point 12.12, click into the axis system and drag the band cursor to 3.13.  
Click between the two lines to move the band cursor along the curves. Move the cursor lines individually to specify the width of the band cursor.
- In the axis system toolbar, click **Set Flags** to flag all the curve points of the leading curve in the selected time period.

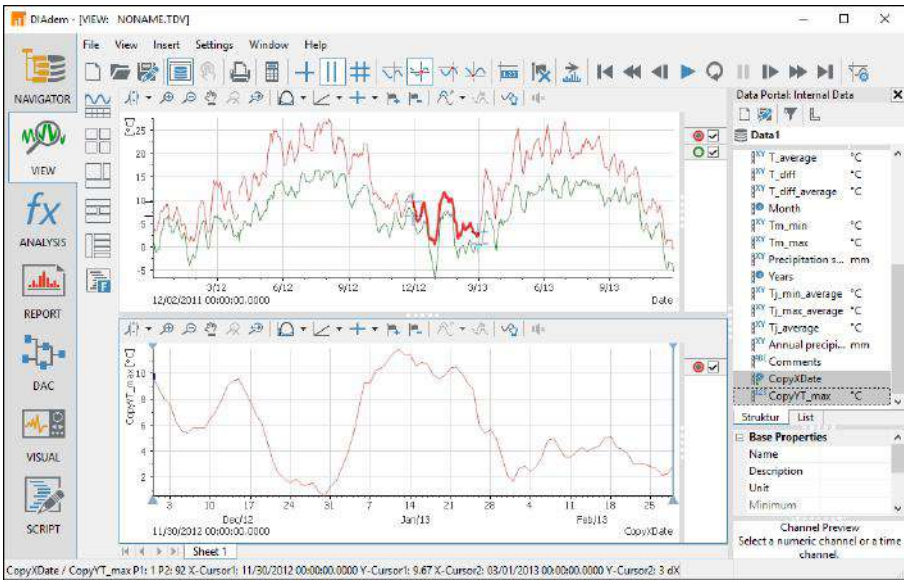


**Note** If you press <Shift> at the same time, DIAdem flags the points of all curves in this period.

- Click **Flags: Copy Data Points** in the toolbar of the axis system to copy the data of the selected curve points to new channels.  
In the Data Portal, DIAdem creates a time channel and a numeric channel with the values of the copied curve section.
- Drag and drop the new channels into the bottom workspace.

- Select **2D Axis System**. DIAdem displays the copied curve section, as shown in Figure 3-2.

**Figure 3-2.** Selecting Curve Sections and Copying them into the Data Portal



- On the DIAdem VIEW toolbar, click **Remove Flags from All Data** to disable the selection.

## Editing Data in Channel Tables

In channel tables you can edit and delete data and add new data. You can enter or generate new data manually.

To edit values in a channel table and to generate new values, complete the following steps.

- Open the function group **Assigned Worksheet Partitions** and select **Channel Table**.



DIAdem creates a new worksheet with a channel table.

- Select the **Comments**, **CopyXDate** and **CopyYT\_Max** channels in the Data Portal to drag and drop these channels into the channel table.

DIAdem displays the columns in the order in which you select the channels in the Data Portal.

- Click into the cell in row **10** of the **CopyYT\_max** column.
- Enter the value **1** and press <Enter>.

DIAdem also displays the new value in the curve in the bottom axis system on the previous worksheet.

5. Right-click next to the channel table or into an empty column and select **Create New Channel** from the context menu.
  - a. Enter the channel name `Generated_Channel`.
  - b. Click **OK** to create the new channel in the channel table and display it in the Data Portal.
6. Right-click the first cell of the empty column **Generated\_Channel** and select **Generate** from the context menu.
  - a. Enter `0.5` as the step width and `100` as the number of values.
  - b. Click **OK** to create the channel values.

DIAdem displays the channel table, as shown in Figure 3-3.

**Figure 3-3.** Editing and Generating Data in Channel Tables

The screenshot shows the DIAdem software interface. The main window displays a channel table with the following columns: Name, Comments, CopyXDate, CopyY1\_max, and Generated\_Channel. The table contains data for various weather-related channels. A new channel 'Generated\_Channel' is highlighted in the table and also in the Data Portal on the right. The Data Portal shows the 'Generated\_Channel' properties, including its name, description, and unit.

Name	Comments	CopyXDate	CopyY1_max	Generated_Channel
Weather	Weather	Weather	Weather	Weather
4	4	92	92	100
Unit			°C	
Channel Contents				
1	Weather data	11/30/2012 00:00:00...	9.86666666666667	1
2	Daily record	12/01/2012 00:00:00...	8.33333333333333	1.5
3	From 2011 to 2013	12/02/2012 00:00:00...	8	2
4		12/03/2012 00:00:00...	7.5	2.5
5		12/04/2012 00:00:00...	6.25	3
6		12/05/2012 00:00:00...	5.5	3.5
7		12/06/2012 00:00:00...	5.4	4
8		12/07/2012 00:00:00...	5.8	4.5
9		12/08/2012 00:00:00...	5.8	5
10		12/09/2012 00:00:00...	1	5.5
11		12/10/2012 00:00:00...	6.5	6
12		12/11/2012 00:00:00...	7.14285714285714	6.5
13		12/12/2012 00:00:00...	8	7
14		12/13/2012 00:00:00...	9	7.5
15		12/14/2012 00:00:00...	9.42857142857143	8
16		12/15/2012 00:00:00...	9.57142857142857	8.5
17		12/16/2012 00:00:00...	8.71428571428571	9
18		12/17/2012 00:00:00...	7.85714285714286	9.5
19		12/18/2012 00:00:00...	6.85714285714286	10
20		12/19/2012 00:00:00...	6.14285714285714	10.5
21		12/20/2012 00:00:00...	4.71428571428571	11

The Data Portal on the right shows the 'Generated\_Channel' properties:

- Name: Generated\_Channel
- Description: (empty)
- Unit: (empty)
- Minimum: 1

To use the layout with all worksheets as a template for similar data sets, click **Save Layout As** in the DIAdem VIEW toolbar.

# Summary

---

The summary provides an overview of the topics discussed in this chapter. It also includes additional information.

## Layouts

A layout can contain several worksheets. DIAdem saves layouts separately from the channels. You can reuse the layout as a template for data sets with a similar structure.

## Areas

Partition worksheets into areas to insert axis systems, channel tables, videos, contours, maps, dialog boxes, text, and images. You can move the separating bars to resize any area in a worksheet. Use the **Assigned Worksheet Partitions** function group to add new worksheets with predefined areas to a layout.

## Axis Systems

DIAdem VIEW provides 2D axis systems, polar axis systems, Bode axis systems, orbit axis systems, and shaft centerline axis systems which all display data as curves. In 2D axis systems you can display data as spikes or stair curves and add constants. To insert data into an axis system, drag and drop channels from the Data Portal into an axis system. Use the band cursor and the frame cursor to zoom curve sections. You open the legend on the right side of an axis system.

## Graphics Cursor

DIAdem VIEW offers various graphics cursors for evaluating curves in axis systems. The free cursor moves freely in the axis system and the curve cursor follows the curve from curve point to curve point. Other graphics cursors determine the maximum values and the minimum values of a curve. If an axis system contains several curves, the graphics cursor follows the leading curve that you specify with the radio buttons in the legend. DIAdem synchronizes all cursors of a worksheet with each other and with videos.

## Flags

Use the band cursor and the frame cursor to mark curve sections with flags, to delete, to copy, or to recalculate the marked curve points.

## Channel Tables

In channel tables you view the individual values of all channel types, edit the values and add new values or channels. In the display properties of a channel table, you can specify whether a channel table only displays the channels that were dragged and dropped into the table or whether the channel table automatically displays all channels of a group or of the Data Portal.

## Videos

In video areas you show videos. If you display the associated measured values as curves in an axis system, you can move a graphics cursor along the curves to display the video frame associated with each measurement value. Double-click an empty video area to insert a video.



## Contours

In contour areas you display 3D data two-dimensionally by displaying the third dimension of the data as a color value and with isolines. You can use a contour display, for example, to display and to analyze characteristic diagrams. If you move the graphics cursor over a contour, DIAdem displays the associated isolines dynamically. You can save the data of every associated isoline and also the x-parallel and y-parallel intersection in the Data Portal.

## Cascades

In cascade areas, for example, you can display oscillation data as a waterfall by mapping the oscillation amplitude over the frequency as a cascade in consecutive tracks. You can zoom into interesting areas and move over them with different measurement cursors. You can also show dynamic and static order lines, which help evaluate the rpm-related vibrations.

## Maps

In map areas you display geographic data in map sections. For example, you can follow the route of a test drive when you move the graphics cursor in an axis system along the data, such as consumption, RPM, and torque, collected during the test drive. To do so, enter the recorded longitude and latitude and, for example, the time channel for synchronization.

## Dialog Boxes

In dialog boxes you enter values, check settings, or start functions to change the displays in other areas of the layout during the analysis. You can include every user dialog box to which you added the `VIEWConnector` control in the dialog editor of DIAdem SCRIPT.

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# Analyzing Data with Mathematical Functions

Use DIAdem ANALYSIS to analyze data mathematically. You can apply predefined standard mathematical functions, including basic mathematics, curve fitting, signal analysis, and statistics. The dialog boxes for these standard functions guide you through the calculation, so you do not have to enter a formula. You select the input data and the settings. Use the DIAdem Calculator to define and calculate your own formulas.

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## Using Mathematical Standard Functions

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DIAdem offers libraries with standard mathematical functions that you can use in DIAdem ANALYSIS in various function groups. The results of the calculations are displayed in new channels in the Data Portal.



**Note** If you did not complete the exercise in the previous chapter, delete the current data from the Data Portal and load the `Data2.tdm` data set from the DIAdem Data folder. You can find this folder in the file browser of DIAdem NAVIGATOR in the **National Instruments** search area.

To create a new group for the calculation results, complete the following steps.

1. Select **DIAdem ANALYSIS**.



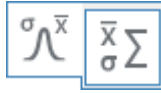
2. Right-click in the Data Portal and select **New»Group** from the context menu.
3. Enter `Results` as the **Name**. Enable the checkbox **Set default group**.
4. Click **OK**.

DIAdem displays the name of the default group in blue font in the Data Portal.

## Calculating the Sum of Channel Values

To total the precipitation for the year 2012, complete the following steps.

1. In the **Statistics** function group, select **Descriptive Statistics**.



2. Select the [1]/Precipitation sum channel in the Data Portal.  
This notation refers to the channel Precipitation sum in the first channel group.
3. Use Drag&Drop to insert this channel into the **Channels** input field in the **Object to be evaluated** section.
4. Deactivate **Calculate over all rows** and enter the **rows** 2-13.



**Tip** To check in which rows the precipitation of the year 2012 is located, switch to DIAdem VIEW and load the channels Month and Precipitation sum into a channel table. The Month channel contains the time values for the monthly precipitation totals.

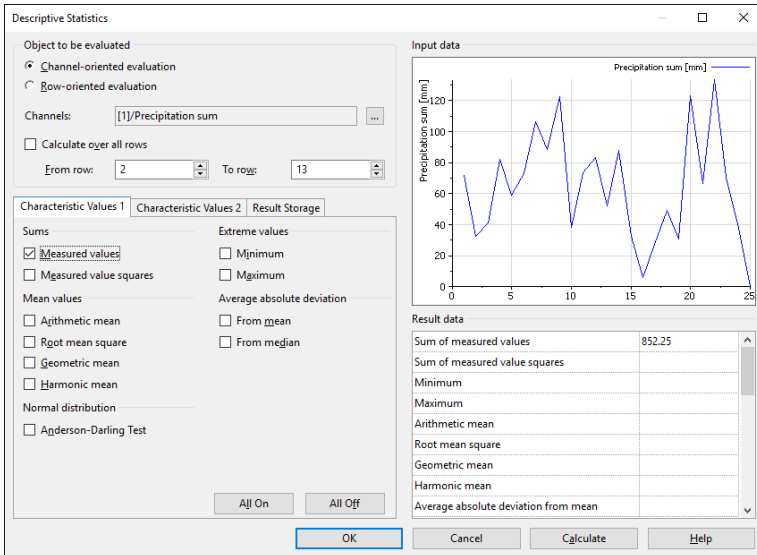
5. Enable **Sums»Measured values** on the **Characteristic values 1** tab.



**Note** On the **Characteristic Values 2** tab, click **All off** if characteristic values have already been selected.

DIAdem displays the **Descriptive Statistics** dialog box, as shown in Figure 4-1. The dialog box displays the channel preview of the precipitation sum in the top right-hand corner and displays the result data below the channel preview.

**Figure 4-1.** Precipitation Summation in Sections



- Click **OK** to calculate the sum and to close the dialog box.

DIAdem stores the result in the custom properties of the channel `Precipitation sum`.



**Note** If you want to perform further calculations using this standard function, click **Calculate**. The dialog box remains open for further entries.

- In the Data Portal, click `[1]/Precipitation sum` and open the property `Custom properties»ResultStatSum`.
- Right-click `Sum` and choose **Rename**. Enter `Result~Precipitation_2012` as the property name and press <Enter>.

## Averaging Channels

To calculate the average monthly temperatures, complete the following steps.

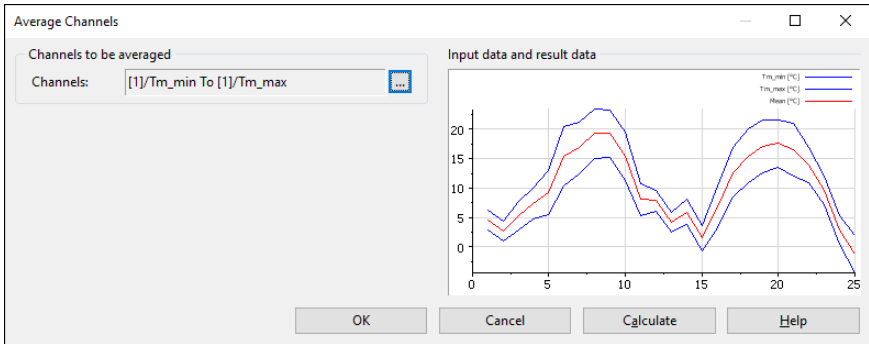
- In the **Channel Functions** function group, select **Average Channels**.



2. Select the channels [1]/Tm\_min and [1]/Tm\_max in the Data Portal.
3. Use Drag&Drop to insert this channel into the **Channels** input field in the **Channels to be averaged** section.

DIAdem displays the dialog box, as shown in Figure 4-2.

**Figure 4-2. Averaging Minimum and Maximum Temperatures**



4. Click **OK**.
5. Right-click `Results/Mean` in the Data Portal and select **Rename**. Enter `Temperatures` as the channel name and press `<Enter>`.

## Calculating with the Units Catalog

The DIAdem units catalog organizes physical quantities and the associated units. Use the units catalog to convert channels into other units.

To convert the calculated average monthly temperatures from degrees Celsius to degrees Fahrenheit, complete the following steps.

1. In the **Channel Functions** function group, select **Convert Channel Unit**.



2. The **Channel** input field in the **Channel to be calculated** section contains the `[2]/Temperatures` channel.

If you see a different channel, select `Results/Temperatures` and drag and drop the selected channel into the input field.

3. Select **Unit>To** [°F] degree Fahrenheit, as shown in Figure 4-3.

**Figure 4-3.** Converting Channel Units with the Units Catalog

4. Click **OK**.
5. Right-click `Results/UnitConverted` in the Data Portal and select **Rename**. Enter the channel name `Temperatures_F` and press <Enter>.



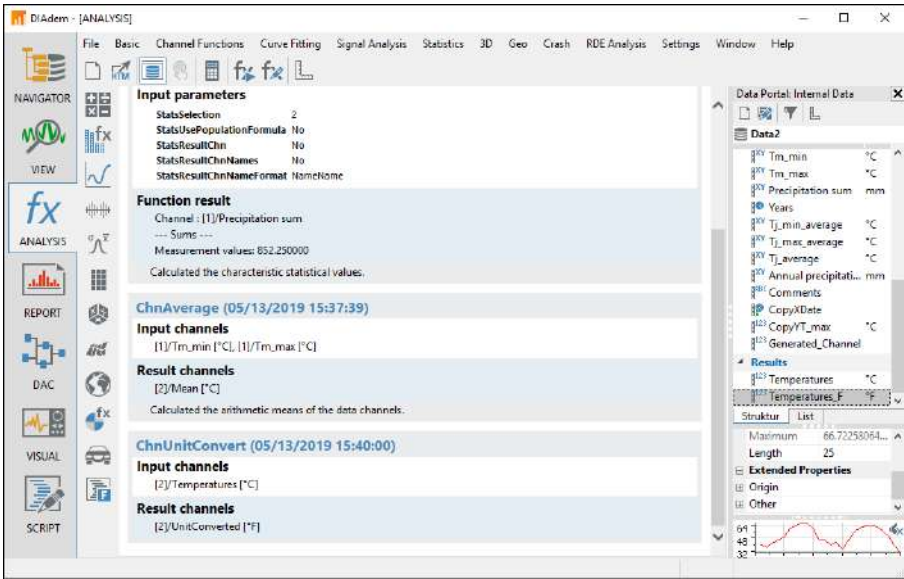
**Note** You can also convert channel data to another unit in the Data Portal. To do so, click the unit entry field in the properties display and click the button with the three dots to open the **Symbol Input Help** dialog box.

DIAdem ANALYSIS displays a record of the calculations, as shown in Figure 4-4, and the Data Portal displays new channels with the calculation results.



**Note** Click **Export ANALYSIS Log** on the toolbar to save the calculation log as HTML file.

**Figure 4-4.** Calculations with Standard Functions Log



Refer to Figure 5-3 in the next chapter to view the curves of the average temperatures and the annual precipitation.

## Calculating Formulas with the Calculator

Use the DIAdem Calculator to calculate your own mathematical formulas. In the Calculator you calculate with channels, variables, and values you enter. DIAdem stores the results in channels or variables.

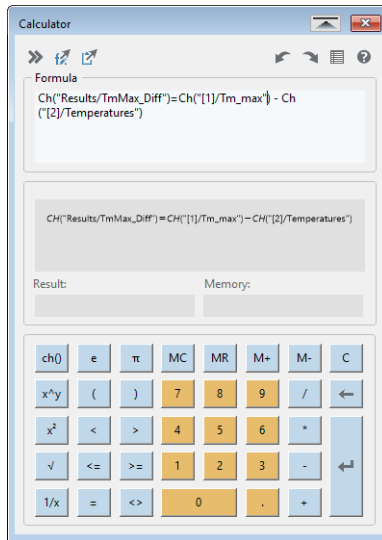
To calculate the difference between maximum monthly temperatures and average temperatures, complete the following steps.

1. Click **Calculator** on the toolbar.
2. Enter the following formula in the Calculator entry field.

`Ch ("Results/TmMax_Diff") = Ch (" [1]/Tm_max") - Ch (" [2]/Temperatures ")`



**Tip** Instead of typing in the entire formula, copy this line and paste it into the Calculator.

**Figure 4-5.** Calculating Formulas with the Calculator

3. Click the **Calculate** button and exit the dialog box through the red close window button. DIAdem adds the new channel `TmMax_Diff` to the `Results` channel group in the Data Portal.

## Summary

The summary provides an overview of the topics discussed in this chapter. It also includes additional information.

### Mathematical Functions

DIAdem ANALYSIS offers a variety of standard functions for analyzing your data. You assign input channels to standard functions, set parameters, and execute the calculation. Click **OK** to execute a calculation once and to close the dialog box. Click **Calculate** to execute several calculations with the same standard function.

### Result Channels

DIAdem ANALYSIS saves calculation results in new channels. This enables you to calculate new data without overwriting the existing channels. In most dialog boxes of the standard functions, you can select **Store result in original channel** to overwrite the existing channels.

### Custom Properties

Some standard functions, such as descriptive statistics or approximation store the calculated characteristic values as custom properties in the result or input channels.



## Default Group

DIAdem stores the result channels of a calculation in the default group in the Data Portal. In the context menu you can define a different group as the default group. DIAdem displays the group name of the default group in blue font.

## Calculator

Use the Calculator to specify your own formulas for analyzing data. The Calculator has functions that range from simple arithmetic functions to advanced scientific and engineering functions. Use the Calculator to calculate channels, variables, and single values. DIAdem stores the results in channels or variables.

## Units

If you assign units from the units catalog to the original channels, DIAdem automatically determines the unit of the result channels. Based on the physical quantities and units of the original channels, the division of distance by time results in a speed with the unit kilometers per hour, for example. **Settings»Units** allows you to add your own units and define unit sets with preferred units.

## Calculation Manager

To execute recurring analysis sequences with a mouse-click you can define simple as well as complex calculations in the calculation manager. An analysis sequence can contain user-specific formulas and default functions and can combine calculations when one calculation step accesses the result from a different calculation step.

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# Creating Reports

Use DIAdem REPORT to document data and present results. In 2D and 3D axis systems, you display your data as curves, bar diagrams, and surfaces. In 2D and 3D tables, you list channel contents. You can label your report with comments and text and illustrate the report with graphics and formulas. You use the Chart Wizard to create and modify 2D axis systems and polar axis systems.

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## Creating Axis Systems

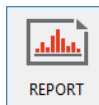
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To create a new layout with the Chart Wizard, complete the following steps.



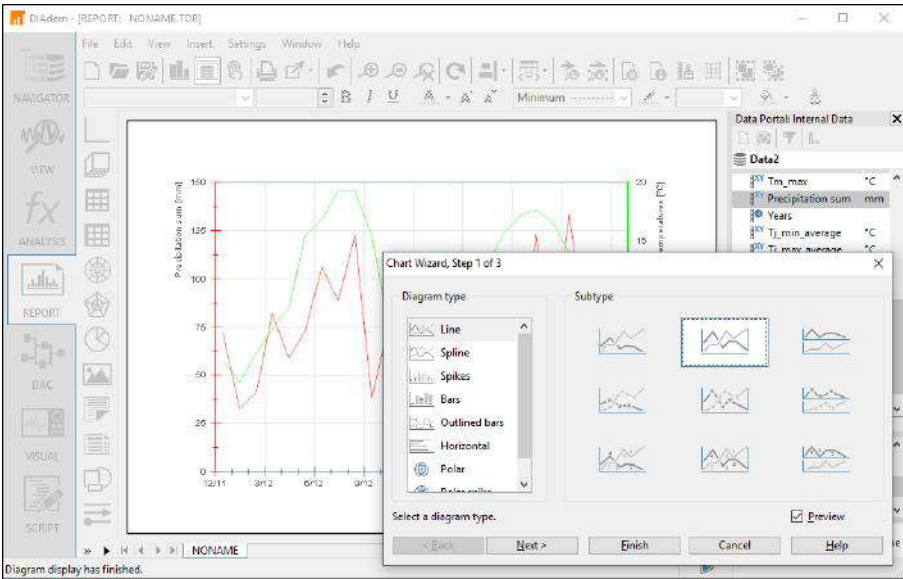
**Note** If you did not complete the exercise in the previous chapter, delete the current data from the Data Portal and load the `Data3.tdm` data set from the DIAdem Data folder. You can find this folder in the file browser of DIAdem NAVIGATOR in the **National Instruments** search area.

1. Select **DIAdem REPORT**.



2. Click **New Layout**.
3. In the Data Portal, select the channel `Weather/Month` and then the channels `Weather/Precipitation sum` and `Results/Temperatures`.
4. Right-click a selected channel and select **Chart Wizard** from the context menu. DIAdem opens the Chart Wizard and creates a new worksheet with an axis system. In the axis system, DIAdem displays the channels that are selected in the Data Portal as curves. DIAdem assigns the first selected channel `Weather/Month` to the x-axis.  
  
In Step 1 you select the diagram type. In Step 2 you add or delete curves. In Step 3 you specify the diagram display on several tabs. The preview, as shown in Figure 5-1, directly displays how the diagram changes.
5. Select the **Lines** diagram type, and then click the **Lines with Multiple Y-Axes** subtype.

**Figure 5-1.** The Chart Wizard Displays the Preview in the Worksheet



6. Click **Next** twice to open Step 3 of 3.
  7. Select the **X-Axis** tab.
  8. Enable **Manual from** for the value range and enter 01/01/2012 as the start and 12/31/2012 as the end.
  9. Click **Finish** to create the axis system.
- In the axis system, DIAdem displays the monthly precipitation and the monthly average temperatures over the date.



**Tip** You can open the Chart Wizard from several locations in DIAdem REPORT. If you want to display curves with various x-channels, open the Chart Wizard on the toolbar. If you want to insert axis systems into the current worksheet, open the Chart Wizard from the **2D Axis Systems** function group or the **Polar Axis Systems** function group. If you want to edit an axis system, open the Chart Wizard from the context menu of the axis system.

## Editing Axis Systems

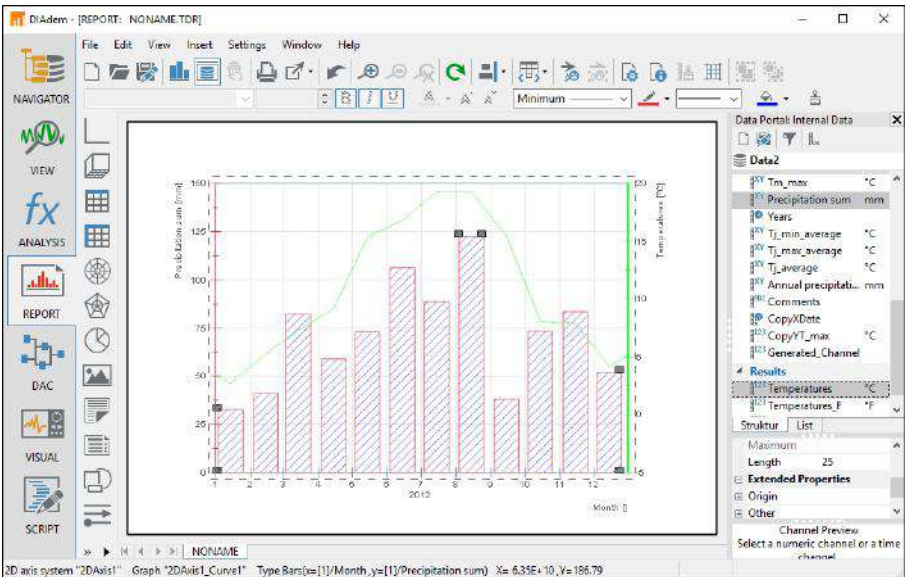
You can move and resize axis systems or parts of an axis system. To make it easier for you to see which objects you can select, DIAdem displays an object in a blue frame as soon as the mouse cursor idles on the object. Double-click the object to open its settings.

Complete the following steps to display the precipitations as bars.

1. Double-click the red curve of the precipitation sum to open the associated curve parameter.
2. Select the **Bars Display type** and the **2D Bars Display mode**.
3. Select the **Filling color** Blue and a **Right diagonal Filling**.
4. Click **OK**.

DIAdem displays the worksheet, as shown in Figure 5-2.

**Figure 5-2.** DIAdem Displays the Precipitation as Bars



5. Click once into a free space in the axis system to select the axis system.
6. To reduce the width of the axis system, move the small square in the middle of the right edge of the selected axis system to the left.

## Graphics and Lines

Illustrate reports with graphics and company logos. Use lines and rectangles to partition the worksheet through lines or to highlight a textbox.

To add a graphic to your worksheet, complete the following steps.

1. In the **Graphics** function group, select **Load Graphic**.



2. Select `Weather.jpg` in the `DIAdem Documents` folder and click **Open**.
3. Click and drag the graphic to the right edge of the workspace.
4. Resize the graphic by dragging the small squares at the corners of the graphic.

To prepare a description field on the right of the worksheet, complete the following steps.

1. Open the function group **Lines and Arrows** and select **Continuous Vertical Line**.



DIAdem inserts a vertical line on the right edge.

2. Move this line slightly to the left to widen the description field.

## Using Text and Variables as Labels

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Add text and variables to a report to explain the contents and highlight specific items. All texts can include formula expressions and DIAdem variables, which DIAdem updates along with the rest of the report. Double @ characters indicate to DIAdem which parts of the text to evaluate dynamically.

To add a text to your report, complete the following steps.

1. Click **Text** on the group bar and select **Text**. The cursor changes to a text cursor.



2. In the worksheet, click into the textbox at the top and type `Weather Report`.
3. Press <Enter> and enter `@@CurrDate@@` in the second row.
4. Click outside the text to conclude the entry.
5. Click the text. To resize the text, drag the small squares at the corners of the text with the mouse.

## Adding and Formatting Channel Properties

In the dialog of the text editor, you edit the text and use variables and expressions that are available to you when you click the button with the three dots at the end of the input field. You can easily drag and drop channel properties from the Data Portal into the worksheet.

To add a channel property to your report and to edit the channel property, complete the following steps.

1. In the Data Portal, click `[1]/Precipitation sum` and open the property `Result»Precipitation_2012`.

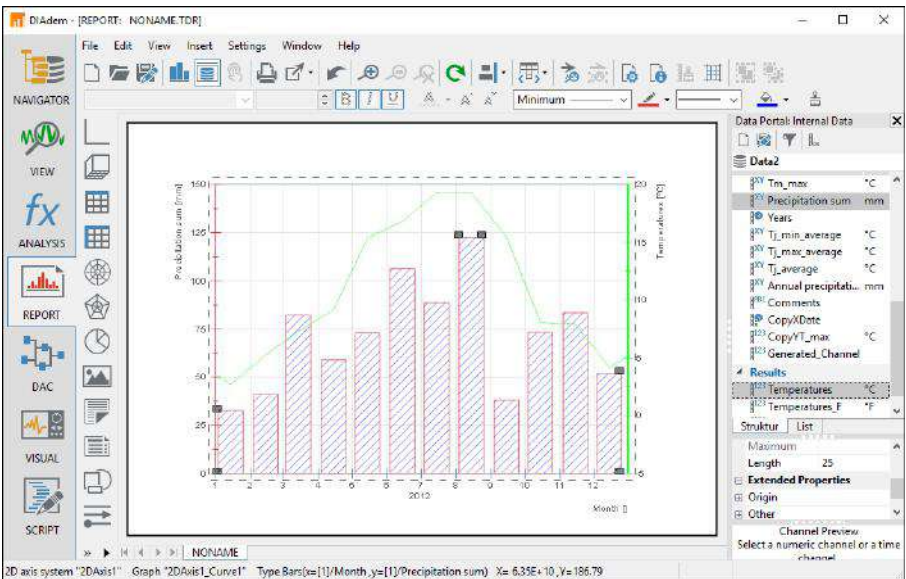
2. Drag this custom property into the textbox.
3. Double-click the inserted text. The text editor displays the following text:
 

```
Result~Precipitation_2012: @@Str(Data.GetChannel("[1]/Precipitation sum").Properties("Result~Precipitation_2012").Value,"AutoAdj")@@
```

  - a. Replace the first term `Result~Precipitation_2012` with the description Annual precipitation.
  - b. Press <Enter> to position the value below the text.
  - c. Enter `mm` at the end of the text.
4. Click the **Position** tab and select **Centered** as the **Relative position**.
5. Click **OK**.
6. Select both texts and the graphic.
7. Click **Orientation** on the group bar and select **Vertical**.

DIAdem displays the worksheet, as shown in Figure 5-3.

**Figure 5-3. Using Text and Variables as Labels**



To use the layout as a template for similar data sets, click **Save Layout As**.

# Summary

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The summary provides an overview of the topics discussed in this chapter. It also includes additional information.

## Layouts

A layout can contain several worksheets. DIAdem saves layouts separately from the channels. You can reuse layouts as templates for data sets with a similar structure.

## Worksheets

Worksheets contain axis systems, tables, text, formulas, and graphics. To add data to the worksheet, drag and drop channels from the Data Portal into axis systems and tables. In addition to selecting data channels from the Data Portal, you also can add data channels by double-clicking an axis system or a table.

Select **Settings»Layout Setup»Worksheet Parameters** to change the page format of a worksheet so that, for example, the table of contents is in portrait format, whereas the diagrams remain in the landscape format.

Export your report as PDF, XPS, and HTML files or individual pages as graphics in various formats, such as PNG, JPG, GIF, TIF, and EMF. Under **Settings»Layout Setup»Layout Parameters** you can add custom properties to a report, for example, the name of a test sequence, in order to search for this property with DataFinder.

## Master Layout

Use a master layout to create a uniform appearance for reports. The master layout remains unchanged in the background of all worksheets and consists of a landscape master and a portrait master. To create a master layout, select **File»Master Layout»New**.

## Chart Wizard

You can use the Chart Wizard to create and to modify 2D axis systems and polar axis systems. The preview function displays each changed setting in the worksheet.

## Axis Systems

Use axis systems to display channels as curves, as bars, and as surfaces. You double-click an axis system to edit the displayed curves, to add new curves, and to delete existing curves. To zoom curve sections, change the scaling of the x-axis and the y-axis with the mouse wheel as soon as you position the cursor over the respective axis.

## Tables

Use tables to list the contents of numeric channels and also text channels. Double-click into table to edit the displayed columns, to add new columns, and to delete existing columns.

## Text

Use text to label worksheets. Use **Add Curve Coordinates** in the context menu of a curve to add comments to values. Text also can include variable information, such as filenames or the current date. For DIAdem, the @@ characters indicate a variable expression. Click **Refresh** on the DIAdem REPORT toolbar to display the current variable contents.

## Formulas

Use formulas to display calculation instructions in graphics. DIAdem uses the formula syntax of the Mathematical Markup Language (MathML) used in word processing.

## Graphics

Use graphics and logos to illustrate worksheets. DIAdem supports numerous different graphic formats including PNG, BMP, JPG, TIF, and WMF.



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# Automating Sequences

Use DIAdem SCRIPT to automate tasks in a script, which combines several work steps for recurring sequences, such as standard calculations and serial evaluations. Scripts, which you can record interactively, use the functions of all DIAdem panels. You can add program structures and dialog boxes to scripts in the integrated script editor.

## Creating Scripts

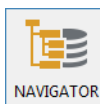
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The recording mode is the easiest way to create scripts. If you enable the recording mode, DIAdem creates a new script in the Script Editor and logs your actions in this script. To create a new script in the recording mode, complete the following steps.

1. Select **DIAdem SCRIPT**.

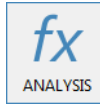


2. On the toolbar, click **Enable Recording Mode** to start recording a script.
  - a. In the dialog box that opens, enter `DIAdem User` as the **Author** and `Manual Example` as the **Comment**.  
DIAdem writes this information directly into the script code to help you identify the script in the future.
  - b. Click **OK**.
3. Select **DIAdem NAVIGATOR**.



4. Click **Delete Internal Data** to delete the data in the Data Portal.  
DIAdem asks if you want to save the data you modified in the Data Portal.
5. In the search input area of the quick search, type `Weather` and click **Search**.
6. Drag and drop the `Data1.tdm` file into the Data Portal.

7. Select **DIAdem ANALYSIS**.

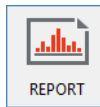


8. In the **Channel Functions** function group, select **Average Channels**.



- a. Select the channels [1]/Tm\_min and [1]/Tm\_max in the Data Portal.
- b. Use Drag&Drop to insert this channel into the **Channels** input field in the **Channels to be averaged** section.
- c. Click **OK** to calculate the mean values and to close the dialog box.

9. Select **DIAdem REPORT**.



10. Click **Load Layout**.

- a. Select Report2.tdr and click **Load**.

DIAdem updates the screen display and displays the loaded data set.

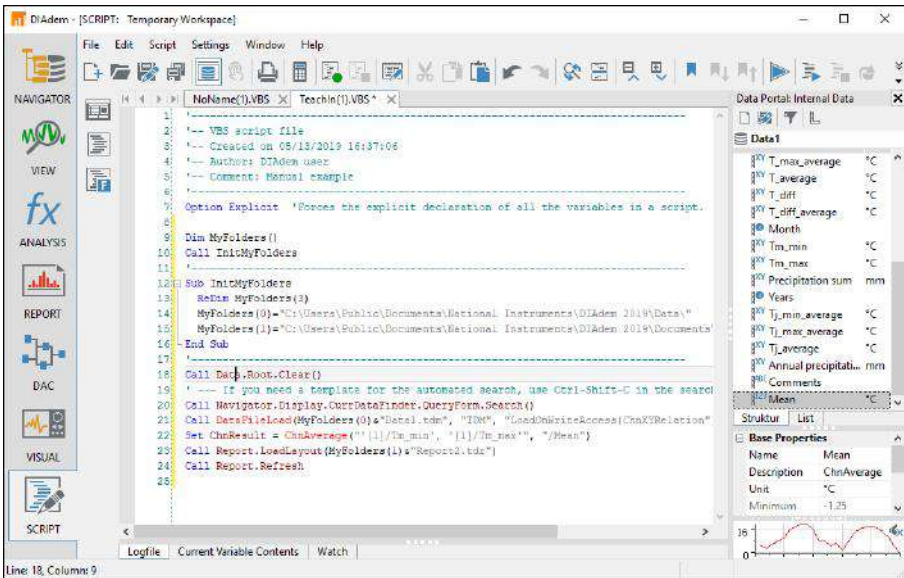
11. Select **DIAdem SCRIPT**.



12. Click **Disable Recording Mode**.

DIAdem displays the recorded script in the script editor, as shown in Figure 6-1.

**Figure 6-1.** Recording Actions in the Script Editor



After the commenting header, DIAdem declares the `MyFolders` path variable and assigns to this variable the paths to the data folder and to the document folder. If you want the script to load the data file or the layout file from another folder, just change the paths at this point in the script.

## Editing Scripts

In the recording mode you have recorded the search for weather data, loaded a data set, and created a report. Expand the recorded script to evaluate further weather data.

To select data interactively complete the following steps.

1. Replace the script line for loading the data file `Data1.tdm`

```
Call DataFileLoad(MyFolders(0) & "Data1.tdm", "TDM",
"LoadOnWriteAccess|ChnXYRelation")
```

with the following script lines:

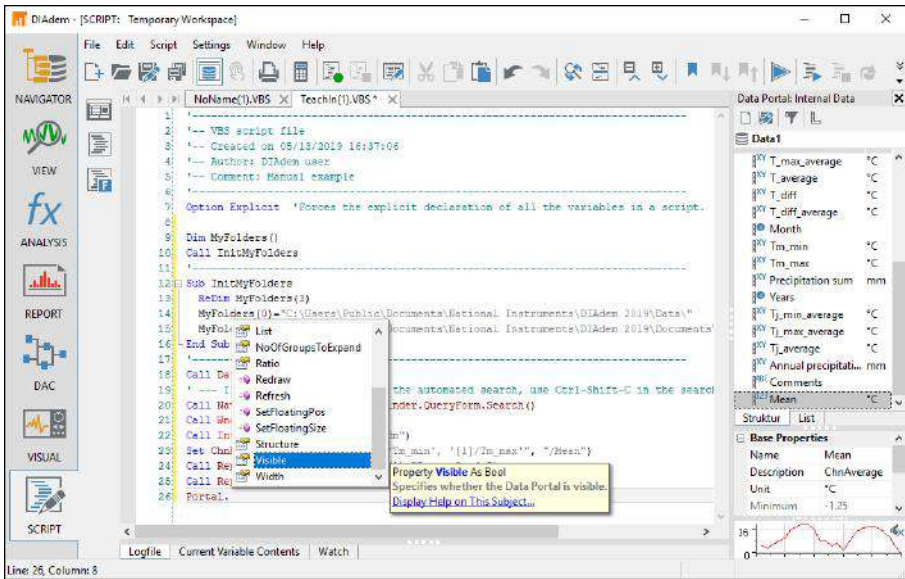
```
Call WndShow("NAVIGATOR", "OPEN")
Call InteractionOn("Load Data4.tdm")
```

The first script line opens the NAVIGATOR panel and the second line stops the script so that you can load data interactively.

2. After the last script line, enter the statement to hide the Data Portal and use CodeCompletion.
  - a. Enter `Portal.`

As soon as you enter the dot behind the `Portal` object, DIAdem offers the methods and properties available for this object for selection, as shown in Figure 6-2.

**Figure 6-2.** CodeCompletion and SmartInfo Make Editing Objects Easier



- b. Double-click `Visible` to insert this property into the script.
- c. Complete the script line as follows:

`Portal.Visible = False`

DIAdem displays the respective SmartInfo for every element in the selection list. Click **Display Help on this Subject** to open the help page on this object.

# Testing Scripts

To test the modified script, complete the following steps.

1. Click **Run Script**.

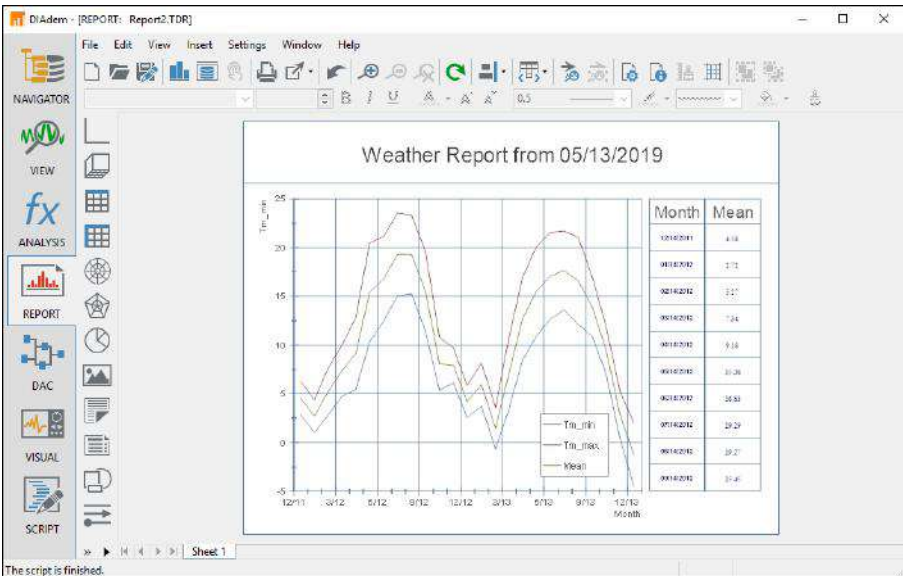
The script opens the NAVIGATOR panel and displays in the **Search Results** all the data files that contain the search term **Weather**.

2. Select **Data4.tdm** to drag&drop the file into the Data Portal.

3. Click the **Load Data4.tdm** message box to end the interaction.

The script opens the REPORT panel. DIAdem updates the date displayed in the heading and hides the Data Portal, as shown in Figure 6-3.

**Figure 6-3.** Report Created with the Script



4. Click **Data Portal** to re-enable the Data Portal for further actions.

To save the script, select **DIAdem SCRIPT** and click **Save File As**.

# Summary

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The summary provides an overview of the topics discussed in this chapter. It also includes additional information.

## Scripts

Scripts allow you to execute a series of commands for finding data, loading data, analyzing data, and creating reports. Scripts provide the VBS functionality and DIAdem functions. You can integrate the standard dialog boxes in scripts or you can create your own dialog boxes.

## Recording Scripts

In the recording mode DIAdem records the command for every action that you execute interactively, in a script.

### <Ctrl-Shift-C>

In the recording mode, DIAdem does not usually record the value assignment for object properties and variables. Press <Ctrl-Shift-C>, for example, in a DIAdem REPORT dialog box, to record the values of properties and variables. If DIAdem is not in the recording mode, also copy the assignment of values with <Ctrl-Shift-C>, but this time to the Windows clipboard. Then insert these assignments into a script and modify the required properties and variables.

## Script Editor

The script editor displays the program code of scripts. While you record actions in the recording mode, DIAdem records the commands directly in the script editor. Use functions such as go to line, bookmarks, restoring, and find and replace, to make script editing easier.

If you click a command, a property, a method, or a variable, the SmartInfo displays the parameters of the command, the property, the method, or the value range of the variable. For further information click **Display Help on this Topic**.

## CodeCompletion

If you enter the name of an object and complete the entry with a dot, the script editor offers the subobjects, events, properties, and methods that are available for this object. Add your selection to the object in the script with a double-click.

When you enter the first characters of a command, for example, and press <Ctrl-Spacebar>, the script editor automatically completes the command. If several commands start with these characters, the script editor offers a selection list of all the possible objects, commands, and procedures.

## Interaction Mode

When you use the interaction mode, you can stop your script and work interactively with DIAdem. Use the `InterActionOn` command to enable the interaction mode in scripts. You end the interaction mode with the **End interaction** button in the toolbar of each panel or in a message box.

## User Commands

To add commands to DIAdem, you can define user commands in a script. For example, you use user commands to run calculations in the calculator, to format axis systems in DIAdem REPORT, or to extend the range of functions in scripts.

## User Dialog Boxes

Create user dialog boxes with the dialog editor of DIAdem SCRIPT in order to enter values, search for settings, or start functions. Use events to connect elements from user dialog boxes and specify how the script proceeds depending on the previously specified settings.

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# Data Acquisition and Visualization

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.

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## Acquiring Measurement Data

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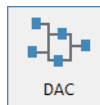
In DIAdem DAC you select functions blocks from the various function groups and connect them with signal buses, to create block diagrams. The measurement data is transferred from data sources to processing blocks, display instruments, and output blocks.

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



**Note** You can later replace the simulated signal with measured data.

1. Select **DIAdem DAC**.



2. Click **New Block Diagram**.
3. In the **Simulation Inputs** function group, select **Function Generator**.



4. In the **Display Instruments** function group, select **Numeric Display**.



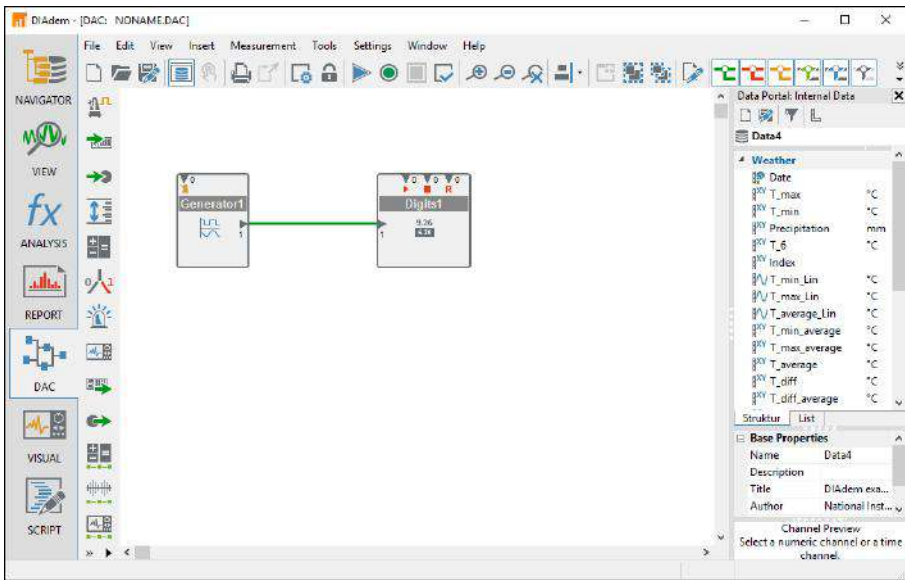
DIAdem inserts every new block in the top left corner of the workspace in DIAdem DAC.



5. Move the block **Digits1** to the right of **Generator1**.
6. Click the output on the right side of **Generator1**. Drag the green line to the input on the left side of the **Digits 1** 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 7-1.

**Figure 7-1.** Block Diagram with Function Generator and Digits Display



7. Click **Start Display** on the toolbar.  
DIAdem opens the DIAdem VISUAL panel and displays the simulated sine values in a Digits display.
8. Click **Stop Measurement**.

# Saving Measurement Data

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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.

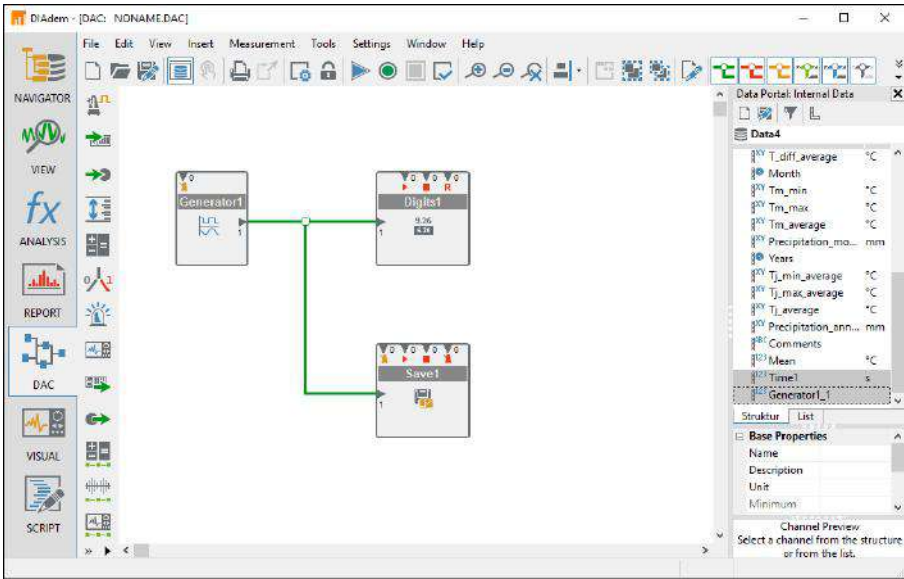
To save the measurement data, complete the following steps.

1. Select **DIAdem DAC**.
2. In the **System** function group, select **Save Data with Trigger**.



3. Place the **Save1** block below the numeric display.
4. Click the green data bus and drag the bus to the data input of the Save block as shown in Figure 7-2.
5. Double-click the **Save1** block.
  - a. Choose **Parameters**.
  - b. Enter 1000 values for **Cycle»Save**.
  - c. Click **OK**.
6. Click **Start Measurement**.  
DIAdem stops the measurement as soon as 1,000 values are saved.
7. Switch to **DIAdem DAC**.  
The new channels **Time1** and **Generator1\_1** are now visible in the default group of the Data Portal.

**Figure 7-2.** Extended Block Diagram with Data Storage



## Monitoring Measurement Signals

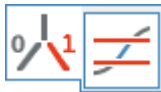
In control blocks you define conditions for monitoring and controlling measurements.

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

1. In the **Simulation Inputs** function group, select **Slider Control**.



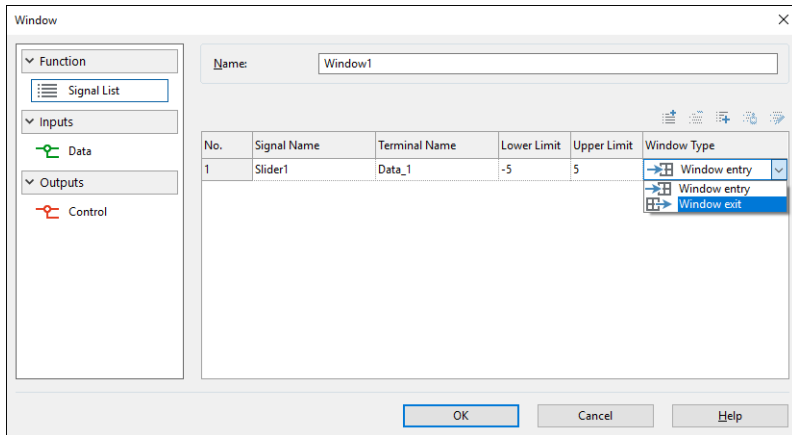
2. Place the **Slider1** block below the function generator.
3. In the **Control** function group, select **Window**.



4. Place the **Window1** block next to the slider.
5. Drag a green bus from the output on the Slider control to the input on the Window condition.
6. Double-click the **Window1** block.

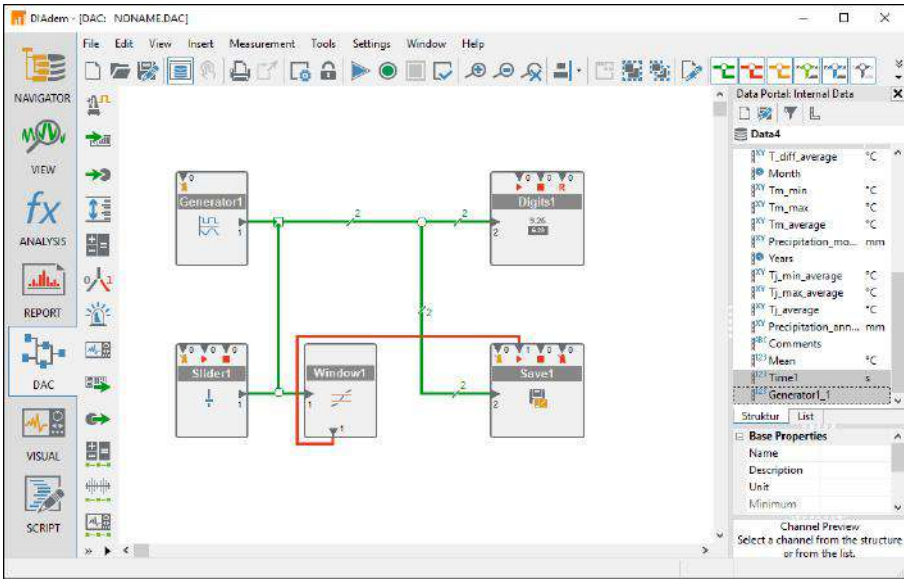
- a. Enter the lower limit -5 and the upper limit 5 in the signal list, as shown in Figure 7-3.
- b. Select `Window exit` as the **Window Type**.

**Figure 7-3. Setting the Window Condition**



- c. Click **OK**.
7. Click the data bus between the **Slider1** and **Window1** blocks and drag a new bus onto the green bus between the **Generator1** and **Digits1** blocks.  
The 2 at the input of the numeric display indicates that two signals now reach the block on this data bus.
  8. As shown in Figure 7-4, drag a line from the output at the bottom of **Window1** to the input with the red triangle at the top of the **Save1** block.  
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 7-4.** Extended Block Diagram with Slider Control and Window Condition

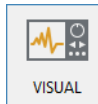


## Visualizing Measurements

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

To design the visualization complete the following steps.

1. Switch to **DIAdem VISUAL**.



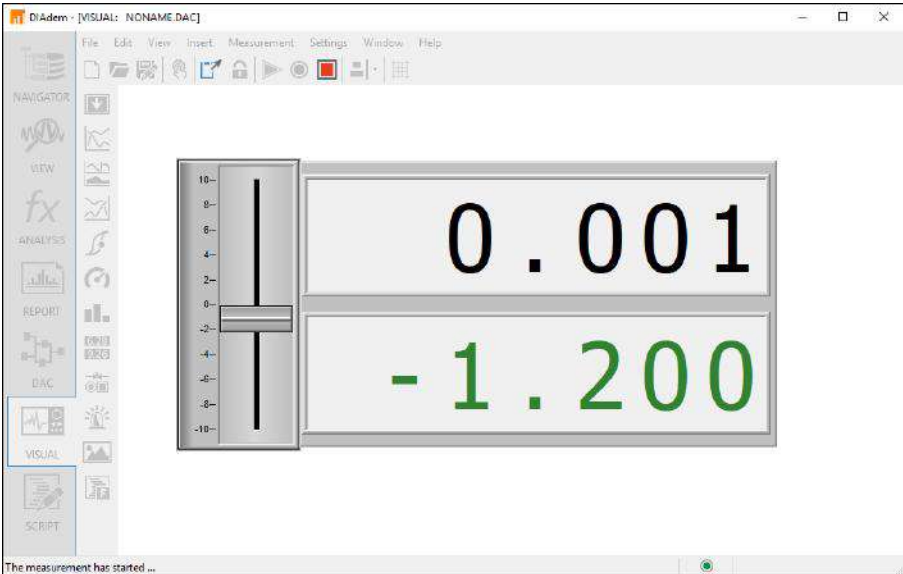
The instruments Slider Control and Digit Display are positioned on top of each other at the top left of the display area of DIAdem VISUAL.

2. Position the two instruments next to each other.

3. Select both instruments.
  - a. Click **Orientation** on the group bar and select **Vertical**.
  - b. Click in the workspace to deselect it.
4. Click **Start Measurement**.
5. Drag the slider control up and down.

As soon as you leave the specified window range between  $-5$  and  $+5$  with the slider, DIAdem starts to save the measured values. Figure 7-5 shows the visualization.

**Figure 7-5.** Visualization with Input Instruments and Display Instruments



6. Click **Stop Measurement** or wait until DIAdem has recorded the specified 1,000 values and created new channels in the Data Portal.

To save the block diagram, click **Save Block Diagram As**.

# Summary

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The summary provides an overview of the topics discussed in this chapter. It also includes additional information.

## DIAdem DAC

You use DIAdem DAC to describe measurement and control tasks in a block diagram. Select function blocks from the various function groups and connect the function blocks with the mouse. When you start a measurement, DIAdem opens the VISUAL panels and runs the visualization.

## Data Acquisition

The blocks on the **Inputs** function group represent data sources in DIAdem DAC, such as A/D converter boards, front-end devices, and other external measuring devices. You register the corresponding drivers in DIAdem DAC and connect the signal inputs and signal outputs. Additional data sources can be input instruments, data files, and calculation results.

## Signal Buses

Signal buses connect the function blocks and transport signals. Connect signal buses to the signal inputs and to the signal outputs on a function block. You can connect these buses with other blocks and also with other buses. To delete a bus, select the bus and press <Del>. DIAdem distinguishes between system buses, control buses, data buses, alarm buses, and text buses.

## DIAdem VISUAL

Select instruments such as gauges, digits, bar display, recorders, or wipers to display the measurement values from the DIAdem VISUAL library. You use input instruments such as switches, dials, or slider controls, to trigger events and control functions during a measurement. When you design a visualization, you can align and connect instruments as you like.

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