



Measurement & Automation Explorer Help for CAN

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This help file describes the NI-CAN software features within National Instruments Measurement & Automation Explorer (MAX). The NI-CAN features within MAX enable you to:

- Verify the installation of your NI CAN and LIN hardware
- Configure software properties for each port
- Create or import configuration information for the Channel API
- Interact with your CAN or LIN network using various tools

To navigate this help file, use the **Contents**, **Index**, and **Search** tabs to the left of this window.

For more information about this help file, refer to the following topics:

[Conventions](#)—formatting and typographical conventions in this help file

[Important Information](#)

[Technical Support and Professional Services](#)

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Conventions

This help file uses the following conventions:

- < > Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, DBIO<3..0>.
- [] Square brackets enclose optional items—for example, [response].
- » The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
-  This icon denotes a tip, which alerts you to advisory information.
-  This icon denotes a note, which alerts you to important information.
- bold** Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes parameter names, emphasis, or an introduction to a key concept.
- green Underlined text in this color denotes a link to a help topic, help file, or Web address.
- italic* Italic text denotes variables or cross references. This font also denotes text that is a placeholder for a word or value that you must supply.
- monospace Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.

CAN and LIN Overview

This topic provides an overview of CAN and LIN concepts.

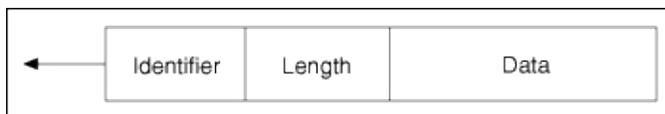
CAN Overview

In the past few decades, the need for improvements in automotive technology has led to increased use of electronic control systems for functions such as engine timing, anti-lock brake systems, and distributorless ignition. With conventional wiring, data is exchanged in these systems using dedicated signal lines. As the complexity and number of devices has increased, using dedicated signal lines has become increasingly difficult and expensive. To overcome the limitations of conventional automotive wiring, Bosch developed the Controller Area Network (CAN) in the mid-1980s. Using CAN, devices (controllers, sensors, and actuators) are connected on a common serial bus.

As CAN implementations increased in the automotive industry, CAN was standardized internationally as ISO 11898.

CAN Data Frame

The data frame is the fundamental unit of data transfer on a CAN network. The following figure shows a simplified view of the CAN data frame.



When multiple CAN devices transmit a frame at the same time, the identifier (ID) resolves the collision. The highest priority ID continues, and the lower priority IDs retry immediately afterward. The ISO 11898 CAN standard specifies two ID formats: the standard format of 11 bits and the extended format of 29 bits.

The ID is followed by a data length code that specifies the number of data bytes in the frame. The length ranges from 0 to 8 data bytes. The ID value determines the meaning of the data bytes.

CAN Remote Frame

In addition to the data frame, the CAN standard specifies the remote frame. The remote frame includes the ID, but no data bytes. A CAN device transmits the remote frame to request that another device transmit the associated data frame for the ID. In other words, the remote frame provides a mechanism to poll for data.

The preceding information provides a simplified description of CAN frames. The CAN frame format includes many other fields, such as error checking and acknowledgement. For more detailed information on the ISO 11898 CAN standard, refer to *Summary of the CAN Standard* in the NI-CAN Help.

LIN Overview

The LIN network uses a Master/Slave approach, comprised of a LIN Master and one or more LIN Slaves. The following figure shows the LIN message frame.



LIN Message Frame

The message header consists of a break used to identify the start of the frame, the sync field used by the slave node for clock synchronization, and an identifier. The identifier (ID) consists of a 6-bit message ID and a 2-bit parity field. The ID denotes a specific message address, but not the destination. Upon reception and interpretation of the ID one slave will begin the message response. The message response consists of 1-8 data bytes of data and an 8-bit checksum.

The sequencing of message frames is controlled by the master and is fixed in a schedule. The schedule may be changed as needed.

The proceeding information provides a simplified description of the LIN message frame. For more details on the LIN message frame and on the LIN specification, refer to *Summary of the LIN Standard* in the NI-CAN Help.

NI-CAN Software Overview

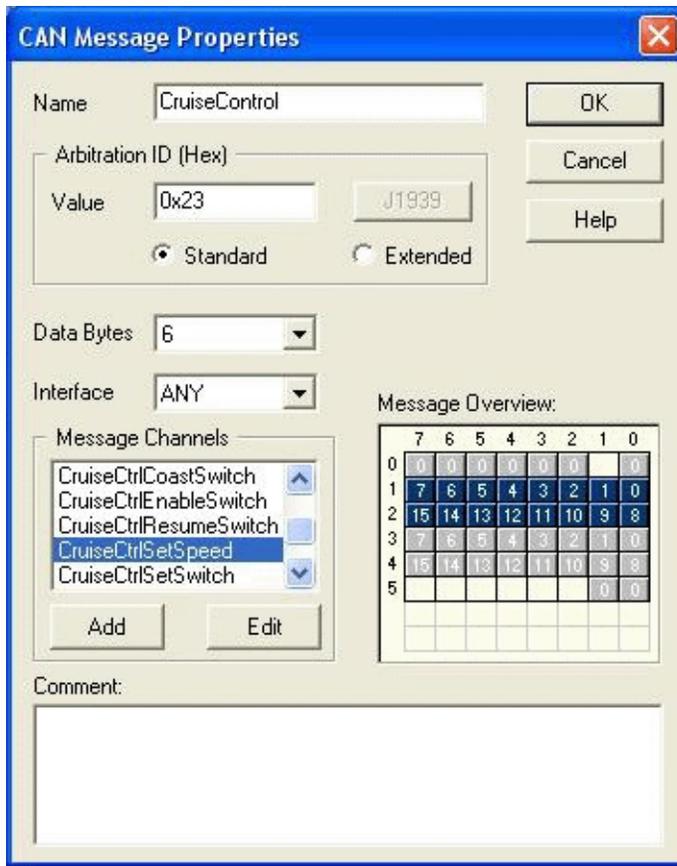
The NI-CAN software provides full-featured Application Programming Interfaces (APIs), plus tools for configuration and analysis within National Instruments Measurement & Automation Explorer (MAX). You can use the NI-CAN APIs to develop applications that are customized to your test and simulation requirements for your CAN and LIN hardware.

Frame API for CAN and LIN

The frame is the fundamental unit of data transfer on a CAN or LIN network. The NI-CAN Frame API provides a set of functions to write and read CAN or LIN frames. Within the Frame API, the data bytes of each frame are not interpreted, but are transferred in their raw format. For example, you can transmit a CAN data frame by calling a write function with the ID, length, and array of data bytes. For more information, refer to the NI-CAN Help at **Help»Help Topics»NI-CAN»Hardware and Software Manual**.

Channel API for CAN

A typical CAN data frame contains multiple values encoded as raw fields. The following figure shows an example set of fields for a 6-byte data frame.



Bytes 1 to 2 contain a **CruiseCtrlSetSpeed** field that represents a vehicle speed in kilometers per hour (km/h). Most CAN devices do not transmit values as floating-point units such as 115.6 km/h. Therefore, this field consists of a 16-bit unsigned integer in which each increment represents 0.0039 km/h. For example, if the field contains the value 25000, that represents $(25000 * 0.0039) = 97.5$ km/h.

Bytes 3 to 4 contain another unsigned integer Vehicle Speed that represents speed in km/h. Bytes 0 and 5 contain various Boolean fields for which 1 indicates "on" and 0 indicates "off."

When you use the NI-CAN Frame API to read CAN data frames, you must write code in your application to convert each raw field to physical units such as km/h. The NI-CAN Channel API enables you to specify this conversion information at configuration time instead of within your application. This configuration information can be imported from Vector CANdb files, or specified directly in MAX.

For each ID you read or write on the CAN network, you specify a number of fields. For each field, you specify its location in the frame, size in bits,

and a formula to convert to/from floating-point units. In other words, you specify the meaning of various fields in each CAN data frame. In NI-CAN terminology, a data frame for which the individual fields are described is called a *message*.

In other National Instruments software products such as NI-DAQ and FieldPoint, an application reads or writes a floating-point value using a channel, which is typically converted to/from a raw value in the measurement hardware. The NI-CAN Channel API also uses the term *channel* to refer to floating-point values converted to/from raw fields in messages. In CAN products of other vendors, this concept is often referred to as a *signal*. When a CAN message is received, NI-CAN converts the raw fields into physical units, which you then obtain using the Channel API read function. When you call the Channel API write function, you provide floating-point values in physical units, which NI-CAN converts into raw fields and transmits as a CAN message.

For more information, refer to the NI-CAN Help at **Help»Help Topics»NI-CAN»Hardware and Software Manual**.

CAN and LIN Hardware

Windows System

National Instruments hardware for CAN is used by both NI-CAN and NI-DNET (DeviceNet) software. National Instruments hardware for LIN is used only by NI-CAN software.

CAN and LIN hardware is displayed under **Devices and Interfaces** in MAX. All NI hardware is installed automatically and displayed when MAX refreshes its configuration. You can refresh MAX by pressing <F5>.

Windows automatically assigns the resources (interrupt number and memory range) for the hardware.

Testing CAN and LIN Hardware

To verify installation of your CAN or LIN hardware, right-click on the CAN or LIN interface, then select **Self-test** in MAX. If the self test passes, the hardware icon shows a checkmark. If the self test fails, the hardware icon shows a ? mark, and the **Test Status** in the right pane describes the problem.

It is also possible to test all CAN and LIN hardware in the system at once by selecting **Tools»»NI-CAN»Test All Local Cards** in the main menu.

Troubleshooting Self Test Failures

The following sections explain common error messages generated by the **Self-test**.

Application In Use

This error occurs if you are running an application that is using the CAN or LIN hardware. The self test aborts to avoid adversely affecting your application. Before running the self test, exit all applications that use NI-CAN or NI-DNET. If you are using LabVIEW, you may need to exit LabVIEW to unload the NI-CAN driver.

Memory Resource Conflict

This error occurs if the memory resource assigned to a CAN or LIN card conflicts with the memory resources being used by other devices in the system. Resource conflicts typically occur when your system contains legacy boards that use resources not properly reserved with the Device Manager. If a resource conflict exists, write down the memory resource that caused the conflict and refer to the documentation for your Windows operating system for instructions on how to use the Device Manager to reserve memory resources for legacy boards. After the conflict has been resolved, run the Self Test again.

Interrupt Resource Conflict

This error occurs if the interrupt resource assigned to a CAN or LIN card conflicts with the interrupt resources being used by other devices in the system. Resource conflicts typically occur when your system contains legacy boards that use resources not properly reserved with the Device Manager. If a resource conflict exists, write down the interrupt resource that caused the conflict and refer to the documentation for your Windows operating system for instructions on how to use the Device Manager to reserve interrupt resources for legacy boards. After the conflict has been resolved, run the Self Test again.

NI-CAN Software Problem Encountered

This error occurs if the Self Test detects that it is unable to communicate correctly with the CAN or LIN hardware using the installed NI-CAN or NI-DNET software. If you get this error, shut down your computer, restart it,

and run the Self Test again.

If the error continues after restart, uninstall NI-CAN and NI-DNET, and then reinstall.

NI-CAN Hardware Problem Encountered

This error occurs if the Self Test detects a defect in the CAN or LIN hardware. If you get this error, write down the numeric code shown with the error, and contact National Instruments.

Configuring CAN and LIN Ports

The physical ports of the CAN and LIN hardware are listed under the hardware's name. To configure software properties for each port, right-click on the port and select **Properties**.

For more information on configuration, refer to [Port Properties Dialog Box](#).

For more information on changing the representation of a CAN card in MAX between NI-CAN and NI-DNET, refer to [Protocol Dialog Box](#).

LabVIEW Real-Time (RT) System

To test and configure PXI CAN cards on a LabVIEW RT system, use the RT Hardware Configuration Utility in **Tools»NI-CAN»RT Hardware Configuration**. The card and port configuration in this utility is similar to **Devices and Interfaces** under Windows. For more information, refer to [LabVIEW RT Configuration](#).

LabVIEW Real-Time (RT) Configuration

LabVIEW RT combines easy-to-use LabVIEW programming with the power of real-time systems. When you use a National Instruments PXI controller as a LabVIEW RT system, you can install a PXI CAN card and use the NI-CAN and NI-DNET APIs to develop real-time applications. For example, you can simulate the behavior of a control algorithm within a CAN device, using data from received CAN messages to generate outgoing CAN messages with deterministic response times.

Installation

As with any other NI product for LabVIEW RT, you download the NI-CAN and NI-DNET software to your LabVIEW RT system using the **Remote Systems** branch in MAX. For more information, refer to the LabVIEW RT documentation.

Hardware Configuration

After you have installed your PXI CAN cards and downloaded the NI-CAN software to your LabVIEW RT system, you need to verify the installation and assign interface names to CAN ports. In the MAX **Tools** menu, select **NI-CAN»RT Hardware Configuration**.

The RT Hardware Configuration tool begins with a dialog that requests your PXI system IP address. Enter the IP address from your original **Remote Systems** configuration, which is the same IP address that you use within LabVIEW. After a connection has been established successfully, subsequent execution of the NI-CAN RT Hardware Configuration tool uses the same IP address. If you need to change the IP address to a different PXI system, select **Server Address** from the **Network** menu.

Within the RT Hardware Configuration tool, if you do not see the installed PXI CAN cards, select **Refresh** from the **View** menu. To perform a self-test for all PXI CAN cards, select **Test All** from the **Test** menu. The status for each card's self-test is displayed in the same manner as the **MAX Devices and Interfaces** branch on your local Windows system.

To assign an interface name to each CAN port, right-click the port and select **Properties**. The resulting properties dialog is the same as the [Port Properties Dialog Box](#) on your local Windows system.

Using NI-CAN Channels

To use the NI-CAN Channel API on your LabVIEW RT system, you must download channel configuration information. Within the **Data Neighborhood** branch in MAX, right-click on **CAN Channels** and select **Send to RT System**.

What to Send

By default, the current channel configuration in MAX is sent to the RT system. If necessary, you can also send channel configurations that you previously saved to a file.

Where to Send

The configuration is sent using an FTP connection to the RT system. The IP address (or machine name) is required for the connection. Enter the IP address from your original Remote Systems configuration, which is the same IP address that you use within LabVIEW.

If your PXI system is configured for password protection, you must provide the FTP user and password. If no password protection is configured, you can leave the FTP user and password blank.

There is no destination file required for the configuration. Within your LabVIEW RT application, you can access the channels without using a file prefix for the **Channel API Get Names** function or **Initialize** function.

Port Properties Dialog Box

Use this dialog box to configure the interface and the baud rate for a port.

Interface

In the **Properties** dialog, you assign an interface name to the port, such as CAN0 or CAN1. The interface name identifies the physical port within NI-CAN APIs. The **Properties** dialog also contains the default baud rate for MAX tools and the Channel API.

Interfaces previously assigned to other physical ports are marked with an asterisk in the list box. If you select an interface used by another port, the other port is reassigned to the first unused interface.

Baud Rate

The baud rate in this dialog is the default value for applications that use the Channel API and for the MAX tools. You can also use the Channel API Set Property function to set the baud rate within your application. Applications with CAN that use the Frame API must set the baud rate using the `ncConfig` function. Applications with LIN that use the Frame API must set the baud rate using the `ncSetAttribute` function.

Use the **Baud Rate** drop box to select from a list of commonly used baud rates.

By selecting the **Advanced** button for CAN hardware, you have full control over the bit timing registers. There are two 8-bit registers, BTR0 and BTR1. The calculations for the bit timing registers use a clock of 8 MHz for the Baud Rate Prescaler (BRP). The user can use one of the following methods to set the registers:

- **Edit Bit Timing Register Value (BTR0, BTR1)**

This method is recommended when you know the required register values.

- **Edit Segments of Bit Timing Register**

This method is recommended when you want to change a particular field in the registers.

- **Baud Rate...**

This button opens a window to view the register values (BTR0 and BTR1) for a given baud rate.

The baud rate is corrected to the nearest possible value. For example, 85 kBaud will be changed to 84.211 kBaud. The values for SJW and SPL do not affect the baud rate. After creating a list, you can pick one of the values and select **Use** to use those BTR values as your baud rate setting.

By selecting the **Advanced** button for LIN hardware, you can enter any value from 2400 to 20000 baud. For information on the actual baud rate calculated, refer to the `ncSetAttribute` function within the Frame API section of your *NI-CAN Hardware and Software Manual*.

Transceiver

This selection is available only for XS CAN cards. National Instruments XS CAN cards contain multiple transceivers for each CAN interface, and the transceiver is selected by software. For more information on XS CAN cards, refer to the NI-CAN Help at **Help»Help Topics»NI-CAN»Hardware and Software Manual**.

The transceiver type in this selection is the default value for applications that use the Frame API or Channel API. This transceiver type is switched into use when your application opens or initializes the specified interface. You can also change the transceiver type within your application, using **Set Attribute** in the Frame API and **Set Property** in the Channel API.

FP-1300 Config

FieldPoint 1300 is the National Instruments modular I/O product for CAN. If you have installed the software for the FP-1300 product, the configuration tool appears in the CAN port right-click menu. To start the FP-1300 Config tool, right-click on a CAN port and select **FP-1300 Config**.

To open help for the FP-1300 Config tool, click on **Help** in the tool's main menu.

Bus Monitor

The Bus Monitor is a tool for monitoring data transfer on a particular CAN or LIN bus. To start the Bus Monitor, right-click on a CAN or LIN port (a sub-item of a card under **Devices and Interfaces**) and select **Bus Monitor**.

The Bus Monitor offers several functions, including:

- Listing of bus traffic
- Display of all data bytes of all transmitted frames on the bus
- Statistics about the appearance of all frames
- Logging of all or single frames

Main Window



Tip The main window can be resized by grabbing and dragging the right bottom corner of the window, or even maximized to occupy the full screen.

MAX Port Settings

Interface and **Baud Rate** display values assigned in MAX to the port. You cannot change them in the Bus Monitor. To change the values, exit the Bus Monitor, right-click on a port in MAX, and select **Port Properties**. After changing the values, restart the Bus Monitor.

Update Rate

Update Rate is the rate at which the Bus Monitor updates (in milliseconds).

Bus Load

Bus Load is a calculation of the amount of bus traffic measured on the selected interface. The calculation is shown as a percentage (%) ranging from 0 to 100%. The only frame types included in the calculation are **data** and **remote**.

This feature is only for available for CAN hardware.

Listen Only

This checkbox is available for CAN Series 2, 847x CAN, and 847x with Sync CAN hardware. When checked, the interface receives frames in a passive manner and does not transmit acknowledgements.

CRC Type

This selection allows you to use **Classic** or **Enhanced** CRC (Checksum) type. This attribute applies only to the USB-8476 and USB-8476s LIN hardware.

Start and Stop Button

The button shows **Stop** when the monitoring is running. You can press it to stop receiving and displaying frames in the list. The button shows **Start** when the monitoring is not running. When the Bus Monitor is launched from MAX, it starts in running mode.

List of Received Messages

The list contains the following information:

- **Arb. ID:** For CAN, the Arbitration ID (standard 11-bit or 29-bit ID) of the CAN frame. Remote frames are denoted with an *R*. Extended frames (29-bit ID) are denoted with an *. For LIN, this field contains the 6-bit ID of the LIN frame.
- **Length:** Number of bytes in the frame
- **Data:** Data bytes contained in the frame
- **Time Stamp:** The timestamp of the most recent frame
- **Rate:** Transmission rate of the frame (in Hertz)
- **dt Min:** Minimum delta time between two frames of the particular Arbitration ID
- **dt Max:** Maximum delta time between two frames of the particular Arbitration ID
- **# (total):** Number of transmitted frames since start

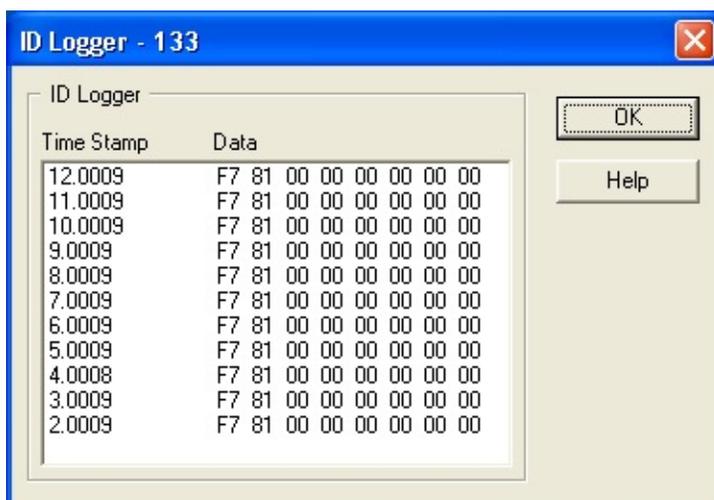


Note You can set the resolution of the timestamps and dt Min and dt Max to either seconds or milliseconds in the **Options** dialog.

ID Logger Window

If you double click on a specific row of a message ID, an additional window called ID Logger pops up.

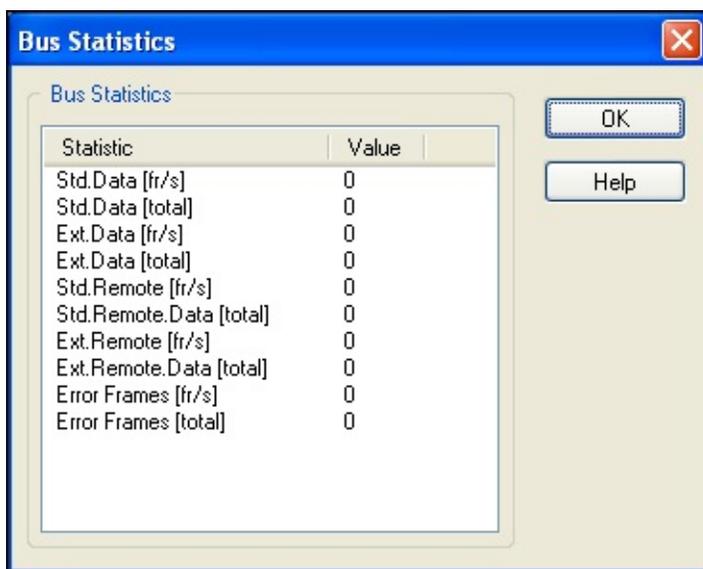
The ID Logger window logs all messages related to the selected ID. Displayed are the time information (when the message was received on the CAN or LIN port) and the message data.



Bus Statistics Button

This button opens another dialog box which displays current bus operation information. For CAN hardware the following statistics are displayed:

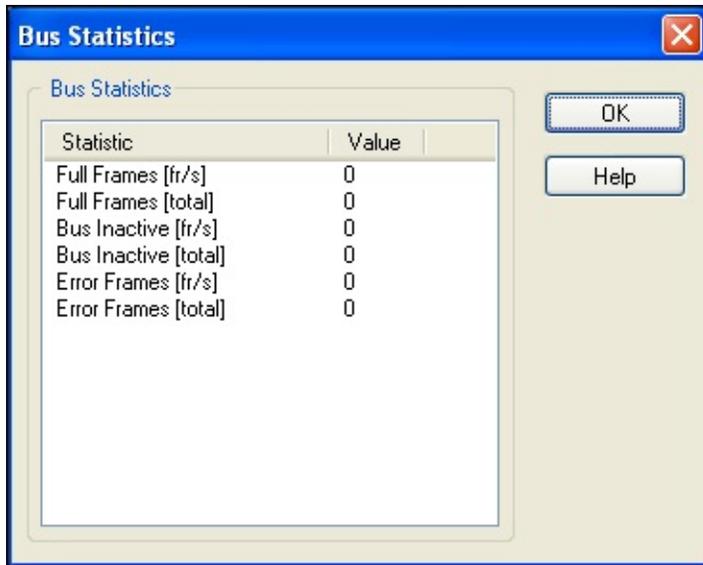
- **Std.Data:** Data frames with an 11-bit Arbitration ID
- **Ext Data:** Data frames with a 29-bit Arbitration ID
- **Remote:** Remote frames
- **Error Frames:** Error frames
- **Fr/s:** Frames per second
- **Total:** Number of received frames since Bus Monitor was started



Statistic	Value
Std.Data [fr/s]	0
Std.Data [total]	0
Ext.Data [fr/s]	0
Ext.Data [total]	0
Std.Remote [fr/s]	0
Std.Remote.Data [total]	0
Ext.Remote [fr/s]	0
Ext.Remote.Data [total]	0
Error Frames [fr/s]	0
Error Frames [total]	0

For LIN hardware the following statistics are displayed:

- **Full Frames:** Full frames
- **Bus Inactive:** Bus inactive frames
- **Error Frames:** Error frames
- **Fr/s:** Frames per second
- **Total:** Number of received frames since the Bus Monitor was started



Error Details

The error code indicates the current status of NI-CAN function calls. Click on **Error Details** to see an explanation of the error code.

Options

This button is disabled when the Bus Monitor is running. To change the options, press the **Stop** button.

Options Window

Attributes

Attributes changes the display options for messages in the list and in the **Disk Streaming** file.

- **Arb ID**

You can display the Arbitration ID of a frame in decimal or hexadecimal format.

- **Time Stamp**

You can display the time stamping of the received frames either in seconds since the start of the scan or **Time of Day** in the format hh:mm:ss.

- **Dist Min/Max**

This selection allows you to display **dt Min** and **dt Max** either in seconds or milliseconds.

- **Error Frame Detection**

This selection specifies whether to log bus errors when the interface detects a bus error. Error frame detection is not supported by Series 1 hardware. For more information on error frame detection for CAN and LIN interfaces refer to the documentation on the **Log Bus Errors?** attribute in your *NI-CAN Hardware and Software Manual*.

Stream to Disk

This selection activates the disk streaming feature. You can use **Stream to Disk** to write frames to a file. **Stream to Disk** stores all received frames or frames with a particular ID to a file.

File Name...

File Name... specifies the filename and the file target directory. The filename can have either a .CSV (comma-separated value), or a .NCL (NI-CAN logfile), extension. The .CSV extension saves the logged data in ASCII format. Typically, .CSV files are used with Microsoft programs like MS Excel. The .NCL extension saves the logged data in binary format. For more information on the .NCL extension, refer to the NI-CAN Logfile specification. The default file extension is .CSV.



Note When logging to a .NCL file, the start trigger frame is always logged. Refer to the *NJ-CAN Hardware and Software Manual* for details on the start trigger frame format.

For **Multi Files** (see below), this specifies the filename root. All files share the same name root; the remaining filename characters (up to four) are replaced by numbers that increment by one from file to file.

Disk Streaming

This option allows you to choose to **Stream All Frames** to the file or to **Stream Single Frame** with a specified arbitration ID.

Separator

You can select tab, semicolon, or comma as the ASCII field delimiter.

Multi File

Use this option to write data to a series of separate files.

Check the **Multi File** option first to enable the other options

The advantage of using the **Multi File** option is that the history of a long run can be retrieved and the concern of having data overwritten is eliminated.

Chain Filename Series

If you select this option, the program searches the filename list in the specified directory for the file with the highest number. The first file number in the new series is the next number after the highest number in the preceding series.

The module checks the chosen directory's contents when the scan starts and generates a new file right after the oldest existing file. Older files are not overwritten.

If you do not select this option, the file numbering restarts when you generate new files. Existing files are overwritten.

Filename Numbering

You can specify the number of digits to append to the filename. The limit is four digits.



Note Because the four-digit selection can possibly create up to 10,000 files, we recommend using digits 1 to 3.

File Numbers

You can enter the following items to name the file and begin the disk streaming procedure:

- **First File No**

This entry determines the first number assigned in the file list. The value allowed here depends on the number of digits specified in **Filename Numbering**: 0, 00, 000, or 0000.

- **Last File No**

This entry determines the last number assigned in the file list. The value allowed here depends on the number of digits specified in **Filename Numbering**: 9, 99, 999, or 9999.

- **Stop after Last File**

If you set this option, disk streaming stops after the file with the last file number is written.

- **Restart after Last File**

Use this option to stream to file in a cyclical fashion. If you check this box and the last possible file is written, the list starts again with file number 0. The value allowed here depends on the number of digits specified in **Filename Numbering**: 9, 99, 999, or 9999.

- **File Switch Condition**

This value determines the amount of data (in kilobytes) written to each file. After this amount of data has been written to one file, next file is generated automatically.

Message Properties Dialog Box

To create a message, right-click **CAN Channels** in **Data Neighborhood** and select **Create Message**. Configure each property of a message using the information in the sections below. For information about changing properties for multiple messages at once, refer to [Changing Properties of Multiple Messages or Channels](#).

Name

The message name can contain up to 64 characters. The message names must be unique in MAX. The message name must not contain a colon (:), period (.), or comma (,).

Arbitration ID

The arbitration ID is the identifier for the CAN message. The standard format contains 11 bits, the extended format 29 bits. You can display the arbitration ID in hexadecimal or decimal by right-clicking on **CAN Channels** and selecting **Options**. In hexadecimal mode, the display has a 0x prefix, but it is not necessary to enter this prefix before the ID.

J1939

The J1939 button is only enabled when selecting **Extended Frame Format**. MAX provides a dialog for editing Extended CAN IDs conforming to the J1939 standard.

Data Bytes

Number of data bytes in the message. A message can contain 1 to 8 data bytes.

Interface

Default interface to be used for this message. If the interface is not provided to the Channel API Initialize function, this default interface is used. If the interface is ANY in MAX, it implies that no interface has been assigned and an interface must be provided to the Initialize function.

Message Channels

The message channel list contains the names of all channels associated with this message. You can add a channel to the message by clicking the **Add** button or change the properties of an existing channel by clicking the **Edit** button.



Note When you are creating a message using the **Create Message** menu selection, you cannot add channels to the message using the **Add** button, as the message does not exist yet. After the message is created, you can add channels by right-clicking on the message, selecting **Properties**, and using the **Add** option to add the desired channels.

Message Overview

The message overview window displays the message with all contained channels graphically. The vertical axis describes the byte number, starting with 0 for the first byte. The horizontal axis describes the bit number of the byte starting with 0 for the least significant bit in the byte. Bytes not available in the message are dimmed.

A channel can start in any valid bit of the message. The channel bits are numbered beginning with 0 for the least significant bit.

The channels are shown in the **Message Overview** using alternating colors.

Clicking on any bit in a channel highlights the channel and selects the channel name in the list box. Clicking again outside of any channel returns to the alternating colors view.

Overlapping bits of two channels are highlighted by red crosses. A red indicator above the message overview indicates an error condition. An error also occurs when the channel bits exceed the 64-bit range of a message. In such an event, the bits are not displayed, but you can recognize the error condition by the red indicator.

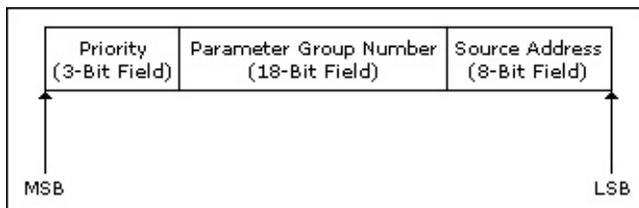
Comment

Contains any comment for documentation purposes. The maximum size of the comment is 1024 characters.

SAE J1939 Arbitration ID

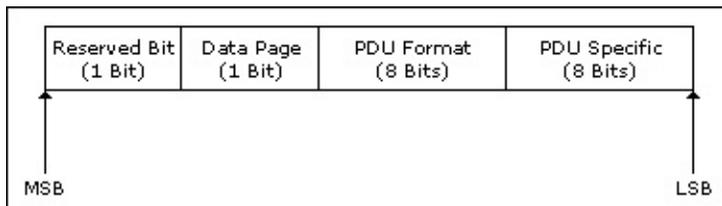
J1939 is a high-speed, Class C type communications network designed to support real-time closed loop control functions between electronic control devices, which may be physically distributed throughout the vehicle.

The J1939 protocol typically uses the 29-bit or the extended format for the arbitration IDs. As shown in the following figure, the arbitration ID comprises of the Priority (first 3 bits), Parameter Group Number (PGN) (18 bits), and the Source Address (8 bits).



29 Bit Arbitration ID

Most messages on J1939 are intended to be broadcast. This means the data is transmitted on the network without directing it to a specific destination. This permits any device to use the data without requiring additional request messages. However, by modifying the PGN, you can direct messages to a specific address (destination address). As shown in the following figure, the PGN comprises of a reserved bit (first bit), data page (1 bit field), PDU (Protocol Data Unit) format (8 bit fields), and the PDU specific field (8 bit fields). PDU specific fields can either represent a group extension or a specific destination address depending on the value of the PDU format fields. For example, for PDU formats between 240 and 255, the PDU specific field denotes a group extension. For PDU formats less than 240, the PDU specific field denotes a destination address.



Parameter Group Number

For a detailed description of the J1939 terminology, refer to the SAE J1939 specifications.

SAE J1939 Arbitration ID Dialog Box

You can invoke this dialog box from the **Message Properties** dialog box. It is available only when the **Arbitration ID** mode is set to **Extended**.

The dialog box shows the arbitration ID in the format of SAE J1939 higher layer protocol. For more information, refer to [SAE J1939 Arbitration ID](#).

Priority

You can set Priority to a value between 0 and 7. This field determines the priority of the message on the bus. You can set the priority of any message from highest (0) to lowest (7).

Source Address

An 8-bit field that contains the identifier of the device or source sending the message. There should be only one device with a given source address.

You can set Source Address to a value between 0 and 255.

Parameter Group Number (PGN)

Represents one or more parameters where a parameter is a piece of data such as Engine RPM. The PGN identifies or labels commands, data, requests, acknowledgements, and negative acknowledgements.

You can edit the PGN in two modes by selecting either **Edit as Number** or **Edit as PGN Segments**. The PGN is displayed in decimal or hexadecimal depending on the setting for the arbitration ID in **Options** dialog box. When using hexadecimal mode, The PGN is displayed with 0x prefix. However, it is not necessary to enter the prefix when entering the value.

When the **Edit as PGN Segments** option is selected to edit the PGN, the various component fields are enabled.

Segments of the PGN are always displayed and entered in decimal format.

Reserved Bit

This bit is currently reserved for future use by the SAE. To comply with SAE J1939, you must set this bit to zero.

Data Page

The data page bit selects an auxiliary page of Parameter Group descriptions. Assignment of all PGNs available in page zero is complete (filled) before the page one assignments are made.

PDU Format

This is an 8-bit field within the PGN that determines the format of a Protocol Data Unit (PDU). It determines whether the message is a broadcast message or directed to a specific address.

PDU Specific

This is an 8-bit field within the PGN that becomes either a Group Extension ID or a Destination address depending on the value of the PDU Format.

Resulting ID

The ID is displayed in decimal or hexadecimal format depending on the setting in the **Options** dialog box.

CAN Channel Properties Dialog Box

To create a channel, right-click on a message in **CAN Channels** and select **Create Channel**. Configure each property for a channel by using the information in the sections below. For information about changing properties for multiple channels at once, refer to [Changing Properties of Multiple Messages or Channels](#).

Channel Name

The channel name can contain up to 64 characters. The channel name must be unique in the message. The name must not contain a colon (:), period (.), or comma (,).

If the channel name is not unique in MAX (that is, at least two messages contain a channel with the same name), the message name must also be specified in the channel string passed to the Channel API Initialize function. For example, if two messages (Message1 and Message2) have a channel with the same name (ChannelX), in the Channel API, the channel is referenced as "Message1.ChannelX" or "Message2.ChannelX".

Start Bit

Start Bit specifies the location of the least significant bit (bit 0) of the channel. The number starts at the least significant bit of the first byte. The maximum bit number allowed in a message containing n bytes is $(8*n)-1$.

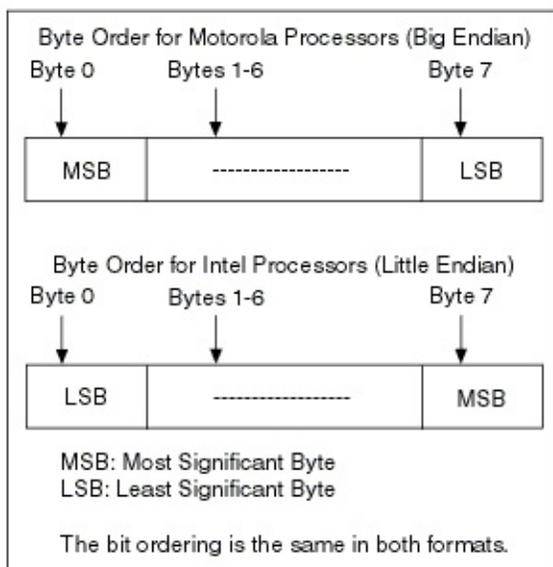
No. of Bits

No. of Bits is the number of bits used for this channel.

Byte Order

Byte Order defines how the bytes of the channel are placed in the message.

As shown in the following figure, Motorola format stores the high-order byte at the starting address, while the Intel format stores the low-order byte at the starting address. The low-order byte contains the bits for the lowest possible values (that is, 0-255), while the high-order byte contains the bits that specify the large values (that is, 256-65535 in a short integer).



Example: Intel Format

The following figure shows the Intel format for a channel with Start Bit=0 and Number of Bits=32.

	7	6	5	4	3	2	1	0
0	7	6	5	4	3	2	1	0
1	15	14	13	12	11	10	9	8
2	23	22	21	20	19	18	17	16
3	31	30	29	28	27	26	25	24
4								
5								
6								
7								

Example: Motorola Format

The following figure shows the Motorola format for a channel with Start Bit=32 and the Number of Bits=32.

	7	6	5	4	3	2	1	0
0								
1	31	30	29	28	27	26	25	24
2	23	22	21	20	19	18	17	16
3	15	14	13	12	11	10	9	8
4	7	6	5	4	3	2	1	0
5								



Note Vector's CANdb Editor supports Motorola Forward and Motorola Backward byte order. Motorola Backward is the same as Motorola Forward, except that the Start Bit counts from the last bit of the message. When you import Motorola Backward channels from a CANdb file, MAX converts the Start Bit to Motorola Forward conventions.

Data Type

Data Type defines how the bits in the channel are interpreted. **Unsigned** type can represent only positive integer values, **Signed** type can represent positive and negative integers, and **IEEE Float** can represent any number with 7 or 15 significant decimals (32 or 64 bit).

Scaling Factor and Offset

You can use **Scaling Factor and Offset** to convert the raw data in a message to or from scaled floating-point units.

You can linearly scale the raw data in the message by using the formula $y = a*x + b$, where a represents the scaling factor and b the scaling offset. x is the value the channel bits represent according to the data type, and y is the resulting scaled channel value.

Scaling can change the range of values the **Data Type** represents.

Minimum and Maximum Value

The **Maximum** and **Minimum** values are used to set the range for the floating-point units of the channels.

The Channel API CAN Read and CAN Write functions do not coerce samples when converting to or from CAN messages.

Default Value

Default Value configures the default value of the channel in scaled floating-point units.

In the Channel API CAN Read function, the default value is returned if no message is received since the start of the application.

In the Channel API CAN Write function, default values are written for channels not specified in the task of the Initialize function.

Refer to the descriptions of the CAN Read and CAN Write functions in the NI-CAN Help at **Help»Help Topics»NI-CAN»Hardware and Software Manual** for further information.

Unit

Unit configures the channel unit string. The string is no more than 64 characters in length. You can use this value to display units (such as volts or RPM) along with the channel's samples.

Comment

Comment contains any comment for documentation purposes. The maximum size of the comment is 1024 characters.

Changing Properties of Multiple Messages or Channels

This topic deals with configuring multiple messages or properties at once. To configure each property of a single message individually, refer to the [Message Properties Dialog Box](#) topic. To configure each property of a single channel individually, refer to the [CAN Channel Properties Dialog Box](#) topic.

Right-click on **CAN Channels** in the MAX Configuration tree.

To change the properties of multiple messages, select the **All Messages** tab at the bottom of the right window. Specify messages by pressing <Ctrl> while selecting in the right window, then right-click and select **Change Common Properties**. Select the checkbox next to each property you want to change, then specify the new value for all messages. Select **OK** to change the selected properties for all selected messages.

To change the properties of multiple channels, select the **All Channels** tab at the bottom of the right window. Specify channels by pressing <Ctrl> while selecting in the right window, then right-click and select **Change Common Properties**. Select the checkbox next to each property that you want to change, then specify the new value for all channels. Select **OK** to change the selected properties for all selected channels.

Test Panel

With the Test Panel, you can read or write channel data for testing purposes.

To start the Test Panel, right-click on a channel in MAX and select **Test Panel** from the menu.

Interface

Use the **Interface** selection to determine which CAN interface to use for read or write of the channel. The Test Panel must be stopped using the **Stop** button to change the Interface.

The USB-847x CAN and LIN interfaces do not support direct reading and writing of channel data, and are not accessible through the Test Panel. If your CAN application requires channel access, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*, in the *NI-CAN Hardware and Software Manual*.

Listen Only

This checkbox is available only for Series 2 hardware and only within the **Read** tab. When checked, the interface receives frames in a passive manner and does not transmit acknowledgements.

Read Tab

The Test Panel starts in read mode using the interface assigned to the message. The default sample rate is 1000 Hz. You can change the sample rate only after clicking on the **Stop** button to stop the reading.

Sample Rate

The sample rate specifies the rate at which CAN data is copied into the waveform. The value of every sample is set to the most recent value received on the channel for that time.



Note When no data is received on the channel, the Default Value specified in Channel Properties is displayed for the channel. At such an event, the error indicator is yellow, indicating an old data warning (error code 0x3FF62009). This means the new displayed data does not contain any new information.

Scaling

You can set the chart to Fixed Scaling or Auto Scaling mode. In the Fixed Scaling mode, the maximum and the minimum values set in Channel Properties are used. When the user does not change the maximum and minimum values, the Test Panel uses the default range of 0 to 10. In Auto Scaling mode, the chart range is adjusted during run time to display the chart in the best possible way.

Error Indicator

The error indicator is gray when no errors are detected. Yellow indicates a warning. A warning does not stop the reading or writing. Red indicates an error, and the reading or writing is stopped. For more details on a warning or error, click on the **Details** button below the indicator.

Write Tab

To change to write mode, click on the tab above the chart display. This is possible only when you stop the reading. With the pointer slide, you can set the value to be written to the channel. For Boolean values (using one bit in the message), a switch is used instead of a slide.

For other channels in the message, the Default Value set in the **Channel Properties** dialog box is written.

The CAN messages are written at the sample rate set on the left side of the panel. If a sample rate of zero is selected, frames are transmitted by clicking on the Send button. This is the default. For nonzero sample rates, the frames are transmitted periodically, and the Send button disappears. If the sample rate is too high—depending on the baud rate, message size, and bus traffic—error 0xBFF62102 is displayed indicating that a sample rate or duration is too large or too small.

Duplicate Message Dialog Box

To duplicate a message in MAX, right-click on the message under **CAN Channels** and select **Duplicate**. In the dialog box you can change the name, arbitration ID, interface, and comment. The duplicated message contains all channels of the original message.



Note All channel names in the duplicated message become ambiguous. In the Channel API Initialize function, you must specify the channel name as <message name>.<channel name> to avoid name conflicts.

Saving Channels in NI-CAN Database File

You can save messages and channels defined in MAX to a file. This option facilitates moving channel configuration information stored in a file to another computer. The files are always saved with a .ncd (NI-CAN Channel Definition) extension.

To save all messages and channels from MAX to a file, right-click on **CAN Channels** in the MAX Configuration tree and select **Save Channel Configuration**.

To save selected messages from MAX to a file, right-click on **CAN Channels** in the MAX Configuration tree and select the **All Messages** tab at the bottom of the right window. Specify messages by pressing <Ctrl> while selecting in the right window, then right-click and select **Save Selected Messages**.

Loading Channels from NI-CAN Database File

To load channels previously saved to a NI-CAN database file (.ncd), right-click on **CAN Channels** in **Data Neighborhood** and select **Load Channel Configuration**. The operation starts with an **Open File** dialog box. After selecting a file and clicking on the **Open** button, the messages contained in the file are displayed alphabetically sorted in the list box.

For performance reasons, you should load only messages required for the application into MAX. To select a message in the list, click on the message name. Channels contained in the message are displayed on the right side. Clicking on the **Load** button copies the message and associated channels into MAX. The dialog box remains open until you click on **Done**, so you can select and load multiple groups of messages.

Selecting Multiple Messages

Left-click on the first message, hold down the mouse button, and move the cursor up or down to select several messages.

To select messages individually, hold down <Ctrl> and click on the messages.

Loading All Messages from the File

To load all messages, select **Add all Messages and Channels**.

Message Name Prefix

MAX does not allow defining two messages with the same name. If the selection contains messages with names already defined in MAX, a dialog box appears to resolve name conflicts before the messages are copied to MAX. To resolve name conflicts, prepend a prefix to all imported messages. After entering the prefix, the user can click on the **Check** button to verify whether the name conflict has been resolved. The prefix is added to all imported messages, not only the message that caused name conflicts.

If the name conflicts are not resolved when you click on the **OK** button, the existing messages with the same name are overwritten. The user is asked to overwrite every message or, by clicking on **Yes to All**, to allow all following messages to be overwritten without further questions.

Loading another NI-CAN Database File

By clicking on the [...] button, you can load another .ncd file into the dialog box to load messages and channels from it without leaving the dialog box.

Importing from CANdb File

MAX can import messages and channels from a CANdb (.dbc) file. Right-click on **CAN Channels** in **Data Neighborhood** and select **Import from CANdb File**. The operation starts with an **Open File** dialog box. After selecting a file and clicking on the **Open** button, the messages contained in the file are displayed alphabetically sorted in the list box.

For performance reasons, you should import only messages required for the application into MAX. To select a message in the list, click on the message name. Channels contained in the message are displayed on the right side. Selecting **Import** copies the message and associated channels into MAX. The dialog box remains open until you click on **Done**, so you can select and import multiple groups of messages.

Selecting Multiple Messages

Left-click the first message, hold down the mouse button, and move the cursor up or down to select several messages.

To select messages individually, hold down <Ctrl> and click on the messages.

Importing All Messages from the File

To import all messages, select **Add all Messages and Channels**.

Message Name Prefix

MAX does not allow defining two messages with the same name. If the selection contains messages with names already defined in MAX, a dialog box appears to resolve name conflicts before the messages are copied into MAX. Name conflicts are resolved by prepending a prefix to all imported messages. After entering the prefix, click on the **Check** button to check if the conflict has been resolved. The prefix is added to all imported messages, not only to the message that caused name conflicts.

If the name conflicts are not resolved when you click on the **OK** button, the existing messages are overwritten. The user is asked to overwrite every message or, by clicking on **Yes to All**, to allow all following messages to be overwritten without further questions.

Importing another CANdb File

By pressing the [...] button, you can load another CANdb file into the dialog box to import messages and channels from it without leaving the dialog box.

Deleting Messages or Channels

To delete all messages and channels from MAX, right-click on **CAN Channels** in the MAX Configuration tree and select **Delete All Channels**.

To delete a single message or channel, right-click on the message or channel and select **Delete**.

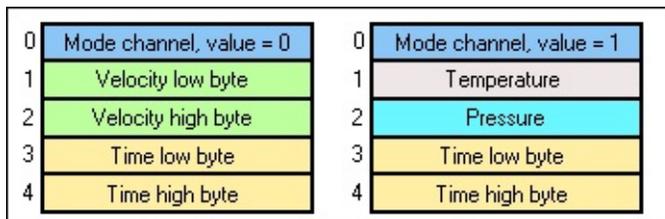
To delete multiple messages, right-click on **CAN Channels** in the MAX Configuration tree. Select the **All Messages** tab at the bottom of the right window. Specify messages by pressing <Ctrl> while selecting in the right window, then right-click and select **Delete Selected Messages**.

To delete multiple channels, right-click on **CAN Channels** in the MAX Configuration tree. Select the **All Channels** tab at the bottom of the right window. Specify channels by pressing <Ctrl> while selecting in the right window, then right-click and select **Delete Selected Channels**.

Mode-Dependent Channels in MAX

Mode-dependent channels allow a portion of a message to be used for different information. The information contained in the portion of the message depends on a mode channel value. Channels valid only on certain mode value are called *mode-dependent channels*.

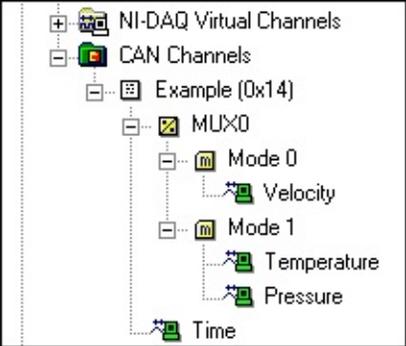
For example, Byte 0 in the 5 byte message is the mode channel. When byte 0 contains the value 0, byte 1 and 2 contain a 16 bit intel signed value representing velocity. When byte 0 contains the value 1, byte 0 is an 8 bit unsigned value representing temperature and byte 2 is an 8 bit signed value representing pressure. Bytes 3 and 4 of the message contain time information and are not mode dependent.



To create mode-dependent channels in MAX, complete the following instructions.

1. Right-click on a message and create a multiplexer.
2. Define the properties of the mode channel in the Multiplexer Properties dialog. Click OK when you're finished.
3. Right-click the multiplexer item that appears in the Configuration tree and select Create Mode to define the value of the mode channel (mode value).
4. Right-click a mode item that was created in the configuration tree and select Create Channel to create the channels that are only valid when the mode-channel contains the specified mode value.

The channels of different modes in the same multiplexer may overlap each other. The new mode-dependent channels should appear as objects in the MAX configuration tree, similar to the new channels in the image below.



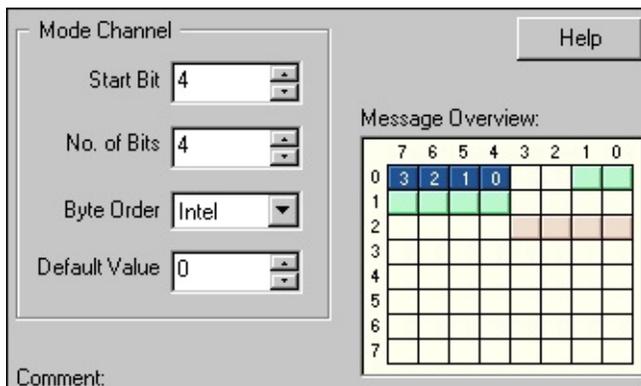
Multiplexer Dialog Box

A multiplexer defines an area within the message which can contain different information (channels) depending on the value of the mode channel (mode value). The mode channel must not overlap other channels within the multiplexer or channels outside of the multiplexer.

The mode channel is defined within the multiplexer dialog box. Mode-dependent channels within the multiplexer are defined by creating mode items on the multiplexer item and channel items on the mode item. The area within the message controlled by the multiplexer is defined by all mode-dependent channels.

The Message Overview window in the Multiplexer Properties dialog box displays channel bits coded by colors:

- The mode channel is displayed with highlighted numbered bits.
- Mode-dependent channels already defined within this multiplexer are green. They are not numbered because one bit can be used by multiple channels.
- Channels outside of the multiplexer are orange. They are not numbered for the same reason.

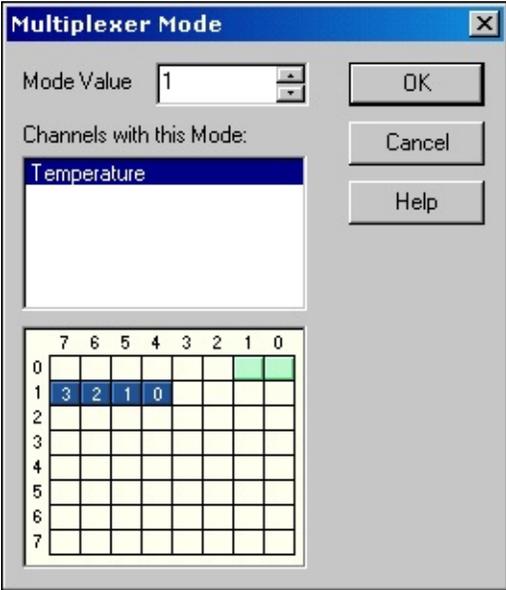


A message can contain more than one multiplexer. Every multiplexer defines its own area in the message. A mode-dependent channel depends always on the value of one mode channel.

Mode Dialog Box

The mode item is created on the multiplexer item. It defines the value of the mode channel. All channels defined within the mode are only valid when the mode channel defined in the multiplexer has the value defined in the mode properties dialog box.

The graphical message overview shows all channels with the mode value as numbered bits. Channels with another mode value in the same multiplexer are green and are not numbered. Channels outside of the multiplexer are not visible in this overview.



Protocol Dialog Box

National Instruments hardware for Controller Area Network (CAN) is used by both NI-CAN and NI-DNET (DeviceNet) software.

You can view each CAN card in MAX with either DeviceNet or CAN features. To change the view of a CAN card in MAX, right-click the card and select **Protocol**. In this dialog, you can select either DeviceNet for NI-DNET, or CAN for NI-CAN.

Use of NI-DNET is restricted to port 1 (top port) of Series 1 CAN cards. The **Protocol** selection is not available for Series 2 CAN cards. When a 2-port Series 1 CAN card is selected as the DeviceNet protocol, only the top port is enabled. For more information on hardware in CAN kits and DeviceNet kits, refer to Chapter 2, *DeviceNet Hardware Overview*, in the *NI-DNET User Manual*.

To develop applications for the NI-CAN or NI-DNET Application Programming Interface (API), you must install API components such as documentation and examples. The software components for both APIs are available within either the NI-CAN or NI-DNET installer. Launch the setup.exe program for the installer in the same manner as your original installation (CD or ni.com download). Within the installer, select both NI-DNET and NI-CAN components in the feature tree.

When you right-click a port in MAX and select **Properties**, the resulting **Interface** selection uses the syntax **CANx** or **DNETx** based on your protocol selection. Regardless of which protocol is selected, the number **x** is the only relevant identifier with respect to NI-CAN and NI-DNET functions. For example, if you select **DNET0** as an interface in MAX, you can run an NI-DNET application that uses **DNET0**, then you can run an NI-CAN application that uses **CAN0**. Both applications refer to the same port and can run at different times, but not simultaneously.

MAX Report Generation

Use the [MAX Report Wizard](#) to generate a report of the NI-CAN hardware and software configuration of the local system. The report includes the following information.

- List of properties for an NI-CAN interface:
 - Protocol
 - Serial Number
 - Series
- List of properties for an NI-CAN port:
 - Interface name
 - Location
 - Transceiver Type (if driver is able to determine it)
 - Transceiver Name (if driver is able to determine it)
 - Baud Rate
 - Sample Point
 - BTR Settings
- CAN channel tables
 - Tables in "NI-CAN Channels" contain all properties which can be configured in MAX/Data Neighborhood/CAN Channels.

By default, the MAX Report Wizard will include any CAN channels listed in MAX. To reduce the MAX report file size, deselect this option when configuring the MAX report.



Note When printing out the MAX report file, depending on paper format and internet browser, the tables can exceed the size of the paper so information may be missing in the printed documentation.

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Belgium	32 0 2 757 00 20
Brazil	55 11 3262 3599
Canada	800 433 3488
China	86 21 6555 7838
Czech Republic	420 224 235 774
Denmark	45 45 76 26 00
Finland	385 0 9 725 725 11
France	33 0 1 48 14 24 24
Germany	49 0 89 741 31 30
India	91 80 41190000
Israel	972 0 3 6393737
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Japan	81 3 5472 2970
Korea	82 02 3451 3400
Lebanon	961 0 1 33 28 28
Malaysia	1800 887710
Mexico	01 800 010 0793
Netherlands	31 0 348 433 466
New Zealand	0800 553 322
Norway	47 0 66 90 76 60
Poland	48 22 3390150
Portugal	351 210 311 210

Russia	7 495 783 68 51
Singapore	1800 226 5886
Slovenia	386 3 425 42 00
South Africa	27 0 11 805 8197
Spain	34 91 640 0085
Sweden	46 0 8 587 895 00
Switzerland	41 56 200 51 51
Taiwan	886 02 2377 2222
Thailand	662 278 6777
Turkey	90 212 279 3031
United Kingdom	44 0 1635 523545
United States (Corporate)	512 683 0100