CAN

NI-CAN™ Hardware and Software Manual

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NATIONAL INSTRUMENTS™

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

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

Worldwide Offices

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Depending on where it is operated, this Class A product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.) Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products.

All Class A products display a simple warning statement of one paragraph in length regarding interference and undesired operation. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

Consult the FCC Web site at `www.fcc.gov` for more information.

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Changes or modifications not expressly approved by NI could void the user's authority to operate the equipment under the FCC Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user is required to correct the interference at their own expense.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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* The CE marking Declaration of Conformity contains important supplementary information and instructions for the user or installer.

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About This Manual

Use the *CAN Hardware and NI-CAN Software for Windows Installation Guide* in the jewel case of the program CD to install and configure the CAN hardware and the NI-CAN software. Use this manual to learn the basics of NI-CAN, as well as how to develop an application.

This manual contains specific programmer reference information about each NI-CAN function and VI.

This manual also describes the hardware features. Unless otherwise noted, this manual applies to the NI CAN Series 2 products, which include the following.

PCI-CAN

- PCI-CAN Series 2 (High-Speed; 1 port)
- PCI-CAN/2 Series 2 (High-Speed; 2 ports)
- PCI-CAN/LS Series 2 (Low-Speed/Fault-Tolerant; 1 port)
- PCI-CAN/LS2 Series 2 (Low-Speed/Fault-Tolerant; 2 ports)
- PCI-CAN/SW Series 2 (Single Wire; 1 port)
- PCI-CAN/SW2 Series 2 (Single Wire; 2 ports)
- PCI-CAN/XS Series 2 (Software Selectable; 1 port)
- PCI-CAN/XS2 Series 2 (Software Selectable; 2 ports)

PXI-846*x*

- PXI-8461 Series 2 (High-Speed; 1 or 2 ports)
- PXI-8460 Series 2 (Low-Speed/Fault-Tolerant; 1 or 2 ports)
- PXI-8463 Series 2 (Single Wire; 1 or 2 ports)
- PXI-8464 Series 2 (Software Selectable; 1 or 2 ports)

PCMCIA-CAN

- PCMCIA-CAN Series 2 (High-Speed; 1 port)
- PCMCIA-CAN/2 Series 2 (High-Speed; 2 ports)
- PCMCIA-CAN/LS Series 2 (Low-Speed/Fault-Tolerant; 1 port)
- PCMCIA-CAN/LS2 Series 2 (Low-Speed/Fault-Tolerant; 2 port)
- PCI-CAN/SW Series 2 (Single Wire; 1 port)

- PCMCIA-CAN/HS/LS Series 2 (1 port High-Speed, 1 port Low-Speed/Fault-Tolerant)
- PCMCIA-CAN/HS/SW Series 2 (1 port High-Speed, 1 port Single Wire)

NI-CAN hardware products that pre-date the Series 2 product line are now referred to as *Series 1*. NI CAN Series 2 products contain several enhancements over Series 1 products, including the Philips SJA1000 CAN controller, improved RTSI synchronization features, updated CAN transceivers, and XS Software Selectable hardware for PCI and PXI. NI-CAN software continues to fully support Series 1 hardware. However, some advanced features are available only with Series 2 hardware. For instance, with PCMCIA, both the card and the cable must be Series 2 to use the advanced features. For a complete description of the differences between Series 1 and Series 2 NI CAN hardware, refer to the *Series 2 versus Series 1* section of Chapter 1, *Introduction*.

To obtain complete documentation of NI CAN Series 1 hardware, refer to the previous version of the *NI-CAN Hardware and Software Manual*, part number 370289E-01, available at `ni.com/manuals`.

Conventions Used in This Manual

The following conventions appear in this manual:

» 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 note, which alerts you to important information.

bold Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. 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.

monospace italic — Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

monospace bold — Bold text in this font denotes the messages and responses that the computer automatically prints to the screen. This font also emphasizes lines of code that are different from the other examples.

Related Documentation

The following documents contain information that you might find helpful as you read this manual:

- ANSI/ISO Standard 11898-1993, *Road Vehicles—Interchange of Digital Information—Controller Area Network (CAN) for High-Speed Communication*
- ANSI/ISO Standard 11519-1, 2 *Road Vehicles—Low Speed Serial Data Communications*, Part 1 and 2
- *CAN Specification Version 2.0*, 1991, Robert Bosch GmbH., Postfach 106050, D-70049 Stuttgart 1
- *CiA Draft Standard 102*, Version 2.0, CAN Physical Layer for Industrial Applications
- *CompactPCI Specification*, Revision 2.0, PCI Industrial Computers Manufacturers Group
- *DeviceNet Specification*, Version 2.0, Open DeviceNet Vendor Association
- *PXI Hardware Specification*, Revision 2.1, National Instruments Corporation
- *PXI Software Specification*, Revision 2.1, National Instruments Corporation
- LabVIEW Online Reference
- Measurement and Automation Explorer (MAX) Online Reference
- Microsoft Win32 Software Development Kit (SDK) Online Help
- SAE J2411, *Single Wire CAN Recommended Practices*

1

Introduction

This chapter provides an introduction to the Controller Area Network (CAN) and the National Instruments products for CAN.

CAN Overview

The data frame is the fundamental unit of data transfer on a CAN network. Figure 1-1 shows a simplified view of the CAN data frame.

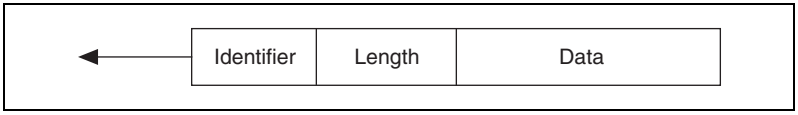


Figure 1-1. Simplified CAN Data Frame

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 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.

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 for error checking and acknowledgement. For more detailed information on the ISO 11898 CAN standard, refer to Appendix B, *Summary of the CAN Standard*.

NI CAN Hardware Overview

This section describes the NI-CAN hardware.

About the NI CAN Series 2 Hardware

NI CAN Series 2 hardware and the NI-CAN software package provide an easy and powerful way to use a desktop or notebook PC to interface to a CAN bus. The hardware features the SJA1000 CAN controller, which is CAN 2.0B compatible and supports a variety of transfer rates up to 1 Mbps. All NI CAN Series 2 hardware uses the Intel 386EX embedded processor to implement time-critical features provided by the NI-CAN software. NI CAN Series 2 hardware supports High-Speed and Low-Speed/Fault-Tolerant physical layers, which fully conform to the ISO 11898 physical layer specification for CAN. In addition, NI CAN Series 2 hardware supports Single Wire CAN.

PCI-CAN Series 2 hardware supports the Real-Time System Integration (RTSI) bus as a way to synchronize multiple interface cards in a system by sharing common timing and triggering signals.

PXI-846*x* Series 2 hardware supports the PXI trigger bus as a way to synchronize multiple interface cards in a system by sharing common timing and triggering signals.

PCMCIA-CAN Series 2 cards also provide a way to synchronize multiple devices by using the PCMCIA-CAN Synchronization cable to externally connect to shared timing and triggering signals. For more information about the synchronization capabilities of the NI CAN Series 2 hardware, refer to the *RTSI* section, the *PXI Trigger Bus (RTSI)* section, or the *Synchronization* section of Chapter 3, *NI CAN Hardware*, for the appropriate hardware type.

PCI-CAN Series 2 hardware is completely software configurable and compliant with the PCI Local Bus Specification. It features the National Instruments MITE bus interface chip that connects the card to the PCI I/O bus. With a PCI-CAN Series 2 card, you can make the PC-compatible computer with PCI Local Bus slots communicate with and control CAN devices.

PXI-846*x* Series 2 hardware is completely software configurable and compliant with the *PXI Specification* and *CompactPCI Specification*. It features the National Instruments MITE bus interface chip that connects the card to the PXI or CompactPCI I/O bus. With a PXI-846*x* Series 2 card,

you can make the PXI or CompactPCI chassis communicate with and control CAN devices.

PCMCIA-CAN Series 2 hardware is a 16-bit, Type II PC Card that is completely software configurable and compliant with the PCMCIA standards for 16-bit PC Cards. With a PCMCIA-CAN Series 2 card, you can make the PC-compatible notebook with PCMCIA slots communicate with and control CAN devices.

Series 2 versus Series 1

The technical information in this manual applies to the NI CAN Series 2 hardware. You can easily identify the series of the NI-CAN hardware by looking at the label. Use the following figures to determine if the hardware is Series 1 or Series 2. The differences are clearly indicated in Figure 1-2, Figure 1-3, Figure 1-4, and Figure 1-5. If the label does not indicate Series 2, the hardware is Series 1. For complete documentation of NI CAN Series 1 hardware, refer to `ni.com/manuals` and search for the part number 370289E-01 to access the October 2002 edition of the *NI-CAN Hardware and Software Manual*.

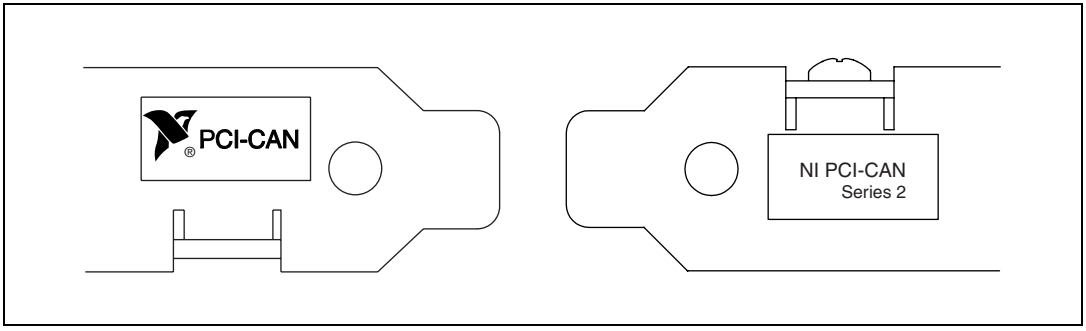


Figure 1-2. NI PCI-CAN Hardware Series 1 and 2 Labels

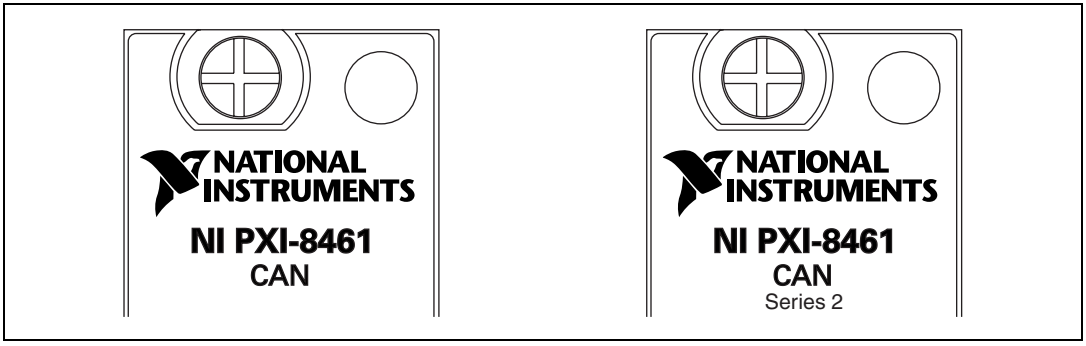


Figure 1-3. NI PXI-CAN Hardware Series 1 and 2 Labels

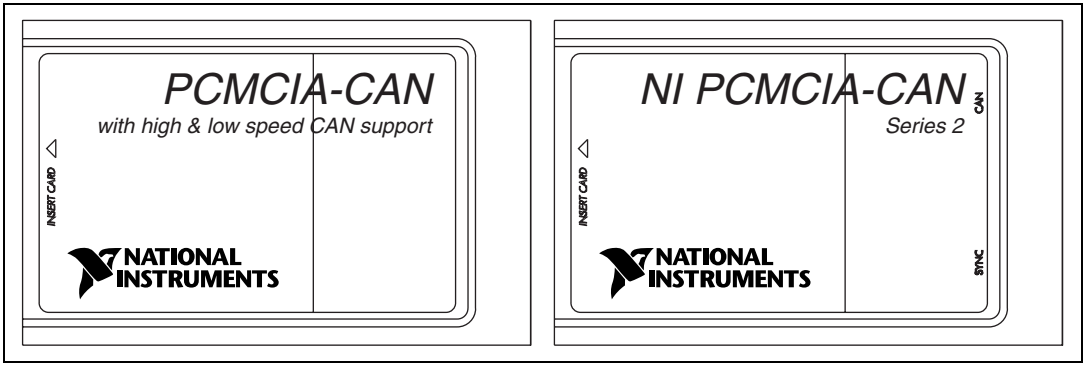


Figure 1-4. NI PCMCIA-CAN Hardware Series 1 and 2 Labels

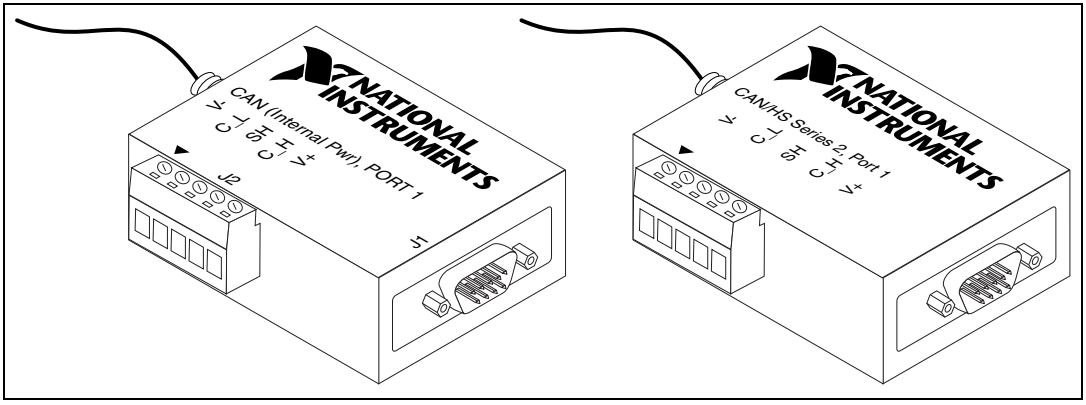


Figure 1-5. NI PCMCIA-CAN Series 1 and 2 Cables

The hardware series is also displayed in Measurement & Automation Explorer (MAX), as shown in Figure 1-6.

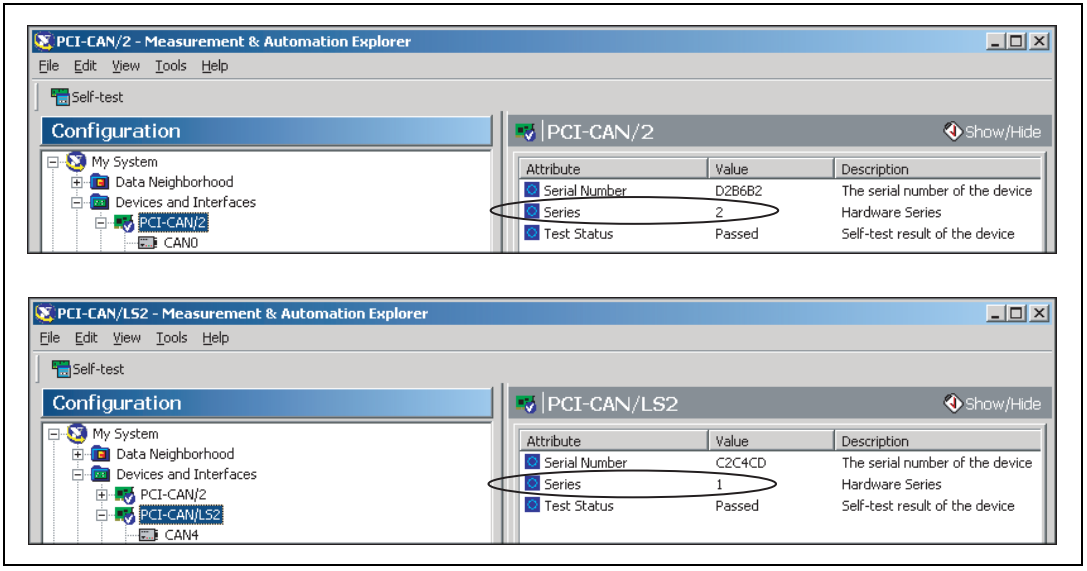


Figure 1-6. Hardware Series Displayed in MAX

The new and improved features supported only by NI CAN Series 2 hardware include:

PCI and PXI

- SJA1000 CAN controller. Series 1 hardware supported the Intel 82527 CAN controller. For more specific information about the SJA1000 CAN controller, refer to the *SJA1000 CAN Controller* section of Chapter 3, *NI CAN Hardware*.
- Improved RTSI synchronization features. For more information about the synchronization capabilities of the NI CAN Series 2 hardware, refer to the *RTSI* section, the *PXI Trigger Bus (RTSI)* section, or the *Synchronization* section of Chapter 3, *NI CAN Hardware*, for the appropriate hardware type.
- Single Wire CAN support.
- XS Software selectable physical layer hardware. This feature allows you to easily configure a CAN port in software to be a High-Speed, Low-Speed/Fault-Tolerant, Single Wire, or external transceiver interface.
- Upgraded CAN transceivers. High-speed hardware uses the TJA1041 transceiver; Low-Speed/Fault-Tolerant hardware uses the TJA1054A

transceiver. Both transceivers have increased voltage tolerance and improved EMC performance over their NI CAN Series 1 predecessors.

- Internally powered physical layer with independent jumper option for controlling the VBAT transceiver input pin either internally or externally. This means High-Speed and Low-Speed/Fault-Tolerant hardware is fully functional by default without supplying any bus power. A jumper option exists to select the source for the VBAT transceiver pin between internal (default) or external. Note that Single Wire CAN requires external bus power.

PCMCIA

- SJA1000 CAN controller. Series 1 hardware supported the Intel 82527 CAN controller. For more specific information about the SJA1000 CAN controller, refer to the *SJA1000 CAN Controller* section of Chapter 3, *NI CAN Hardware*.
- Synchronization capability for PCMCIA hardware. For more information about PCMCIA synchronization, refer to the *Synchronization* section of Chapter 3, *NI CAN Hardware*.
- Improved performance and reduced power consumption. For more information, refer to the *PCMCIA-CAN Series 2* section of Appendix C, *Specifications*.

PCMCIA Cables

- Single Wire CAN support.
- Upgraded CAN transceivers. High-speed hardware uses the TJA1041 transceiver; Low-Speed/Fault-Tolerant hardware uses the TJA1054A transceiver. Both transceivers have increased voltage tolerance and improved EMC performance over their NI CAN Series 1 predecessors.
- Internally powered physical layer for High-Speed and Low-Speed/Fault-Tolerant. This means High-Speed and Low-Speed/Fault-Tolerant hardware is fully functional by default without supplying any bus power. Notice that Single Wire CAN requires external bus power.
- NI-CAN 2.2 is required for full functionality of the PCMCIA cables. Using these cables with any version of NI-CAN prior to 2.2 will prevent use of the following functions:
  - High-speed error reporting
  - Transceiver sleep modes
  - Single-wire transceivers

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). The NI-CAN APIs enable you to develop applications that are customized to the test and simulation requirements.

MAX

The NI-CAN features within MAX enable you to:

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

For more information, refer to Chapter 2, *Installation and Configuration*.

Frame API

As described in the *CAN Overview* section, the frame is the fundamental unit of data transfer on a CAN network. The NI-CAN Frame API provides a set of functions to write and read CAN 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 data frame by calling a write function with the ID, length, and array of data bytes.

For more information, refer to Chapter 9, *Using the Frame API*.

Channel API

A typical CAN data frame contains multiple values encoded as raw fields. Figure 1-7 shows an example set of fields for a 6-byte data frame.

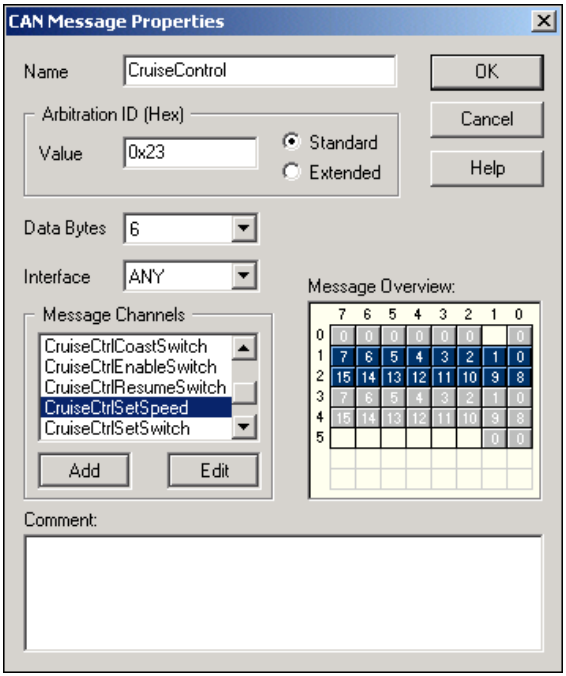


Figure 1-7. Example of CruiseControl Message

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 **VehicleSpeed** 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 the 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 the 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, NI-DAQmx, 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 Chapter 6, *Using the Channel API*.

2

Installation and Configuration

This chapter explains how to install and configure CAN hardware.

Safety Information

The following section contains important safety information that you *must* follow when installing and using the module.

Do *not* operate the module in a manner not specified in this document. Misuse of the module can result in a hazard. You can compromise the safety protection built into the module if the module is damaged in any way. If the module is damaged, return it to National Instruments (NI) for repair.

Do *not* substitute parts or modify the module except as described in this document. Use the module only with the chassis, modules, accessories, and cables specified in the installation instructions. You *must* have all covers and filler panels installed during operation of the module.

Do *not* operate the module in an explosive atmosphere or where there may be flammable gases or fumes. If you ***must*** operate the module in such an environment, it must be in a suitably rated enclosure.

If you need to clean the module, use a soft, nonmetallic brush. Make sure that the module is completely dry and free from contaminants before returning it to service.

Operate the module only at or below Pollution Degree 2. Pollution is foreign matter in a solid, liquid, or gaseous state that can reduce dielectric strength or surface resistivity. The following is a description of pollution degrees:

Pollution Degree 1 means no pollution or only dry, nonconductive pollution occurs. The pollution has no influence.

Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.

Pollution Degree 3 means that conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation.

You ***must*** insulate signal connections for the maximum voltage for which the module is rated. Do ***not*** exceed the maximum ratings for the module. Do ***not*** install wiring while the module is live with electrical signals.

Do not remove or add connector blocks when power is connected to the system. Avoid contact between your body and the connector block signal when hot swapping modules. Remove power from signal lines before connecting them to or disconnecting them from the module.

Operate the module at or below the *installation category*[1] marked on the hardware label. Measurement circuits are subjected to *working voltages*[2] and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Installation categories establish standard impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of installation categories:

- Installation Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS[3] voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.
- Installation Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (for example, 115 AC voltage for U.S. or 230 AC voltage for Europe). Examples of Installation Category II are measurements performed on household appliances, portable tools, and similar modules.
- Installation Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples

[1] Installation categories, also referred to as measurement categories, are defined in electrical safety standard IEC 61010-1.

[2] Working voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

[3] MAINS is defined as a hazardous live electrical supply system that powers equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

are wiring, including cables, bus bars, junction boxes, switches, socket outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.

- Installation Category IV is for measurements performed at the primary electrical supply installation (<1,000 V). Examples include electricity meters and measurements on primary overcurrent protection devices and on ripple control units

Measurement & Automation Explorer (MAX)

Measurement & Automation Explorer (MAX) provides access to all of the National Instruments products. Like other NI software products, NI-CAN uses MAX as the centralized location for all configuration and tools.

To launch MAX, select the **Measurement & Automation** shortcut on the desktop, or within the Windows **Programs** menu under **National Instruments»Measurement & Automation**.

For information about the NI-CAN software within MAX, consult the MAX online help. A reference is in the MAX **Help** menu under **Help Topics»NI-CAN**.

View help for items in the MAX **Configuration** tree by using the built-in MAX help pane. If this help pane is not shown on the far right, select the **Show/Hide** button in the upper right.

View help for a dialog box by selecting the **Help** button in the window.

The following sections provide an overview of some common tasks you can perform within MAX.

Verify Installation of the CAN Hardware

Within the **Devices & Interfaces** branch of the MAX **Configuration** tree, NI CAN cards are listed along with other hardware in the local computer system, as shown in Figure 2-1.

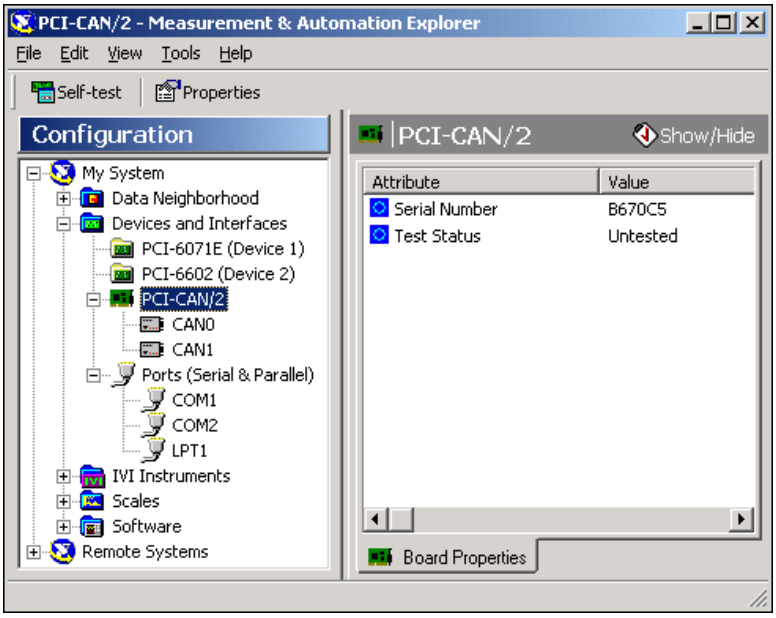


Figure 2-1. NI-CAN Cards Listed in MAX

If the NI CAN hardware is not listed here, MAX is not configured to search for new devices on startup. To search for the new hardware, press <F5>.

To verify installation of the CAN hardware, right-click the CAN card, then select **Self-test**. If the self-test passes, the card icon shows a checkmark. If the self-test fails, the card icon shows an *X* mark, and the **Test Status** in the right pane describes the problem. Refer to Appendix A, *Troubleshooting and Common Questions*, for information about resolving hardware installation problems.

Configure CAN Ports

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

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.

CAN Channels

Within the **Data Neighborhood** branch of the MAX **Configuration** tree, the **CAN Channels** branch lists information for the NI-CAN Channel API, as shown in Figure 2-2.

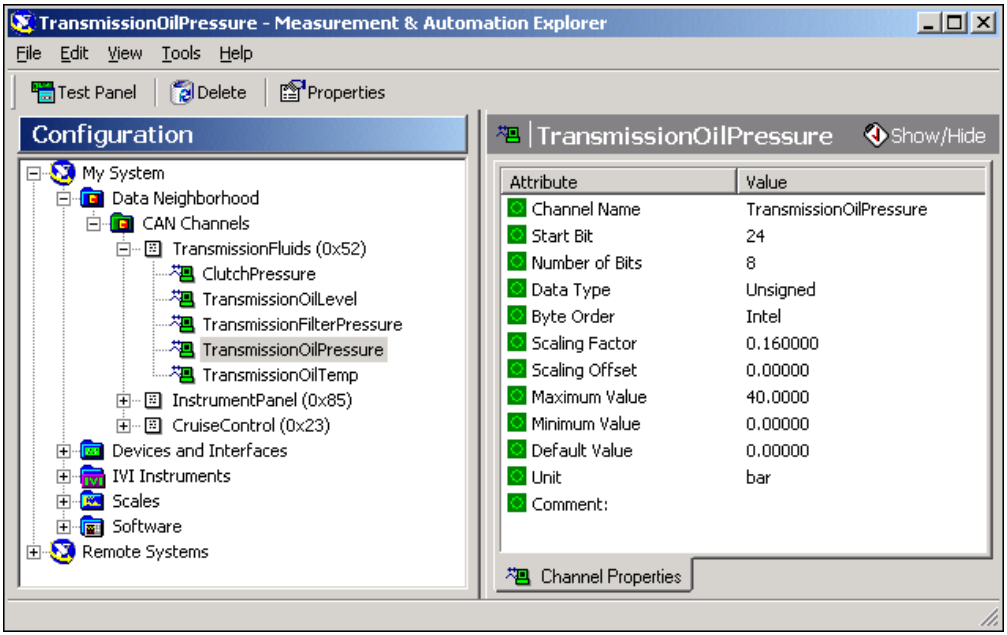


Figure 2-2. CAN Channels in MAX

The **CAN Channels** branch lists CAN messages for use with the Channel API. A set of channels is specified for each message.

For information about creating information under **CAN Channels**, refer to the *Choose Source of Channel Configuration* section of Chapter 6, *Using the Channel API*.

LabVIEW Real-Time (RT) Configuration

LabVIEW Real-Time (RT) combines easy-to-use LabVIEW programming with the power of real-time systems. When you use a National Instruments PXI Controller you can install a PXI-CAN card and use the NI-CAN API 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. This and other real-time applications can also be developed if you are using CompactRIO as your LabVIEW RT system. You can install a CompactRIO CAN module and use the NI-CAN software and the LabVIEW FPGA I/O to develop your applications.

When you install the NI-CAN software, the installer checks for the presence of the LabVIEW RT module. If LabVIEW RT exists, the NI-CAN installer copies components for LabVIEW RT to the Windows system. As with any other NI product for LabVIEW RT, you then download the NI-CAN software to the LabVIEW RT system using the **Remote Systems** branch in MAX. For more information, refer to the LabVIEW RT documentation.

PXI System

After you have installed the PXI CAN cards and downloaded the NI-CAN software to the LabVIEW RT system, you need to verify the installation. Within the **Tools** menu in MAX, select **NI-CAN»RT Hardware Configuration**. The RT Hardware Configuration tool provides features similar to **Devices & Interfaces** on the local system. Use the RT Hardware Configuration tool to self-test the CAN cards and assign an interface name to each physical CAN port.

To use the Channel API on the LabVIEW RT system, you must also download channel configuration information. Right-click the **CAN Channels** heading, then select **Send to RT System**. This downloads all information under CAN Channels to the LabVIEW RT system, so you can execute the same LabVIEW VIs on the LabVIEW RT system as on the Windows system.

CompactRIO System

After you have installed the CompactRIO CAN modules and downloaded NI-RIO and NI-CAN software, you need to enable the CompactRIO Reconfigurable Embedded Chassis for use in LabVIEW. For instructions on how to enable the CompactRIO Reconfigurable Embedded Chassis for use in LabVIEW, refer to the MAX help.

To use the Channel API on the LabVIEW RT system, you must download the channel configuration information. Right-click the **CAN Channels** heading, then select **Send to RT System**. This downloads all the information under CAN Channels to the LabVIEW RT system. To utilize the CAN channels on the CompactRIO system, you need to use *Frame to Channel Conversion*. For more information, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

Tools

NI-CAN provides tools that you can launch from MAX.

- **Bus Monitor**—Displays statistics for raw CAN frames. This provides a basic tool to analyze CAN network traffic. Launch this tool by right-clicking a CAN interface (port).
- **Test Panel**—Read or write physical units for a CAN channel. This provides a simple debugging tool to experiment with CAN channels. Launch this tool by right-clicking a CAN channel.
- **NI-Spy**—Monitor function calls to the NI-CAN APIs. This tool helps in debugging programming problems in the application. To launch this tool, open the **Software** branch of the MAX Configuration tree, right-click **NI Spy**, and select **Launch NI Spy**.
- **FP1300 Configuration**—FieldPoint 1300 is the National Instruments modular I/O product for CAN. If you have installed the software for the FP1300 product, launch this tool by right-clicking a CAN interface (port).

Using NI-CAN with NI-DNET

DeviceNet is a higher-level protocol based on CAN, typically used for industrial automation or machine control applications. NI-DNET is the National Instruments software for DeviceNet.

NI-CAN uses the same software infrastructure as NI-DNET, so both APIs can be used with the same CAN card. The general rule is that each CAN card can only be used for one API at a time.

Use of NI-DNET is restricted to port 1 (top port) of Series 1 CAN cards. National Instruments hardware kits for CAN ship with Series 2 cards, which cannot be used with NI-DNET. National Instruments hardware kits for DeviceNet ship with Series 1 cards, which can be used with both NI-DNET and NI-CAN. For information on identification of the series, refer to the *Series 2 versus Series 1* subsection of the *NI CAN Hardware Overview* section of Chapter 1, *Introduction*.

You can view each Series 1 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. When the CAN protocol is selected, you can access CAN tools in MAX, such as the **Bus Monitor** tool.

In order to develop NI-DNET applications, you must install NI-DNET components such as documentation and examples. The NI-DNET software components are available within the NI-CAN installer.

Launch the `setup.exe` program for the NI-CAN installer in the same manner as the 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 **CAN***x* or **DNET***x* based on the 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.

3

NI CAN Hardware

This chapter describes the NI CAN Series 2 hardware.

SJA1000 CAN Controller

All NI CAN Series 2 hardware uses the SJA1000 controller to implement the CAN protocol. This chip is CAN 2.0B compatible, and supports both 11-bit and 29-bit identifiers. Using the NI-CAN software package with the SJA1000 enables features such as:

- **Listen-Only mode**—In this mode, the CAN controller does not provide an acknowledge signal on the bus, even if a message is received successfully. This mode is useful for passively monitoring a CAN bus. This feature is provided as the **Listen-Only** attribute of the Frame API and the **Interface Listen-Only** property of the Channel API.
- **64-byte receive FIFO**—Helps prevent data overrun errors.
- **Single/dual acceptance filter**—Allows flexible filtering of CAN messages through programming of acceptance mask and comparator registers. This feature is provided as the **Series 2 Filter Mode** attribute of the Frame API and the **Interface Series 2 Filter Mode** property of the Channel API.
- **Self-reception request**—When enabled, a successfully transmitted message is received simultaneously. This feature is provided as the **Self Reception** attribute of the Frame API and the **Interface Self Reception** property of the Channel API.
- **Transmit/Receive error counters**—These counters are provided as the **Receive (and Transmit) Error Counter** attribute of the Frame API, and the **Interface Receive (and Transmit) Error Counter** property of the Channel API.

PCI-CAN

High-Speed Physical Layer

The CAN physical layer circuitry interfaces the CAN protocol controller to the physical bus wires. The PCI-CAN High-Speed physical layer is powered internally (from the card) through a DC-DC converter, and is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PCI-CAN High-Speed hardware uses the Philips TJA1041 High-Speed CAN transceiver. The TJA1041 is fully compatible with the ISO 11898 standard and supports baud rates up to 1 Mbps. This device also supports advanced power management through a low-power sleep mode. This feature is provided as the **Transceiver Mode** attribute of the Frame API and the **Interface Transceiver Mode** property of the Channel API. For detailed TJA1041 specifications, refer to the Philips TJA1041 data sheet.

Bus Power Requirements

Because the High-Speed physical layer is completely powered internally, there is no need to supply bus power. The V– signal serves as the reference ground for the isolated signals. Refer to the *PCI and PXI Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to a High-Speed CAN interface.

VBAT Jumper

The TJA1041 features a battery voltage input pin, VBAT. This signal can be supplied either internally or externally through the CAN bus V+ signal, as controlled by the VBAT jumper setting. By default, the jumper is set to INT, and VBAT is supplied internally. Some applications may require explicit control of the transceiver VBAT pin; for example, to test the performance of CAN devices on a network where battery power is lost. If external control of VBAT is required, you can configure the PCI-CAN hardware by switching the VBAT jumper from its default INT position to EXT, as shown in Figure 3-1.

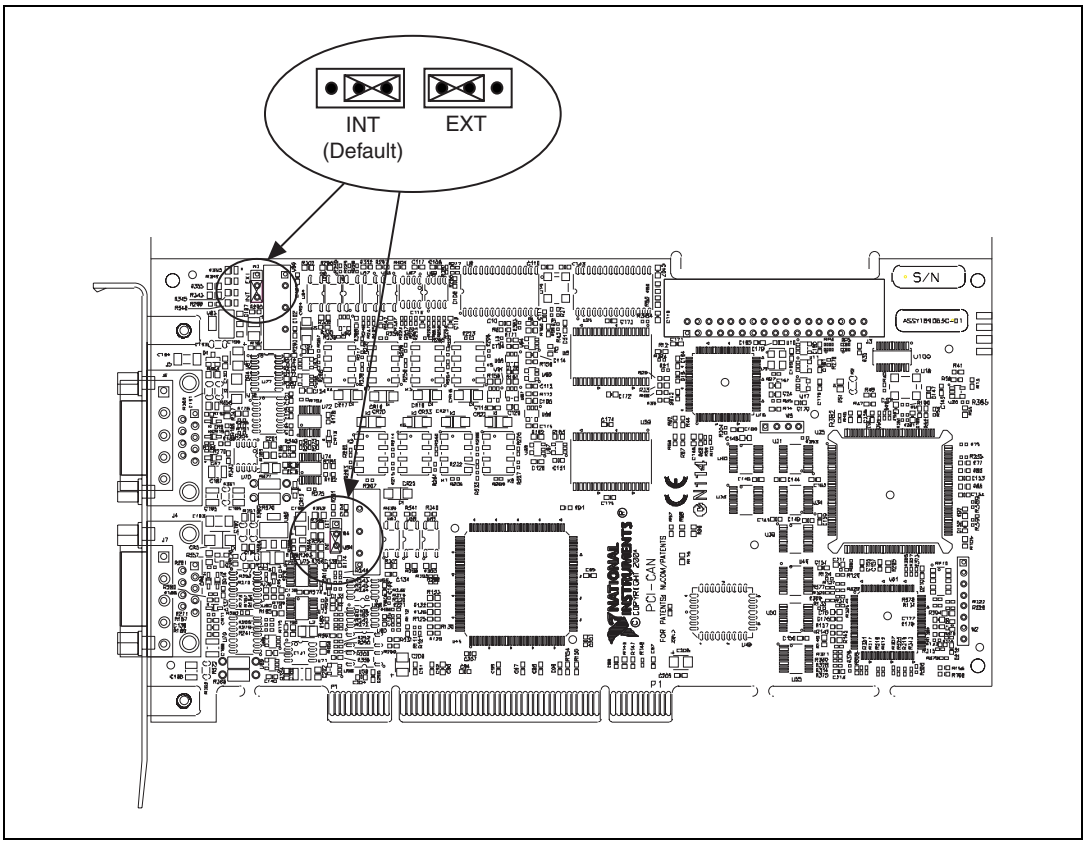


Figure 3-1. High-Speed VBAT Jumper Settings

With the VBAT jumper set to EXT, you must supply power on the CAN V+ signal. The power supply should be a DC power supply with an output of 8 to 27 V, as specified in Table 3-1. You should take these requirements into account when determining the bus power supply requirements for the system.

Table 3-1. CAN V+ Signal Power Supply

Characteristic	Specification
Voltage	8–27 VDC on V+ connector pin (referenced to V–)
Current	30 µA typical 40 µA maximum

If you are unsure how to configure VBAT, leave the jumper set to its default value, INT.

Low-Speed/Fault-Tolerant Physical Layer

The PCI-CAN Low-Speed/Fault-Tolerant physical layer is powered internally (from the card) through a DC-DC converter, and is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PCI-CAN Low-Speed/Fault-Tolerant hardware uses the Philips TJA1054A Low-Speed/Fault-Tolerant transceiver. The TJA1054A supports baud rates up to 125 kbps. The transceiver can detect and automatically recover from the following CAN bus failures:

- CAN_H wire interrupted
- CAN_L wire interrupted
- CAN_H short-circuited to battery
- CAN_L short-circuited to battery
- CAN_H short-circuited to VCC
- CAN_L short-circuited to VCC
- CAN_H short-circuited to ground
- CAN_L short-circuited to ground
- CAN_H and CAN_L mutually short-circuited

The TJA1054A supports advanced power management through a low-power sleep mode. This feature is provided as the **Transceiver Mode** attribute of the Frame API and the **Interface Transceiver Mode** property of the Channel API. For detailed specifications about the TJA1054A, refer to the Philips TJA1054 data sheet.

Bus Power Requirements

Because the Low-Speed/Fault-Tolerant physical layer is completely powered internally, there is no need to supply bus power. The V– signal serves as the reference ground for the isolated signals. Refer to the *PCI and PXI Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to a Low-Speed/Fault-Tolerant CAN interface.

VBAT Jumper

The TJA1054A features a battery voltage input pin, VBAT. This signal can be supplied either internally or externally through the CAN bus V+ signal, as controlled by the VBAT jumper setting. By default, the jumper is set to INT, and VBAT is supplied internally. Some applications may require explicit control of the transceiver VBAT pin; for example, to test the performance of CAN devices on a network where battery power is lost. If external control of VBAT is required, you can configure the PCI-CAN hardware by switching the VBAT jumper from its default INT position to EXT, as shown in Figure 3-2.

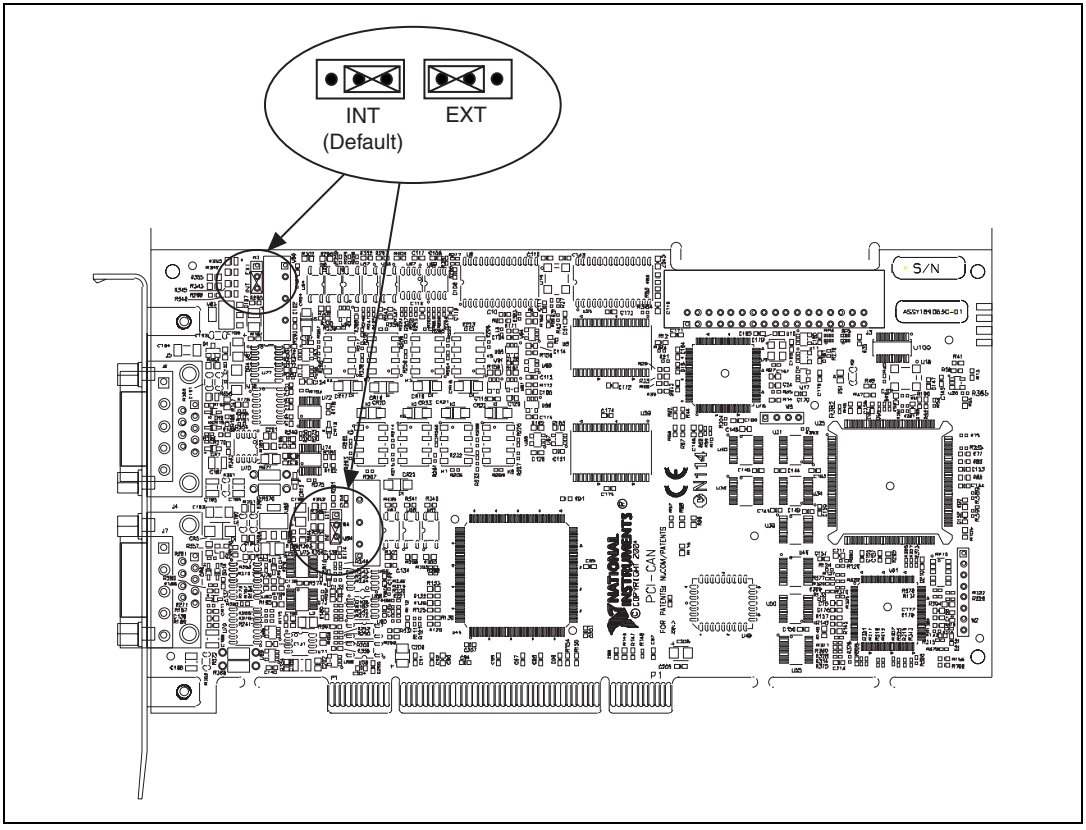


Figure 3-2. Low-Speed/Fault-Tolerant VBAT Jumper Settings

With the VBAT jumper set to EXT, you must supply power on the CAN V+ signal. The power supply should be a DC power supply with an output of 8 to 27 V, as specified in Table 3-2. You should take these requirements into

account when determining the bus power supply requirements for the system.

Table 3-2. CAN V+ Signal Power Supply

Characteristic	Specification
Voltage	8–27 VDC on V+ connector pin (referenced to V–)
Current	30 µA typical 125 µA maximum

If you are unsure how to configure VBAT, leave the jumper set to its default value, INT.

Single Wire Physical Layer

The PCI-CAN Single Wire physical layer is powered internally (from the card) through a DC-DC converter. However, the Single Wire CAN transceiver does require bus power. (For more information, refer to the *Bus Power Requirements* section.) The physical layer is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PCI-CAN Single Wire hardware uses the Philips AU5790 Single Wire CAN transceiver. The AU5790 supports baud rates up to 33.3 kbps in normal transmission mode and 83.3 kbps in High-Speed transmission mode. The achievable baud rate is primarily a function of the network characteristics (termination and number of nodes on the bus), and assumes bus loading as per SAE J2411. Each Single Wire CAN port has a local bus load resistance of 9.09 kΩ between the CAN_H and RTH pins of the transceiver to provide protection against the loss of ground. The AU5790 also supports advanced power management through low-power sleep and wake-up modes. For detailed AU5790 specifications, refer to the Philips AU5790 data sheet.

Bus Power Requirements

The Single Wire physical layer requires external bus power to provide the signal levels necessary to fully use all AU5790 operating modes. This is because some modes require higher signal levels than the internal DC/DC converter on the PCI-CAN board can provide. You must supply power

on the CAN V+ signal. The power supply should be a DC power supply with an output of 8 to 18 V, as specified in Table 3-3. A power supply of 12 VDC is recommended. You should take these requirements into account when determining requirements of the bus power supply for the system.

Table 3-3. CAN V+ Signal Power Supply

Characteristic	Specification
Voltage	8–18 VDC (12 VDC typical) on V+ connector pin (referenced to V–)
Current	40 mA typical 90 mA maximum

VBAT Jumper

Because the AU5790 requires external bus power, there is no option to power the VBAT signal internally. For this reason, the VBAT jumper is not present on Single Wire hardware, and external bus power must be provided.

XS Software Selectable Physical Layer

PCI-CAN/XS hardware allows you to select each port individually in the physical layer for one of the following transceivers:

- High-Speed
- Low-Speed/Fault-Tolerant
- Single Wire
- External

When an XS port is selected as High-Speed, it behaves exactly as a dedicated High-Speed interface with the TJA1041 transceiver.

When an XS port is selected as Low-Speed/Fault-Tolerant, it behaves exactly as a dedicated Low-Speed/Fault-Tolerant interface with the TJA1054A transceiver.

When an XS port is selected as Single Wire, it behaves exactly as a dedicated Single Wire interface with the AU5790 transceiver.

Note that the bus power requirements and VBAT jumper setting for an XS port depend on the mode selected. Refer to the appropriate High-Speed, Low-Speed/Fault-Tolerant, or Single Wire physical layer section to determine the behavior for the mode selected. For example, the bus power

requirements and VBAT jumper operation for an XS port configured for Single Wire mode are identical to those of a dedicated Single Wire node.

When an XS port is selected as external, all onboard transceivers are bypassed, and the CAN controller RX, TX, and mode/status control signals are routed directly to the I/O connector. Refer to the *PCI and PXI Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to an XS CAN interface.

External mode is intended for interfacing custom physical layer circuits to NI CAN hardware. For example, to use a particular CAN transceiver that is not supported natively by the NI CAN hardware, you can use an XS port configured for external mode to connect to the custom-built transceiver circuit and access the bus as usual using NI-CAN software. In addition to the CAN controller RX and TX signals, you also can control two MODE output pins and one STATUS input pin on an external mode port. These MODE and STATUS signals are useful for controlling the operating mode of the custom physical layer and monitoring for any error conditions on the bus. These pins are provided in software as the **Transceiver External Outputs (and Inputs)** attribute of the Frame API and the **Interface Transceiver External Outputs (and Inputs)** property of the Channel API.

Because power is not routed through the connector of an XS port, an external transceiver circuit requires bus power to be supplied.

You can change the transceiver type within MAX using the **Properties** dialog for each port. The transceiver type selected within MAX is used as the default for NI-CAN applications. The initial transceiver configuration in MAX is High-Speed for Port 1 and Low-Speed/Fault-Tolerant for Port 2.

You also can change the transceiver type within the application, which overrides the value in MAX. This feature is provided as the **Transceiver Type** attribute of the Frame API, and the **Interface Transceiver Type** property of the Channel API.

Note While an XS board is booting, or during the process of switching between any of the physical layer options, the CAN bus lines are isolated from the rest of the bus. The XS board does not connect to the bus until an application is started. This ensures that an XS board does not interfere with the operation of an active bus.

RTSI

The RTSI bus gives you the ability to synchronize multiple NI CAN cards with other National Instruments hardware products such as DAQ, IMAQ, and Motion. The RTSI bus consists of a flexible interconnect scheme for sharing timing and triggering signals in a system. For PCI hardware, the RTSI bus interface is a connector at the top of the card, and you can synchronize multiple cards by connecting a RTSI ribbon cable between the cards that need to share timing and triggering signals. Figure 3-3 shows the RTSI signal interconnect architecture for NI PCI-CAN hardware.

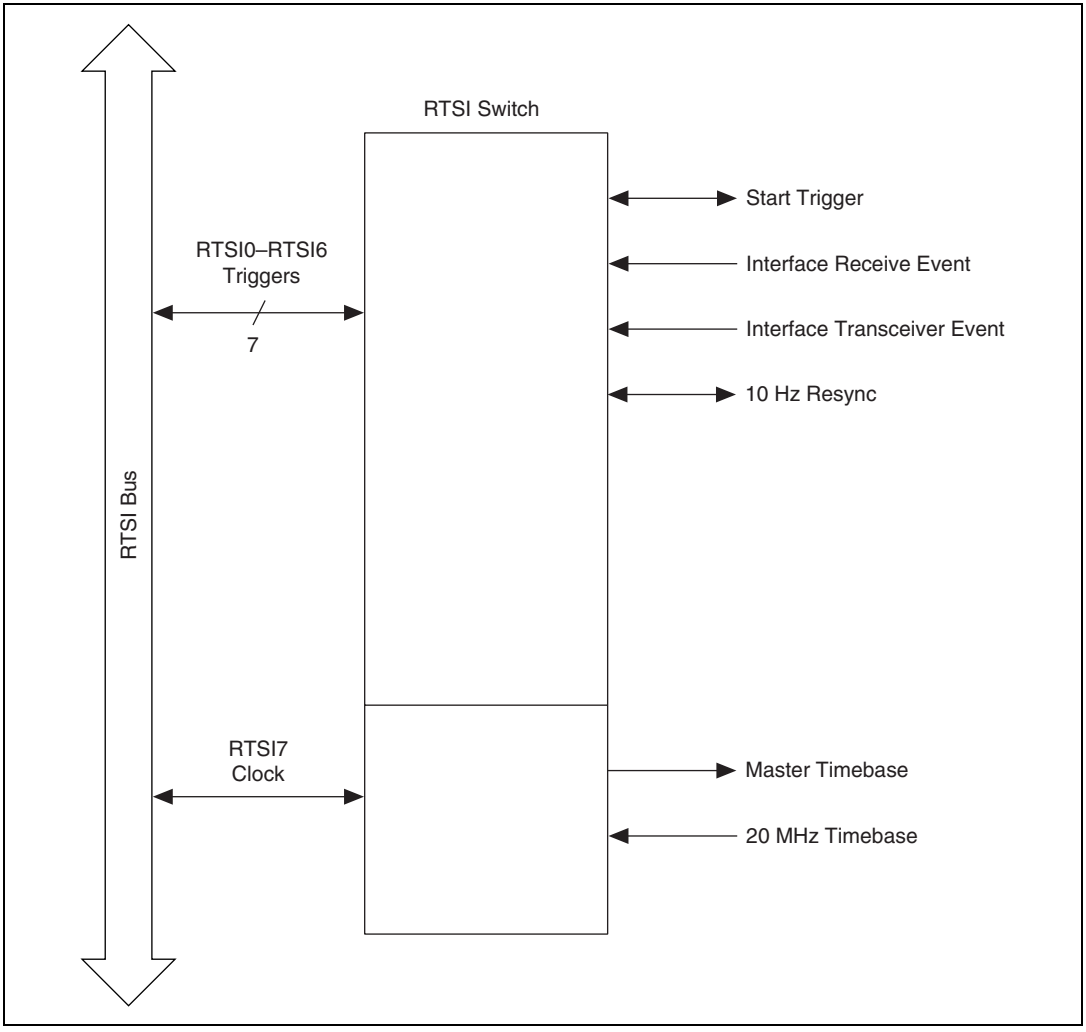


Figure 3-3. RTSI Signal Interconnect Architecture for NI PCI-CAN Hardware

Refer to the **CAN Connect Terminals.vi** for a description of the RTSI signals shown in Figure 3-3.

PXI-846*x*

High-Speed Physical Layer

The CAN physical layer circuitry interfaces the CAN protocol controller to the physical bus wires. The PXI-8461 physical layer is powered internally (from the card) through a DC-DC converter, and is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PXI-8461 hardware uses the Philips TJA1041 High-Speed CAN transceiver. The TJA1041 is fully compatible with the ISO 11898 standard and supports baud rates up to 1 Mbps. This device also supports advanced power management through a low-power sleep mode. This feature is provided as the **Transceiver Mode** attribute of the Frame API and the **Interface Transceiver Mode** property of the Channel API. For detailed TJA1041 specifications, refer to the Philips TJA1041 data sheet.

Bus Power Requirements

Because the High-Speed physical layer is completely powered internally, there is no need to supply bus power. The V– signal serves as the reference ground for the isolated signals. Refer to the *PCI and PXI Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to a High-Speed CAN interface.

VBAT Jumper

The TJA1041 features a battery voltage input pin, VBAT. This signal can be supplied either internally or externally through the CAN bus V+ signal, as controlled by the VBAT jumper setting. By default, the jumper is set to INT, and VBAT is supplied internally. Some applications may require explicit control of the transceiver VBAT pin; for example, to test the performance of CAN devices on a network where battery power is lost. If external control of VBAT is required, you can configure the PXI-8461 hardware by switching the VBAT jumper from its default INT position to EXT, as shown in Figure 3-4.

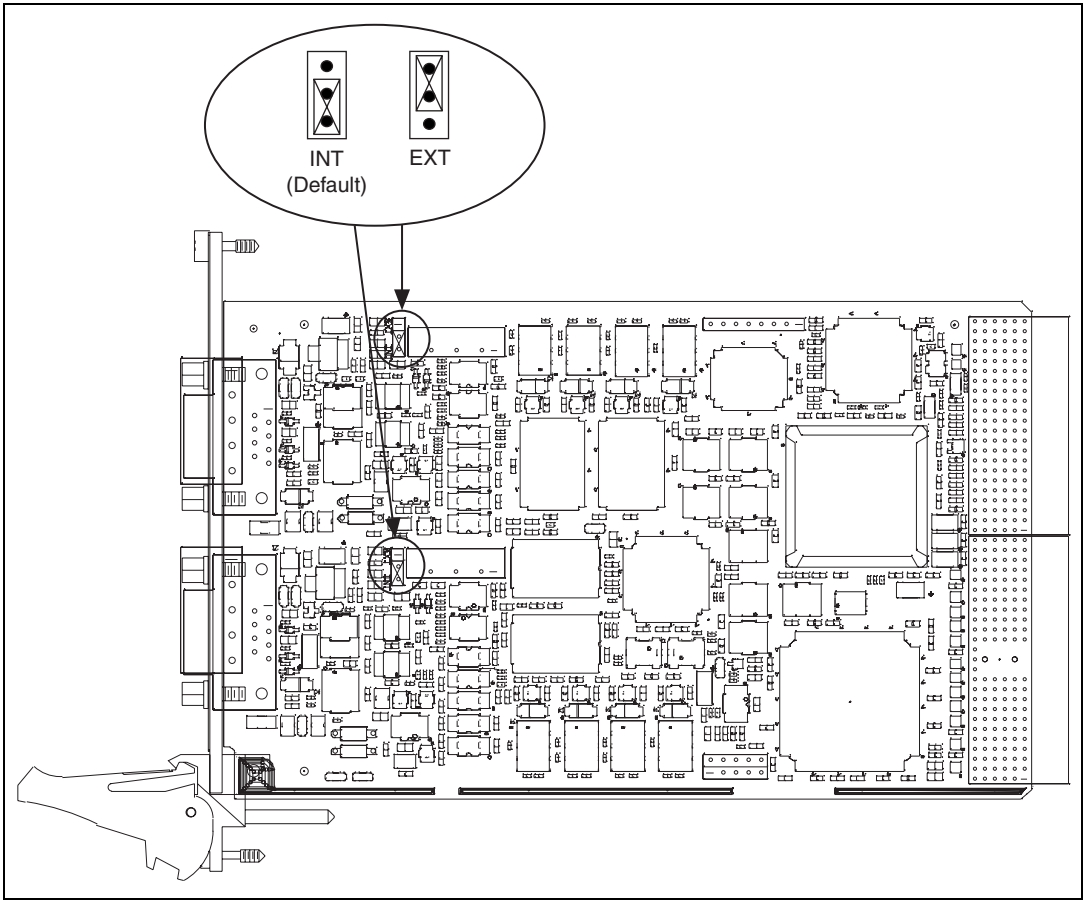


Figure 3-4. High-Speed VBAT Jumper Settings

With the VBAT jumper set to EXT, you must supply power on the CAN V+ signal. The power supply should be a DC power supply with an output of 8 to 27 V, as specified in Table 3-4. You should take these requirements into account when determining requirements of the bus power supply for the system.

Table 3-4. CAN V+ Signal Power Supply

Characteristic	Specification
Voltage	8–27 VDC on V+ connector pin (referenced to V–)
Current	30 µA typical 40 µA maximum

If you are unsure how to configure VBAT, leave the jumper set to its default value, INT.

Low-Speed/Fault-Tolerant Physical Layer

The PXI-8460 physical layer is powered internally (from the card) through a DC-DC converter, and is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PXI-8460 hardware uses the Philips TJA1054A Low-Speed/Fault-Tolerant transceiver. The TJA1054A supports baud rates up to 125 kbps. The transceiver can detect and automatically recover from the following CAN bus failures:

- CAN_H wire interrupted
- CAN_L wire interrupted
- CAN_H short-circuited to battery
- CAN_L short-circuited to battery
- CAN_H short-circuited to VCC
- CAN_L short-circuited to VCC
- CAN_H short-circuited to ground
- CAN_L short-circuited to ground
- CAN_H and CAN_L mutually short-circuited

The TJA1054A supports advanced power management through a low-power sleep mode. This feature is provided as the **Transceiver Mode** attribute of the Frame API and the **Interface Transceiver Mode** property of the Channel API. For detailed TJA1054A specifications, refer to the Philips TJA1054 data sheet.

Bus Power Requirements

Because the Low-Speed/Fault-Tolerant physical layer is completely powered internally, there is no need to supply bus power. The V– signal serves as the reference ground for the isolated signals. Refer to the *PCI and PXI Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to a Low-Speed/Fault-Tolerant CAN interface.

VBAT Jumper

The TJA1054A features a battery voltage input pin, VBAT. This signal can be supplied either internally or externally through the CAN bus V+ signal, as controlled by the VBAT jumper setting. By default, the jumper is set to INT, and VBAT is supplied internally. Some applications may require explicit control of the transceiver VBAT pin; for example, to test the performance of CAN devices on a network where battery power is lost. If external control of VBAT is required, you can configure the PXI-8460 hardware by switching the VBAT jumper from its default INT position to EXT, as shown in Figure 3-5.

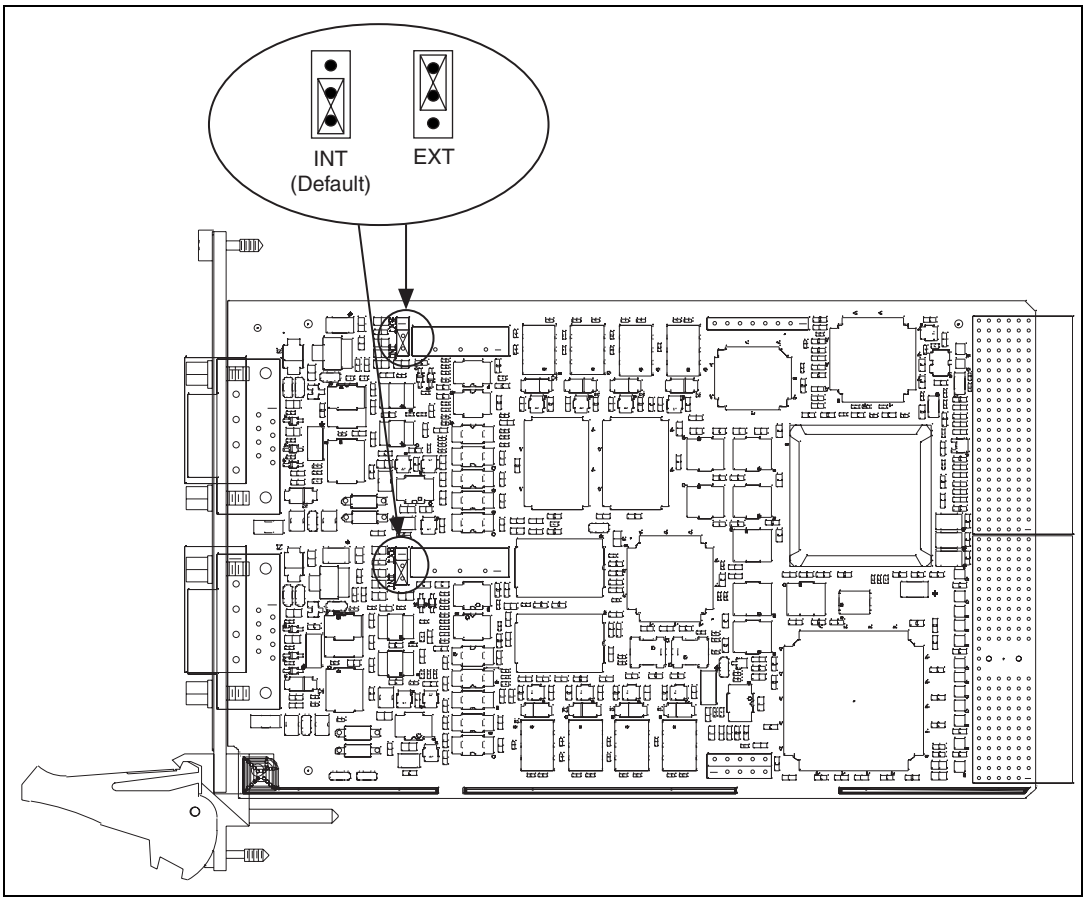


Figure 3-5. Low-Speed/Fault-Tolerant VBAT Jumper Settings

With the VBAT jumper set to EXT, you must supply power on the CAN V+ signal. The power supply should be a DC power supply with an output of 8 to 27 V, as specified in Table 3-5. You should take these requirements into account when determining the bus power supply requirements for the system.

Table 3-5. CAN V+ Signal Power Supply

Characteristic	Specification
Voltage	8–27 VDC on V+ connector pin (referenced to V–)
Current	30 µA typical 125 µA maximum

If you are unsure how to configure VBAT, leave the jumper set to its default value, INT.

Single Wire Physical Layer

The PXI-8463 physical layer is powered internally (from the card) through a DC-DC converter. However, the Single Wire CAN transceiver does require bus power (for more information, refer to the *Bus Power Requirements* section). The physical layer is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PXI-8463 hardware uses the Philips AU5790 Single Wire CAN transceiver. The AU5790 supports baud rates up to 33.3 kbps in normal transmission mode and 83.3 kbps in High-Speed transmission mode. The achievable baud rate is primarily a function of the network characteristics (termination and number of nodes on the bus), and assumes bus loading as per SAE J2411. Each Single Wire CAN port has a local bus load resistance of 9.09 kΩ between the CAN_H and RTH pins of the transceiver to provide protection against the loss of ground. The AU5790 also supports advanced power management through low-power sleep and wake-up modes. For detailed specifications of the AU5790, refer to the Philips AU5790 data sheet.

Bus Power Requirements

The Single Wire physical layer requires external bus power to provide the signal levels necessary to fully use all operating modes of the AU5790. This is because some modes require higher signal levels than the internal DC-DC converter on the PXI-8463 board can provide. You must supply power on the CAN V+ signal. The power supply should be a DC power

supply with an output of 8 V to 18 V, as specified in Table 3-6. A power supply of 12 VDC is recommended. You should take these requirements into account when determining the bus power supply requirements for the system.

Table 3-6. CAN V+ Signal Power Supply

Characteristic	Specification
Voltage	8–18 VDC (12 VDC typical) on V+ connector pin (referenced to V–)
Current	40 mA typical 90 mA maximum

VBAT Jumper

Because the AU5790 requires external bus power, there is no option to power the VBAT signal internally. For this reason, the VBAT jumper is not present on Single Wire hardware, and external bus power must be provided.

XS Software Selectable Physical Layer

PXI-8464 hardware allows each port in the physical layer to be individually selected for one of the following transceivers:

- High-Speed
- Low-Speed/Fault-Tolerant
- Single Wire
- External

When an XS port is selected as **High-Speed**, it behaves exactly as a dedicated High-Speed interface with the TJA1041 transceiver.

When an XS port is selected as **Low-Speed/Fault-Tolerant**, it behaves exactly as a dedicated Low-Speed/Fault-Tolerant interface with the TJA1054A transceiver.

When an XS port is selected as **Single Wire**, it behaves exactly as a dedicated Single Wire interface with the AU5790 transceiver.

The bus power requirements and VBAT jumper setting for an XS port depend on the mode selected. Refer to the appropriate High-Speed, Low-Speed/Fault-Tolerant, or Single Wire physical layer section to determine the behavior for the mode selected. For example, the bus power

requirements and VBAT jumper operation for an XS port configured for **Single Wire** mode are identical to those of a dedicated Single Wire node.

When an XS port is selected as external, all onboard transceivers are bypassed, and the CAN controller RX, TX, and mode/status control signals are routed directly to the I/O connector. Refer to the *PCI and PXI Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to an XS CAN interface.

External mode is intended for interfacing custom physical layer circuits to NI CAN hardware. For example, to use a particular CAN transceiver that is not supported natively by the NI CAN hardware, you can use an XS port configured for external mode to connect to the custom-built transceiver circuit and access the bus as usual using NI CAN software. In addition to the CAN controller RX and TX signals, you also can control two MODE output pins and one STATUS input pin on an external mode port. These MODE and STATUS signals are useful for controlling the operating mode of the custom physical layer and monitoring for any error conditions on the bus. These pins are provided in software as the **Transceiver External Outputs (and Inputs)** attribute of the Frame API and the **Interface Transceiver External Outputs (and Inputs)** property of the Channel API.

Because power is not routed through the connector of an XS port, an external transceiver circuit requires bus power to be supplied.

You can change the transceiver type within MAX using the Properties dialog for each port. The transceiver type selected within MAX is used as the default for NI-CAN applications. The initial transceiver configuration in MAX is **High-Speed** for Port 1 and **Low-Speed/Fault-Tolerant** for Port 2.

You also can change the transceiver type within the application, which overrides the value in MAX. This feature is provided as the **Transceiver Type** attribute of the Frame API, and the **Interface Transceiver Type** property of the Channel API.

Note While an XS board is booting, or during the process of switching between any of the physical layer options, the CAN bus lines are isolated from the rest of the bus. The XS board does not connect to the bus until an application is started. This ensures that an XS board does not interfere with the operation of an active bus.

PXI Trigger Bus (RTSI)

The PXI trigger bus provides the ability to synchronize multiple NI CAN cards with other National Instruments hardware products such as DAQ, IMAQ, and Motion. The PXI trigger bus consists of a flexible interconnect scheme for sharing timing and triggering signals in a system. For PXI hardware, the PXI trigger bus is built into the chassis backplane, so all devices in the same PXI chassis can share timing and triggering signals. The functionality of the PXI trigger bus is very similar to the RTSI bus for PCI hardware, with a few added features. In addition to the bused PXI triggers, the PXI bus includes an independent **PXI_Star** trigger for each slot in a chassis that is oriented in a star configuration from the star trigger slot (slot 2). The star configuration makes **PXI_Star** well suited for applications that require a trigger signal with very low skew between slots. PXI-846*x* hardware can route this **PXI_Star** trigger to its start trigger signal. The **PXI_Clk10** signal is a 10 MHz timebase signal in a PXI chassis. PXI-846*x* hardware can use this **PXI_CLlk10** signal as its master timebase for synchronization. Figure 3-6 shows the RTSI signal interconnect architecture for NI PXI CAN hardware.

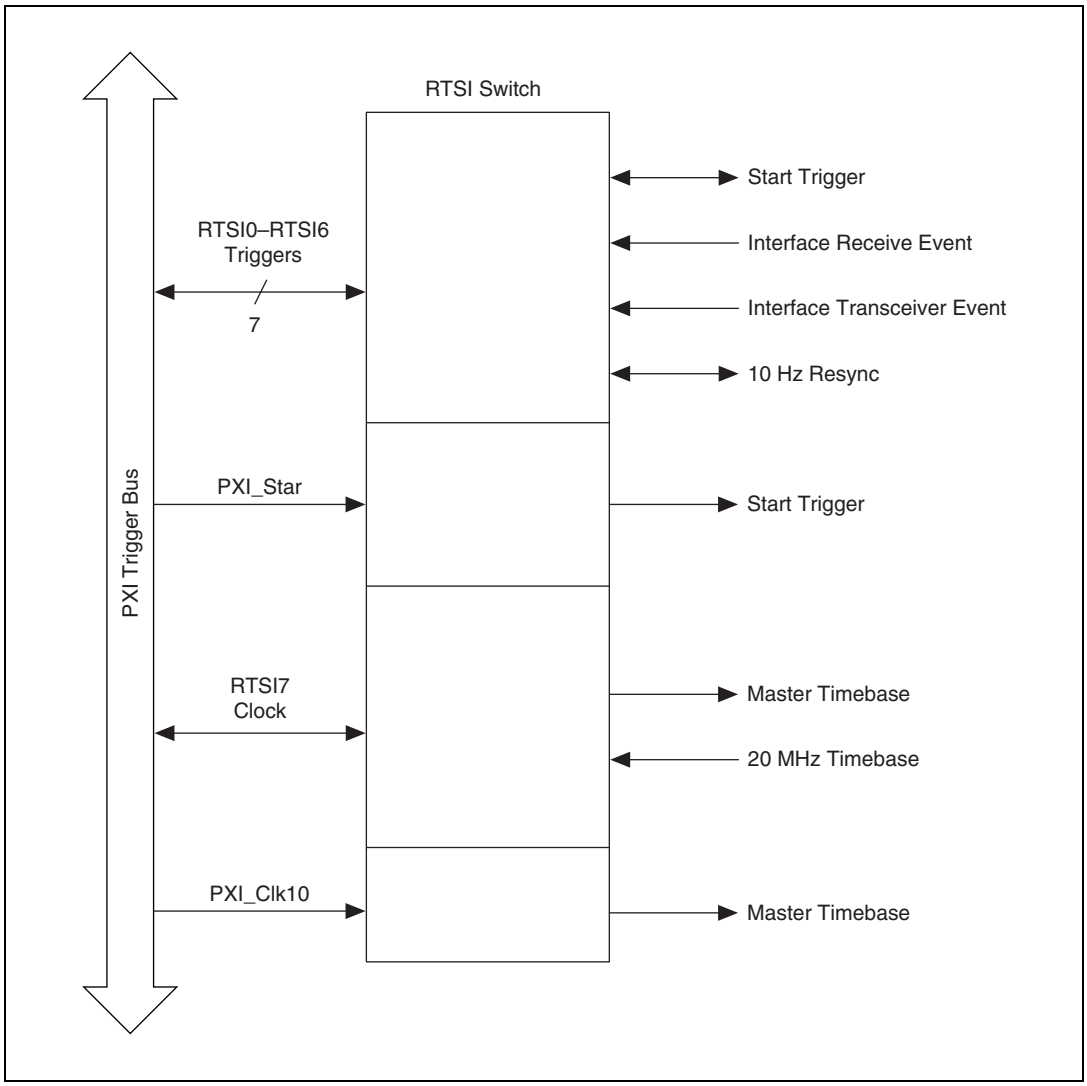


Figure 3-6. RTSI Signal Interconnect Architecture for NI PXI CAN Hardware

Note NI-CAN software uses the naming convention RTSI to refer also to a PXI trigger signal.

Refer to the **CAN Connect Terminals.vi** for a description of the RTSI signals shown in Figure 3-6.

PCMCIA-CAN

For PCMCIA-CAN cards, the physical layer is implemented inside the cable.

The three types of physical layers available for PCMCIA-CAN cards are:

- High-Speed
- Low-Speed/Fault-Tolerant
- Single Wire

The High-Speed and Low-Speed/Fault-Tolerant cables are powered internally through an onboard DC-DC converter. The Single Wire cables must be powered externally, through the CAN bus.

PCMCIA-CAN High-Speed Cables

The PCMCIA-CAN High-Speed physical layer is powered internally (from the card through a DC-DC converter), and is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PCMCIA-CAN High-Speed hardware uses the Philips TJA1041 High-Speed CAN transceiver. The TJA1041 is fully compatible with the ISO 11898 standard and supports baud rates up to 1 Mbps. This device also supports advanced power management through a low-power sleep mode. This feature is provided as the **Transceiver Mode** attribute of the Frame API and the **Interface Transceiver Mode** property of the Channel API. For detailed TJA1041 specifications, refer to the Philips TJA1041 data sheet.

Bus Power Requirements

Because the High-Speed physical layer is completely powered internally, there is no need to supply bus power. The V– signal serves as the reference ground for the isolated signals. Refer to the *PCMCIA Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to a High-Speed CAN interface.

PCMCIA-CAN Low-Speed/Fault-Tolerant Cables

The PCMCIA-CAN/LS cable physical layer is powered internally (from the card) through a DC-DC converter, and is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC it is installed in from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PCMCIA-CAN Low-Speed/Fault-Tolerant hardware uses the Philips TJA1054A Low-Speed/Fault-Tolerant transceiver. The TJA1054A supports baud rates up to 125 kbps. The transceiver can detect and automatically recover from the following CAN bus failures:

- CAN_H wire interrupted
- CAN_L wire interrupted
- CAN_H short-circuited to battery
- CAN_L short-circuited to battery
- CAN_H short-circuited to VCC
- CAN_L short-circuited to VCC
- CAN_H short-circuited to ground
- CAN_L short-circuited to ground
- CAN_H and CAN_L mutually short-circuited

The TJA1054A supports advanced power management through a low-power sleep mode. This feature is provided as the **Transceiver Mode** attribute of the Frame API and the **Interface Transceiver Mode** property of the Channel API. For detailed specifications about the TJA1054A, refer to the Philips TJA1054 data sheet.

Bus Power Requirements

Because the PCMCIA-CAN/LS cable is completely powered internally, there is no need to supply bus power. The V– signal serves as the reference ground for the isolated signals. Refer to the *PCMCIA Connector Pinout* section of Chapter 4, *Connectors and Cables*, for information about how to connect signals to a Low-Speed/Fault-Tolerant CAN interface.

PCMCIA-CAN Single Wire Cables

The PCMCIA-CAN Single Wire physical layer is powered externally from the CAN bus. (For more information, refer to the *Bus Power Requirements* section.) The physical layer is optically isolated up to 500 V. This isolation protects the NI CAN hardware and the PC in which it is installed from being damaged by high-voltage spikes on the CAN bus.

Transceiver

PCMCIA-CAN Single Wire hardware uses the Philips AU5790 Single Wire CAN transceiver. The AU5790 supports baud rates up to 33.3 kbps in normal transmission mode and 83.3 kbps in High-Speed transmission mode. The achievable baud rate is primarily a function of the network characteristics (termination and number of nodes on the bus), and assumes bus loading as per SAE J2411. Each Single Wire CAN port has a local bus load resistance of 9.09 kΩ between the CAN_H and RTH pins of the transceiver to provide protection against the loss of ground. The AU5790 also supports advanced power management through low-power sleep and wake-up modes. For detailed AU5790 specifications, refer to the Philips AU5790 data sheet.

Bus Power Requirements

The Single Wire physical layer requires external bus power to provide the signal levels necessary to fully use all AU5790 operating modes. You must supply power on the CAN V+ signal. The power supply should be a DC power supply with an output of 8 to 18 V, as specified in Table 3-3. A power supply of 12 VDC is recommended. You should take these requirements into account when determining requirements of the bus power supply for the system.

Table 3-7. CAN V+ Signal Power Supply

Characteristic	Specification
Voltage	8–18 VDC (12 VDC typical) on V+ connector pin (referenced to V–)
Current	40 mA typical 90 mA maximum

Synchronization

The PCMCIA-CAN synchronization cable provides the ability to synchronize a Series 2 PCMCIA-CAN card with other National Instruments hardware or external devices. The synchronization cable provides a flexible interconnect scheme for sharing timing and triggering signals in a system. For example, PCMCIA-CAN synchronization is specifically designed to integrate well with National Instruments E Series DAQCard hardware. Timing and triggering signals can be shared by wiring the synchronization cable signals to the appropriate terminals on a DAQ terminal block.

The functionality of the PCMCIA-CAN synchronization cable is very similar to the RTSI bus for PCI hardware, with a few limitations:

- Four general-purpose I/O trigger lines, as opposed to seven for RTSI
- TRIG7_CLK clock line is an input-only signal that can receive a master timebase; the PCMCIA-CAN card cannot drive a timebase onto TRIG7_CLK

Figure 3-7 shows the PCMCIA-CAN synchronization signal interconnect architecture for NI PCMCIA-CAN hardware.

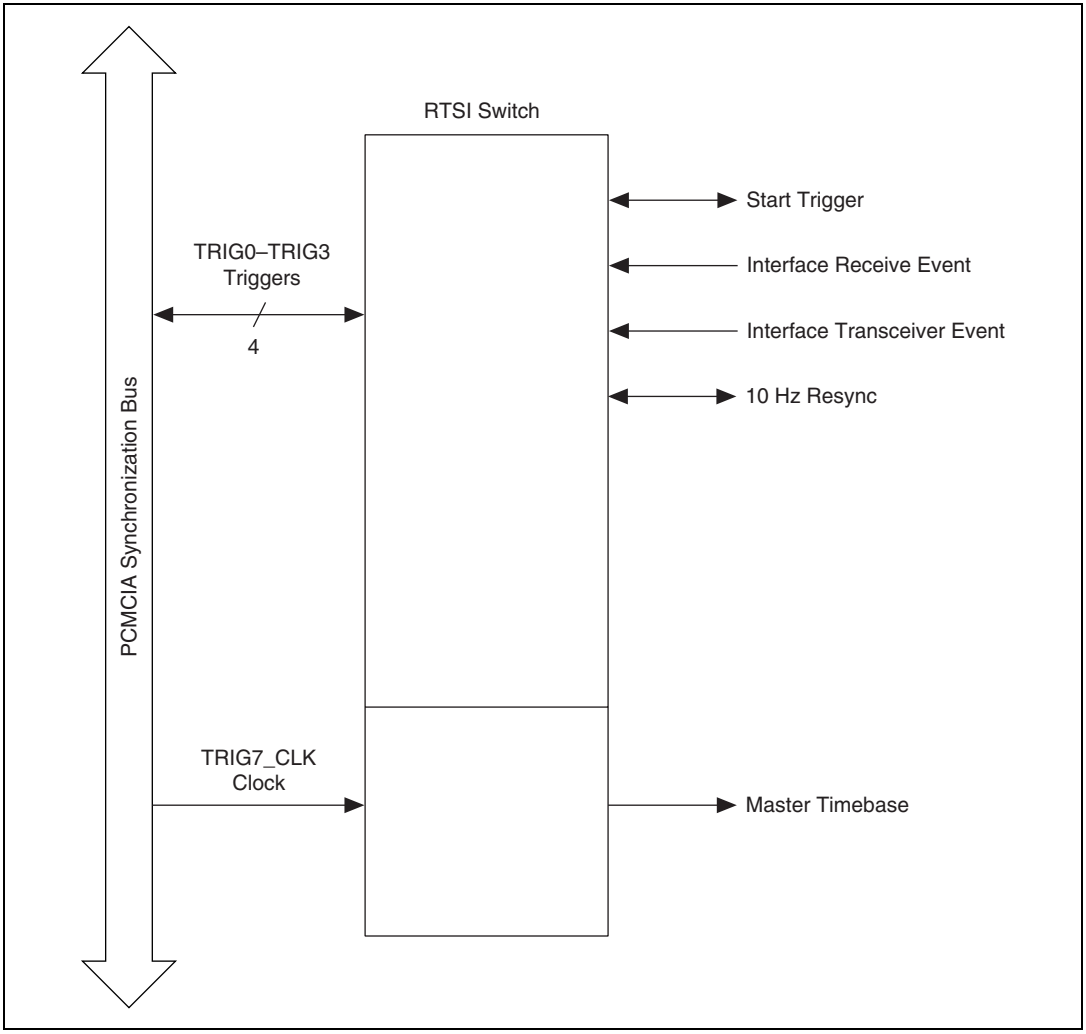


Figure 3-7. PCMCIA-CAN Synchronization Signal Interconnect Architecture for NI PCMCIA-CAN Hardware

Note NI-CAN software uses the naming convention *RTSI* to refer also to a PCMCIA synchronization trigger line. Specifically, TRIG_0 through TRIG_3 are named **RTSI0** through **RTSI3**, and TRIG7_CLK is named **RTSI Clock** (**RTSI7**).

Table 3-8 shows the function of each trigger line and its corresponding wire color.

Table 3-8. PCMCIA-CAN Trigger Lines and Wire Colors

Signal	Function	Wire Color
TRIG_0 (RTSI0)	General I/O trigger	Red
TRIG_1 (RTSI1)	General I/O trigger	Orange
TRIG_2 (RTSI2)	General I/O trigger	Yellow
TRIG_3 (RTSI3)	General I/O trigger	Green
TRIG7_CLK (**RTSI7/RTSI Clock**)	Input-only timebase	White
GND	Ground	Black, brown, blue, purple, gray

To improve the signal integrity of the trigger lines, all GND wires should be connected to digital logic ground of the system. Unused trigger lines may also be grounded. Refer to the *PCMCIA-CAN Series 2* section of Appendix C, *Specifications*, for detailed DC operating characteristics.

CAN for CompactRIO

What is CompactRIO?

National Instruments CompactRIO is an advanced embedded control and acquisition system powered by NI reconfigurable I/O (RIO) technology. CompactRIO combines a low-power-consumption, real-time embedded processor with a high-performance RIO FPGA chipset. The RIO core has built-in data transfer mechanisms to pass data to the embedded processor for real-time analysis, post processing, data logging, or communication to a networked host computer. CompactRIO provides direct hardware access to the I/O circuitry of each I/O module using LabVIEW FPGA I/O functions. Each I/O module includes built-in connectivity, signal conditioning, conversion circuitry (such as ADC or DAC), and an optional isolation barrier.

NI 9853

The NI 9853 is a CAN I/O module for the CompactRIO platform. For information on the NI 9853 CAN module, refer to the *NI 9853 Operating Instructions*. For information on the software support for the NI 9853, refer to the LabVIEW FPGA help.

4

Connectors and Cables

This chapter describes the input and output signal connections to the NI CAN hardware and the cabling requirements for interfacing to a CAN network. Cables should be constructed to meet these requirements, as well as the requirements of the other CAN devices in the network.

High-Speed CAN

PCI and PXI Connector Pinout

PCI-CAN and PXI-8461 hardware have a 9-pin male D-SUB (DB9) connector for each port. The 9-pin D-SUB connector follows the pinout recommended by CiA DS 102. Figure 4-1 shows the 9-pin D-SUB connector pinout.

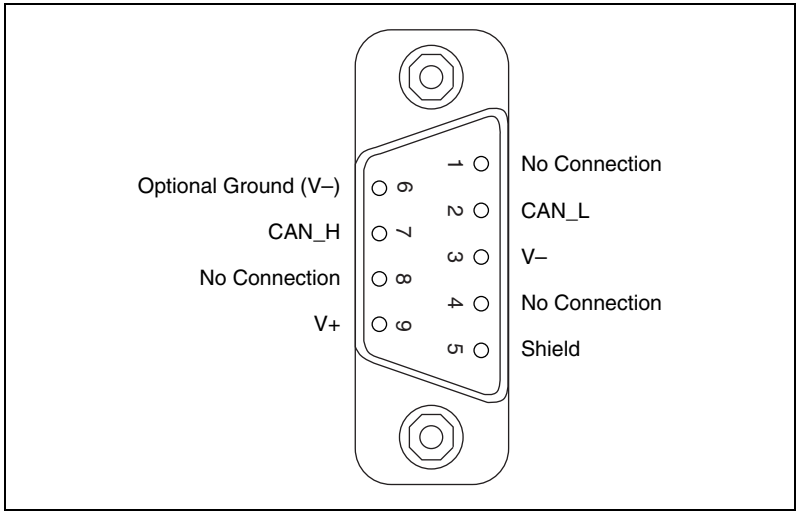


Figure 4-1. Pinout for 9-Pin D-SUB Connector

Table 4-1. 9-Pin D-SUB Connector Pin Descriptions

D-SUB Pin	Signal	Description
1	No Connection	—
2	CAN_L	CAN_L bus line
3	V–	CAN reference ground
4	No Connection	—
5	(Shield)	Optional CAN shield
6	(V–)	Optional CAN reference ground
7	CAN_H	CAN_H bus line
8	No Connection	—
9	(V+)	Optional CAN power supply if bus power or external VBAT is required

CAN_H and CAN_L are signals lines that carry the data on the CAN network. These signals should be connected using twisted-pair cable.

V– serves as the reference ground for CAN_H and CAN_L.

V+ supplies bus power to the CAN physical layer if external power is required. All High-Speed Series 2 PCI and PXI hardware is powered internally, so it is not necessary to supply V+, unless you have configured the VBAT jumper for EXT.

Shield is an optional connection when using a shielded CAN cable. Connecting the optional CAN shield may improve signal integrity in a noisy environment.

PCMCIA Connector Pinout

PCMCIA-CAN cables have both a 9-pin male D-SUB and Combicon-style pluggable screw terminal connector for each port. Figure 4-2 shows the end of a PCMCIA-CAN cable. The arrow points to pin 1 of the 5-pin screw terminal block. All of the signals on the 5-pin screw terminal are connected directly to the corresponding pins on the 9-pin D-SUB.

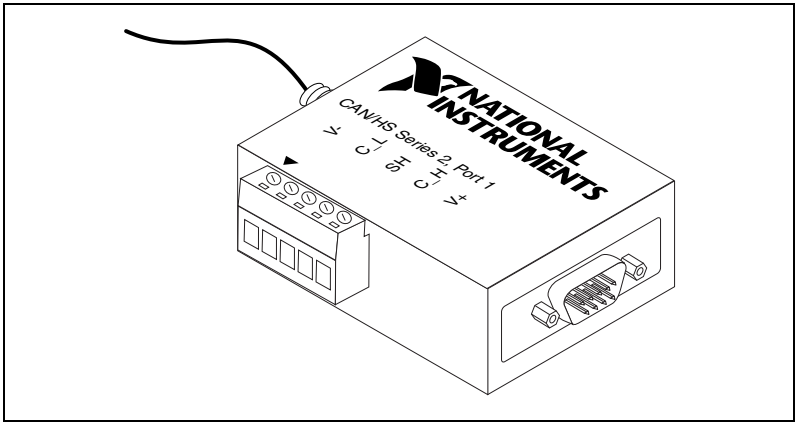


Figure 4-2. PCMCIA-CAN Cable

Table 4-2. PCMCIA-CAN Cable Connector Pin Descriptions

D-SUB Pin	Combicon Pin	Signal	Description
1	—	No Connection	—
2	2	CAN_L	CAN_L bus line
3	1	V–	CAN reference ground
4	—	No Connection	—
5	3	(Shield)	Optional CAN shield
6	—	(V–)	Optional CAN reference ground
7	4	CAN_H	CAN_H bus line
8	—	No Connection	—
9	5	No Connection	—

CAN_H and CAN_L are signal lines that carry the data on the CAN network. These signals should be connected using twisted-pair cable.

V– serves as the reference ground for CAN_H and CAN_L.

Shield is an optional connection when using a shielded CAN cable. Connecting the optional CAN shield may improve signal integrity in a noisy environment.

Cabling Requirements for High-Speed CAN

Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11898, shown in Table 4-3.

Belden cable (3084A) meets all of those requirements, and should be suitable for most applications.

Table 4-3. ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Impedance	108 Ω minimum, 120 Ω nominal, 132 Ω maximum
Length-related resistance	70 mΩ/m nominal
Specific line delay	5 ns/m nominal

Cable Lengths

The allowable cable length is affected by the characteristics of the cabling and the desired bit transmission rates. Detailed cable length recommendations can be found in the ISO 11898, CiA DS 102, and DeviceNet specifications.

ISO 11898 specifies 40 m total cable length with a maximum stub length of 0.3 m for a bit rate of 1 Mb/s. The ISO 11898 specification says that significantly longer cable lengths may be allowed at lower bit rates, but each node should be analyzed for signal integrity problems.

Table 4-4 lists the DeviceNet cable length specifications.

Table 4-4. DeviceNet Cable Length Specifications

Bit Rate	Thick Cable	Thin Cable
500 kb/s	100 m	100 m
250 kb/s	200 m	100 m
100 kb/s	500 m	100 m

Number of Devices

The maximum number of devices depends on the electrical characteristics of the devices on the network. If all of the devices meet the requirements of ISO 11898, at least 30 devices may be connected to the bus. Higher numbers of devices may be connected if the electrical characteristics of the devices do not degrade signal quality below ISO 11898 signal level specifications. If all of the devices on the network meet the DeviceNet specifications, 64 devices may be connected to the network.

Cable Termination

The pair of signal wires (CAN_H and CAN_L) constitutes a transmission line. If the transmission line is not terminated, each signal change on the line causes reflections that may cause communication failures.

Because communication flows both ways on the CAN bus, CAN requires that both ends of the cable be terminated. However, this requirement does not mean that every device should have a termination resistor. If multiple devices are placed along the cable, only the devices on the ends of the cable should have termination resistors. Refer to Figure 4-3 for an example of where termination resistors should be placed in a system with more than two devices.

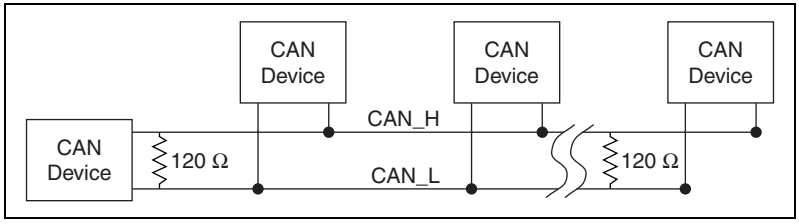


Figure 4-3. Termination Resistor Placement

The termination resistors on a cable should match the nominal impedance of the cable. ISO 11898 requires a cable with a nominal impedance of 120 Ω; therefore, a 120 Ω resistor should be used at each end of the cable. Each termination resistor should be capable of dissipating 0.25 W of power.

Cabling Example

Figure 4-4 shows an example of a cable to connect two CAN devices. For the internal power configuration, no V+ connection is required.

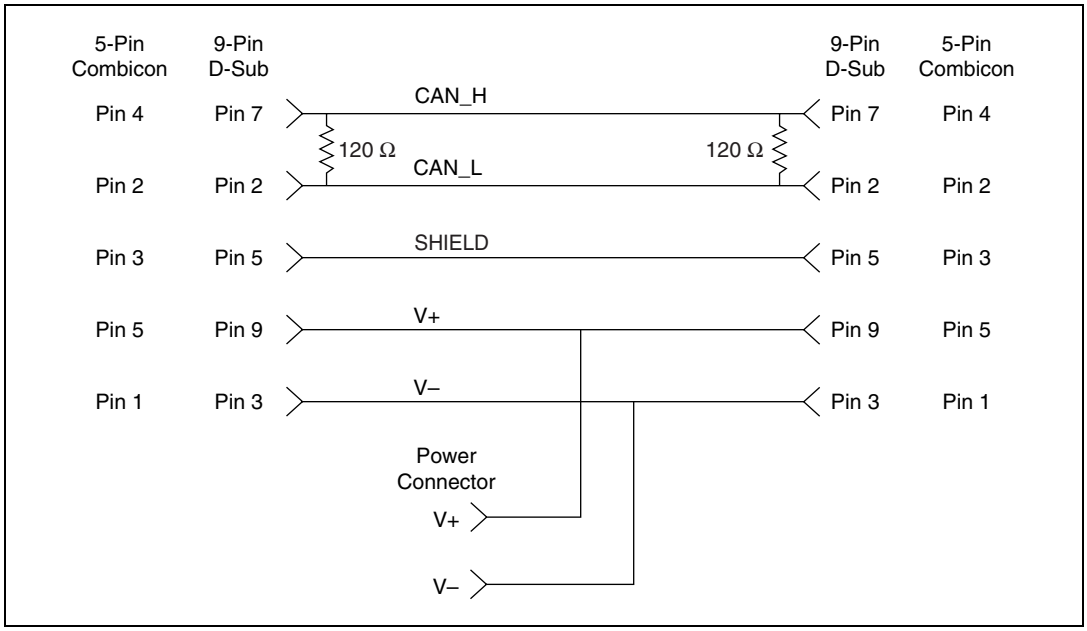


Figure 4-4. Cabling Example

Low-Speed/Fault-Tolerant CAN

PCI and PXI Connector Pinout

PCI-CAN/LS and PXI-8460 hardware have a 9-pin male D-SUB (DB9) connector for each port. The 9-pin D-SUB connector follows the pinout recommended by CiA DS 102. Figure 4-5 shows the 9-pin D-SUB connector pinout.

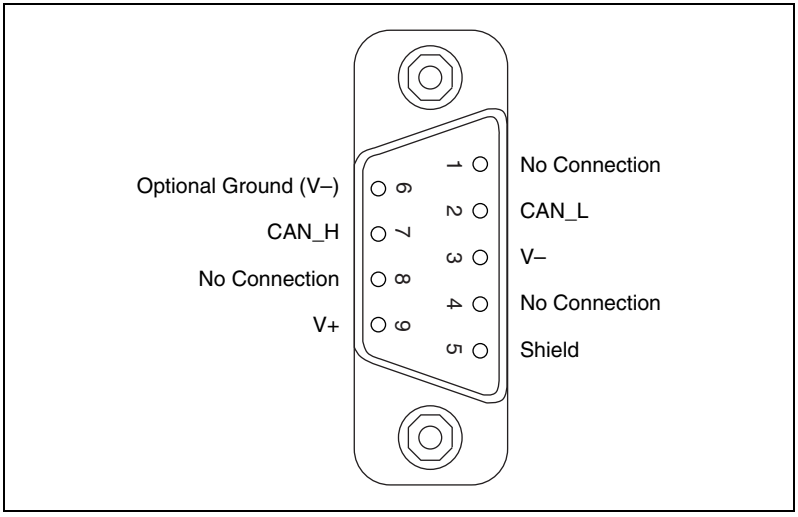


Figure 4-5. Pinout for 9-Pin D-SUB Connector

Table 4-5. 9-Pin D-SUB Connector Pin Descriptions

D-SUB Pin	Signal	Description
1	No Connection	—
2	CAN_L	CAN_L bus line
3	V–	CAN reference ground
4	No Connection	—
5	(Shield)	Optional CAN shield
6	(V–)	Optional CAN reference ground
7	CAN_H	CAN_H bus line
8	No Connection	—
9	(V+)	Optional CAN power supply if bus power or external VBAT is required

CAN_H and CAN_L are signals lines that carry the data on the CAN network. These signals should be connected using twisted-pair cable.

V– serves as the reference ground for CAN_H and CAN_L.

V+ supplies bus power to the CAN physical layer if external power is required. All Low-Speed/Fault-Tolerant Series 2 PCI and PXI hardware is powered internally, so it is not necessary to supply V+ unless you have configured the VBAT jumper for EXT.

Shield is an optional connection when using a shielded CAN cable. Connecting the optional CAN shield may improve signal integrity in a noisy environment.

PCMCIA Connector Pinout

PCMCIA-CAN cables have both a 9-pin male D-SUB and Combicon-style pluggable screw terminal connector for each port. Figure 4-6 shows the end of a PCMCIA-CAN cable. The arrow points to pin 1 of the 7-pin screw terminal block. All of the signals on the 7-pin screw terminal, except RTL and RTH, are connected directly to the corresponding pins on the 9-pin D-SUB.

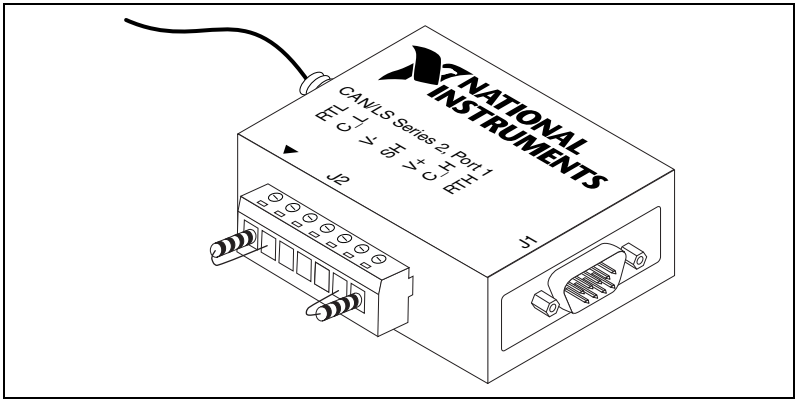


Figure 4-6. PCMCIA-CAN/LS Cable

Table 4-6. PCMCIA-CAN/LS Cable Connector Pin Descriptions

D-SUB Pin	Combicon Pin	Signal	Description
1	—	No Connection	—
2	2	CAN_L	CAN_L bus line
3	3	V–	CAN reference ground
4	—	No Connection	—
5	4	(Shield)	Optional CAN shield

Table 4-6. PCMCIA-CAN/LS Cable Connector Pin Descriptions (Continued)

D-SUB Pin	Combicon Pin	Signal	Description
6	—	(V–)	Optional CAN reference ground
7	6	CAN_H	CAN_H bus line
8	—	No Connection	—
9	5	No Connection	—

CAN_H and CAN_L are signal lines that carry the data on the CAN network. These signals should be connected using twisted-pair cable.

V– serves as the reference ground for CAN_H and CAN_L.

Shield is an optional connection when using a shielded CAN cable. Connecting the optional CAN shield may improve signal integrity in a noisy environment.

Cabling Requirements for Low-Speed/Fault-Tolerant CAN

Cable Specifications

Cables should meet the physical medium requirements shown in Table 4-7.

Table 4-7. Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

Characteristic	Value
Length-related resistance	90 mΩ/m nominal
Length-related capacitance: CAN_L and ground, CAN_H and ground, CAN_L and CAN_H	30 pF/m nominal

Belden cable (3084A) meets all of those requirements, and should be suitable for most applications.

Number of Devices

The maximum number of devices depends on the electrical characteristics of the devices on the network. If all of the devices meet the requirements of typical Low-Speed/Fault-Tolerant CAN, up to 32 devices may be connected to the bus. Higher numbers of devices may be connected if the electrical characteristics of the devices do not degrade signal quality below Low-Speed/Fault-Tolerant signal level specifications.

Termination

Every device on the low-speed CAN network requires a termination resistor for each CAN data line: R_{RTH} for CAN_H and R_{RTL} for CAN_L. Figure 4-7 shows termination resistor placement in a low-speed CAN network.

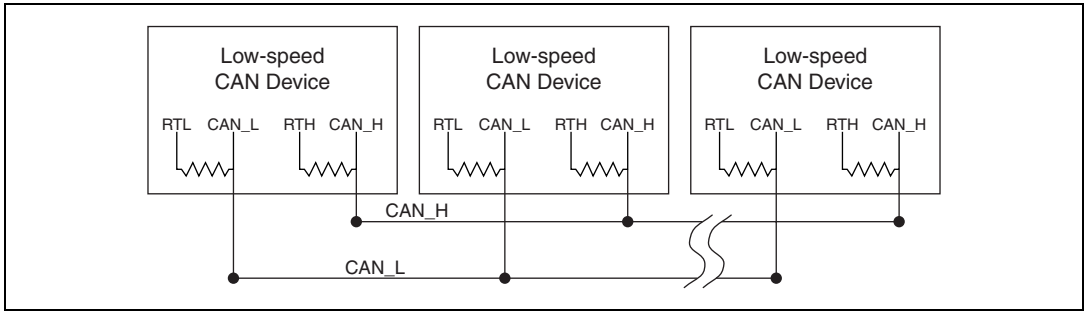


Figure 4-7. Termination Resistor Placement for Low-Speed CAN

The following sections explain how to determine the correct resistor values for the low-speed CAN card, and how to replace those resistors, if necessary.

Determining the Necessary Termination Resistance for the Board

Unlike High-Speed CAN, low-speed CAN requires termination at the low-speed CAN transceiver instead of on the cable. The termination requires two resistors: RTH for CAN_H and RTL for CAN_L. This configuration allows the Philips fault-tolerant CAN transceiver to detect and recover from bus faults. You can use the PCI-CAN/LS, PXI-8460, or PCMCIA-CAN/LS to connect to a low-speed CAN network having from two to 32 nodes as specified by Philips (including the port on the NI CAN Low-Speed/Fault-Tolerant interface). You also can use the Low-Speed/Fault-Tolerant interface to communicate with individual low-speed CAN devices. It is important to determine the overall

termination of the existing network, or the termination of the individual device, before connecting it to a Low-Speed/Fault-Tolerant port. Philips recommends an overall RTH and RTL termination of 100 to 500 Ω (each) for a properly terminated low-speed network. The overall network termination may be determined as follows:

$$\frac{1}{R_{\text{RTH overall}^{\dagger}}} = \frac{1}{R_{\text{RTH node 1}}} + \frac{1}{R_{\text{RTH node 2}}} + \frac{1}{R_{\text{RTH node 3}}} + \frac{1}{R_{\text{RTH node n}}}$$

Philips also recommends an individual device RTH and RTL termination of 500 to 16 kΩ. The PCI-CAN/LS or PXI-8460 card ships with termination resistor values of 510 Ω ±5% per port mounted on the PCB. The PCI-CAN/LS or PXI-8460 kit also includes a pair of 15 kΩ ±5% resistors for each port. After determining the termination of the existing network or device, you can use the following formula to indicate which value should be placed on the PCI-CAN/LS or PXI-8460 card in order to produce the proper overall RTH and RTL termination of 100 to 500 Ω upon connection of the card:

$$R_{\text{RTH overall}^{*\dagger}} = \frac{1}{\left(\frac{1}{R_{\text{RTH of low-speed CAN interface}^{**}}} + \frac{1}{R_{\text{RTH of existing network or device}}}\right)}$$

$^{*}R_{\text{RTH overall}}$ should be between 100 and 500 Ω

$^{**}R_{\text{RTH of low-speed CAN interface}}$ = 510 Ω ±5% (mounted) or 15 kΩ ±5% (in kit)

$^{\dagger}R_{\text{RTH}} = R_{\text{RTL}}$

As the formula indicates, the 510 Ω ±5% shipped on the card will work with properly terminated networks having a total RTH and RTL termination of 125 to 500 Ω, or individual devices having an RTH and RTL termination of 500 to 16 kΩ. For communication with a network having an overall RTH and RTL termination of 100 to 125 Ω, you will need to replace the 510 Ω resistors with the 15 kΩ resistors in the kit. Refer to the *Replacing the Termination Resistors on the PCI-CAN/LS Board* section.

The PCMCIA-CAN/LS cable ships with screw-terminal mounted RTH and RTL values of 510 Ω ±5% per port. The PCMCIA-CAN/LS cable also internally mounts a pair of 15.8 kΩ ±1% resistors in parallel with the external 510 Ω resistors for each port. This produces an effective RTH and RTL of 494 Ω per port for the PCMCIA-CAN/LS cable. After determining the termination of the existing network or device, you can use the formula below to indicate which configuration should be used on the

PCMCIA-CAN/LS cable to produce the proper overall RTH and RTL termination of 100 to 500 Ω upon connection of the cable:

$$R_{\text{RTH overall}*,\dagger} = \frac{1}{\left(\frac{1}{R_{\text{RTH of PCMCIA-CAN/LS}**}} + \frac{1}{R_{\text{RTH of existing network or device}}}\right)}$$

$*R_{\text{RTH overall}}$ should be between 100 and 500 Ω

$**R_{\text{RTH of PCMCIA-CAN/LS}}$ = 494 Ω (510 Ω ±5% (external) in parallel with 15.8 kΩ ±1% (internal)), or 15.8 kΩ ±1% (internal) only

$\dagger R_{\text{RTH}} = R_{\text{RTL}}$

As the formula indicates, the 510 Ω ±5% in parallel with 15.8 kΩ ±1% shipped on the cable will work with properly terminated networks having a total RTH and RTL termination of 125 to 500 Ω, or individual devices having an RTH and RTL termination of 500 to 16 KΩ. For communication with a network having an overall RTH and RTL termination of 100 to 125 Ω, you will need to disconnect the 510 Ω resistors from the 7-pin pluggable screw terminal. This will make the RTH and RTL values of the PCMCIA-CAN/LS cable equal to the internal resistance of 15.8 kΩ ±1%. To produce RTH and RTL values between 494 and 15.8 kΩ on the PCMCIA-CAN/LS cable, use the following formula:

$$R_{\text{External RTH of PCMCIA-CAN/LS}\dagger} = \frac{1}{\left(\frac{1}{R_{\text{Desired RTH of PCMCIA-CAN/LS}}} - \frac{1}{R_{\text{Internal RTH of PCMCIA-CAN/}}}\right.}$$

$***R_{\text{Internal RTH of PCMCIA-CAN/LS}}$ = 15.8 kΩ ±1%

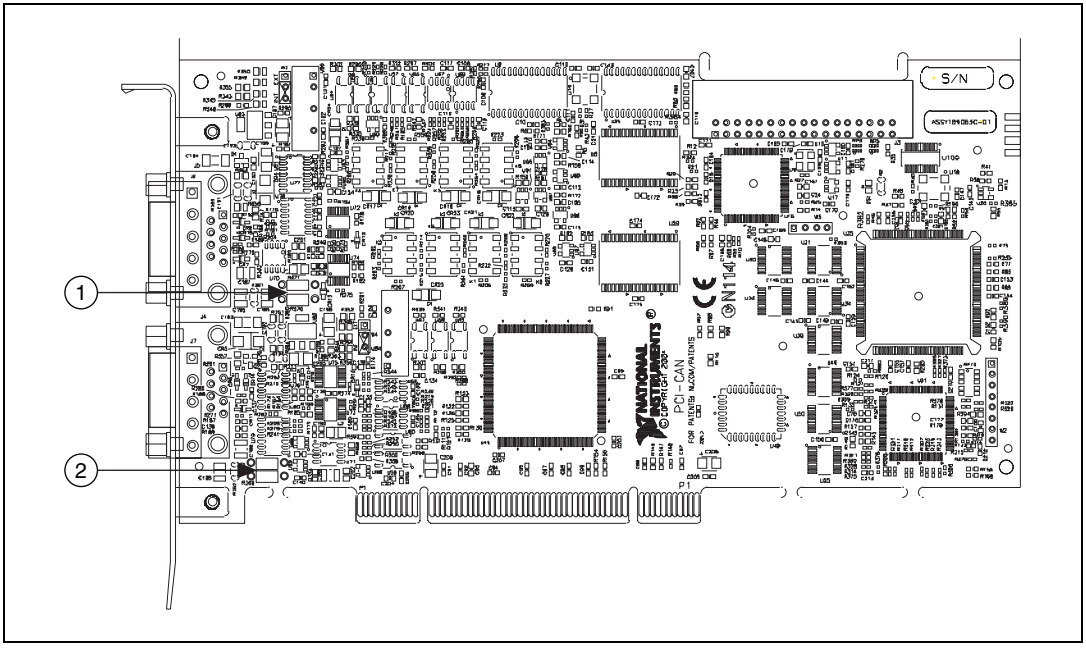
$\dagger R_{\text{RTH}} = R_{\text{RTL}}$

For information on replacing the external RTH and RTL resistors on the PCMCIA-CAN/LS cable, refer to the *Replacing the Termination Resistors on the PCMCIA-CAN/LS Cable* section.

Replacing the Termination Resistors on the PCI-CAN/LS Board

Complete the following steps to replace the termination resistors on the PCI-CAN/LS card, after you have determined the correct value in the *Determining the Necessary Termination Resistance for the Board* section.

1. Remove the termination resistors on the low-speed CAN card. Figure 4-8 shows the location of the termination resistor sockets on a PCI-CAN/LS2 card.



1	Port 1 Termination Resistors	2	Port 2 Termination Resistors

Figure 4-8. Location of Termination Resistors on PCI-CAN/LS2 Board

2. Cut and bend the lead wires of the resistors you want to install. Refer to Figure 4-9.

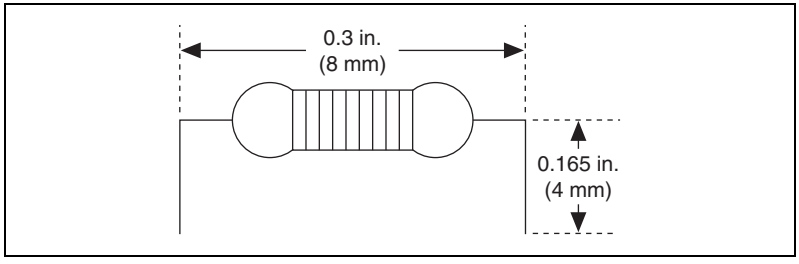


Figure 4-9. Preparing Lead Wires of Replacement Resistors

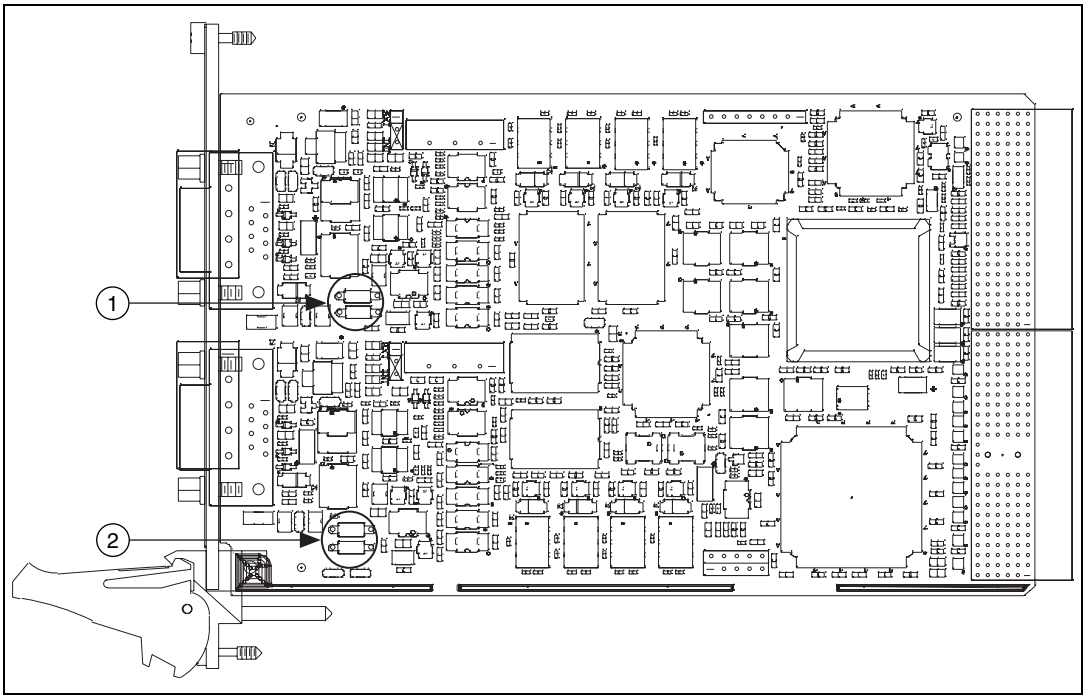
3. Insert the replacement resistors into the empty sockets.

4. Refer to the *CAN Hardware and NI-CAN Software for Windows Installation Guide* in the jewel case of the program CD to complete the hardware installation.

Replacing the Termination Resistors on the PXI-8460 Board

Complete the following steps to replace the termination resistors, after you have determined the correct value in the *Determining the Necessary Termination Resistance for the Board* section.

1. Remove the termination resistors on the PXI-8460. Figure 4-10 shows the location of the termination resistor sockets on a PXI-8460.



1 Port 1 Termination Resistors	2 Port 2 Termination Resistors

Figure 4-10. Location of Termination Resistors on a PXI-8460

2. Cut and bend the lead wires of the resistors you want to install. Refer to Figure 4-11.

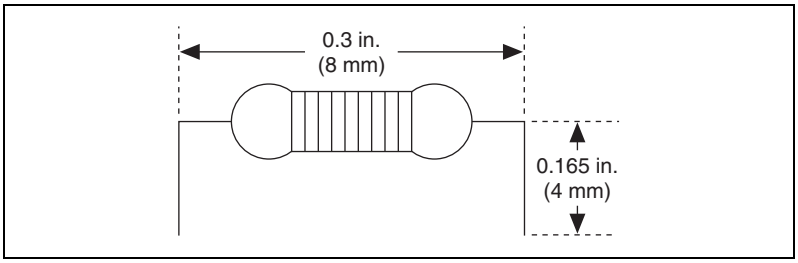


Figure 4-11. Preparing Lead Wires of Replacement Resistors

3. Insert the replacement resistors into the empty sockets.
4. Refer to the *CAN Hardware and NI-CAN Software for Windows Installation Guide* in the jewel case of the program CD to complete the hardware installation.

Replacing the Termination Resistors on the PCMCIA-CAN/LS Cable

Complete the following steps to replace the termination resistors on the PCMCIA-CAN/LS cable after you have determined the correct value in the *Determining the Necessary Termination Resistance for the Board* section.

1. Remove the two termination resistors on the PCMCIA-CAN/LS cable by loosening the pluggable terminal block mounting screws for pins 1 and 2 (RTL) and pins 6 and 7 (RTH).
2. Bend and cut the lead wires of the two resistors you want to install, as shown Figure 4-12.

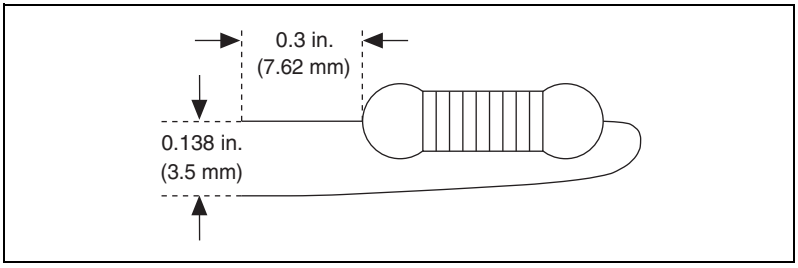


Figure 4-12. Preparing Lead Wires of PCMCIA-CAN/LS Cable Replacement Resistors

3. Mount RTL by inserting the leads of one resistor into pins 1 and 2 of the pluggable terminal block and tightening the mounting screws. Mount RTH by inserting the leads of the second resistor into pins 6 and 7 of the pluggable terminal block and tightening the mounting screws.
4. Refer to the *CAN Hardware and NI-CAN Software for Windows Installation Guide* in the jewel case of the program CD to complete the hardware installation.

Cabling Example

Figure 4-13 shows an example of a cable to connect two low-speed CAN devices. For the PCMCIA-CAN/LS cables, only V–, CAN_L, and CAN_H are required to be connected to the bus.

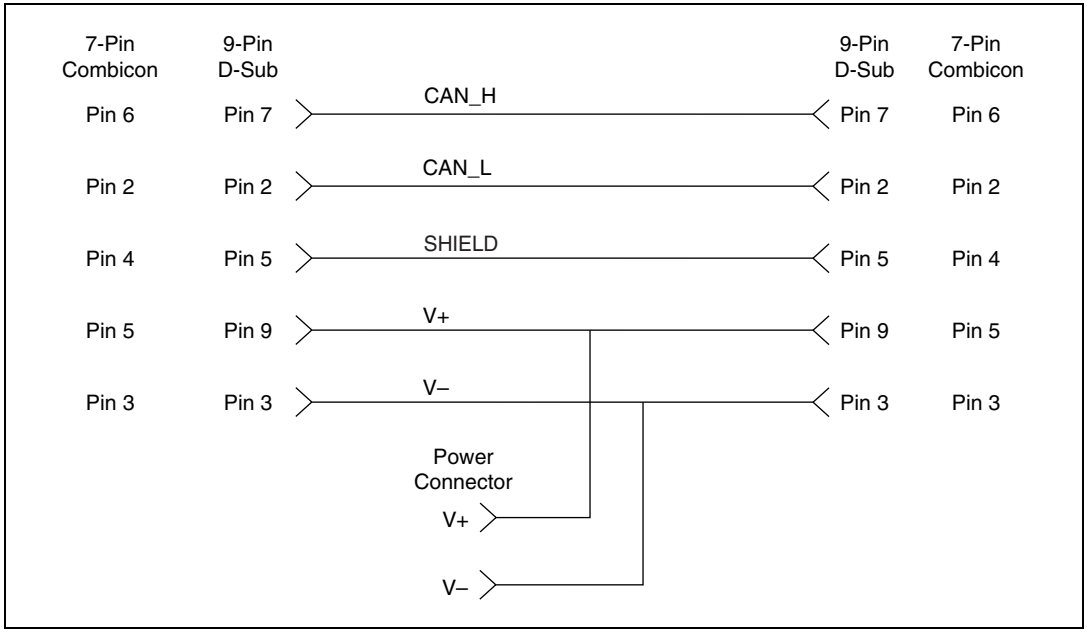


Figure 4-13. Cabling Example

Single Wire CAN

PCI and PXI Connector Pinout

PCI-CAN/SW and PXI-8463 hardware have a 9-pin male D-SUB (DB9) connector for each port. Figure 4-14 shows the 9-pin D-SUB connector pinout.

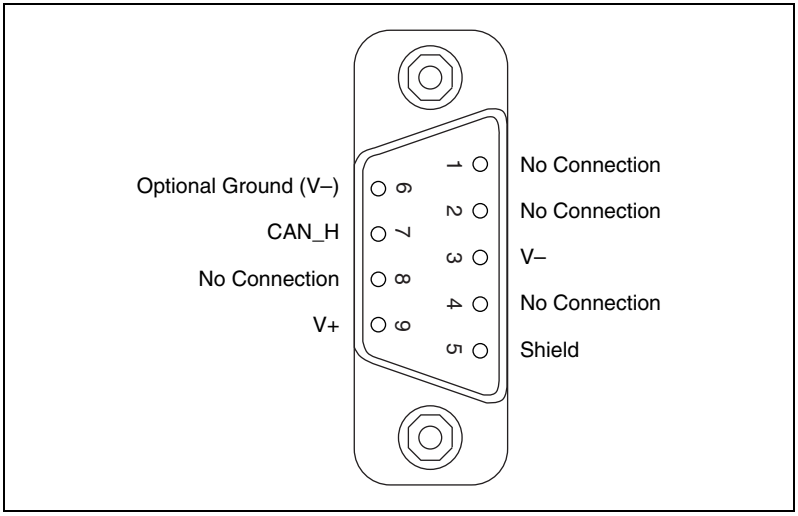


Figure 4-14. Pinout for 9-Pin D-SUB Connector

Table 4-8. 9-Pin D-SUB Connector Pin Descriptions

D-SUB Pin	Signal	Description
1	No Connection	—
2	No Connection	—
3	V–	CAN reference ground
4	No Connection	—
5	(Shield)	Optional CAN shield
6	(V–)	Optional CAN reference ground
7	CAN_H	CAN_H bus line

Table 4-8. 9-Pin D-SUB Connector Pin Descriptions (Continued)

D-SUB Pin	Signal	Description
8	No Connection	—
9	V+	CAN power supply

CAN_H is the signal line that carries the data on the CAN network.

V– serves as the reference ground for CAN_H.

V+ supplies bus power to the Single Wire CAN transceiver.

Shield is an optional connection when using a shielded CAN cable. Connecting the optional CAN shield may improve signal integrity in a noisy environment.

PCMCIA-CAN Connector Pinout

PCMCIA-CAN cables have both a 9-pin male D-SUB and Combicon-style pluggable screw terminal connector for each port. Figure 4-2 shows the end of a PCMCIA-CAN cable. The arrow points to pin 1 of the 5-pin screw terminal block. All of the signals on the 5-pin screw terminal are connected directly to the corresponding pins on the 9-pin D-SUB.

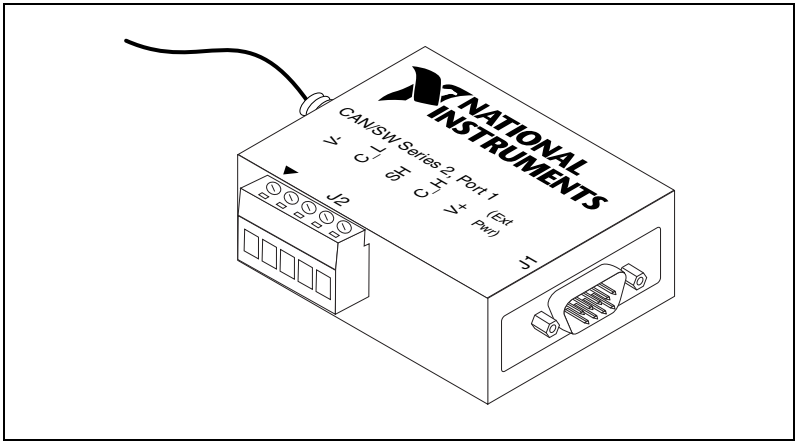


Figure 4-15. PCI-CAN Cable

Table 4-9. PCMCIA-CAN Cable Connector Pin Descriptions

D-SUB Pin	Combicon Pin	Signal	Description
1	—	No Connection	—
2	2	No Connection	—
3	1	V–	CAN reference ground
4	—	No Connection	—
5	3	(Shield)	Optional CAN shield
6	—	(V–)	Optional CAN reference ground
7	4	CAN_H	CAN_H bus line
8	—	No Connection	—
9	5	(V+)	CAN power supply

CAN_H is the signal line that carries the data on the CAN network.

V– serves as the reference ground for CAN_H.

V+ supplies bus power to the Single Wire CAN transceiver.

Shield is an optional connection when using a shielded CAN cable. Connecting the optional CAN shield may improve signal integrity in a noisy environment.

Cabling Requirements for Single Wire CAN

The number of nodes on the network, the total cable length of the system, the bus loading of each node, and the clock tolerance are all interrelated. It is therefore the responsibility of the system designer to factor in all of the above parameters when designing a Single Wire CAN network. The SAE J2411 standard provides some recommended specifications that can help in making these decisions:

Cable Length

There shall be no more than 60 m between any two network system ECU nodes.

Number of Devices

As stated previously, the maximum number of Single Wire CAN nodes allowed on the network depends on the electrical characteristics of the devices and cable. If all of the devices and cables meet the requirements of J2411, between 2 and 32 devices may be networked together.

Termination (Bus Loading)

NI Single Wire CAN hardware includes a built-in 9.09 kΩ load resistor as specified by J2411.

Cabling Example

Figure 4-16 shows an example of a cable to connect two Single Wire CAN devices.

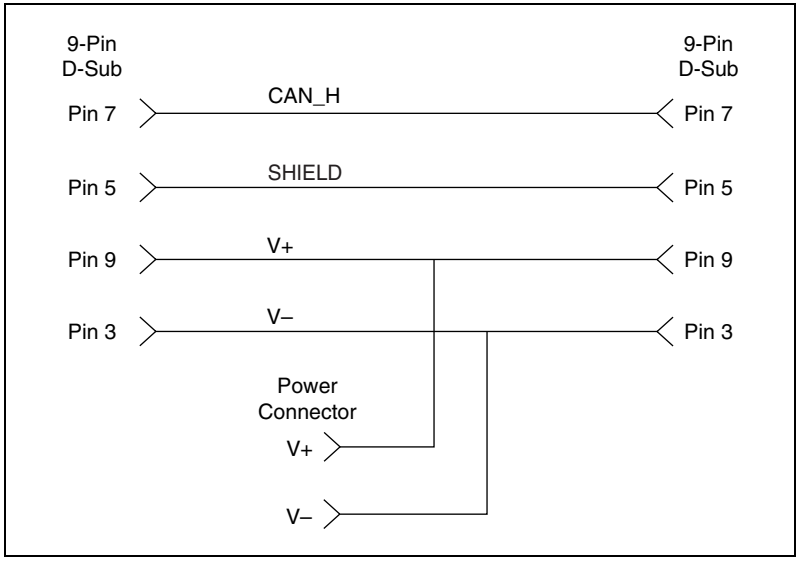


Figure 4-16. Cabling Example

XS CAN

PCI and PXI Connector Pinout

PCI-CAN/XS and PXI-8464 hardware have a 9-pin male D-SUB (DB9) connector for each port.

When an XS port is selected as **High-Speed**, its connector pinout is identical to a dedicated High-Speed interface as described in the *PCI and PXI Connector Pinout* section.

When an XS port is selected as **Low-Speed/Fault-Tolerant**, its connector pinout is identical to a dedicated Low-Speed/Fault-Tolerant interface as described in the *PCI and PXI Connector Pinout* section.

When an XS port is selected as **Single Wire**, its connector pinout is identical to a dedicated Single Wire interface as described in the *PCI and PXI Connector Pinout* section.

When an XS port has been selected as **External**, a different set of signals is routed to the 9-pin D-SUB connector. Figure 4-17 shows the 9-pin D-SUB connector pinout for an XS port in **External** mode.

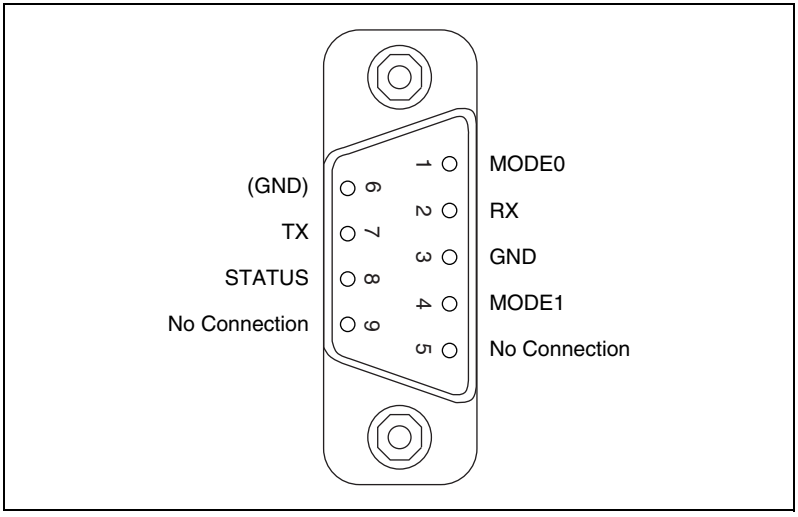


Figure 4-17. Pinout for 9-Pin D-SUB Connector

Table 4-10. 9-Pin D-SUB Connector Pin Descriptions

D-SUB Pin	Signal	Description
1	MODE0	Digital output signal for external transceiver mode control (XS port in external mode only)
2	RX	RX0 pin from SJA1000 CAN controller (XS port in external mode only)
3	GND	Ground
4	MODE1	Digital output signal for external transceiver mode control (XS port in external mode only)
5	No Connection	Do not connect signals to this pin
6	(GND)	Optional ground
7	TX	TX0 pin from SJA1000 CAN controller (XS port in external mode only)
8	STATUS	Digital input signal for external transceiver error reporting (XS port in external mode only)
9	No Connection	Do not connect signals to this pin

RX and TX are the serial receive and transmit signals from the SJA1000 CAN controller. GND serves as the reference ground for RX and TX.

MODE0 and MODE1 are digital output signals for controlling the mode selection of an external transceiver. For example, the TJA1041 and TJA1054A have STB and EN input pins to select the transceiver operating mode.

STATUS is a digital input signal for monitoring the status of an external transceiver. For example, the TJA1041 and TJA1054A have an ERR output to report bus fault conditions.

Cabling Requirements for XS CAN

For cabling requirements information, refer to the appropriate section on cabling requirements for High-Speed, Low-Speed/Fault-Tolerant, or Single Wire CAN depending on the XS port mode. Note that due to the different cabling requirements for each physical layer, when switching an XS port, you may also need to change out the cable to meet the network cabling requirements.

When designing external transceiver circuits for an XS port in external mode, keep the signal connections between the 9-pin D-SUB connector and the transceiver circuit as short as possible. Ideally, the external transceiver circuit should mount directly to the 9-pin D-SUB connector if possible.

External Transceiver Example

Figure 4-18 shows an example of an external transceiver circuit for an XS port in External mode.

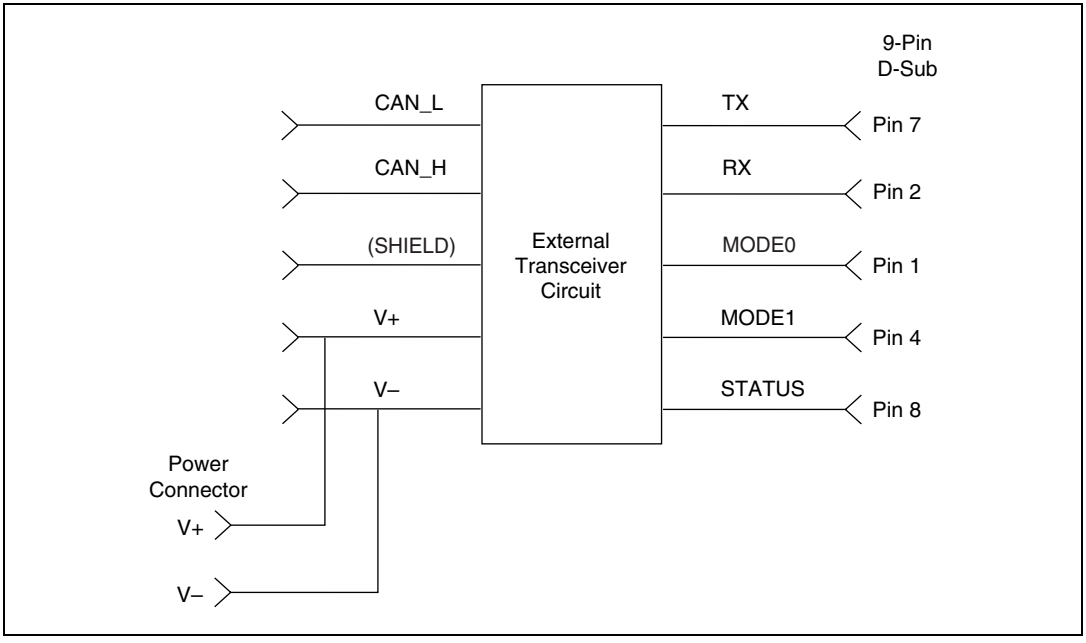


Figure 4-18. External Transceiver Circuit for an XS Port in External Mode

5

Application Development

This chapter explains how to develop an application using the NI-CAN APIs.

Choose the Programming Language

The programming language you use for application development determines how to access the NI-CAN APIs.

LabVIEW

NI-CAN functions and controls are available in the LabVIEW palettes. In LabVIEW 7.0 or later, the NI-CAN palette is located within the top-level **NI Measurements** palette. In earlier LabVIEW versions, the NI-CAN palette is located at the top-level. The top level of the NI-CAN function palette contains subpalettes for the Channel API and Frame API. Each subpalette of an API contains the most commonly used functions, with subpalettes for advanced functions.

The reference for each NI-CAN Channel API function is in Chapter 7, *Channel API for LabVIEW*. The reference for each NI-CAN Frame API function is in Chapter 10, *Frame API for LabVIEW*. To access the reference for a function from within LabVIEW, press <Ctrl-H> to open the help window, click the NI-CAN function, and then follow the link.

The NI-CAN software includes a full set of examples for LabVIEW. These examples teach basic NI-CAN programming as well as advanced topics. The example help describes each example and includes a link you can use to open the VI.

The NI-CAN example help is in **Help»Find Examples»Hardware Input and Output»CAN**.

LabWindows™/CVI™

Within LabWindows/CVI, the NI-CAN function panel is in **Libraries» NI-CAN**. Like other LabWindows/CVI function panels, the NI-CAN function panel provides help for each function and the ability to generate code.

The reference for each NI-CAN Channel API function is in Chapter 8, *Channel API for C*. The reference for each NI-CAN Frame API function is in Chapter 11, *Frame API for C*. You can access the reference for each function directly from within the function panel.

The header file for both NI-CAN APIs is `nican.h`. The library for both NI-CAN APIs is `nican.lib`.

The NI-CAN software includes a full set of examples for LabWindows/CVI. The NI-CAN examples are installed in the LabWindows/CVI directory under `samples\nican`.

Each example provides a complete LabWindows/CVI project (`.prj` file). A description of each example is provided in comments at the top of the `.c` file.

Visual C++ 6

The NI-CAN software supports Microsoft Visual C/C++ version 6.

The header file and library for Visual C/C++ 6 are in the `MS Visual C` folder of the NI-CAN folder. The typical path to this folder is `\Program Files\National Instruments\NI-CAN\MS Visual C`.

To use either NI-CAN API, include the `nican.h` header file in the code, then link with the `nicanmsc.lib` library file.

For C applications (files with `.c` extension), include the header file by adding a `#include` to the beginning of the code, such as:

```
#include "nican.h"
```

For C++ applications (files with `.cpp` extension), define `_cplusplus` before including the header, such as:

```
#define _cplusplus
#include "nican.h"
```

The `_cplusplus` define enables the transition from C++ to the C language NI-CAN functions.

The reference for each NI-CAN Channel API function is in Chapter 8, *Channel API for C*. The reference for each NI-CAN Frame API function is in Chapter 11, *Frame API for C*.

You can find examples for the C language in the `MS Visual C` subfolder of the `NI-CAN` folder. Each example is in a separate folder. A description of each example is in comments at the top of the `.c` file.

At the command prompt, after setting MSVC environment variables (such as with MS `vcvars32.bat`), you can build each example using a command such as:

```
cl -I.. singin.c ..\nicanmsc.lib
```

Borland C/C++

The header file and library for Borland C/C++ are in the `Borland C` folder of the NI-CAN folder. The typical path to this folder is `\Program Files\National Instruments\NI-CAN\Borland C`.

To use either NI-CAN API, include the `nican.h` header file in the code, then link with the `nicanbor.lib` library file.

For C applications (files with `.c` extension), include the header file by adding a `#include` to the beginning of the code, such as:

```
#include "nican.h"
```

For C++ applications (files with `.cpp` extension), define `_cplusplus` before including the header, such as:

```
#define _cplusplus
#include "nican.h"
```

The `_cplusplus` define enables the transition from C++ to the C language NI-CAN functions.

The reference for each NI-CAN Channel API function is in Chapter 8, *Channel API for C*. The reference for each NI-CAN Frame API function is in Chapter 11, *Frame API for C*.

You can find examples for the C language in the `Borland C` subfolder of the NI-CAN folder. Each example is in a separate folder. A description of each example is in comments at the top of the `.c` file.

Microsoft Visual Basic

The NI-CAN software supports Microsoft Visual Basic 6.0 or later.

To create an application in Visual Basic, add the `NI-CAN Channel API.BAS` or `NI-CAN Frame API.BAS` file with the `WIN32 API.BAS` file to the project. `WIN32 API.BAS` defines API calls to the Windows system which are called by functions defined in the `NI-CAN Channel API.BAS` and `NI-CAN Frame API.BAS` files. Adding these files to the project allows you to call any of the functions declared in them from the code.

The `.BAS` files are located in the `MS Visual Basic` folder of the NI-CAN folder. The typical path to this folder is `\Program Files\National Instruments\NI-CAN\MS Visual Basic`.

The reference for each NI-CAN Channel API function is Chapter 8, *Channel API for C*. The reference for each NI-CAN Frame API function is Chapter 11, *Frame API for C*.

You can find examples for Visual Basic in the `Channel API examples` and `Frame API examples` subfolders of the `MS Visual Basic` folder. Each example is in a separate folder. A `.vbp` file with the same name as the example opens the Visual Basic project. A description of the example is located in a Help form within the project.

Other Programming Languages

The NI-CAN software does not provide formal support for programming languages other than those described in the preceding sections. Nevertheless, you may find libraries and examples for other programming languages on the National Instruments Web site, `ni.com`.

If the programming language provides a mechanism to call a Dynamic Link Library (DLL), you can create code to call NI-CAN functions. All functions for the Channel API and Frame API are in `nican.dll`.

If the programming language supports the Microsoft Win32 APIs, you can load pointers to NI-CAN functions in the application. The following text demonstrates use of the Win32 functions for C/C++ environments other than Visual C/C++ 6. For more detailed information, refer to Microsoft documentation.

The following C language code fragment shows how to call Win32 `LoadLibrary` to load the DLL for the NI-CAN Channel API:

```
#include <windows.h>
```

```
#include "nican.h"

HINSTANCE NicanLib = NULL;

NicanLib = LoadLibrary("nican.dll");
```

Next, the application must call the Win32 `GetProcAddress` function to obtain a pointer to each NI-CAN function that the application will use. For each NI-CAN function, you must declare a pointer variable using the prototype of the function. For the prototypes of each NI-CAN function, refer to the C language chapters in this manual.

```
static nctTypeStatus (NCT_FUNC * PnctInitStart)
    (const str TaskList, i32 Interface, i32 Direction,
    f64 SampleRate, nctTypeTaskRef * TaskRef);

static nctTypeStatus (NCT_FUNC * PnctRead)
    (nctTypeTaskRef TaskRef, u32 NumberOfSamplesToRead,
    nctTypeTimestamp * StartTime, nctTypeTimestamp *
    DeltaTime, f64 * SampleArray, u32 *
    NumberOfSamplesReturned);

static nctTypeStatus (NCT_FUNC * PnctClear)
    (nctTypeTaskRef TaskRef);

PnctInitStart = (nctTypeStatus (NCT_FUNC *)
    (const str, i32, i32, f64, nctTypeTaskRef *))
    GetProcAddress(NicanLib, (LPCSTR)"nctInitStart");

PnctRead = (nctTypeStatus (NCT_FUNC *)
    (nctTypeTaskRef, u32, nctTypeTimestamp *,
    nctTypeTimestamp *, f64 *, u32 *))
    GetProcAddress(NicanLib, (LPCSTR)"nctRead");

PnctClear = (nctTypeStatus (NCT_FUNC *)
    (nctTypeTaskRef))
    GetProcAddress(NicanLib, (LPCSTR)"nctClear");
```

The application must de-reference the pointer to call the NI-CAN function, as shown by the following code:

```
nctTypeStatus status;

nctTypeTaskRef TaskRef;

status = (*PnctInitStart)("mychannel1, mychannel2", 0,
nctModeInput, 1000.0, &TaskRef);
```

Before exiting the application, you must unload the NI-CAN DLL as follows:

```
FreeLibrary(NicanLib);
```

Choose Which API To Use

For a given NI-CAN interface such as **CAN0**, you can use only one API at a time. Therefore, for new application development, you need to decide which API to use.

For example, if you have one application that uses the Channel API and another application that uses the Frame API, you cannot use **CAN0** with both at the same time. As an alternative, you can connect **CAN0** and **CAN1** to the same network, then use **CAN0** with one application and **CAN1** with the other, if you have a 2-port CAN card. As another alternative, you can use **CAN0** in both applications, but run each application at a different time (not simultaneously).

Because the Channel API provides access to the CAN network in easy-to-use physical units, it is recommended over the Frame API for customers who are getting started with NI-CAN. You also need to use the Channel API if you want to utilize CAN messages or channels that are defined in CAN database files.

Nevertheless, because the Frame API provides lower-level access to the CAN network, there are a few reasons why you might want to use it over the Channel API:

- You are continuing with an application developed with NI-CAN version 1.6 or earlier. The Frame API is compatible with such code.
- You need to implement a command/response protocol in which you send a command to the device, and then the device replies by sending a response. Command/response protocols typically use a fixed pair of IDs for each device, and the ID does not determine the meaning of the data bytes.
- The devices require use of remote frames. The Channel API does not provide support for remote frames, but the Frame API has extensive features to transmit and receive remote frames. For more information, refer to the *Remote Frames* section of Chapter 9, *Using the Frame API*.
- The Frame API provides RTSI features that are lower level than the synchronization features of the Channel API. If you have advanced requirements for synchronizing CAN and DAQ cards, you may need to use the Frame API. For more information, refer to the *RTSI* section of Chapter 9, *Using the Frame API*.

In some cases, applications might require the ability to convert CAN data between a CAN *frame* and a CAN *channel*. For information on frame to

channel conversion, channel to frame conversion, and virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

6

Using the Channel API

This chapter helps you get started with the Channel API.

Choose Source of Channel Configuration

The first step in using the Channel API is to create the channel configuration for the applications. This channel configuration describes how the NI-CAN software converts raw data in messages to or from the physical units of each channel.

The NI-CAN software provides various methods to create the channel configuration. The flowchart in Figure 6-1 shows a process you can use to decide the source of the channel configuration. A description of each step in the decision process follows the flowchart.

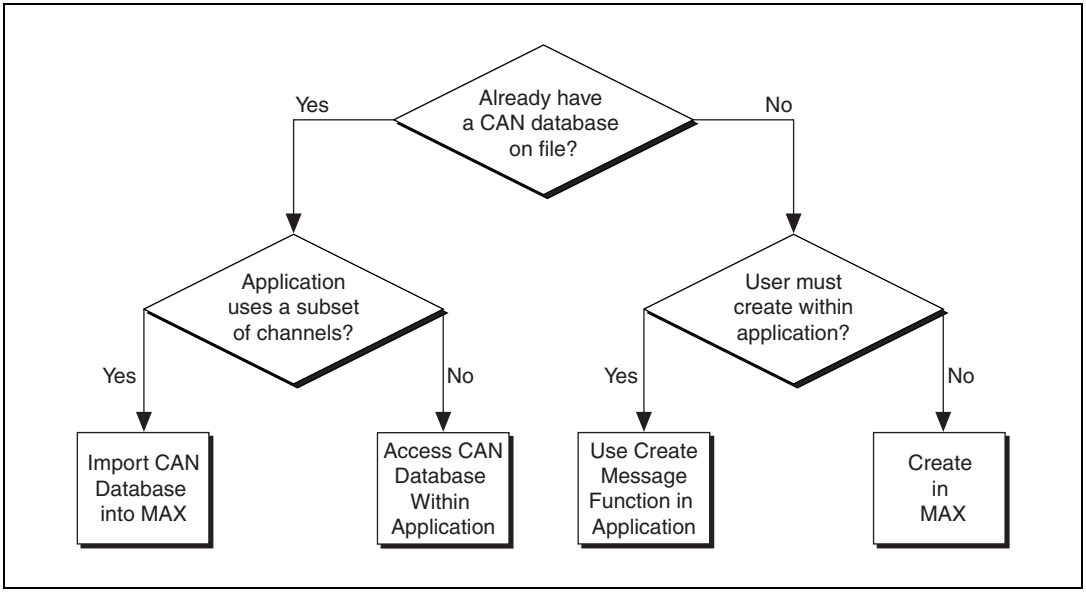


Figure 6-1. Decision Process for Choosing Source of Channel Configuration

Already Have a CAN Database File?

If you have a CAN database file, the channel configuration has already been created using a tool such as Vector's CANdb Editor. You can use each signal name in the CAN database as a channel name in the NI-CAN Channel API.

If you answer yes, refer to the *Application Uses a Subset of Channels?* section. If you answer no, refer to the *User Must Create within Application?* section.

Application Uses a Subset of Channels?

If the CAN database file contains a large number of channel descriptions (1,000 or more), does the application use only a subset of these channels (100 or less)? Importing the channels into MAX provides many benefits, but managing the transfer of large amounts of data from CAN databases can be cumbersome. For example, if the large CAN database file is updated periodically, you need to ensure that the changes are reflected in MAX after each update.

If you answer yes, refer to the *Import CAN Database into MAX* section. If you answer no, refer to the *Access CAN Database within Application* section.

There are limitations on how NI-CAN uses information from a Vector CANdb database file. For current information on NI-CAN support for Vector CANdb files, refer to the NI-CAN readme file.

Import CAN Database into MAX

The benefits of importing channels into MAX include:

- The option of initializing the channel name alone within the Channel API. No path to the CAN database file is required.
- Using the **Test Panel** in MAX to read and write the channels.

To import channel configurations from a Vector CANdb file into MAX, right-click the **CAN Channels** heading, then select **Import from CANdb File**. Use shift-click to select multiple channels, and then select **Import**. If you need to select another set, you can select the channels and then **Import** again. When you are finished with the import, select **Done** to return to MAX.

You can download the MAX channel configuration to a LabVIEW RT system by right-clicking the **CAN Channels** heading, and selecting **Send to RT System**.

Access CAN Database within Application

To access the CAN database within the application, you must initialize the channel name with the file path as a prefix. For example, if you are using a channel named `EngineRPM` in the `C:\DBC_Files\Prototype.DBC` file, you pass the following name to the Init Start function:

```
C:\DBC_Files\Prototype.DBC::EngineRPM
```

For more information, refer to the description of the Init Start function in the Channel API reference chapters.

You can download the channel configuration to a LabVIEW RT system by right-clicking the **CAN Channels** heading, and selecting **Send to RT System**.

User Must Create within Application?

Are you developing an application that another person will use, and that person must create the channel configuration using the application itself?

If you answer yes, refer to the *Use Create Message Function in Application* section.

If you answer no, you create the channel configuration within MAX. You can save the MAX channel configuration to a file, so this method does not prevent you from deploying the application for use by others. For more information, refer to the *Create in MAX* section.

Use Create Message Function in Application

The Create Message function (**CAN Create Message** in LabVIEW and `nctCreateMessage` in other languages) takes inputs for a single message configuration, then one or more channel configurations. By using Create Message to create the channel configurations, the application is entirely self contained, not depending on MAX or a CAN database file.

The inputs to Create Message are relatively advanced for many users. Use of MAX or a CAN database helps to isolate the application end user from the specifics of CAN message encoding.

Mode dependent channels are a special kind of CAN message used within some networks. Refer to the *Mode Dependent Channels* section of this chapter for more information. If you must support creation of mode dependent channel configurations within the application, use the Create MessageEx function instead of Create Message. The Create MessageEx function provides extensions for creation of mode dependent as well as normal channels.

Create in MAX

To create channel configurations within MAX, right-click the **CAN Channels** heading, then select **Create Message**. Enter the message properties, then select **OK**. Right-click the message name, then select **Create Channel**. Enter the channel properties, then select **OK**. Select **Create Channel** again for each channel contained in the message. Channel names are case sensitive.

To save channel configurations to a file, right-click the **CAN Channels** heading, then select **Save Channel Configuration**. The resulting NI-CAN database uses file extension `.ncd`. You can access the NI-CAN database using the Init Start function just like any other CAN database. By simply installing the NI-CAN database file along with the application, you can deploy the application to a variety of users.

Channel API Basic Programming Model

When you use the Channel API, the first step is to initialize a list of channels with the same direction, such as input or output. You can then read or write this list of channels as a unit. The term *task* refers to a list of channels you read or write together. A common use of the task concept is to read/write all channels of a message.

The diagram in Figure 6-2 describes the basic programming model for the NI-CAN Channel API. Within the application, you repeat this basic programming model for each task. The diagram is followed by a description of each step in the model.

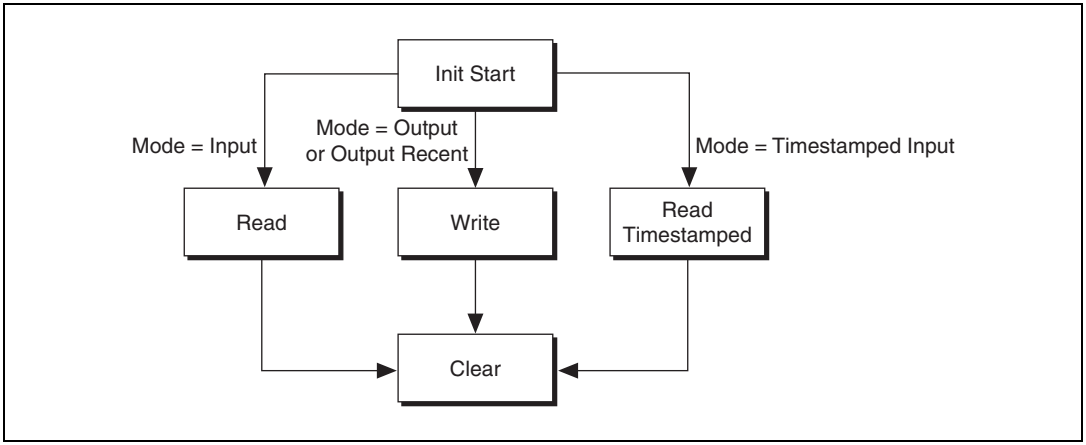


Figure 6-2. Basic Programming Model for Channel API

Init Start

The Init Start function initializes a list of channels as a single task, then starts communication for that task.

The Init Start function uses the following input parameters:

- **channel list**—Specifies the list of channels for the task, with one string for each channel.
- **interface**—Specifies the CAN interface to use for the task. The interface is an enumeration in which `0` specifies CAN0, `1` specifies CAN1, and so on. The baud rate is taken from the properties of the interface in MAX.
- **mode**—Specifies the I/O mode to use for the task. This determines the direction of data transfer for the task (that is, Input or Output). It also determines the type of Read or Write function you use with the task. For more information, refer to the following sections.
- **sample rate**—Specifies the rate of sampling for input and output modes. The sample rate is specified in Hertz (samples per second). For more information, refer to the *Read* and *Write* sections.

The Init Start function simply calls the Initialize function followed by the Start function. This provides an easy way to start a list of channels.

There are a few scenarios in which you cannot use Init Start:

- **Set Property**—If you need to set properties for the task, you must call Initialize, Set Property, and Start in sequence. For example, use Set

Property if you need to specify the baud rate for the interface within the application. For more information, refer to the *Set Property* section.

- **Synchronization**—If you need to synchronize multiple cards, you must call Initialize, then the appropriate functions to synchronize and start the cards. For more information, refer to the *Synchronization* section.
- **Create Message**—If you need to create channel configurations within the application, you must call Create Message and Start in sequence. For assistance is deciding whether Create Message is appropriate for the application, refer to the *Choose Source of Channel Configuration* section.

The Init Start function is **CAN Init Start** in LabVIEW and `nctInitStart` in other languages.

Read

If the mode of Init Start is Input, the application must call the Read function to obtain floating-point samples. The application typically calls Read in a loop until done.

The Read function is **CAN Read** in LabVIEW (all types that don't end in **Time** & **Dbl**) and `nctRead` in other languages.

The behavior of Read depends on the initialized sample rate.

sample rate = 0

Read returns a single sample from the most recent message(s) received from the network. One sample is returned for every channel in the Init Start list.

Figure 6-3 shows an example of Read with sample rate = `0`. *A*, *B*, and *C* represent messages for the initialized channels. If no message is received since the start of the application, the Default Value in MAX (*def*) is returned, along with a warning.

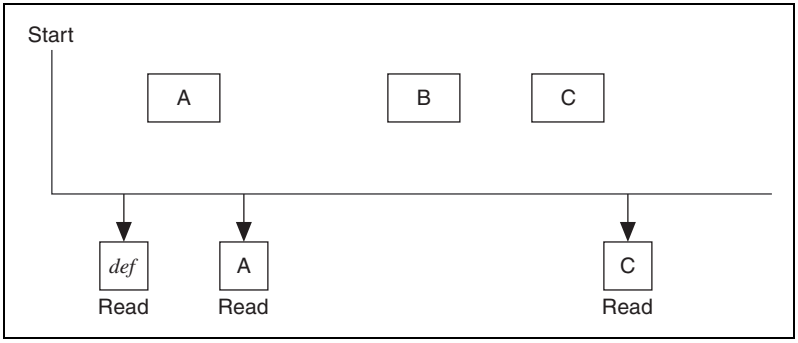


Figure 6-3. Example of Read with sample rate = 0

sample rate > 0

Read returns an array of samples for every channel in the Init Start list. Each time the clock ticks at the specified rate, a sample from the most recent message(s) is inserted into the arrays. In other words, the samples are repeated in the array at the specified rate until a new message is received. By using the same sample rate with NI-DAQ Analog Input channels or NI-DAQmx Analog Input channels, you can compare CAN and DAQ samples over time.

Figure 6-4 shows an example of Read with sample rate > 0. *A*, *B*, and *C* represent messages for the initialized channels. <*delta-t*> represents the time between samples as specified by the sample rate. *def* represents the Default Value in MAX.

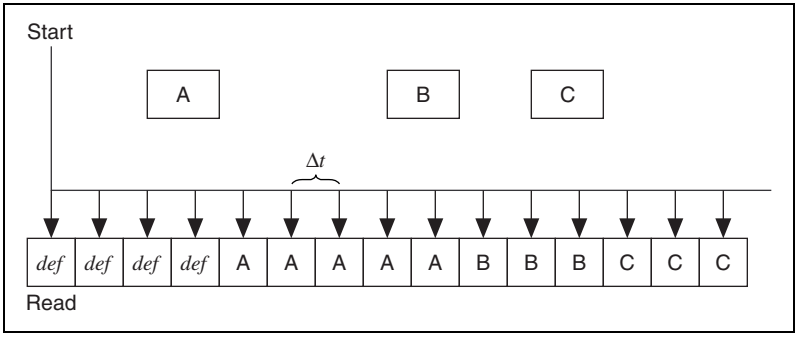


Figure 6-4. Example of Read with sample rate > 0

Read Timestamped

If the Init Start mode is Timestamped Input, the application must call the Read Timestamped function to obtain floating-point samples. The application typically calls Read Timestamped in a loop until done.

The Read Timestamped function returns samples that correspond to messages received from network. For each message, an associated sample is returned along with a timestamp that specifies when the message arrived. An array of timestamped samples is returned for every channel in the Init Start list.

The Read Timestamped function is **CAN Read** in LabVIEW (types that end in **Time** and **Dbl**) and `nctReadTimestamped` in other languages.

Figure 6-5 shows an example of Read Timestamped. *A*, *B*, and *C* represent messages for the initialized channels. A*t*, B*t*, and C*t* represent the times when each message was received.

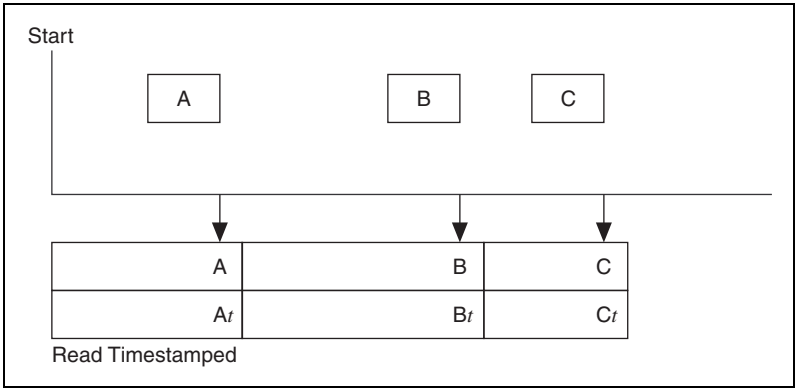


Figure 6-5. Example of Read Timestamped

Write

If the Init Start mode is Output (or Output Recent), the application must call the Write function to output floating-point samples. The application typically calls Write in a loop until done.

The Write function is **CAN Write** in LabVIEW and `nctWrite` in other languages.

The behavior of Write depends on the initialized sample rate.

sample rate = 0

Write transmits a message immediately on the network. The samples provided to write are used to form the data bytes of the message. One sample must be specified for every channel in the Init Start list. The Init Start mode must be Output for this behavior (not Output Recent).

Figure 6-6 shows an example of Write with sample rate = `0`. *A*, *B*, *C*, and *D* represent messages for the initialized channels. For each Write, the associated messages are transmitted as quickly as possible.

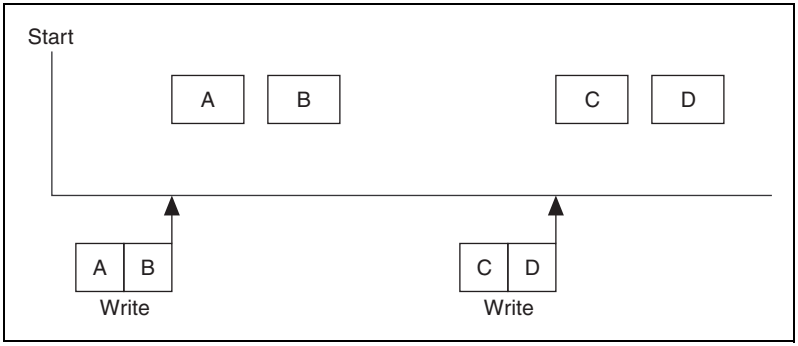


Figure 6-6. Example of Write with Sample Rate = 0

sample rate > 0, Output mode

You provide an array of samples for every channel in the Init Start list. Each time the clock ticks at the specified rate, the next message is transmitted. Each message uses the next sample from the array(s) to form the data bytes of the message. In other words, the samples from the array are transmitted periodically onto the network. By using the same sample rate with NI-DAQ Analog Output channels or NI-DAQmx Analog Output channels, you can output synchronized CAN and DAQ samples over time.

Figure 6-7 shows an example of Write with sample rate > `0` and Output mode. *A*, *B*, *C* and *D* represent messages for the initialized channels. <*delta-t*> represents the time between message transmission as specified by the sample rate.

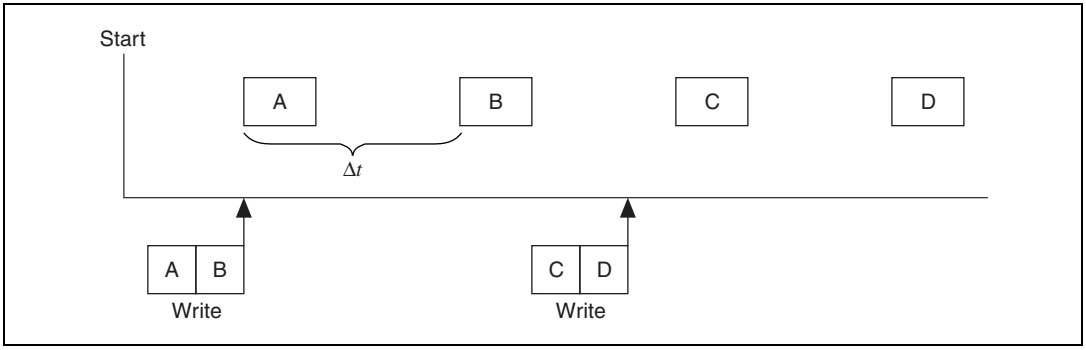


Figure 6-7. Example of Write with Sample Rate > 0, Output Mode

sample rate > 0, Output Recent mode

You provide a single sample for every channel in the Init Start list. Each time the clock ticks at the specified rate, the next message is transmitted using the most recent sample that you provided. The Output Recent mode is useful when you have multiple tasks running at different rates, because you can write samples for all tasks in a single loop.

Figure 6-8 shows an example of Write with sample rate > 0 and Output Recent mode.

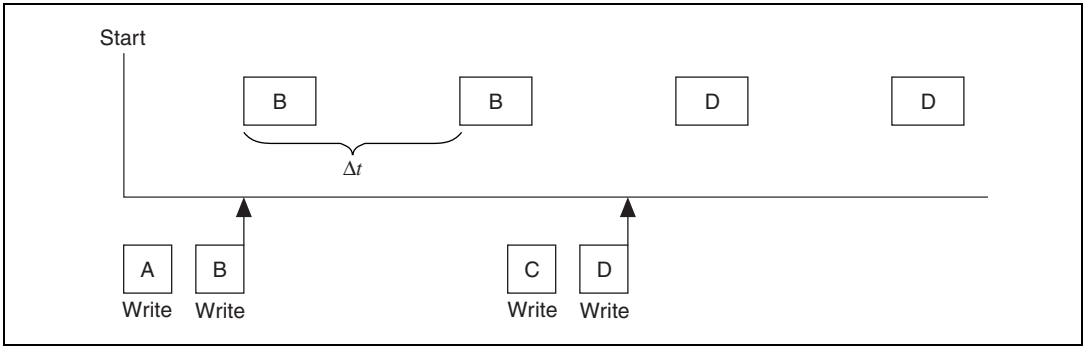


Figure 6-8. Example of Write with Sample Rate > 0, Output Recent Mode

Clear

The Clear function stops communication for the task, then clears the configuration.

For every task that you initialize, you must call Clear prior to exiting the application.

The Clear function is **CAN Clear** in LabVIEW and `nctClear` in other languages.

Additional Programming Topics

The following sections provide information you can use to extend the basic programming model.

Get Names

If you are developing an application that another person will use, you may not want to specify a fixed channel list in the application. Ideally, you want the end-user to select the channels of interest from user interface controls, such as list boxes.

The Get Names function queries MAX or a CAN database and returns a list of all channels in that database. You can use this list to populate user-interface controls. The end-user can then select channels from these controls, avoiding the need to type each name using the keyboard. Once the user makes his selections, the application can pass the resulting list to Init Start.

The Get Names function is **CAN Get Names** in LabVIEW and `nctGetNames` in other languages.

Synchronization

The NI-CAN Channel API uses RTSI to synchronize specific functional units on each card. For CAN cards, the functional unit is the interface (port). For DAQ cards, the functional unit is a specific measurement such as Analog Input or Analog Output. Each function routes two signals over the RTSI connection:

- **timebase**—This is a common clock shared by both cards. The shared timebase ensures that sampling does not drift. The timebase applies to all functional units on the card.
- **start trigger**—This signal is sent from one functional unit to the other functional unit when sampling starts. The shared start trigger ensures that both units start simultaneously.

Note If you are using E Series or M Series DAQ hardware which supports the NI-DAQmx API, refer to the NI-CAN to NI-DAQmx synchronization VIs in LabVIEW for examples of CAN and DAQ synchronization. These VIs need LabVIEW version 7.0 or later.

Set Property

The Init Start function uses interface and channel configuration as specified in MAX or the CAN database file. If you need to change this configuration within the application, you cannot use Init Start, because most properties cannot be changed while the task is running.

For example, to set the baud rate for the interface within the application, use the following calling sequence:

- Initialize the task as stopped. The Initialize function is **CAN Initialize** in LabVIEW and `nctInitialize` in other languages.
- Use Set Property to specify the new value for the baud rate property. The Set Property function is **CAN Set Property** in LabVIEW and `nctSetProperty` in other languages.
- Start the task with the Start function. The Start function is **CAN Start** in LabVIEW and `nctStart` in other languages.

After the task is started, you may need to change properties again. To change properties within the application, use the Stop function to stop the task, Set Property to change properties, and then start the task again.

You also can use the Get Property function to get the value of any property. The Get Property function returns values whether the task is running or not.

Frame to Channel Conversion

Introduction

As described in the *NI-CAN Software Overview* of Chapter 1, NI-CAN supports two distinct formats for CAN data. The first format is the CAN *frame*, which represents a raw frame consisting of an ID, type, data bytes, and timestamp. The second format is the CAN *channel*, which represents a field in the data of a specific ID, scaled to a floating point value in physical units (such as Volts or Revolutions-per-minute).

Many applications require the ability to convert CAN data from one format to another. As one example, consider an application that logs CAN traffic to a file for an extended period of time. Since CAN frames occur in an event driven manner, the most efficient means of file storage is to use CAN frames as the data format. Nevertheless, when displaying the contents of the log file, you may need to plot the data as waveforms for specific CAN channels. Therefore, the application must convert the CAN frames in the file into CAN channels for waveform display.

Figure 6-9 demonstrates how you can use NI-CAN to display waveforms of CAN channels using a log file consisting of CAN frames. NI-CAN provides a virtual CAN card with two interfaces, CAN256 and CAN257. The two virtual interfaces are connected by a virtual bus. When you write CAN frames to one virtual interface, those frames are received by the other virtual interface, and can be read as channels. This feature allows you to read and write CAN data in the same manner as two real CAN interfaces connected by a real CAN cable. The conversion does not require real NI CAN hardware, and your application is not required to check for specific CAN IDs.

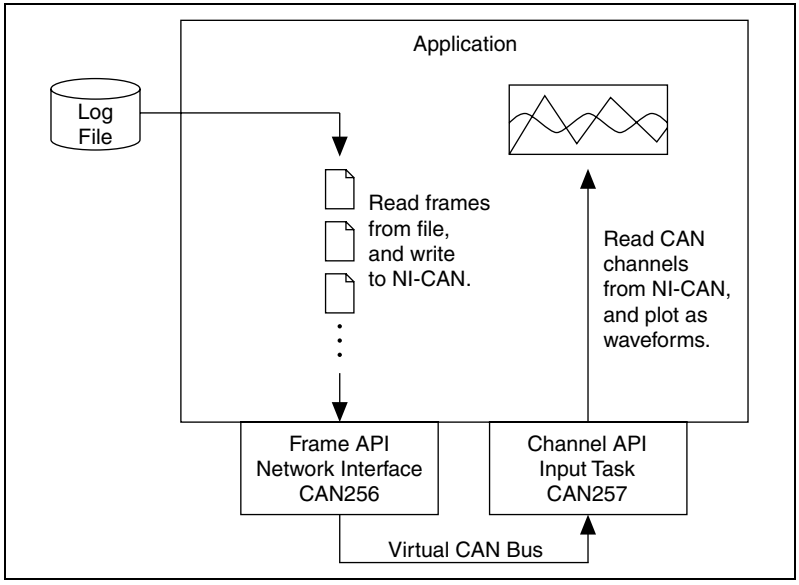


Figure 6-9. Display Waveforms of CAN Channels Using a Log File of CAN Frames

When Should I Use Frame to Channel Conversion?

The following sections outline some applications that use frame to channel conversion, channel to frame conversion, or other aspects of the virtual interface concept.

Logging

As explained in the *Introduction*, logging is one of the primary applications for frame to channel conversion. Since overall CAN traffic does not occur at a fixed rate, the most efficient implementation is to store each CAN frame as it is received. The file of CAN frames can later be displayed as channels using NI-CAN's frame to channel conversion.

In addition to displaying a log file as channels, you can also use NI-CAN to create a log file using channel data. The process for this channel to frame conversion is essentially a reversal of the operations shown in Figure 6-9. You obtain CAN channel data from front panel controls, and write that CAN channel data to a Channel API output task on a virtual interface (CAN257). Next, you read the resulting CAN frames from a Frame API virtual interface (CAN256), and write those frames to the log file. At a subsequent date, you can replay this log file to a real CAN interface using the timestamped transmit feature (**Transmit Mode** attribute of the Frame API network interface).

Although NI-CAN examples demonstrate a simple binary log file format, your logging or replay application can access any file format that you require. Although there is a wide variety of CAN log file formats available from other companies, almost all use CAN frames as the fundamental data type. Once you obtain the specification for a specific CAN log file format, it is relatively straightforward to convert the file contents to data that is compatible with the NI-CAN Frame API.

CompactRIO

The rugged enclosure and real-time capabilities of CompactRIO, as discussed in the *CAN for CompactRIO* section of Chapter 3, make it an ideal product for testing in the field, such as drive testing of an automobile. Since the LabVIEW FPGA I/O interface for CAN provides access to CAN frames only, you must use NI-CAN's frame to channel conversion features when access to CAN channels is required.

For logging applications, the LabVIEW application on CompactRIO is simple: read CAN frames and store them in a file. When the CAN log file is later transferred from CompactRIO to a lab computer, the application on that computer can use NI-CAN to read frames from the log file and display as CAN channels, as shown in Figure 6-9. In addition, if the LabVIEW application on CompactRIO stores a second log file with analog/digital samples, that data can be displayed on the lab computer as waveforms synchronized with the CAN channels.

For applications in which you must execute a control model within CompactRIO, you typically wire CAN channels as inputs and outputs to the control model. In order to implement this, you can install NI-CAN on the LabVIEW RT controller of CompactRIO. Your LabVIEW FPGA VI reads and writes CAN frames, and transfers those CAN frames to/from LabVIEW RT as you would any other I/O. Your LabVIEW RT VI uses NI-CAN's virtual interfaces to convert the CAN frames to/from CAN channels. Your NI-CAN Channel API tasks use sample rate 0 and

single-sample read/write, thus providing immediate single-point values for the control model.

Development without CAN Hardware

The virtual interface can enable development of an NI-CAN application on a computer that does not contain NI CAN hardware. Although the NI-CAN virtual interface does impose some *Limitations*, most functions return successful status. In addition, the virtual bus feature may enable you to debug your application by simulating limited CAN traffic. For example, if your application is intended to test a CAN *node*, you can run your test on CAN256, and run a simple simulation of the node on CAN257.

Database Queries

For large test applications that are deployed to several end-users, it is common to query CAN databases for initial configuration of a test. For example, you specify a list of channel names, each with parameters for display in a single waveform graph, then save that test configuration to a file. The application that queries the CAN database to create a test configuration file often executes on a system without NI CAN hardware.

By initializing a Channel API task on CAN256, you can use the CAN Get Property function to obtain detailed information for each message and channel in a CAN database.

Enhance an Existing Frame API Application

You have a large Frame API application for an older version of NI-CAN (1.*x*), and that application can benefit from display of CAN data as channels. Rather than changing all of the application's CAN communication from the Frame API to the Channel API, you can use frame to channel conversion to enhance the existing code. For example, the bulk of the application can communicate on a real interface (i.e. CAN0) using the Frame API, but you can add code that uses virtual interfaces to convert raw frame data to/from channel data for additional displays.

Virtual Bus Timing

The NI-CAN virtual interface provides an attribute that does not exist on real interfaces. Virtual Bus Timing is a boolean attribute that specifies whether the time between successive CAN frames is simulated by NI-CAN when the frames transfer across the virtual bus.

When Virtual Bus Timing is true (default), the time between frames is simulated. Frame timestamps are recalculated as they transfer across the virtual bus. This mode is useful when you want the virtual bus to behave as much like a real bus as possible. For example, if you use the technique shown in Figure 6-9 to display a log file that was captured over 200 seconds of time, the channel waveforms will scroll slowly to display data for 200 seconds. This is due to the fact that when you write two frames whose timestamps are a few seconds apart, NI-CAN will delay a few seconds on the virtual bus, and therefore the Channel API Read of CAN257 will delay between the two frames. The programming model used to write NI-CAN applications for real CAN hardware can be used for a majority of applications with Virtual Bus Timing enabled. Refer to the *Channel API Basic Programming Model* in this chapter, and the *Frame API Basic Programming Model* section of Chapter 9, for information on programming real CAN hardware.

When Virtual Bus Timing is false, the time between frames is not simulated. Frame timestamps are unchanged as they transfer across the virtual bus. This mode is useful when you want to convert CAN data from frames to channels as quickly as possible. For example, if you use the technique shown in Figure 6-9 to display a log file that was captured over 200 seconds of time, the channel waveforms will scroll by very quickly. This is due to the fact that when you write two frames whose timestamps are a few seconds apart, NI-CAN will not delay the transfer on the virtual bus, and therefore the Channel API Read of CAN257 will not delay between the two frames. Although the conversion occurs quickly, you will presumably use products like LabVIEW or DIAdem to search the waveforms for specific events. When Virtual Bus Timing is disabled, time advances only up to the timestamp of the last frame written onto the virtual bus. As a result, if NI-CAN detects that a frame with a timestamp lesser than the previous frame timestamp is being written onto the virtual bus, an error will be returned. Refer to the *Programming Model for Virtual Bus Timing Disabled* section in this chapter for information on developing an application that converts frames to channels or channels to frames without simulating frame timing.

When you change the Virtual Bus Timing in your application, you must set the same value on both virtual interfaces, CAN256 and CAN257.

Limitations

The virtual interface is not designed to support all of the features of a real interface. This section serves as the primary reference for the limitations of the virtual interface.

For each NI-CAN feature, the virtual interface will behave in one of three ways:

- **Error**—The NI-CAN function returns an error. This occurs for features that are not supported, and which represent high-level capabilities that your application would require. For example, the virtual interface does not support Frame API CAN Objects, so the error helps to clarify that you cannot execute applications that rely on CAN Objects.
- **Non-operational**—The NI-CAN function returns success, but the feature performs in a fixed, non-operational manner. This occurs for features that your application typically would not rely on. For example, the virtual interface always returns zero for the **Serial Number** attribute, because your application may display the serial number, but operate correctly when the number is invalid.
- **Operational**—The NI-CAN function returns success, and operates as expected with regard to the virtual bus. For example, if you write a frame to a virtual network interface using the Frame API, that frame will transfer across the virtual bus to the other virtual interface.

Table 6-1 lists all **Error** features for the virtual interface. The VBT column lists the values (T=true, F=false) of the Virtual Bus Timing attribute for which the **Error** behavior applies. If the VBT column lists both T and F, then Virtual Bus Timing does not affect the **Error** feature listed.

Table 6-2 lists all **Operational** features for the virtual interface. The VBT column lists the values (T=true, F=false) of the Virtual Bus Timing attribute for which the **Operational** behavior applies. If the VBT column lists both T and F, then Virtual Bus Timing does not affect the **Operational** features listed.

All features that are not explicitly listed in Table 6-1 or Table 6-2 are **Non-operational**. The behavior of **Non-operational** features is not documented in this manual. Your application should not make assumptions regarding the behavior of **Non-operational** features beyond the fact that NI-CAN returns success.

Table 6-1. Error Features for the Virtual Interface

Feature	VBT	Explanation
Channel API: Initialize of Output (or Output Recent) mode with Sample Rate greater than 0	T, F	The virtual interface does not support periodic timing for transmit. For channel to frame conversion, you must set the Channel API sample rate to `0`, and perform periodic timing within your application.
Channel API: Set Property of Timestamp Format	F	Since timestamps are not changed when **Virtual Bus Timing** is false, this attribute does not apply.
Frame API: Open of CAN Object	T, F	CAN Objects are not supported. For the Frame API, the virtual interface is limited to the Network Interface.
Frame API: Read (or ReadMult) of Delay frame	F	When virtual bus timing is disabled, the virtual interface does not simulate timing between frames, so the Delay frame does not apply. For information on the Delay frame, refer to **ncWriteNetMult.vi** (LabVIEW) or `ncWriteMult` (C/C++).
Frame API: Set Attribute of Log Comm Warnings	T, F	The special Comm Warnings frame is not supported on virtual interfaces. If you write this frame, it will not be received on the other interface.
Frame API: Set Attribute of Timestamp Format	F	Since timestamps are not changed when **Virtual Bus Timing** is false, this attribute does not apply. The error is returned when an interface or task is started.
Frame API: Set Attribute of Transmit Mode	F	Since timestamps are not interpreted when **Virtual Bus Timing** is false, this attribute does not apply. The error is returned when an interface or task is started.
Frame API: Wait (or CreateNotification or CreateOccurrence) for any state except Write Multiple	F	When virtual bus timing is disabled, the virtual interface is limited to quick conversion of frames to/from channels. The **Write Multiple** state remains useful for streaming of frames to channels, but other states do not apply.

Table 6-2. Operational Features for the Virtual Interface

Feature	VBT	Explanation
Channel API: Clear	T, F	As with a real interface, the Channel API task for a virtual interface must be cleared.
Channel API: Get Property of Message or Channel properties	T, F	Useful for database queries. You pass the filepath for the database into the original Initialize function.
Channel API: Initialize of Input mode with Sample Rate equal 0	T, F	Read most recent value for each channel. Useful for simulated control models.
Channel API: Initialize of Input mode with Sample Rate greater than 0	T, F	Read periodically sampled values for each channel. Useful to display frames in waveform graphs.
Channel API: Initialize of Timestamped Input mode	T, F	Read timestamped samples.
Channel API: Initialize of Output (or Output Recent) mode with Sample Rate equal 0	T, F	Write channel values to transmit a frame. Useful for simulated control models, or to create a log file.
Channel API: Read	T, F	Read channels that correspond to frames received from the virtual bus. All Read types are supported.
Channel API: Set Property of Timestamp Format	T	Determines whether to use absolute or relative timestamps when reading frames from the virtual bus.
Channel API: Start or Stop	T, F	Controls whether frames are transmitted to or received from the virtual bus. Start includes the InitStart function.
Channel API: Write	T, F	Write channels that correspond to frames transmitted to the virtual bus. All Write types are supported.
Frame API: Action of Start or Stop	T, F	Controls whether frames are transmitted to or received from the virtual bus. Action opcodes for **Reset** and **RTSI Output** are Non-operational.
Frame API: Close	T, F	As with a real Network Interface, the virtual Network Interface must be closed.

Table 6-2. Operational Features for the Virtual Interface (Continued)

Feature	VBT	Explanation
Frame API: Config of Network Interface	T, F	The only valid attribute is **Start On Open**. All other attributes are ignored. The only valid virtual interface names are CAN256 and CAN257.
Frame API: Get Attribute of Read Entries Pending	T, F	Returns the number of frames pending in virtual Network Interface read queue.
Frame API: Get Attribute of Read Mult Size for Notification	T	Returns the number of frames used as a threshold for the **Read Multiple** state.
Frame API: Get Attribute of Write Entries Free	T, F	Returns the number of frames that can be accepted to write without causing an overflow error.
Frame API: Get Attribute of Write Entries Pending	T, F	Returns the number of frames pending in virtual Network Interface write queue.
Frame API: Open of Network Interface	T, F	Config of the Network Interface is ignored (Non-operational). The only valid virtual interface names are CAN256 and CAN257.
Frame API: Read or ReadMult	T, F	Receive frames from the virtual bus. When **Virtual Bus Mode** is true (default), Delay frames are operational. For information on the Delay frame, refer to **ncWriteNetMult.vi** (LabVIEW) or `ncWriteMult` (C/C++).
Frame API: Set Attribute of Log Start Trigger	T, F	Determine whether to return a start trigger frame from ReadMult. Start trigger frames are useful for logging/replay applications.
Frame API: Set Attribute of Read Mult Size for Notification	T	Sets the number of frames used as a threshold for the **Read Multiple** state. For more information on the **Read Multiple** state, refer to **ncWaitForState.vi**.
Frame API: Set Attribute of Timeline Recovery	T	Determine whether to perform timeline recovery for simulated bus timing.
Frame API: Set Attribute of Timestamp Format	T	Determines whether to use absolute or relative timestamps when reading frames from the virtual bus.
Frame API: Set Attribute of Transmit Mode	T	When you submit timestamped frames to WriteMult, this determines whether to delay between frames.

Table 6-2. Operational Features for the Virtual Interface (Continued)

Feature	VBT	Explanation
Frame API: Wait (or CreateNotification or CreateOccurrence)	T	All states are operational only when **Virtual Bus Timing** is true (default).
Frame API: Wait (or CreateNotification or CreateOccurrence) for Write Multiple state	T, F	The **Write Multiple** state is useful for streaming of frames to channels, so it is supported for both **Virtual Bus Timing** values.
Frame API: Write or WriteMult	T, F	Transmit frames to the virtual bus.

Programming Model for Virtual Bus Timing Disabled

There are some key rules to keep in mind while writing an application that does Frame to Channel Conversion or Channel to Frame Conversion with Virtual Bus Timing disabled:

- Do the Frame to Channel/ Channel to Frame Conversion within the same thread/process. In LabVIEW, create a single VI to transmit the CAN frames using **ncWriteNetMult.vi** and perform channel read using **CAN Read.vi**.
- The Channel API Read task on the first virtual CAN interface requires a CAN frame to be written into the buffer of the second virtual CAN interface for it to start. Therefore, ensure that your application is written such that the first CAN frame is written using **ncWriteNetMult.vi** before the Channel API task times out.

The following steps demonstrate how to write a typical Frame to Channel Conversion application using both the NI-CAN APIs together.

1. Configure and Open the CAN Network Interface Object.

   Prior to opening and communicating on a CAN port, you must configure the CAN Network Interface Object. Configure the CAN Network Interface Object using **ncConfigNet**. Set **Start on Open** to `FALSE`. Specify CAN256 as the **ObjName**.

   Open the CAN Network Interface Object by calling **ncOpen.vi**. Specify CAN256 as the **ObjName**.

2. Initialize the Channel API task.

   Initialize the CAN channels in your application using **CAN Initialize.vi**. Specify CAN257 as the **Interface**.

3. Disable Virtual Bus Timing on CAN256.

   Turn Virtual Bus Timing off on CAN256 (Frame API Object) by calling **ncSetAttr.vi** for Virtual Bus Timing with a value 0.

4. Disable Virtual Bus Timing on CAN257.

   Turn Virtual Bus Timing off on CAN257 (Channel API task) by calling **CAN Set Property.vi** for Virtual Bus Timing with a value 0.

5. Start Communication on the Virtual Bus (CAN256).

   Start communication on the CAN Network Interface Object (CAN256) by calling **ncAction.vi** with **Start** as the opcode.

6. Start Communication on the Virtual Bus (CAN257).

   Start communication on the CAN channel task for virtual interface CAN257 by calling **CAN Start.vi**.

7. Write CAN frames on to the Virtual Bus (CAN256).

   Transmit frames on the virtual bus by calling **ncWriteNetMult.vi** on CAN256. If the size of the frames array is greater than 512, call **ncWriteNetMult.vi** within a loop and with a subset of the total data frames each iteration of the loop.

8. Read the CAN frames as Channels (CAN 257).

   Read CAN frames as channels by calling **CAN Read.vi** on the channel task. You can use any of the Read types (single point read, waveform read or timestamped read). Refer to the *Read* section in this chapter for more information on the different CAN Read types.

9. Stop and Close the communication on the CAN Network Interface Object (CAN 256).

   Close the virtual interface (CAN256) by calling **ncClose.vi**.

10. Clear the Channel API task (CAN257).

    Clear the virtual task on CAN257 by calling **CAN Clear.vi**.

Note For Channel to Frame conversion, use the Channel API's **CAN Write.vi** to write CAN channels on the virtual bus and the Frame API's **ncReadNetMult.vi** to read the CAN frames.

Mode Dependent Channels

By definition, CAN supports a limited number of unique identifiers to transmit data between the nodes of a network. In some cases the number of available identifiers is too small to transmit all of the data, so an extension to these identifiers is needed. The concept of *mode dependent messages* defines a mode channel that functions like a sub-identifier within a CAN frame to determine the meaning of the rest of the data transmitted in the frame.

The mode channel is an implicit channel inside the CAN frame that cannot be accessed by an application for read or write operations. Each channel that relies on a mode channel is associated to a certain mode of that mode channel. This way the mode channel determines the distribution of the data in a CAN frame to the associated CAN channels in the application. Since a single CAN frame no longer contains data for all of these mode dependent channels associated with a CAN message, mode dependent channel data is buffered inside the NI-CAN driver. If the application reads data from a channel, the most recent received value will be returned for that channel. Writing data from mode dependent channels will result in sending one CAN frame per mode, defined for the appropriate task. If more than one mode channel is defined for a CAN message, the NI-CAN driver assures that each mode of each mode channel is sent at least once with every write operation.

For periodic data transmission the property **Message Multiple Frame Distribution** determines the mode for the transmission of the CAN frames of the appropriate CAN message. If **Message Multiple Frame Distribution** is set to `Uniform`, the CAN frames are sent equally distributed within the time frame selected for the transmission. If **Message Multiple Frame Distribution** is set to `Burst`, all CAN frames associated to the CAN message will be transmitted as fast as possible at the beginning of the time frame selected for the transmission.

As mentioned before, a consequence of using mode dependent channels is that not every CAN frame received contains data for all channels associated with the appropriate CAN message. If you are reading data in timestamped mode for normal CAN channels, you receive data for all of the channels associated with the CAN message and timestamp information denoting when the data was received by the CAN interface. In the case of mode dependent channels, you get valid data only for those channels that were part of the most recent CAN frame, along with the timestamp denoting when the frame was received by the CAN interface.

The data of any mode dependent channel is invalid if it is not transmitted with the most recent CAN frame associated with the CAN message. The invalid data is replaced with a special value. Before you can start a CAN task that uses mode dependent messages, you have to define the special value for these cases by setting the property **Value for Invalid Data**.

Mode Dependent Channels in MAX

Mode dependent channels can be defined interactively in MAX. To create mode dependent channels in MAX, right-click on a message and create a multiplexer.

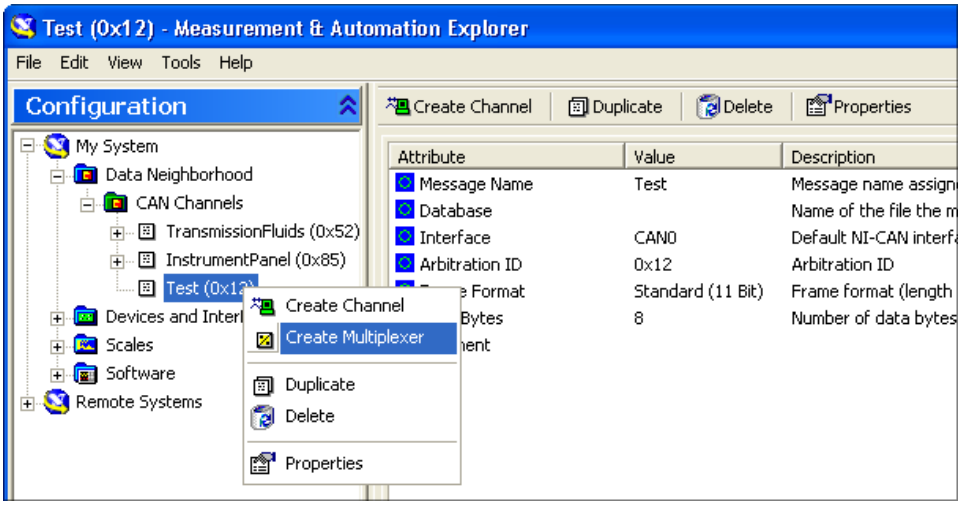


Figure 6-10. Creating a Multiplexer in MAX

Within the multiplexer dialog box define the properties of the mode channel. On a multiplexer item create a mode item and define the value of the mode channel (mode value). On a mode item, create channels which 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.

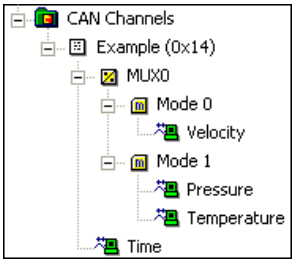


Figure 6-11. Mode Dependent Channels in the MAX Configuration Tree

7

Channel API for LabVIEW

This chapter lists the LabVIEW VIs for the NI-CAN Channel API and describes the format, purpose, and parameters for each VI. The VIs in this chapter are listed alphabetically.

Unless otherwise stated, each NI-CAN VI suspends execution of the calling thread until it completes.

Section Headings

The following are section headings found in the Channel API for LabVIEW VIs.

Purpose

Each VI description includes a brief statement of the purpose of the VI.

Format

The format section describes the format of each VI.

Input and Output

The input and output parameters for each VI are listed.

Description

The description section gives details about the purpose and effect of each VI.

List of VIs

The following table is an alphabetical list of the NI-CAN VIs for the Channel API.

Table 7-1. Channel API for LabVIEW VIs

Function	Purpose
CAN Clear	Stop communication for the task and then clear the configuration.
CAN Clear with NI-DAQ	Stop and clear the CAN task and the NI-DAQ task synchronized with **CAN Sync Start with NI-DAQ.vi**.

Table 7-1. Channel API for LabVIEW VIs (Continued)

Function	Purpose
CAN Clear with NI-DAQmx	Stop and clear the CAN task and the NI-DAQmx task synchronized with **CAN Sync Start with NI-DAQmx.vi**.
CAN Clear Multiple with NI-DAQ	Stop and clear the list of CAN tasks and the list of NI-DAQ tasks synchronized with **CAN Sync Start Multiple with NI-DAQ.vi**.
CAN Clear Multiple with NI-DAQmx	Stop and clear the list of CAN tasks and the list of NI-DAQmx tasks synchronized with **CAN Sync Start Multiple with NI-DAQmx.vi**.
CAN Connect Terminals	Connect terminals in the CAN hardware.
CAN Create Message	Create a message configuration and associated channel configurations within the LabVIEW application.
CAN Create MessageEx	Create a message configuration and associated channel configurations within the LabVIEW application. In addition you can specify mode dependent channels with **CAN Create MessageEx.vi**. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.
CAN Disconnect Terminals	Disconnect terminals in the CAN hardware.
CAN Get Names	Get an array of CAN channel names or message names from MAX or a CAN database file.
CAN Get Property	Get a property for the task, or a single channel within the task. The poly VI selection determines the property to get.
CAN Initialize	Initialize a task for the specified channel list.
CAN Init Start	Initialize a task for the specified channel list, then start communication.
CAN Read	Read samples from a CAN task initialized as input. Samples are obtained from received CAN messages. The poly VI selection determines the data type to read.

Table 7-1. Channel API for LabVIEW VIs (Continued)

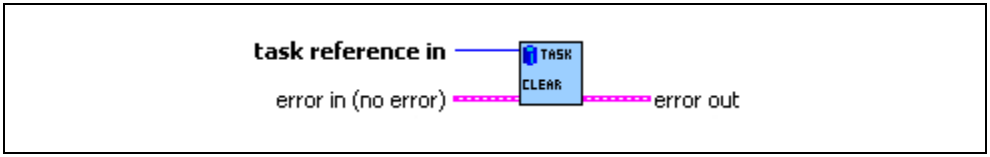
Function	Purpose
CAN Set Property	Set a property for the task, or a single channel within the task. The poly VI selection determines the property to set.
CAN Start	Start communication for the specified task.
CAN Stop	Stop communication for the specified task.
CAN Sync Start with NI-DAQ	Synchronize and start the specified CAN task and NI-DAQ task.
CAN Sync Start with NI-DAQmx	Synchronize and start the specified CAN task and NI-DAQmx task.
CAN Sync Start Multiple with NI-DAQ	Synchronize and start the specified list of multiple CAN tasks and NI-DAQ tasks. This is a more complex implementation of **CAN Sync Start with NI-DAQ.vi** that supports multiple CAN and a single NI-DAQ hardware product.
CAN Sync Start Multiple with NI-DAQmx	Synchronize and start the specified list of multiple CAN tasks and NI-DAQmx tasks. This is a more complex implementation of **CAN Sync Start with NI-DAQmx.vi** that supports multiple CAN and a single NI-DAQmx hardware product.
CAN Write	Write samples to a CAN task initialized as Output. (Refer to the **mode** parameter of **CAN Init Start.vi**.) Samples are placed into transmitted CAN messages. The poly VI selection determines the data type to write.

CAN Clear.vi

Purpose

Stop communication for the task and then clear the configuration.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from **CAN Init Start.vi**, **CAN Initialize.vi**, or **CAN Create Message.vi**, and then wired through subsequent VIs.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is `TRUE` if an error occurred. Unlike other VIs, this VI will execute when **status** is `TRUE`.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is `TRUE` if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The **CAN Clear** VI must always be the final NI-CAN VI called for each task. If you do not use the **CAN Clear** VI, the remaining task configurations can cause problems in execution of subsequent NI-CAN applications.

If the cleared task is the last running task for the initialized interface (refer to **CAN Init Start.vi**), the **CAN Clear** VI also stops communication on the CAN controller of the interface and disconnects all terminal connections for that interface.

Unlike other VIs, this VI will execute when **status** is `TRUE` in **Error in**.

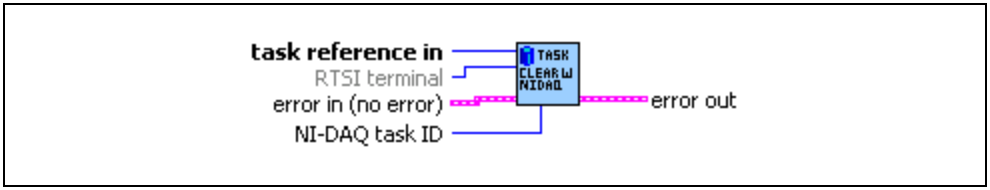
Because this VI clears the task, the task reference is not wired as an output. To change properties of a running task, use **CAN Stop.vi** to stop the task, **CAN Set Property.vi** to change the desired property, and then **CAN Start.vi** to restart the task.

CAN Clear with NI-DAQ.vi

Purpose

Stop and clear the CAN task and the NI-DAQ task synchronized with **CAN Sync Start with NI-DAQ.vi**.

Format



Inputs

task reference in is the NI-CAN task reference you passed through the **CAN Sync Start with NI-DAQ** VI.

If you wire the same **RTSI terminal** that you passed into the **CAN Sync Start with NI-DAQ** VI, this VI clears the routing in NI-DAQ. If you leave **RTSI terminal** unwired, the VI retains the routing in NI-DAQ. This VI always clears RTSI routing for NI-CAN.

NI-DAQ task ID is the same NI-DAQ task ID you wired into the **CAN Sync Start with NI-DAQ** VI.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is `TRUE` if an error occurred. If **status** is `TRUE`, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is `TRUE` if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

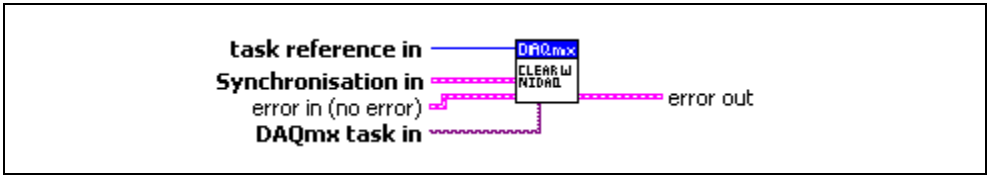
This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so that you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

CAN Clear with NI-DAQmx.vi

Purpose

Stop and clear the CAN task and the NI-DAQmx task synchronized with **CAN Sync Start with NI-DAQmx.vi**.

Format



Inputs

task reference in is the NI-CAN task reference you passed through the **CAN Sync Start with NI-DAQmx** VI.

Synchronisation in defines a cluster with information about the signals that have been routed between the cards and about additional DAQmx tasks that may have been created for synchronization. This information is needed to clear the routings in the NI-CAN and the NI-DAQmx devices after the measurement has been finished.

Counter task in is the task from an **NI-DAQmx Create Virtual Channel** VI. This additional NI-DAQmx task is created under certain circumstances to generate a common timebase clock for cards that do not support sharing of timebases through RTSI (like DAQ cards or NI-CAN Series 1 cards).

Routes out is a 1-dimensional array of terminal names of signals that have been routed between the cards.

Source terminal is the name of the terminal where the route starts.

Destination terminal is the name of the terminal where the route ends.

DAQmx task in is the same **DAQmx task in** you wired into CAN Sync Start Multiple with NI-DAQmx.vi.

Outputs

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is `TRUE` if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so that you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

CAN Clear Multiple with NI-DAQ.vi

Purpose

Stop and clear the list of CAN tasks and the NI-DAQ task synchronized with **CAN Sync Start Multiple with NI-DAQ.vi**.

Format

Inputs

CAN task reference list is the same array of NI-CAN task references you wired into the **CAN Sync Start Multiple with NI-DAQ** VI.

If you wire the same **RTSI terminal** that you passed into **CAN Sync Start Multiple with NI-DAQ.vi**, this VI clears the routing in NI-DAQ. If you leave **RTSI terminal** unwired, the VI retains the routing in NI-DAQ. This VI always clears RTSI routing for NI-CAN.

NI-DAQ task ID is the NI-DAQ task ID you wired into the **CAN Sync Start Multiple with NI-DAQ** VI.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is `TRUE` if an error occurred. If **status** is `TRUE`, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is `TRUE` if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

All tasks are cleared to their state prior to **CAN Sync Start Multiple with NI-DAQ**. For example, this VI clears terminal routing of the NI-DAQ device to the default state.

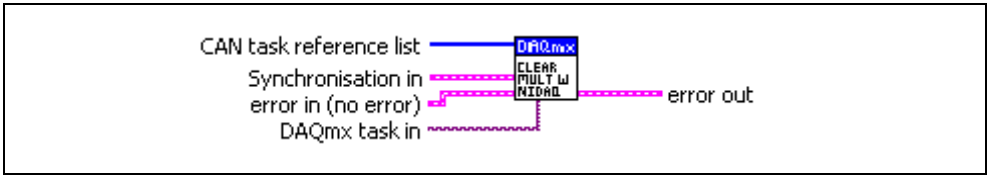
This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

CAN Clear Multiple with NI-DAQmx.vi

Purpose

Stop and clear the list of CAN tasks and the NI-DAQmx task synchronized with **CAN Sync Start Multiple with NI-DAQmx.vi**.

Format



Inputs

CAN task reference list is the same array of NI-CAN task references you wired into the **CAN Sync Start Multiple with NI-DAQmx** VI.

Synchronisation in defines a cluster with information about the signals that have been routed between the cards and about additional DAQmx tasks that may have been created for synchronization. This information is needed to clear the routings in the NI-CAN and the NI-DAQmx devices after the measurement has been finished.

Counter task in is the task from an **NI-DAQmx Create Virtual Channe**l VI. This additional NI-DAQmx task is created under certain circumstances to generate a common timebase clock for cards that do not support sharing of timebases through RTSI (like DAQ cards or NI-CAN Series 1 cards).

Routes out is a 1-dimensional array of terminal names of signals that have been routed between the cards.

Source terminal is the name of the terminal where the route starts.

Destination terminal is the name of the terminal where the route ends.

DAQmx task in is the same **DAQmx task in** you wired into CAN Sync Start Multiple with NI-DAQmx.vi.

Outputs

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is `TRUE` if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

All tasks are cleared to their state prior to **CAN Sync Start Multiple with NI-DAQmx.vi**. For example, this VI clears terminal routing of all NI-DAQ devices to the default state.

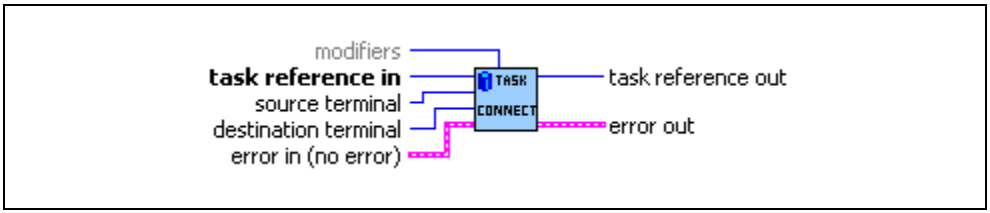
This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

CAN Connect Terminals.vi

Purpose

Connect terminals in the CAN hardware.

Format



Inputs

U32

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from **CAN Init Start.vi**, **CAN Initialize.vi**, or **CAN Create Message.vi**, and then wired through subsequent VIs.

U16

source terminal specifies the source of the connection.

Once the connection is successfully created, behavior flows from **source terminal** to **destination terminal**.

For a list of valid source/destination pairs, refer to the *Valid Combinations of Source/Destination* section.

The following list describes each value of **source terminal**:

RTSI0 … RTSI6

Selects a general-purpose RTSI line as source (input) of the connection.

RTSI7/RTSI Clock

Selects RTSI line 7 as source (input) of the connection. **RTSI7** is dedicated for routing of a timebase (10 MHz or 20 MHz). **RTSI7** is also known as **RTSI Clock** in some National Instruments software products, such as NI-DAQ.

The only valid **destination terminal** for this source is **Master Timebase**.

For PCI and PXI form factors, this receives a 20 MHz (default) timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting the 20 MHz oscillator (board clock) of the DAQ card to **RTSI7/RTSI Clock**, and then connecting **RTSI7/RTSI Clock** to **Master Timebase** on the CAN card.

For PCMCIA form factor, a 10 MHz timebase is required on **RTSI7/RTSI Clock**. For synchronization with a PCMCIA DAQcard, this is done by programming **FREQOUT** signal of the the DAQcard to 10 MHz, then wiring **FREQOUT** to the **RTSI7/RTSI Clock** of the CAN card.

This value applies to Series 2 cards only (returns error for Series 1).

PXI_Star

PXI_Star selects the PXI star trigger signal.

Within a PXI chassis, some PXI products can source star trigger from Slot 2 to all higher-numbered slots. **PXI_Star** enables the PXI CAN card to receive the star trigger when it is in Slot 3 or higher.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

PXI_Clk10

PXI_Clk10 selects the PXI 10 MHz backplane clock.

The only valid **destination terminal** for this source is **Master Timebase**. This routes the 10 MHz PXI backplane clock for use as the timebase of the CAN card. When you use **PXI_Clk10** as the timebase for the CAN card, you must also use **PXI_Clk10** as the timebase for other PXI cards to perform synchronized input/output.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

20 MHz Timebase

20 MHz Timebase selects the local 20 MHz oscillator of the CAN card.

The only valid **destination terminal** for this source is **RTSI7/RTSI Clock**. This routes the local 20 MHz clock of the CAN card for use as a timebase by other NI cards. For example, you can synchronize two CAN cards by connecting **20 MHz Timebase** to **RTSI7/RTSI Clock** on one CAN card and then connecting **RTSI7/RTSI Clock** to **Master Timebase** on the other CAN card.

20 MHz Timebase applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the task interface, such as the **interface** input to **CAN Initialize.vi**.

This value applies to Series 2 PXI or PCI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCMCIA CAN card, selecting this value results in an error.

10 Hz Resync Clock

10 Hz Resync Clock selects a 10 Hz, 50 percent duty cycle clock. This slow rate is required for resynchronization of Series 1 CAN cards. On each pulse of the resync clock, the other CAN card brings its clock into sync.

By selecting **RTSI0** to **RTSI6** as the **destination terminal**, you route the 10 Hz clock to synchronize with other Series 1 CAN cards. NI-DAQ cards cannot use the 10 Hz resync clock, so this selection is limited to synchronization of two or more CAN cards.

10 Hz Resync Clock applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the task interface, such as the **interface** input to **CAN Initialize.vi**.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are using a mix of Series 1 and Series 2 CAN cards, you must use the **10 Hz Resync Clock**.

Interface Receive Event

Interface Receive Event selects the dedicated receive interrupt output on the Philips SJA1000 CAN controller. When a received frame successfully passes the acceptance filter, a pulse with the width of one bit time is output during the last bit of the end of frame position of the CAN frame. Incoming CAN frames can be filtered using the **Series 2 Filter Mode** property.

The CAN controller is specified by the task interface, such as the **interface** input to **CAN Initialize.vi**.

The **Interface Receive Event** can be used as the start trigger for other NI cards, or for external instruments.

Since this value requires the Philips SJA1000 CAN controller, it applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

Interface Transceiver Event

Interface Transceiver Event selects the NERR signal from the CAN transceiver. The Low-Speed/Fault-Tolerant transceiver and the High-Speed transceiver provide the NERR signal. This signal asserts when the transceiver detects a fault. The default value of NERR is logic-high, which indicates no error.

The CAN controller is specified by the task interface, such as the **interface** input to **CAN Initialize.vi**.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

Start Trigger

Start Trigger selects the start trigger, the event that begins sampling for tasks.

The start trigger is the same for all tasks using a given interface, such as the **interface** input to **CAN Initialize.vi**.

In the default (disconnected) state of the **Start Trigger** destination, the start trigger occurs when communication begins on the interface.

By selecting **RTSI0** to **RTSI6** as the **destination terminal**, you route the start trigger of this CAN card to the start trigger of other CAN or DAQ cards. This ensures that sampling begins at the same time on both cards. For example, you can synchronize two CAN cards by routing **Start Trigger** as the **source terminal** on one CAN card and then routing **Start Trigger** as the **destination terminal** on the other CAN card, with both cards using the same RTSI line for the connections.

destination terminal specifies the destination of the connection.

The following list describes each value of **destination terminal**:

RTSI0 … RTSI6

Selects a general-purpose RTSI line as destination (output) of the connection.

RTSI7/RTSI Clock

Selects RTSI line 7 as destination (output) of the connection. **RTSI7** is dedicated for routing of a timebase. **RTSI7** is also known as **RTSI Clock** in some National Instruments software products, such as NI-DAQ. The only valid source terminal for this source is **20 MHz Timebase**. The CAN card can import a 10 MHz or 20 MHz timebase, but can export only a 20 MHz timebase.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

Master Timebase

Master Timebase instructs the CAN card to use the source of the connection as the master timebase. The CAN card uses this master timebase for input sampling (including timestamps of received messages) as well as periodic output sampling.

For PCI and PXI form factors, you can use **RTSI7/RTSI Clock** as the **source terminal**. By default this receives a 20 MHz timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting the 20 MHz oscillator (board clock) of the DAQ card to **RTSI7/RTSI Clock**, and then connecting **RTSI7/RTSI Clock** to **Master Timebase** on the CAN card. To change the **Master Timebase Rate** to 10 MHz, use **CAN Set Property.vi** to change the **Hardware Master Timebase Rate**.

For PXI form factor, you also can use **PXI_Clk10** as the **source terminal**. This receives the PXI 10 MHz backplane clock for use as the master timebase.

For PCMCIA form factor, you can use **RTSI7/RTSI Clock** as the **source terminal**. Unlike PCI and PXI, the PCMCIA CAN card requires a 10 MHz timebase on **RTSI7/RTSI Clock**. For synchronization with a PCMCIA DAQcard, this is done by programming the **FREQOUT** signal of the DAQcard to 10 MHz, then wiring **FREQOUT** to the **RTSI7/RTSI Clock** of the CAN card.

Master Timebase applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the task interface, such as the **interface** input to **CAN Initialize.vi**.

The default (disconnected) state of this destination means the CAN card uses its local 20 MHz timebase as the master timebase.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

10 Hz Resync Clock

10 Hz Resync Clock instructs the CAN card to use a 10 Hz, 50 percent duty cycle clock to resynchronize its local timebase. This slow rate is required for resynchronization of CAN cards. On each low-to-high transition of the resync clock, this CAN card brings its local timebase into sync.

When synchronizing to an E Series MIO card, a typical use of this value is to use **RTSI0** to **RTSI6** as the **source terminal**, then use NI-DAQ functions to program the Counter 0 of the MIO card to generate a 10 Hz 50 percent duty cycle clock on the RTSI line. For an example, refer to **CAN Sync Start with NI-DAQ.vi**.

When synchronizing to a CAN card, a typical use of this value is to use **RTSI0** to **RTSI6** as the **source terminal**, then route the **10 Hz Resync Clock** of the other CAN card as the **source terminal** to the same RTSI line.

10 Hz Resync Clock applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the task interface, such as the **interface** input to **CAN Initialize.vi**.

The default (disconnected) state of this destination means the CAN card does not resynchronize its local timebase.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are using a mix of Series 1 and Series 2 CAN cards, you must use the **10 Hz Resync Clock**.

Start Trigger

Start Trigger selects the start trigger, the event that begins sampling for tasks. The start trigger occurs on the first low-to-high transition of the source terminal.

The start trigger is the same for all tasks using a given interface, such as the **interface** input to **CAN Initialize.vi**.

By selecting **RTSI0** to **RTSI6**, or **PXI_Star** for PXI hardware, as the **source terminal**, you route the start trigger from another CAN or DAQ card. This ensures that sampling begins at the same time on both cards. For example, you can synchronize with an E Series DAQ MIO card by routing the AI start trigger of the MIO card to a RTSI line and then routing the same RTSI line with **Start Trigger** as the **destination terminal** on the CAN card.

The default (disconnected) state of this destination means the start trigger occurs when communication begins on the interface. Because communication begins when the first interface task is started, this does not synchronize sampling with other NI cards.

modifiers provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so **modifiers** must be left unwired.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is `TRUE` if an error occurred. If **status** is `TRUE`, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is `TRUE` if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

This VI connects a specific pair of source/destination terminals. One of the terminals is typically a RTSI signal, and the other terminal is an internal terminal in the CAN hardware. By connecting internal terminals to RTSI, you can synchronize the CAN card with another hardware product such as an NI-DAQ card.

The most common uses of RTSI synchronization are demonstrated by **CAN Sync Start with NI-DAQ.vi**, **CAN Sync Start with NI-DAQmx.vi**, **CAN Sync Start Multiple with NI-DAQ.vi**, and **CAN Sync Start Multiple with NI-DAQmx.vi**. The diagram for each of these example VIs uses **CAN Connect Terminals**, and therefore serves as a good starting point when learning this VI.

When the final task for a given interface is cleared with **CAN Clear.vi**, NI-CAN disconnects all terminal connections for that interface. Therefore, **CAN Disconnect Terminals.vi** is not required for most applications. NI-DAQ terminals remain connected after the tasks are cleared, so you must disconnect NI-DAQ terminals manually at the end of the application.

For a list of valid source/destination pairs, refer to the *Valid Combinations of Source/Destination* section.

Valid Combinations of Source/Destination

Table 7-2 lists all valid combinations of **source terminal** and **destination terminal**.

The series of the NI CAN hardware determines what combinations of **source terminal** to **destination terminal** are valid. Within Table 7-2, *1* indicates Series 1 hardware, and *2* indicates Series 2 hardware. You can determine the series of the NI CAN hardware by selecting the name of the card within the **Devices and Interfaces** view in the left pane of MAX.

Series 1 hardware has the following limitations.

- PXI cards do not support **RTSI6**.
- Signals received from a RTSI source cannot occur faster than 1 kHz. This prevents the card from receiving a 10 MHz or 20 MHz timebase, such as NI E Series MIO hardware provides.

- Signals received from a RTSI source must be at least 100 µs in length to be detected. This prevents the card from receiving triggers in the nanoseconds range, such as the AI trigger that E Series MIO hardware provides. Series 2 CAN cards also send RTSI pulses in the nanoseconds range, so Series 1 CAN cards cannot receive RTSI input from Series 2 CAN cards.
- For CAN cards with High-Speed (HS) ports only, four RTSI signals are available for input (source), and four RTSI signals are available for output (destination). This limitation applies to the number of signals per direction, not the RTSI signal number. For example, if you connect **RTSI0**, **RTSI1**, **RTSI3**, and **RTSI5** as input, connecting **RTSI4** as input will return an error.
- For CAN cards with one or more Low-Speed (LS) ports, two RTSI signals are available for input (source), and three RTSI signals are available for output (destination).

Series 2 hardware has the following limitations.

- For all form factors (PCI, PXI, PCMCIA), the connection of **Interface Transceiver Event** to a RTSI destination depends on the physical port location. If the interface is on Port 1, you can connect to only even-numbered RTSI lines (**RTSI0**, **RTSI2**, **RTSI4**, **RTSI6**). If the interface is on Port 2, you can connect to only odd-numbered RTSI lines (**RTSI1**, **RTSI3**, **RTSI5**). You can determine the location by selecting name of the interface in MAX.
- PCI cards do not support the **PXI_Star** and **PXI_Clk10** terminals, as those signals exist on the PXI backplane.
- PCMCIA cards do not support the **20 MHz Timebase**, **PXI_Star**, and **PXI_Clk10** terminals. Because **20 MHz Timebase** is not supported, you cannot synchronize the timebases of two PCMCIA CAN cards.
- On PCMCIA cards, **RTSI4**, **RTSI5** and **RTSI6** are not available.

Table 7-2. Valid combinations of Source/Destination

Source	Destination				
	RTSI0 to RTSI6	**RTSI_ CLOCK**	**Master Timebase**	**10 Hz Resync Clock**	**Start Trigger**
RTSI0 to RTSI6	—	—	—	1,2	1,2
RTSI7/RTSI Clock	—	—	2	—	—
PXI_Star	—	—	—	—	2
PXI_Clk10	—	—	2	—	—
20 MHz Timebase	—	2	—	—	—
10 Hz Resync Clock	1,2	—	—	—	1,2
Interface Receive Event	2	—	—	—	2
Interface Transceiver Event	2	—	—	—	—
Start Trigger	1,2	—	—	—	—

1—Valid Connection for Series 1 Hardware

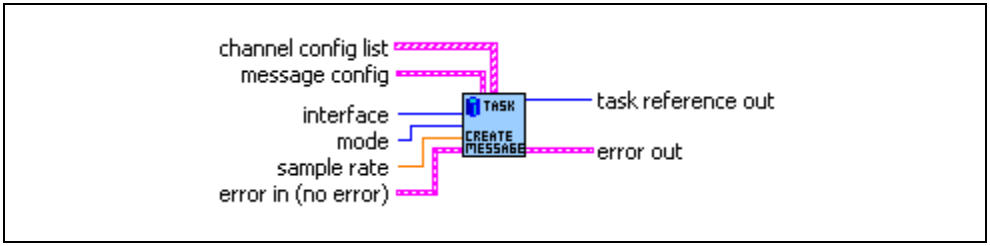
2—Valid Connection for Series 2 Hardware

CAN Create Message.vi

Purpose

Create a message configuration and associated channel configurations within the LabVIEW application.

Format



Inputs

U16

interface specifies the CAN interface to use for this task.

The interface input uses a ring typedef in which value `0` selects **CAN0**, value `1` selects **CAN1**, and so on.

The **interface** input is required. Since the messages and channels are not defined in MAX, you cannot use **MAX default** as the **interface**.

The default baud rate for the **interface** is defined within MAX, but you can change it by setting the Interface Baud Rate property with **CAN Set Property.vi**.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

U16

mode specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as single point, array, or waveform.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ waveforms. You also can use this input mode to read a single point from the most recent message, such as for control or simulation.

Output

Output channel data to CAN messages for transmit. Use **CAN Write.vi** to write output samples as single-point, array, or waveform. Each sample value that you write is transmitted in a message on the network. If you write an array or waveform, the samples are buffered for subsequent transmit.

Output Recent

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use **CAN Write.vi** to provide a single sample per channel. Each periodic message uses the sample values from the most recent **CAN Write.vi**.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to **CAN Read.vi** for more information.

Timestamped Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as an array of sample/timestamp pairs (Poly VI types ending in *Timestamped Dbl*).

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

sample rate specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For **mode** of **Input**, a **sample rate** of zero means that **CAN Read** returns a single point from the most recent message received, and greater than zero means that **CAN Read** returns samples timed at the specified rate.

For **mode** of **Output**, a **sample rate** of zero means that CAN messages transmit immediately when **CAN Write** is called, and greater than zero means that CAN messages are transmitted periodically at the specified rate.

For **mode** of **Timestamped Input**, **sample rate** is ignored.

When the **interface** specifies a virtual interface (256 or 257), and **mode** is **Output** or **Output Recent**, this **sample rate** must be zero (greater than zero not supported).

message config configures properties for a new message. These properties are similar to the message properties in MAX. **Can Create Message.vi** creates a task for a single message with one or more channels.

message ID

Configures the arbitration ID of the message.

Use the **extended ID?** Boolean to specify whether the ID is standard (11-bit) or extended (29-bit).

extended ID?

Configures a Boolean value that indicates whether the arbitration ID of the message is standard 11-bit format (FALSE) or extended 29-bit format (TRUE).

number of bytes

Configures the number of data bytes in the message. The range is `1` to `8`.

channel config list configures a list of channels for the new message. The **channel config list** is an array of clusters, with one cluster for each channel. The properties of each channel entry are similar to the channel properties in MAX:

start bit

Configures the starting bit position in the message. The range is `0` (lowest bit in first byte) to `63` (highest bit in last byte).

number of bits

Configures the number of bits for the raw data in the message. The range is `1` to `64`.

byte order

Configures the byte order of the channel in the message.

The value of **byte order** is an enumeration:

`0`	**Intel**	Bytes are in little-endian order, with most-significant first.

1	**Motorola**	Bytes are in big-endian order, with least-significant first.

data type

Configures the data type of the channel in the message.

The value of **Channel Data Type** is an enumeration:

0	**Signed**	Raw data in the message is a signed integer.
1	**Unsigned**	Raw data in the message is an unsigned integer.
2	**IEEE Float**	Raw data in the message is floating-point; no scaling required.

scaling factor

Configures the scaling factor used to convert raw data in the message to/from scaled floating-point units. The scaling factor is the *A* in the linear scaling formula $AX + B$, where X is the raw data, and B is the scaling offset.

scaling offset

Configures the scaling offset used to convert raw data in the message to/from scaled floating-point units. The scaling offset is the *B* in the linear scaling formula $AX + B$, where X is the raw data, and A is the scaling factor.

min value

Configures the minimum value of the channel in scaled floating-point units.

The **CAN Read** and **CAN Write** VIs do not coerce samples when converting to/from CAN messages. You can use this value with property nodes to set the range of front-panel controls and indicators.

max value

Configures the maximum value of the channel in scaled floating-point units.

The **CAN Read** and **CAN Write** VIs do not coerce samples when converting to/from CAN messages. You can use this value with

property nodes to set the range of front-panel controls and indicators.

default value

Configures the default value of the channel in scaled floating-point units.

For information on how the **default value** is used, refer to **CAN Read.vi** and **CAN Write.vi**.

unit string

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 samples on a channel.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

Outputs

Use **task reference out** with all subsequent VIs to reference the task. Wire this task reference to **CAN Start.vi** before you read or write samples for the message.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning:

VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

To use message and channel configurations from MAX or a CAN database, use **CAN Init Start.vi** or **CAN Initialize.vi**. The **CAN Create Message** provides an alternative in which you create the message and channel configurations within the application, without use of MAX or a CAN database.

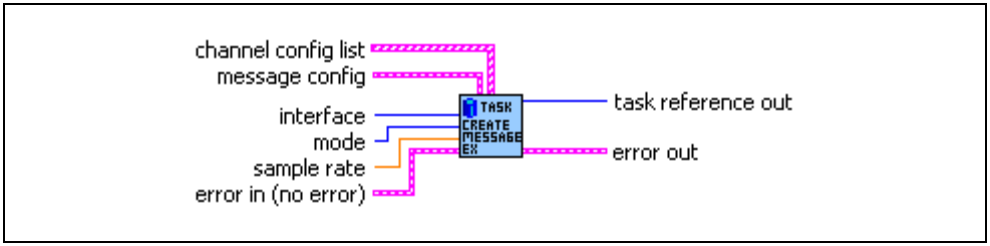
CAN Create Message returns a task reference that you wire to **CAN Start.vi** to start communication for the message and its channels.

CAN Create MessageEx.vi

Purpose

Create a message configuration and associated channel configurations within the application.

Format



Inputs

U16

interface specifies the CAN interface to use for this task.

The interface input uses a `ring` typedef in which value `0` selects **CAN0**, value `1` selects **CAN1**, and so on.

The **interface** input is required. Since the messages and channels are not defined in MAX, you cannot use **MAX default** as the **interface**.

The default baud rate for the **interface** is defined within MAX, but you can change it by setting the Interface Baud Rate property with **CAN Set Property.vi**.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

U16

mode specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as single point, array, or waveform.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ waveforms. You also can use this

input mode to read a single point from the most recent message, such as for control or simulation.

Output

Output channel data to CAN messages for transmit. Use **CAN Write.vi** to write output samples as single-point, array, or waveform. Each sample value that you write is transmitted in a message on the network. If you write an array or waveform, the samples are buffered for subsequent transmit.

Output Recent

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use **CAN Write.vi** to provide a single sample per channel. Each periodic message uses the sample values from the most recent **CAN Write.vi**.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to **CAN Read.vi** for more information.

Timestamped Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as an array of sample/timestamp pairs (Poly VI types ending in *Timestamped Dbl*).

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

sample rate specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For **mode** of **Input**, a **sample rate** of zero means that **CAN Read** returns a single point from the most recent message received, and greater than zero means that **CAN Read** returns samples timed at the specified rate.

For **mode** of **Output**, a **sample rate** of zero means that CAN messages transmit immediately when **CAN Write** is called, and greater than zero means that CAN messages are transmitted periodically at the specified rate.

For **mode** of **Timestamped Input**, **sample rate** is ignored.

When the **interface** specifies a virtual interface (256 or 257), and **mode** is **Output** or **Output Recent**, this **sample rate** must be zero (greater than zero not supported).

message config configures properties for a new message. These properties are similar to the message properties in MAX. **Can Create Message.vi** creates a task for a single message with one or more channels.

message ID

Configures the arbitration ID of the message.

Use the **extended ID?** Boolean to specify whether the ID is standard (11-bit) or extended (29-bit).

extended ID?

Configures a Boolean value that indicates whether the arbitration ID of the message is standard 11-bit format (FALSE) or extended 29-bit format (TRUE).

number of bytes

Configures the number of data bytes in the message. The range is `1` to `8`.

channel config list configures a list of channels for the new message. The **channel config list** is an array of clusters, with one cluster for each channel. The properties of each channel entry are similar to the channel properties in MAX:

start bit

Configures the starting bit position in the message. The range is `0` (lowest bit in first byte) to `63` (highest bit in last byte).

number of bits

Configures the number of bits for the raw data in the message. The range is `1` to `64`.

byte order

Configures the byte order of a channel in the message.

The value of **byte order** is an enumeration:

`0`	**Intel**	Bytes are in little-endian order, with most-significant first.

1	**Motorola**	Bytes are in big-endian order, with least-significant first.

data type

Configures the data type of a channel in the message.

The value of **Channel Data Type** is an enumeration:

0	**Signed**	Raw data in the message is a signed integer.
1	**Unsigned**	Raw data in the message is an unsigned integer.
2	**IEEE Float**	Raw data in the message is floating-point; no scaling required.

scaling factor

Configures the scaling factor used to convert raw data in the message to/from scaled floating-point units. The scaling factor is the *A* in the linear scaling formula $AX + B$, where X is the raw data, and B is the scaling offset.

scaling offset

Configures the scaling offset used to convert raw data in the message to/from scaled floating-point units. The scaling offset is the *B* in the linear scaling formula $AX + B$, where X is the raw data, and A is the scaling factor.

min value

Configures the minimum value of the channel in scaled floating-point units.

The **CAN Read** and **CAN Write** VIs do not coerce samples when converting to/from CAN messages. You can use this value with property nodes to set the range of front-panel controls and indicators.

max value

Configures the maximum value of the channel in scaled floating-point units.

The **CAN Read** and **CAN Write** VIs do not coerce samples when converting to/from CAN messages. You can use this value with

property nodes to set the range of front-panel controls and indicators.

default value

Configures the default value of the channel in scaled floating-point units.

For information on how the **default value** is used, refer to **CAN Read.vi** and **CAN Write.vi**.

unit string

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 samples on a channel.

Mode channel config configures a list of the mode channels for this (data) channel. Currently, only one mode channel is allowed per (data) channel. Note that the same mode channel can be specified for several channels.

Mode value

Configures the mode channel value for which the data channel is valid.

Start Bit

Configures the starting bit position in the message. The range is `0` (lowest bit in first byte) to `63` (highest bit in last byte).

Num bits

Configures the number of bits for the raw data in the message. The range is `1` to `64`.

byte order

Configures the byte order of a channel in the message.

The value of **byte order** is an enumeration:

`0`	**Intel**	Bytes are in little-endian order, with most-significant first.

1 **Motorola** Bytes are in big-endian order, with least-significant first.

Default Value

This field is reserved. Set it to 0.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

Outputs

Use **task reference out** with all subsequent VIs to reference the task. Wire this task reference to **CAN Start.vi** before you read or write samples for the message.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

To use message and channel configurations from MAX or a CAN database, use the nctInitStart or nctInitialize functions. **CAN Create MessageEx.vi** function provides an alternative in which you create the message and channel configurations within the application, without use of MAX or a CAN database. In addition **CAN Create MessageEx.vi**

offers optionally the possibility to specify mode dependent messages without using MAX or CAN databases.

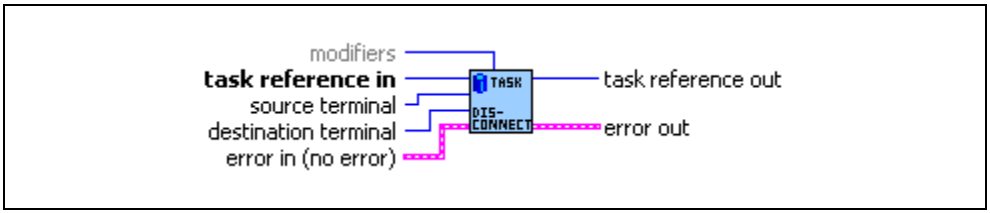
CAN Create MessageEx.vi returns a task reference that you wire to **CAN Start.vi** to start communication for the message and its channels.

CAN Disconnect Terminals.vi

Purpose

Disconnect terminals in the CAN hardware.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from **CAN Init Start.vi**, **CAN Initialize.vi**, or **CAN Create Message.vi**, and then wired through subsequent VIs.

source terminal specifies the connection source.

For a description of values for **source terminal**, refer to **CAN Connect Terminals.vi**.

destination terminal specifies the connection destination.

For a description of values for **destination terminal**, refer to **CAN Connect Terminals.vi**.

modifiers provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so **modifiers** must be left unwired.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute

the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

This VI disconnects a specific pair of source/destination terminals that you previously connected with **CAN Connect Terminals.vi**.

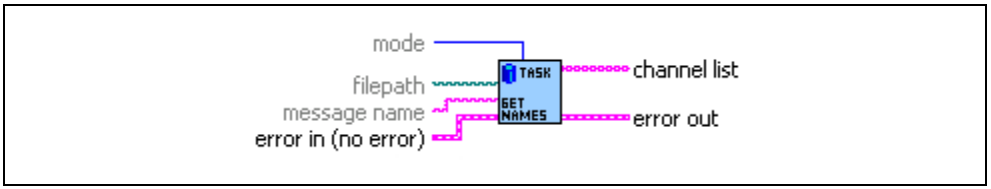
When the final task for a given interface is cleared with **CAN Clear.vi**, NI-CAN disconnects all terminal connections for that interface. Therefore, the **CAN Disconnect Terminals** VI is not required for most applications. You typically use this VI to change RTSI connections dynamically while the application is running. First, use **CAN Stop.vi** to stop all tasks for the interface, then use **CAN Disconnect Terminals** and **CAN Connect Terminals** to adjust RTSI connections, then **CAN Start.vi** to restart sampling.

CAN Get Names.vi

Purpose

Get an array of CAN channel names or message names from MAX or a CAN database file.

Format



Inputs

filepath is an optional path to a CAN database file from which to get channel names. The file must use either a `.DBC` or `.NCD` extension. Files with extension `.DBC` use the CANdb database format. Files with extension `.NCD` use the NI-CAN database format. You can generate NI-CAN database files from the **Save Channels** selection in MAX.

The default (unwired) value of **filepath** is empty, which means to get the channel names from MAX. The MAX CAN channels are in the MAX CAN Channels listing within **Data Neighborhood**.

message name is an optional input that filters the names for a specific message. The default (unwired) value is an empty string, which means to return all names in the database. If you wire a nonempty string, the **channel list** output is limited to channels of the specified message. This input applies to **mode** of **channels** only. It is ignored for **mode** of **messages**.

mode is an optional input that specifies the type of names to return.

The value of **mode** is an enumeration:

`0`	**channels**	Return list of channel names. You can write this list to **CAN Init Start**. This is the default value.
`1`	**messages**	Return list of message names.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

channel list returns the array of channel names, one string entry per channel.

The names in **channel list** use the minimum syntax required to properly initialize the channels:

- If a channel name is used within only one message in the database, **CAN Get Names** returns only the channel name in the array.
- If a channel name is used within multiple messages, **CAN Get Names** prepends the message name to that channel name, with a decimal point separating the message and channel name. This syntax ensures that the duplicate channel is associated to a single message in the database.

For more information on the syntax conventions for channel names, refer to **CAN Init Start.vi**.

To start a task for all channels returned from **CAN Get Names**, wire **channel list** to the **CAN Init Start** VI to start a task.

You also can wire **channel list** to the property nodes of a front panel control such as a ring or list box. The user of the VI can then select names using this control, and the selected names can be wired to **CAN Init Start**.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is

returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

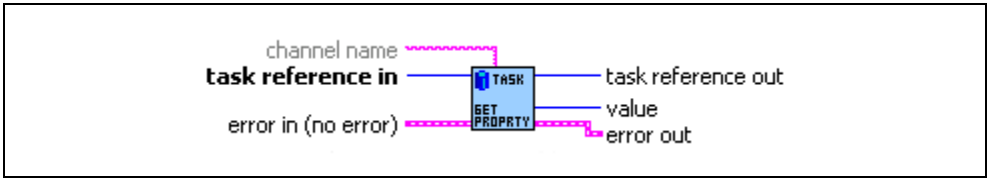
CAN Get Property.vi

Purpose

Get a property for the task, or a single channel within the task. The poly VI selection determines the property to get.

To select the property, right-click the VI, go to **Select Type** and select the property by name. For LabVIEW 7.0 and later, you can right-click the VI and select **Visible Items»Poly VI Selector** to select the property from within the diagram.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from **CAN Init Start.vi**, **CAN Initialize.vi**, or **CAN Create Message.vi**, and then wired through subsequent VIs.

channel name specifies an individual channel within the task. The default (unwired) value of channel name is empty, which means the property applies to the entire task, not a specific channel.

Properties that begin with the word *Channel* or *Message* do not apply to the entire task, but an individual channel or message within the task. For these channel-specific properties, you must wire the name of a channel from channel list into the **channel name** input.

For properties that do not begin with the word *Channel* or *Message*, you must leave **channel name** unwired (empty).

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

The poly output **value** returns the property value. You select the property returned in **value** by selecting the Poly VI type. The data type of **value** is also determined by the Poly VI selection. For information about the different properties provided by **CAN Get Property**, refer to the Poly VI Types section.

To select the property, right-click the VI, go to **Select Type**, and select the property by name.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Poly VI Types

Behavior After Final Output

Returns the **Behavior After Final Output** property, which is used with some output task configurations. For more information, refer to the Behavior After Final Output property in **CAN Set Property**.

Channel Byte Order

Returns the byte order of a channel in the message.

The value of **Channel Byte Order** is an enumeration:

0	**Intel**	Bytes are in little-endian order, with most-significant first.
1	**Motorola**	Bytes are in big-endian order, with least-significant first.

The value of this property cannot be changed using **CAN Set Property**.

Channel Data Type

Returns the data type of a channel in the message.

The value of **Channel Data Type** is an enumeration:

0	**Signed**	Raw data in the message is a signed integer.
1	**Unsigned**	Raw data in the message is an unsigned integer.
2	**IEEE Float**	Raw data in the message is floating-point; no scaling required.

The value of this property cannot be changed using **CAN Set Property**.

Channel Default Value

Returns the default value of the channel in scaled floating-point units.

For information on how **Channel Default Value** is used, refer to **CAN Read.vi** and **CAN Write.vi**.

The value of this property is originally set within MAX, **CAN Create Message.vi** or **CAN Create MessageEx.vi**. If the channel is initialized directly from a CAN database, the value is `0.0` by default, but it can be changed using **CAN Set Property.vi**.

Channel Maximum Value

Returns the maximum value of the channel in scaled floating-point units.

The **CAN Read** and **CAN Write** VIs do not coerce samples when converting to/from CAN messages. You can use this value with property nodes to set the range of front-panel controls and indicators.

The value of this property cannot be changed using **CAN Set Property**.

Channel Minimum Value

Returns the minimum value of the channel in scaled floating-point units.

The **CAN Read** and **CAN Write** VIs do not coerce samples when converting to/from CAN messages. You can use this value with property nodes to set the range of front-panel controls and indicators.

The value of this property cannot be changed using **CAN Set Property**.

Channel Mode Value

Returns the value of the mode channel associated to this channel. This property applies only to mode dependent channels.

Channel Number of Bits

Returns the number of bits in the message. The range is `1` to `64`.

The value of this property cannot be changed using **CAN Set Property**.

Channel Scaling Factor

Returns the scaling factor used to convert raw bits of the message to/from scaled floating-point units. The scaling factor is the *A* in the linear scaling formula $AX + B$, where X is the raw data, and B is the scaling offset.

CAN messages use the raw data, and the **CAN Read** and **CAN Write** VIs provide access to samples in floating-point units.

The value of this property cannot be changed using **CAN Set Property**.

Channel Scaling Offset

Returns the scaling offset used to convert raw bits of the message to/from scaled floating-point units. The scaling offset is the *B* in the linear scaling formula $AX + B$, where X is the raw data, and A is the scaling factor.

CAN messages use the raw data, and the **CAN Read** and **CAN Write** VIs provide access to samples in floating-point units.

The value of this property cannot be changed using **CAN Set Property**.

Channel Start Bit

Returns the starting bit position in the message. The range is `0` (lowest bit in first byte) to `63` (highest bit in last byte).

The value of this property cannot be changed using **CAN Set Property**.

Channel Unit String

Returns the unit string of the channel. The string is no more than 80 characters in length.

You can use this value to display units (such as volts or RPM) along with the samples on a channel.

The value of this property cannot be changed using **CAN Set Property**.

Hardware Form Factor

Returns the hardware form factor for the NI-CAN hardware that contains Interface.

The value of **Hardware Form Factor** is an enumeration:

0 **PCI**

1 **PXI**

2 **PCMCIA**

3 **AT**

Hardware Master Timebase Rate

Returns the present Hardware **Master Timebase Rate** in MHz, programmed into the CAN hardware. For PCMCIA, this property will always return 10 MHz.

Hardware Serial Number

Returns the hardware serial number for the NI-CAN hardware that contains Interface.

Hardware Series

Returns the hardware series for the NI CAN hardware that contains Interface.

The value of **Hardware Series** is an enumeration:

0	**Series 1**	Series 1 hardware uses the Intel 82527 CAN controller.
1	**Series 2**	Series 2 hardware uses the Philips SJA1000 CAN controller and includes improved RTSI features.

Newer hardware series often have more features, so the application may need to determine which is installed.

Hardware Timestamp Format

Returns the present **Timestamp Format** programmed into the CAN hardware. This property applies to the entire card.

Interface

Returns the interface initialized for the task, such as with the **CAN Init Start VI**.

Interface Baud Rate

Returns the baud rate in use by the Interface.

Basic baud rates such as 125000 and 500000 are specified as the numeric rate.

Advanced baud rates are specified as `8000`*XXYY* hex, where *YY* is the value of Bit Timing Register 0 (BTR0), and *XX* is the value of Bit Timing Register 1 (BTR1) of the CAN controller chip. For more information, refer to the **Interface Properties** dialog in MAX.

The value of this property is originally set within MAX, but it can be changed using **CAN Set Property.vi**.

Interface Listen Only?

Returns a Boolean value that indicates whether the listen only feature of the Philips SJA1000 CAN controller is enabled (TRUE) or disabled (FALSE). For more information, refer to the Interface Listen Only? property in **CAN Set Property**.

Since the listen only feature requires the Philips SJA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only.

Interface Receive Error Counter

Returns the Receive Error Counter as described in the CAN specification.

Since the error counts require the Philips SJA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only. If you are using Series 1 NI CAN hardware, this property returns an error.

Interface Self Reception?

Returns the Interface Self Reception property as configured with **CAN Set Property.vi**.

This property is supported on Series 2 NI CAN hardware only (returns error for Series 1).

Interface Series 2 Error/Arb Capture

Returns the current values of the Error Code Capture register and Arbitration Lost Capture register from the Philips SJA1000 CAN controller chip.

The Error Code Capture register provides information on bus errors that occur according to the CAN standard. A bus error increments either the Interface Transmit Error Counter or the Interface Receive Error Counter. When communication starts on the interface, the first bus error is captured into the Error Code Capture register, and retained until you get this property. After you get this property, the Error Code Capture register is again enabled to capture information for the next bus error.

The Arbitration Lost Capture register provides information on a loss of arbitration during transmit. Loss of arbitration is not considered an error. When communication starts on the interface, the first arbitration loss is captured into the Arbitration Lost Capture register, and retained until you get this property. After you get this property, the Arbitration Lost Capture register is again enabled to capture information for the next arbitration loss.

For each of the capture registers, a single-bit New flag indicates whether a new error has occurred since the last Get. If the New flag of a register is set, the associated fields contain new information. If the New flag of a register is clear, the associated fields are the same as the previous Get.

This property is commonly used with the Interface Single Shot Transmit property. When using **CAN Write.vi** to transmit the single frame, you can get this property to determine if the transmit was successful. If the single shot transmit was not successful, this property provides detailed information for the failure.

This property is supported for Series 2 hardware only (not Series 1). Since the information and bit format is very specific to the Philips SJA1000 CAN controller on Series 2 hardware, National Instruments cannot guarantee compatibility for this property on future hardware series. When using this property in the application, it is best to get the Hardware Series to verify that the CAN hardware is Series 2.

For information regarding the format of the bits in this property, refer to Series 2 Error/Arb Capture attribute in the **ncGetAttr.vi** function of the Frame API.

Interface Series 2 Comparator

Returns the value of the Interface Series 2 Comparator property (refer to **CAN Set Property.vi**).

Interface Series 2 Filter Mode

Returns the value of the Interface Series 2 Filter Mode property (refer to **CAN Set Property.vi**).

Interface Series 2 Mask

Returns the value of the Interface Series 2 Mask property (refer to **CAN Set Property.vi**).

Interface Single Shot Transmit?

Returns the value of the Interface Single Shot Transmit? property (refer to **CAN Set Property.vi**).

Interface Transceiver External Inputs

Returns the transceiver external inputs for the interface that was initialized for the task.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this property allows you to determine the input voltage on the STATUS pin of the CAN port.

For many models of CAN transceiver, an NERR pin is provided for detection of faults and other status. For such transceivers, you can wire the NERR pin to the STATUS pin of the CAN port.

This property is supported for Series 2 XS cards only.

This property uses a bit mask. When using the property, use bitwise *and* operations to check for values, not equality checks (equal, greater than, and so on).

`00000001` hex STATUS

This bit is set when 5 V exists on the STATUS pin.

This bit is clear when 0 V exists on the STATUS pin.

Interface Transceiver External Outputs

Returns the transceiver external outputs for the interface that was initialized for the task.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this property allows you to determine the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you to determine if the CAN controller chip is sleeping.

For more information on the format of the value returned in this property, refer to the description of **Interface Transceiver External Outputs** property in **CAN Set Property.vi**.

This property is supported for Series 2 XS cards only.

Interface Transceiver Mode

Returns the transceiver mode for the interface that was initialized for the task.

The transceiver mode changes when you set the mode within the application, or when a remote wakeup transitions the interface from **Sleep** to **Normal** mode. For more information, refer to **CAN Set Property.vi**.

This property uses the following values:

Normal

Transceiver is awake in normal communication mode.

Sleep

Transceiver and the CAN controller chip are both in sleep mode.

Single Wire Wakeup

Single Wire transceiver is in Wakeup Transmission mode.

Single Wire High-Speed

Single Wire transceiver is in High-Speed Transmission mode.

Interface Transceiver Type

Returns the type of transceiver for the interface that was initialized for the task. For hardware other than Series 2 XS cards, the transceiver type is fixed. For Series 2 XS cards, the transceiver type reflects the most recent value specified by MAX or **CAN Set Property.vi**.

This property is not supported on the PCMCIA form factor.

This property uses the following values:

High-Speed

Transceiver type is High-Speed (HS).

Low-Speed/Fault-Tolerant

Transceiver type is Low-Speed / Fault-Tolerant (LS).

Single Wire

Transceiver type is Single Wire (SW).

External

Transceiver type is External. This transceiver type is available on Series 2 XS cards only. For more information, refer to **CAN Set Property.vi**.

Disconnect

Transceiver type is Disconnect. This transceiver type is available on Series 2 XS cards only. For more information, refer to **CAN Set Property.vi**.

Interface Transmit Error Counter

Returns the Transmit Error Counter as described in the CAN specification.

Since the error counts require the Philips SJA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only. If you are using Series 1 NI CAN hardware, this property returns an error.

Interface Virtual Bus Timing

Returns a Boolean value of **True** or **False** to indicate whether **Virtual Bus Timing** has been set or not for the specified virtual task. This property is applicable to all tasks opened on the virtual interface.

If this property is selected on real hardware, an error will be returned.

Message ID

Returns the arbitration ID of the channel message.

To determine whether the ID is standard (11-bit) or extended (29-bit), get the **Message ID is Extended?** property.

The value of this property cannot be changed using **CAN Set Property**.

Message ID is Extended?

Returns a Boolean value that indicates whether the arbitration ID of the channel message is standard 11-bit format (FALSE) or extended 29-bit format (TRUE).

The value of this property cannot be changed using **CAN Set Property**.

Message Name

Returns the name of the channel message. The string is no more than 80 characters in length.

The value of this property cannot be changed using **CAN Set Property**.

Message Number of Data Bytes

Returns the number of data bytes in the channel message. The range is `1` to `8`.

The value of this property cannot be changed using **CAN Set Property**.

Mode

Returns the mode initialized for the task, such as with the **CAN Init Start** VI.

Message Multiple Frame Distribution

Returns the **Message Multiple Frame Distribution** property which is used to determine if the CAN frames associated to a group of mode dependent channels are sent even spaced or in burst mode.

Number of Channels

Returns the number of channels initialized in channel list. This is the number of array entries required when using **CAN Read** or **CAN Write**.

Channel Mode Dependency

Returns the number of mode dependent channels within a channel. So far a hierarchy of one mode dependent channel per channel is supported.

`0` Channel is not mode dependent

`1` Channel is mode dependent

This property applies only to mode dependent channels.

Number of Samples Pending

Returns the number of samples available to be read using **CAN Read**. If you set the number of samples to read input of **CAN Read** to this value, **CAN Read** returns immediately without waiting.

This property applies only to tasks initialized with **mode** of **Input** and **sample rate** greater than zero. For all other configurations, it returns an error.

Sample Rate

Returns the sample rate initialized for the task, such as with the **CAN Init Start** VI.

Timeout

Returns the **Timeout** property, which is used with some task configurations. For more information, refer to the Timeout property in **CAN Set Property**.

Value for invalid data

Sets the value that is returned on time stamped read for mode dependent channels that have not been received with the most recent CAN frame associated with the CAN message. This property applies only to mode dependent channels that are read with the time stamped read operation. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

Version Build

Returns the build number of the NI-CAN software. This number applies to **Development**, **Alpha**, and **Beta** phase only, and should be ignored for **Release** phase.

Version Comment

Returns a comment string for the NI-CAN software. If you received a custom release of NI-CAN from National Instruments, this comment often describes special features of the release.

Version Major

Returns the major version of the NI-CAN software, such as the *2* in version *2.1.5*.

Version Minor

Returns the minor version of the NI-CAN software, such as the *1* in version *2.1.5*.

Version Phase

Returns the phase of the NI-CAN software.

The value of **Version Phase** is an enumeration:

`0` **Development**

`1` **Alpha**

`2` **Beta**

`3` **Release**

Versions of NI-CAN in hardware kits or on `ni.com` will always be **Release**.

Version Update

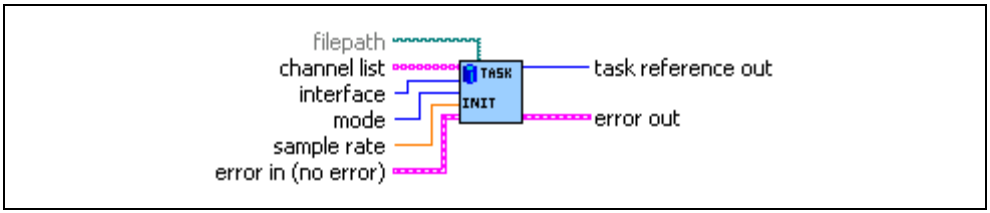
Returns the update version of the NI-CAN software, such as the *5* in version *2.1.5*.

CAN Initialize.vi

Purpose

Initialize a task for the specified channel list.

Format



Inputs

filepath is an optional path to a CAN database file from which to import the channel (signal) configurations.

If **filepath** is unwired (empty), the channel configuration is obtained from MAX. The MAX CAN channels are in the MAX CAN Channels listing within **Data Neighborhood**.

channel list is the array of channel names to initialize as a task. Each channel name is provided in an array entry.

For more information, refer to the channel list input of **CAN Init Start.vi**.

interface specifies the CAN interface to use for this task.

The interface input uses a `ring` typedef in which value `0` selects **CAN0**, value `1` selects **CAN1**, and so on.

The default (unwired) value is **MAX default**, which means to use the default interface as defined in the Message/Channel configuration properties. If the default interface in MAX is **All**, or if **filepath** is wired to use a CAN database (not MAX), the **interface** is a required input to this VI.

The Channel API and Frame API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Frame API, this function returns an error.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

mode specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as single-point, array, or waveform.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ waveforms. You also can use this input mode to read a single point from the most recent message, such as for control or simulation.

For this mode, the channels in **channel list** can be contained in multiple messages.

Output

Output channel data to CAN messages for transmit. Use **CAN Write.vi** to write output samples as single point, array, or waveform. Each sample value you write is transmitted in a message on the network. If you write an array or waveform, the samples are buffered for subsequent transmit.

For this mode, there are restrictions on using channels in **channel list** that are contained in multiple messages. Refer to **CAN Write.vi** for more information.

Output Recent

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use **CAN Write.vi** to provide a single sample per channel. Each periodic message uses the sample values from the most recent **CAN Write.vi**.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to **CAN Write.vi** for more information.

Timestamped Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as an array of sample/timestamp pairs (Poly VI types ending in *Timestamped Dbl*).

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

For this mode, the channels in **channel list** must be contained in a single message.

sample rate specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For **mode** of **Input**, **sample rate** of zero means that **CAN Read** returns a single point from the most recent message received, and greater than zero means that **CAN Read** returns samples timed at the specified rate.

For **mode** of **Output**, **sample rate** of zero means that CAN messages transmit immediately when **CAN Write** is called, and greater than zero means that CAN messages are transmitted periodically at the specified rate.

For **mode** of **Output Recent**, sample rate must be greater than zero (periodic transmit).

For **mode** of **Timestamped Input**, **sample rate** is ignored.

When the **interface** specifies a virtual interface (256 or 257), and **mode** is **Output** or **Output Recent**, this **sample rate** must be zero (greater than zero not supported).

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

Use **task reference out** with all subsequent VIs to reference the task. Wire this task reference to **CAN Start.vi** before you read or write samples for the message.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

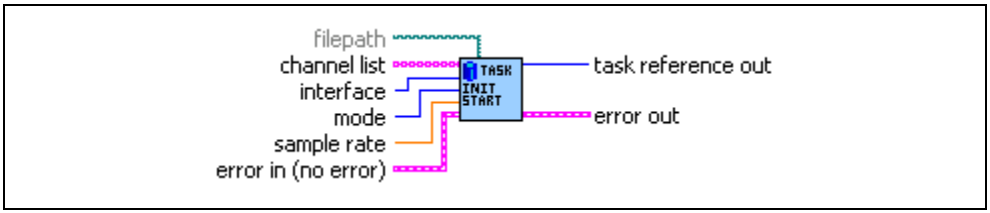
The **CAN Initialize** VI does not start communication. This enables you to use **CAN Set Property.vi** to change the properties of a task, or **CAN Connect Terminals.vi** to synchronize CAN or DAQ cards. After you change properties or connections, use **CAN Start.vi** to start communication for the task.

CAN Init Start.vi

Purpose

Initialize a task for the specified channel list, then start communication.

Format



Inputs

filepath is an optional path to a CAN database file from which to import the channel (signal) configurations.

If **filepath** is unwired (empty), the channel configuration is obtained from MAX. The MAX CAN channels are in the MAX CAN Channels listing within **Data Neighborhood**.

channel list is the array of channel names to initialize and start as a task. Each channel name is provided in an array entry.

You can type in the channel list entries as string constants, or you can obtain the list from MAX or another CAN database by using **CAN Get Names.vi**. Channel names are case sensitive.

You can initialize the same **channel list** with different **interface**, **mode**, or **sample rate**, because each task reference is unique.

The following paragraphs describe the syntax of each channel name. Brackets indicate optional fields.

[*message*.]*channel*

- *message* refers to the message in which the *channel* is contained. The message name must be followed by a decimal point.

  If the *channel* name occurs in multiple messages, you must specify the *message* name to identify the channel uniquely. Within MAX, channels with the same name in multiple messages are shown with a yellow exclamation point.

If the *channel* name is unique across all channels, the *message* name is not required.

- *channel* refers to the channel (signal) name in MAX or the CAN database (indicated by **filepath**).

If you are using mode dependent channels, and each channel name is not unique, you will need to use a special syntax described in the *Mode Dependent Channel Syntax* section at the end of the function description.

The following examples demonstrate the channel list syntax:

1. List of channels, each channel name unique across all messages.
   - *myChan1*
   - *myChan2*
   - *myChan3*
2. List of channels, with one channel duplicated across two messages. *MyChan2* and *MyChan3* must be unique across all messages.
   - *myMessage1.myChan1*
   - *myChan2*
   - *myMessage2.myChan1*
   - *myChan3*

interface specifies the CAN interface to use for this task.

The interface input uses a ring typedef in which value `0` selects **CAN0**, value `1` selects **CAN1**, and so on.

The default (unwired) value is **MAX default**, which means to use the default interface as defined in the Message/Channel configuration properties. If the default interface in MAX is **All**, or if **filepath** is wired to use a CAN database (not MAX), the **interface** is a required input to this VI.

The Channel API and Frame API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Frame API, this function returns an error.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

mode specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as single-point, array, or waveform.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ waveforms. You also can use this input mode to read a single point from the most recent message, such as for control or simulation.

For this mode, the channels in **channel list** can be contained in multiple messages.

Output

Output channel data to CAN messages for transmit. Use **CAN Write.vi** to write output samples as single-point, array, or waveform. Each sample value that you write is transmitted in a message on the network. If you write an array or waveform, the samples are buffered for subsequent transmit.

For this mode, there are restrictions on using channels in **channel list** that are contained in multiple messages. Refer to **CAN Write.vi** for more information.

Output Recent

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use **CAN Write.vi** to provide a single sample per channel. Each periodic message uses the sample values from the most recent **CAN Write.vi**.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to **CAN Write.vi** for more information.

Timestamped Input

Input channel data from received CAN messages. Use **CAN Read.vi** to obtain input samples as an array of sample/timestamp pairs (Poly VI types ending in *Timestamped Dbl*).

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

For this mode, the channels in **channel list** must be contained in a single message.

sample rate specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For **mode** of **Input**, a **sample rate** of zero means that **CAN Read** returns a single point from the most recent message received, and greater than zero means that **CAN Read** returns samples timed at the specified rate.

For **mode** of **Output**, a **sample rate** of zero means that CAN messages transmit immediately when **CAN Write** is called, and greater than zero means that CAN messages are transmitted periodically at the specified rate.

For **mode** of **Output Recent**, sample rate must be greater than zero (periodic transmit).

For **mode** of **Timestamped Input**, **sample rate** is ignored.

When the **interface** specifies a virtual interface (256 or 257), and **mode** is **Output** or **Output Recent**, this **sample rate** must be zero (greater than zero not supported).

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

Use **task reference out** with all subsequent VIs to reference the running task. Because **CAN Init Start** starts communication, you can wire this task reference to **CAN Read.vi** or **CAN Write.vi**.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The diagram for this VI simply calls **CAN Initialize.vi** followed by **CAN Start.vi**. This provides an easy way to start a list of channels.

The following list describes the scenarios for which **CAN Init Start.vi** cannot be used:

- If you need to set properties for the channels, use **CAN Initialize.vi**, then **CAN Set Property.vi**, then **CAN Start.vi**. The **CAN Init Start** VI starts communication, and most channel properties cannot be changed after the task is started.
- If you need to synchronize tasks for multiple NI-CAN or NI-DAQ cards, refer to the VIs in the **CAN/DAQ Synchronization** palette, such as **CAN Sync Start with NI-DAQ.vi**.
- If you need to create channel configurations entirely within LabVIEW, without using MAX or a CAN database file, use **CAN Create Message.vi**, then **CAN Start.vi**. The **CAN Init Start** VI accepts only channel names defined in MAX or a CAN database file.

Mode Dependent Channel Syntax

If you are using mode dependent channels, and each channel name is not unique, you will need to use a special syntax described in this section. Within MAX, channels with the same name are shown with a yellow exclamation point. For channels with unique names, you can use the simple syntax described previously for *channel list*. The brackets [] define optional parameters:

[*message name*.[[*multiplexer*.]*mode_value*.]]*channel*.

- *message name* refers to the message in which the channel is contained. The *message name* must be followed by a decimal point.
- *multiplexer* refers to the multiplexer name in MAX or the CAN database. The *multiplexer* must be followed by a decimal point.

- *mode_value* refers to the multiplexer mode in MAX or the CAN database. The *mode_value* must be followed by a decimal point.
- *channel* refers to the channel (signal) name in MAX or the CAN database.

You cannot use the same channel name for a normal CAN channel and a mode dependent CAN channel within the same CAN message.

For more information on mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

CAN Read.vi

Purpose

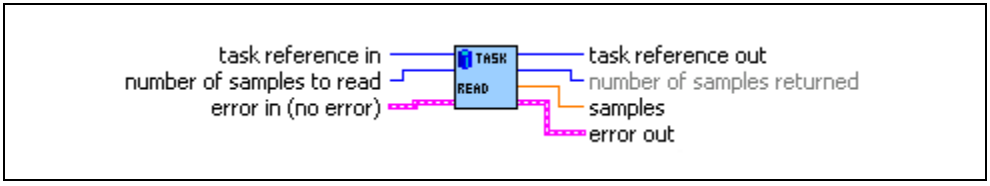
Read samples from a CAN task initialized as input. Samples are obtained from received CAN messages. The poly VI selection determines the data type to read.

To select the data type, right-click the VI, go to **Select Type**, and select the type by name.

For LabVIEW 7.0 and later, you can right-click the VI and select **Visible Items»Poly VI Selector** to select the data type from within the diagram.

For an overview of CAN Read, refer to the *Read* and *Read Timestamped* sections of Chapter 6, *Using the Channel API*.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from **CAN Init Start.vi**, **CAN Initialize.vi**, or **CAN Create Message.vi**, and then wired through subsequent VIs.

The **mode** initialized for the task must be either **Input** or **Timestamped Input**.

number of samples to read specifies the number of samples to read for the task. For single-sample Poly VI types, **CAN Read** always returns one sample, so this input is ignored.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

number of samples returned indicates the number of samples returned in the **samples** output.

The poly output **samples** returns the samples read from received CAN messages. The type of the poly output is determined by the Poly VI selection. For information on the different poly VI types provided by **CAN Read**, refer to the Poly VI Types section.

To select the data type, right-click the VI, go to **Select Type**, and select the type by name.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Poly VI Types

The name of each Poly VI type uses the following conventions:

- The first term is either **Single-Chan** or **Multi-Chan**. This indicates whether the type returns data for a single channel or multiple channels. **Multi-Chan** types return an array of analogous **Single-Chan** types, one entry for each channel initialized in **channel list** of

CAN Init Start. **Single-Chan** types are convenient because no array indexing is required, but you are limited to reading only one CAN channel.

- The second term is either **Single-Samp** or **Multi-Samp**. This indicates whether the type returns a single sample, or an array of multiple samples. **Single-Samp** types are often used for single point control applications, such as within LabVIEW RT.
- The third term indicates the data type used for each sample. The type *Dbl* indicates double-precision (64-bit) floating point. The type *Wfm* indicates the waveform data type. The types *1D* and *2D* indicate one and two-dimensional arrays, respectively. The types **Time** & **Dbl** indicate a cluster of a LabVIEW timestamp and a double-precision sample.

Single-Chan Single-Samp Dbl

Returns a single sample for the first channel initialized in channel list.

If the initialized sample rate is greater than zero, this poly VI type waits for the next sample time, then returns a single sample. This enables you to execute a control loop at a specific rate.

If the initialized **sample rate** is zero, this poly VI immediately returns a single sample.

The **samples** output returns a single sample from the most recent message received. If no message has been received since you started the task, the Default Value of the channel is returned in **samples**.

You can use **error out** to determine whether a new message has been received since the previous call to **CAN Read** (or **CAN Start**). If no message has been received, the warning code `3FF62009` hex is returned in **error out**. If a new message has been received, the success code `0` is returned in **error out**.

To use this type, you must set the initialized mode to **Input** (not **Timestamped Input**).

Unless an error occurs, **number of samples returned** is one.

Multi-Chan Single-Samp 1D Dbl

Returns an array, one entry for each channel initialized in channel list. Each entry consists of a single sample.

The order of channel entries in **samples** is the same as the order in the original **channel list**.

If the initialized sample rate is greater than zero, this poly VI type waits for the next sample time, then returns a single sample for each channel. This enables you to execute a control loop at a specific rate.

If the initialized **sample rate** is zero, this poly VI immediately returns a single sample for each channel.

The **samples** output returns a single sample for each channel from the most recent message received. If no message has been received for a channel since you started the task, the Default Value of the channel is returned in **samples**.

You can specify channels in **channel list** that span multiple messages. A sample from the most recent message is returned for all channels.

You can use **error out** to determine whether a new message has been received since the previous call to **CAN Read** (or **CAN Start**). If no message has been received for one or more channels, the warning code **3FF62009** hex is returned in **error out**. If a new message has been received for all channels, the success code **0** is returned in **error out**.

To use this type, you must set the initialized mode to **Input** (not **Timestamped Input**).

Unless an error occurs, **number of samples returned** is one. The **samples** array is indexed by channel, and the entry for each channel contains a single sample.

If you need to determine the number of channels in the task after initialization, get the **Number of Channels** property for the task reference.

Single-Chan Multi-Samp 1D Dbl

Returns an array of samples for the first channel initialized in channel list.

The initialized sample rate must be greater than zero for this poly VI, because each sample in the array indicates the value of the CAN channel at a specific point in time. In other words, the **sample rate** specifies a virtual clock that copies the most recent value from CAN messages for each sample time. The changes in sample values from message to message enable you to view the CAN channel over time, such as for comparison with other CAN or DAQ input channels.

This VI waits until all samples arrive in time before returning. To avoid internal waiting within the VI, you can use **CAN Get Property** to obtain the **Number Of Samples Pending**, and pass that as the **number of samples to read**.

If the initialized **sample rate** is zero, this poly VI returns an error. If the intent is simply to read the most recent sample for a task, use the **Single-Chan Single-Samp Dbl** type.

If no message has been received since you started the task, the Default Value of the channel is returned in all entries of the **samples** array.

You can use **error out** to determine whether a new message has been received since the previous call to **CAN Read** (or **CAN Start**). If no message has been received, the warning code **3FF62009** hex is returned in **error out**. If a new message has been received, the success code **0** is returned in **error out**.

To use this type, you must set the initialized mode to **Input** (not **Timestamped Input**).

Unless an error occurs, the **number of samples returned** is equal to **number of samples to read**.

Multi-Chan Multi-Samp 2D Dbl

Returns an array, one entry for each channel initialized in channel list. Each entry consists of an array of samples.

The order of channel entries in **samples** is the same as the order in the original **channel list**.

The initialized sample rate must be greater than zero for this poly VI, because each sample in the array indicates the value of each CAN channel at a specific point in time. In other words, the **sample rate** specifies a virtual clock that copies the most recent value from CAN messages for each sample time. The changes in sample values from message to message enable you to view the CAN channels over time, such as for comparison with other CAN or DAQ input channels.

This VI waits until all samples arrive in time before returning. To avoid internal waiting within the VI, you can use **CAN Get Property** to obtain the **Number Of Samples Pending**, and pass that as the **number of samples to read**.

If the initialized **sample rate** is zero, this poly VI returns an error. If the intent is simply to read the most recent samples for a task, use the **Multi-Chan Single-Samp 1D Dbl** type.

If no message has been received for a channel since you started the task, the Default Value of the channel is returned in **samples**.

You can specify channels in **channel list** that span multiple messages. At each point in time, a sample from the most recent message is returned for all channels.

You can use **error out** to determine whether a new message has been received since the previous call to **CAN Read** (or **CAN Start**). If no message has been received for one or more channels, the warning code `3FF62009` hex is returned in **error out**. If a new message has been received for all channels, the success code `0` is returned in **error out**.

To use this type, you must set the initialized mode to **Input** (not **Timestamped Input**).

Unless an error occurs, the **number of samples returned** is equal to **number of samples to read**.

If you need to determine the number of channels in the task after initialization, get the **Number of Channels** property for the task reference.

Single-Chan Multi-Samp Wfm

Returns a single waveform for the first channel initialized in *channel list*.

The initialized sample rate must be greater than zero for this poly VI, because each sample in the array indicates the value of the CAN channel at a specific point in time. In other words, the **sample rate** specifies a virtual clock that copies the most recent value from CAN messages for each sample time. The changes in sample values from message to message enable you to view the CAN channel over time, such as for comparison with other CAN or DAQ input channels.

This VI waits until all samples arrive in time before returning. To avoid internal waiting within the VI, you can use **CAN Get Property** to obtain the **Number Of Samples Pending**, and pass that as the **number of samples to read**.

The start time of a waveform indicates the time of the first CAN sample in the array. The delta time of a waveform indicates the time between each sample in the array, as determined by the original **sample rate**.

If the initialized **sample rate** is zero, this poly VI returns an error. If the intent is to simply read the most recent sample for a task, use the **Single-Chan Single-Samp Dbl** type.

If no message has been received since you started the task, the Default Value of the channel is returned in all entries of the **samples** waveform.

You can use **error out** to determine whether a new message has been received since the previous call to **CAN Read** (or **CAN Start**). If no message has been received, the warning code **`3FF62009`** hex is returned in **error out**. If a new message has been received, the success code **`0`** is returned in **error out**.

To use this type, you must set the initialized **mode** to **Input** (not **Timestamped Input**).

Unless an error occurs, the **number of samples returned** is equal to **number of samples to read**.

Multi-Chan Multi-Samp 1D Wfm

Returns an array, one entry for each channel initialized in channel list. Each entry consists of a single waveform.

The order of channel entries in **samples** is the same as the order in the original **channel list**.

The initialized sample rate must be greater than zero for this poly VI, because each sample in the array of a waveform indicates the value of the CAN channel at a specific point in time. In other words, the **sample rate** specifies a virtual clock that copies the most recent value from CAN messages for each sample time. The changes in sample values from message to message enable you to view the CAN channel over time, such as for comparison with other CAN or DAQ input channels.

This VI waits until all samples arrive in time before returning. To avoid internal waiting within the VI, you can use **CAN Get Property** to obtain the **Number Of Samples Pending**, and pass that as the **number of samples to read**.

The start time for each waveform indicates the time of the first CAN sample in the array. The delta time of a waveform indicates the time between each sample in the array, as determined by the original **sample rate**.

If the initialized **sample rate** is zero, this poly VI returns an error. If the intent is simply to read the most recent samples for a task, use the **Multi-Chan Single-Samp 1D Dbl** type.

If no message has been received for a channel since you started the task, the Default Value of the channel is returned in **samples**.

You can specify channels in **channel list** that span multiple messages. At each point in time, a sample from the most recent message is returned for all channels.

You can use **error out** to determine whether a new message has been received since the previous call to **CAN Read** (or **CAN Start**). If no message has been received for one or more channels, the warning code **3FF62009** hex is returned in **error out**. If a new message has been received for all channels, the success code **0** is returned in **error out**.

To use this type, you must set the initialized mode to **Input** (not **Timestamped Input**).

Unless an error occurs, the **number of samples returned** is equal to **number of samples to read**.

If you need to determine the number of channels in the task after initialization, get the **Number of Channels** property for the task reference.

Single-Chan Multi-Samp 1D Time & Dbl

Returns an array of clusters. Each cluster corresponds to a received message for the first channel initialized in channel list. Each cluster contains the sample value, and a timestamp that indicates when the message was received.

To use this type, you must set the initialized mode to **Timestamped Input** (not **Input**).

The Timeout property determines whether this VI will wait for the **number of samples to read** messages to arrive from the network. The default value of **Timeout** is zero, but you can change it using **CAN Set Property.vi**.

If **Timeout** is greater than zero, the VI will wait for **number of samples to read** messages to arrive. If **number of samples to read** messages are not received before the **Timeout** expires, an error is returned. **Timeout** is specified as milliseconds.

If **Timeout** is zero, the VI will not wait for messages, but instead returns samples from the messages received since the previous call to **CAN Read**. The number of samples returned is indicated in the **number of samples returned** output, up to a maximum of **number of samples to read** messages. If no new message has been received, **number of samples returned** is 0, and **error out** indicates success.

Because the timing of values in **samples** is determined by when the message is received, the sample rate input is not used with this poly VI type.

Multi-Chan Multi-Samp 2D Time & Dbl

Returns an array, one entry for each channel initialized in channel list. Each entry consists of an array of clusters. Each cluster corresponds to a received message for the channels initialized in channel list. Each cluster contains the sample value, and a timestamp that indicates when the message was received.

The order of channel entries in **samples** is the same as the order in the original **channel list**.

To use this type, you must set the initialized mode to **Timestamped Input** (not **Input**).

You cannot specify channels in **channel list** that span multiple messages.

The Timeout property determines whether this VI waits for the **number of samples to read** messages to arrive from the network. The default value of **Timeout** is zero, but you can change it using **CAN Set Property.vi**.

If **Timeout** is greater than zero, the VI will wait for **number of samples to read** messages to arrive. If **number of samples to read** messages are not received before the **Timeout** expires, an error is returned. **Timeout** is specified as milliseconds.

If **Timeout** is zero, the VI will not wait for messages, but instead returns samples from the messages received since the previous call to **CAN Read**. The number of samples returned is indicated in the **number of samples returned** output, up to a maximum of **number of samples to read** messages. If no new message has been received, **number of samples returned** is `0`, and **error out** indicates success.

Because the timing of values in **samples** is determined by when the message is received, the sample rate input is not used with this poly VI type.

If you need to determine the number of channels in the task after initialization, get the **Number of Channels** property for the task reference.

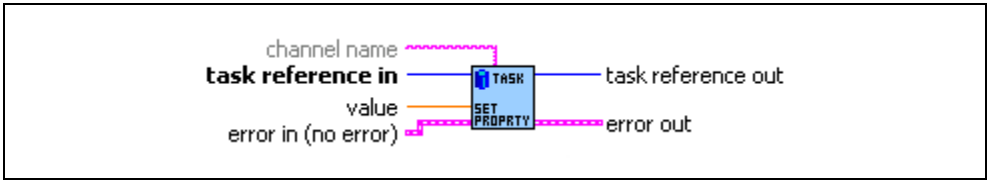
CAN Set Property.vi

Purpose

Set a property for the task, or a single channel within the task. The poly VI selection determines the property to set.

To select the property, right-click the VI, go to **Select Type** and select the property by name. For LabVIEW 7.0 and later, you can right-click the VI and select **Visible Items»Poly VI Selector** to select the property from within the diagram.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from VIs such as **CAN Initialize.vi** or **CAN Create Message.vi**, and then wired through subsequent VIs.

channel name specifies an individual channel within the task. The default (unwired) value of channel name is empty, which means that the property applies to the entire task, not a specific channel.

Properties that begin with the word *Channel* or *Message* do not apply to the entire task, but an individual channel or message within the task. For these channel-specific properties, you must wire the name of a channel from channel list into the **channel name** input.

For properties that do not begin with the word *Channel* or *Message*, you must leave **channel name** unwired (empty).

The poly input **value** specifies the property value. You select the property to set as **value** by selecting the Poly VI type. The data type of **value** is also determined by the Poly VI selection. For information on the different properties provided by **CAN Get Property**, refer to the Poly VI Types section.

To select the property, right-click the VI, go to **Select Type** and select the property by name.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

You cannot set a property while the task is running. If you need to change a property prior to starting the task, you cannot use **CAN Init Start.vi**. First, call **CAN Initialize.vi**, followed by **CAN Set Property** and then **CAN Start.vi**. After you start the task, you also can change a property by calling **CAN Stop.vi**, followed by **CAN Set Property**, and then **CAN Start** again.

Poly VI Types

Behavior After Final Output

The **Behavior After Final Output** property applies only to tasks initialized with mode of **Output**, and sample rate greater than zero. The value specifies the behavior to perform after the final periodic sample is transmitted.

Behavior After Final Output uses the following values:

Repeat Final Sample

Transmit messages for the final sample(s) repeatedly. The final messages are transmitted periodically as specified by **sample rate**.

If there is significant delay between subsequent calls to **CAN Write.vi**, this value means that periodic messages continue between **CAN Write** calls, and messages with the data of the final sample will be repeated on the network.

Repeat Final Sample is the default value of the **Behavior After Final Output** property.

Cease Transmit

Cease transmit of messages until the next call to **CAN Write**.

If there is significant delay between subsequent calls to **CAN Write**, this value means that periodic messages cease between **CAN Write** calls, and the data of the final sample will not be repeated on the network.

Channel Default Value

Sets the default value of the channel in scaled floating-point units.

For information on how the **Channel Default Value** is used, refer to **CAN Read.vi** and **CAN Write.vi**.

The value of this property is originally set within MAX. If the channel is initialized directly from a CAN database, the value is `0.0` by default.

Hardware Master Timebase Rate

Sets the rate (in MHz) of the external clock that is exported to the CAN card.

The values for this property are:

20 MHz (20) When synchronizing 2 CAN cards or synchronizing a CAN card with an E Series DAQ card, the 20 MHz master timebase rate is to be used. By default, this property is set to 20 MHz.

10 MHz (10) The master timebase rate should be set to 10 MHz when synchronizing a CAN card with an M Series DAQ card. The M Series DAQ card can export a 20 MHz clock but it does this by using one of its two counters.

If your CAN-DAQ application does not use the 2 DAQ counters then, you can leave the timebase rate set to 20 MHz (default).

This property can be set either before or after calling **CAN Connect Terminals.vi** to connect the **RTSI_CLK** to **Master Timebase**. However, this property must always be called prior to starting the task.

This property is applicable only to PCI and PXI Series 2 cards. For PCMCIA cards, setting this attribute will return an error. On PXI cards, if **PXI_CLK10** is routed to the **Master Timebase**, then the rate is fixed at 10 MHz (it over-rides any previous setting of this property). Setting this property for Series 1 cards will also result in a NI-CAN error.

Hardware Timestamp Format

Sets the format of the timestamps reported by the on-board timer on the CAN card. The default value for this property is **Absolute**.

The values for this property are:

0	**Absolute**	Sets the timestamp format to absolute. In the absolute format, the timestamp returned by NI-CAN read functions is the LabVIEW date/time format (DBL representing the number of seconds elapsed since 12:00 a.m., Friday, January 1, 1904).
1	**Relative**	Sets the timestamp format to relative. In the relative format, the timestamp returned by the NI-CAN read functions will be zero based (DBL representing the number of seconds since the CAN controller for that task was started).

A typical use case for this property would be if data received from two RTSI synchronized CAN cards is to be correlated. For that use case, this property must be set to 1 for all of the CAN cards being synchronized. Setting this property on one port of a 2-port card will also reset the timestamp of the second port, since resetting the timestamp on the CAN port involves resetting the on-board timer.

This property should be set prior to starting any tasks on the CAN card.

Interface Baud Rate

Sets the baud rate in use by the Interface.

This property applies to all tasks initialized with the **Interface**.

You can specify the following basic baud rates as the numeric rate: 33333, 83333, 100000, 125000, 200000, 250000, 400000, 500000, 800000, and 1000000.

You can specify advanced baud rates as `8000`*XXYY* hex, where *YY* is the value of Bit Timing Register 0 (BTR0), and *XX* is the value of Bit Timing Register 1 (BTR1) of the CAN controller. For more information, refer to the Interface Properties dialog in MAX.

The value of this property is originally set within MAX.

Interface Listen Only?

Sets a Boolean value that indicates whether the listen only feature of the Philips SJA1000 CAN controller is enabled (TRUE) or disabled (FALSE).

This property applies to all tasks initialized with the Interface.

If **Interface Listen Only?** is FALSE, the **Interface** can transmit CAN messages; therefore, **CAN Write.vi** operates normally. When CAN messages are received by the **Interface**, those messages are acknowledged. Because FALSE is the behavior specified in the CAN specification, it is the default value of **Interface Listen Only?**.

If **Interface Listen Only?** is TRUE, the **Interface** *cannot* transmit CAN messages; therefore, **CAN Write.vi** returns an error. When CAN messages are received by the **Interface**, those messages are *not* acknowledged. The Philips SJA1000 CAN controller enters error passive state when listen only is enabled (but no error-passive warning is returned). The TRUE value of **Interface Listen Only?** enables passive monitoring of network traffic, which can be useful for debugging scenarios in which only one device exists on the network.

Since the listen only feature requires the Philips SJA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only. If you are using Series 1 NI CAN hardware, an attempt to set this property returns error `nctErrRequiresNewSeries` (**code** `BFF6210D` hex, **status** `T`).

Interface Self Reception?

Specifies whether to echo successfully transmitted CAN frames as received frames. Each reception occurs just as if the frame were received from another CAN device. This enables you to initialize the same channels for both input and output.

For self reception to operate properly, another CAN node must receive and acknowledge each transmit.

FALSE disables self reception mode (default), and TRUE enables self reception mode.

The self reception mode is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware. For Series 1 hardware, this property must be left at its default (FALSE).

Interface Series 2 Comparator

Specifies the filter comparator for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This property is not supported for Series 1 hardware (returns error).

This property specifies a comparator value that is checked against the ID, RTR, and data bits. The Interface Series 2 Mask determines the applicable bits for comparison.

The default value of this property is zero.

The mapping of bits in this property to the ID, RTR, and data bits of incoming frames is determined by the value of the Interface Series 2 Filter Mode property. The Series 2 filter mode determines the format of this property as well as the Series 2 mask.

Interface Series 2 Filter Mode

All Series 2 hardware uses the Philips SJA1000 CAN controller. The Philips SJA1000 CAN controller provides sophisticated filtering of received frames. This property specifies the filtering mode, which is used in conjunction with the Interface Series 2 Mask and Interface Series 2 Comparator properties.

This property is not supported for Series 1 hardware (returns error).

Since the format of the Series 2 filters is very specific to the Philips SJA1000 CAN controller, National Instruments cannot guarantee compatibility for this property on future hardware series. When using this property in the application, it is best to get the Hardware Series property to verify that the CAN hardware is Series 2.

The filtering specified by the Series 2 filter properties applies to all input tasks for that interface. For example, if you specify filters that discard ID 5, then open an **Input** task to receive channels of ID 5, the task will not receive data.

The default value for this property is **Single Standard**.

The values for this property are summarized below. For detailed information on each value, including the format of the **Interface Series 2 Mask** and **Interface Series 2 Comparator** properties for each mode, refer to **Series 2 Filter Mode** attribute in the **ncSetAttr.vi** function of the Frame API.

Single Standard

Filter all standard (11-bit) frames using a single mask/comparator filter.

Single Extended

Filter all extended (29-bit) frames using a single mask/comparator filter.

Dual Standard

Filter all standard (11-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

Dual Extended

Filter all extended (29-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

Interface Series 2 Mask

Specifies the filter mask for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This property is not supported for Series 1 hardware (returns error).

This property specifies a bit mask that determines the ID, RTR, and data bits that are compared. If a bit is clear in the mask, the corresponding bit in the **Interface Series 2 Comparator** is checked. If a bit in the mask is set, that bit is ignored for the purpose of filtering (don't care).

The default value of this property is hex FFFFFFFF, which means that all messages are received.

The mapping of bits in this property to the ID, RTR, and data bits of incoming frames is determined by the value of the **Interface Series 2 Filter Mode** property. The Series 2 filter mode determines the format of this property as well as the Series 2 comparator.

Interface Single Shot Transmit?

Specifies whether to retry failed CAN frame transmissions (Series 2 only).

If **Interface Single Shot Transmit?** is FALSE (default), failed transmissions retry as defined in the CAN specification. If a CAN frame is not transmitted successfully, the CAN controller will immediately retry.

If **Interface Single Shot Transmit?** is TRUE, all transmissions are single shot. If a CAN frame is not transmitted successfully, the CAN controller will not retry.

The single-shot transmit feature is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware (set returns error).

Interface Transceiver External Outputs

Sets the transceiver external outputs for the interface that was initialized for the task.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this property allows you to set the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you control the sleep mode of the on-board CAN controller chip.

For many models of CAN transceiver, EN and NSTB pins control the transceiver mode, such as whether the transceiver is sleeping or communicating normally. For such transceivers, you can wire the EN and NSTB pins to the MODE0 and MODE1 pins of the CAN port.

The default value of this property is 00000003 hex. For many models of transceiver, this specifies normal communication mode for the transceiver and CAN controller chip. If the transceiver requires a different MODE0/MODE1 combination for normal mode, you can use external inverters to change the default 5 V to 0 V.

This property is supported for Series 2 XS cards only. This property is not supported when the Interface Transceiver Type is any value other than **External**. To control the mode of an internal transceiver, use the Interface Transceiver Mode property.

This property uses a bit mask. Use bitwise OR operations to set multiple values.

`00000001` hex MODE0

Set this bit to drive 5 V on the MODE0 pin. This is the default value. This bit is set automatically when a remote wakeup is detected.

Clear this bit to drive 0 V on the MODE0 pin.

`00000002` hex MODE1

Set this bit to drive 5 V on the MODE1 pin. This is the default value. This bit is set automatically when a remote wakeup is detected.

Clear this bit to drive 0 V on the MODE1 pin.

`00000100` hex Sleep CAN controller chip

Set this bit to place the CAN controller chip into sleep mode. This bit controls the mode of the CAN controller chip (sleep or normal), and the independent MODE0/MODE1 bits control the mode of the external transceiver. When you set this bit to place the CAN controller into sleep mode, you typically specify MODE0/MODE1 bits that place the external transceiver into sleep mode as well.

When the CAN controller is asleep, a remote wakeup will automatically place the CAN controller into its normal mode of communication. In addition, the MODE0/MODE1 pins are restored to their default values of 5 V. Therefore, a remote wakeup causes this property to change from the value that you set for sleep mode, back to its default `00000003` hex. You can determine when this has occurred by getting Interface Transceiver External Outputs using **CAN Get Property.vi**. For more information on remote wakeup, refer to the Interface Transceiver Mode property for internal transceivers.

Clear this bit to place the CAN controller chip into normal communication mode. If the CAN controller was previously in

sleep mode, this performs a local wakeup to restore communication.

Interface Transceiver Mode

Sets the transceiver mode for the interface that was initialized for the task. The transceiver mode controls whether the transceiver is asleep or communicating, as well as other special modes.

This property is supported on Series 2 cards only.

For Series 2 cards for the PCMCIA form factor, this property requires a corresponding Series 2 cable (dongle). For information on how to identify the series of the PCMCIA cable, refer to the *Series 2 versus Series 1* subsection of the *NI CAN Hardware Overview* section of Chapter 1, *Introduction*.

For Series 2 XS cards, this property is not supported when the Interface Transceiver Type is **External**. To control the mode of an external transceiver, use the **Interface Transceiver External Outputs** property.

The default value for this property is **Normal**.

This property uses the following values:

Normal

Set transceiver to normal communication mode. If you set sleep mode previously, this performs a local wakeup of the transceiver and CAN controller chip.

Sleep

Set transceiver and the CAN controller chip to sleep (or standby) mode.

If the transceiver supports multiple sleep/standby modes, the NI CAN hardware implementation ensures that all of those modes are equivalent with regard to the behavior of the transceiver on the network. For more information on the physical specifications of the **Normal** and **Sleep** modes for each transceiver, refer to Chapter 3, *NI CAN Hardware*.

You can set **Sleep** mode only while the interface is communicating. If at least one task for the interface has not been started (such as with **CAN Start.vi**), setting the transceiver mode to **Sleep** will return an error.

When the interface enters sleep mode, communication is not possible until a wakeup occurs. All pending frame transmissions are deferred until the wakeup occurs. The transceiver and CAN controller wake from **Sleep** mode when either a local wakeup or remote wakeup occurs.

If you set sleep mode when the CAN controller is actively transmitting a frame (that is, won arbitration), the interface will not enter sleep mode until the frame is transmitted successfully (acknowledgement detected).

A *local wakeup* occurs when the application sets the transceiver mode to **Normal** (or some other communication mode).

A *remote wakeup* occurs when a remote node transmits a CAN frame (referred to as the *wakeup frame*). The wakeup frame wakes up the transceiver and CAN controller chip of the NI CAN interface. The wakeup frame is not received or acknowledged by the CAN controller chip. When the wakeup frame ends, the NI CAN interface enters **Normal** mode, and again receives and transmits CAN frames. If the node that transmitted the wakeup frame did not detect an acknowledgement (such as if other nodes were also waking), it will retry the transmission, and the retry will be received by the NI CAN interface.

For a remote wakeup to occur for Single Wire transceivers, the node that transmits the wakeup frame must first place the network into the **Single Wire Wakeup Transmission** mode by asserting a higher voltage (typically 12 V). For more information, refer to Single Wire Wakeup mode.

When the local or remote wakeup occurs, frame transmissions resume from the point at which the original sleep was set.

You can detect when a remote wakeup occurs by using **CAN Get Property.vi** with the **Interface Transceiver Mode** property.

Single Wire Wakeup

Set Single Wire transceiver to **Wakeup Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire Wakeup Transmission** mode drives a higher voltage level on the network to wake up all sleeping nodes. Other than this higher voltage, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

Since you use the **Single Wire Wakeup** mode to wake up other nodes on the network, it is not typically used in combination with **Sleep** mode for a given interface.

The timing of how long the wakeup voltage is driven is controlled entirely by the application. The application will typically change to **Single Wire Wakeup** mode, transmit a wakeup frame, then return to **Normal** mode.

The following sequence demonstrates a typical sequence of steps for sleep and wakeup between two Single Wire NI CAN interfaces. The sequence assumes that **CAN0** is the sleeping node, and **CAN1** originates the wakeup.

1. Start both **CAN0** and **CAN1**. Both use the default **Normal** mode.
2. Set **Interface Transceiver Mode** of **CAN0** to **Sleep**.
3. Set **Interface Transceiver Mode** of **CAN1** to **Single Wire Wakeup**.
4. Write data to **CAN1** to transmit a wakeup frame to **CAN0**.
5. Set **Interface Transceiver Mode** of **CAN1** to **Normal**.
6. Now both **CAN0** and **CAN1** are in **Normal** mode again.

Single Wire High-Speed

Set Single Wire transceiver to **High-Speed Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire High-Speed Transmission** mode disables the internal waveshaping function of the transceiver, which allows baud rates up to 100 kbytes/s to be used. The disadvantage versus **Normal** (which allows up to 40 kbytes/s baud) is degraded EMC performance. Other than the disabled waveshaping, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

This mode has no relationship to High-Speed (HS) transceivers. It is merely a higher speed mode of the Single Wire (SW) transceiver, typically used for downloading large amounts of data to a node.

The Single Wire transceiver does not support use of this mode in conjunction with **Sleep** mode. For example, a remote wakeup

cannot transition from **Sleep** to this **Single Wire High-Speed** mode.

Interface Transceiver Type

For XS Software Selectable Physical Layer cards that provide a software-switchable transceiver, the **Interface Transceiver Type** property sets the type of transceiver. When the transceiver is switched from one type to another, NI-CAN ensures that the switch is undetectable from the perspective of other nodes on the network.

The default value for this property is specified within MAX. If you change the transceiver type in MAX to correspond to the network in use, you can avoid setting this property within the application.

This property applies to all tasks initialized with the same interface.

You cannot set this property for Series 1 hardware, or for Series 2 hardware other than XS (fixed HS, LS, or SW cards).

This property uses the following values:

High-Speed

Switch the transceiver to **High-Speed** (HS).

Low-Speed/Fault-Tolerant

Switch the transceiver to **Low-Speed/Fault-Tolerant** (LS).

Single Wire

Switch the transceiver to **Single Wire** (SW).

External

Switch the transceiver to **External**. The **External** type allows you to connect a transceiver externally to the interface. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

When this transceiver type is selected, you can use the **Transceiver External Outputs** and **Transceiver External Inputs** properties to access the external mode and status pins of the connector.

Disconnect

Disconnect the CAN controller chip from the connector. This value is used when you physically switch an external transceiver. You first set **Interface Transceiver Type** to **Disconnect**, then switch from one external transceiver to another, then set **Interface Transceiver Type** to **External**. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

Interface Virtual Bus Timing

Sets the **Virtual Bus Timing** of the virtual device.

Interface Virtual Bus Timing uses the following values:

0	**False**	Virtual Bus Timing is turned off. By turning Virtual Bus Timing off, the CAN bus simulation is disabled and CAN frames are copied from the write queue of one virtual interface to the read queue of the second virtual interface. This setting is useful if you desire to only convert frames to channels or vice versa and not simulate actual CAN bus communication.
1	**True**	Virtual Bus Timing is turned on (default). By turning Virtual Bus Timing on, frame timestamps are recalculated as they transfer across the virtual bus. This mode is useful when you want the virtual bus to behave as much like a real bus as possible.

If this property is set on real hardware, an error will be returned.

Virtual Bus Timing has to be set to the same value on both virtual interfaces. This property must be set prior to starting the virtual interface. Refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*, for more information.

Message Multiple Frame Distribution

Sets the **Message Multiple Frame Distribution** property which is used to determine if the CAN frames associated to a group of mode dependent channels are sent even spaced or in burst mode.

Message Multiple Frame Distribution uses the following values:

0	**Uniform**	**Uniform** distribution transmits mode dependent messages uniformly (evenly spaced) on the network.
1	**Burst**	**Burst** distribution transmits mode dependent messages back to back on the network.

This property applies only to mode dependent channels that are transmitted periodically. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

DBL

Timeout

Sets a time in milliseconds to wait for samples. The default value is zero.

For all task configurations, the **Timeout** specifies the time that Read will wait for the start trigger. If the application does not use **CAN Connect Terminals**, the start trigger occurs when the task starts (**CAN Start**). If you connect a start trigger from a RTSI line or other source, **Timeout** specifies the number of milliseconds to wait. Timeout of zero means to wait up to 10 seconds for the start trigger.

Use of the **Timeout** property depends on the initialized mode of the task:

- **Output**—For each **Output** task, NI-CAN uses a buffer to store samples for transmit. If the number of samples you provide to **CAN Write** exceeds the size of the underlying buffer, NI-CAN waits for sufficient space to become available (due to successful transmits). The **Timeout** specifies the number of milliseconds to wait for available buffer space. Timeout of zero means to wait up to 10 seconds.
- **Input**—The timeout value does *not* apply. For **Input** tasks initialized with **sample rate** greater than zero, the **number of samples to read** input to **CAN Read.vi** implicitly specifies the time to wait. For **Input** tasks initialized with **sample rate** equal to zero, the **CAN Read** VI always returns available samples immediately, without waiting.
- **Timestamped Input**—A timeout of zero means to return available samples immediately. A timeout greater than zero means that **CAN Read.vi** will wait a maximum of **Timeout** milliseconds for **number of samples to read** samples to become available before returning.
- **Output Recent**—The timeout value does not apply.

Value for invalid data

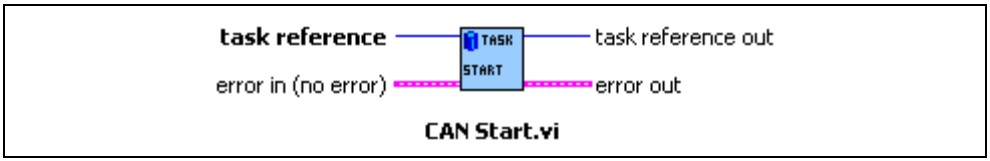
Sets the value that is returned on time stamped read for mode dependent channels that have not been received with the most resent CAN frame associated with the CAN message. This property applies only to mode dependent channels that are read with the time stamped read operation. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

CAN Start.vi

Purpose

Start communication for the specified task.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from VIs such as **CAN Initialize.vi** or **CAN Create Message.vi**, and then wired through subsequent VIs.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

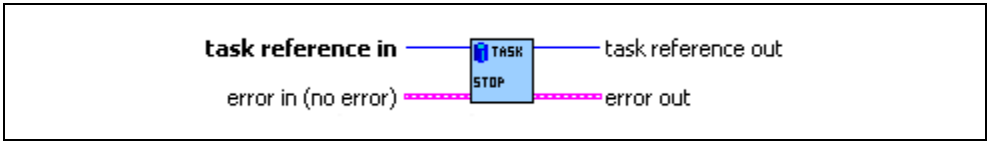
You must start communication for a task to use **CAN Read.vi** or **CAN Write.vi**. After you start communication, you can no longer change the configuration of the task with **CAN Set Property.vi** or **CAN Connect Terminals.vi**.

CAN Stop.vi

Purpose

Stop communication for the specified task.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from **CAN Init Start.vi**, **CAN Initialize.vi**, or **CAN Create Message.vi**, and then wired through subsequent VIs.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

This VI stops communication so that you can change the configuration of the task, such as by using **CAN Set Property.vi** or **CAN Connect Terminals.vi**. After you change the configuration, use **CAN Start.vi** to start again.

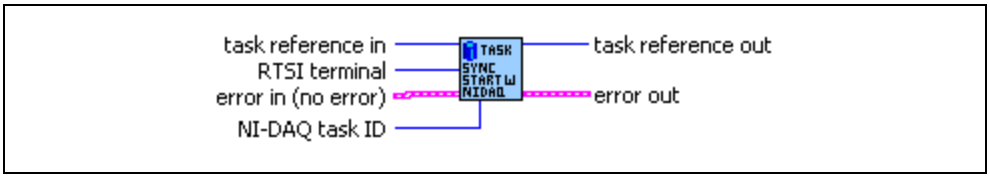
This VI does not clear the configuration for the task; therefore, do *not* use it as the last NI-CAN VI in the application. **CAN Clear.vi** must always be the last NI-CAN VI for each task.

CAN Sync Start with NI-DAQ.vi

Purpose

Synchronize and start the specified CAN task and NI-DAQ task.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from VIs such as **CAN Initialize.vi** or **CAN Create Message.vi**.

NI-DAQ task ID is the task ID from an NI-DAQ configuration VI, such as **AI Config** or **AO Config**.

When this VI returns, do not call an NI-DAQ start VI for the task. The LabVIEW diagram of this VI starts the **NI-DAQ task ID** for you, so you can immediately call NI-DAQ read or write VIs.

RTSI terminal specifies the RTSI terminal number to use for the shared start trigger. This input uses a `ring` typedef to select terminals from **RTSI0** to **RTSI6**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent NI-CAN VIs for this task.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The CAN and NI-DAQ task execute on different NI hardware products. To use the input/output samples of these tasks together in the application, the NI hardware products must be synchronized with RTSI terminal connections. Both NI hardware products must use a common timebase to avoid clock drift, and a common start trigger to start input/output at the same time.

This VI uses NI-CAN and NI-DAQ RTSI functions to synchronize the NI hardware products to a common timebase and start trigger, and then it starts sampling on both tasks. The function used to connect RTSI terminals on the CAN card is **CAN Connect Terminals.vi**.

When you use this VI to start the tasks, you must use **CAN Clear with NI-DAQ.vi** to clear the tasks.

This VI synchronizes a single CAN hardware product to a single NI-DAQ hardware product. To synchronize multiple CAN cards to a single NI-DAQ card, refer to **CAN Sync Start Multiple with NI-DAQ.vi**.

This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so that you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

The diagram of this VI assumes that the NI-DAQ product is an E Series MIO device. If you are using a different NI hardware product, refer to the diagram as a starting point.

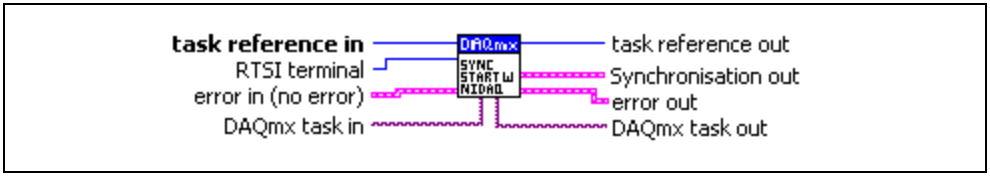
The diagram of this VI issues the start trigger immediately. To implement more complex triggering, such as using an AI trigger to start, refer to the diagram as a starting point.

CAN Sync Start with NI-DAQmx.vi

Purpose

Synchronize and start the specified CAN task and NI-DAQmx task.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from VIs such as **CAN Initialize.vi** or **CAN Create Message.vi**.

DAQmx task in is the task from an NI-DAQmx configuration VI, such as **DAQmx Create Virtual Channel**.

When this VI returns, do not call an **DAQmx Start Task** VI for the task. The LabVIEW diagram of this VI starts the **NI-DAQmx task** for you, so you can immediately call NI-DAQmx read or write VIs.

RTSI terminal specifies the RTSI terminal number to use for the shared start trigger. This input uses a `ring` typedef to select terminals from **RTSI0** to **RTSI6**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent NI-CAN VIs for this task.

Synchronisation out defines a cluster with information about the signals that have been routed between the cards and about additional DAQmx tasks that may have been created for synchronization.

Counter task out is the task from an **NI-DAQmx Create Virtual Channel** VI. This additional NI-DAQmx task is created under certain circumstances to generate a common timebase clock for cards that do not support sharing of timebases through RTSI (like DAQ cards or NI-CAN Series 1 cards).

Routes out is a 1-dimensional array of terminal names of signals that have been routed between the cards.

Source terminal is the name of the terminal where the route starts.

Destination terminal is the name of the terminal where the route ends.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The CAN and NI-DAQmx task execute on different NI hardware products. To use the input/output samples of these tasks together in the application, the NI hardware products must be synchronized with RTSI terminal connections. Both NI hardware products must use a common timebase to avoid clock drift, and a common start trigger to start input/output at the same time.

This VI uses NI-CAN and NI-DAQmx RTSI functions to synchronize the NI hardware products to a common timebase and start trigger, and then it starts sampling on both tasks. The function used to connect RTSI terminals on the CAN card is **CAN Connect Terminals.vi**.

When you use this VI to start the tasks, you must use **CAN Clear with NI-DAQmx.vi** to clear the tasks.

This VI synchronizes a single CAN hardware product to a single NI-DAQ hardware product. To synchronize multiple CAN cards and/or multiple NI-DAQ cards, refer to **CAN Sync Start Multiple with NI-DAQmx.vi**.

This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so that you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

This VI is designed to support most E Series MIO devices and M Series MIO devices through NI-DAQmx. If you are using a different NI hardware product, refer to the diagram as a starting point.

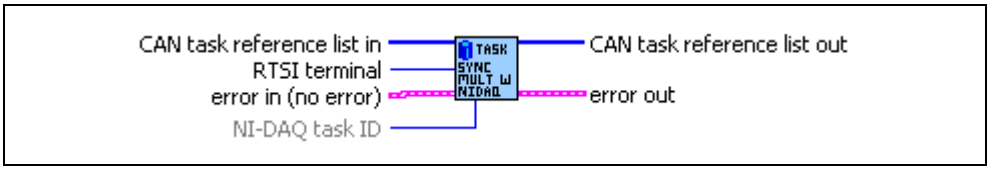
The diagram of this VI issues the start trigger immediately. To implement more complex triggering, such as using an AI trigger to start, refer to the diagram as a starting point.

CAN Sync Start Multiple with NI-DAQ.vi

Purpose

Synchronize and start the specified list of multiple CAN tasks and a single NI-DAQ task. This is a more complex implementation of **CAN Sync Start with NI-DAQ.vi** that supports multiple CAN hardware products.

Format



Inputs

CAN task reference list in is an array of NI-CAN task references. Each task reference is originally returned from VIs such as **CAN Initialize.vi** or **CAN Create Message.vi**. You can build the task references into an array using the LabVIEW **Build Array** VI.

NI-DAQ task ID is a task ID originally returned from an NI-DAQ configuration VI, such as **AI Config** or **AO Config**.

When this VI returns, do not call an NI-DAQ start VI. The LabVIEW diagram of this VI starts **NI-DAQ task ID** for you, so you can immediately call NI-DAQ read or write VIs.

RTSI terminal specifies the RTSI terminal number to use for the shared start trigger. This input uses a ring typedef to select terminals from **RTSI0** to **RTSI6**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

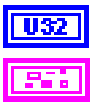
status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is

returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs



CAN task reference list out is the same as **CAN task reference list in**.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The CAN and NI-DAQ tasks execute on different NI hardware products. To use the input/output samples of these tasks together in the application, the NI hardware products must be synchronized with RTSI terminal connections. Both NI hardware products must use a common timebase to avoid clock drift, and a common start trigger to start input/output at the same time.

This VI uses NI-CAN and NI-DAQ RTSI functions to synchronize the NI hardware products to a common timebase and start trigger, and then it starts sampling on all tasks. The function used to connect RTSI terminals on the CAN card is **CAN Connect Terminals.vi**.

When you use this VI to start the tasks, you must use **CAN Clear Multiple with NI-DAQ.vi** to clear the tasks.

This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so that you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

This VI does not demonstrate synchronization of multiple NI-DAQ hardware products. Refer to NI-DAQ for examples of synchronizing the timebase and trigger of multiple DAQ cards.

The diagram of this VI assumes that all NI-DAQ products are E Series MIO devices. If you are using a different NI hardware product, refer to the diagram as a starting point.

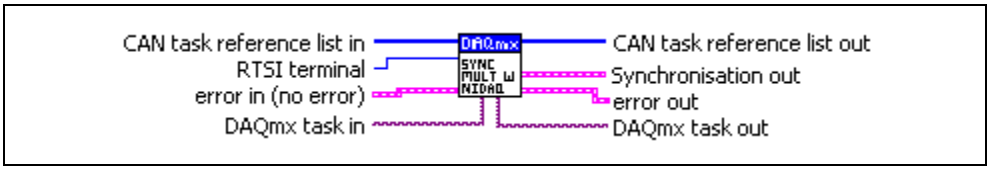
The diagram of this VI issues the start trigger immediately. To implement more complex triggering, such as using an AI trigger to start, refer to the diagram as a starting point.

CAN Sync Start Multiple with NI-DAQmx.vi

Purpose

Synchronize and start the specified list of multiple CAN tasks and a single NI-DAQmx task. This is a more complex implementation of **CAN Sync Start with NI-DAQmx.vi** that supports multiple CAN hardware products.

Format



Inputs

CAN task reference list in is an array of NI-CAN task references. Each task reference is originally returned from VIs such as **CAN Initialize.vi** or **CAN Create Message.vi**. You can build the task references into an array using the LabVIEW **Build Array** VI.

DAQmx task in is the task from an NI-DAQmx configuration VI, such as **DAQmx Create Virtual Channel**.

When this VI returns, do not call an **DAQmx Start Task** VI for the task. The LabVIEW diagram of this VI starts the **NI-DAQmx task** for you, so you can immediately call NI-DAQmx read or write VIs.

RTSI terminal specifies the RTSI terminal number to use for the shared start trigger. This input uses a `ring` typedef to select terminals from **RTSI0** to **RTSI6**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is

returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

CAN task reference list out is the same as **CAN task reference list in**.

Synchronisation out defines a cluster with information about the signals that have been routed between the cards and about additional DAQmx tasks that may have been created for synchronization.

Counter task out is the task from an **NI-DAQmx Create Virtual Channel** VI. This additional NI-DAQmx task is created under certain circumstances to generate a common timebase clock for cards that do not support sharing of timebases through RTSI (like DAQ cards or NI-CAN Series 1 cards).

Routes out is a 1-dimensional array of terminal names of signals that have been routed between the cards.

Source terminal is the name of the terminal where the route starts.

Destination terminal is the name of the terminal where the route ends.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The CAN and NI-DAQmx tasks execute on different NI hardware products. To use the input/output samples of these tasks together in the application, the NI hardware products must be synchronized with RTSI terminal connections. Both NI hardware products must use a common timebase to avoid clock drift, and a common start trigger to start input/output at the same time.

This VI uses NI-CAN and NI-DAQmx RTSI functions to synchronize the NI hardware products to a common timebase and start trigger, and then it starts sampling on all tasks. The function used to connect RTSI terminals on the CAN card is **CAN Connect Terminals.vi**.

When you use this VI to start the tasks, you must use **CAN Clear Multiple with NI-DAQmx.vi** to clear the tasks.

This VI is intended to serve as an example. You can use the VI as is, but the LabVIEW diagram is commented so that you can use the VI as a starting point for more complex synchronization scenarios. Before you customize the LabVIEW diagram, save a copy of the VI for editing.

This VI does not demonstrate synchronization of multiple NI-DAQmx hardware products. Refer to NI-DAQ for examples of synchronizing the timebase and trigger of multiple DAQ cards.

This VI is designed to support most E Series MIO devices and M Series MIO devices through NI-DAQmx. If you are using a different NI hardware product, refer to the diagram as a starting point.

The diagram of this VI issues the start trigger immediately. To implement more complex triggering, such as using an AI trigger to start, refer to the diagram as a starting point.

CAN Write.vi

Purpose

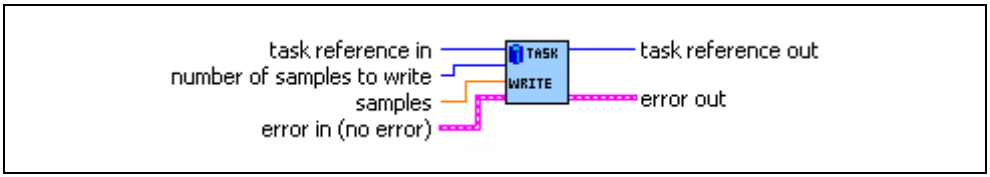
Write samples to a CAN task initialized as Output (refer to the **mode** parameter of **CAN Init Start.vi**). Samples are placed into transmitted CAN messages. The poly VI selection determines the data type to write.

To select the data type, right-click the VI, go to **Select Type**, and select the type by name.

For LabVIEW 7.0 and later, you can right-click the VI and select **Visible Items»Poly VI Selector** to select the data type from within the diagram.

For an overview of CAN Write, refer to the *Write* section of Chapter 6, *Using the Channel API*.

Format



Inputs

task reference in is the task reference from the previous NI-CAN VI. The task reference is originally returned from **CAN Init Start.vi**, **CAN Initialize.vi**, or **CAN Create Message.vi**, and then wired through subsequent VIs.

The **mode** initialized for the task must be **Output**.

number of samples to write specifies the number of samples to write for the task. For single-sample Poly VI types, **CAN Write** always accepts one sample, so this input is ignored.

The poly input **samples** specifies the samples to transmit in CAN messages. The the poly input type is determined by the Poly VI selection. For information on the different poly VI types provided by **CAN Write**, refer to the *Poly VI Types* section.

To select the data type, right-click the VI, go to **Select Type**, and select the type by name.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs

task reference out is the same as **task reference in**. Wire the task reference to subsequent VIs for this task.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Poly VI Types

The name of each Poly VI type uses the following conventions:

- The first term is either **Single-Chan** or **Multi-Chan**. This indicates whether the type specifies data for a single channel or multiple channels. **Multi-Chan** types specify an array of analogous **Single-Chan** types, one entry for each channel initialized in **channel list** of **CAN Init Start**. **Single-Chan** types are convenient because no array indexing is required, but you are limited to writing only one CAN channel.
- The second term is either **Single-Samp** or **Multi-Samp**. This indicates whether the type specifies a single sample, or an array of multiple samples. **Single-Samp** types are often

used for single-point control applications, such as within LabVIEW RT. **Single-Samp** types are required for the **Output Recent** mode.

- The third term indicates the data type used for each sample. The type *Dbl* indicates double-precision (64-bit) floating point. The type *Wfm* indicates the waveform data type. The types *1D* and *2D* indicate one and two-dimensional arrays, respectively.

Single-Chan Single-Samp Dbl

Writes a single sample for the first channel initialized in channel list.

You can use this type with **Output** mode or **Output Recent** mode.

If the initialized sample rate is greater than zero, the task transmits a CAN message periodically at the specified rate. The first **CAN Write** transmits a message immediately, and then begins a periodic timer at the specified rate. Each subsequent message transmission is based on the timer, and uses the most recent sample provided by **CAN Write**.

If the initialized **sample rate** is zero, the message is transmitted immediately each time you call **CAN Write**.

Because all channels of a message are transmitted on the network as a unit, **CAN Write** enforces the following rules:

- You *cannot* write the same message in more than one task.
- You *can* write more than one message in a single task.
- You *can* write a subset of channels for a message in a single task. For channels that are not included in the task, the Default Value is transmitted in the CAN message. Because this Poly VI writes only one channel, the **Default Value** will always be used for any remaining channels in the associated message.

For many applications, the most straightforward technique is to assign a single task for each message you want to transmit. In each task, include all channels of that message in the **channel list**. This ensures that you can provide new samples for the entire message with each **CAN Write**.

Multi-Chan Single-Samp 1D Dbl

Writes an array, one entry for each channel initialized in channel list. Each entry consists of a single sample.

You can use this type with **Output** mode or **Output Recent** mode.

The messages transmitted by **CAN Write** are determined by the associated **channel list**. If all channels are contained in a single message, only that message is transmitted. If a few channels are contained in one message, and the remaining channels are contained in a second message, two messages are transmitted.

If the initialized sample rate is greater than zero, the task transmits associated CAN messages periodically at the specified rate. The first **CAN Write** transmits messages

immediately, and then begins a periodic timer at the specified rate. Each subsequent transmission of messages is based on the timer and uses the most recent samples provided by **CAN Write**.

If the initialized **sample rate** is zero, the messages are transmitted immediately each time you call **CAN Write**.

Because all channels of a message are transmitted on the network as a unit, **CAN Write** enforces the following rules:

- You *cannot* write the same message in more than one task.
- You *can* write more than one message in a single task.
- You *can* write a subset of channels for a message in a single task. For channels that are not included in the task, the Default Value is transmitted in the CAN message.

For many applications, the most straightforward technique is to assign a single task for each message that you want to transmit. In each task, include all channels of that message in the **channel list**. This ensures that you can provide new samples for the entire message with each **CAN Write**.

Single-Chan Multi-Samp 1D Dbl

Writes an array of samples for the first channel initialized in channel list.

You can use this type with **Output** mode only (not **Output Recent** mode).

If the initialized sample rate is greater than zero, the task transmits a CAN message periodically at the specified rate. This Poly VI is used to transmit a sequence of messages periodically, with a unique sample value in each message. The first **CAN Write** transmits a message immediately using the first sample in the array, and then begins a periodic timer at the specified rate. Each subsequent message transmission is based on the timer, and uses the next sample in the array. After the final sample in the array has been transmitted, subsequent behavior is determined by the Behavior After Final Output property. The default **Behavior After Final Output** is to retransmit the final sample each period until **CAN Write** is called again.

If the initialized **sample rate** is zero, a message is transmitted immediately for each entry in the array, with as little delay as possible between messages. After the message for the final sample is transmitted, no further transmissions occur until **CAN Write** is called again, regardless of the **Behavior After Final Output** property.

Because all channels of a message are transmitted on the network as a unit, **CAN Write** enforces the following rules:

- You *cannot* write the same message in more than one task.
- You *can* write more than one message in a single task.
- You *can* write a subset of channels for a message in a single task. For channels that are not included in the task, the Default Value is transmitted in the CAN message.

Because this Poly VI writes only one channel, the **Default Value** will always be used for any remaining channels in the associated message.

For many applications, the most straightforward technique is to assign a single task for each message that you want to transmit. In each task, include all channels of that message in the **channel list**. This ensures that you can provide new samples for the entire message with each **CAN Write**.

Multi-Chan Multi-Samp 2D Dbl

Writes an array, one entry for each channel initialized in channel list. Each entry consists of an array of samples.

You can use this type with **Output** mode only (not **Output Recent** mode).

The messages transmitted by **CAN Write** are determined by the associated **channel list**. If all channels are contained in a single message, only that message is transmitted. If a few channels are contained in one message, and the remaining channels are contained in a second message, two messages are transmitted.

If the initialized sample rate is greater than zero, the task transmits associated CAN messages periodically at the specified rate. This Poly VI is used to transmit a sequence of messages periodically, with unique sample values in each set of messages. The first **CAN Write** transmits associated messages immediately using the first sample in the array of each channel, and then begins a periodic timer at the specified rate. Each subsequent transmission of messages is based on the timer, and uses the next sample in the array of each channel. After the final sample in the array of each channel has been transmitted, subsequent behavior is determined by the **Behavior After Final Output** property. The default **Behavior After Final Output** is to retransmit the final sample each period until **CAN Write** is called again.

If the initialized **sample rate** is zero, the task transmits associated messages immediately for each entry in the array of each channel, with as little delay as possible between messages. After the message for the final sample is transmitted, no further transmissions occur until **CAN Write** is called again, regardless of the **Behavior After Final Output** property.

Because all channels of a message are transmitted on the network as a unit, **CAN Write** enforces the following rules:

- You *cannot* write the same message in more than one task.
- You *can* write more than one message in a single task.
- You *can* write a subset of channels for a message in a single task. For channels that are not included in the task, the Default Value is transmitted in the CAN message.

For many applications, the most straightforward technique is to assign a single task for each message that you want to transmit. In each task, include all channels of that message in the **channel list**. This ensures that you can provide new samples for the entire message with each **CAN Write**.

Single-Chan Multi-Samp Wfm

Writes a single waveform for the first channel initialized in channel list.

The start time and delta time of the waveform does not affect the beginning of message transmission. Therefore, this Poly VI type is equivalent to the Single-Chan Multi-Samp 1D Dbl Poly VI type.

Multi-Chan Multi-Samp 1D Wfm

Writes an array, one entry for each channel initialized in channel list. Each entry consists of a single waveform.

The start time and delta time of each waveform does not affect the beginning of message transmission. Therefore, this Poly VI type is equivalent to the Multi-Chan Multi-Samp 2D Dbl Poly VI type.

8

Channel API for C

This chapter lists the NI-CAN functions and describes the format, purpose, and parameters.

Unless otherwise stated, each NI-CAN function suspends execution of the calling thread until it completes. The functions in this chapter are listed alphabetically.

Section Headings

The following are section headings found in the Channel API for C functions.

Purpose

Each function description includes a brief statement of the purpose of the function.

Format

The format section describes the format of each function for the C programming language.

Input and Output

The input and output parameters for each function are listed.

Description

The description section gives details about the purpose and effect of each function.

Data Types

The following data types are used with functions of the NI-CAN Channel API for C.

Table 8-1. NI-CAN Channel API for C, Data Types

Data Type	Purpose
`i8`	8-bit signed integer
`i16`	16-bit signed integer
`i32`	32-bit signed integer
`u8`	8-bit unsigned integer

Table 8-1. NI-CAN Channel API for C, Data Types (Continued)

Data Type	Purpose
u16	16-bit unsigned integer
u32	32-bit unsigned integer
f32	32-bit floating-point number
f64	64-bit floating-point number
str	ASCII string represented as an array of characters terminated by null character (`'\0'`). This type is used with output strings.
cstr	ASCII string represented as an array of characters terminated by null character (`'\0'`). This type is used with input strings.
nctTypeTaskRef	Reference to an initialized task. Refer to nctInitStart for more information.
nctTypeStatus	Status returned from NI-CAN functions. Refer to ncStatusToString in the Frame API for more information.
nctTypeTimestamp	Timestamp. Refer to nctReadTimestamped for more information.

List of Functions

Table 8-2 contains an alphabetical list of the NI-CAN Channel API for C functions.

Table 8-2. NI-CAN Channel API for C Functions

Function	Purpose
nctClear	Stop communication for the task and then clear the configuration.
nctConnectTerminals	Connect terminals in the CAN hardware.
nctCreateMessage	Create a message configuration and associated channel configurations within the application.

Table 8-2. NI-CAN Channel API for C Functions (Continued)

Function	Purpose
nctCreateMessageEx	Create a message configuration and associated channel configurations within the application. nctCreateMessageEx allows you to create normal CAN channels and mode dependent channels. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.
nctDisconnectTerminals	Disconnect terminals in the CAN hardware.
nctGetNames	Get an array of CAN channel names or message names from MAX or a CAN database file.
nctGetNamesLength	Get the required size for a specified list of channels to allocate an array for the ChannelList input of nctGetNames.
nctGetProperty	Get a property for the task, or a single channel within the task.
nctInitialize	Initialize a task for the specified channel list.
nctInitStart	Initialize a task for the specified channel list, then start communication.
nctRead	Read samples from a CAN task initialized with Mode of nctModeInput. Samples are obtained from received CAN messages.
nctReadTimestamped	Read samples from a CAN task initialized with Mode of nctModeTimestampedInput.
nctSetProperty	Set a property for the task, or a single channel within the task.
nctStart	Start communication for the specified task.
nctStop	Stop communication for the specified task.
nctWrite	Write samples to a CAN task initialized as nctModeOutput. Samples are placed into transmitted CAN messages.

nctClear

Purpose

Stop communication for the task and then clear the configuration.

Format

```
nctTypeStatus    nctClear(
                     nctTypeTaskRef    TaskRef);
```

Inputs

`TaskRef`	Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the `ncStatusToString` function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Description

The `nctClear` function must always be the final NI-CAN function called for each task. If you do not use the `nctClear` function, the remaining task configurations can cause problems in execution of subsequent NI-CAN applications.

If the cleared task is the last running task for the initialized `Interface` (refer to `nctInitStart`), the `nctClear` function also stops communication on the CAN controller of the interface and disconnects all terminal connections for that interface.

Because this function clears the task, `TaskRef` cannot be used with subsequent functions. To change properties of a running task, use `nctStop` to stop the task, `nctSetProperty` to change the desired property, then `nctStart` to restart the task.

nctConnectTerminals

Purpose

Connect terminals in the CAN hardware.

Format

```
nctTypeStatus    nctConnectTerminals(
                     nctTypeTaskRef    TaskRef,
                     u32               SourceTerminal,
                     u32               DestinationTerminal,
                     u32               Modifiers);
```

Inputs

`TaskRef`

Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

`SourceTerminal`

Specifies the connection source.

Once the connection is successfully created, behavior flows from `SourceTerminal` to `DestinationTerminal`.

For a list of valid source/destination pairs, refer to the *Valid Combinations of Source/Destination* section.

The following list describes each value of `SourceTerminal`:

`nctSrcTermRTSI0 … nctSrcTermRTSI6`

Selects a general-purpose RTSI line as source (input) of the connection.

`nctSrcTermRTSI_Clock`

Selects the RTSI clock line as source (input) of the connection. This terminal is also RTSI line 7. **RTSI7** is dedicated for routing of a timebase (10 MHz or 20 MHz).

The only valid DestinationTerminal for this source is `nctDestTermMasterTimebase`.

For PCI and PXI form factors, this receives a 20 MHz (default) timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting 20 MHz oscillator (board clock) of the DAQ card to `nctSrcTermRTSI_Clock`, and then connecting `nctSrcTermRTSI_Clock` to `nctDestTermMasterTimebase` on the CAN card.

For PCMCIA form factor, a 10 MHz timebase is required on `nctSrcTermRTSI_Clock`. For synchronization with a PCMCIA DAQcard, this is done by programming the **FREQOUT** signal of the DAQcard to 10 MHz, then wiring **FREQOUT** to the `nctSrcTermRTSI_Clock` of the CAN card.

This value applies to Series 2 cards only (returns error for Series 1).

`nctSrcTermPXI_Star`

`nctSrcTermPXI_Star` selects the PXI star trigger signal.

Within a PXI chassis, some PXI products can source star trigger from Slot 2 to all higher-numbered slots. **PXI_Star** enables the PXI CAN card to receive the star trigger when it is in Slot 3 or higher.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

`nctSrcTermPXI_Clk10`

`nctSrcTermPXI_Clk10` selects the 10 MHz backplane clock.

The only valid `DestinationTerminal` for this source is `nctDestTermMasterTimebase`. This routes the 10 MHz PXI backplane clock for use as the timebase of the CAN card. When you use **PXI_Clk10** as the timebase for the CAN card, you must also use **PXI_Clk10** as the timebase for other PXI cards to perform synchronized input/output.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

`nctSrcTerm20MHzTimebase`

`nctSrcTerm20MHzTimebase` selects the local 20 MHz oscillator of the CAN card.

The only valid `DestinationTerminal` for this source is `nctDestTermRTSI_Clock`. This routes the local 20 MHz clock of the CAN card for use as a timebase by other NI cards. For example, you can synchronize two CAN cards by connecting `nctSrcTerm20MHzTimebase` to `nctDestTermRTSI_CLOCK` on one CAN card, and then connecting `nctSrcTermRTSI_CLOCK` to `nctDestTermMasterTimebase` on the other CAN card.

`nctSrcTerm20MHzTimebase` applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the task interface, such as the `Interface` input to `nctInitialize`.

This value applies to Series 2 PXI or PCI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCMCIA CAN card, selecting this value results in an error.

`nctSrcTerm10HzResyncClock`

`nctSrcTerm10HzResyncClock` selects a 10 Hz, 50 percent duty cycle clock. This slow rate is required for resynchronization of CAN cards. On each pulse of the resync clock, the other CAN card brings its clock into sync.

By selecting **RTSI0**–**RTSI6** as the `DestinationTerminal`, you route the 10 Hz clock to synchronize with other CAN cards. NI-DAQ and NI-DAQmx cards cannot use the 10 Hz resync clock, so this selection is limited to synchronization of two or more CAN cards.

nctSrcTerm10HzResyncClock applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the task interface, such as the Interface input to nctInitialize.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are using a mix of Series 1 and Series 2 CAN cards, you must use nctSrcTerm10HzResyncClock.

nctSrcTermIntfReceiveEvent

nctSrcTermIntfReceiveEvent selects the dedicated receive interrupt output on the Philips SJA1000 CAN controller. When a received frame successfully passes the acceptance filter, a pulse with the width of one bit time is output during the last bit of the end of frame position of the CAN frame. Incoming CAN frames can be filtered using the nctPropIntfSeries2FilterMode property. The CAN controller is specified by the task interface, such as the Interface input to nctInitialize.

nctSrcTermIntfReceiveEvent can be used as the start trigger for other NI cards, or for external instruments.

Since this value requires the Philips SJA1000 CAN controller, it applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

nctSrcTermIntfTransceiverEvent

nctSrcTermIntfTransceiverEvent selects the NERR signal from the CAN transceiver. The Low-Speed/Fault-Tolerant transceiver and the High-Speed transceiver provide the NERR signal. This signal asserts when a fault is detected by the transceiver. The default value of NERR is logic-high, which indicates no error.

The CAN controller is specified by the task interface, such as the Interface input to nctInitialize.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

`nctSrcTermStartTrigger`

`nctSrcTermStartTrigger` selects the start trigger, the event that begins sampling for tasks.

The start trigger is the same for all tasks using a given interface, such as the `Interface` input to `nctInitialize`.

In the default (disconnected) state of the `nctDestTermStartTrigger` destination, the start trigger occurs when communication begins on the interface.

By selecting **RTSI0–RTSI6** as the `DestinationTerminal`, you route the start trigger of this CAN card to the start trigger of other CAN or DAQ cards. This ensures that sampling begins at the same time on both cards. For example, you can synchronize two CAN cards by routing `nctSrcTermStartTrigger` as the `SourceTerminal` on one CAN card, and then routing `nctDestTermStartTrigger` as the `DestinationTerminal` on the other CAN card, with both cards using the same RTSI line for the connections.

`DestinationTerminal` Specifies the destination of the connection.

The following list describes each value of `DestinationTerminal`:

`nctDestTermRTSI0 … nctDestTermRTSI6`

Selects a general-purpose RTSI line as destination (output) of the connection.

`nctDestTermRTSI_Clock`

Selects the RTSI clock line as destination (output) of the connection. This terminal is also RTSI line 7. **RTSI7** is dedicated for routing of a timebase. The CAN card can import a 10 MHz or 20 MHz timebase, but can export only a 20 MHz timebase.

The only valid SourceTerminal for this source is nctSrcTerm20MHzTimebase.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

nctDestTermMasterTimebase

nctDestTermMasterTimebase instructs the CAN card to use the source of the connection as the master timebase. The CAN card uses this master timebase for input sampling (including timestamps of received messages) as well as periodic output sampling.

For PCI and PXI form factors, you can use nctSrcTermRTSI_Clock as the SourceTerminal. By default this receives a 20 MHz timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting the 20 MHz oscillator (board clock) of the DAQ card to **RTSI Clock** (**RTSI7**), and then connecting nctSrcTermRTSI_Clock to nctDestTermMasterTimebase on the CAN card. To change the Master Timebase rate to 10 MHz, use nctSetProperty to change the nctPropHwMasterTimebaseRate.

For PXI form factor, you also can use nctSrcTermPXI_Clk10 as the SourceTerminal. This receives the PXI 10 MHz backplane clock for use as the master timebase.

For PCMCIA form factor, you can use nctSrcTermRTSI_Clock as the SourceTerminal. Unlike PCI and PXI, the PCMCIA CAN card requires a 10 MHz timebase on nctSrcTermRTSI_Clock (TRIG7_CLK). For synchronization with a PCMCIA DAQcard, this is done by programming the **FREQOUT** signal of the DAQ card to 10 MHz, then wiring **FREQOUT** to the nctSrcTermRTSI_Clock of the CAN card.

nctDestTermMasterTimebase applies to the entire CAN card, including both interfaces of a 2-port CAN

card. The CAN card is specified by the task interface, such as the `Interface` input to `nctInitialize`.

The default (disconnected) state of this destination means the CAN card uses its local 20 MHz timebase as the master timebase.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

`nctDestTerm10HzResyncClock`

`nctDestTerm10HzResyncClock` instructs the CAN card to use a 10 Hz, 50 percent duty cycle clock to resynchronize its local timebase. This slow rate is required for resynchronization of CAN cards. On each low-to-high transition of the resync clock, this CAN card brings its local timebase into sync.

When synchronizing to an E Series MIO card, a typical use of this value is to use **RTSI0–RTSI6** as the `SourceTerminal`, then use NI-DAQ or NI-DAQmx functions to program the Counter 0 of the MIO card to generate a 10 Hz 50 percent duty cycle clock on the RTSI line.

When synchronizing to a CAN card, a typical use of this value is to use **RTSI0–RTSI6** as the `SourceTerminal`, then route the `nctSrcTerm10HzResyncClock` of the other CAN card as the `SourceTerminal` to the same RTSI line.

`nctDestTerm10HzResyncClock` applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the task interface, such as the `Interface` input to `nctInitialize`.

The default (disconnected) state of this destination means the CAN card does not resynchronize its local timebase.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are

using a mix of Series 1 and Series 2 CAN cards, you must `nctDestTerm10HzResyncClock`.

`nctDestTermStartTrigger`

`nctDestTermStartTrigger` selects the start trigger, the event that begins sampling for tasks. The start trigger occurs on the first low-to-high transition of the source terminal.

The start trigger is the same for all tasks using a given interface, such as the `Interface` input to `nctInitialize`.

By selecting **RTSI0–RTSI6**, or `nctSrcTermPXI_Star` for PXI hardware, as the `SourceTerminal`, you route the start trigger from another CAN or DAQ card. This ensures that sampling begins at the same time on both cards. For example, you can synchronize with an E Series DAQ MIO card by routing the AI start trigger of the MIO card to a RTSI line and then routing the same RTSI line with `nctDestTermStartTrigger` as the `DestinationTerminal` on the CAN card.

The default (disconnected) state of this destination means the start trigger occurs when communication begins on the interface. Because communication begins when the first task of the interface is started, this does not synchronize sampling with other NI cards.

`Modifiers` — Provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so you must pass `Modifiers` as zero.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

Description

This VI connects a specific pair of source/destination terminals. One of the terminals is typically a RTSI signal, and the other terminal is an internal terminal in the CAN hardware. By connecting internal terminals to RTSI, you can synchronize the CAN card with another hardware product such as an NI-DAQ or NI-DAQmx card.

The most common uses of RTSI synchronization are demonstrated by the CAN/DAQ programming examples.

When the final task for a given interface is cleared with nctClear, NI-CAN disconnects all terminal connections for that interface. Therefore, the nctDisconnectTerminals function is not required for most applications. NI-DAQ or NI-DAQmx terminals remain connected after the tasks are cleared, so you must disconnect NI-DAQ or NI-DAQmx terminals manually at the end of the application.

For a list of valid source/destination pairs, refer to the *Valid Combinations of Source/Destination* section.

Valid Combinations of Source/Destination

Table 8-3 lists all valid combinations of SourceTerminal and DestinationTerminal.

The series of the NI CAN hardware determines what combinations of SourceTerminal to DestinationTerminal are valid. Within Table 8-3, *1* indicates Series 1 hardware, and *2* indicates Series 2 hardware. You can determine the series of the NI CAN hardware by selecting the name of the card within the **Devices and Interfaces** view in the left pane of MAX.

Series 1 hardware has the following limitations:

- PXI cards do not support **RTSI6**.
- Signals received from a RTSI source cannot occur faster than 1 kHz. This prevents the card from receiving a 10 MHz or 20 MHz timebase, such as provided by NI E Series MIO hardware.
- Signals received from a RTSI source must be at least 100 µs in length to be detected. This prevents the card from receiving triggers in the nanoseconds range, such as the AI trigger provided by NI E Series MIO hardware. Series 2 CAN cards also send RTSI pulses in the nanoseconds range, so Series 1 CAN cards cannot receive RTSI input from Series 2 CAN cards.

- For CAN cards with High-Speed (HS) ports only, four RTSI signals are available for input (source), and four RTSI signals are available for output (destination). This limitation applies to the number of signals per direction, not the RTSI signal number. For example, if you connect **RTSI0**, **RTSI1**, **RTSI3**, and **RTSI5** as input, connecting **RTSI4** as input will return an error.
- For CAN cards with one or more Low-Speed (LS) ports, two RTSI signals are available for input (source), and three RTSI signals are available for output (destination).

Series 2 hardware has the following limitations:

- For all form factors (PCI, PXI, PCMCIA), the connection of **Interface Transceiver Event** to a RTSI destination is dependent on the physical port location. If the interface is located on Port 1, you can connect to even-numbered RTSI lines only (**RTSI0**, **RTSI2**, **RTSI4**, **RTSI6**). If the interface is located on Port 2, you can connect to odd-numbered RTSI lines only (**RTSI1**, **RTSI3**, **RTSI5**). You can determine the location by selecting the name of the interface in MAX.
- PCI cards do not support the **PXI_Star** and **PXI_Clk10** terminals, as those signals exist on the PXI backplane.
- PCMCIA cards do not support the **20 MHz Timebase**, **PXI_Star**, and **PXI_Clk10** terminals. Because **20 MHz Timebase** is not supported, you cannot synchronize the timebases of two PCMCIA CAN cards.
- On PCMCIA cards, **RTSI4**, **RTSI5** and **RTSI6** are not available.

Table 8-3. Valid Combinations of Source/Destination

Source	Destination				
	RTSI0 to RTSI6	**RTSI_Clock**	**Master Timebase**	**10 Hz Resync Clock**	**Start Trigger**
RTSI0 to RTSI6	—	—	—	1,2	1,2
RTSI_Clock	—	—	2	—	—
PXI_Star	—	—	—	—	2
PXI_Clk10	—	—	2	—	—
20 MHz Timebase	—	2	—	—	—
10 Hz Resync Clock	1,2	—	—	—	1,2
Interface Receive Event	2	—	—	—	2
Interface Transceiver Event	2	—	—	—	—
Start Trigger	1,2	—	—	—	—

1—Valid Connection for Series 1 Hardware

2—Valid Connection for Series 2 Hardware

nctCreateMessage

Purpose

Create a message configuration and associated channel configurations within the application.

Format

```
nctTypeStatus    nctCreateMessage(
                     nctTypeMessageConfig     MessageConfig,
                     u32                      NumberOfChannels,
                     nctTypeChannelConfig *   ChannelConfigList,
                     i32                      Interface,
                     i32                      Mode,
                     f64                      SampleRate,
                     nctTypeTaskRef *         TaskRef)
```

Inputs

`MessageConfig`

Configures properties for a new message. This function creates a task for a single message with one or more channels. You provide the properties in a C `struct`.

The properties are similar to the message properties in MAX:

`u32` `MsgArbitrationID`

Configures the arbitration ID of the message.

Use the `Extended` Boolean to specify whether the ID is standard (11-bit) or extended (29-bit).

`u32` `Extended`

Configures a Boolean value that indicates whether the message arbitration ID is standard 11-bit format (`0`) or extended 29-bit format (`1`).

`u32` `MsgDataBytes`

Configures the number of data bytes in the message. The range is `0` to `8`.

`NumberOfChannels`

Specifies the number of channel configurations you provide in `ChannelConfigList`.

`ChannelConfigList`

Configures the list of channels for the new message. `ChannelConfigList` is an array of a C `struct`, with one C `struct` for each channel.

The properties of each channel are similar to the channel properties in MAX:

`u32` `StartBit`

Configures the starting bit position in the message. The range is `0` (lowest bit in first byte), to `63` (highest bit in last byte).

`u32` `NumBits`

Configures the number of bits in the message. The range is `1` to `64`.

`u32` `DataType`

Configures the data type of the channel in the message. Values are `nctDataSigned`, `nctDataUnsigned`, and `nctDataFloat`.

`u32` `ByteOrder`

Configures the byte order of the channel in the message. Values are `nctOrderIntel` (little-endian), and `nctOrderMotorola` (big-endian).

`f64` `ScalingFactor`

Configures the scaling factor used to convert raw bits of the message to/from scaled floating-point units. The scaling factor is the *A* in the linear scaling formula $AX + B$, where *X* is the raw data, and *B* is the scaling offset.

`f64` `ScalingOffset`

Configures the scaling offset used to convert raw bits of the message to/from scaled floating-point units. The scaling offset is the *B* in the linear scaling formula $AX + B$, where *X* is the raw data, and *A* is the scaling factor.

`f64` `MaxValue`

Configures the maximum value of the channel in scaled floating-point units.

The nctRead and nctWrite functions do not coerce samples when converting to/from CAN messages. You can use this value with the user-interface functions of the development environment to set the range of front-panel controls and indicators.

f64 MinValue

Configures the minimum value of the channel in scaled floating-point units.

The nctRead and nctWrite functions do not coerce samples when converting to/from CAN messages. You can use this value with the user-interface functions of the development environment to set the range of front-panel controls and indicators.

f64 DefaultValue

Configures the default value of the channel in scaled floating-point units.

For information on how the DefaultValue is used, refer to the nctRead and nctWrite functions.

const str Unit

Configures the unit string of the channel. 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 samples on the channel.

Interface

Specifies the CAN interface to use for this task.

The interface input uses an enumeration in which value 0 selects **CAN0**, value 1 selects **CAN1**, and so on.

The default baud rate for the Interface is defined within MAX, but you can change it by setting the nctPropIntfBaudRate property with nctSetProperty.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

`Mode`

Specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

`nctModeInput`

Input channel data from received CAN messages. Use the `nctRead` function to obtain input samples as single-point, array, or waveform. Each sample value that you write is transmitted in a message on the network. If you write an array or waveform, the samples are buffered for subsequent transmit.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ or NI-DAQmx waveforms. You also can use this input mode to read a single point from the most recent message, such as for control or simulation.

`nctModeOutput`

Output channel data to CAN messages for transmit. Use the `nctWrite` function to write output samples as single-point, array, or waveform.

`nctModeOutputRecent`

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use `nctWrite` to provide a single sample per channel. Each periodic message uses the sample values from the most recent `nctWrite`.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to `nctWrite` for more information.

`nctModeTimestampedInput`

Input channel data from received CAN messages. Use the `nctRead` function to obtain input samples

as an array of sample/timestamp pairs (refer to nctReadTimestamped).

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

SampleRate — Specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For Mode of nctModeInput, SampleRate of zero means nctRead returns a single point from the most recent message received, and greater than zero means nctRead returns samples timed at the specified rate.

For Mode of nctModeOutput, SampleRate of zero means CAN messages transmit immediately when nctWrite is called, and greater than zero means CAN messages are transmitted periodically at the specified rate.

For Mode of nctModeOutputRecent, SampleRate must be greater than zero (periodic transmit).

For Mode of nctModeTimestampedInput, SampleRate is ignored.

When the Interface specifies a virtual interface (256 or 257), and Mode is nctModeOutput or nctModeOutputRecent, this SampleRate must be zero (greater than zero not supported).

Outputs

TaskRef — Use TaskRef with all subsequent functions to reference the task. Pass this task reference to nctStart before you read or write samples for the message.

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

Description

To use message and channel configurations from MAX or a CAN database, use the `nctInitStart` or `nctInitialize` functions. The `nctCreateMessage` function provides an alternative in which you create the message and channel configurations within the application, without use of MAX or a CAN database.

`nctCreateMessage` returns a task reference you wire to `nctStart` to start communication for the message and its channels.

nctCreateMessageEx

Purpose

Create a mode dependent message configuration and associated channel configurations within the application.

Format

```
nctTypeStatus    nctCreateMessageEx(
                     u32                    ConfigId,
                     void *                 MessageConfig,
                     u32                    NumberOfChannels,
                     void *                 ChannelConfigList,
                     i32                    Interface,
                     i32                    Mode,
                     f64                    SampleRate,
                     nctTypeTaskRef *       TaskRef)
```

Inputs

`ConfigId`

Specifies the type of structures you provide in `MessageConfig` and `ChannelConfigList`. Currently, the following values are supported:

The properties are similar to the message properties in MAX:

`1`

In this case, the `MessageConfig` and `ChannelConfigList` parameters behave exactly as those described for the `nctCreateMessage` function. This mode is provided for compatibility.

`2`

This value allows to define mode dependent channels. The `MessageConfig` parameter behaves the same way as for `ConfigId` = `1`. The `ChannelConfigList` parameter must be passed an array of structures described below. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

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This value is reserved for internal purposes. Do not use.

All other values for this parameter return an error.

MessageConfig

Configures properties for a new message. For both ConfigId = 1 and ConfigId = 2, you provide the properties as a pointer to a C struct:

The properties are similar to the message properties in MAX:

u32 MsgArbitrationID

Configures the arbitration ID of the message.

Use the Extended property.to specify whether the ID is standard (11-bit) or extended (29-bit).

u32 Extended

Configures a Boolean value that indicates whether the arbitration ID of the message is standard 11-bit format (0) or extended 29-bit format (1).

u32 MsgDataBytes

Configures the number of data bytes in the message. The range is 0 to 8.

NumberOfChannels

Specifies the number of channel configurations you provide in ChannelConfigList.

ChannelConfigList

Configures the list of channels for the new message. ChannelConfigList is an array of a C struct, with one C struct for each channel. For ConfigId = 1, refer to the ChannelConfigList parameter of the nctCreateMessage function. For ConfigId = 2 use this structure:

The properties of each channel are similar to the channel properties in MAX:

u32 StartBit

Configures the starting bit position in the message. The range is 0 (lowest bit in first byte), to 63 (highest bit in last byte).

`u32` `NumBits`

Configures the number of bits in the message. The range is `1` to `64`.

`u32` `DataType`

Configures the data type of the channel in the message. Values are `nctDataSigned`, `nctDataUnsigned`, and `nctDataFloat`.

`u32` `ByteOrder`

Configures the byte order of the channel in the message. Values are `nctOrderIntel` (little-endian), and `nctOrderMotorola` (big-endian).

`f64` `ScalingFactor`

Configures the scaling factor used to convert raw bits of the message to/from scaled floating-point units. The scaling factor is the *A* in the linear scaling formula $AX + B$, where X is the raw data, and B is the scaling offset.

`f64` `ScalingOffset`

Configures the scaling offset used to convert raw bits of the message to/from scaled floating-point units. The scaling offset is the *B* in the linear scaling formula $AX + B$, where X is the raw data, and A is the scaling factor.

`f64` `MaxValue`

Configures the maximum value of the channel in scaled floating-point units.

The `nctRead` and `nctWrite` functions do not coerce samples when converting to/from CAN messages. You can use this value with the user-interface functions of the development environment to set the range of front-panel controls and indicators.

`f64` `MinValue`

Configures the minimum value of the channel in scaled floating-point units.

The `nctRead` and `nctWrite` functions do not coerce samples when converting to/from CAN messages. You can use this value with the user-interface functions of the development environment to set the range of front-panel controls and indicators.

`f64` `DefaultValue`

Configures the default value of the channel in scaled floating-point units.

For information on how the `DefaultValue` is used, refer to the `nctRead` and `nctWrite` functions.

`const str` `Unit`

Configures the unit string of the channel. 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 samples on the channel.

`u32` `NumModeChannels`

Configures whether to use a mode channel for this channel. The range is `0` to `1`.

For `0`, this channel is valid in each frame (mode independent channel).

For `1`, this channel is valid only if the mode channel described in the `ModeChannel` struct applies (mode dependent channel). For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

`struct` `ModeChannel`

Configures the mode channel for this (data) channel. Note that the same mode channel can be specified for several channels. The structure contains following fields:

`u32` `ModeValue`
Configures the value of the mode channel for which the data channel is valid. The value is always considered unsigned.

`u32` `StartBit`
Configures the starting bit position in the message. The range is `0` (lowest bit in first byte), to `63` (highest bit in last byte).

`u32` `NumBits`
Configures the number of bits in the message. The range is `0` to `64`.

`u32` `ByteOrder`
Configures the byte order of the mode channel in the message. Values are `nctOrderIntel` (little-endian), and `nctOrderMotorola` (big-endian).

`u32` `DefaultValue`
This field is reserved. Set it to `0`.

`Interface` Specifies the CAN interface to use for this task.

The interface input uses an enumeration in which value `0` selects **CAN0**, value `1` selects **CAN1**, and so on.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

`Mode` Specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

`nctModeInput`

Input channel data from received CAN messages. Use the `nctRead` function to obtain input samples as single-point, array, or waveform. Each periodic message uses the sample values from the most recent `nctWrite`.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ or NI-DAQmx waveforms. You also can use this input mode to read a single point from the most recent message, such as for control or simulation.

For this mode, the channels in `ChannelList` can be contained in multiple messages.

`nctModeOutput`

Output channel data to CAN messages for transmit. Use the `nctWrite` function to write output samples as single-point, array, or waveform.

For this mode, there are restrictions on using channels in `ChannelList` that are contained in multiple messages. Refer to `nctWrite` for more information.

`nctModeOutputRecent`

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use `nctWrite` to provide a single sample per channel. Each periodic message uses the sample values from the most recent `nctWrite`.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to `nctWrite` for more information.

`nctModeTimestampedInput`

Input channel data from received CAN messages. Use the `nctReadTimestamped` function to obtain input samples as an array of sample/timestamp pairs. Refer to `nctReadTimestamped` for more information.

For this mode, the channels in `ChannelList` must be contained in a single message.

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

`SampleRate` — Specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For `Mode` of `nctModeInput`, `SampleRate` of zero means `nctRead` returns a single point from the most recent message received, and greater than zero means `nctRead` returns samples timed at the specified rate.

For `Mode` of `nctModeOutput`, `SampleRate` of zero means CAN messages transmit immediately when `nctWrite` is called, and greater than zero means CAN messages are transmitted periodically at the specified rate.

For `Mode` of `nctModeTimestampedInput`, `SampleRate` is ignored.

When the `Interface` specifies a virtual interface (256 or 257), and `Mode` is `nctModeOutput` or `nctModeOutputRecent`, this `SampleRate` must be zero (greater than zero not supported).

Outputs

`TaskRef` — Use `TaskRef` with all subsequent functions to reference the task. Pass this task reference to `nctStart` before you read or write samples for the message.

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means that the function executed successfully. A negative value specifies an error, which means that the function did not perform the expected behavior. A positive value specifies a warning, which means that the function performed as expected, but a condition arose that may require attention.

Use the `ncStatusToString` function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Description

To use message and channel configurations from MAX or a CAN database, use the `nctInitStart` or `nctInitialize` functions. The `nctCreateMessage` function provides an alternative in which you create the message and channel configurations within the application, without use of MAX or a CAN database.

`nctCreateMessageEx` returns a task reference you wire to `nctStart` to start communication for the message and its channels.

nctDisconnectTerminals

Purpose

Disconnect terminals in the CAN hardware.

Format

```
nctTypeStatus    nctDisconnectTerminals(
                     nctTypeTaskRef    TaskRef,
                     u32               SourceTerminal,
                     u32               DestinationTerminal,
                     u32               Modifiers);
```

Inputs

`TaskRef`	Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.
`SourceTerminal`	Specifies the source of the connection. For a description of values for `SourceTerminal`, refer to `nctConnectTerminals`.
`DestinationTerminal`	Specifies the destination of the connection. For a description of values for `DestinationTerminal`, refer to `nctConnectTerminals`.
`Modifiers`	Provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so you must pass `Modifiers` as zero.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the `ncStatusToString` function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Description

This function disconnects a specific pair of source/destination terminals you previously connected with nctConnectTerminals.

When the final task for a given interface is cleared with nctClear, NI-CAN disconnects all terminal connections for that interface. Therefore, the nctDisconnectTerminals function is not required for most applications. You typically use this function to change RTSI connections dynamically while the application is running. First use nctStop to stop all tasks for the interface, then use nctDisconnectTerminals and nctConnectTerminals to adjust RTSI connections, then nctStart to restart sampling.

nctGetNames

Purpose

Get an array of CAN channel names or message names from MAX or a CAN database file.

Format

```
nctTypeStatus    nctGetNames(
                     cstr            FilePath,
                     u32             Mode,
                     cstr            MessageName,
                     u32             SizeofChannelList,
                     str             ChannelList);
```

Inputs

`FilePath`

`FilePath` is an optional path to a CAN database file from which to get channel names. The file must use either `.DBC` or `.NCD` extension. Files with extension `.DBC` use the CANdb database format. Files with extension `.NCD` use the NI-CAN database format. You can generate NI-CAN database files from the **Save Channels** selection in MAX.

If you pass `NULL` or empty-string to `FilePath`, this function gets the channel names from MAX. The MAX CAN channels are in the MAX CAN Channels listing within **Data Neighborhood**.

`Mode`

Specifies the type of names to return.

`nctGetNamesModeChannels`

Return list of channel names. You can pass the returned `ChannelList` to `nctInitStart`.

`nctGetNamesModeMessages`

Return list of message names.

`MessageName`

`MessageName` is an optional input that filters the names for a specific message. If you pass `NULL` or empty-string to `MessageName`, this function returns all names in the database. If you pass a non empty string, the `ChannelList` output is limited to channels of the specified message.

This input applies to `Mode` of `nctGetNamesModeChannels` only. It is ignored for `Mode` of `nctGetNamesModeMessages`.

`SizeofChannelList` Number of bytes allocated for the `ChannelList` output.

If all of the channel names do not fit in the allocated `ChannelList`, this function returns as much as possible with an error.

Use the `nctGetNamesLength` function to determine the proper `SizeofChannelList`.

Outputs

`ChannelList` Returns the comma-separated list of channel names.

Each name in `ChannelList` uses the minimum syntax required to properly initialize:

If a channel name is used within only one message in the database, `nctGetNames` returns only the channel name in the list. If a channel name is used within multiple messages, `nctGetNames` prepends the message name to that channel name, with a decimal point separating the message and channel name. This syntax ensures that the duplicate channel is associated to a single message in the database.

For more information on the syntax conventions for channel names, refer to `nctInitStart`.

To start a task for all channels returned from `nctGetNames`, pass `ChannelList` to the `nctInitStart` function to start a task.

You also can use `ChannelList` with a user-interface control such as a ring or list box. The user of the application can then select names using this control, and the selected names can be passed to `nctInitStart`.

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the `ncStatusToString` function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Note The function `nctGetNames` returns the string results as an array of `char (*char)`. VB is not able to convert this array to a string automatically. Therefore, VB users should call the wrapper function `nct_GetNames`.

nctGetNamesLength

Purpose

Get the required size for a specified list of channels to allocate an array for the `ChannelList` input of `nctGetNames`.

Format

```
nctTypeStatus    nctGetNamesLength(
                     cstr              FilePath,
                     u32               Mode,
                     cstr              MessageName,
                     u32 *             SizeofChannelList);
```

Inputs

`FilePath`

`FilePath` is an optional path to a *CAN database* file from which to get channel names. The file must use either the `.DBC` or `.NCD` extension.

If you pass `NULL` or empty-string to `FilePath`, this function examines the channel names from MAX.

For more information on `FilePath`, refer to `nctGetNames`.

`Mode`

Specifies the type of names to examine.

`nctGetNamesModeChannels`

Examine the list of channel names.

`nctGetNamesModeMessages`

Examine the list of message names.

`MessageName`

`MessageName` is an optional input that filters the names for a specific *message*. If you pass `NULL` or empty-string to `MessageName`, this function returns all names in the database. If you pass a nonempty string, the `SizeofChannelList` output is limited to channels of the specified message.

This input applies to `Mode of nctGetNamesModeChannels` only. It is ignored for `Mode of nctGetNamesModeMessages`.

Outputs

SizeofChannelList	Number of bytes required for nctGetNames to return all names for the specified FilePath, Mode, and MessageName. After calling nctGetNamesLength, you can allocate an array of size SizeofChannelList, then pass that array to nctGetNames using the same input parameters. This ensures that nctGetNames will return all names without error.

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

nctGetProperty

Purpose

Get a property for the task, or a single channel within the task.

Format

```
nctTypeStatus    nctGetProperty(
                     nctTypeTaskRef    TaskRef,
                     cstr              ChannelName,
                     u32               PropertyId,
                     u32               SizeofValue,
                     void *            Value)
```

Inputs

`TaskRef`

Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

`ChannelName`

Specifies an individual channel within the task. If you pass empty-string to `ChannelName`, this means the property applies to the entire task, not a specific channel.

Properties that begin with the word *Channel* or *Message* do not apply to the entire task, but an individual channel or message within the task. For these channel-specific properties, you must pass the name of a channel from channel list into the `ChannelName` input.

For properties that do not begin with the word *Channel* or *Message*, you must pass empty-string (`""`) into `ChannelName`. You must not pass `NULL` into `ChannelName`.

`PropertyId`

Selects the property to get.

For a description of each property, including its data type and `PropertyId`, refer to the Properties section.

`SizeofValue`

Number of bytes allocated for the `Value` output. This size normally depends on the data type listed in the description of the property.

Outputs

`Value` — Returns the property value. `PropertyId` determines the data type of the returned value.

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Properties

`u32` `nctPropBehavAfterFinalOut`

Returns the `nctPropBehavAfterFinalOut` property, which is used with some output task configurations. For more information, refer to the `nctPropBehavAfterFinalOut` property in `nctSetProperty`.

`u32` `nctPropChanByteOrder`

Returns the byte order of the channel in the message. Values are `nctOrderIntel` (little-endian), and `nctOrderMotorola` (big-endian).

The value of this property is originally set within MAX or the CAN database and cannot be changed using `nctSetProperty`.

`u32` `nctPropChanDataType`

Returns the data type of the channel in the message. Values are `nctDataSigned`, `nctDataUnsigned`, and `nctDataFloat`.

The value of this property is originally set within MAX or the CAN database and cannot be changed using `nctSetProperty`.

`f64` `nctPropChanDefaultValue`

Returns the default value of the channel in scaled floating-point units.

For information on how `nctPropChanDefaultValue` is used, refer to the `nctRead` and `nctWrite` functions.

The value of this property is originally set within MAX. If the channel is initialized directly from a CAN database, the value is `0.0` by default, but it can be changed using `nctSetProperty`.

`u32` `nctPropChanIsModeDependent`

Returns if a channel is mode dependent (`1`) or not (`0`).

`f64` `nctPropChanMaxValue`

Returns the maximum value of the channel in scaled floating-point units.

The `nctRead` and `nctWrite` functions do not coerce samples when converting to/from CAN messages. You can use this value with the user-interface functions of the development environment to set the range of front-panel controls and indicators.

The value of this property is originally set within MAX or the CAN database and cannot be changed using `nctSetProperty`.

`f64` `nctPropChanMinValue`

Returns the minimum value of the channel in scaled floating-point units.

The `nctRead` and `nctWrite` functions do not coerce samples when converting to/from CAN messages. You can use this value with the user-interface functions of the development environment to set the range of front-panel controls and indicators.

The value of this property is originally set within MAX or the CAN database and cannot be changed using `nctSetProperty`.

`u32` `nctPropChanModeValue`

Returns the value of the mode channel associated to this channel. This property applies only to mode dependent channels. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

`u32` `nctPropChanNumBits`

Returns the number of bits in the channel. The range is `0` to `64`.

The value of this property is originally set within MAX or the CAN database and cannot be changed using `nctSetProperty`.

`f64` `nctPropChanScalFactor`

Returns the scaling factor used to convert raw bits of the message to/from scaled floating-point units. The scaling factor is the A in the linear scaling formula $AX + B$, where X is the raw data, and B is the scaling offset.

CAN messages use the raw data, and the `nctRead` and `nctWrite` functions provide access to samples in floating-point units.

The value of this property is originally set within MAX or the CAN database and cannot be changed using `nctSetProperty`.

f64 nctPropChanScalOffset

Returns the scaling offset used to convert raw bits of the message to/from scaled floating-point units. The scaling offset is the *B* in the linear scaling formula *AX* + *B*, where *X* is the raw data, and *A* is the scaling factor.

CAN messages use the raw data, and the nctRead and nctWrite functions provide access to samples in floating-point units.

The value of this property is originally set within MAX or the CAN database and cannot be changed using nctSetProperty.

u32 nctPropChanStartBit

Returns the starting bit position in the message. The range is 0 (lowest bit in first byte), to 63 (highest bit in last byte).

The value of this property is originally set within MAX or the CAN database and cannot be changed using nctSetProperty.

str nctPropChanUnitString

Returns the unit string of the channel. The string is no more than 80 characters in length. You can use this value to display units (such as volts or RPM) along with the samples on the channel.

The value of this property is originally set within MAX or the CAN database and cannot be changed using nctSetProperty.

u32 nctPropHwFormFactor

Returns the hardware form factor for the NI-CAN hardware that contains interface. Values are nctHwFormFactorPCI, nctHwFormFactorPXI, nctHwFormFactorPCMCIA, and nctHwFormFactorAT.

u32 nctPropHwMasterTimebaseRate

Returns the present Hardware Master Timebase Rate in MHz, programmed into the CAN hardware. For PCMCIA, this property will always return 10 MHz.

u32 nctPropHwSerialNum

Returns the hardware serial number for the NI-CAN hardware that contains interface.

u32 nctPropHwSeries

Returns the hardware series for the NI CAN hardware that contains interface. Values are nctHwSeries1 and nctHwSeries2.

Newer hardware series are often capable of more features, so the application may need to determine which is installed.

u32 nctPropHwTimestampFormat

Returns the present Timestamp Format programmed into the CAN hardware. This property applies to the entire card.

u32 nctPropInterface

Returns the interface initialized for the task, such as with the nctInitStart function.

u32 nctPropIntfBaudRate

Returns the baud rate in use by the interface.

Basic baud rates such as 125000 and 500000 are specified as the numeric rate.

Advanced baud rates are specified as 8000*XXYY* hex, where *YY* is the value of Bit Timing Register 0 (BTR0), and *XX* is the value of Bit Timing Register 1 (BTR1). For more information, refer to the **Port Properties** dialog in MAX.

The value of this property is originally set within MAX, but it can be changed using nctSetProperty.

u32 nctPropIntfListenOnly

Returns a Boolean value that indicates whether the listen only feature of the Philips SJA1000 CAN controller is enabled (TRUE) or disabled (FALSE). For more information, refer to the nctPropIntfListenOnly property in nctSetProperty.

Since the listen only feature requires the Philips SJA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only.

u32 nctPropIntfRxErrorCounter

Returns the Receive Error Counter as described in the CAN specification.

Since the error count requires the Philips SJA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only. If you are using Series 1 NI CAN hardware, this property returns an error.

u32 nctPropIntfSelfReception

Returns the nctPropIntfSelfReception property as configured with nctSetProperty.

This property is supported on Series 2 NI CAN hardware only (returns error for Series 1).

u32 nctPropIntfSeries2ErrArbCapture

Returns the current values of the Error Code Capture register and Arbitration Lost Capture register from the Philips SJA1000 CAN controller chip.

The Error Code Capture register provides information on bus errors that occur according to the CAN standard. A bus error increments either the Transmit Error Counter or the

Receive Error Counter. When communication starts on the interface, the first bus error is captured into the Error Code Capture register, and retained until you get this property. After you get this property, the Error Code Capture register is again enabled to capture information for the next bus error.

The Arbitration Lost Capture register provides information on a loss of arbitration during transmits. Loss of arbitration is not considered an error. When communication starts on the interface, the first arbitration loss is captured into the Arbitration Lost Capture register, and retained until you get this property. After you get this property, the Arbitration Lost Capture register is again enabled to capture information for the next arbitration loss.

For each of the capture registers, a single-bit New flag indicates whether a new error has occurred since the last Get. If the New flag of a register is set, the associated fields contain new information. If the New flag of a register is clear, the associated fields are the same as the previous Get.

This property is commonly used with the `nctPropIntfSingleShotTx` property. When `nctWrite` is used to transmit the single frame, you can get this property to determine if the transmit was successful. If the single shot transmit was not successful, this property provides detailed information for the failure.

This property is supported for Series 2 hardware only (Series 1 returns error). Since the information and bit format is very specific to the Philips SJA1000 CAN controller on Series 2 hardware, National Instruments cannot guarantee compatibility for this property on future hardware series. When using this property in the application, it is best to get the `nctPropHwSeries` property to verify that the CAN hardware is Series 2. For information regarding the format of the bits in this property, refer to `NC_ATTR_SERIES2_ERR_ARB_CAPTURE (Series 2 Error/Arb Capture)` attribute in the `ncGetAttribute` function of the Frame API.

`u32` `nctPropIntfSeries2Comp`

Returns the value of the `nctPropIntfSeries2Comp` property (refer to `nctSetProperty`).

`u32` `nctPropIntfSeries2FilterMode`

Returns the value of the `nctPropIntfSeries2FilterMode` property (refer to `nctSetProperty`).

`u32` `nctPropIntfSeries2Mask`

Returns the value of the `nctPropIntfSeries2Mask` property (refer to `nctSetProperty`).

u32 nctPropIntfSingleShotTx

Returns the value of the nctPropIntfSingleShotTx property (refer to nctSetProperty).

u32 nctPropIntfTransceiverExternalIn

Returns the transceiver external inputs for the interface that was initialized for the task.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this property allows you to determine the input voltage on the STATUS pin of the CAN port.

For many models of CAN transceiver, an NERR pin is provided for detection of faults and other status. For such transceivers, you can wire the NERR pin to the STATUS pin of the CAN port.

This property is supported for Series 2 XS cards only.

This property uses a bit mask. When using the property, use bitwise AND operations to check for values, not equality checks (equal, greater than, and so on).

nctTransceiverInStatus(00000001 hex, STATUS pin)

This bit is set when 5 V exists on the STATUS pin.

This bit is clear when 0 V exists on the STATUS pin.

u32 nctPropIntfTransceiverExternalOut

Returns the transceiver external outputs for the interface that was initialized for the task.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this property allows you to determine the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you to determine if the CAN controller chip is sleeping.

For more information on the format of the value returned in this property, refer to the description of nctPropIntfTransceiverExternalOut in nctSetProperty.

This property is supported for Series 2 XS cards only.

u32 nctPropIntfTransceiverMode

Returns the transceiver mode for the interface that was initialized for the task.

The transceiver mode changes when you set the mode within the application, or when a remote wakeup transitions the interface from **Sleep** to **Normal** mode. For more information, refer to nctSetProperty.

This property is supported for Series 2 cards only.

This property uses the following values:

`nctTransceiverModeNormal`

Transceiver is awake in **Normal** communication mode.

`nctTransceiverModeSleep`

Transceiver and the CAN controller chip are both in **Sleep** mode.

`nctTransceiverModeSWWakeup`

Single Wire transceiver is in **Wakeup Transmission** mode.

`nctTransceiverModeSWHighSpeed`

Single Wire transceiver is in **High-Speed Transmission** mode.

`u32 nctPropIntfTransceiverType`

Returns the type of transceiver for the interface that was initialized for the task. For hardware other than Series 2 XS cards, the transceiver type is fixed. For Series 2 XS cards, the transceiver type reflects the most recent value specified by MAX or `nctSetProperty`.

This property is not supported on the PCMCIA form factor.

This property uses the following values:

`nctTransceiverTypeHS`

Transceiver type is **High-Speed** (HS).

`nctTransceiverTypeLS`

Transceiver type is **Low-Speed/Fault-Tolerant** (LS).

`nctTransceiverTypeSW`

Transceiver type is **Single Wire** (SW).

`nctTransceiverTypeExternal`

Transceiver type is **External**. This transceiver type is available on Series 2 XS cards only. For more information, refer to `nctSetProperty`.

`nctTransceiverTypeDisconnect`

Transceiver type is **Disconnect**. This transceiver type is available on Series 2 XS cards only. For more information, refer to `nctSetProperty`.

`u32 nctPropIntfTxErrorCounter`

Returns the Transmit Error Counter as described in the CAN specification.

Since the error count requires the Philips SJA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only. If you are using Series 1 NI CAN hardware, this property returns an error.

u32 nctPropIntfVirtualBusTiming

Returns a Boolean value of True or False to indicate whether Virtual Bus Timing has been set or not for the specified virtual task. This property is applicable to all tasks opened on the virtual interface.

If this property is selected on real hardware, an error will be returned.

u32 nctPropMode

Returns the mode initialized for the task, such as with the nctInitStart function.

u32 nctPropMsgArbitrationId

Returns the arbitration ID of the channel message.

To determine whether the ID is standard (11-bit) or extended (29-bit), get the nctPropMsgIsExtended property.

The value of this property is originally set within MAX or the CAN database and cannot be changed using nctSetProperty.

u32 nctPropMsgByteLength

Returns the number of data bytes in the channel message. The range is 0 to 8.

The value of this property is originally set within MAX or the CAN database and cannot be changed using nctSetProperty.

u32 nctPropMsgIsExtended

Returns a Boolean value that indicates whether the arbitration ID of the channel message is standard 11-bit format (0) or extended 29-bit format (1).

The value of this property is originally set within MAX or the CAN database and cannot be changed using nctSetProperty.

str nctPropMsgName

Returns the name of the channel message. The string is no more than 80 characters in length.

The value of this property is originally set within MAX or the CAN database and cannot be changed using nctSetProperty.

u32 nctPropMsgDistribution

Returns the nctPropMsgDistribution which is used to determine if the CAN frames associated to a group of mode dependent channels are sent even spaced or in burst mode. This property applies only for mode dependent channels that are transmitted periodically. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

`f64` `nctPropNoValue`

Returns the value that is returned on timestamped read for mode dependent channels that have not been received with the most resent CAN frame associated with the CAN message. This Property applies only to mode dependent channels that are read with the timestamped read operation. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

`u32` `nctPropNumChannels`

Returns the number of channels initialized in channel list. This is the number of array entries required when using `nctRead` or `nctWrite`.

`f64` `nctPropSampleRate`

Returns the `sample rate` initialized for the task, such as with the `nctInitStart` function.

`u32` `nctPropSamplesPending`

Returns the number of samples available to be read using `nctRead`. If you set the `NumberOfSamplesToRead` input of `nctRead` to this value, `nctRead` returns immediately without waiting.

This property applies only to tasks initialized with `Mode` of `nctModeInput`, and `SampleRate` greater than zero. For all other configurations, it returns an error.

`f64` `nctPropTimeout`

Returns the `nctPropTimeout` property, which is used with some task configurations. For more information, refer to the `nctPropTimeout` property in `nctSetProperty`.

`u32` `nctPropVersionBuild`

Returns the build number of the NI-CAN software. This number applies to `nctPhaseDevelopment`, `nctPhaseAlpha`, and `nctPhaseBeta` phase only, and should be ignored for `nctPhaseRelease` phase.

`str` `nctPropVersionComment`

Returns a comment string for the NI-CAN software. If you received a custom release of NI-CAN from National Instruments, this comment often describes special features of the release.

`u32` `nctPropVersionMajor`

Returns the major version of the NI-CAN software, such as the *2* in version *2.1.5*.

`u32` `nctPropVersionMinor`

Returns the minor version of the NI-CAN software, such as the *1* in version *2.1.5*.

`u32 nctPropVersionPhase`

Returns the phase of the NI-CAN software. Values are `nctPhaseDevelopment`, `nctPhaseAlpha`, `nctPhaseBeta`, and `nctPhaseRelease`. Versions of NI-CAN in hardware kits or on `ni.com` will always be `nctPhaseRelease`.

`u32 nctPropVersionUpdate`

Returns the update version of the NI-CAN software, such as the *5* in version *2.1.5*.

nctInitialize

Purpose

Initialize a task for the specified channel list.

Format

```
nctTypeStatus    nctInitialize(
                     cstr              ChannelList,
                     i32               Interface,
                     i32               Mode,
                     f64               SampleRate,
                     nctTypeTaskRef *  TaskRef);
```

Inputs

`ChannelList`

Comma-separated list of channel names to initialize as a task.

For more information, refer to the channel list input of `nctInitStart`.

`Interface`

Specifies the CAN interface to use for this task.

The interface input uses an enumeration in which value `0` selects **CAN0**, value `1` selects **CAN1**, and so on.

If you pass the special value `-1` to `Interface`, this function uses the default interface as defined in the Message/Channel configuration properties. If the default interface in MAX is **All**, or if one or more channels in `ChannelList` specifies a *filepath*, the `Interface` is a required input to this function.

The Channel API and Frame API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Frame API, this function returns an error.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

`Mode`

Specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

`nctModeInput`

Input channel data from received CAN messages. Use the `nctRead` function to obtain input samples as single-point, array, or waveform. Each sample value you write is transmitted in a message on the network. If you write an array or waveform, the samples are buffered for subsequent transmit.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ or NI-DAQmx waveforms. You also can use this input mode to read a single point from the most recent message, such as for control or simulation.

For this mode, the channels in `ChannelList` can be contained in multiple messages.

`nctModeOutput`

Output channel data to CAN messages for transmit. Use the `nctWrite` function to write output samples as single-point, array, or waveform.

For this mode, there are restrictions on using channels in `ChannelList` that are contained in multiple messages. Refer to `nctWrite` for more information.

`nctModeOutputRecent`

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use `nctWrite` to provide a single sample per channel. Each periodic message uses the sample values from the most recent `nctWrite`.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to `nctWrite` for more information.

`nctModeTimestampedInput`

Input channel data from received CAN messages. Use the `nctReadTimestamped` function to obtain input samples as an array of sample/timestamp pairs. Refer to `nctReadTimestamped` for more information.

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

For this mode, the channels in `ChannelList` must be contained in a single message.

`SampleRate` — Specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For `Mode` of `nctModeInput`, `SampleRate` of zero means `nctRead` returns a single point from the most recent message received, and greater than zero means `nctRead` returns samples timed at the specified rate.

For `Mode` of `nctModeOutput`, `SampleRate` of zero means CAN messages transmit immediately when `nctWrite` is called, and greater than zero means CAN messages are transmitted periodically at the specified rate.

For `Mode` of `nctModeTimestampedInput`, `SampleRate` is ignored.

When the `Interface` specifies a virtual interface (256 or 257), and `Mode` is `nctModeOutput` or `nctModeOutputRecent`, this `SampleRate` must be zero (greater than zero not supported).

Outputs

`TaskRef` — Use `TaskRef` with all subsequent functions to reference the task. Pass this task reference to `nctStart` before you read or write samples for the message.

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the `ncStatusToString` function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Description

The `nctInitialize` function does not start communication. This enables you to use `nctSetProperty` to change the properties of the task, or `nctConnectTerminals` to synchronize CAN or DAQ cards. After you change properties or connections, use `nctStart` to start communication for the task.

nctInitStart

Purpose

Initialize a task for the specified channel list, then start communication.

Format

```
nctTypeStatus    nctInitStart(
                     cstr              ChannelList,
                     i32               Interface,
                     i32               Mode,
                     f64               SampleRate,
                     nctTypeTaskRef *  TaskRef);
```

Inputs

`ChannelList`

Comma-separated list of channel names to initialize as a task.

You can type in the channel list as a string constant, or you can obtain the list from MAX or another CAN database by using the `nctGetNames` function. Channel names are case sensitive.

You can initialize the same `ChannelList` with different `Interface`, `Mode`, or `SampleRate`, because each task reference is unique.

If you are using mode dependent channels, and each channel name is not unique, you will need to use a special syntax described in the *Mode Dependent Channel Syntax* section at the end of the function description.

The following paragraphs describe the syntax of each channel name. Brackets indicate optional fields.

[*filepath*::][*message*.]*channel*

- *filepath* is the path to a CAN database file from which to import the channel (signal) configurations. The filepath must use Windows directory syntax, and must be followed by a double-colon.

  If *filepath* is not included, the channel configuration is obtained from MAX. The MAX CAN channels are in the MAX CAN Channels listing within **Data Neighborhood**.

  Once you specify a *filepath*, it will continue to be applied to subsequent names in the channel list until you specify a new *filepath*. After using *filepath* for a CAN database file, you can

revert to using MAX by specifying an empty *filepath* (double colon only).

For more information about the syntax of channel names refer to the *Mode Dependent Channel Syntax* section of the `nctInitStart` function description.

- *message* refers to the message in which the *channel* is contained. The message name must be followed by a decimal point.

  If the *channel* name occurs in multiple messages, you must specify the *message* name to identify the channel uniquely. Within MAX, channels with the same name in multiple messages are shown with a yellow exclamation point.

  If the *channel* name is unique across all channels, the *message* name is not required.
- *channel* refers to the channel (signal) name in MAX or the *filepath* CAN database.

The following examples demonstrate the channel list syntax:

- List of channels from MAX, each channel name unique across all messages.

  ```
  myChan1,myChan2,myChan3
  ```
- List of channels from a CANdb file, each channel name unique across all messages.

  ```
  C:\MyCandb\MyChannels.DBC::myChan1

  myChan2,myChan3
  ```
- List of channels from MAX, with one channel duplicated across two messages. `MyChan2` and `MyChan3` must be unique across all messages.

  ```
  myMessage1.myChan1,myChan2,

  myMessage2.myChan1,myChan3
  ```
- List of two channels from a CANdb file, then two channels from MAX.

  ```
  C:\MyCandb\MoreChannels.DBC::myChan1,

  myChan2,::myChan3,myChan4
  ```

`Interface`

Specifies the CAN interface to use for this task.

The interface input uses an enumeration in which value `0` selects **CAN0**, value `1` selects **CAN1**, and so on.

If you pass the special value `-1` to `Interface`, this function uses the default interface as defined in the Message/Channel configuration properties. If the default interface in MAX is **All**, or if one or more channels in `ChannelList` specifies a *filepath*, the `Interface` is a required input to this function.

The Channel API and Frame API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Frame API, this function returns an error.

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

`Mode`

Specifies the I/O mode for the task. For an overview of the I/O modes, including figures, refer to the *Channel API Basic Programming Model* section of Chapter 6, *Using the Channel API*, for the Channel API.

`nctModeInput`

Input channel data from received CAN messages. Use the `nctRead` function to obtain input samples as single-point, array, or waveform. Each periodic message uses the sample values from the most recent `nctWrite`.

Use this input mode to read waveforms of timed samples, such as for comparison with NI-DAQ or NI-DAQmx waveforms. You also can use this input mode to read a single point from the most recent message, such as for control or simulation.

For this mode, the channels in `ChannelList` can be contained in multiple messages.

`nctModeOutput`

Output channel data to CAN messages for transmit. Use the `nctWrite` function to write output samples as single-point, array, or waveform.

For this mode, there are restrictions on using channels in `ChannelList` that are contained in multiple messages. Refer to `nctWrite` for more information.

`nctModeOutputRecent`

Output channel data to CAN messages for transmit. This mode is used with sample rate greater than zero (periodic transmit). Use `nctWrite` to provide a single sample per channel. Each periodic message uses the sample values from the most recent `nctWrite`.

For this mode, there are restrictions on using channels in channel list that are contained in multiple messages. Refer to `nctWrite` for more information.

`nctModeTimestampedInput`

Input channel data from received CAN messages. Use the `nctReadTimestamped` function to obtain input samples as an array of sample/timestamp pairs. Refer to `nctReadTimestamped` for more information.

For this mode, the channels in `ChannelList` must be contained in a single message.

Use this input mode to read samples with timestamps that indicate when each message is received from the network.

If `nctModeTimestampedInput` mode is used, the task cannot be started with `nctInitStart` because the **Value for invalid data** must be set up through `nctSetProperty` before calling `nctStart`. Use the sequence `nctInitialize`, `nctSetProperty` (`nctPropNoValue`) and `nctStart` instead.

`SampleRate` Specifies the timing to use for samples of the task. The sample rate is specified in Hertz (samples per second). A sample rate of zero means to sample immediately.

For `Mode` of `nctModeInput`, `SampleRate` of zero means `nctRead` returns a single point from the most recent message received, and greater than zero means `nctRead` returns samples timed at the specified rate.

For Mode of nctModeOutput, SampleRate of zero means CAN messages transmit immediately when nctWrite is called, and greater than zero means CAN messages are transmitted periodically at the specified rate.

For Mode of nctModeTimestampedInput, SampleRate is ignored.

When the Interface specifies a virtual interface (256 or 257), and Mode is nctModeOutput or nctModeOutputRecent, this SampleRate must be zero (greater than zero not supported).

Outputs

TaskRef

Use TaskRef with all subsequent functions to reference the running task. Because nctInitStart starts communication, you can pass this task reference to nctRead or nctWrite.

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

Description

The code for this function simply calls nctInitialize followed by nctStart. This provides an easy way to start a list of channels.

The following list describes the scenarios for which nctInitStart cannot be used:

- If you need to set properties for the channels, use nctInitialize, then nctSetProperty, then nctStart. The nctInitStart function starts communication, and most channel properties cannot be changed after the task is started.
- If you need to synchronize tasks for multiple NI-CAN, NI-DAQ, or NI-DAQmx cards, use nctInitialize, then nctConnectTerminals to synchronize, the nctStart to start communication.
- If you need to create channel configurations entirely within the application, without using MAX or a CAN database file, use nctCreateMessage or *nctCreateMessageEx*, then nctStart. The nctInitStart function accepts only channel names defined in MAX or a CAN database file.

Mode Dependent Channel Syntax

If you are using mode dependent channels, and each channel name is not unique, you will need to use a special syntax described in this section. For the large majority of channels, you can use the simple syntax described previously for *channel list*. The brackets [ ] define optional parameters:

[*message name*.[[*multiplexer*.]*mode_value*.]]*channel*.

- *message* refers to the message in which the channel is contained. The *message name* must be followed by a decimal point. If the channel name is not unique within MAX or the database file, you must specify the *message name* to identify the channel uniquely.

  Within MAX, channels with the same name are shown with a yellow exclamation point. This feature can be changed in the **CAN Channels»Options** dialog box.

  If the channel name is unique across all channels, the message name is not required.
- *multiplexer* refers to the multiplexer name in MAX or the CAN database. The message name must be followed by a decimal point. It applies only to mode dependent messages and must be omitted for normal CAN channels. If more than one multiplexer is defined for the message and the channel name is not unique within the CAN message, you must specify the multiplexer name to identify the channel uniquely.
- *mode_value* refers to the multiplexer mode in MAX or the CAN database. The *message name* must be followed by a decimal point. It applies only to mode dependent messages and must be omitted for normal CAN channels. If the channel name is not unique within the multiplexer, you must specify the mode to identify the channel uniquely.
- *channel* refers to the channel (signal) name in MAX or the CAN database.

You cannot use the same channel name for a normal CAN channel and a mode dependent CAN channel within the same CAN message.

If the name of a channel is unique within MAX or the database, it can be referenced by the channel API using its channel name.

For more information on mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

nctRead

Purpose

Read samples from a CAN task initialized with `Mode` of `nctModeInput`. Samples are obtained from received CAN messages. For an overview of `nctRead`, refer to the *Read* section of Chapter 6, *Using the Channel API*.

Format

```
nctTypeStatus    nctRead(
                     nctTypeTaskRef       TaskRef,
                     u32                  NumberOfSamplesToRead,
                     nctTypeTimestamp *   StartTime,
                     nctTypeTimestamp *   DeltaTime,
                     f64 *                SampleArray,
                     u32 *                NumberOfSamplesReturned);
```

Inputs

`TaskRef`

Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

The `Mode` initialized for the task must be `nctModeInput`.

`NumberOfSamplesToRead`

Specifies the number of samples to read for the task. For single-sample input, pass `1` to this parameter.

If the initialized `sample rate` is zero, you must pass `NumberOfSamplesToRead` no greater than `1`. `SampleRate` of zero means `nctRead` immediately returns a single sample from the most recent message(s) received.

Outputs

`StartTime`

Returns the time of the first CAN sample in `SampleArray`.

This parameter is optional. If you pass `NULL` for the `StartTime` parameter, the `nctRead` function proceeds normally.

If the initialized `sample rate` is greater than zero, the `StartTime` is determined by the sample timing.

If the initialized `SampleRate` is zero, the `StartTime` is zero, because the most recent sample is returned regardless of timing.

StartTime uses the nctTypeTimestamp data type. The nctTypeTimestamp data type is a 64-bit unsigned integer compatible with the Microsoft Win32 FILETIME type. This absolute time is kept in a Coordinated Universal Time (UTC) format. UTC time is loosely defined as the current date and time of day in Greenwich, England. Microsoft defines its UTC time (FILETIME) as a 64-bit counter of 100 ns intervals that have elapsed since 12:00 a.m., January 1, 1601. Because nctTypeTimestamp is compatible with Win32 FILETIME, you can pass it into the Win32 FileTimeToLocalFileTime function to convert it to the local time zone, and then pass the resulting local time to the Win32 FileTimeToSystemTime function to convert to the Win32 SYSTEMTIME type. SYSTEMTIME is a struct with fields for year, month, day, and so on. For more information on Win32 time types and functions, refer to the Microsoft Win32 documentation.

DeltaTime

Returns the time between each sample in SampleArray.

This parameter is optional. If you pass NULL for the DeltaTime parameter, the nctRead function proceeds normally.

If the initialized sample rate is greater than zero, the DeltaTime is determined by the sample timing.

If the initialized sample rate is zero, the DeltaTime is zero, because the most recent sample is returned regardless of timing.

DeltaTime uses the nctTypeTimestamp data type. The delta time is a relative 64-bit counter of 100 ns intervals, not an absolute UTC time. Nevertheless, you can use functions like the Win32 FileTimeToSystemTime function to convert to the Win32 SYSTEMTIME type. In addition, you can use the 32-bit LowPart of DeltaTime to obtain a simple 100 ns count, because SampleRates as slow as 0.4 Hz are still limited to a 32-bit 100 ns count.

SampleArray

Returns an array of arrays (2D array), one array for each channel initialized in the task. The array of each channel must have NumberOfSamplesToRead entries allocated.

For example, if you call nctInitStart with ChannelList of mych1,mych2,mych3, then call nctRead with NumberOfSamplesToRead of 10, SampleArray must be allocated as:

```
f64 SampleArray[3][10];
```

The order of channel entries in SampleArray is the same as the order in the original ChannelList.

If you need to determine the number of channels in the task after initialization, get the nctPropNumChannels property for the task reference.

If no message has been received since you started the task, the default value of the channel (nctPropChanDefaultValue) is returned in all entries of SampleArray.

NumberOfSamplesReturned

Indicates the number of samples returned for each channel in SampleArray. The remaining entries are left unchanged (zero).

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

Description

When using Mode of nctModeInput, you can specify channels in ChannelList that span multiple messages.

If the initialized SampleRate is greater than zero, this function returns an array of samples, each of which indicates the value of the CAN channel at a specific point in time. The nctRead function waits for these samples to arrive in time before returning. In other words, the SampleRate specifies a virtual clock that copies the most recent value from CAN messages for each sample time. The changes in sample values from message to message enable you to view the CAN channel over time, such as for comparison with other CAN or DAQ input channels. To avoid internal waiting, you can use nctGetProperty to obtain nctPropSamplesPending property, and pass that as the NumberOfSamplesToRead parameter to nctRead.

If the initialized SampleRate is zero, nctRead immediately returns a single sample from the most recent message(s) received. For this single-point read, you must pass the NumberOfSamplesToRead parameter as 1.

You can use the return value of nctRead to determine whether a new message has been received since the previous call to nctRead (or nctStart). If no message has been received,

the warning code `CanWarnOldData` is returned. If a new message has been received, the success code `0` is returned.

If no message has been received since you started the task, the default value of the channel (`nctPropChanDefaultValue`) is returned in all entries of `SampleArray`.

nctReadTimestamped

Purpose

Read samples from a CAN task initialized with `Mode` of `nctModeTimestampedInput`. For an overview of `nctReadTimestamped`, refer to the *Read Timestamped* section of Chapter 6, *Using the Channel API*.

Format

```
nctTypeStatus    nctReadTimestamped(
                     nctTypeTaskRef       TaskRef,
                     u32                  NumberOfSamplesToRead,
                     nctTypeTimestamp *   TimestampArray,
                     f64 *                SampleArray,
                     u32 *                NumberOfSamplesReturned);
```

Inputs

`TaskRef`

Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

The `Mode` initialized for the task must be `nctModeTimestampedInput`.

`NumberOfSamplesToRead`

Specifies the number of samples to read for the task.

Outputs

`TimestampArray`

Returns the time at which each corresponding sample in `SampleArray` was received in a CAN message.

The timestamps are returned as an array of arrays (2D array), one array for each channel initialized in the task. The array of each channel must have `NumberOfSamplesToRead` entries allocated.

For example, if you call `nctInitStart` with `ChannelList` of `mych1,mych2`, then call `nctReadTimestamped` with `NumberOfSamplesToRead` of `20`, both `TimestampArray` and `SampleArray` must be allocated as:

```
nctTypeTimestamp TimestampArray[2][20];
f64 SampleArray[2][20];
```

The order of channel entries in `TimestampArray` is the same as the order in the original `ChannelList`.

If you need to determine the number of channels in the task after initialization, get the nctPropNumChannels property for the task reference.

Each timestamp in TimestampArray uses the nctTypeTimestamp data type. The nctTypeTimestamp data type is a 64-bit unsigned integer compatible with the Microsoft Win32 FILETIME type. This absolute time is kept in a Coordinated Universal Time (UTC) format. UTC time is loosely defined as the current date and time of day in Greenwich, England. Microsoft defines its UTC time (FILETIME) as a 64-bit counter of 100 ns intervals that have elapsed since 12:00 a.m., January 1, 1601. Because nctTypeTimestamp is compatible with Win32 FILETIME, you can pass it into the Win32 FileTimeToLocalFileTime function to convert it to the local time zone, and then pass the resulting local time to the Win32 FileTimeToSystemTime function to convert to the Win32 SYSTEMTIME type. SYSTEMTIME is a struct with fields for year, month, day, and so on. For more information on Win32 time types and functions, refer to the Microsoft Win32 documentation.

SampleArray

Returns the sample value(s) for each received CAN message.

The samples are returned as an array of arrays (2D array), one array for each channel initialized in the task. The array of each channel must have NumberOfSamplesToRead entries allocated.

You must allocate SampleArray exactly as TimestampArray, and the order of channel entries is the same for both.

NumberOfSamplesReturned

Indicates the number of samples returned for each channel in SampleArray, and the number of timestamps returned for each channel in TimestampArray. The remaining entries are left unchanged (zero).

Return Value

The return value indicates the function call status as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

Description

Each returned sample corresponds to a received CAN message for the channels initialized in ChannelList. For each sample, nctReadTimestamped returns the sample value and a timestamp that indicates when the message was received.

When using Mode of nctModeTimestampedInput, you *cannot* specify channels in ChannelList that span multiple messages.

Because the timing of samples returned by nctReadTimestamped is determined by when the message is received, the initialized sample rate is not used.

The nctPropTimeout property determines whether this function waits for the NumberOfSamplesToRead messages to arrive from the network. The default value of nctPropTimeout is zero, but you can change it using the nctSetProperty function.

If nctPropTimeout is greater than zero, the function will wait for NumberOfSamplesToRead messages to arrive. If NumberOfSamplesToRead messages are not received before the nctPropTimeout expires, an error is returned.

If nctPropTimeout is zero, the function does not wait for messages, but instead returns samples from the messages received since the previous call to nctReadTimestamped. The number of samples returned is indicated in the NumberOfSamplesReturned output, up to a maximum of NumberOfSamplesToRead messages. If no new message has been received, NumberOfSamplesReturned is 0, and the return value indicates success.

nctSetProperty

Purpose

Set a property for the task, or a single channel within the task.

Format

```
nctTypeStatus    nctSetProperty(
                     nctTypeTaskRef    TaskRef,
                     cstr              ChannelName,
                     u32               PropertyId,
                     u32               SizeofValue,
                     void *            Value)
```

Inputs

`TaskRef`

Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

`ChannelName`

Specifies an individual channel within the task. If you pass `NULL` or empty-string to `ChannelName`, this means the property applies to the entire task, not a specific channel.

Properties that begin with the word *Channel* or *Message* do not apply to the entire task, but an individual channel or message within the task. For these channel-specific properties, you must pass the name of a channel from `ChannelList` into the `ChannelName` input.

For properties that do not begin with the word *Channel* or *Message*, you must pass empty-string (`""`) into `ChannelName`. You must not pass `NULL` into `ChannelName`.

`PropertyId`

Selects the property to set.

For a description of each property, including its data type and `PropertyId`, refer to the Properties section.

`SizeofValue`

Number of bytes provided for the `Value` output. This size will normally depend on the data type listed in the description of the property.

`Value`

Provides the property value. `PropertyId` determines the data type of the value.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

Description

You cannot set a property while the task is running. If you need to change a property prior to starting the task, you cannot use nctInitStart. First call nctInitialize, followed by nctSetProperty, and then nctStart. After you start the task, you also can change a property by calling nctStop, followed by nctSetProperty, and then nctStart again.

Properties

u32 nctPropBehavAfterFinalOut

The nctPropBehavAfterFinalOut property applies only to tasks initialized with mode of nctModeOutput, and sample rate greater than zero. The value specifies the behavior to perform after the final periodic sample is transmitted.

nctPropBehavAfterFinalOut uses the following values:

nctOutBehavRepeatFinalSample

Transmit messages for the final sample(s) repeatedly. The final messages are transmitted periodically as specified by SampleRate.

If there is significant delay between subsequent calls to nctWrite, this value means periodic messages continue between nctWrite calls, and messages with the data of the final sample are repeated on the network.

nctOutBehavRepeatFinalSample is the default value of the nctPropBehavAfterFinalOut property.

nctOutBehavCeaseTransmit

Cease transmit of messages until the next call to nctWrite.

If there is significant delay between subsequent calls to nctWrite, this value means periodic messages cease between nctWrite calls, and the data of the final sample is not repeated on the network.

`f64` `nctPropChanDefaultValue`

Sets the default value of the channel in scaled floating-point units.

For information on how the `nctPropChanDefaultValue` is used, refer to the `nctRead` and `nctWrite` functions.

The value of this property is originally set within MAX. If the channel is initialized directly from a CAN database, the value is `0.0` by default, but it can be changed using `nctSetProperty`.

`u32` `nctPropHwMasterTimebaseRate`

Sets the rate (in MHz) of the external clock that is exported to the CAN card.

The decimal values for this property are:

`20`

When synchronizing 2 CAN cards or synchronizing a CAN card with an E Series DAQ card, the 20 MHz master timebase rate is to be used. By default, this property is set to 20 MHz.

`10`

The master timebase rate should be set to 10 MHz when synchronizing a CAN card with an M Series DAQ card. The M Series DAQ card can export a 20 MHz clock but it does this by using one of its two counters.

If your CAN-DAQ application does not use the 2 DAQ counters then, you can leave the timebase rate set to 20 MHz (default).

This property can be set either before or after calling `nctConnectTerminals` to connect the **RTSI_CLK** to Master Timebase. However, this property must always be called prior to starting the task.

This property is applicable only to PCI and PXI Series 2 cards. For PCMCIA cards, setting this attribute will return an error. On PXI cards, if **PXI_CLK10** is routed to the Master Timebase, then the rate is fixed at 10 MHz (it over rides any previous setting of this property). Setting this property for Series 1 cards will also result in an NI-CAN error.

`u32` `nctPropHwTimestampFormat`

Sets the format of the timestamps reported by the on-board timer on the CAN card. The default value for this property is `Absolute`.

The values for this property are:

`0 (Absolute)`

Sets the timestamp format to absolute. In the absolute format, the timestamp returned by NI-CAN read functions is the LabVIEW date/time format (DBL representing the number of seconds elapsed since 12:00 a.m., Friday, January 1, 1904).

1 (Relative)

Sets the timestamp format to relative. In the relative format, the timestamp returned by the NI-CAN read functions will be zero based (DBL representing the number of seconds since the CAN controller for that task was started).

A typical use case for this property would be if data received from two RTSI synchronized CAN cards is to be correlated. For that use case, this property must be set to 1 for all of the CAN cards being synchronized. Setting this property on one port of a 2-port card will also reset the timestamp of the second port, since resetting the timestamp on the CAN port involves resets the on-board timer.

This property should be set prior to starting any tasks on the CAN card.

u32 nctPropIntfBaudRate

Sets the baud rate in use by the interface.

This property applies to all tasks initialized with the Interface.

You can specify the following basic baud rates as the numeric rate: 33333, 83333, 100000, 125000, 200000, 250000, 400000, 500000, 800000, and 1000000.

You can specify advanced baud rates as 8000*XXYY* hex, where *YY* is the value of Bit Timing Register 0 (BTR0), and *XX* is the value of Bit Timing Register 1 (BTR1). For more information, refer to the **Interface Properties** dialog in MAX.

The value of this property is originally set within MAX, but it can be changed using nctSetProperty.

u32 nctPropIntfListenOnly

Sets a Boolean value that indicates whether the listen only feature of the Philips SJA1000 CAN controller is enabled (1) or disabled (0).

This property applies to all tasks initialized with the interface.

If nctPropIntfListenOnly is 0, the Interface can transmit CAN messages; therefore the nctWrite function operates normally. When CAN messages are received by the Interface, those messages are acknowledged. Because disabled (0) is the behavior specified in the CAN specification, it is the default value of nctPropIntfListenOnly.

If nctPropIntfListenOnly is 1, the Interface *cannot* transmit CAN messages; therefore the nctWrite function returns an error. When CAN messages are received by the Interface, those messages are *not* acknowledged. The Philips SJA1000 CAN controller enters error passive state when listen only is enabled (but no error-passive warning is returned). The enabled (1) value of nctPropIntfListenOnly enables passive monitoring of network traffic, which can be useful for debugging scenarios in which only one device exists on the network.

Since the listen only feature requires the Philips STA1000 CAN controller, this property is supported on Series 2 NI CAN hardware only. If you are using Series 1 NI CAN hardware, an attempt to set this property returns error code `CanErrRequiresSeries2`.

`u32` `nctPropIntfSelfReception`

Specifies whether to echo successfully transmitted CAN frames as received frames. Each reception occurs just as if the frame were received from another CAN device. This enables you to initialize the same channels for both input and output.

For self reception to operate properly, another CAN node must receive and acknowledge each transmit.

False disables self reception mode (default), and True enables self reception mode.

The self reception mode is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware. For Series 1 hardware, this property must be left at its default (`False`).

`u32` `nctPropIntfSeries2Comp`

Specifies the filter comparator for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This property is not supported for Series 1 hardware (returns error).

This property specifies a comparator value that is checked against the ID, RTR, and data bits. The `nctPropIntfSeries2Mask` determines the applicable bits for comparison.

The default value of this property is zero.

The mapping of bits in this property to the ID, RTR, and data bits of incoming frames is determined by the value of the `nctPropIntfSeries2FilterMode` property. The Series 2 filter mode determines the format of this property as well as the Series 2 mask.

`u32` `nctPropIntfSeries2FilterMode`

All Series 2 hardware uses the Philips SJA1000 CAN controller. The Philips SJA1000 CAN controller provides sophisticated filtering of received frames. This property specifies the filtering mode, which is used in conjunction with the `nctPropIntfSeries2Mask` and `nctPropIntfSeries2Comp` properties.

This property is not supported for Series 1 hardware (returns error).

Since the format of the Series 2 filters is very specific to the Philips SJA1000 CAN controller, National Instruments cannot guarantee compatibility for this property on future hardware series. When using this property in the application, it is best to get the `nctPropHwSeries` property to verify that the CAN hardware is Series 2.

The filtering specified by the Series 2 filter properties applies to all input tasks for that interface. For example, if you specify filters that discard ID 5, then open an Input task to receive channels of ID 5, the task will not receive data.

The default value for this property is nctFilterSingleStandard.

The values for this property are summarized below. For detailed information on each value, including the format of the nctPropIntfSeries2Mask and nctPropIntfSeries2Comp properties for each mode, refer to NC_ATTR_SERIES2_FILTER_MODE (Series 2 Filter Mode) attribute in the ncConfig function of the Frame API.

nctFilterSingleStandard(Single Standard)

Filter all standard (11-bit) frames using a single mask/comparator filter.

nctFilterSingleExtended(Single Extended)

Filter all extended (29-bit) frames using a single mask/comparator filter.

nctFilterDualStandard(Dual Standard)

Filter all standard (11-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

nctFilterDualExtended(Dual Extended)

Filter all extended (29-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

u32 nctPropIntfSeries2Mask

Specifies the filter mask for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This property is not supported for Series 1 hardware (returns error).

This property specifies a bit mask that determines the ID, RTR, and data bits that are compared. If a bit is clear in the mask, the corresponding bit in the nctPropIntfSeries2Comp is checked. If a bit in the mask is set, that bit is ignored for the purpose of filtering (don't care).

The default value of this property is hex FFFFFFFF, which means that all messages are received.

The mapping of bits in this property to the ID, RTR, and data bits of incoming frames is determined by the value of the nctPropIntfSeries2FilterMode property. The Series 2 filter mode determines the format of this property as well as the Series 2 comparator.

u32 nctPropIntfSingleShotTx

Specifies whether to retry failed CAN frame transmissions (Series 2 only).

If nctPropIntfSingleShotTx is 0 (default), failed transmissions retry as defined in the CAN specification. If a CAN frame is not transmitted successfully, the CAN controller will immediately retry.

If nctPropIntfSingleShotTx is 1, all transmissions are single shot. If a CAN frame is not transmitted successfully, the CAN controller will not retry.

The single-shot transmit feature is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware (returns error).

u32 nctPropIntfTransceiverExternalOut

Sets the transceiver external outputs for the interface that was initialized for the task.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this property allows you to set the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you control the sleep mode of the on-board CAN controller chip.

For many models of CAN transceiver, EN and NSTB pins control the transceiver mode, such as whether the transceiver is sleeping, or communicating normally. For such transceivers, you can wire the EN and NSTB pins to the MODE0 and MODE1 pins of the CAN port.

The default value of this property is 00000003 hex. For many models of transceiver, this specifies normal communication mode for the transceiver and CAN controller chip. If the transceiver requires a different MODE0/MODE1 combination for normal mode, you can use external inverters to change the default 5 V to 0 V.

This property is supported for Series 2 XS cards only. This property is not supported when the nctPropIntfTransceiverType property is any value other than External. To control the mode of an internal transceiver, use the nctPropIntfTransceiverMode property.

This property uses a bit mask. Use bitwise OR operations to set multiple values.

nctTransceiverOutMode0 (00000001 hex, MODEO pin)

Set this bit to drive 5 V on the MODE0 pin. This is the default value. This bit is set automatically when a remote wakeup is detected. Clear this bit to drive 0 V on the MODE0 pin.

nctTransceiverOutMode1 (00000001 hex, MODE1 pin)

Set this bit to drive 5 V on the MODE1 pin. This is the default value. This bit is set automatically when a remote wakeup is detected. Clear this bit to drive 0 V on the MODE1 pin.

nctTransceiverOutSleep (00000100 hex, Sleep CAN controller chip)

Set this bit to place the CAN controller chip into sleep mode. This bit controls the mode of the CAN controller chip (sleep or normal), and the independent MODE0/MODE1 bits control the mode of the

external transceiver. When you set this bit to place the CAN controller into sleep mode, you typically specify MODE0/MODE1 bits that place the external transceiver into sleep mode as well.

When the CAN controller is asleep, a remote wakeup will automatically place the CAN controller into its normal mode of communication. In addition, the MODE0/MODE1 pins are restored to their default values of 5 V. Therefore, a remote wakeup causes this property to change from the value that you set for sleep mode, back to its default `00000003` hex. You can determine when this has occurred by getting `nctPropIntfTransceiverExternalOut` using `nctGetProperty`. For more information on remote wakeup, refer to the `nctPropIntfTransceiverMode` property for internal transceivers.

Clear this bit to place the CAN controller chip into normal communication mode. If the CAN controller was previously in sleep mode, this performs a local wakeup to restore communication.

`u32` `nctPropIntfTransceiverMode`

Sets the transceiver mode for the interface that was initialized for the task. The transceiver mode controls whether the transceiver is asleep or communicating, as well as other special modes.

This property is supported on Series 2 cards only.

For Series 2 cards for the PCMCIA form factor, this property requires a corresponding Series 2 cable (dongle). For information on how to identify the series of the PCMCIA cable, refer to the *Series 2 versus Series 1* subsection of the *NI CAN Hardware Overview* section of Chapter 1, *Introduction*.

For Series 2 XS cards, this property is not supported when the `nctPropIntfTransceiverType` property is External. To control the mode of an external transceiver, use the `nctPropIntfTransceiverExternalOut` property.

The default value for this property is **Normal**.

This property uses the following values:

`nctTransceiverModeNormal`

Set transceiver to normal communication mode. If you set **Sleep** mode previously, this performs a local wakeup of the transceiver and CAN controller chip.

`nctTransceiverModeSleep`

Set transceiver and the CAN controller chip to sleep (or standby) mode.

If the transceiver supports multiple sleep/standby modes, the NI CAN hardware implementation ensures that all of those modes are equivalent with regard to the

behavior of the transceiver on the network. For more information on the physical specifications of the **Normal** and **Sleep** modes for each transceiver, refer to Chapter 3, *NI CAN Hardware*.

You can set **Sleep** mode only while the interface is communicating. If at least one task for the interface has not been started (such as with `nctStart`), setting the transceiver mode to **Sleep** will return an error.

When the interface enters sleep mode, communication is not possible until a wakeup occurs. All pending frame transmissions are deferred until the wakeup occurs. The transceiver and CAN controller wake from sleep mode when either a local wakeup or remote wakeup occurs.

If you set **Sleep** mode when the CAN controller is actively transmitting a frame (that is, won arbitration), the interface will not enter **Sleep** mode until the frame is transmitted successfully (acknowledgement detected).

A *local wakeup* occurs when the application sets the transceiver mode to **Normal** (or some other communication mode).

A *remote wakeup* occurs when a remote node transmits a CAN frame (referred to as the *wakeup frame*). The wakeup frame wakes up the transceiver and CAN controller chip of the NI CAN interface. The wakeup frame is not received or acknowledged by the CAN controller chip. When the wakeup frame ends, the NI CAN interface enters **Normal** mode, and again receives and transmits CAN frames. If the node that transmitted the wakeup frame did not detect an acknowledgement (such as if other nodes were also waking), it will retry the transmission, and the retry will be received by the NI CAN interface.

For a remote wakeup to occur for Single Wire transceivers, the node that transmits the wakeup frame must first place the network into the **Single Wire Wakeup Transmission** mode by asserting a higher voltage (typically 12 V). For more information, refer to `nctTransceiverModeSWWakeup` mode.

When the local or remote wakeup occurs, frame transmissions resume from the point at which the original **Sleep** was set.

You can detect when a remote wakeup occurs by using `nctGetProperty` with the `nctPropIntfTransceiverMode` property.

`nctTransceiverModeSWWakeup`

Set Single Wire transceiver to **Wakeup Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire Wakeup Transmission** mode drives a higher voltage level on the network to wakeup all sleeping nodes. Other than this higher voltage, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

Since you use the **Single Wire Wakeup** mode to wakeup other nodes on the network, it is not typically used in combination with **Sleep** mode for a given interface.

The timing of how long the wakeup voltage is driven is controlled entirely by the application. The application will typically change to **Single Wire Wakeup** mode, transmit a wakeup frame, then return to **Normal** mode.

The following sequence demonstrates a typical sequence of steps for sleep and wakeup between two Single Wire NI CAN interfaces. The sequence assumes that **CAN0** is the sleeping node, and **CAN1** originates the wakeup.

1. Start both **CAN0** and **CAN1**. Both use the default **Normal** mode.
2. Set `nctPropIntfTransceiverMode` of **CAN0** to **Sleep**.
3. Set `nctPropIntfTransceiverMode` of **CAN1** to **Single Wire Wakeup**.
4. Write data to **CAN1** to transmit a wakeup frame to **CAN0**.
5. Set `nctPropIntfTransceiverMode` of **CAN1** to **Normal**.
6. Now both **CAN0** and **CAN1** are in **Normal** mode again.

`nctTransceiverModeSWHighSpeed`

Set Single Wire transceiver to **High-Speed Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire High-Speed Transmission** mode disables the internal waveshaping function of the transceiver, which allows baud rates up to 100 kbytes/s to be used. The disadvantage versus **Normal** (which allows up to 40 kbytes/s baud) is degraded EMC performance. Other than the disabled waveshaping, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

This mode has no relationship to High-Speed (HS) transceivers. It is merely a higher speed mode of the Single Wire (SW) transceiver, typically used for downloading large amounts of data to a node.

The Single Wire transceiver does not support use of this mode in conjunction with **Sleep** mode. For example, a remote wakeup cannot transition from **Sleep** to this **Single Wire High-Speed** mode.

`u32` `nctPropIntfTransceiverType`

For XS Software Selectable Physical Layer cards that provide a software-switchable transceiver, the `nctPropIntfTransceiverType` property sets the type of transceiver. When the transceiver is switched from one type to another, NI-CAN ensures that the switch is undetectable from the perspective of other nodes on the network.

The default value for this property is specified within MAX. If you change the transceiver type in MAX to correspond to the network in use, you can avoid setting this property within the application.

This property applies to all tasks initialized with the same `interface`.

You cannot set this property for Series 1 hardware, or for Series 2 hardware other than XS (fixed HS, LS, or SW cards).

This property uses the following values:

`nctTransceiverTypeHS`

Switch the transceiver to **High-Speed** (HS).

`nctTransceiverTypeLS`

Switch the transceiver to **Low-Speed/Fault-Tolerant** (LS).

`nctTransceiverTypeSW`

Switch the transceiver to **Single Wire** (SW).

`nctTransceiverTypeExternal`

Switch the transceiver to **External**. The **External** type allows you to connect a transceiver externally to the interface. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

When this transceiver type is selected, you can use the `nctPropIntfTransceiverExternalOut` and `nctPropIntfTransceiverExternalIn` properties to access the external mode and status pins of the connector.

`nctTransceiverTypeDisconnect`

Disconnect the CAN controller chip from the connector. This value is used when you physically switch an external transceiver. You first set `nctPropIntfTransceiverType` to `nctTransceiverTypeDisconnect`, then switch from one external transceiver to another, then set `nctPropIntfTransceiverType` to `nctTransceiverTypeExternal`. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

`u32 nctPropIntfVirtualBusTiming`

Sets the Virtual Bus Timing of the virtual device.

The values for this property are:

`FALSE (0)`

Virtual Bus Timing is turned off. By turning Virtual Bus Timing off, the CAN bus simulation is disabled and CAN frames are copied from the write queue of one virtual interface to the read queue of the second virtual interface. This setting is useful if you desire to only convert frames to channels or vice versa and not simulate actual CAN bus communication.

TRUE (1)

Virtual Bus Timing is turned on (default). By turning Virtual Bus Timing on, frame timestamps are recalculated as they transfer across the virtual bus. This mode is useful when you want the virtual bus to behave as much like a real bus as possible.

If this property is set on real hardware, an error will be returned.

The Virtual Bus Timing has to be set to the same value on both virtual interfaces.

This property must be set prior to starting the virtual interface. Refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*, for more information.

u32 nctPropMsgDistribution

Sets the nctPropMsgDistribution property which is used to determine if the CAN frames associated with a group of mode dependent channels are sent even-spaced or in burst mode.

nctDistrUniform

Transmits mode dependent messages uniformly (evenly spaced) on the network.

nctDistrBurst

Transmits mode dependent messages back to back on the network.

This property applies only to mode dependent channels that are transmitted periodically. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

f64 nctPropNoValue

Sets the value that is returned on timestamped read for mode dependent channels that have not been received with the most resent CAN frame associated with the CAN message. This property applies only to mode dependent channels that are read with the timestamped read operation. For more information about mode dependent channels, refer to the *Mode Dependent Channels* section of Chapter 6, *Using the Channel API*.

f64 nctPropTimeout

Sets a time in milliseconds to wait for samples. The default value is zero.

For all task configurations, nctPropTimeout specifies the time that Read will wait for the start trigger. If the application does not use nctConnectTerminals, the start trigger occurs when the task starts (nctStart). If you connect a start trigger from a RTSI line or other source, nctPropTimeout specifies the number of milliseconds to wait. nctPropTimeout of zero means to wait up to 10 seconds for the start trigger.

Usage of the nctPropTimeout property depends on the initialized mode of the task:

- nctModeOutput: For each nctModeOutput task, NI-CAN uses a buffer to store samples for transmit. If the number of samples you provide to nctWrite exceeds the size of the underlying buffer, NI-CAN waits for sufficient space to become

available (due to successful transmits). The nctPropTimeout specifies the number of milliseconds to wait for available buffer space. Timeout of zero means to wait up to 10 seconds.

- nctModeInput: The timeout value does *not* apply. For nctModeInput tasks initialized with SampleRate greater than zero, the NumberOfSamplesToRead input to nctRead implicitly specifies the time to wait. For nctModeInput tasks initialized with SampleRate equal to zero, the nctRead function always returns available samples immediately, without waiting.
- nctModeTimestampedInput: A timeout of zero means to return available samples immediately. A timeout greater than zero means nctRead will wait a maximum of nctPropTimeout milliseconds for NumberOfSamplesToRead samples to become available before returning.
- nctModeOutputRecent: The timeout value does not apply.

nctStart

Purpose

Start communication for the specified task.

Format

```
nctTypeStatus    nctStart(
                     nctTypeTaskRef    TaskRef);
```

Inputs

`TaskRef`	Task reference from the previous NI-CAN function. The task reference is originally returned from functions such as `nctInitialize`, or `nctCreateMessage`.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the `ncStatusToString` function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Description

You must start communication for a task to use `nctRead` or `nctWrite`. After you start communication, you can no longer change the configuration of the task with `nctSetProperty` or `nctConnectTerminals`.

nctStop

Purpose

Stop communication for the specified task.

Format

```
nctTypeStatus    nctStop(
                     nctTypeTaskRef    TaskRef);
```

Inputs

`TaskRef`	Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the `ncStatusToString` function of the Frame API to obtain a descriptive string for the return value. The `ncStatusToString` and `ncGetHardwareInfo` functions are the only Frame API functions that can be called within a Channel API application.

Description

This function stops communication so you can change the configuration of the task, such as by using `nctSetProperty` or `nctConnectTerminals`. After you change the configuration, use `nctStart` to start again.

This function does not clear the configuration for the task; therefore, do *not* use it as the last NI-CAN function in the application. The `nctClear` function must always be used as the last NI-CAN function for each task.

nctWrite

Purpose

Write samples to a CAN task initialized as `nctModeOutput`. Samples are placed into transmitted CAN messages. For an overview of `nctWrite`, refer to the *Write* section of Chapter 6, *Using the Channel API*.

Format

```
nctTypeStatus    nctWrite(
                     nctTypeTaskRef    TaskRef,
                     u32               NumberOfSamplesToWrite,
                     f64 *             SampleArray);
```

Inputs

`TaskRef`

Task reference from the previous NI-CAN function. The task reference is originally returned from `nctInitStart`, `nctInitialize`, or `nctCreateMessage`.

The `Mode` initialized for the task must be `nctModeOutput`.

`NumberOfSamplesToWrite`

Specifies the number of samples to write for the task. For single-sample output, pass `1` to this parameter.

`SampleArray`

Provides an array of arrays (2D array), one array for each channel initialized in the task. The array of each channel must have `NumberOfSamplesToWrite` samples.

For example, if you call `nctInitStart` with `ChannelList` of `mych1,mych2,mych3`, then call `nctWrite` with `NumberOfSamplesToWrite` of `10`, `SampleArray` must be allocated as:

```
f64 SampleArray[3][10];
```

You must provide a valid sample value in each entry of the arrays.

The order of channel entries in `SampleArray` is the same as the order in the original `ChannelList`.

To determine the number of channels in the task after initialization, get the `nctPropNumChannels` property for the task reference.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function of the Frame API to obtain a descriptive string for the return value. The ncStatusToString and ncGetHardwareInfo functions are the only Frame API functions that can be called within a Channel API application.

Description

The associated ChannelList determines the messages transmitted by nctWrite. If all channels are contained in a single message, only that message is transmitted. If a few channels are contained in one message, and the remaining channels are contained in a second message, then two messages are transmitted.

If the initialized sample rate is greater than zero, the task transmits associated CAN messages periodically at the specified rate. The first nctWrite transmits associated messages immediately using the first sample in the array of each channel, and then begins a periodic timer at the specified rate. Each subsequent transmission of messages is based on the timer, and uses the next sample in the array of each channel. After the final sample in the array of each channel has been transmitted, subsequent behavior is determined by the nctPropBehavAfterFinalOut property. The default nctPropBehavAfterFinalOut behavior is to retransmit the final sample each period until nctWrite is called again.

If the initialized SampleRate is zero, the task transmits associated messages immediately for each entry in the array of each channel, with as little delay as possible between messages. After the message for the final sample is transmitted, no further transmissions occur until nctWrite is called again, regardless of the nctPropBehavAfterFinalOut property.

Because all channels of a message are transmitted on the network as a unit, nctWrite enforces the following rules:

- You *cannot* write the same message in more than one nctModeOutput task.
- You *can* write more than one message in a single nctModeOutput task.
- You *can* write a subset of channels for a message in a single nctModeOutput task. For channels that are not included in the task, the channel default value (nctPropChanDefaultValue) is transmitted in the CAN message.

For many applications, the most straightforward technique is to assign a single nctModeOutput task for each message you want to transmit. In each task, include all

channels of that message in the `ChannelList`. This ensures you can provide new samples for the entire message with each `nctWrite`.

9

Using the Frame API

This chapter provides information to help you get started with the Frame API.

Choose Which Objects To Use

An application written for the NI-CAN Frame API communicates on the network by using various objects. Which Frame API objects to use depends largely on the needs of the application. The following sections discuss the objects provided by the Frame API, and reasons why you might use each class of object.

Using CAN Network Interface Objects

The CAN Network Interface Object encapsulates a physical interface to a CAN network, usually a CAN port on an AT, PCI, PCMCIA or PXI card.

You use the CAN Network Interface Object to read and write complete CAN frames. As a CAN frame arrives from over the network, it can be placed into the read queue of the CAN Network Interface Object. You can retrieve CAN frames from this read queue using the `ncRead` or `ncReadMult` function. The read functions provide a timestamp of when the frame was received, the arbitration ID of the frame, the type of frame (data, remote, or RTSI), the data length, and the data bytes. You also can use the CAN Network Interface Object to write CAN frames using the `ncWrite` function.

Some possible uses for the CAN Network Interface Object include the following:

- You can use the read queue to log all CAN frames transferred across the network. This log is useful when you need to view CAN traffic to verify that all CAN devices are functioning properly.
- You can use the write queue to transmit a sequence of CAN frames in quick succession.
- You can read and write CAN frames for access to configuration settings within a device. Because such settings generally are not

accessed during normal device operation, a dedicated CAN Object is not appropriate.

- For higher level protocols based on CAN, you can use sequences of write/read transactions to initialize communication with a device. In these protocols, specific sequences of CAN frames often need to be exchanged before you can access the data from a device. In such cases, you can use the CAN Network Interface Object to set up communication, then use CAN Objects for actual data transfer with the device.

In general, you use CAN Network Interface Objects for situations in which you need to transfer arbitrary CAN frames.

Using CAN Objects

The CAN Object encapsulates a specific CAN arbitration ID and its associated data.

Every CAN Object is always associated with a specific CAN Network Interface Object, used to identify the physical interface on which the CAN Object is located. The application can use multiple CAN Objects in conjunction with their associated CAN Network Interface Object.

The CAN Object provides high-level access to a specific arbitration ID. You can configure each CAN Object for different forms of background access. For example, you can configure a CAN Object to transmit a data frame every 100 milliseconds, or to periodically poll for data by transmitting a remote frame and receiving the data frame response. The arbitration ID, direction of data transfer, data length, and when data transfer occurs (periodic or unsolicited) are all preconfigured for the CAN Object. When you have configured and opened the CAN Object, data transfer is handled in the background using read and write queues. For example, if the CAN Object periodically polls for data, the NI-CAN driver automatically handles the periodic transmission of remote frames, and stores incoming data in the read queue of the CAN Object for later retrieval by the `ncRead` function. For CAN Objects that receive data frames, the `ncRead` function provides a timestamp of when the data frame arrived, and the data bytes of the frame. For CAN Objects that transmit data frames, the `ncWrite` function provides the outgoing data bytes.

Some possible uses for CAN Objects include the following:

- You can configure a CAN Object to periodically transmit a data frame for a specific arbitration ID. The CAN Object transmits the same data bytes repetitively until different data is provided using `ncWrite`.

- You can configure a CAN Object to watch for unsolicited data frames received for its arbitration ID, then store that data in the read queue of the CAN Object. A watchdog timeout is provided to ensure that incoming data is received periodically. This configuration is useful when you want to apply a timeout to data received for a specific arbitration ID and store that data in a dedicated queue. If you do not need to apply a timeout for a given arbitration ID, it is preferable to use the CAN Network Interface Object to receive that data.
- You can configure a CAN Object to periodically poll for data by transmitting a remote frame and receiving the data frame response. This configuration is useful for communication with devices that require a remote frame to transmit their data.
- You can configure a CAN Object to transmit a data frame whenever it receives a remote frame for its arbitration ID. You can use this configuration to simulate a device which responds to remote frames.

In general, you use CAN Objects for data transfer for a specific arbitration ID, especially when that data transfer needs to occur periodically.

Frame API Basic Programming Model

The following steps demonstrate how to use the Frame API functions in the application. The steps are shown in Figure 9-1 in flowchart form.

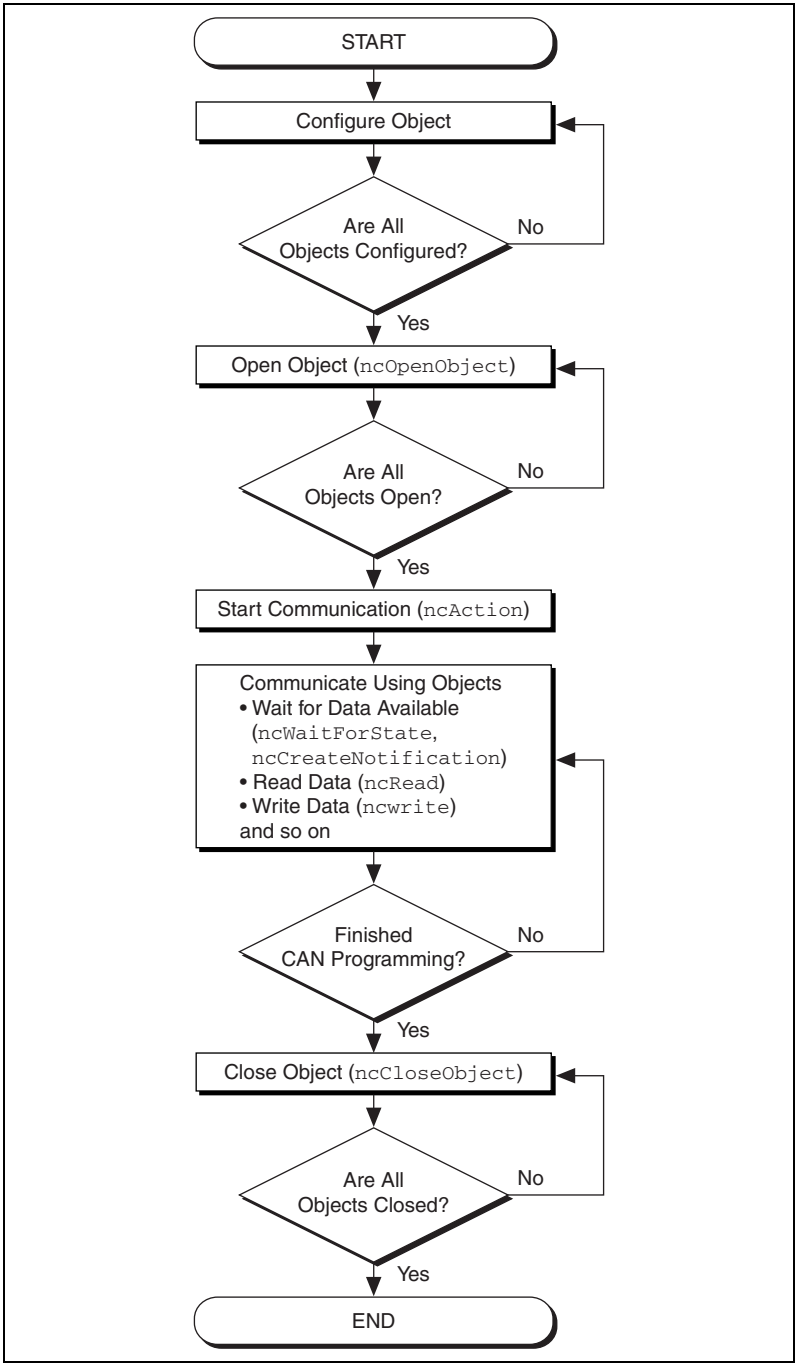


Figure 9-1. Programming Model for NI-CAN Frame API

Step 1. Configure Objects

Prior to opening the objects used in the application, you must configure the objects with their initial attribute settings. Each object is configured within the application by calling the `ncConfig` function. This function takes the name of the object to configure, along with a list of configuration attribute settings.

Step 2. Open Objects

You must call the `ncOpenObject` function to open each object you use within the application.

The `ncOpenObject` function returns a handle for use in all subsequent Frame API calls for that object. When you are using the LabVIEW function library, this handle is passed through the upper left and right terminals of each Frame API function used after the open.

Step 3. Start Communication

You must start communication on the CAN network before you can use the objects to transfer data.

If you configured the CAN Network Interface Object to start on open, that object and all of its higher level CAN Objects are started automatically by the `ncOpenObject` function, so nothing special is required for this step.

If you disabled the start-on-open attribute, when the application is ready to start communication, use the CAN Network Interface Object to call the `ncAction` function with the `Opcode` parameter set to `NC_OP_START`. This call is often useful when you want to use `ncWrite` to place outgoing data in write queues prior to starting communication. This call is also useful in high bus load situations, because it is more efficient to start communication after all objects have been opened.

Step 4. Communicate Using Objects

After you open the objects and start communication, you are ready to transfer data on the CAN network. The manner in which data is transferred depends on the configuration of the objects you are using. For this example, assume that you are communicating with a CAN device that periodically transmits a data frame. To receive this data, assume that a CAN Object is configured to watch for data frames received for its arbitration ID and store that data in its read queue.

Step 4a. Wait for Available Data

To wait for the arrival of a data frame from the device, you can call `ncWaitForState` with the `DesiredState` parameter set to `NC_ST_READ_AVAIL`. The `NC_ST_READ_AVAIL` state tells you that data for the CAN Object has been received from the network and placed into the read queue of the object.

When receiving data from the device, if the only requirement is to obtain the most recent data, you are not required to wait for the `NC_ST_READ_AVAIL` state. If this is the case, you can set the read queue length of the CAN Object to zero during configuration, so that it only holds the most recent data bytes. Then you can use the `ncRead` function as needed to obtain the most recent data bytes received.

Step 4b. Read Data

Read the data bytes using `ncRead`. For CAN Objects that receive data frames, `ncRead` returns a timestamp of when the data was received, followed by the actual data bytes (the number of which you configured in step 1).

Steps 4a and 4b should be repeated for each data value you want to read from the CAN device.

Step 5. Close Objects

When you are finished accessing the CAN devices, close all objects using the `ncCloseObject` function before you exit the application.

Additional Programming Topics

The following sections include information you can use to extend the basic programming model.

RTSI

The Frame API provides RTSI features that are lower level than the synchronization features of the Channel API. The following list describes some of the more commonly used RTSI features in the Frame API.

- You can configure the CAN Network Interface Object to log a special RTSI frame into the read queue when a RTSI input transitions from low to high. This RTSI frame is timestamped, so you can use it to

analyze the time of the RTSI pulse relative to the CAN frames on the network.

- You can configure the CAN Object to generate a RTSI output pulse when its ID is received. This allows you to trigger other products based on the reception of a specific CAN frame.
- You can configure the CAN Object to transmit a CAN frame when a RTSI input transitions from low to high. This allows you to transmit based on a functional unit in another product, such as a counter in an NI-DAQ or NI-DAQmx E Series MIO product.
- You can use `ncConnectTerminals` and the **Timestamp Format** attribute to synchronize multiple CAN cards by connecting timebases and start triggers. The `ncConnectTerminals` function provides additional RTSI features that can be used in conjunction with the object-based RTSI features described above.

For more information on RTSI configuration, refer to the `ncConfig` and `ncConnectTerminals` functions in this manual.

Remote Frames

The Frame API has extensive features to transmit and receive remote frames. The following list describes some of the more commonly used remote frame features in the Frame API.

- The CAN Network Interface Object can transmit arbitrary remote frames.
- If you are using Series 2 hardware or later, the CAN Network Interface Object can receive remote frames, such as to monitor bus traffic. Series 1 hardware uses the Intel 82527 CAN controller, which cannot receive arbitrary remote frames.
- You can configure a CAN Object to transmit a remote frame and receive the corresponding data frame. The remote frame can be transmitted periodically, based on a RTSI input, or each time you call `ncWrite`.
- You can configure a CAN Object to transmit a data frame in response to reception of the corresponding remote frame.

Using Queues

To maintain an ordered history of data transfers, NI-CAN supports the use of queues, also known as FIFO (first-in-first-out) buffers. The basic behavior of such queues is common to all NI-CAN objects.

There are two basic types of NI-CAN queues: the read queue and the write queue. NI-CAN uses the read queue to store incoming network data items in the order they arrive. You access the read queue using `ncRead` to obtain the data. NI-CAN uses the write queue to transmit network frames one at a time using the network interface hardware. You access the write queue using `ncWrite` to store network data items for transmission.

State Transitions

The `NC_ST_READ_AVAIL` state transitions from false to true when NI-CAN places a new data item into an empty read queue, and remains true until you read the last data item from the queue and the queue is empty.

The `NC_ST_READ_MULT` state transitions from false to true when the number of items in a queue exceeds a threshold. The threshold is set using the `NC_ATTR_NOTIFY_MULT_LEN` attribute. The `NC_ST_READ_MULT` state and `ncReadMult` function are useful in high-traffic networks in which data items arrive quickly.

The `NC_ST_WRITE_SUCCESS` state transitions from false to true when the write queue is empty and NI-CAN has successfully transmitted the last data item onto the network. The `NC_ST_WRITE_SUCCESS` state remains true until you write another data item into the write queue. When communication starts, the `NC_ST_WRITE_SUCCESS` state is true by default.

Empty Queues

For both read and write queues, the behavior for reading an empty queue is similar. When you read an empty queue, the previous data item is returned again. For example, if you call `ncRead` when `NC_ST_READ_AVAIL` is false, the data from the previous call to `ncRead` is returned again, along with the `CanWarnOldData` warning. If no data item has yet arrived for the read queue, a default data item is returned, which consists of all zeros. You should generally wait for `NC_ST_READ_AVAIL` prior to the first call to `ncRead`.

Full Queues

For both read and write queues, the behavior for writing a full queue is similar. When you write a full queue, NI-CAN returns the `CanErrOverflowWrite` error code. For example, if you write too many data items to a write queue, the `ncWrite` function eventually returns the overflow error.

Disabling Queues

If you do not need a complete history of all data items, you can disable the read queue and/or write queue by setting its length to zero. Zero length queues are typically used only with CAN objects, not the CAN Network Interface Object. Using zero length queues generally saves memory, and often results in better performance. When a new data item arrives for a zero length queue, it overwrites the previous item without indicating an overflow. The `NC_ST_READ_AVAIL` and `NC_ST_WRITE_SUCCESS` states still behave as usual, but you can ignore them if you want only the most recent data. For example, when NI-CAN writes a new data item to the read buffer, the `NC_ST_READ_AVAIL` state becomes true until the data item is read. If you only want the most recent data, you can ignore the `NC_ST_READ_AVAIL` state, as well as the `CanWarnOldData` warning returned by `ncRead`.

Using the CAN Network Interface Object with CAN Objects

For many applications, it is desirable to use a CAN Network Interface Object in conjunction with higher level CAN Objects. For example, you can use CAN objects to transmit data or remote frames periodically, and use the CAN Network Interface Object to receive all incoming frames.

When one or more CAN Objects are open, the CAN Network Interface Object cannot receive frames which would normally be handled by the CAN Objects. The flowchart in Figure 9-2 shows the steps performed by the Frame API when a CAN frame is received.

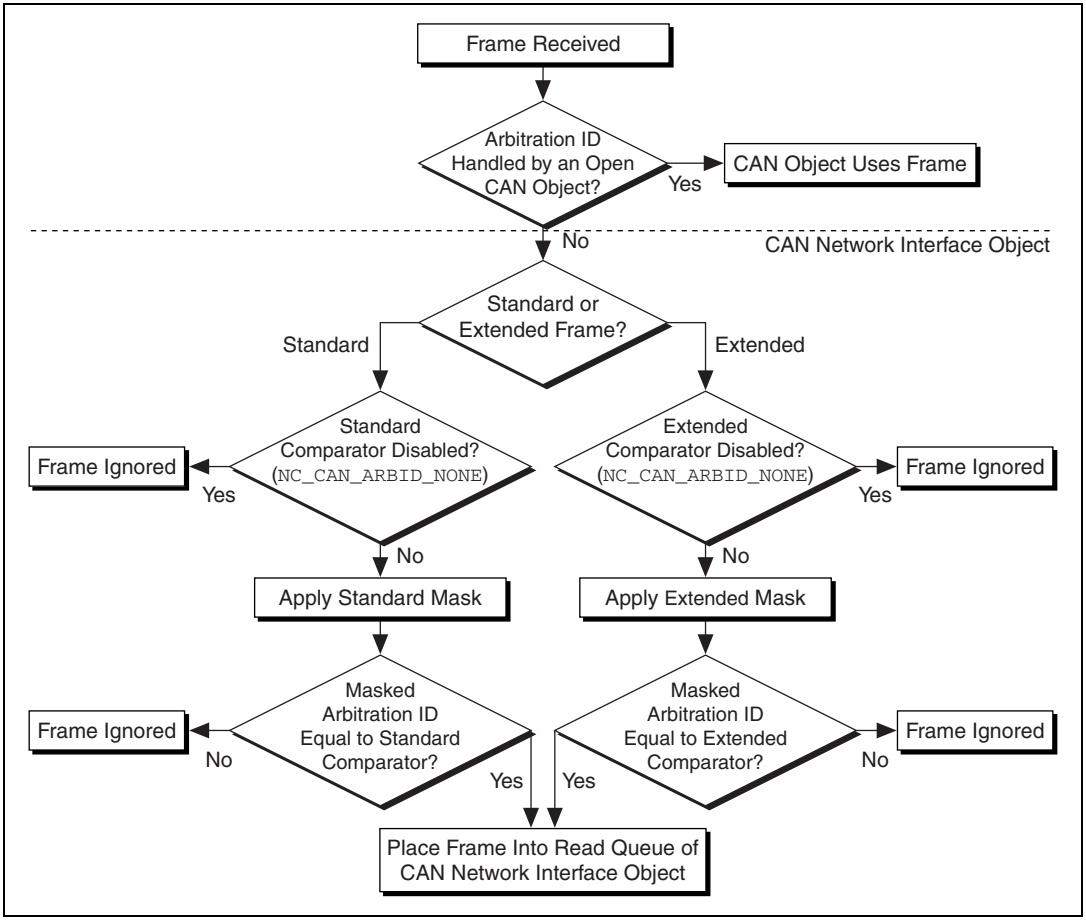


Figure 9-2. Flowchart for CAN Frame Reception

The decisions in Figure 9-2 are generally performed by the onboard CAN communications controller chip. Nevertheless, if you intend to use CAN Objects as the sole means of accessing the CAN bus, it is best to disable all frame reception in the CAN Network Interface Object by setting the comparator attributes to `NC_CAN_ARBID_NONE` (hex `CFFFFFFF`). By doing this, the CAN communications controller chip is best able to filter out all incoming frames except those handled by CAN Objects.

Detecting State Changes

You can detect state changes for an object using one of the following schemes:

- Call `ncWaitForState` to wait for one or more states to occur.
- Use `ncCreateNotification` in C/C++ to register a callback for one or more states.
- Use `ncCreateOccurrence` in LabVIEW to create an occurrence for one or more states.
- Call `ncGetAttribute` to get the `NC_ATTR_STATE` attribute.

Use the `ncWaitForState` function when the application must wait for a specific state before proceeding. For example, if you call `ncWrite` to write a frame, and the application cannot proceed until the frame is successfully transmitted, you can call `ncWaitForState` to wait for `NC_ST_WRITE_SUCCESS`.

Use the `ncCreateNotification` function in C/C++ when the application must handle a specific state, but can perform other processing while waiting for that state to occur. The `ncCreateNotification` function registers a callback function, which is invoked when the desired state occurs. For example, a callback function for `NC_ST_READ_AVAIL` can call `ncRead` and place the resulting data in a buffer. The application can then perform any tasks desired, and process the CAN data only as needed.

Use the `ncCreateOccurrence` function in LabVIEW when the application must handle a specific state, but can perform other processing while waiting for that state to occur. The `ncCreateOccurrence` function creates a LabVIEW occurrence, which is set when the desired state occurs. Occurrences are the mechanism used in LabVIEW to provide multithreaded execution.

Use the `ncGetAttribute` function when you need to determine the current state of an object.

Frame to Channel Conversion

Many applications require the ability to convert CAN data between a CAN *frame* and a CAN *channel*. For information on frame to channel conversion, channel to frame conversion, and virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

10

Frame API for LabVIEW

This chapter lists the LabVIEW VIs for the NI-CAN Frame API and describes the format, purpose, and parameters for each VI. The VIs in this chapter are listed alphabetically.

Unless otherwise stated, each NI-CAN VI suspends execution of the calling thread until it completes.

Section Headings

The following are section headings found in the Frame API for LabVIEW VIs.

Purpose

Each VI description includes a brief statement of the purpose of the VI.

Format

The format section describes the format of each VI.

Input and Output

The input and output parameters for each VI are listed.

Description

The description section gives details about the purpose and effect of each VI.

CAN Network Interface Object

The CAN Network Interface Object section gives details about using the VI with the CAN Network Interface Object.

CAN Object

The CAN Object section gives details about using the VI with the CAN Object.

List of VIs

The following table is an alphabetical list of the NI-CAN VIs for the Frame API.

Table 10-1. Frame API for LabVIEW VIs

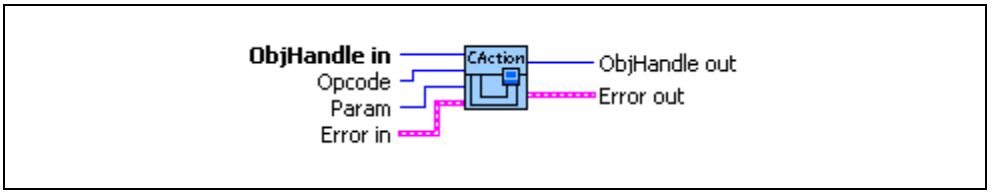
Function	Purpose
ncAction.vi	Perform an action on an object.
ncClose.vi	Close an object.
ncConfigCANNet.vi	Configure a CAN Network Interface Object before opening it.
ncConfigCANNetRTSI.vi	Configure a CAN Network Interface Object with RTSI features.
ncConfigCANObj.vi	Configure a CAN Object before using it.
ncConfigCANObjRTSI.vi	Configure a CAN Object with RTSI features.
ncConnectTerminals.vi	Connect terminals in the CAN hardware.
ncCreateOccur.vi	Create a LabVIEW occurrence for an object.
ncDisconnectTerminals.vi	Disconnect terminals in the CAN hardware.
ncGetAttr.vi	Get the value of an object attribute.
ncGetHardwareInfo.vi	Get NI-CAN hardware information.
ncGetTimer.vi	Get the absolute timestamp attribute.
ncOpen.vi	Open an object.
ncReadNet.vi	Read single frame from a CAN Network Interface Object.
ncReadNetMult.vi	Read multiple frames from a CAN Network Interface Object.
ncReadObj.vi	Read single frame from a CAN Object.
ncReadObjMult.vi	Read multiple frames from a CAN Object.
ncSetAttr.vi	Set the value of an object attribute.
ncWaitForState.vi	Wait for one or more states to occur in an object.
ncWriteNet.vi	Write a single frame to a CAN Network Interface Object.
ncWriteNetMult.vi	Write multiple frames to a CAN Network Interface Object.
ncWriteObj.vi	Write a single frame to a CAN Object.

ncAction.vi

Purpose

Perform an action on an object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

Opcode is the operation code indicating which action to perform. Refer to Tables 10-2 and 10-3.

Param is an optional parameter whose meaning is defined by **Opcode**.

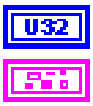
Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output



ObjHandle out is the object handle for the next NI-CAN VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

ncAction.vi is a general purpose VI you can use to perform an action on the object specified by **ObjHandle in**. Its normal use is to start and stop network communication on a CAN Network Interface Object.

NI-CAN provides VIs such as **ncOpen.vi** and **ncReadNet.vi** for the most frequently used and/or complex actions. **ncAction.vi** provides an easy, general purpose way to perform actions that are used less frequently or are relatively simple.

CAN Network Interface Object

NI-CAN propagates all actions on the CAN Network Interface Object up to all open CAN Objects.

Table 10-2 describes the actions supported by the CAN Network Interface Object.

Table 10-2. Actions Supported by the CAN Network Interface Object

Opcode	Param	Description
`Start`	N/A (ignored)	Transitions network interface from stopped (idle) state to started (running) state. If network interface is already started, this operation has no effect. When a network interface is started, it is communicating on the network. When you execute the Start action on a stopped CAN Network Interface Object, NI-CAN propagates it upward to all open higher-level CAN Objects. Thus, you can use it to start all higher-level network communication simultaneously.
`Stop`	N/A (ignored)	Transitions network interface from started state to stopped state. If network interface is already stopped, this operation has no effect. When a network interface is stopped, it is not communicating on the network. The Stop action clears all entries from the read queue of the Network Interface. When you execute the Stop action on a running CAN Network Interface Object, NI-CAN propagates it upward to all open higher-level CAN Objects.
`Reset`	N/A (ignored)	Resets network interface. The Reset action first issues the Stop action, then clears all entries from the write queue, then resets the CAN chip. Resetting the CAN chip sets the CAN error counters to zero, returning the CAN chip to error active state. The reset action is propagated up to all open higher-level CAN Objects.
`Output on RTSI line`	N/A (ignored)	Output a pulse or toggle on the RTSI line depending upon the **RTSI Behavior** attribute.

CAN Object

All actions performed on a CAN Object affect that CAN Object alone, and do not affect other CAN Objects or communication as a whole. Table 10-3 describes the actions supported by the CAN Object.

Table 10-3. Actions Supported by the CAN Object

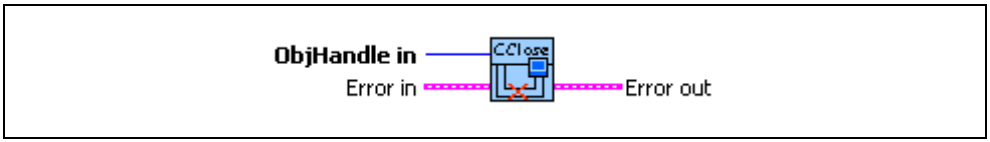
Opcode	Param	Description
`Start`	N/A (ignored)	Transitions the CAN object from stopped (idle) state to started (running) state. If the CAN object is already started, this operation has no effect.
`Stop`	N/A (ignored)	Stops the CAN Object. For example, if the CAN Object is configured to transmit data frames periodically, this action stops the periodic transmissions. This action will also clear all entries from the read queue.
`Reset`	N/A (ignored)	Resets the CAN Object. Stops the CAN Object, then clears all entries from read and write queues.
`Output on RTSI line`	N/A (ignored)	Output a pulse or toggle on the RTSI line depending upon the **RTSI Behavior** attribute.

ncClose.vi

Purpose

Close an object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. Unlike other NI-CAN VIs, this VI always closes the object, regardless of the value of **status**.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is

returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

ncClose.vi closes an object when it no longer needs to be in use, such as when the application is about to exit. When an object is closed, NI-CAN stops all pending operations and clears all configuration for the object (including RTSI), and the application can no longer use that specific **ObjHandle in**.

Unlike other NI-CAN VIs, this VI always closes the object, regardless of the **Status** in **Error In**.

CAN Network Interface Object

ObjHandle in refers to an open CAN Network Interface Object.

CAN Object

ObjHandle in refers to an open CAN Object.

ncConfigCANNet.vi

Purpose

Configure a CAN Network Interface Object before opening it.

Format

Input

ObjName is the name of the CAN Network Interface Object to configure. This name uses the syntax "CAN*x*", where *x* is a decimal number starting at zero that indicates the CAN network interface (**CAN0**, **CAN1**, up to **CAN63**). CAN network interface names are associated with physical CAN ports using the Measurement and Automation Explorer (MAX).

The Frame API and Channel API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Channel API, this function returns an error.

The special interface values 256 and 257 refer to virtual interfaces. For virtual interfaces, the only valid attribute is **Start On Open**. All other attributes in the config cluster are ignored. The mask and comparator attributes are always zero for virtual interfaces (receive all frames).

For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

CAN Network Interface Config provides the core configuration attributes of the CAN Network Interface Object. This cluster uses the typedef `ncNetAttr.ctl`. You can wire in the cluster by first placing it on the front panel from the NI-CAN Controls palette, or you can right-click the VI input and select **Create Constant** or **Create Control**.

Start On Open indicates whether communication starts for the CAN Network Interface Object (and all applicable CAN Objects) immediately upon opening the object with **ncOpen.vi**.
The default is TRUE, which starts communication when **ncOpen.vi** is called. If you set **Start On Open** to FALSE, you can call **ncSetAttr.vi** after opening the interface, then **ncAction.vi** to

start communication. **ncSetAttr.vi** can be used to set attributes that are not contained within **ncConfigCANNet.vi**.

Baud Rate is the baud rate to use for communication. Basic baud rates are supported, including 33333, 83333, 100000, 125000, 250000, 500000, and 1000000. If you are familiar with the Bit Timing registers used in CAN controllers, you can use a special hexadecimal baud rate of `0x8000zzyy`, where *yy* is the desired value for register 0 (BTR0), and *zz* is the desired value for register 1 (BTR1) of the CAN controller.

For the Frame API, the **Baud Rate** has no relationship with the baud rate property in MAX. You must always configure the **Baud Rate** with **ncConfigCANNet.vi**.

Read Queue Length is the maximum number of unread frames for the internal read queue of the CAN Network Interface Object. The recommended value is `100`.

The internal read queue exists between the CAN hardware and the NI-CAN device driver. This internal read queue holds frames temporarily prior to transfer a larger queue in the NI-CAN device driver. The larger NI-CAN device driver queue grows as needed in order to accommodate high bus loads.

For more information on reading from the CAN Network Interface Object, refer to **ncReadNetMult.vi**.

Write Queue Length is the maximum number of frames for the internal write queue of the CAN Network Interface Object awaiting transmission. The recommended value is `10`.

The internal write queue exists between the CAN hardware and the NI-CAN driver. This internal write queue holds frames temporarily prior to transfer to CAN hardware from a larger queue in the NI-CAN device driver.

For more information on writing to the CAN Network Interface object, refer to **ncWriteNetMult.vi**.

Standard Comparator is the CAN arbitration ID for the standard (11-bit) frame comparator. For information on how this attribute is used to filter received frames for the Network Interface, refer to the following **Standard Mask** attribute.

If you intend to open the Network Interface, most applications can set this attribute and the **Standard Mask** to `0` in order to receive all standard frames.

If you intend to use CAN Objects as the sole means of receiving standard frames from the network, you should disable all standard frame reception in the Network Interface by setting this attribute to the special value `CFFFFFFF` hex. With this setting, the Network Interface is best able to filter out incoming standard frames except those handled by CAN Objects.

Standard Mask is the bit mask used in conjunction with the **Standard Comparator** attribute for filtration of incoming standard (11-bit) CAN frames. For each bit set in the mask, NI-CAN compares the corresponding bit in the **Standard Comparator** to the arbitration ID of the received frame. If the mask/comparator matches, the frame is stored in the Network Interface queue, otherwise it is discarded. Bits in the mask that are clear are treated as don't-cares. For example, hex `00000700` means to compare only the three upper bits of the 11-bit standard ID.

If you set the **Standard Comparator** to `CFFFFFFF` hex, this attribute is ignored, because all standard frame reception is disabled for the Network Interface.

Most applications can set this attribute and the **Standard Comparator** to `0` to receive all standard frames. This is particularly advisable for Series 2 hardware, because the Philips SJA1000 CAN controller does not support distinct filters for standard and extended IDs. For Series 2, nonzero values for this attribute are implemented in software, as an additional filter applied after the **Series 2 Filter Mode**. When you set this attribute to zero for Series 2, filtering is optimized to use only the **Series 2 Filter Mode** attribute for the SJA1000.

Extended Comparator is the CAN arbitration ID for the extended (29-bit) frame comparator. For information on how this attribute is used to filter extended frames for the Network Interface, refer to the following **Extended Mask** attribute.

If you intend to open the Network Interface, most applications can set this attribute and the **Extended Mask** to `0` in order to receive all extended frames.

If you intend to use CAN Objects as the sole means of receiving extended frames from the network, you should disable all extended frame reception in the Network Interface by setting this attribute to the special value CFFFFFFF hex. With this setting, the Network Interface is best able to filter out incoming extended frames except those handled by CAN Objects.

Extended Mask is the bit mask used in conjunction with the **Extended Comparator** attribute for filtration of incoming extended (29-bit) CAN frames. For each bit set in the mask, NI-CAN compares the corresponding bit in the **Extended Comparator** to the arbitration ID of the received frame. If the mask/comparator matches, the frame is stored in the Network Interface queue, otherwise it is discarded. Bits in the mask that are clear are treated as don't-cares. For example, hex 1F000000 means to compare only the five upper bits of the 29-bit extended ID.

If you set the **Extended Comparator** to CFFFFFFF hex, this attribute is ignored, because all extended frame reception is disabled for the Network Interface.

Most applications can set this attribute and the **Extended Comparator** to 0 to receive all extended frames. This is particularly advisable for Series 2 hardware, because the Philips SJA1000 CAN controller does not support distinct filters for standard and extended IDs. For Series 2, nonzero values for this attribute are implemented in software, as an additional filter applied after the **Series 2 Filter Mode**. When you set this attribute to zero for Series 2, filtering is optimized to use only the **Series 2 Filter Mode** attribute for the SJA1000.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The Network Interface provides read/write access to all IDs on the network.

If you intend to use RTSI features to synchronize the Network Interface with other National Instruments cards, refer to **ncConfigCANNetRTSI.vi**.

If you need to log transceiver fault indications to the Network Interface read queue, refer to the **Log Comm Warnings** attribute of **ncSetAttr.vi**.

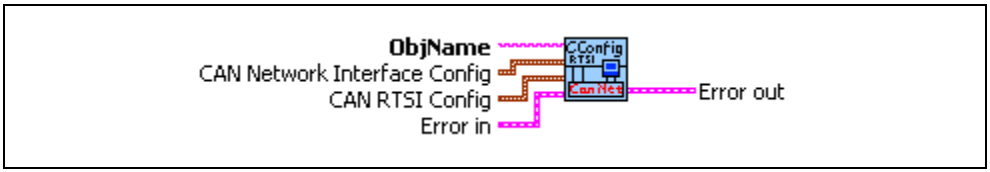
The first NI-CAN VI in the application will normally be **ncConfigCANNet.vi**.

ncConfigCANNetRTSI.vi

Purpose

Configure a CAN Network Interface Object with RTSI features.

Format



Input

ObjName is the name of the CAN Network Interface Object to configure. This name uses the syntax "CAN*x*", where *x* is a decimal number starting at zero that indicates the CAN network interface (**CAN0**, **CAN1**, up to **CAN63**). CAN network interface names are associated with physical CAN ports using the Measurement and Automation Explorer (MAX).

CAN Network Interface Config provides the core configuration attributes of the CAN Network Interface Object. This cluster uses the typedef `ncNetAttr.ctl`. You can wire in the cluster by first placing it on the front panel from the NI-CAN **Controls** palette, or you can right-click the VI input and select **Create Constant** or **Create Control**. For more information, refer to **ncConfigCANNet.vi**.

CAN RTSI Config provides RTSI configuration attributes for the CAN Network Interface Object. This cluster uses the typedef `ncCANRtsiAttr.ctl`. You can wire in the cluster by first placing it on the front panel from the NI-CAN Controls palette, or you can right-click the VI input and select **Create Constant** or **Create Control**.

RTSI Mode specifies the behavior of the Network Interface with respect to RTSI, including whether the RTSI signal is an input or output.

Disable RTSI

Disables RTSI behavior for the Network Interface. All other RTSI attributes are ignored. Using this mode is equivalent to calling **ncConfigCANNet.vi**.

On RTSI Input - Transmit CAN Frame

The Network Interface will transmit a frame from its write queue when the RTSI input transitions from low to high. To begin transmission, at least one data frame must be written using **ncWriteNet.vi**. If the write queue becomes empty due to frame transmissions, the last frame will be transmitted on each RTSI pulse until another frame is provided using **ncWriteNet.vi**.

On RTSI Input - Timestamp RTSI event

When the RTSI input transitions from low to high, a timestamp is measured and stored in the read queue of the Network Interface. The special RTSI frame uses the following format:

Arbitration ID: `40000001` hex

Timestamp: Time when RTSI input transitioned from low-to-high

IsRemote: `3`

DataLength: RTSI signal detected (**RTSI Signal**)

Data: N/A (ignore)

When calling **ncReadNet.vi** or **ncReadNetMult.vi** to read frames from the Network Interface, you typically use the **IsRemote** field to differentiate RTSI timestamps from CAN frames. Refer to **ncReadNetMult.vi** for more information.

Note When you configure a DAQ card to pulse the RTSI signal periodically, do not exceed 1,000 Hertz (pulse every millisecond). If the RTSI input is pulsed faster than 1kHz on a consistent basis, CAN performance will be adversely affected (for example, lost data frames).

RTSI Output on Receiving CAN Frame

The Network Interface will output the RTSI signal whenever a CAN frame is stored in the read queue.

If the hardware is Series 2, NI-CAN connects a special pin of the Philips SJA1000 CAN controller to the RTSI output. This hardware connection provides jitter in the nanoseconds range, enabling triggering of external oscilloscopes and so on.

RTSI Output on Transmitting CAN Frame

The Network Interface will output the RTSI signal whenever a CAN frame is successfully transmitted from the write queue.

RTSI Output on ncAction.vi call

The Network Interface will output the RTSI signal whenever **ncAction.vi** is called with **Opcode** Output on RTSI line. This RTSI mode can be used to manually toggle/pulse a RTSI output within the application.

RTSI Signal defines the RTSI signal associated with the **RTSI Mode**. Valid values are `0` to `6`, corresponding to **RTSI0** to **RTSI6** on other National Instruments cards.

Series 1 and 2 CAN cards each have limitations regarding RTSI. For information on these limitations, refer to the *Valid Combinations of Source/Destination* section in the **CAN Connect Terminals.vi** function of the Channel API for LabVIEW.

RTSI Behavior specifies whether to pulse or toggle a RTSI output. This attribute is ignored when **RTSI Mode** specifies input (which are always detected low to high):

Output RTSI Pulse:	Pulse the RTSI output. For Series 1 CAN cards, the pulse is at least 100 µs. For Series 2 CAN cards, the pulse is at least 100 ns.
Toggle RTSI Line:	If the previous state was high, the output toggles low, then vice-versa.

RTSI Skip specifies the number of RTSI inputs (low-to-high transitions) to skip for **RTSI Mode** On RTSI Input - Timestamp RTSI event, and On RTSI Input - Transmit CAN Frame. It is ignored for all other **RTSI Mode** values. For example, if the RTSI input transitions every 1ms, **RTSI Skip** of `9` means that a timestamp will be stored in the read queue every 10ms.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

RTSI is a bus that interconnects National Instruments DAQ, IMAQ, Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. Refer to Chapter 3, *NI CAN Hardware*, for more details on the RTSI hardware connector.

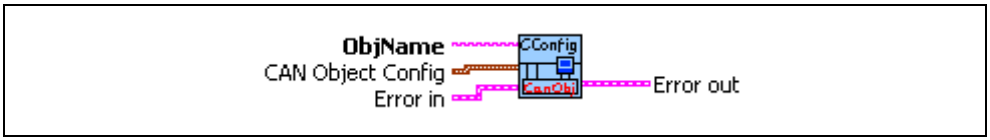
If you are not using RTSI features to synchronize the Network Interface with other National Instruments cards, refer to **ncConfigCANNet.vi**.

ncConfigCANObj.vi

Purpose

Configure a CAN Object before using it.

Format



Input

ObjName is the name of the CAN Object to configure. This name uses the syntax “CAN*x*::STD*y*” or “CAN*x*::XTD*y*”. CAN*x* is the name of the CAN network interface that you used for the preceding **ncConfigCANNet.vi** call. STD indicates that the CAN Object uses a standard (11-bit) arbitration ID. XTD indicates that the CAN Object uses an extended (29-bit) arbitration ID. The number *y* specifies the actual arbitration ID of the CAN Object. The number *y* is decimal by default, but you also can use hexadecimal by adding “0x” to the beginning of the number. For example, “CAN0::STD25” indicates standard ID 25 decimal on **CAN0**, and “CAN1::XTD0x0000F652” indicates extended ID F652 hexadecimal on **CAN1**.

The special virtual interface names “CAN256” and “CAN257” are not supported for CAN Objects.

CAN Object Config provides the core configuration attributes of the CAN Object. This cluster uses the typedef `ncObjAttr.ctl`. You can wire in the cluster by first placing it on the front panel from the NI-CAN Controls palette, or you can right-click the VI input and select **Create Constant** or **Create Control**.

Period specifies the rate of periodic behavior in milliseconds.

The behavior depends on the **Communication Type** as follows:

Transmit Data Periodically,
Transmit Periodic Waveform,
Receive Periodic Using Remote

Period specifies the time between subsequent transmissions, and must be set greater than zero.

Receive Unsolicited,
Transmit by Response Only

Period specifies a watchdog timeout. If a frame is not received at least once every period, a timeout error is returned. Setting **Period** to zero disables the watchdog timer.

Transmit Data by Call,
Receive by Call Using Remote

Period specifies a minimum interval between subsequent transmissions. Even if **ncWriteObj.vi** is called very frequently, frames are transmitted on the network at a rate no more than **Period**. Setting **Period** to zero disables the minimum interval timer.

Read Queue Length is the maximum number of unread frames for the read queue of the CAN Object. For more information, refer to **ncReadObj.vi**.

If **Communication Type** is set to receive data, a typical value is `10`. If **Communication Type** is set to transmit data, a typical value is `0`.

Write Queue Length is the maximum number of frames for the write queue of the CAN Object awaiting transmission. For more information, refer to **ncWriteObj.vi**.

If **Communication Type** is set to receive data, a typical value is `0`. If **Communication Type** is set to transmit data, a typical value is `10`.

Receive Changes Only applies only to **Communication Type** selections in which the CAN Object receives data frames (ignored for other types). For those configurations, **Receive Changes Only** specifies whether duplicated data should be placed in the read queue. When set to FALSE (default), all data frames for the CAN Object ID are placed in the read queue. When set to TRUE, data frames are placed into the read queue only if the data bytes differ from the previously received data bytes in the read queue.

This attribute has no effect on the usage of a watchdog timeout for the CAN Object. For example, if this attribute is TRUE and you

also specify a watchdog timeout, NI-CAN restarts the watchdog timer every time it receives a data frame for the ID of the CAN Object, regardless of whether the data differs from the previous frame.

Communication Type specifies the behavior of the CAN Object with respect to its ID, including the direction of data transfer:

Receive Unsolicited

Receive data frames for a specific ID.

This type is useful for receiving a few IDs (1–10) into dedicated read queues. For high performance applications (more IDs, fast frame rates), the Network Interface is recommended to receive all IDs.

Period specifies a watchdog timeout, and **Receive Changes Only** specifies whether to place duplicate data frames into the read queue. **Transmit by Response** is ignored.

Receive Periodic Using Remote

Periodically transmit remote frame for a specific ID in order to receive the associated data frame. Every **Period**, the CAN Object transmits a remote frame, and then places the resulting data frame response in the read queue.

If the data frame is not received in response to the transmit remote frame, the periodic transmission is put on hold.

Period specifies the periodic rate, and **Receive Changes Only** specifies whether to place duplicate data frames into the read queue. **Transmit by Response** is ignored.

Receive by Call Using Remote

Transmit remote frame for a specific ID by calling **ncWriteObj.vi**. The CAN Object places the resulting data frame response in the read queue.

Period specifies a minimum interval, and **Receive Changes Only** specifies whether to place duplicate data frames into the read queue. **Transmit by Response** is ignored.

Transmit Data Periodically

Periodically transmit data frame for a specific ID. When the CAN Object transmits the last entry from the write queue, that entry is used every period until you provide a new data frame using **ncWriteObj.vi**. If you keep the write queue filled with unique data, this behavior allows you to ensure that each period transmits a unique data frame.

If the write queue is empty when communication starts, the first periodic transmit does not occur until you provide the first data frame with **ncWriteObj.vi**.

Period specifies the periodic rate, and **Transmit by Response** specifies whether to transmit the data of the previous period in response to a remote frame. If **Transmit by Response** is true, the data from the previous (periodic) transmit will be retransmitted in case a remote frame is received, even if there are frames pending in the write buffer. **Receive Changes Only** is ignored.

Transmit by Response Only

Transmit data frame for a specific ID only in response to a received remote frame. When you call **ncWriteObj.vi**, the data is placed in the write queue, and remains there until a remote frame is received.

Period specifies a watchdog timeout. **Transmit by Response** is assumed as TRUE regardless of the attribute setting. **Receive Changes Only** is ignored.

Transmit Data by Call

Transmit data frame when **ncWriteObj.vi** is called. When **ncWriteObj.vi** is called quickly, data frames are placed in the write queue for back to back transmit.

Period specifies a minimum interval, and **Transmit by Response** specifies whether to transmit the previous data frame in response to a remote frame. **Receive Changes Only** is ignored.

Transmit Periodic Waveform

Transmit a fixed sequence of data frames over and over, one data frame every **Period**.

The following steps describe typical usage of this type.

1. Configure CAN Network Interface Object with **Start On Open** FALSE, then open the Network Interface.
2. Configure the CAN Object as **Transmit Periodic Waveform** and a nonzero **Write Queue Length**, then open the CAN Object.
3. Call **ncWriteObj.vi** for the CAN Object, once for every entry specified for the **Write Queue Length**.
4. Use **ncAction.vi** to start the Network Interface (not the CAN Object). The CAN Object transmits the first frame in the write queue, then waits the specified period, then transmits the second frame, and so on. After the last frame is transmitted, the CAN Objects waits the specified period, then transmits the first frame again.

If you need to change the waveform contents at runtime, or if you need to transmit very large waveforms (more than 100 frames), we recommend using the **Transmit Data Periodically** type. Using that type, you can write frames to the Write Queue until full (overflow error), then wait some time for a few frames to transmit, then continue writing new frames.

This communication type has the following limitations:

- **Write Queue Length** must be greater than zero.
- You must write exactly **Write Queue Length** values before starting communication (no less).
- Once communication is started, you cannot write additional values.

Period specifies the periodic rate. **Transmit by Response** and **Receive Changes Only** are ignored.

Transmit By Response applies only to **Communication Type** of **Transmit Data by Call** and **Transmit Data Periodically** (ignored for other types). For those configurations, **Transmit By**

Response specifies whether the CAN Object should automatically respond with the previously transmitted data frame when it receives a remote frame. When set to FALSE (default), the CAN Object transmits data frames only as configured, and ignores all remote frames for its ID. When set to TRUE, the CAN Object responds to incoming remote frames.

U32

Data Length specifies the number of bytes in the data frames for the ID of this CAN Object. This number is placed in the Data Length Code (DLC) of all transmitted data frames and remote frames for the CAN Object. This is also the number of data bytes returned from **ncReadObj.vi** when the communication type indicates receive.

Examples of Different Communication Types

The following figures demonstrate how you can use the **Communication Type** attribute for actual network data transfer. Each figure shows two separate NI-CAN applications that are physically connected across a CAN network.

Figure 10-1 shows a CAN Object that periodically transmits data to another CAN Object. The receiving CAN Object can queue up to five data values.

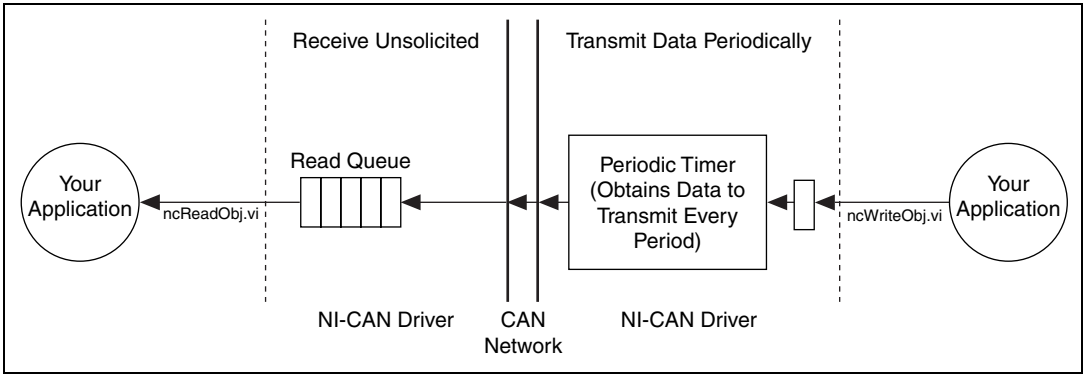


Figure 10-1. Example of Periodic Transmission

Figure 10-2 shows a CAN Object that polls data from another CAN Object. NI-CAN transmits the CAN remote frame when you call **ncWriteObj.vi**.

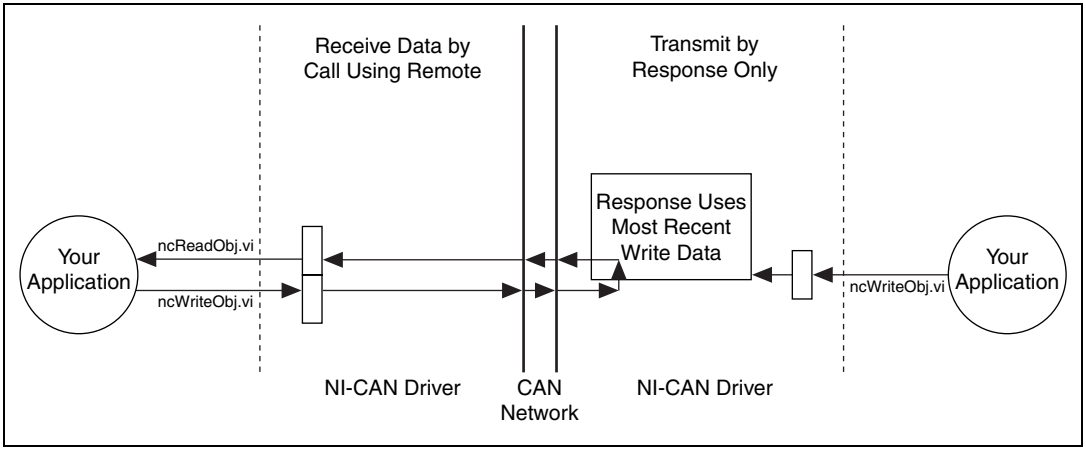


Figure 10-2. Example of Polling Remote Data Using ncWriteObj.vi

Figure 10-3 shows a CAN Object that polls data from another CAN Object. NI-CAN transmits the remote frame periodically and places only changed data into the read queue.

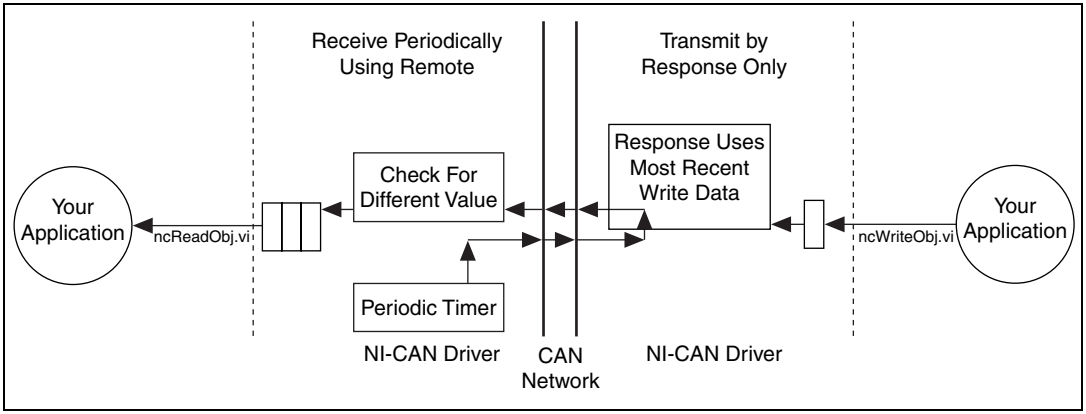


Figure 10-3. Example of Periodic Polling of Remote Data

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI

executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

The CAN Object provides read/write access to a specific ID on the network.

You normally call **ncConfigCANNet.vi** before this VI in order to configure the Network Interface attributes, then call **ncConfigCANObj.vi** for each CAN Object desired.

If you intend to use RTSI features to synchronize the CAN Object with other National Instruments cards, refer to **ncConfigCANObjRTSI.vi**.

When a network frame is transmitted on a CAN-based network, it always begins with the arbitration ID. This arbitration ID is primarily used for collision resolution when more than one frame is transmitted simultaneously, but often is also used as a simple mechanism to identify data. The CAN arbitration ID, along with its associated data, is referred to as a CAN Object.

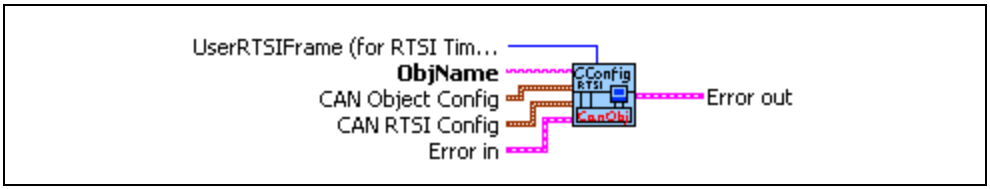
The NI-CAN implementation of CAN provides high-level access to CAN Objects on an individual basis. You can configure each CAN Object for different forms of communication (such as periodic polling, receiving unsolicited CAN data frames, and so on). After you configure a CAN Object and open it for communication, use **ncReadObj.vi** and **ncWriteObj.vi** to access the data of the CAN Object. The NI-CAN driver performs all other details regarding the object.

ncConfigCANObjRTSI.vi

Purpose

Configure a CAN Object with RTSI features.

Format



Input

ObjName is the name of the CAN Object to configure. This name uses the syntax "CAN*x*::STD*y*" or "CAN*x*::XTD*y*". CAN*x* is the name of the CAN network interface that you used for the preceding **ncConfigCANNet.vi** call. STD indicates that the CAN Object uses a standard (11-bit) arbitration ID. XTD indicates that the CAN Object uses an extended (29-bit) arbitration ID. The number *y* specifies the actual arbitration ID of the CAN Object. The number *y* is decimal by default, but you also can use hexadecimal by adding "0x" to the beginning of the number. For example, "CAN0::STD25" indicates standard ID 25 decimal on **CAN0**, and "CAN1::XTD0x0000F652" indicates extended ID F652 hexadecimal on **CAN1**.

CAN Object Config provides the core configuration attributes of the CAN Object. This cluster uses the typedef `ncObjAttr.ctl`. You can wire in the cluster by first placing it on the front panel from the NI-CAN Controls palette, or you can right-click the VI input and select **Create Constant** or **Create Control**. For more information, refer to **ncConfigCANObj.vi**.

CAN RTSI Config provides RTSI configuration attributes for the CAN Object. This cluster uses the typedef `ncCANRtsiAttr.ctl`. You can wire in the cluster by first placing it on the front panel from the NI-CAN Controls palette, or you can right-click the VI input and select **Create Constant** or **Create Control**.

RTSI Mode specifies the behavior of the CAN Object with respect to RTSI, including whether the RTSI signal is an input or output.

Disable RTSI

Disables RTSI behavior for the CAN Object. All other RTSI attributes are ignored. Using this mode is equivalent to calling **ncConfigCANObj.vi**.

On RTSI Input - Transmit CAN Frame

The CAN Object will transmit a frame from its write queue when the RTSI input transitions from low to high. To begin transmission, at least one data frame must be written using **ncWriteObj.vi**. If the write queue becomes empty due to frame transmissions, the last frame will be transmitted on each RTSI pulse until another frame is provided using **ncWriteObj.vi**.

In order to use this **RTSI Mode**, you must configure the **Communication Type** of this CAN Object to either **Transmit Data by Call**, **Transmit Data Periodically**, or **Transmit Periodic Waveform**. The **Period** attribute is ignored when this RTSI mode is selected.

On RTSI Input - Timestamp RTSI event

When the RTSI input transitions from low to high, a timestamp is measured and stored in the read queue of the CAN Object. The special RTSI frame uses the following format:

Timestamp:	Time when RTSI input transitioned from low to high
Data:	User-defined 4 byte data pattern (refer to **UserRTSIFrame** for details)

Note When you configure a DAQ card to pulse the RTSI signal periodically, do not exceed 1,000 Hertz (pulse every millisecond). If the RTSI input is pulsed faster than 1kHz on a consistent basis, CAN performance will be adversely affected (for example, lost data frames).

RTSI Output on Receiving CAN Frame

The CAN Object will output the RTSI signal whenever a CAN frame is stored in the read queue.

In order to use this **RTSI Mode**, you must configure the **Communication Type** of this CAN Object to **Receive Unsolicited**.

RTSI Output on Transmitting CAN Frame

The CAN Object will output the RTSI signal whenever a CAN frame is successfully transmitted.

In order to use this **RTSI Mode**, you must configure the **Communication Type** of this CAN Object to either **Transmit Data by Call**, **Transmit Data Periodically**, or **Transmit Periodic Waveform**.

RTSI Output on ncAction.vi call

The CAN Object will output the RTSI signal whenever **ncAction.vi** is called with Opcode Output on RTSI line. This RTSI mode can be used to manually toggle/pulse a RTSI output within the application.

RTSI Signal defines the RTSI signal associated with the **RTSI Mode**. Valid values are `0` to `6`, corresponding to **RTSI0** to **RTSI6** on other National Instruments cards.

Series 1 and 2 CAN cards each have limitations regarding RTSI. For information on these limitations, refer to the *Valid Combinations of Source/Destination* section in the **CAN Connect Terminals.vi** function of the Channel API for LabVIEW.

RTSI Behavior specifies whether to pulse or toggle a RTSI output. This attribute is ignored when **RTSI Mode** specifies input (always detected low to high):

Output RTSI Pulse:	Pulse the RTSI output. For Series 1 CAN cards, the pulse is at least 100 µs. For Series 2 CAN cards, the pulse is at least 100 ns.
Toggle RTSI Line:	If the previous state was high, the output toggles low, then vice-versa.

RTSI Skip specifies the number of RTSI inputs (low-to-high transitions) to skip for **RTSI Mode** On RTSI Input - Timestamp RTSI event, and On RTSI Input - Transmit CAN Frame. It is ignored for all other **RTSI Mode** values. For example, if the RTSI

input transitions from low to high every 1 ms, **RTSI Skip** of `9` means that a timestamp will be stored in the read queue every 10 ms.

UserRTSIFrame specifies a 4-byte pattern used to differentiate RTSI timestamps from CAN data frames. It is provided as a `U32`, and the high byte is stored as byte 0 from **ncReadObj.vi**. For example, `AABBCCDD` hexadecimal is returned as `AA` in byte 0, `BB` in byte 1, and so on.

This attribute is used only for **RTSI Mode** On RTSI Input - Timestamp RTSI event. It is ignored for all other **RTSI Mode** values.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

RTSI is a bus that interconnects National Instruments DAQ, IMAQ, Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. Refer to Chapter 3, *NI CAN Hardware*, for more details on the RTSI hardware connector.

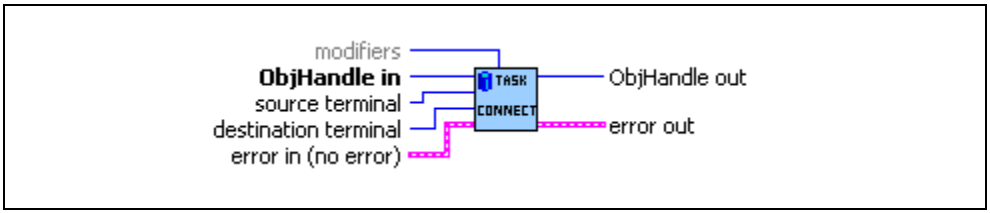
If you are not using RTSI features to synchronize the CAN Object with other National Instruments cards, refer to **ncConfigCANObj.vi**.

ncConnectTerminals.vi

Purpose

Connect terminals in the CAN hardware.

Format



Inputs

U32

ObjHandle in is the object handle from the previous NI-CAN VI. The handle reference originated from **ncOpen.vi**.

U16

source terminal specifies the source of the connection.

Once the connection is successfully created, behavior flows from **source terminal** to **destination terminal**.

For a list of valid source/destination pairs, refer to the *Valid Combinations of Source/Destination* section.

The following list describes each value of **source terminal**:

RTSI0 … RTSI6

Selects a general-purpose RTSI line as source (input) of the connection.

RTSI7/RTSI Clock

Selects RTSI line 7 as source (input) of the connection. **RTSI7** is dedicated for routing of a timebase (10 MHz or 20 MHz). **RTSI7** is also known as **RTSI Clock** in some National Instruments software products, such as NI-DAQ or NI-DAQmx.

The only valid **destination terminal** for this source is **Master Timebase**.

For PCI and PXI form factors, this receives a 20 MHz (default) timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting the 20 MHz oscillator (board clock) of the DAQ card to **RTSI7/RTSI Clock**, and then connecting **RTSI7/RTSI Clock** to **Master Timebase** on the CAN card.

For PCMCIA form factor, a 10 MHz timebase is required on **RTSI7/RTSI Clock**. For synchronization with a PCMCIA DAQcard, this is done by programming **FREQOUT** signal of the the DAQcard to 10 MHz, then wiring **FREQOUT** to the **RTSI7/RTSI Clock** of the CAN card.

This value applies to Series 2 cards only (returns error for Series 1).

PXI_Star

PXI_Star selects the PXI star trigger signal.

Within a PXI chassis, some PXI products can source star trigger from Slot 2 to all higher-numbered slots. **PXI_Star** enables the PXI CAN card to receive the star trigger when it is in Slot 3 or higher.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

PXI_Clk10

PXI_Clk10 selects the PXI 10 MHz backplane clock.

The only valid **destination terminal** for this source is **Master Timebase**. This routes the 10 MHz PXI backplane clock for use as the timebase of the CAN card. When you use **PXI_Clk10** as the timebase for the CAN card, you must also use **PXI_Clk10** as the timebase for other PXI cards to perform synchronized input/output.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

20 MHz Timebase

20 MHz Timebase selects the local 20 MHz oscillator of the CAN card.

The only valid **destination terminal** for this source is **RTSI7/RTSI Clock**. This routes the local 20 MHz clock of the CAN card for use as a timebase by other NI cards. For example, you can synchronize two CAN cards by connecting **20 MHz Timebase** to **RTSI7/RTSI Clock** on one CAN card and then connecting **RTSI7/RTSI Clock** to **Master Timebase** on the other CAN card.

20 MHz Timebase applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the **ObjName** input to **ncOpen.vi**.

This value applies to Series 2 PXI or PCI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCMCIA CAN card, selecting this value results in an error.

10 Hz Resync Clock

10 Hz Resync Clock selects a 10 Hz, 50 percent duty cycle clock. This slow rate is required for resynchronization of Series 1 CAN cards. On each pulse of the resync clock, the other CAN card brings its clock into sync.

By selecting **RTSI0** to **RTSI6** as the **destination terminal**, you route the 10 Hz clock to synchronize with other Series 1 CAN cards. NI-DAQ or NI-DAQmx cards cannot use the 10 Hz resync clock, so this selection is limited to synchronization of two or more CAN cards.

10 Hz Resync Clock applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the **ObjName** input to **ncOpen.vi**.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are using a mix of Series 1 and Series 2 CAN cards, you must use the **10 Hz Resync Clock**.

Interface Receive Event

Interface Receive Event selects the dedicated receive interrupt output on the Philips SJA1000 CAN controller. When a received frame successfully passes the acceptance filter, a pulse with the width of one bit time is output during the last bit of the end of frame position of the CAN frame. Incoming CAN frames can be filtered using the **Series 2 Filter Mode** attribute.

The CAN controller is specified by **ObjName** input to **ncOpen.vi**.

The **Interface Receive Event** can be used as the start trigger for other NI cards, or for external instruments.

Since this value requires the Philips SJA1000 CAN controller, it applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

Interface Transceiver Event

Interface Transceiver Event selects the NERR signal from the CAN transceiver. The Low-Speed/Fault-Tolerant transceiver and the High-Speed transceiver provide the NERR signal. This signal asserts when the transceiver detects a fault. The default value of NERR is logic-high, which indicates no error.

The CAN controller is specified by the **ObjName** input to **ncOpen.vi**.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

Start Trigger

Start Trigger selects the start trigger, the event that begins sampling for tasks.

The start trigger is the same for all CAN objects using a given interface, as specified by the **ObjName** input to **ncOpen.vi**.

In the default (disconnected) state of the **Start Trigger** destination, the start trigger occurs when communication begins on the interface.

By selecting **RTSI0** to **RTSI6** as the **destination terminal**, you route the start trigger of this CAN card to the start trigger of other CAN or DAQ cards. This ensures that sampling begins at the same time on both cards. For example, you can synchronize two CAN cards by routing **Start Trigger** as the **source terminal** on one CAN card and then routing **Start Trigger** as the **destination terminal** on the other CAN card, with both cards using the same RTSI line for the connections.

destination terminal specifies the destination of the connection.

The following list describes each value of **destination terminal**:

RTSI0 … RTSI6

Selects a general-purpose RTSI line as destination (output) of the connection.

RTSI7/RTSI Clock

Selects RTSI line 7 as destination (output) of the connection. **RTSI7** is dedicated for routing of a timebase. **RTSI7** is also known as **RTSI Clock** in some National Instruments software products, such as NI-DAQ or NI-DAQmx. The only valid source terminal for this source is 2**0 MHz Timebase**. The CAN card can import a 10 MHz or 20 MHz timebase, but can export only a 20 MHz timebase.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

Master Timebase

Master Timebase instructs the CAN card to use the source of the connection as the master timebase. The CAN card uses this master timebase for input sampling (including timestamps of received messages) as well as periodic output sampling.

For PCI and PXI form factors, you can use **RTSI7/RTSI Clock** as the **source terminal**. By default this receives a 20 MHz timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting the 20 MHz oscillator (board clock) of the DAQ card to **RTSI7/RTSI Clock**, and then connecting **RTSI7/RTSI Clock** to **Master Timebase** on the CAN card. To change the **Master Timebase Rate** to 10 MHz, use **ncSetAttr.vi** to change the **Master Timebase Rate** attribute.

For PXI form factor, you also can use **PXI_Clk10** as the **source terminal**. This receives the PXI 10 MHz backplane clock for use as the master timebase.

For PCMCIA form factor, you can use **RTSI7/RTSI Clock** as the **source terminal**. Unlike PCI and PXI, the PCMCIA CAN card requires a 10 MHz timebase on **RTSI7/RTSI Clock**. For synchronization with a PCMCIA DAQcard, this is done by

programming the **FREQOUT** signal of the DAQ card to 10 MHz, then wiring **FREQOUT** to the **RTSI7/RTSI Clock** of the CAN card.

Master Timebase applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the **ObjName** input to **ncOpen.vi**.

The default (disconnected) state of this destination means the CAN card uses its local 20 MHz timebase as the master timebase.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

10 Hz Resync Clock

10 Hz Resync Clock instructs the CAN card to use a 10 Hz, 50 percent duty cycle clock to resynchronize its local timebase. This slow rate is required for resynchronization of CAN cards. On each low-to-high transition of the resync clock, this CAN card brings its local timebase into sync.

When synchronizing to an E Series MIO card, a typical use of this value is to use **RTSI0** to **RTSI6** as the **source terminal**, then use NI-DAQ or NI-DAQmx functions to program the Counter 0 of the MIO card to generate a 10 Hz 50 percent duty cycle clock on the RTSI line.

When synchronizing to a CAN card, a typical use of this value is to use **RTSI0** to **RTSI6** as the **source terminal**, then route the **10 Hz Resync Clock** of the other CAN card as the **source terminal** to the same RTSI line.

10 Hz Resync Clock applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the **ObjName** input to **ncOpen.vi**.

The default (disconnected) state of this destination means the CAN card does not resynchronize its local timebase.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are using a mix of Series 1 and Series 2 CAN cards, you must use the **10 Hz Resync Clock**.

Start Trigger

Start Trigger selects the start trigger, the event that starts communication for all CAN objects on the same port. The start trigger occurs on the first low-to-high transition of the source terminal.

The start trigger is the same for all CAN objects using a given interface, as specified by the **ObjName** input to **ncOpen.vi**.

By selecting `RTSI0 to RTSI6`, or **PXI_Star** for PXI hardware, as the **source terminal**, you route the start trigger from another CAN or DAQ card. This ensures that sampling begins at the same time on both cards. For example, you can synchronize with an E Series DAQ MIO card by routing the AI start trigger of the MIO card to a RTSI line and then routing the same RTSI line with **Start Trigger** as the **destination terminal** on the CAN card.

The default (disconnected) state of this destination means the start trigger occurs when communication begins on the interface.

modifiers provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so **modifiers** must be left unwired.

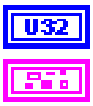
Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs



ObjHandle out is the object handle for the next VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

This VI connects a specific pair of source/destination terminals. One of the terminals is typically a RTSI signal, and the other terminal is an internal terminal in the CAN hardware. By connecting internal terminals to RTSI, you can synchronize the CAN card with another hardware product such as an NI-DAQ or NI-DAQmx card.

When the final CAN object for a given port is closed with **ncClose.vi**, NI-CAN disconnects all terminal connections for that interface. Therefore, **ncDisconnectTerminals.vi** is not required for most applications. NI-DAQ and NI-DAQmx terminals remain connected after the Network Interface and all higher-level CAN objects are closed, so you must disconnect NI-DAQ and NI-DAQmx terminals manually at the end of the application.

For a list of valid source/destination pairs, refer to the following section.

Valid Combinations of Source/Destination

Table 10-4 lists all valid combinations of **source terminal** and **destination terminal**.

The series of the NI CAN hardware determines what combinations of **source terminal** to **destination terminal** are valid. Within Table 10-4, *1* indicates Series 1 hardware, and *2* indicates Series 2 hardware. You can determine the series of the NI CAN hardware by selecting the name of the card within the **Devices and Interfaces** view in the left pane of MAX.

Series 1 hardware has the following limitations.

- PXI cards do not support **RTSI6**.
- Signals received from a RTSI source cannot occur faster than 1 kHz. This prevents the card from receiving a 10 MHz or 20 MHz timebase, such as NI E Series MIO hardware provides.
- Signals received from a RTSI source must be at least 100 µs in length to be detected. This prevents the card from receiving triggers in the nanoseconds range, such as the AI trigger that E Series MIO hardware provides. Series 2 CAN cards also send RTSI pulses in the nanoseconds range, so Series 1 CAN cards cannot receive RTSI input from Series 2 CAN cards.
- For CAN cards with High-Speed (HS) ports only, four RTSI signals are available for input (source), and four RTSI signals are available for output (destination). This limitation applies to the number of signals per direction, not the RTSI signal number. For example, if you connect **RTSI0**, **RTSI1**, **RTSI3**, and **RTSI5** as input, connecting **RTSI4** as input will return an error.
- For CAN cards with one or more Low-Speed (LS) ports, two RTSI signals are available for input (source), and three RTSI signals are available for output (destination).

Series 2 hardware has the following limitations.

- For all form factors (PCI, PXI, PCMCIA), the connection of **Interface Transceiver Event** to a RTSI destination depends on the physical port location. If the interface is on Port 1, you can connect to only even-numbered RTSI lines (**RTSI0**, **RTSI2**, **RTSI4**, **RTSI6**). If the interface is on Port 2, you can connect to only odd-numbered RTSI lines (**RTSI1**, **RTSI3**, **RTSI5**). You can determine the location by selecting the name of the interface in MAX.
- PCI cards do not support the **PXI_Star** and **PXI_Clk10** terminals, as those signals exist on the PXI backplane.
- PCMCIA cards do not support the **20 MHz Timebase**, **PXI_Star**, and **PXI_Clk10** terminals. Because **20 MHz Timebase** is not supported, you cannot synchronize the timebases of two PCMCIA CAN cards.
- On PCMCIA cards, **RTSI4**, **RTSI5** and **RTSI6** are not available.

Table 10-4. Valid Combinations of Source/Destination

Source	Destination				
	RTSI0 to RTSI6	**RTSI_ CLOCK**	**Master Timebase**	**10 Hz Resync Clock**	**Start Trigger**
RTSI0 to RTSI6	—	—	—	1,2	1,2
RTSI7/RTSI Clock	—	—	2	—	—
PXI_Star	—	—	—	—	2
PXI_Clk10	—	—	2	—	—
20 MHz Timebase	—	2	—	—	—
10 Hz Resync Clock	1,2	—	—	—	1,2
Interface Receive Event	2	—	—	—	2
Interface Transceiver Event	2	—	—	—	—
Start Trigger	1,2	—	—	—	—

1—Valid Connection for Series 1 Hardware

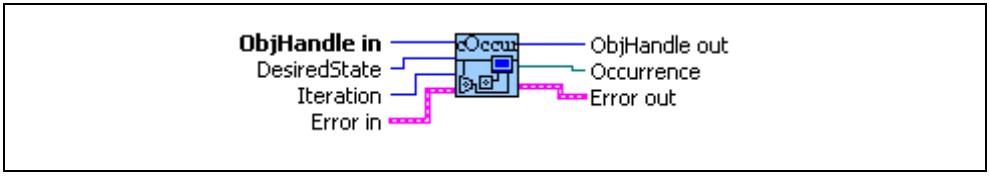
2—Valid Connection for Series 2 Hardware

ncCreateOccur.vi

Purpose

Create a LabVIEW occurrence for an object.

Format



Input

U32

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

U32

DesiredState specifies a bit mask of states for which notification is desired. You can use a single state alone, or you can OR them together:

`00000001` hex Read Available

At least one frame is available, which you can obtain using an appropriate read VI.

The state is set whenever a frame arrives for the object. The state is cleared when the read queue is empty.

`00000002` hex Write Success

All frames provided through write VIs have been successfully transmitted onto the network. Successful transmit means that the frame won arbitration, and was acknowledged by a remote device.

The state is set when the last frame in the write queue is transmitted successfully. The state is cleared when a write VI is called.

When communication starts the **Write Success** state is true by default.

For CAN Objects, **Write Success** does not always mean that transmission has stopped. For example, if a CAN Object is configured for **Transmit Data Periodically**, **Write Success** occurs when the write queue has been emptied, but periodic transmit of the last frame continues.

`00000040` hex Remote Wakeup

Remote wakeup occurred, and **Transceiver Mode** has changed from **Sleep** to **Normal**. For more information on remote wakeup, refer to **Transceiver Mode**.

This state is set when a remote wakeup occurs (end of wakeup frame). This state is not set when the application changes **Transceiver Mode** from **Sleep** to **Normal** (local wakeup).

This state is cleared when:

- You open the Network Interface, such as when the application begins.
- You stop the Network Interface.
- You set the **Transceiver Mode**, such as each time you set **Sleep** mode.

For as long as this state is true, the **Transceiver Mode** is **Normal**. The **Transceiver Mode** also can be **Normal** when this state is false, such as when you perform a local wakeup.

`00000008` hex Read Multiple

A specified number of frames are available, which you can obtain using either **ncReadNetMult.vi** or **ncReadObjMult.vi**. The number of frames is configured using the **ReadMult Size for Notification** attribute of **ncSetAttr.vi**.

The state is set whenever the specified number of frames are stored in the read queue of the object. The state is cleared when you call the read VI, and less than the specified number of frames exist in the read queue.

00000080 hex Write Multiple

The state is set whenever there is free space in the write queue to accept at least 512 frames to write. The state is cleared when you call **ncWriteNet.vi** or **ncWriteNetMult.vi** and less than 512 frames can be accepted to write in the write queue.

This state is valid only on the Network Interface.

Iteration is an optional loop iteration count. If **ncCreateOccur.vi** is called inside a loop, the iteration count of the loop is wired to **Iteration** to ensure that the occurrence is created only once. If **Iteration** is left unwired, the occurrence is created each time **ncCreateOccur.vi** is called, which decreases overall performance.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

Occurrence returns the LabVIEW occurrence, for use with LabVIEW **Wait on Occurrence** VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning:

VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

ncCreateOccur.vi creates a notification occurrence for the object specified by **ObjHandle**. The NI-CAN driver uses the occurrence callback to communicate state changes to the application.

ncCreateOccur.vi is not recommended for use with LabVIEW Real-Time (RT). Due to the internal implementation of occurrences in LabVIEW, their use can have negative effects on real-time performance.

This VI is normally used when you want to allow other code to execute while waiting for NI-CAN states, especially when the other code does not call NI-CAN VIs. If such background execution is not needed, **ncWaitForState.vi** offers better overall performance. **ncWaitForState.vi** cannot be used at the same time as **ncCreateOccur.vi**.

The functions **ncWaitForState.vi** and **ncCreateOccur.vi** use the same underlying implementation. Therefore, for each object handle, only one of these functions can be pending at a time. For example, you cannot invoke **ncWaitForState.vi** twice from different VIs for the same object. For different object handles, these functions can overlap in execution.

If you are using LabVIEW 7.0 or later, consider using **ncWaitForState.vi** for background execution. LabVIEW 7.0 improved the underlying threading model, such that **ncWaitForState.vi** does not block the execution of other VIs in the same diagram.

Upon successful return from **ncCreateOccur.vi**, the occurrence is set whenever one of the states specified by **DesiredState** occurs in the object, or if an error occurs in the object. If **DesiredState** is zero, occurrences are disabled for the object specified by **ObjHandle**.

The **Occurrence** output is normally wired into the LabVIEW **Wait on Occurrence** VI. **Wait on Occurrence** takes the **Occurrence**, and also a timeout and flag indicating whether to ignore a pending state. For more information on **Wait On Occurrence**, refer to the *LabVIEW Online Reference*.

When **Wait on Occurrence** completes, you should execute code to handle the **DesiredState**. For example:

- If **DesiredState** is **Read Available**, you should call **ncReadNet.vi** or **ncReadObj.vi** to read the available data.
- If **DesiredState** is **Read Multiple**, you should call **ncReadNetMult.vi** or **ncReadObjMult.vi** to read the available data.

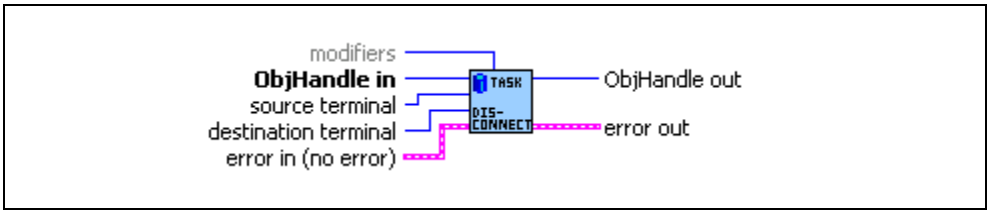
After it has been created, the **Occurrence** will be set each time a **DesiredState** goes from false to true. When you no longer want to wait on the **Occurrence** (for example, when terminating the application), call **ncCreateOccur.vi** with **DesiredState** zero.

ncDisconnectTerminals.vi

Purpose

Disconnect terminals in the CAN hardware.

Format



Inputs

ObjHandle in is the object handle from the previous NI-CAN VI. The handle reference originated from **ncOpen.vi**.

source terminal specifies the connection source.

For a description of values for **source terminal**, refer to **ncConnectTerminals.vi**.

destination terminal specifies the connection destination.

For a description of values for **destination terminal**, refer to **ncConnectTerminals.vi**.

modifiers provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so **modifiers** must be left unwired.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

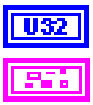
status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is

returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Outputs



ObjHandle out is the object handle for the next VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

This VI disconnects a specific pair of source/destination terminals that you previously connected with **ncConnectTerminals.vi**.

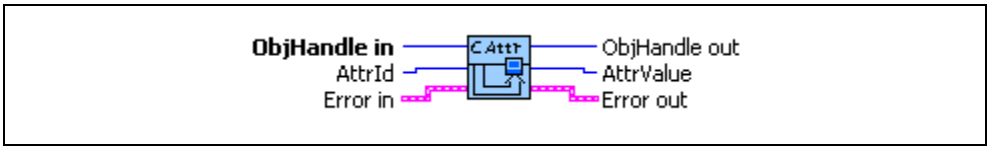
When the final CAN object for a given port is closed with **ncClose.vi**, NI-CAN disconnects all terminal connections for that interface. Therefore, **ncDisconnectTerminals.vi** is not required for most applications. You typically use this VI to change RTSI connections dynamically while the application is running. First, use **ncAction.vi** to stop all objects for the interface, then use **ncDisconnectTerminals.vi** and **ncConnectTerminals.vi** to adjust RTSI connections. Then use **ncAction.vi** with the opcode to start the network interface and higher-level CAN Objects to restart communication.

ncGetAttr.vi

Purpose

Get the value of an object attribute.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

AttrId specifies the attribute to get.

Form Factor

Returns the form factor of the card on which the Network Interface or CAN Object is located.

The returned Form Factor is an enumeration.

0	PCI
1	PXI
2	PCMCIA
3	AT

Interface Number

Returns the **Interface Number** of the port on which the Network Interface or CAN Object is located.

This is the same number that you used in the **ObjName** string of the previous Config and Open VIs.

Listen Only?

Returns the **Listen Only?** attribute as configured with **ncSetAttr.vi**.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

Log Comm Warnings

Returns TRUE or FALSE depending on whether communication warnings (including transceiver faults) were logged to the Network Interface read queue. For more information, refer to this attribute in **ncSetAttr.vi**.

Log Start Trigger?

Returns the value of the **Log Start Trigger?** attribute as configured with **ncSetAttr.vi**.

Master Timebase Rate

Returns the present **Master Timebase Rate** in MHz, programmed into the CAN hardware. For PCMCIA, this attribute will always return 10 MHz.

Object State

Returns the current state bit mask of the object. Polling with **ncGetAttr.vi** provides an alternative method of state detection than **ncWaitForState.vi** or **ncCreateOccur.vi**. For more information on the states returned from this attribute, refer to the **DesiredState** input of **ncWaitForState.vi**.

Protocol Version

For NI-CAN, this returns `02000200` hex, which corresponds to version 2.0B of the Bosch CAN specifications. For more information on the encoding of the version, refer to the Software Version section of this function.

This attribute is available only from the Network Interface, not CAN Objects.

Read Entries Pending

Returns the number of frames available in the read queue. Polling the available frames with this attribute can be used as an alternative to **ncWaitForState.vi** and **ncCreateOccur.vi**.

ReadMult Size for Notification

Returns the number of frames used as a threshold for the **Read Multiple** state. For more information, refer to this attribute in **ncSetAttr.vi**.

Receive Error Counter

Returns the **Receive Error Counter** from the SJA1000 CAN controller. This Receive Error Counter is specified in the Bosch CAN standard as well as ISO CAN standards.

This attribute is unsupported for Series 1 hardware (returns error). This attribute is available only from the Network Interface, not CAN Objects.

Self Reception?

Returns the **Self Reception** attribute as configured with **ncSetAttr.vi**.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

Serial Number

Returns the **Serial Number** of the card on which the Network Interface or CAN Object is located.

Series

Returns the **Series** of the card on which the Network Interface or CAN Object is located.

Series 1 hardware products use the Intel 82527 CAN controller.

Series 2 hardware products use the Philips SJA1000 CAN controller, plus improved RTSI synchronization features.

The returned Series is an enumeration.

`0`	Series 1
`1`	Series 2

Series 2 Comparator

Returns the **Series 2 Comparator** attribute as configured with **ncSetAttr.vi**.

This attribute is available only from the Network Interface, not CAN Objects.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

Series 2 Error/Arb Capture

Returns the current values of the Error Code Capture register and Arbitration Lost Capture register from the Philips SJA1000 CAN controller chip.

The Error Code Capture register provides information on bus errors that occur according to the CAN standard. A bus error increments either the **Transmit Error Counter** or the **Receive Error Counter**. When communication starts on the interface, the first bus error is captured into the Error Code Capture register, and retained until you get this attribute. After you get this attribute, the Error Code Capture register is again enabled to capture information for the next bus error.

The Arbitration Lost Capture register provides information on a loss of arbitration during transmits. Loss of arbitration is not considered an error. When communication starts on the interface, the first arbitration loss is captured into the Arbitration Lost Capture register, and retained until you get this attribute. After you get this attribute, the Arbitration Lost Capture register is again enabled to capture information for the next arbitration loss.

For each of the capture registers, a single-bit New flag indicates whether a new error has occurred since the last Get. If the New flag of a register is set, the associated fields contain new information. If the New flag of a register is clear, the associated fields are the same as the previous Get.

This attribute is commonly used with the **Single Shot Transmit** attribute. When a Write function is used to transmit the single frame, you can get this attribute to

determine if the transmit was successful. If the single shot transmit was not successful, this attribute provides detailed information for the failure.

This attribute is supported for Series 2 hardware only (returns error for Series 1). Since the information and bit format is very specific to the Philips SJA1000 CAN controller on Series 2 hardware, National Instruments cannot guarantee compatibility for this attribute on future hardware series. When using this attribute in the application, it is best to get the **Series** to verify that the CAN hardware is Series 2.

Figure 10-4 and the associated tables describe the format of bit fields in this attribute. The lowest byte (bits 0–7) corresponds to the Error Code Capture register. The next byte (bits 8–15) corresponds to the Arbitration Lost Capture register. Bit 16 (`00010000` hex) is the New flag for the Error Code Capture fields. Bit 17 (`00020000` hex) is the New flag for the Arbitration Lost Capture field. Bits marked as "X" are reserved, and should be ignored by the application.

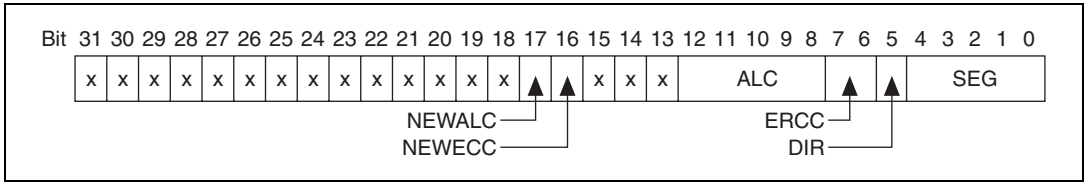


Figure 10-4. Series 2 Error/Arb Capture Format

Table 10-5. SEG Field of the Error Code Capture Register

Value in SEG Field	Meaning
0	No error (ignore DIR and ERRC as well)
2	ID.28 to ID.21 (most significant bits of identifier)
3	Start of frame

Table 10-5. SEG Field of the Error Code Capture Register (Continued)

Value in SEG Field	Meaning
4	Bit SRTR (RTR for standard frames)
5	Bit IDE
6	ID.20 to ID.18
7	ID.17 to ID.13
8	CRC sequence
9	Reserved bit 0
10	Data field
11	Data length code
12	Bit RTR (RTR for extended frames)
13	Reserved bit 1
14	ID.4 to ID.0
15	ID.12 to ID.5
17	Active error flag
18	Intermission
19	Tolerate dominant bits
22	Passive error flag
23	Error delimiter
24	CRC delimiter
25	Acknowledge slot
26	End of frame
27	Acknowledge delimiter
28	Overload flag

Table 10-6. DIR Field of the Error Code Capture Register

Value in DIR Field	Meaning
0	TX; error occurred during transmission
1	RX; error occurred during reception

Table 10-7. ERRC Field of the Error Code Capture Register

Value in ERRC Field	Meaning
0	Bit error
1	Form error
2	Stuff error
3	Other type of error

Table 10-8. ALC Field Contains the Arbitration Lost Capture Register

Value in ALC Field	Meaning
0	ID.28 (most significant bit of identifier; first ID bit in frame)
1	ID.27
2	ID.26
3	ID.25
4	ID.24
5	ID.23
6	ID.22

Table 10-8. ALC Field Contains the Arbitration Lost Capture Register (Continued)

Value in ALC Field	Meaning
7	ID.21
8	ID.20
9	ID.19
10	ID.18
11	SRTR (RTR for standard frames)
12	IDE
13	ID.17 (extended frames only)
14	ID.16 (extended frames only)
15	ID.15 (extended frames only)
16	ID.14 (extended frames only)
17	ID.13 (extended frames only)
18	ID.12 (extended frames only)
19	ID.11 (extended frames only)
20	ID.10 (extended frames only)
21	ID.9 (extended frames only)
22	ID.8 (extended frames only)
23	ID.7 (extended frames only)
24	ID.6 (extended frames only)
25	ID.5 (extended frames only)
26	ID.4 (extended frames only)
27	ID.3 (extended frames only)
28	ID.2 (extended frames only)
29	ID.1 (extended frames only)

Table 10-8. ALC Field Contains the Arbitration Lost Capture Register (Continued)

Value in ALC Field	Meaning
30	ID.0 (extended frames only)
31	SRTR (RTR for extended frames)

Table 10-9. NEWECC Field is the New Flag for the Error Code Capture Register

Value in NEWECC Field	Meaning
0	SEG, DIR, and ERRC fields contain the same value as the last Get of this attribute. If no error has occurred since the start of communication, all fields are zero.
1	SEG, DIR, and ERRC fields contain information for a new bus error.

Table 10-10. NEWALC Field is the New Flag for the Arbitration Lost Capture Register

Value in NEWALC Field	Meaning
0	ALC field contains the same value as the last Get of this attribute.
1	ALC field contains information for a new arbitration loss.

Series 2 Filter Mode

Returns the **Series 2 Filter Mode** attribute as configured with **ncSetAttr.vi**.

This attribute is available only from the Network Interface, not CAN Objects.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

Series 2 Mask

Returns the **Series 2 Mask** attribute as configured with **ncSetAttr.vi**.

This attribute is available only from the Network Interface, not CAN Objects.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

Single Shot Transmit?

Returns the **Single Shot Transmit** attribute as configured with **ncSetAttr.vi**.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

Software Version

Version of the NI-CAN software, with major, minor, update, and beta build numbers encoded in the `U32` from high to low bytes. For example, 2.0.1 would be `02000100` hex, and 2.1beta5 would be `02010005` hex.

This attribute is provided for backward compatibility. **ncGetHardwareInfo.vi** VI provides more complete version information.

Timeline Recovery

Returns the **Timeline Recovery** attribute for the CAN Network Interface Object.

Timestamp Format

Returns the present **Timestamp Format** programmed into the CAN hardware. This attribute applies to the entire card.

Transceiver External Inputs

Returns the **Transceiver External Inputs** for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this attribute allows you to determine the input voltage on the STATUS pin of the CAN port.

For many models of CAN transceiver, an NERR pin is provided for detection of faults and other status. For such transceivers, you can wire the NERR pin to the STATUS pin of the CAN port.

This attribute is supported for Series 2 XS cards only (returns error for non-XS cards).

This attribute uses a bit mask. When using the attribute, use bitwise AND operations to check for values, not equality checks (equal, greater than, and so on).

`00000001` hex STATUS

This bit is set when 5 V exists on the STATUS pin.

This bit is clear when 0 V exists on the STATUS pin.

Transceiver External Outputs

Returns the **Transceiver External Outputs** for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this attribute allows you to determine the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you to determine if the CAN controller chip is sleeping.

For more information on the format of the value returned in this attribute, refer to the description of **Transceiver External Outputs** in **ncSetAttr.vi**.

This attribute is supported for Series 2 XS cards only (returns error for non-XS cards).

Transceiver Mode

Returns the **Transceiver Mode** for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

For Series 2 cards for the PCMCIA form factor, this property requires a corresponding Series 2 cable (dongle). For information on how to identify the series of the PCMCIA cable, refer to the *Series 2 versus Series 1* subsection of the *NI CAN Hardware Overview* section of Chapter 1, *Introduction*.

The **Transceiver Mode** changes when you set the mode within the application, or when a remote wakeup transitions the interface from **Sleep** to **Normal** mode. For more information, refer to **ncSetAttr.vi**.

This attribute uses the following values:

`0` (Normal)

Transceiver is awake and in **Normal** communication mode.

`1` (Sleep)

Transceiver and the CAN controller chip are both in **Sleep** mode.

`2` (Single Wire Wakeup)

Single Wire transceiver is in **Wakeup Transmission** mode.

`3` (Single Wire High-Speed)

Single Wire transceiver is in **High-Speed Transmission** mode.

Transceiver Type

Returns the type of transceiver for the Network Interface. For hardware other than Series 2 XS cards, the **Transceiver Type** is fixed. For Series 2 XS cards, the **Transceiver Type** reflects the most recent value specified by MAX or **ncSetAttr.vi**.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

This attribute is not supported on the PCMCIA form factor.

This attribute uses the following values:

`0` (High-Speed)
Transceiver type is **High-Speed** (HS).

`1` (Low-Speed/Fault-Tolerant)
Transceiver type is **Low-Speed/Fault-Tolerant** (LS).

`2` (Single Wire)
Transceiver type is **Single Wire** (SW).

`3` (External)
Transceiver type is **External**. This transceiver type is available on Series 2 XS cards only. For more information, refer to **ncSetAttr.vi**.

`4` (Disconnect)
Transceiver type is **Disconnect**. This transceiver type is available on Series 2 XS cards only. For more information, refer to **ncSetAttr.vi**.

Transmit Error Counter

Returns the **Transmit Error Counter** from the Philips SJA1000 CAN controller. This **Transmit Error Counter** is specified in the Bosch CAN standard as well as ISO CAN standards.

This attribute is unsupported for Series 1 hardware (returns error). This attribute is available only from the Network Interface, not CAN Objects.

Transmit Mode

Returns the **Transmit Mode** the CAN Network Interface Object is presently configured for.

The returned **Transmit Mode** is an enumeration.

0	**Immediate Transmit**
1	**Time stamped Transmit**

User RTSI Frame

Returns the **User RTSI Frame** attribute as configured with **ncSetAttr.vi**.

Virtual Bus Timing

Returns a Boolean value of True or False to indicate whether **Virtual Bus Timing** has been set or not for the specified virtual interface. This attribute is applicable to all CAN Objects opened on the virtual interface.

Write Entries Free

Returns the number of frames that can be accepted for a CAN Network Interface Object or CAN Object to write without causing overflow error.

Write Entries Pending

Returns the number of frames pending transmission in the write queue. If the intent is to verify that all pending frames have been transmitted successfully, waiting for the **Write Success** state is preferable to this attribute.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute

the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

AttrValue returns the attribute value specified by **AttrId**.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

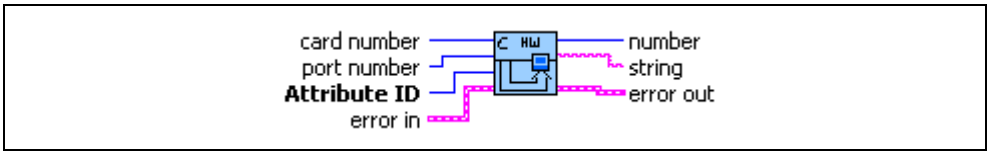
ncGetAttr.vi gets the value of the attribute specified by **AttrId** from the object specified by **ObjHandle**. Within NI-CAN objects, you use attributes to access configuration settings, status, and other information about the object, but not data.

ncGetHardwareInfo.vi

Purpose

Get NI-CAN hardware information.

Format



Input

card number specifies the CAN card number from 1 to **Number of Cards**, where **Number of Cards** is the number of CAN cards in the system. You can determine the number of cards in the system by using this VI with **card number** = `1`, **port number** = `1`, and **attribute ID** = **Number of Cards**.

port number specifies the CAN port number from `1` to **Number of Ports**, where **Number of Ports** is the number of CAN ports on this CAN card. You can determine the number of ports on this CAN card by using this VI with **port number** = `1`, and **attribute ID** = **Number of Ports**.

attribute ID specifies the attribute to get.

Version Major

Returns the major version of the NI-CAN software in the **number** output. Use **card number** `1` and **port number** `1` as inputs.

The major version is the ‘X’ in X.Y.Z.

Version Minor

Returns the minor version of the NI-CAN software in the **number** output. Use **card number** `1` and **port number** `1` as inputs.

The minor version is the ‘Y’ in X.Y.Z.

Version Update

Returns the update version of the NI-CAN software in the **number** output. Use **card number** `1` and **port number** `1` as inputs.

The update version is the ‘Z’ in X.Y.Z.

Version Phase

Returns the phase of the NI-CAN software in the **number** output. Use **card number** `1` and **port number** `1` as inputs.

Phase 1 specifies Alpha, phase 2 specifies Beta, and phase 3 specifies Final release. Unless you are participating in an NI-CAN beta program, you will always see **3**.

Version Build

Returns the build of the NI-CAN software in the **number** output. Use **card number** `1` and **port number** `1` as inputs.

With each software development phase, subsequent NI-CAN builds are numbered sequentially. A given Final release version always uses the same build number, so unless you are participating in an NI-CAN beta program, this build number is not relevant.

Version Comment

Returns any special comment on the NI-CAN software in the **string** output. Use **card number** `1` and **port number** `1` as inputs.

This string is normally empty for a Final release. In rare circumstances, an NI-CAN prototype or patch may be released to a specific customer. For these special releases, the version comment describes the special features of the release.

Number of Cards

Returns the number of NI-CAN cards in the system in the **number** output. Use **card number** `1` and **port number** `1` as inputs.

If you are displaying all hardware information, you get this attribute first, then iterate through all CAN cards with a For loop. Inside the For loop on a card, you get all card-wide attributes including `Number Of Ports`, then use another For loop to get port-wide attributes.

Serial Number

Card-wide attribute that returns the serial number of the card in the **number** output. Use the desired **card number**, and **port number** `1` as inputs.

Form Factor

Card-wide attribute that returns the form factor of the card in the **number** output. Use the desired **card number**, and **port number** `1` as inputs.

The returned Form Factor is an enumeration.

`0`	PCI
`1`	PXI
`2`	PCMCIA
`3`	AT

Series

Card-wide attribute that returns the series of the card in the **number** output. Use the desired **card number**, and **port number** `1` as inputs.

Series 1 hardware products use the Intel 82527 CAN controller.

Series 2 hardware products use the Philips SJA1000 CAN controller, plus improved RTSI synchronization features.

The returned Series is an enumeration.

`0`	Series 1
`1`	Series 2

Number of Ports

Card-wide attribute that returns the number of ports on the card in the **number** output. Use the desired **card number**, and **port number** `1` as inputs.

If you are displaying all hardware information, you get this attribute within the For loop for all cards, then iterate through all CAN ports to get port-wide attributes.

Transceiver Type

This port-wide attribute returns the type of transceiver in the **number** output. Use the desired **card number** and **port number** as inputs.

For hardware other than Series 2 XS cards, the transceiver type is fixed. For Series 2 XS cards, the transceiver type reflects the most recent value specified by MAX or **ncSetAttr.vi**.

This attribute is not supported on the PCMCIA form factor.

This attribute uses the following values:

`0` (High-Speed)
Transceiver type is **High-Speed** (HS).

`1` (Low-Speed/Fault-Tolerant)
Transceiver type is **Low-Speed/Fault-Tolerant** (LS).

`2` (Single Wire)
Transceiver type is **Single Wire** (SW).

`3` (External)
Transceiver type is **External**. This transceiver type is available on Series 2 XS cards only. For more information, refer to **ncSetAttr.vi**.

`4` (Disconnect)
Transceiver type is **Disconnect**. This transceiver type is available on Series 2 XS cards only. For more information, refer to **ncSetAttr.vi**.

Interface Number

Port-wide attribute that returns the interface number of the port in the **number** output. Use the desired **card number** and **port number** as inputs.

The interface number is assigned to a physical port using the Measurement and Automation Explorer (MAX). The interface number is used as a string in the Frame API (for example, “CAN0”). The interface number is used for the **interface** input in the Channel API.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

If the attribute is a **number**, the value is returned in this output terminal.

If the attribute is a **string**, the value is returned in this output terminal.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

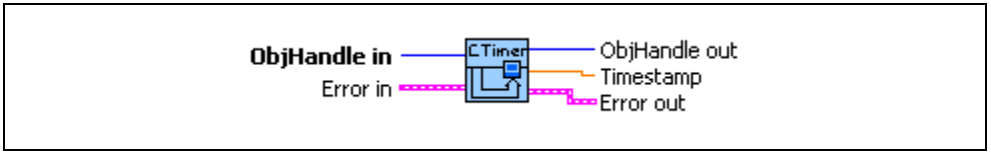
This VI provides information about available CAN cards, but does not require you to open/start sessions. First get **Number of Cards**, then loop for each card. For each card, you can get card-wide attributes (such as **Form Factor**), and you also can get the **Number of Ports**. For each port, you can get port-wide attributes such as the **Transceiver**.

ncGetTimer.vi

Purpose

Get the absolute timestamp attribute.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

Timestamp returns the absolute timestamp value. The value matches the absolute timestamp format used within LabVIEW itself. LabVIEW time is a `DBL` representing the number of seconds elapsed since 12:00 a.m., Friday, January 1, 1904, Coordinated Universal Time (UTC). You can wire this **Timestamp** to LabVIEW time functions such as **Seconds To Date/Time**.

You also can display the time in a numeric indicator of type `DBL` by using **Format & Precision** to select **Time & Date** format.

Note If you use **Time & Date** format, LabVIEW limits the **Seconds Precision** to `3`, which shows only milliseconds. The NI-CAN timestamp provides microsecond precision. If you need to view microsecond precision, change the timestamp to `decimal` format, with six digits of precision.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

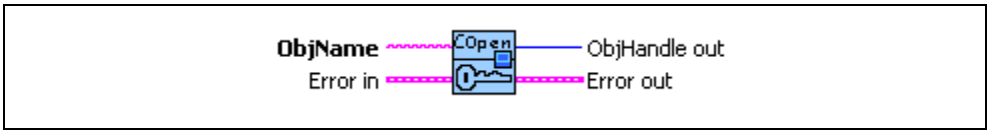
This VI can be used only with the Network Interface, and not with CAN Objects.

ncOpen.vi

Purpose

Open an object.

Format



Input

ObjName is the name of the object to open. You must have already wired this name into a previous config VI.

CAN Network Interface Object

This name uses the syntax "CAN*x*", where *x* is a decimal number starting at zero that indicates the CAN network interface (**CAN0**, **CAN1**, up to **CAN63**). CAN network interface names are associated with physical CAN ports using the Measurement and Automation Explorer (MAX).

The special interface values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

CAN Object

This name uses the syntax "CAN*x*::STD*y*" or "CAN*x*::XTD*y*". CAN*x* is the name of the CAN network interface that you used for the preceding **ncConfigCANNet.vi** call. STD indicates that the CAN Object uses a standard (11-bit) arbitration ID. XTD indicates that the CAN Object uses an extended (29-bit) arbitration ID. The number *y* specifies the actual arbitration ID of the CAN Object. The number *y* is decimal by default, but you also can use hexadecimal by adding "0x" to the beginning of the number. For example, "CAN0::STD25" indicates standard ID 25 decimal on CAN0, and "CAN1::XTD0x0000F652" indicates extended ID F652 hexadecimal on **CAN1**.

The special virtual interface names "CAN256" and "CAN257" are not supported for CAN Objects.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for all subsequent NI-CAN VIs for this object, including the final call to **ncClose.vi**.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

ncOpen.vi takes the name of an object to open and returns a handle to that object that you use with subsequent NI-CAN function calls.

The Frame API and Channel API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Channel API, this function returns an error.

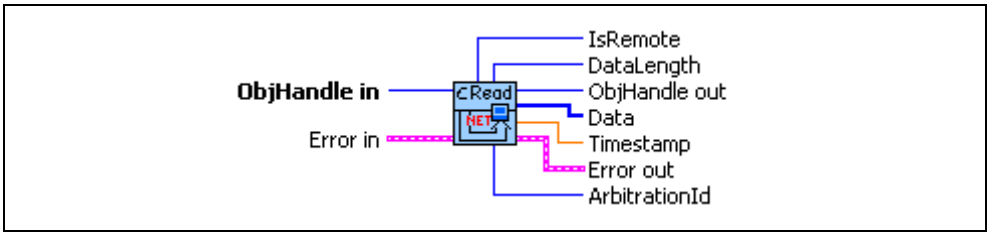
If **ncOpen.vi** is successful, a handle to the newly opened object is returned. You use this object handle for all subsequent function calls for the object.

ncReadNet.vi

Purpose

Read single frame from a CAN Network Interface Object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of 0 means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

Note The description of the output terminals is specified by the frame type. The value of **IsRemote** indicates the frame type. For a description of each frame type, refer to the *Frame Types* section.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

ncReadNet.vi is useful when you need to process one frame at a time, because it returns separate outputs for **ArbitrationId**, **Timestamp**, and so on. In order to read multiple frames at a time, such as for high-bandwidth networks, use **ncReadNetMult.vi**.

Since NI-CAN handles the read queue in the background, this VI does not wait for new frames to arrive. To ensure that a new frame is available before calling **ncReadNet.vi**, first wait for the **Read Available** state using **ncWaitForState.vi**.

When you call **ncReadNet.vi** for an empty read queue (**Read Available** state False), the frame from the previous call to **ncReadNet.vi** is returned again, along with the `CanWarnOldData` warning `(status=F, code=3FF62009 hex)`.

When a frame arrives for a full read queue, NI-CAN discards the new frame, and the next call to **ncReadNet.vi** returns the error `CanErrOverflowRead (status=T, code= BFF62028 hex)`. If you detect this overflow, switch to using **ncReadNetMult.vi** to read multiple frames.

Although the Network Interface allows **Read Queue Length** of zero, this is not recommended, because every new frame will always overwrite the previous frame.

You can use the Network Interface and CAN Objects simultaneously. When a CAN frame arrives from the network, NI-CAN first checks the **ArbitrationId** for an open CAN Object. If no CAN Object applies, NI-CAN checks the comparators and masks of the Network Interface (including the **Series 2 Filter Mode** attributes). If the frame passes that filter, NI-CAN places the frame into the read queue of the Network Interface.

Error Active, Error Passive, and Bus Off States

When the CAN communication controller transfers into the error passive state, NI-CAN returns the warning `CanCommWarning (Status=F, code=3ff6200B hex)` from read VIs.

When the transmit error counter of the CAN communication controller increments above 255, the network interface transfers into the **bus off** state as dictated by the CAN protocol. The network interface stops communication so that you can correct the defect in the network, such as a malfunctioning cable or device. When **bus off** occurs, NI-CAN returns the error `CanCommError (status=T, code=BFF6200B hex)` from read VIs.

If no CAN devices are connected to the network interface port, and you attempt to transmit a frame, the `CanWarnComm` warning is returned. This warning occurs because the missing acknowledgment bit increments the transmit error counter until the network interface reaches the `error passive` state, but **bus off** state is never reached.

For more information about low-speed communication error handling, refer to the **Log Comm Warnings** attribute in **ncSetAttr.vi**.

Frame Types

IsRemote indicates the frame type. The frame type determines the interpretation of the remaining fields. The following tables describe the fields of the cluster for each value of **IsRemote**.

Table 10-11. IsRemote Value 0: CAN Data Frame

Field Name	Data Type	Description
IsRemote	U32	Value `0` represents a CAN data frame. The CAN data frame contains data from the network.
ArbitrationId	U32	Specifies the arbitration ID to transmit in the CAN data frame. A standard ID (11-bit) is specified by default.
DataLength	U32	Indicates the number of data bytes in the **Data** array.
Data	[U8]	The received data bytes (8 maximum).

Table 10-12. IsRemote Value 1: CAN Remote Frame

Field Name	Data Type	Description
IsRemote		Value `1` represents a CAN remote frame. Only Series 2 or later can receive remote frames using the Network Interface. For Series 1 hardware, you must handle incoming remote frames with CAN Object only.
ArbitrationId		Specifies the arbitration ID to transmit in the CAN data frame.
DataLength		Returns the Data Length Code in the remote frame, but with no data.
Data		Ignored. No data bytes are contained in a CAN remote frame.

Table 10-13. IsRemote Value 2: Communication Warning or Error Frame

Field Name	Data Type	Description
IsRemote		Value 2 represents a communication warning or error frame. This indicates a communication problem reported by the CAN controller or the low-speed CAN transceiver. This frame type occurs only when you set the **Log Comm Warnings** attribute to TRUE and the CAN controller is in the error passive state. For more information on communication problems, refer to the *Description* section.
ArbitrationId		8000000B hex—Comm. error: General 4000000B hex—Comm. warning: General 8001000B hex—Comm. error: Stuffing 4001000B hex—Comm. warning: Stuffing 8002000B hex—Comm. error: Format 4002000B hex—Comm. warning: Format 8003000B hex—Comm. error: No Ack 4003000B hex—Comm. warning: No Ack 8004000B hex—Comm. error: Tx 1 Rx 0 4004000B hex—Comm. warning: Tx 1 Rx 0 8005000B hex—Comm. error: Tx 0 Rx 1 4005000B hex—Comm. warning: Tx 0 Rx 1 8006000B hex—Comm. error: Bad CRC 4006000B hex—Comm. warning: Bad CRC 0000000B hex—Comm. Error/warnings cleared 8000000C hex—Transceiver fault warning 0000000C hex—Transceiver fault cleared

Table 10-13. IsRemote Value 2: Communication Warning or Error Frame (Continued)

Field Name	Data Type	Description
DataLength		Ignored.
Data		Ignored.

Table 10-14. IsRemote Value 3: RTSI Frame

Field Name	Data Type	Description
IsRemote		Value 3 represents a CAN data frame. This indicates when a RTSI input pulse occurred relative to incoming CAN frames. This frame type occurs only when you set the **RTSI Mode** attribute to **On RTSI Input–Timestamp** event (refer to **ncConfigCANNetRTSI.vi** for details).
ArbitrationId		Is the special value 40000001 hex.
DataLength		The RTSI signal detected.
Data		Ignored.

Table 10-15. IsRemote Value 4: Start Trigger Frame

Field Name	Data Type	Description
IsRemote	U32	Value 4 represents the start trigger frame. When the **Log Start Trigger** attribute is enabled, this frame indicates the time when the start trigger occurs. For example, if you use **ncConnectTerminals.vi** to connect a RTSI input to the start trigger, this frame occurs when the RTSI input pulses for the first time. Another use case for logging the start trigger would be for logging the received CAN frames in a file. This ensures that the first frame in a logfile is a start trigger frame, which specifies the absolute time (date/time) at which CAN communication started.
ArbitrationId	U32	Zero.
DataLength	U32	One.
Data	[U8]	The **Data** array contains a single byte that specifies the timestamp format used for all the subsequent CAN frames. The value is `0` for absolute timestamps, and `1` for relative timestamps.
Timestamp	DBL	This indicates the time of the start trigger in the absolute format. Within a logfile, this timestamp indicates the date and time at which communication started. The timestamp is a LabVIEW numeric double with **Format and Precision** of **Absolute** time (date/time). The format of this timestamp is always absolute, even when **Data** byte 0 specifies relative timestamp format. This absolute timestamp provides date/time information even when the CAN frames use the relative format.

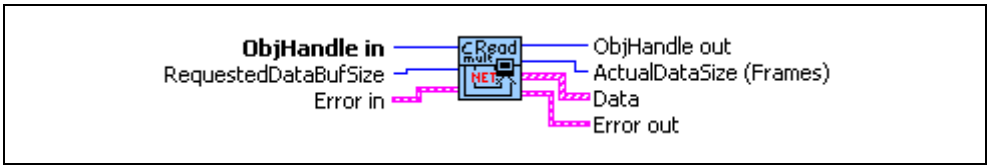
Note If you use **Time & Date** format, LabVIEW limits the **Seconds Precision** to `3`, which shows only milliseconds. The NI-CAN timestamp provides microsecond precision. If you need to view microsecond precision, change the timestamp to decimal format, with six digits of precision.

ncReadNetMult.vi

Purpose

Read multiple frames from a CAN Network Interface Object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

RequestedDataBufSize specifies the maximum number of frames desired. To empty the read queue, call **ncGetAttr.vi** for the **Read Entries Pending** attribute to get the actual number of frames in the read queue and use that number as the **RequestedDataBufSize**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

ActualDataSize (Frames) specifies the number of frames returned in **Data**. This number is less than or equal to **RequestedDataBufSize**.

Data returns an array of clusters. Each cluster in the array uses the typedef `CanFrameTimed.ctl`, with the following elements.

Note Within each cluster, **IsRemote** indicates the frame type. The frame type determines the interpretation of the remaining fields. For a description of each frame type, refer to *Frame Types*.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

Since NI-CAN handles the read queue in the background, this VI does not wait for new frames to arrive. To ensure that new frames are available before calling **ncReadNetMult.vi**, first wait for the **Read Available** state or **Read Multiple** state using **ncWaitForState.vi**.

When you call **ncReadNetMult.vi** for an empty read queue (**Read Available** state False), **Error out** returns `success (status=F, code=0)`, and **ActualDataSize (Frames)** returns `0`.

When a frame arrives for a full read queue, NI-CAN discards the new frame, and the next call to **ncReadNetMult.vi** returns the error `CanErrOverflowRead (status=T, code= BFF62028 hex)`. If you detect this overflow, try to read in a relatively tight loop (few milliseconds each read).

Although the Network Interface allows **Read Queue Length** of zero, this is not recommended, because every new frame will always overwrite the previous frame.

You can use the Network Interface and CAN Objects simultaneously. When a CAN frame arrives from the network, NI-CAN first checks the **ArbitrationId** for an open CAN Object. If no CAN Object applies, NI-CAN checks the comparators and masks of the Network Interface (including the **Series 2 Filter Mode** attributes). If the frame passes that filter, NI-CAN places the frame into the read queue of the Network Interface.

Error Active, Error Passive, and Bus Off States

When the CAN communication controller transfers into the error passive state, NI-CAN returns the warning `CanCommWarning (Status=F, code=3ff6200B hex)` from read VIs.

When the transmit error counter of the CAN communication controller increments above 255, the network interface transfers into the **bus off** state as dictated by the CAN protocol. The network interface stops communication so that you can correct the defect in the network, such as a malfunctioning cable or device. When **bus off** occurs, NI-CAN returns the error `CanCommError (status=T, code=BFF6200B hex)` from read VIs.

If no CAN devices are connected to the network interface port, and you attempt to transmit a frame, the warning `CanWarnComm` is returned. This warning occurs because the missing acknowledgment bit increments the transmit error counter until the network interface reaches the `error passive` state, but **bus off** state is never reached.

For more information about low-speed communication error handling, refer to the **Log Comm Warnings** attribute in **ncSetAttr.vi**.

Frame Types

IsRemote indicates the frame type. The frame type determines the interpretation of the remaining fields. The following tables describe the fields of the cluster for each value of **IsRemote**.

Table 10-16. IsRemote value 0: CAN Data Frame

Field Name	Data Type	Description
IsRemote	U32	Value `0` represents a CAN data frame. The CAN data frame contains data from the network.
ArbitrationId	U32	Specifies the arbitration ID to transmit in the CAN data frame. A standard ID (11-bit) is specified by default.
DataLength	U32	Indicates the number of data bytes in the **Data** array.
Data	[U8]	The received data bytes (8 maximum).

Table 10-17. IsRemote Value 1: CAN Remote Frame

Field Name	Data Type	Description
IsRemote		Value `1` represents a CAN remote frame. Only Series 2 or later can receive remote frames using the Network Interface. For Series 1 hardware, you must handle incoming remote frames with CAN Object only.
ArbitrationId		Specifies the arbitration ID to transmit in the CAN data frame.
DataLength		Returns the Data Length Code in the remote frame, but with no data.
Data		Ignored. No data bytes are contained in a CAN remote frame.

Table 10-18. IsRemote Value 2: Communication Warning or Error Frame

Field Name	Data Type	Description
IsRemote		Value 2 represents a communication warning or error frame. This indicates a communication problem reported by the CAN controller or the low-speed CAN transceiver. This frame type occurs only when you set the **Log Comm Warnings** attribute to TRUE and the CAN controller is in the error passive state. For more information on communication problems, refer to the *Description* section.
ArbitrationId		8000000B hex—Comm. error: General 4000000B hex—Comm. warning: General 8001000B hex—Comm. error: Stuffing 4001000B hex—Comm. warning: Stuffing 8002000B hex—Comm. error: Format 4002000B hex—Comm. warning: Format 8003000B hex—Comm. error: No Ack 4003000B hex—Comm. warning: No Ack 8004000B hex—Comm. error: Tx 1 Rx 0 4004000B hex—Comm. warning: Tx 1 Rx 0 8005000B hex—Comm. error: Tx 0 Rx 1 4005000B hex—Comm. warning: Tx 0 Rx 1 8006000B hex—Comm. error: Bad CRC 4006000B hex—Comm. warning: Bad CRC 0000000B hex—Comm. Error/warnings cleared 8000000C hex—Transceiver fault warning 0000000C hex—Transceiver fault cleared

Table 10-18. IsRemote Value 2: Communication Warning or Error Frame (Continued)

Field Name	Data Type	Description
DataLength		Ignored.
Data		Ignored.

Table 10-19. IsRemote Value 3: RTSI Frame

Field Name	Data Type	Description
IsRemote		Value 3 represents a CAN data frame. This indicates when a RTSI input pulse occurred relative to incoming CAN frames. This frame type occurs only when you set the **RTSI Mode** attribute to **On RTSI Input–Timestamp** event (refer to **ncConfigCANNetRTSI.vi** for details).
ArbitrationId		Is the special value 40000001 hex.
DataLength		The RTSI signal detected.
Data		Ignored.

Table 10-20. IsRemote Value 4: Start Trigger Frame

Field Name	Data Type	Description
IsRemote		Value 4 represents the start trigger frame. When the **Log Start Trigger** attribute is enabled, this frame indicates the time when the start trigger occurs. For example, if you use **ncConnectTerminals.vi** to connect a RTSI input to the start trigger, this frame occurs when the RTSI input pulses for the first time. Another use case for logging the start trigger would be for logging the received CAN frames in a file. This ensures that the first frame in a logfile is a start trigger frame, which specifies the absolute time (date/time) at which CAN communication started.
ArbitrationId		Zero.
DataLength		One.
Data		The **Data** array contains a single byte that specifies the timestamp format used for all the subsequent CAN frames. The value is `0` for absolute timestamps, and `1` for relative timestamps.
Timestamp		This indicates the time of the start trigger in the absolute format. Within a logfile, this timestamp indicates the date and time at which communication started. The timestamp is a LabVIEW numeric double with **Format and Precision** of **Absolute** time (date/time). The format of this timestamp is always absolute, even when **Data** byte 0 specifies relative timestamp format. This absolute timestamp provides date/time information even when the CAN frames use the relative format.

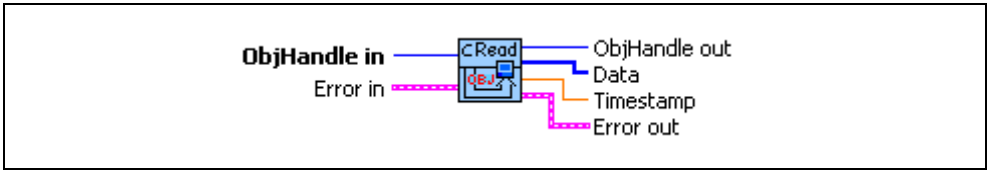
Note If you use **Time & Date** format, LabVIEW limits the **Seconds Precision** to `3`, which shows only milliseconds. The NI-CAN timestamp provides microsecond precision. If you need to view microsecond precision, change the timestamp to decimal format, with six digits of precision.

ncReadObj.vi

Purpose

Read single frame from a CAN Object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

Data array returns 8 data bytes. The actual number of valid data bytes depends on the CAN Object configuration specified in **ncConfigCANObj.vi**.

If the CAN Object **Communication Type** specifies `Transmit`, data frames are transmitted, not received, so **ncReadObj.vi** has no effect.

If the CAN Object **Communication Type** specifies `Receive`, **Data** always contains **Data Length** valid bytes, where **Data Length** was configured using **ncConfigCANObj.vi**.

Timestamp returns the absolute timestamp when the frame was placed into the read queue. The value matches the absolute timestamp format used within LabVIEW itself. LabVIEW time is a `DBL` representing the number of seconds elapsed since 12:00 a.m., Friday, January 1, 1904, Coordinated Universal Time (UTC). You can wire this **Timestamp** to LabVIEW time functions such as **Seconds To Date/Time**. You also can display the time in a numeric indicator of type `DBL` by using **Format & Precision** to select **Time & Date** format.

Note If you use **Time & Date** format, LabVIEW limits the **Seconds Precision** to `3`, which shows only milliseconds. The NI-CAN timestamp provides microsecond precision. If you need to view microsecond precision, change the timestamp to *decimal* format, with six digits of precision.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

ncReadObj.vi is useful when you need to process one frame at a time. In order to read multiple frames at a time, such as for high-bandwidth networks, use **ncReadObjMult.vi**.

Since NI-CAN handles the read queue in the background, this VI does not wait for a new frame to arrive. To ensure that a new frame is available before calling **ncReadObj.vi**, first wait for the **Read Available** state using **ncWaitForState.vi**.

When you call **ncReadObj.vi** for an empty read queue (**Read Available** state False), the frame from the previous call to **ncReadObj.vi** is returned again, along with the warning `CanWarnOldData (status=F, code=3FF62009 hex)`.

When a frame arrives for a full read queue, NI-CAN discards the new frame, and the next call to **ncReadObj.vi** returns the error `CanErrOverflowRead (status=T, code= BFF62028 hex)`. If you detect this overflow, switch to using **ncReadObjMult.vi** to read in a relatively tight loop (few milliseconds each read).

If you only need to obtain the most recent frame received for the CAN Object, you can set **Read Queue Length** to zero. When the read queue uses a zero length, only the most recent frame is stored, and overflow errors do not occur.

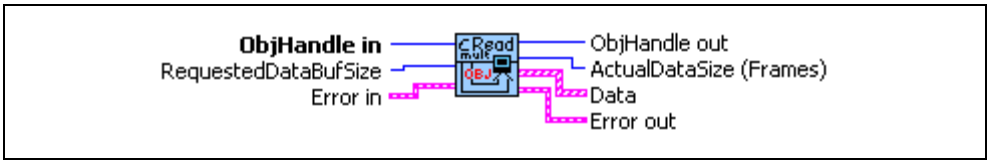
You can use the Network Interface and CAN Objects simultaneously. When a CAN frame arrives from the network, NI-CAN first checks the **ArbitrationId** for an open CAN Object. If no CAN Object applies, NI-CAN checks the comparators and masks of the Network Interface (including the **Series 2 Filter Mode** attributes). If the frame passes that filter, NI-CAN places the frame into the read queue of the Network Interface.

ncReadObjMult.vi

Purpose

Read multiple frames from a CAN Object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

RequestedDataBufSize specifies the maximum number of frames desired. For most applications, this will be the same as the configured **Read Queue Length** in order to empty the read queue with each call to **ncReadObjMult.vi**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

ActualDataSize (Frames) specifies the number of frames returned in **Data**. This number is less than or equal to **RequestedDataBufSize**.

Data returns an array of clusters. Each cluster in the array uses the typedef `CanDataTimed.ctl` with the following elements:

Data array returns 8 data bytes. The actual number of valid data bytes depends on the CAN Object configuration specified in **ncConfigCANObj.vi**.

If the CAN Object **Communication Type** specifies `Transmit`, data frames are transmitted, not received, so **Data** is ignored. For this **Communication Type**, **ncReadObjMult.vi** has no effect.

If the CAN Object **Communication Type** specifies `Receive`, **Data** always contains **Data Length** valid bytes, where **Data Length** was configured using **ncConfigCANObj.vi**.

Timestamp returns the absolute timestamp when the frame was placed into the read queue. The value matches the absolute timestamp format used within LabVIEW itself. LabVIEW time is a `DBL` representing the number of seconds elapsed since 12:00 a.m., Friday, January 1, 1904, Coordinated Universal Time (UTC). You can wire this **Timestamp** to LabVIEW time functions such as **Seconds To Date/Time**. You also can display the time in a numeric indicator of type `DBL` by using **Format & Precision** to select **Time & Date** format.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

Since NI-CAN handles the read queue in the background, this VI does not wait for new frames to arrive. To ensure that new frames are available before calling **ncReadObjMult.vi**, first wait for the **Read Available** state or **Read Multiple** state using **ncWaitForState.vi**.

When you call **ncReadObjMult.vi** for an empty read queue (**Read Available** state False), **Error out** returns `success (status=F, code=0)`, and **ActualDataSize (Frames)** returns `0`.

When a frame arrives for a full read queue, NI-CAN discards the new frame, and the next call to **ncReadObjMult.vi** returns the error `CanErrOverflowRead (status=T, code=BFF62028 hex)`. If you detect this overflow, try to read in a relatively tight loop (few milliseconds each read).

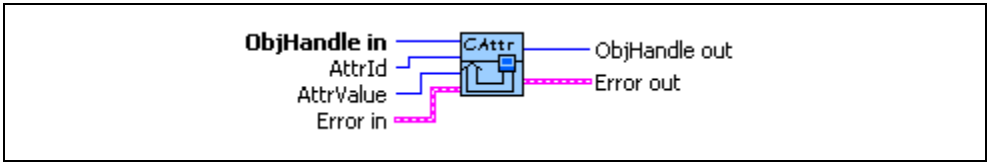
You can use the Network Interface and CAN Objects simultaneously. When a CAN frame arrives from the network, NI-CAN first checks the **ArbitrationId** for an open CAN Object. If no CAN Object applies, NI-CAN checks the comparators and masks of the Network Interface (including the **Series 2 Filter Mode** attributes). If the frame passes that filter, NI-CAN places the frame into the read queue of the Network Interface.

ncSetAttr.vi

Purpose

Set the value of an object attribute. The attributes provided in this VI allow for additional configuration beyond the attributes of **ncConfig** VIs.

Format



Input

U32

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

U32

AttrId specifies the attribute to set.

Listen Only?

Specifies whether to use the listen only feature of the Philips SJA1000 CAN controller (Series 2 only).

Communication must be stopped to set this attribute. Use **Start On Open** FALSE with **ncConfigCANNet.vi**, set the attribute, then use **ncAction.vi** to start communication.

The values for this attribute are:

0 (FALSE)

When set to FALSE, listen only mode is disabled (default).

Received frames are ACKnowledged, and frames can be transmitted using **ncWriteNet.vi** and **ncWriteObj.vi**.

1 (TRUE)

When set to TRUE, listen only mode is enabled.

The Network Interface and CAN Objects can only receive frames. The interface does not transmit on the network: no ACKnowledgements are transmitted for received frames, and **ncWriteNet.vi** and **ncWriteObj.vi** will return an error. The Philips SJA1000 CAN controller enters error passive state when listen only is enabled.

The listen only mode is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware (returns error).

This attribute is available only for the Network Interface, not CAN Objects.

Log Comm Warnings

Specifies whether to log communication warnings (including transceiver faults) to the Network Interface read queue.

The values for this attribute are:

`0` (FALSE)

When set to FALSE, the Network Interface reports CAN communication warnings (including transceiver faults) in **Error out** of the read VIs. For more information, refer to **ncReadNetMult.vi**.

`1` (TRUE)

When set to TRUE, the Network Interface reports CAN communication warnings (including transceiver faults) by storing a special frame in the read queue. The communication warnings are not reported in **Error out**. For more information on communication warnings and errors, refer to **ncReadNetMult.vi**. The special communication warning frame uses the following format:

Arbitration ID:
Error/warning ID (refer to **ncReadNetMult.vi**)

Timestamp:
Time when error/warning occurred

IsRemote:
2

DataLength:
0

Data:
N/A (ignore)

When calling **ncReadNet.vi** or **ncReadNetMult.vi** to read frames from the Network Interface, you typically use the **IsRemote** field to differentiate communications warnings from CAN frames. Refer to **ncReadNetMult.vi** for more information.

This attribute is available only from the Network Interface, not CAN Objects.

Log Start Trigger?

Set this attribute to true if you wish to log the start trigger into the read queue of the CAN Network Interface Object.

The values for this attribute are:

0 (FALSE)

Disables the logging of the start trigger (default) in the read queue of the Network Interface Object.

1 (TRUE)

Enables the logging of the start trigger in the read queue of the Network Interface Object. The start trigger is logged when the CAN chip starts communication.

This attribute should be set prior to starting the CAN network interface object. This attribute is applicable only to the CAN Network Interface Object and setting this attribute on CAN objects will result in a NI-CAN error.

Note Setting this attribute to true in applications that only transmit CAN frames has no effect.

Master Timebase Rate

Sets the rate (in MHz) of the external clock that is exported to the CAN card.

The values for this attribute are:

`20` (20 MHz)

When synchronizing 2 CAN cards or synchronizing a CAN card with an E Series DAQ card, the 20 MHz **Master Timebase Rate** is to be used. By default, this attribute is set to 20 MHz.

`10` (10 MHz)

The **Master Timebase Rate** should be set to 10 MHz when synchronizing a CAN card with an M Series DAQ card. The M Series DAQ card can export a 20 MHz clock but it does this by using one of its two counters.

If your CAN-DAQ application does not use the 2 DAQ counters then, you can leave the timebase rate set to 20 MHz (default).

This attribute can be set either before or after calling **ncConnectTerminals.vi** to connect the **RTSI_CLK** to **Master Timebase**. However, this attribute must always be called prior to starting the Network Interface Object.

This attribute is applicable only to PCI and PXI Series 2 cards. For PCMCIA cards, setting this attribute will return an error. On PXI cards, if **PXI_CLK10** is routed to the **Master Timebase**, then the rate is fixed at 10 MHz (it over rides any previous setting of this attribute). Setting this attribute for Series 1 cards will also result in a NI-CAN error.

ReadMult Size for Notification

Sets the number of frames used as a threshold for the **Read Multiple** state. For more information on the **Read Multiple** state, refer to **ncWaitForState.vi**.

The default value is one half of **Read Queue Length**.

Self Reception?

Specifies whether to echo successfully transmitted CAN frames into the read queue of the Network Interface and/or CAN Objects (Series 2 only). Each reception occurs just as if the frame were received from another CAN device.

For self reception to operate properly, another CAN node must receive and acknowledge each transmit. If a transmitted frame is not successfully acknowledged, it is not echoed into the read queue.

Communication must be stopped to set this attribute. Use **Start On Open** FALSE with **ncConfigCANNet.vi**, set the attribute, then use **ncAction.vi** to start communication.

`0` (FALSE)

Disables **Self Reception** mode (default). Transmitted frames do not appear in read queues.

`1` (TRUE)

Enables **Self Reception** mode. Transmitted frames appear in read queues as if they were received from another CAN device.

The **Self Reception** mode is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware. For Series 1 hardware, this attribute must be left at its default (zero).

This attribute is available only for the Network Interface, not CAN Objects.

Series 2 Comparator

Specifies the filter comparator for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This attribute is not supported for Series 1 hardware (returns error).

This attribute specifies a comparator value that is checked against the ID, RTR, and data bits. The **Series 2 Mask** determines the applicable bits for comparison.

The default value of this attribute is zero.

The mapping of bits in this attribute to the ID, RTR, and data bits of incoming frames is determined by the value of the **Series 2 Filter Mode** attribute. Refer to **Series 2 Filter Mode** to understand the format of this attribute as well as the **Series 2 Mask**.

Communication must be stopped to set this attribute. Use **Start On Open** FALSE with **ncConfigCANNet.vi**, set the desired attributes, then use **ncAction.vi** to start communication.

Series 2 Mask

Specifies the filter mask for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This attribute is not supported for Series 1 hardware (returns error).

This attribute specifies a bit mask that determines the ID, RTR, and data bits that are compared. If a bit is clear in the mask, the corresponding bit in the **Series 2 Comparator** is checked. If a bit in the mask is set, that bit is ignored for the purpose of filtering (don't care). This interpretation is the opposite of the legacy **Standard/Extended Mask** attributes.

The default value of this attribute is hex `FFFFFFFF`, which means that all frames are received.

The mapping of bits in this attribute to the ID, RTR, and data bits of incoming frames is determined by the value of the **Series 2 Filter Mode** attribute. Refer to **Series 2 Filter Mode** to understand the format of this attribute as well as the **Series 2 Comparator**.

Communication must be stopped to set this attribute. Use **Start On Open** FALSE with **ncConfigCANNet.vi**, set the desired attributes, then use **ncAction.vi** to start communication.

Series 2 Filter Mode

All Series 2 hardware uses the Philips SJA1000 CAN controller. The Philips SJA1000 CAN controller provides sophisticated filtering of received frames. This attribute specifies the filtering mode, which is used in

conjunction with the **Series 2 Mask** and **Series 2 Comparator** attributes.

This attribute is not supported for Series 1 hardware (returns error). For Series 1, the **Standard Mask/Comparator** and **Extended Mask/Comparator** attributes are programmed directly into the Intel 82527 CAN controller. Use those attributes to specify filtering of received frames on Series 1 hardware.

For Series 2 hardware, the Philips SJA1000 does not support distinct standard and extended masking. Therefore, on Series 2 hardware the **Standard Mask/Comparator** and **Extended Mask/Comparator** attributes are implemented in software (for backward compatibility). Since software masking can have an adverse impact on receive performance, National Instruments recommends that you disable software masking for Series 2 hardware. Disable software masking by specifying don't-care (`0`) for all four mask/comparator attributes of **ncConfigCANNet.vi**.

Communication must be stopped to set this attribute. Use **Start On Open** FALSE with **ncConfigCANNet.vi**, set the desired attributes, then use **ncAction.vi** to start communication.

Since the format of the Series 2 filters is very specific to the Philips SJA1000 CAN controller, National Instruments cannot guarantee compatibility for this attribute on future hardware series. When using this attribute in the application, it is best to get the **Series** attribute to verify that the CAN hardware is Series 2.

The filtering specified by this attribute and the Series 2 Mask/Comparator applies to the CAN Network Interface Object and all CAN Objects for that interface. For example, if you specify filters that discard ID 5, then open a CAN Object to receive ID 5, the CAN Object will not receive data.

The default value for this attribute is **Single Standard**.

This attribute uses the following values:

`0`	(Single Standard)

Filter all standard (11-bit) frames using a single mask/comparator filter.

Figure 10-5 describes the format of the **Series 2 Mask** and **Series 2 Comparator** attributes for this filter mode.

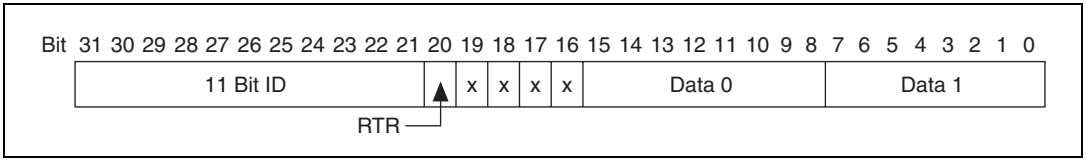


Figure 10-5. Mask/Comparator for Single-Standard Filter Mode

The 11 Bit ID compares all 11 bits of standard IDs. The RTR bit determines whether the filter compares remote (`0`) or data (`1`) frames. Bits marked as "X" are reserved, and should be cleared to zero by the application. Data 0 compares the first data byte in the frame, and Data 1 compares the second data byte.

`1` (Single Extended)

Filter all extended (29-bit) frames using a single mask/comparator filter.

Figure 10-6 describes the format of the **Series 2 Mask** and **Series 2 Comparator** attributes for this filter mode.

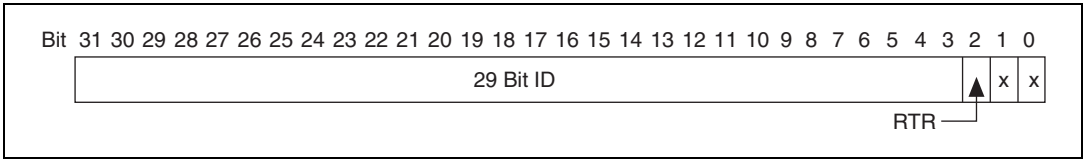


Figure 10-6. Mask/Comparator for Single-Extended Filter Mode

The 29 Bit ID compares all 29 bits of extended IDs. The RTR bit determines whether the filter compares remote (`0`) or data (`1`) frames. Bits marked as "X" are reserved, and should be cleared to zero by the application.

2 (Dual Standard)

Filter all standard (11-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

Figure 10-7 describes the format of the **Series 2 Mask** and **Series 2 Comparator** attributes for this filter mode.

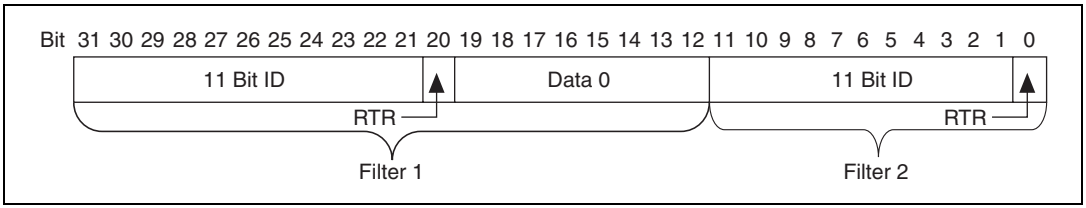


Figure 10-7. Mask/Comparator for Dual-Standard Filter Mode

Filter 1 includes the 11 Bit ID, the RTR bit, and the first data byte in the frame. Filter 2 includes the 11 bit ID, and the RTR bit (no data).

3 (Dual Extended)

Filter all extended (29-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

Figure 10-8 describes the format of the **Series 2 Mask** and **Series 2 Comparator** attributes for this filter mode.

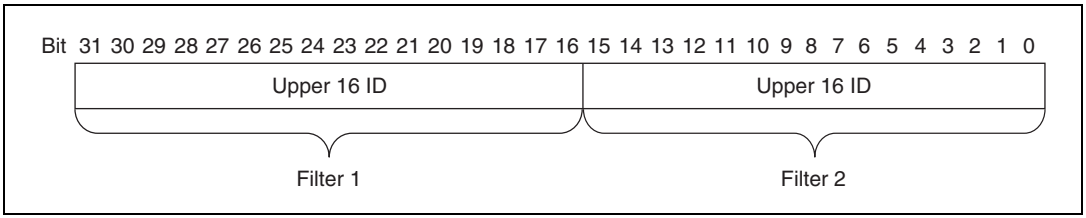


Figure 10-8. Mask/Comparator for Dual-Extended Filter Mode

Each Upper 16 ID filter compares the 16 most significant bits of the 29-bit extended ID.

Single Shot Transmit?

Specifies whether to retry failed CAN frame transmissions (Series 2 only).

Communication must be stopped to set this attribute. Use **Start On Open** FALSE with **ncConfigCANNet.vi**, set the attribute, then use **ncAction.vi** to start communication.

`0` (Retry Enabled)

Enables retry as defined in the CAN specification (default). If a CAN frame is not transmitted successfully, the CAN controller will immediately retry.

`1` (Single Shot Transmit)

Single shot transmit. If a CAN frame is not transmitted successfully, the CAN controller will not retry.

The Single Shot Transmit feature is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware. For Series 1 hardware, this attribute must be left at its default (zero).

This attribute is available only for the Network Interface, not CAN Objects.

Timeline Recovery

Specifies whether to configure the CAN Network Interface Object to recover the original timeline when a timestamped transmit is late.

This attribute is applicable only when the **Transmit Mode** attribute is set to **Timestamped Transmit** (`1`).

Due to factors such as CAN bus arbitration, the time that a frame transmits successfully may be later than the original time specified. When a timestamped transmit is late, this attribute determines how NI-CAN will adjust transmit times for subsequent frames.

The values for this attribute are:

`0` (FALSE)

Do not recover the original timeline.

Frames always transmit with the original gap or greater. This behavior is useful when you need to maintain a minimum gap between frames. Figure 10-9 shows an original timeline of three frames with a 10 ms gap. When frame B transmits 3 ms late, frame C continues to transmit 10 ms later, so the actual timeline slips.

`1` (TRUE)

Recover the original timeline.

When a timestamped transmit is late, the subsequent frame will transmit with a reduced gap. This behavior is useful when you need to maintain a timeline, such as when synchronizing CAN output with analog or digital output. Figure 10-10 shows an original timeline of three frames with a 10 ms gap. When frame B transmits 3 ms late, frame C transmits 7 ms later in order to recover the timeline.

The default value for this attribute is FALSE.

This attribute has to be set prior to starting the CAN Network Interface Object.

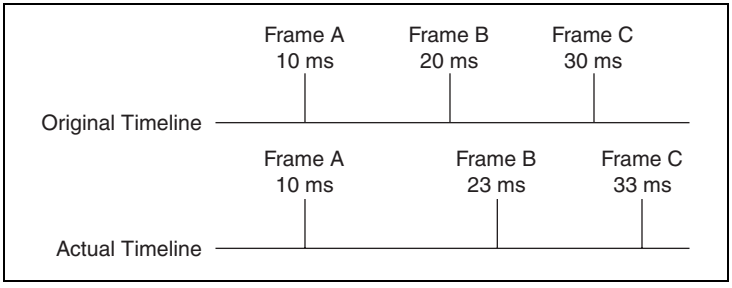


Figure 10-9. Example with Time Recovery Disabled

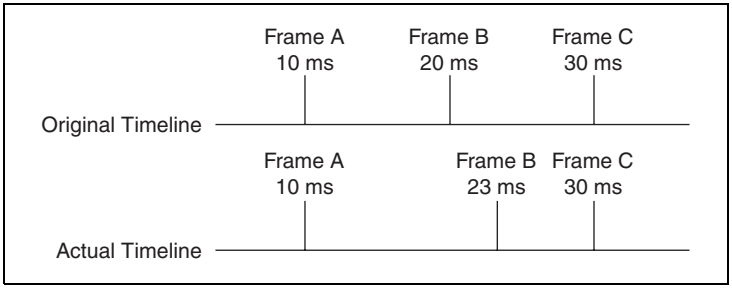


Figure 10-10. Example with Time Recovery Enabled

Timestamp Format

Sets the format of the timestamps reported by the on-board timer on the CAN card.

The default value for this attribute is `Absolute`.

The values for this attribute are:

`0` (Absolute)

Sets the timestamp format to absolute. In the absolute format, the timestamp returned by NI-CAN read functions is the LabVIEW date/time format (DBL representing the number of seconds elapsed since 12:00 a.m., Friday, January 1, 1904).

`1` (Relative)

Sets the timestamp format to relative. In the relative format, the timestamp returned by the NI-CAN read functions will be zero based (DBL representing the number of seconds since the start trigger occurred).

A typical use case for this attribute would be if data received from two RTSI synchronized CAN cards is to be correlated. For that use case, this attribute must be set to `1` for all of the CAN cards being synchronized. Setting this attribute on one port of a 2-port card will also reset the timestamp of the second port, since resetting the timestamp on the CAN port resets the on-board timer.

This attribute should be set prior to starting any communication on the CAN card.

Transceiver External Outputs

Sets the transceiver external outputs for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this attribute allows you to set the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you control the sleep mode of the on-board CAN controller chip.

For many models of CAN transceiver, EN and NSTB pins control the transceiver mode, such as whether the transceiver is sleeping, or communicating normally. For such transceivers, you can wire the EN and NSTB pins to the MODE0 and MODE1 pins of the CAN port.

The default value of this attribute is `00000003` hex. For many models of transceiver, this specifies normal communication mode for the transceiver and CAN controller chip. If the transceiver requires a different MODE0/MODE1 combination for normal mode, you can use external inverters to change the default 5 V to 0 V.

This attribute is supported for Series 2 XS cards only. This attribute is not supported when the **Transceiver Type** is any value other than **External**. To control the mode of an internal transceiver, use the **Transceiver Mode** attribute.

This attribute uses a bit mask. Use bitwise OR operations to set multiple values.

`00000001` hex (MODE0)

Set this bit to drive 5 V on the MODE0 pin. This is the default value. This bit is set automatically when a remote wakeup is detected.

Clear this bit to drive 0 V on the MODE0 pin.

00000002 hex (MODE1)

Set this bit to drive 5 V on the MODE1 pin. This is the default value. This bit is set automatically when a remote wakeup is detected.

Clear this bit to drive 0 V on the MODE1 pin.

00000100 hex (Sleep CAN controller chip)

Set this bit to place the CAN controller chip into sleep mode. This bit controls the mode of the CAN controller chip (sleep or normal), and the independent MODE0/MODE1 bits control the mode of the external transceiver. When you set this bit to place the CAN controller into **Sleep** mode, you typically specify MODE0/MODE1 bits that place the external transceiver into sleep mode as well.

When the CAN controller is asleep, a remote wakeup will automatically place the CAN controller into its normal mode of communication. In addition, the MODE0/MODE1 pins are restored to their default values of 5 V. Therefore, a remote wakeup causes this attribute to change from the value that you set for sleep mode, back to its default 00000003 hex. You can determine when this has occurred by getting **Transceiver External Outputs** using **ncGetAttr.vi**. For more information on remote wakeup, refer to the **Transceiver Mode** attribute for internal transceivers.

Clear this bit to place the CAN controller chip into normal communication mode. If the CAN controller was previously in sleep mode, this performs a local wakeup to restore communication.

Transceiver Mode

Sets the transceiver mode for the Network Interface. The transceiver mode controls whether the transceiver is asleep or communicating, as well as other special modes.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to

communication by CAN Objects as well as the associated Network Interface.

This attribute is supported on Series 2 cards only.

For Series 2 cards for the PCMCIA form factor, this property requires a corresponding Series 2 cable (dongle). For information on how to identify the series of the PCMCIA cable, refer to the *Series 2 versus Series 1* subsection of the *NI CAN Hardware Overview* section of Chapter 1, *Introduction*.

For Series 2 XS cards, this attribute is not supported when the **Transceiver Type** is **External**. To control the mode of an external transceiver, use the **Transceiver External Outputs** attribute.

The default value for this attribute is **Normal**.

This attribute uses the following values:

`0` (Normal)

Set transceiver to normal communication mode. If you set **Sleep** mode previously, this performs a local wakeup of the transceiver and CAN controller chip.

`1` (Sleep)

Set transceiver and the CAN controller chip to sleep (or standby) mode.

If the transceiver supports multiple sleep/standby modes, the NI CAN hardware implementation ensures that all of those modes are equivalent with regard to the behavior of a transceiver on the network. For more information on the physical specifications of the **Normal** and **Sleep** modes of each transceiver, refer to Chapter 3, *NI CAN Hardware*.

You can set **Sleep** mode only while the interface is communicating. If the Network Interface has not been started, setting the transceiver mode to **Sleep** will return an error.

When the interface enters sleep mode, communication is not possible until a wakeup occurs. All pending frame transmissions are deferred until the wakeup occurs. The transceiver and CAN controller wake from **Sleep** mode when either a local wakeup or remote wakeup occurs.

A *local wakeup* occurs when the application sets the transceiver mode to **Normal** (or some other communication mode).

A *remote wakeup* occurs when a remote node transmits a CAN frame (referred to as the *wakeup frame*). The wakeup frame wakes up the transceiver and CAN controller chip of the NI CAN interface. The wakeup frame is not received or acknowledged by the CAN controller chip. When the wakeup frame ends, the NI CAN interface enters **Normal** mode, and again receives and transmits CAN frames. If the node that transmitted the wakeup frame did not detect an acknowledgement (such as if other nodes were also waking), it will retry the transmission, and the retry will be received by the NI CAN interface.

For a remote wakeup to occur for Single Wire transceivers, the node that transmits the wakeup frame must first place the network into the **Single Wire Wakeup Transmission** mode by asserting a higher voltage (typically 12 V). For more information, refer to mode 2.

When the local or remote wakeup occurs, frame transmissions resume from the point at which the original **Sleep** was set.

You can detect when a remote wakeup occurs by using **ncDisconnectTerminals.vi** with the **Transceiver Mode** attribute. If you need to suspend the application while waiting for the remote wakeup, use the **Remote Wakeup** state of **ncWaitForState.vi** or **ncCreateOccur.vi**.

2 (Single Wire Wakeup)

Set Single Wire transceiver to **Wakeup Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire Wakeup Transmission** mode drives a higher voltage level on the network to wakeup all sleeping nodes. Other than this higher voltage, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

Since you use the **Single Wire Wakeup** mode to wakeup other nodes on the network, it is not typically used in combination with **Sleep** mode for a given interface.

The timing of how long the wakeup voltage is driven is controlled entirely by the application. The application will typically change to **Single Wire Wakeup** mode, transmit a wakeup frame, then return to **Normal** mode.

The following sequence demonstrates a typical sequence of steps for sleep and wakeup between two Single Wire NI CAN interfaces. The sequence assumes that **CAN0** is the sleeping node, and **CAN1** originates the wakeup.

1. Start both **CAN0** and **CAN1**. Both use the default **Normal** mode.
2. Set **Transceiver Mode** of **CAN0** to **Sleep**.
3. Set **Transceiver Mode** of **CAN1** to **Single Wire Wakeup**.
4. Write data to **CAN1** to transmit a wakeup frame to **CAN0**.
5. Set **Transceiver Mode** of **CAN1** to **Normal**.
6. Now both **CAN0** and **CAN1** are in **Normal** mode again.

3 (Single Wire High-Speed)

Set Single Wire transceiver to **High-Speed Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire High-Speed Transmission** mode disables the internal waveshaping function of the transceiver, which allows baud rates up to 100 kbytes/s to be used. The disadvantage versus **Normal** (which allows up to 40 kbytes/s baud) is degraded EMC performance. Other than the disabled waveshaping, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

This mode has no relationship to High-Speed (HS) transceivers. It is merely a higher speed mode of the Single Wire (SW) transceiver, typically used for downloading large amounts of data to a node.

The Single Wire transceiver does not support use of this mode in conjunction with **Sleep** mode. For example, a remote wakeup cannot transition from **Sleep** to this **Single Wire High-Speed** mode.

Transceiver Type

For XS Software Selectable Physical Layer cards that provide a software-switchable transceiver, the **Transceiver Type** attribute sets the type of transceiver. When the transceiver is switched from one type to another, NI-CAN ensures that the switch is undetectable from the perspective of other nodes on the network.

The default value for this attribute is specified within MAX. If you change the transceiver type in MAX to correspond to the network in use, you can avoid setting this attribute within the application.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

Communication for all objects on the Network Interface must be stopped prior to setting this attribute. You typically do this by calling **ncConfigCANNet.vi** with **Start On Open** set to False, then **ncOpen.vi** of the Network Interface, then **ncSetAttr.vi** to set **Transceiver Type**, then **ncAction.vi** to start communication. Prior to changing the **Transceiver Type** again, you must use **ncAction.vi** to stop communication.

You cannot set this attribute for Series 1 hardware, or for Series 2 hardware other than XS (fixed HS, LS, or SW cards).

This attribute uses the following values:

`0` (High-Speed)

Switch the transceiver to **High-Speed** (HS).

`1` (Low-Speed/Fault-Tolerant)

Switch the transceiver to **Low-Speed/Fault-Tolerant** (LS).

`2` (Single Wire)

Switch the transceiver to **Single Wire** (SW).

`3` (External)

Switch the transceiver to **External**. The **External** type allows you to connect a transceiver externally to the interface. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

When this transceiver type is selected, you can use the **Transceiver External Outputs** and **Transceiver External Inputs** attributes to access the external mode and status pins of the connector.

`4` (Disconnect)

Disconnect the CAN controller chip from the connector. This value is used when you physically switch an external transceiver. You first set **Transceiver Type** to **Disconnect**, then switch from

one external transceiver to another, then set **Transceiver Type** to **External**. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

Transmit Mode

Specifies whether to configure the CAN Network Interface Object to **Immediate Transmit** mode or **Timestamped Transmit** mode.

The default value for this attribute is zero (Immediate Transmit).

The values for this attribute are:

`0` (Immediate Transmit)

Configures the Network Interface Object in the **Immediate Transmit** mode. In the **Immediate Transmit** mode, the CAN frames are transmitted as soon as they are written into the Network Interface Object's write queue. CAN frames can be written into the Network Interface Objects write queue by either using **ncWriteNet.vi** or **ncWriteNetMult.vi**. Timestamps are ignored by NI-CAN when the Network Interface Object is configured in this mode.

`1` (Timestamped Transmit)

Configures the Network Interface Object in the **Timestamped Transmit** mode. In this mode, NI-CAN spaces the frame transmission according to the difference in timestamps between consecutive frames. For example, if every frame provided to **ncWriteNetMult.vi** increments by 10 milliseconds, the frames will be transmitted with a 10 millisecond gap.

If the timestamp of the CAN frame to be transmitted is less than the timestamp of the previous CAN frame, **Timestamped Transmit** is reset and the CAN frame will be transmitted immediately on the bus without adding any delay. For example, if you write a frame with a relative timestamp 30 ms

followed by a frame with a timestamp 15 ms, the two frames will be transmitted back to back.

Use **ncWriteNetMult.vi** to write CAN frames with timestamps into the write queue of the Network Interface Object.

To use the **ncWriteNet.vi** in **Timestamped Transmit** mode, refer to the description of **ncWriteNet.vi**.

This attribute has to be set prior to starting the CAN Network Interface Object.

User RTSI Frame

Sets the user RTSI frame. This attribute is normally configured using the **UserRTSIFrame** input of **ncConfigCANObjRTSI.vi**. This attribute allows that value to be changed while running. For more information, refer to **ncConfigCANObjRTSI.vi**.

This attribute is available only for CAN Objects, not the Network Interface.

Virtual Bus Timing

Sets the Virtual Bus Timing of the virtual device.

The values for this attribute are:

`0` (FALSE)

Virtual Bus Timing is turned off. By turning Virtual Bus Timing off, the CAN bus simulation is disabled and CAN frames are copied from the write queue of one virtual interface to the read queue of the second virtual interface. This setting is useful if you desire to only convert frames to channels or vice versa and not simulate actual CAN bus communication.

`1` (TRUE)

Virtual Bus Timing is turned on (default). By turning Virtual Bus Timing on, frame timestamps are recalculated as they transfer across the virtual bus.

This mode is useful when you want the virtual bus to behave as much like a real bus as possible.

If this attribute is set on real hardware, an error will be returned.

The Virtual Bus Timing has to be set to the same value on both virtual interfaces.

This attribute must be set prior to starting the virtual interface.

Refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*, for more information.

AttrValue provides the attribute value for **AttrId**.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is

returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

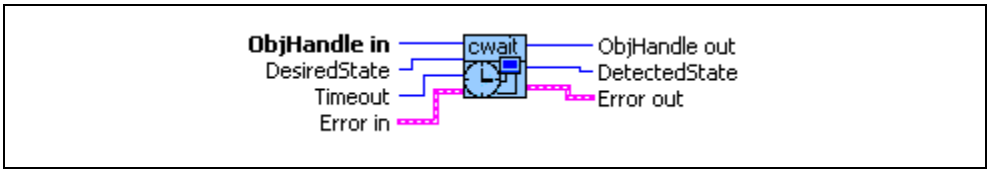
ncSetAttr.vi sets the value of the attribute specified by **AttrId** in the object specified by **ObjHandle in**.

ncWaitForState.vi

Purpose

Wait for one or more states to occur in an object.

Format



Input

U32

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

U32

DesiredState specifies a bit mask of states for which notification is desired. You can use a single state alone, or you can OR them together:

`00000001` hex Read Available

At least one frame is available, which you can obtain using an appropriate read VI.

The state is set whenever a frame arrives for the object. The state is cleared when the read queue is empty.

`00000002` hex Write Success

All frames provided through write VIs have been successfully transmitted onto the network. Successful transmit means that the frame won arbitration, and was acknowledged by a remote device.

The state is set when the last frame in the write queue is transmitted successfully. The state is cleared when a write VI is called.

When communication starts, the **Write Success** state is TRUE by default.

For CAN Objects, **Write Success** does not always mean that transmission has stopped. For example, if a CAN Object is configured for **Transmit Data Periodically**, **Write Success** occurs when the write queue has been emptied, but periodic transmit of the last frame continues.

`00000008` hex Read Multiple

A specified number of frames are available, which you can obtain using either **ncReadNetMult.vi** or **ncReadObjMult.vi**. The number of frames is configured using the **ReadMult Size for Notification** attribute of **ncSetAttr.vi**.

The state is set whenever the specified number of frames are stored in the read queue of the object. The state is cleared when you call the read VI, and less than the specified number of frames exist in the read queue.

`00000040` hex Remote Wakeup

Remote wakeup occurred, and **Transceiver Mode** has changed from **Sleep** to **Normal**. For more information on remote wakeup, refer to **Transceiver Mode**.

This state is set when a remote wakeup occurs (end of wakeup frame). This state is not set when the application changes **Transceiver Mode** from **Sleep** to **Normal** (local wakeup).

This state is cleared when:

- You open the Network Interface, such as when the application begins.
- You stop the Network Interface.
- You set the **Transceiver Mode**, such as each time you set **Sleep** mode.

For as long as this state is true, the transceiver mode is **Normal**. The **Transceiver Mode** also can be **Normal** when this state is false, such as when you perform a local wakeup.

`00000080` hex Write Multiple

The state is set whenever there is free space in the write queue to accept at least 512 frames to write. The state is cleared when you call **ncWriteNet.vi** or **ncWriteNetMult.vi** and less than 512 frames can be accepted to write in the write queue.

This state is valid only on the Network Interface.

Timeout specifies the maximum number of milliseconds to wait for one of the states in **DesiredState**. If the **Timeout** expires before a state occurs, the error `CanErrFunctionTimeout` is returned in **Error out** `(status=T, code=BFF62001 hex)`. If **Timeout** is unwired, the default value of `0` will cause the wait to return the current status immediately. Thus, it will behave like calling **ncGetAttr.vi** for the **Object State** attribute.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

DetectedState is the current state of object when desired states occur. If an error caused the wait to abort, **DetectedState** is zero.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute

the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

Use **ncWaitForState.vi** to wait for one or more states to occur in the object specified by **ObjHandle**. If an error occurs in the object, wait aborts and returns the error in **Error out**.

While waiting for the desired states, **ncWaitForState.vi** suspends execution of the current LabVIEW thread. VIs assigned to other threads can still execute. The thread of a VI can be changed in the **Priority** control in the **Execution** category of VI properties.

If you want to execute code in the same LabVIEW thread while waiting for NI-CAN states, refer to **ncCreateOccur.vi**. It requires more execution time than **ncWaitForState.vi**, but **ncCreateOccur.vi** allows other code in the thread to execute.

The functions **ncWaitForState.vi** and **ncCreateOccur.vi** use the same underlying implementation. Therefore, for each object handle, only one of these functions can be pending at a time. For example, you cannot invoke **ncWaitForState.vi** twice from different VIs for the same object. For different object handles, these functions can overlap in execution.

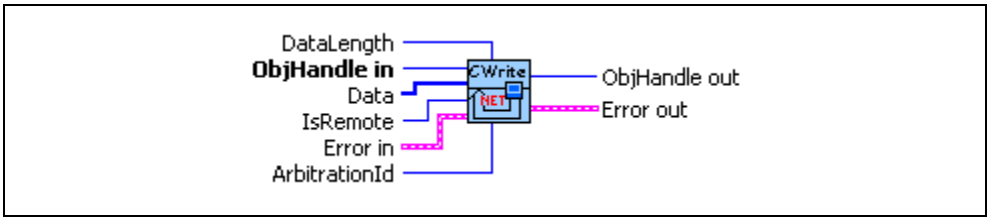
Note The **ncWaitForState.vi** function was formerly **ncWait.vi**.

ncWriteNet.vi

Purpose

Write a single frame to a CAN Network Interface Object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

Note The description of the input terminals is specified by the frame type. The value of **IsRemote** indicates the frame type. For a description of each frame type, refer to the *Frame Types* section.

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

You use **ncWriteNet.vi** to place a frame into the Network Interface write queue. Since NI-CAN handles the write queue in the background, this VI does not wait for the frame to be transmitted on the network.

To transmit a set of frames as quickly as possible, simply call **ncWriteNet.vi** once per frame, without using **ncWaitForState.vi** after each write. This technique makes good use of the write queue to optimize frame transmission.

Once you have written frames, if you need to wait for the final **ncWriteNet.vi** to be transmitted successfully, use **ncWaitForState.vi** with the **Write Success** state. The **Write Success** state sets when all frames of the write queue have been successfully transmitted. The **Write Success** state clears whenever you call **ncWriteNet.vi**.

The **ncWriteNet.vi** and **ncWriteNetMult.vi** functions share a common write queue in the Network Interface. Therefore, when you set the **Transmit Mode** attribute to Timestamped Transmit, **ncWriteNetMult.vi** places timestamped frames into the queue, and **ncWriteNet.vi** places non-timestamped frames into the queue. If you write timestamped frames followed by a non-timestamped frame, the timestamped frames will transmit first, followed immediately by the non-timestamped frame. For example, assume you write 3 frames A, B, and C with **ncWriteNetMult.vi**, followed by frame D with **ncWriteNet.vi**, and frame E with **ncWriteNetMult.vi**. Frames A, B, and C will transmit in their timed sequence. Frame D immediately follows frame C. Frame E transmits with the expected time distance from frame C, because the non-timestamped frame does not affect **ncWriteNetMult.vi** timing.

Sporadic, recoverable errors on the network are handled automatically by the CAN protocol. As such, after **ncWriteNet.vi** returns successfully, NI-CAN eventually transmits the frame on the network unless there is a serious network problem. Network problems such as missing or malfunctioning devices are often reported as the warning `CanWarmComm (status=F, code=3FF6200B hex)`.

If the write queue is full, a call to **ncWriteNet.vi** returns the error `CanErrOverflowWrite (status=T, code=BFF62008 hex)`. In many cases, this error is recoverable, so you should not exit the application when it occurs. For example, if you want to transmit thousands of frames in succession (for example, downloading code), the application can check for the error `CanErrOverflowWrite`, and when detected, simply wait a few milliseconds for some of the frames to transmit, then call **ncWriteNet.vi** again. If the second call to **ncWriteNet.vi** returns an error, that can be treated as an unrecoverable error (no other device is ACKing the frames).

Although the Network Interface allows **Write Queue Length** of zero, this is not recommended, because every new frame will always overwrite the previous frame.

Frame Types

IsRemote indicates the frame type. The frame type determines the interpretation of the remaining fields. The following tables describe the fields of the cluster for each value of **IsRemote**.

Table 10-21. IsRemote value 0: CAN Data Frame

Field Name	Data Type	Description
IsRemote		Value `0` represents a CAN data frame. The CAN data frame contains data from the network.
ArbitrationId		Specifies the arbitration ID to transmit in the CAN data frame. A standard ID (11-bit) is specified by default. In order to specify an extended ID (29-bit), OR in the bit mask `20000000` hex.
DataLength		Indicates the number of data bytes in the **Data** array.
Data		Specifies the data bytes (8 maximum).

Table 10-22. IsRemote value 1: CAN Remote Frame

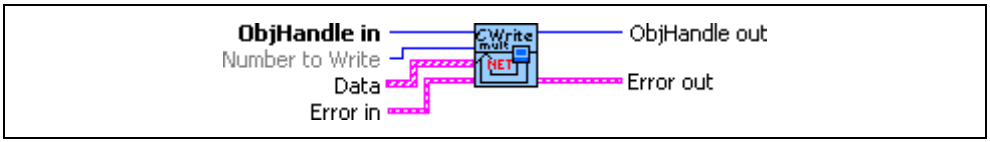
Field Name	Data Type	Description
IsRemote		Value `1` represents a CAN remote frame. Both Series 1 and Series 2 hardware can receive remote frames using the Network Interface.
ArbitrationId		Specifies the arbitration ID of the remote frame to transmit.
DataLength		Specifies the number of bytes requested. The value is transmitted in the CAN remote frame, but with no data.
Data		Ignored. No data bytes are contained in a CAN remote frame.

ncWriteNetMult.vi

Purpose

Write multiple frames to a CAN Network Interface Object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

NumberToWrite indicates the number of frames in the **Data** array to write to the Network Interface.

This input is optional. When this input is unwired, the function will write all valid frames listed in the **Data** array. The **NumberToWrite** input is most useful when you have a large array of frames, and you only want to transmit a subset of that array.

Data is an array of clusters. Each cluster represents a CAN frame to write. The cluster uses the typedef `CanFrameTimed.ctl`, the same typedef as **ncReadNetMult.vi**.

Within each cluster, **IsRemote** indicates the frame type. The frame type determines the interpretation of the remaining fields. For a description of each frame type, refer to the *Frame Types* topic in the Description section.

The maximum number of clusters you can provide to each **ncWriteNetMult.vi** is 512. For more information, refer to the *Writing Large Numbers of Frames* topic in the Description section.

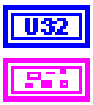
Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output



ObjHandle out is the object handle for the next NI-CAN VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

Use **ncWriteNetMult.vi** to place one or more frames into the Network Interface write queue. This function does not wait for the frames to be transmitted on the network.

Timestamped Transmit

In addition to supporting multiple frames, this function is preferable to **ncWriteNet.vi** in that it supports timestamped frames. To enable timestamped transmit, use **ncSetAttr.vi** to set the **Transmit Mode** attribute to Timestamped Transmit mode (`1`).

In Timestamped Transmit mode, NI-CAN times the transmission according to the difference in timestamps between consecutive frames. For example, if every frame provided to **ncWriteNetMult.vi** increments by 10 milliseconds, the frames will be transmitted with a 10 millisecond gap.

If the timestamp of one frame is less than the timestamp of the preceding frame, the timeline is reset, and both frames transmit back to back. For example, if you write a frame with relative timestamp 30 ms followed by a frame with timestamp 15 ms, the two frames will be

transmitted back to back. This sort of behavior can occur when you transmit a logfile of timestamped frames repeatedly, because on the second traversal of the logfile, the timestamp of the first frame will be less than the timestamp of the last frame.

The first frame that you provide to **ncWriteNetMult.vi** always transmits immediately, regardless of its timestamp. If you need to delay transmission of first frame after start, you can write a Delay frame or Start Trigger frame as described in *Frame Types*.

Immediate Transmit

The default value for the **Transmit Mode** attribute is **Immediate Transmit** mode (`0`). You can also use **ncSetAttr.vi** to set the **Transmit Mode** attribute to Immediate Transmit mode.

In Immediate Transmit mode, NI-CAN ignores the timestamp in each frame, and transmits the frames as fast as possible. This behavior is equivalent to the **ncWriteNet.vi** function, except that you can write multiple frames for transmission in quick succession.

Writing Large Numbers of Frames

Although NI-CAN provides a large write queue to store frames pending transmission, writing timestamped frames from a logfile with thousands of frames can eventually fill this queue.

When the Network Interface write queue cannot hold all frames provided, **ncWriteNetMult.vi** returns an overflow error. When this overflow error is returned, none of the frames provided in the **Data** array have been written. This enables your application to try the same **Data** array again at a later time.

To determine when adequate space is available in the write queue to retry **ncWriteNetMult.vi** after an overflow, you can use **ncWaitForState.vi** with the **Write Multiple** state. The **Write Multiple** state will transition from false to true when space is available for at least 512 frames. Since you must limit the **Data** input of **ncWriteNetMult.vi** to 512 frames or less, the **Write Multiple** state indicates that a retry will succeed.

Another technique to recover from a write queue overflow is to use **ncGetAttr.vi** with the **Write Entries Free** attribute. Although this technique requires you to call **ncGetAttr.vi** periodically until the desired number of frame entries is available, it avoids the need to determine a proper **Timeout** for **ncWaitForState.vi**. When the time difference between frames varies from milliseconds to seconds, it may be difficult to determine how long to wait for entries to become available.

After writing a sequence of timestamped frames with **ncWriteNetMult.vi**, you cannot close the Network Interface, because you must wait for the last timestamped frame to transmit onto the network. You can wait for the final transmit to complete using **ncWaitForState.vi** with the **Write Success** state. You can also use **ncGetAttr.vi** with the **Write Entries Pending** attribute to query periodically, which provides the option of aborting the timestamped transmission by closing the Network Interface.

Frame Types

Within each cluster of the **Data** array, **IsRemote** indicates the frame type. The frame type determines the interpretation of the remaining fields. The following tables describe the fields of the cluster for each value of **IsRemote**.

Table 10-23. Cluster with **IsRemote** value 0: CAN Data Frame

Field Name	Data Type	Description
IsRemote		Value `0` specifies a CAN data frame. The CAN data frame transfers data on the network.
ArbitrationId		Specifies the arbitration ID to transmit in the CAN data frame. A standard ID (11-bit) is specified by default. In order to specify an extended ID (29-bit), OR in the bit mask `20000000` hex.
DataLength		Specifies the number of bytes in the **Data** array to transmit in the CAN data frame.
Data		Data bytes to transmit in the CAN data frame.
Timestamp		If the **Transmit Mode** attribute is Immediate Transmit (default), this field is ignored, and CAN frames transmit as quickly as possible. If the **Transmit Mode** attribute is Timestamped Transmit, this field specifies a timestamp. The timestamp is used to time transmission of CAN frames as described in the preceding *Timestamped Transmit* topic. The timestamp is a LabVIEW numeric DBL with **Format and Precision** of **Absolute time** (time and date) or **Relative time** (zero based). The integer part contains seconds, and the fractional part contains milliseconds and microseconds.

Table 10-24. Cluster with **IsRemote** value 1: CAN Remote Frame

Field Name	Data Type	Description
IsRemote		Value `1` specifies a CAN remote frame. The CAN remote frame requests data for its arbitration ID.
ArbitrationId		Specifies the arbitration ID of the remote frame to transmit.
DataLength		Specifies the number of bytes requested. The value is transmitted in the CAN remote frame, but with no data.
Data		Ignored. No data bytes are contained in a CAN remote frame.
Timestamp		If the **Transmit Mode** attribute is Immediate Transmit (default), this field is ignored, and CAN frames transmit as quickly as possible. If the **Transmit Mode** attribute is Timestamped Transmit, this field specifies a timestamp. The timestamp is used to time transmission of CAN frames as described in the preceding *Timestamped Transmit* topic. The timestamp is a LabVIEW numeric DBL with **Format and Precision** of **Absolute time** (date/time) or **Relative time** (zero based). The integer part contains seconds, and the fractional part contains milliseconds and microseconds. You can use either absolute or relative time, because the timing is determined solely on the difference in the timestamps of sequential frames.

Table 10-25. Cluster with **IsRemote** value 4: Start Trigger Frame

Field Name	Data Type	Description
IsRemote		Value `4` specifies a start trigger frame. When you use **ncWriteNetMult.vi** to write frames from a logfile for timestamped transmit, you can write the start trigger frame as the first frame. The start trigger frame reproduces the delay from start of communication to the first CAN frame. For example, if you write a start trigger frame followed by a CAN data frame with relative timestamp 20 ms, NI-CAN will delay 20 ms before transmitting the CAN data frame. If you write the CAN data frame without the start trigger frame, NI-CAN will transmit the CAN data frame immediately.
ArbitrationId		Value `0` is required.
DataLength		Value `1` is required.

Table 10-25. Cluster with **IsRemote** value 4: Start Trigger Frame (Continued)

Field Name	Data Type	Description
Data		The single data byte in the array specifies the **Timestamp Format** (defined by **ncSetAttr.vi**) used for all subsequent CAN frames. The value is `0` for absolute timestamps, and `1` for relative timestamps. In order for NI-CAN to delay the proper time for the start trigger, this timestamp format must match the format used in all subsequent frames provided to **ncWriteNetMult.vi**.
Timestamp		Absolute timestamp of the start trigger. Within a logfile, this timestamp indicates the date and time at which CAN communication started. The timestamp is a LabVIEW numeric DBL with **Format and Precision** of **Absolute time** (date/time). The format of this timestamp is always absolute, even when **Data** byte 0 specifies relative timestamp format. This absolute timestamp provides data/time information even when the CAN frames of a logfile use the relative format. When **Data** byte 0 specifies absolute format (`0`), the difference between this timestamp and the absolute timestamp of the subsequent CAN frame is used as the delay for transmit of that CAN frame. When **Data** byte 0 specifies relative format (`1`), this timestamp is ignored by NI-CAN, and the relative timestamp of the subsequent CAN frame is used as the transmit delay.

Table 10-26. Cluster with **IsRemote** value 5: Delay Frame

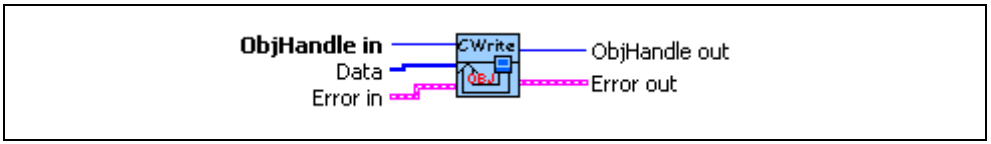
Field Name	Data Type	Description
IsRemote		Value `5` specifies a delay frame. Use the delay frame to insert an additional delay between any two timestamped frames. For example, if you write a CAN frame with relative timestamp 20 ms, followed by a delay frame of 30 ms, followed by a CAN frame with timestamp 55 ms, NI-CAN will transmit the CAN frames 65 ms apart.
ArbitrationId		Value `0` is required.
DataLength		Value `0` is required.
Data		Ignored.
Timestamp		Specifies the delay to insert (not a timestamp). The delay is a LabVIEW numeric DBL with **Format and Precision** of **Relative time**. The integer part contains seconds, and the fractional part contains milliseconds and microseconds. The maximum delay supported is 180.0 seconds (3 minutes).

ncWriteObj.vi

Purpose

Write a single frame to a CAN Object.

Format



Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from **ncOpen.vi**.

Data array specifies the data bytes (8 maximum).

Error in describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the **Error in** cluster in **Error out**.

status is TRUE if an error occurred. If **status** is TRUE, the VI does not perform any operations.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Output

ObjHandle out is the object handle for the next NI-CAN VI.

Error out describes error conditions. If the **Error in** cluster indicated an error, the **Error out** cluster contains the same information. Otherwise, **Error out** describes the error status of this VI.

status is TRUE if an error occurred.

code is the error code number identifying an error. A value of `0` means success. A negative value means error: VI did not execute the intended operation. A positive value means warning: VI executed intended operation, but an informational warning is returned. For a description of the **code**, wire the error cluster to a LabVIEW error-handling VI, such as the **Simple Error Handler**.

source identifies the VI where the error occurred.

Description

You use **ncWriteObj.vi** to place a frame into the CAN Object write queue. Since NI-CAN handles the write queue in the background, this VI does not wait for the frame to be transmitted on the network.

Once you have written frames, if you need to wait for the final **ncWriteObj.vi** to be transmitted successfully, use **ncWaitForState.vi** with the **Write Success** state. The **Write Success** state sets when all frames of the write queue have been successfully transmitted. The **Write Success** state clears whenever you call **ncWriteObj.vi**.

The **Write Success** state does not necessarily mean that all transmission has stopped for the CAN Object. For example, when the CAN Object **Communication Type** is **Transmit Data Periodically**, the **Write Success** state sets when the final frame in the write queue is transmitted, but the previous frame will be transmitted again once the **Period** expires.

Sporadic, recoverable errors on the network are handled automatically by the CAN protocol. As such, after **ncWriteObj.vi** returns successfully, NI-CAN eventually transmits the frame on the network unless there is a serious network problem. Network problems such as missing or malfunctioning devices are often reported as the warning `CanWarmComm (status=F, code=3FF6200B hex)`.

If the write queue is full, a call to **ncWriteObj.vi** returns the error `CanErrOverflowWrite (status=T, code=BFF62008 hex)`. In many cases, this error is recoverable, so you should not exit the application when it occurs. For example, if you want to transmit thousands of frames in succession (for example, large waveform transmitted periodically), the application can check for the error `CanErrOverflowWrite`, and when detected, simply wait a few milliseconds for some of the frames to transmit, then call **ncWriteObj.vi** again. If the second call to **ncWriteObj.vi** returns an error, that can be treated as an unrecoverable error (for example, no other device is ACKing the frames).

If you need to write a sequence of frames to the CAN Object, and ensure that each frame is transmitted, configure the **Write Queue Length** of the CAN Object to greater than zero. If you only need to transmit the most recent frame provided with **ncWriteObj.vi**, you can set the **Write Queue Length** to zero.

If the CAN Object **Communication Type** specifies **Receive** behavior, **ncWriteObj.vi** can be used to transmit a remote frame. When using **ncWriteObj.vi** to transmit a remote frame, the **Data** input can be left unwired.

11

Frame API for C

This chapter lists the NI-CAN functions and describes the format, purpose, and parameters.

Unless otherwise stated, each NI-CAN function suspends execution of the calling thread until it completes. The functions in this chapter are listed alphabetically.

Section Headings

The following are section headings found in the Frame API for C functions.

Purpose

Each function description includes a brief statement of the purpose of the function.

Format

The format section describes the format of each function for the C programming language.

Input and Output

The input and output parameters for each function are listed.

Description

The description section gives details about the purpose and effect of each function.

CAN Network Interface Object

The CAN Network Interface Object section gives details about using the function with the CAN Network Interface Object.

CAN Object

The CAN Object section gives details about using the function with the CAN Object.

Data Types

The following data types are used with functions of the NI-CAN Frame API for C.

Table 11-1. NI-CAN Frame API for C, Data Types

Data Type	Purpose
NCTYPE_INT8	8-bit signed integer
NCTYPE_INT16	16-bit signed integer
NCTYPE_INT32	32-bit signed integer
NCTYPE_UINT8	8-bit unsigned integer
NCTYPE_UINT16	16-bit unsigned integer
NCTYPE_UINT32	32-bit unsigned integer
NCTYPE_BOOL	Boolean value. Constants NC_TRUE (1) and NC_FALSE (0) are used for comparisons.
NCTYPE_STRING	ASCII string represented as an array of characters terminated by null character ('\0').
NCTYPE_*type*_P	Pointer to a variable of type *type*.
NCTYPE_ANY_P	Pointer to a variable of any type, used in cases where actual data type can vary depending on the object in use.
NCTYPE_OBJH	32-bit unsigned integer used to reference an open object in the Frame API.
NCTYPE_ATTRID	Attribute identifier. Uses constants with prefix NC_ATTR_.
NCTYPE_OPCODE	Operation code for ncAction function. Uses constants with prefix NC_OP_.
NCTYPE_STATE	Object states, encoded as a 32-bit mask, one bit for each state. Refer to ncWaitForState for more information.

Table 11-1. NI-CAN Frame API for C, Data Types (Continued)

Data Type	Purpose
NCTYPE_STATUS	Status returned from NI-CAN functions. Refer to ncStatusToString for more information.
NCTYPE_CAN_ARBID	CAN arbitration ID. The 30h bit is accessed using bitmask NC_FL_CAN_ARBID_XTD (2000000 hex). If this bit is clear, the CAN arbitration ID is standard (11-bit). If this bit is set, the CAN arbitration ID is extended (29-bit). Special constant NC_CAN_ARBID_NONE (CFFFFFFF hex) indicates no CAN arbitration ID, and is used to set the comparator attribute of the CAN Network Interface. Refer to ncConfig for more information.

List of Functions

The following table contains an alphabetical list of the NI-CAN Frame API for C functions.

Table 11-2. NI-CAN Frame API for C Functions

Function	Purpose
ncAction	Perform an action on an object.
ncCloseObject	Close an object.
ncConfig	Configure an object before using it.
ncConnectTerminals	Connect terminals in the CAN hardware.
ncCreateNotification	Create a notification callback for an object.
ncDisconnectTerminals	Disconnect terminals in the CAN hardware.
ncGetAttribute	Get the value of an object attribute.
ncGetHardwareInfo	Get NI-CAN hardware information.
ncOpenObject	Open an object.
ncRead	Read the data value of an object.
ncReadMult	Read multiple data values from the queue of an object.
ncSetAttribute	Set the value of an object attribute.
ncStatusToString	Convert status code into a descriptive string.

Table 11-2. NI-CAN Frame API for C Functions (Continued)

Function	Purpose
ncWaitForState	Wait for one or more states to occur in an object.
ncWrite	Write the data value of an object.
ncWriteMult	Write multiple frames to a CAN Network Interface Object.

ncAction

Purpose

Perform an action on an object.

Format

```
NCTYPE_STATUS    ncAction(
                          NCTYPE_OBJH ObjHandle,
                          NCTYPE_OPCODE Opcode,
                          NCTYPE_UINT32 Param)
```

Input

`ObjHandle`	Object handle from `ncOpenObject`.
`Opcode`	Operation code indicating which action to perform.
`Param`	Parameter whose meaning is defined by `Opcode`.

Output

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

`ncAction` is a general purpose function you can use to perform an action on the object specified by `ObjHandle`. Its normal use is to start and stop network communication on a CAN Network Interface Object.

For the most frequently used and/or complex actions, NI-CAN provides functions such as `ncOpenObject` and `ncRead`. `ncAction` provides an easy, general purpose way to perform actions that are used less frequently or are relatively simple.

CAN Network Interface Object

NI-CAN propagates all actions on the CAN Network Interface Object up to all open CAN Objects. Table 11-3 describes the actions supported by the CAN Network Interface Object.

Table 11-3. Actions Supported by the CAN Network Interface Object

Opcode	Param	Description
NC_OP_START (80000001 hex)	N/A (ignored)	Transitions network interface from stopped (idle) state to started (running) state. If network interface is already started, this operation has no effect. When a network interface is started, it is communicating on the network. When you execute NC_OP_START on a stopped CAN Network Interface Object, NI-CAN propagates it upward to all open higher-level CAN Objects. Thus, you can use it to start all higher-level network communication simultaneously.
NC_OP_STOP (80000002 hex)	N/A (ignored)	Transitions network interface from started state to stopped state. If network interface is already stopped, this operation has no effect. When a network interface is stopped, it is not communicating on the network. The stop action clears all entries from the read queue of the Network Interface Object. When you execute NC_OP_STOP on a running CAN Network Interface Object, NI-CAN propagates it upward to all open higher-level CAN Objects.
NC_OP_RESET (80000003 hex)	N/A (ignored)	Resets network interface. Stops network interface, then clears all entries from read and write queues. NC_OP_RESET is propagated up to all open higher-level CAN Objects.
NC_OP_RTSI_OUT (80000004 hex)	N/A (ignored)	Output a pulse or toggle on the RTSI line depending upon the NC_ATTR_RTSI_SIG_BEHAV

CAN Object

All actions performed on a CAN Object affect that CAN Object alone, and do not affect other CAN Objects or communication as a whole.

Table 11-4 describes the actions supported by the CAN Object.

Table 11-4. Actions Supported by the CAN Object

Opcode	Param	Description
NC_OP_START (80000001 hex)	N/A (ignored)	Transitions the CAN object from stopped (idle) state to started (running) state. If the CAN object is already started, this operation has no effect.
NC_OP_STOP (80000002 hex)	N/A (ignored)	Stops the CAN Object. For example, if the CAN Object is configured to transmit data frames periodically, this action stops the periodic transmissions. This action will also clear all entries from the read queue.
NC_OP_RESET (80000003 hex)	N/A (ignored)	Resets the CAN Object. Stops the CAN Object, then clears all entries from read and write queues.
NC_OP_RTSI_OUT (80000004 hex)	N/A (ignored)	Output a pulse or toggle on the RTSI line depending upon the NC_ATTR_RTSI_SIG_BEHAV.

ncCloseObject

Purpose

Close an object.

Format

```
NCTYPE_STATUSncCloseObject(NCTYPE_OBJH ObjHandle)
```

Input

`ObjHandle`	Object handle.

Output

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

`ncCloseObject` closes an object when it no longer needs to be in use, such as when the application is about to exit. When an object is closed, NI-CAN stops all pending operations and clears all configuration for the object (including RTSI), and you can no longer use the `ObjHandle` in the application.

CAN Network Interface Object

`ObjHandle` refers to an open CAN Network Interface Object.

CAN Object

`ObjHandle` refers to an open CAN Object.

ncConfig

Purpose

Configure an object before using it.

Format

```
NCTYPE_STATUS    ncConfig(
                         NCTYPE_STRING ObjName,
                         NCTYPE_UINT32 NumAttrs,
                         NCTYPE_ATTRID_P AttrIdList,
                         NCTYPE_UINT32_P AttrValueList)
```

Input

`ObjName`	ASCII name of the object to configure.
`NumAttrs`	Number of configuration attributes.
`AttrIdList`	List of configuration attribute identifiers.
`AttrValueList`	List of configuration attribute values.

Output

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

`ncConfig` initializes the configuration attributes of an object before opening it. The first NI-CAN function in the application will normally be `ncConfig` of the CAN Network Interface Object.

`NumAttr` indicates the number of configuration attributes in `AttrIdList` and `AttrValueList`. `AttrIdList` is an array of attribute IDs, and `AttrValueList` is an array of values. The host data type for each value in `AttrValueList` is `NCTYPE_UINT32`, which all configuration attributes can use.

The Frame API and Channel API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Channel API, this function returns an error.

The following sections describe how to use ncConfig with the Network Interface and CAN Object. The description for each object specifies the syntax for ObjName, plus a description of the commonly used attributes for AttrIdList.

CAN Network Interface Object

ObjName is the name of the CAN Network Interface Object to configure. This string uses the syntax "CAN*x*", where *x* is a decimal number starting at zero that indicates the CAN network interface (**CAN0**, **CAN1**, up to **CAN63**). CAN network interface names are associated with physical CAN ports using the Measurement and Automation Explorer (MAX).

The special **ObjName** values "CAN256" and "CAN257" refer to virtual interfaces. For virtual interfaces, the only valid attribute is Start On Open. All other attributes in the AttrIdList are ignored. The mask and comparator attributes are always zero for virtual interfaces (receive all frames).

For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

The following attribute IDs are commonly used for CAN Network Interface Object configuration.

NC_ATTR_BAUD_RATE (Baud Rate)

Baud Rate is the baud rate to use for communication. Common baud rates are supported, including 33333, 83333, 100000, 125000, 250000, 500000, and 1000000. If you are familiar with the Bit Timing registers used in CAN controllers, you can use a special hexadecimal baud rate of 0x8000*zzyy*, where *yy* is the desired value for register 0 (BTR0), and *zz* is the desired value for register 1 (BTR1) of the CAN controller.

NC_ATTR_CAN_COMP_STD (Standard Comparator)

Standard Comparator is the CAN arbitration ID for the standard (11-bit) frame comparator. For information on how this attribute is used to filter received frames for the Network Interface, refer to the following NC_ATTR_CAN_MASK_STD (Standard Mask) attribute.

If you intend to open the Network Interface, most applications can set this attribute and the Standard Mask to 0 in order to receive all standard frames.

If you intend to use CAN Objects as the sole means of receiving standard frames from the network, you should disable all standard frame reception in the Network Interface by setting this attribute to the special value CFFFFFFF hex. With this setting, the Network Interface

is best able to filter out incoming standard frames except those handled by CAN Objects.

NC_ATTR_CAN_COMP_XTD (Extended Comparator)

Extended Comparator is the CAN arbitration ID for the extended (29-bit) frame comparator. For information on how this attribute is used to filter extended frames for the Network Interface, refer to the following NC_ATTR_CAN_MASK_XTD (Extended Mask) attribute.

If you intend to open the Network Interface, most applications can set this attribute and the Extended Mask to 0 in order to receive all extended frames.

If you intend to use CAN Objects as the sole means of receiving extended frames from the network, you should disable all extended frame reception in the Network Interface by setting this attribute to the special value CFFFFFFF hex. With this setting, the Network Interface is best able to filter out incoming extended frames except those handled by CAN Objects.

NC_ATTR_CAN_MASK_STD (Standard Mask)

Standard Mask is the bit mask used in conjunction with the Standard Comparator attribute for filtration of incoming standard (11-bit) CAN frames. For each bit set in the mask, NI-CAN compares the corresponding bit in the Standard Comparator to the arbitration ID of the received frame. If the mask/comparator matches, the frame is stored in the Network Interface queue, otherwise it is discarded. Bits in the mask that are clear are treated as don't-cares. For example, hex 00000700 means to compare only the upper 3 bits of the 11-bit standard ID.

If you set the Standard Comparator to CFFFFFFF hex, this attribute is ignored, because all standard frame reception is disabled for the Network Interface.

Most applications can set this attribute and the Standard Comparator to 0 to receive all standard frames. This is particularly advisable for Series 2 hardware, because the Philips SJA1000 CAN controller does not support distinct filters for standard and extended IDs. For Series 2, nonzero values for this attribute are implemented in software, as an additional filter applied after the Series 2 Filter Mode. When you set this attribute to zero for Series 2, filtering is optimized to use only the Series 2 Filter Mode attribute for the SJA1000.

NC_ATTR_CAN_MASK_XTD (Extended Mask)

Extended Mask is the bit mask used in conjunction with the Extended Comparator attribute for filtration of incoming extended (29-bit) CAN frames. For each bit set in the mask, NI-CAN compares the corresponding bit in the Extended Comparator to the arbitration ID of the received frame. If the mask/comparator matches, the frame is stored in the Network Interface queue, otherwise it is discarded. Bits in the mask that are clear are treated as don't-cares. For example, hex 1F000000 means to compare only the upper 5 bits of the 29-bit extended ID.

If you set the Extended Comparator to CFFFFFFF hex, this attribute is ignored, because all extended frame reception is disabled for the Network Interface.

Most applications can set this attribute and the Extended Comparator to 0 to receive all extended frames. This is particularly advisable for Series 2 hardware, because the Philips SJA1000 CAN controller does not support distinct filters for standard and extended IDs. For Series 2, nonzero values for this attribute are implemented in software, as an additional filter applied after the Series 2 Filter Mode. When you set this attribute to zero for Series 2, filtering is optimized to use only the Series 2 Filter Mode attribute for the SJA1000.

NC_ATTR_LISTEN_ONLY (Listen Only)

Listen Only specifies whether to use the listen only feature of the Philips SJA1000 CAN controller (Series 2 only).

NC_FALSE disables listen only mode (default). Received frames are ACKnowledged, and frames can be transmitted using ncWrite.

NC_TRUE enables listen only mode. The Network Interface and CAN Objects can only receive frames. The interface does not transmit on the network: no ACKnowledgements are transmitted for received frames, and ncWrite will return an error. The Philips SJA1000 CAN controller enters error passive state when listen only is enabled.

The listen only mode is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware. For Series 1 hardware, this attribute must be left out of the AttrIdList.

NC_ATTR_NOTIFY_MULT_LEN (ReadMult Size for Notification)

Sets the number of frames used as a threshold for the Read Multiple state. For more information on the Read Multiple state, refer to ncWaitForState.

The default value is one half of Read Queue Length.

NC_ATTR_READ_Q_LEN (Read Queue Length)

Read Queue Length is the maximum number of unread frames for the internal read queue of the CAN Network Interface Object. The recommended value is 100.

The internal read queue exists between the CAN hardware and the NI-CAN device driver. This internal read queue holds frames temporarily prior to transfer a larger queue in the NI-CAN device driver. The larger NI-CAN device driver queue grows as needed in order to accommodate high bus loads.

NC_ATTR_SELF_RECEPTION (Self Reception)

Specifies whether to echo successfully transmitted CAN frames into the read queue of the Network Interface and/or CAN Objects (Series 2 only). Each reception occurs just as if the frame were received from another CAN device.

For self reception to operate properly, another CAN node must receive and acknowledge each transmit. If a transmitted frame is not successfully acknowledged, it is not echoed into the read queue.

NC_FALSE disables Self Reception mode (default). Transmitted frames do not appear in read queues.

NC_TRUE enables Self Reception mode. Transmitted frames appear in read queues as if they were received from another CAN device.

The Self Reception mode is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware. For Series 1 hardware, this attribute must be left out of the AttrIdList.

NC_ATTR_SERIES2_FILTER_MODE (Series 2 Filter Mode)

All Series 2 hardware uses the Philips SJA1000 CAN controller. The Philips SJA1000 CAN controller provides sophisticated filtering of received frames. This attribute specifies the filtering mode, which is used in conjunction with the Series 2 Mask and Series 2 Comparator attributes.

This attribute is not supported for Series 1 hardware (returns error). For Series 1, the `Standard Mask/Comparator` and `Extended Mask/Comparator` attributes are programmed directly into the Intel 82527 CAN controller. Use those attributes to specify filtering of received frames on Series 1 hardware.

For Series 2 hardware, the Philips SJA1000 does not support distinct standard and extended masking. Therefore, on Series 2 hardware the `Standard Mask/Comparator` and `Extended Mask/Comparator` attributes are implemented in software (for backward compatibility). Since software masking can have an adverse impact on receive performance, National Instruments recommends that you disable software masking for Series 2 hardware. Disable software masking by specifying don't-care (`0`) for all four mask/comparator attributes of **ncConfigCANNet.vi**.

Since the format of the Series 2 filters is very specific to the Philips SJA1000 CAN controller, National Instruments cannot guarantee compatibility for this attribute on future hardware series. When using this attribute in the application, it is best to get the `NC_ATTR_HW_SERIES (Series)` attribute to verify that the CAN hardware is Series 2.

The filtering specified by this attribute and the Series 2 Mask/Comparator applies to the CAN Network Interface Object and all CAN Objects for that interface. For example, if you specify filters that discard ID 5, then open a CAN Object to receive ID 5, the CAN Object will not receive data.

The default value for this attribute is `NC_FILTER_SINGLE_STANDARD`.

This attribute uses the following values:

`NC_FILTER_SINGLE_EXTENDED` (Single Extended)

Filter all extended (29-bit) frames using a single mask/comparator filter.

Figure 11-1 describes the format of the `Series 2 Mask` and `Series 2 Comparator` attributes for this filter mode.

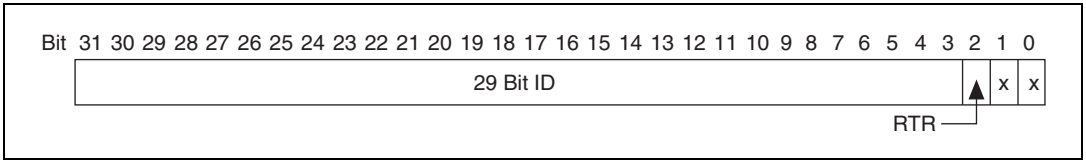


Figure 11-1. Mask/Comparator for Single-Extended Filter Mode

The 29 Bit ID compares all 29 bits of extended IDs. The RTR bit determines whether the filter compares remote (`0`) or data (`1`) frames. Bits marked as "X" are reserved, and should be cleared to zero by the application.

`NC_FILTER_SINGLE_STANDARD` (Single Standard)

Filter all standard (11-bit) frames using a single mask/comparator filter.

Figure 11-2 describes the format of the `Series 2 Mask` and `Series 2 Comparator` attributes for this filter mode.

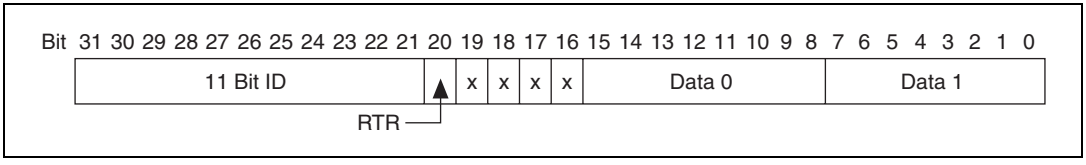


Figure 11-2. Mask/Comparator for Single-Standard Filter Mode

The 11 Bit ID compares all 11 bits of standard IDs. The RTR bit determines whether the filter compares remote (`0`) or data (`1`) frames. Bits marked as "X" are reserved, and should be cleared to zero by the application. Data 0 compares the first data byte in the frame, and Data 1 compares the second data byte.

`NC_FILTER_DUAL_EXTENDED` (Dual Extended)

Filter all extended (29-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

Figure 11-3 describes the format of the `Series 2 Mask` and `Series 2 Comparator` attributes for this filter mode.

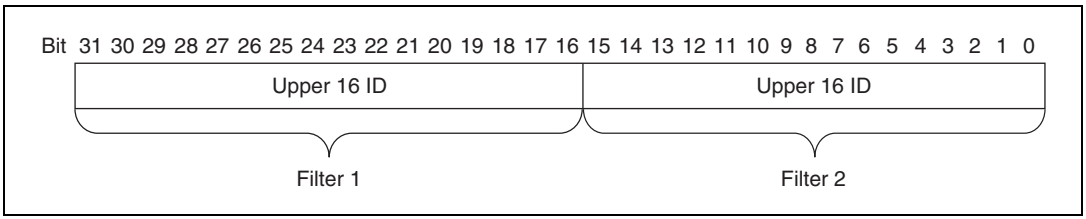


Figure 11-3. Mask/Comparator for Dual-Extended Filter Mode

Each Upper 16 ID filter compares the 16 most significant bits of the 29-bit extended ID.

`NC_FILTER_DUAL_STANDARD` (Dual Standard)

Filter all standard (11-bit) frames using a two separate mask/comparator filters. If either filter matches the frame, it is received. The frame is discarded only when neither filter detects a match.

Figure 11-4 describes the format of the `Series 2 Mask` and `Series 2 Comparator` attributes for this filter mode.

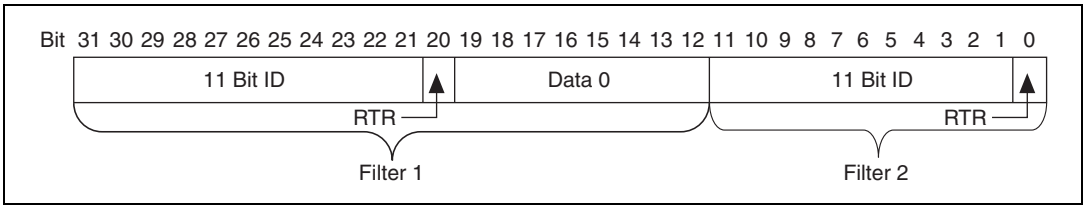


Figure 11-4. Mask/Comparator for Dual-Standard Filter Mode

Filter 1 includes the 11 Bit ID, the RTR bit, and the first data byte in the frame. Filter 2 includes the 11 bit ID, and the RTR bit (no data).

`NC_ATTR_SERIES2_COMP` (Series 2 Comparator)

Specifies the filter comparator for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This attribute is not supported for Series 1 hardware (returns error).

This attribute specifies a comparator value that is checked against the ID, RTR, and data bits. The `NC_ATTR_SERIES2_MASK (Series 2 Mask)` determines the applicable bits for comparison.

The default value of this attribute is zero.

The mapping of bits in this attribute to the ID, RTR, and data bits of incoming frames is determined by the value of the NC_ATTR_SERIES2_FILTER_MODE (Series 2 Filter Mode) attribute. Refer to NC_ATTR_SERIES2_FILTER_MODE (Series 2 Filter Mode) to understand the format of this attribute as well as the Series 2 Mask.

NC_ATTR_SERIES2_MASK (Series 2 Mask)

Specifies the filter mask for the Philips SJA1000 CAN controller on all Series 2 CAN hardware. This attribute is not supported for Series 1 hardware (returns error).

This attribute specifies a bit mask that determines the ID, RTR, and data bits that are compared. If a bit is clear in the mask, the corresponding bit in the NC_ATTR_SERIES2_COMP (Series 2 Comparator) is checked. If a bit in the mask is set, that bit is ignored for the purpose of filtering (don't care). This interpretation is the opposite of the legacy Standard/Extended Mask attributes.

The default value of this attribute is hex FFFFFFFF, which means that all frames are received.

The mapping of bits in this attribute to the ID, RTR, and data bits of incoming frames is determined by the value of the NC_ATTR_SERIES2_FILTER_MODE (Series 2 Filter Mode) attribute. Refer to NC_ATTR_SERIES2_FILTER_MODE (Series 2 Filter Mode) to understand the format of this attribute as well as the Series 2 Comparator.

NC_ATTR_SINGLE_SHOT_TX (Single Shot Transmit)

Specifies whether to retry failed CAN frame transmissions (Series 2 only).

NC_FALSE enables retry as defined in the CAN specification (default). If a CAN frame is not transmitted successfully, the CAN controller will immediately retry.

NC_TRUE enables single-shot transmit behavior (no retry). If a CAN frame is not transmitted successfully, the CAN controller will not retry.

The Single Shot Transmit feature is not available on the Intel 82527 CAN controller used by Series 1 CAN hardware. For Series 1 hardware, this attribute must be left out of the AttrIdList.

NC_ATTR_START_ON_OPEN (Start On Open)

Start On Open indicates whether communication starts for the CAN Network Interface Object (and all applicable CAN Objects) immediately upon opening the object with ncOpenObject. The default is NC_TRUE (1), which starts communication when ncOpenObject is called. If you set Start On Open to NC_FALSE (0), you can call ncSetAttribute after opening the interface, then ncAction to start communication. The ncSetAttribute function can be used to set attributes that are not contained within the ncConfig function.

NC_ATTR_WRITE_Q_LEN (Write Queue Length)

Write Queue Length is the maximum number of frames for the internal write queue of the CAN Network Interface Object awaiting transmission. The recommended value is 10.

The internal write queue exists between the CAN hardware and the NI-CAN driver. This internal write queue holds frames temporarily prior to transfer to CAN hardware from a larger queue in the NI-CAN device driver.

For more information on writing to the CAN Network Interface object, refer to ncWriteMult.

The following attribute ID is used to enable logging of transceiver faults.

NC_ATTR_LOG_COMM_ERRS (Log Comm Warnings)

Log Comm Warnings specifies whether to log communication warnings (including transceiver faults) to the Network Interface read queue.

When set to NC_FALSE (default), the Network Interface reports CAN communication warnings (including transceiver faults) in the return status of read functions. For more information, refer to ncReadMult.

When set to NC_TRUE, the Network Interface reports CAN communication warnings (including transceiver faults) by storing a special frame in the read queue. The communication warnings are not reported in the return status. For more information on communication warnings and errors, refer to ncReadMult. The special communication warning frame uses the following format:

Arbitration ID: Error/warning ID (refer to ncReadMult)

Timestamp:	Time when error/warning occurred
IsRemote:	2
DataLength:	0
Data:	N/A (ignore)

When calling ncRead or ncReadMult to read frames from the Network Interface, you typically use the IsRemote field to differentiate communications warnings from CAN frames. Refer to ncReadMult for more information.

RTSI is a bus that interconnects National Instruments DAQ, IMAQ, Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. Refer to Chapter 3, *NI CAN Hardware*, for more details on the RTSI hardware connector.

The following attribute IDs are used to enable RTSI synchronization between two or more National Instruments cards:

NC_ATTR_RTSI_MODE (RTSI Mode)

RTSI Mode specifies the behavior of the Network Interface with respect to RTSI, including whether the RTSI signal is an input or output:

NC_RTSI_NONE

Disables RTSI behavior for the Network Interface (default). All other RTSI attributes are ignored.

NC_RTSI_OUT_ACTION_ONLY

The Network Interface will output the RTSI signal whenever the ncAction function is called with Opcode NC_OP_RTSI_OUT. This RTSI mode can be used to manually toggle/pulse a RTSI output within the application.

NC_RTSI_OUT_ON_RX

The Network Interface will output the RTSI signal whenever a CAN frame is stored in the read queue.

If the hardware is Series 2, NI-CAN connects a terminal of the Philips SJA1000 CAN controller to the RTSI

output. This hardware connection provides jitter in the nanoseconds range, enabling triggering of external oscilloscopes and so on.

`NC_RTSI_OUT_ON_TX`

The Network Interface will output the RTSI signal whenever a CAN frame is successfully transmitted from the write queue.

`NC_RTSI_TIME_ON_IN`

When the RTSI input transitions from low to high, a timestamp is measured and stored in the read queue of the Network Interface. The special RTSI frame uses the following format:

`Arbitration ID:40000001` hex

`Timestamp`: Time when RTSI input transitioned from low to high

`IsRemote`: `3` (`NC_FRMTYPE_RTSI`)

`DataLength`: RTSI signal detected (`RTSI Signal`)

`Data`: N/A (ignore)

When calling `ncRead` or `ncReadMult` to read frames from the Network Interface, use the `IsRemote` field to differentiate RTSI timestamps from CAN frames. Refer to `ncReadMult` for more information.

`NC_RTSI_TX_ON_IN`

The Network Interface will transmit a frame from its write queue when the RTSI input transitions from low to high. To begin transmission, at least one data frame must be written using `ncWrite`. If the write queue becomes empty due to frame transmissions, the last frame will be retransmitted on each RTSI pulse until another frame is provided using `ncWrite`.

Note When you configure a DAQ card to pulse the RTSI signal periodically, do not exceed 1,000 Hertz (pulse every millisecond). If the RTSI input is pulsed faster than 1 kHz on a consistent basis, CAN performance will be adversely affected (for example, lost data frames).

NC_ATTR_RTSI_SIG_BEHAV (RTSI Behavior)

RTSI Behavior specifies whether to pulse or toggle a RTSI output. This attribute is ignored when RTSI Mode specifies input (detected low to high):

RTSI_SIG_PULSE

Pulse the RTSI output. For Series 1 CAN cards, the pulse is at least 100 µs. For Series 2 CAN cards, the pulse is at least 100 ns.

RTSI_SIG_TOGGLE

If the previous state was high, the output toggles low, then vice-versa.

NC_ATTR_RTSI_SIGNAL (RTSI Signal)

RTSI Signal defines the RTSI signal associated with the RTSI Mode. Valid values are 0 to 6, corresponding to **RTSI0–RTSI6** on other National Instruments cards.

Series 1 and 2 CAN cards each have limitations regarding RTSI. For information on these limitations, refer to *Valid Combinations of Source/Destination* in the **CAN Connect Terminals.vi** function of the Channel API for LabVIEW.

NC_ATTR_RTSI_SKIP (RTSI Skip)

RTSI Skip specifies the number of RTSI inputs (low-to-high transitions) to skip for RTSI input modes. It is ignored for RTSI output modes. For example, for RTSI Mode NC_RTSI_TIME_ON_IN, if the RTSI input transitions from low to high every 1 ms, RTSI Skip of 9 means that a timestamp will be stored in the read queue every 10 ms.

CAN Object

ObjName is the name of the CAN Object to configure. This string uses the syntax "CAN*x*::STD*y*" or "CAN*x*::XTD*y*". CAN*x* is the name of the CAN network interface that you used for the preceding ncConfig function. STD indicates that the CAN Object uses a standard (11-bit) arbitration ID. XTD indicates that the CAN Object uses an extended (29-bit) arbitration ID. The number *y* specifies the actual arbitration ID of the CAN Object. The number *y* is decimal by default, but you also can use hexadecimal by adding "0x" to the beginning of the number. For example, "CAN0::STD25" indicates standard ID 25 decimal on **CAN0**, and "CAN1::XTD0x0000F652" indicates extended ID F652 hexadecimal on CAN1.

In order to configure one or more CAN objects, you must configure the CAN Network Interface Object first.

The special virtual interface names “CAN256” and “CAN257” are not supported for CAN Objects.

The following attribute IDs are commonly used for CAN Object configuration:

`NC_ATTR_COMM_TYPE` (Communication Type)

`Communication Type` specifies the behavior of the CAN Object with respect to its ID, including the direction of data transfer:

`NC_CAN_COMM_RX_BY_CALL` (Receive By Call Using Remote)

Transmit remote frame for a specific ID by calling `ncWrite`. The CAN Object places the resulting data frame response in the read queue.

`Period` specifies a minimum interval, and `Receive Changes Only` specifies whether to place duplicate data frames into the read queue. `Transmit by Response` is ignored.

`NC_CAN_COMM_RX_PERIODIC` (Receive Periodic Using Remote)

Periodically transmit a remote frame for a specific ID in order to receive the associated data frame. Every `Period` the CAN Object transmits a remote frame, and then places the resulting data frame response in the read queue. If the data frame is not received in response to the transmit remote frame, the periodic transmission is put on hold.

`Period` specifies the periodic rate, and `Receive Changes Only` specifies whether to place duplicate data frames into the read queue. `Transmit by Response` is ignored.

`NC_CAN_COMM_RX_UNSOL` (Receive Unsolicited)

Receive data frames for a specific ID.

This type is useful for receiving a few IDs (1–10) into dedicated read queues. For high

performance applications (more IDs, fast frame rates), the Network Interface is recommended to receive all IDs.

`Period` specifies a watchdog timeout, and `Receive Changes Only` specifies whether to place duplicate data frames into the read queue. `Transmit by Response` is ignored.

`NC_CAN_COMM_TX_BY_CALL` (Transmit Data By Call)

Transmit data frame when `ncWrite` is called. When `ncWrite` is called quickly, data frames are placed in the write queue for back to back transmit.

`Period` specifies a minimum interval, and `Transmit by Response` specifies whether to retransmit the previous data frame in response to a remote frame. `Receive Changes Only` is ignored.

`NC_CAN_COMM_TX_PERIODIC` (Transmit Data Periodically)

Periodically transmit data frame for a specific ID. When the CAN Object transmits the last entry from the write queue, that entry is used every period until you provide a new data frame using `ncWrite`. If you keep the write queue filled with unique data, this behavior allows you to ensure that each period transmits a unique data frame.

If the write queue is empty when communication starts, the first periodic transmit does not occur until you provide the first data frame with `ncWrite`.

`Period` specifies the periodic rate, and `Transmit by Response` specifies whether to transmit the previous period data in response to a remote frame. If `Transmit by Response` is true, the data from the previous (periodic) transmit will be retransmitted in case a remote frame is received, even if there are frames

pending in the write buffer. `Receive Changes Only` is ignored.

`NC_CAN_COMM_TX_RESP_ONLY` (Transmit By Response Only)

Transmit data frame for a specific ID only in response to a received remote frame. When you call `ncWrite`, the data is placed in the write queue, and remains there until a remote frame is received.

`Period` specifies a watchdog timeout. `Transmit by Response` is assumed as TRUE regardless of the attribute setting. `Receive Changes Only` is ignored.

`NC_CAN_COMM_TX_WAVEFORM` (Transmit Periodic Waveform)

Transmit a fixed sequence of data frames over and over, one data frame every `Period`.

The following steps describe typical usage of this type:

1. Configure CAN Network Interface Object with `Start On Open` `FALSE`, then open the Network Interface.
2. Configure the CAN Object as Transmit Periodic Waveform and a nonzero `Write Queue Length`, then open the CAN Object.
3. Call `ncWrite` for the CAN Object, once for every entry specified for the `Write Queue Length`.
4. Use `ncAction` to start the Network Interface (not the CAN Object). The CAN Object transmits the first frame in the write queue, then waits the specified period, then transmits the second frame, and so on. After the last frame is transmitted, the CAN Objects waits the specified period, then transmits the first frame again.

If you need to change the waveform contents at runtime, or if you need to transmit very large waveforms (more than 100 frames), we recommend using the NC_CAN_COMM_TX_PERIODIC type. Using that type, you can write frames to the Write Queue until full (overflow error), then wait some time for a few frames to transmit, then continue writing new frames.

This communication type has the following limitations:

- Write Queue Length must be greater than zero.
- You must write exactly Write Queue Length values before starting communication (no less).
- Once communication is started, you cannot write additional values.

Period specifies the periodic rate. Transmit by Response and Receive Changes Only are ignored.

NC_ATTR_DATA_LEN (Data Length)

Data Length specifies the number of bytes in the data frames for this CAN Object ID. This number is placed in the Data Length Code (DLC) of all transmitted data frames and remote frames for the CAN Object. This is also the number of data bytes returned from ncRead when the communication type indicates receive.

NC_ATTR_NOTIFY_MULT_LEN (ReadMult Size for Notification)

Sets the number of frames used as a threshold for the Read Multiple state. For more information on the Read Multiple state, refer to ncWaitForState.

The default value is one half of Read Queue Length.

NC_ATTR_PERIOD (Period)

Period specifies the rate of periodic behavior in milliseconds.

The behavior depends on the Communication Type as follows:

NC_CAN_COMM_RX_BY_CALL

Period specifies a minimum interval between subsequent transmissions. Even if ncWrite is called very frequently, frames are transmitted on the network at a rate no more than Period. Setting Period to zero disables the minimum interval timer.

NC_CAN_COMM_RX_PERIODIC

Period specifies the time between subsequent transmissions, and must be set greater than zero.

NC_CAN_COMM_RX_UNSOL

NC_CAN_COMM_TX_BY_CALL

NC_CAN_COMM_TX_PERIODIC

NC_CAN_COMM_TX_RESP_ONLY

Period specifies a watchdog timeout. If a frame is not received at least once every period, a timeout error is returned. Setting Period to zero disables the watchdog timer.

NC_CAN_COMM_TX_WAVEFORM

NC_ATTR_READ_Q_LEN (Read Queue Length)

Read Queue Length is the maximum number of unread frames for the read queue of the CAN Object. For more information, refer to ncRead.

If Communication Type is set to receive data, a typical value is 10. If Communication Type is set to transmit data, a typical value is 0.

NC_ATTR_RX_CHANGES_ONLY (Receive Changes Only)

Receive Changes Only applies only to Communication Type selections in which the CAN Object receives data frames (ignored for

other types). For those configurations, `Receive Changes Only` specifies whether duplicated data should be placed in the read queue. When set to `NC_FALSE` (default), all data frames for the CAN Object ID are placed in the read queue. When set to `NC_TRUE`, data frames are placed into the read queue only if the data bytes differ from the previously received data bytes.

This attribute has no effect on the usage of a watchdog timeout for the CAN Object. For example, if this attribute is `NC_TRUE` and you also specify a watchdog timeout, NI-CAN restarts the watchdog timer every time it receives a data frame for the CAN Object ID, regardless of whether the data differs from the previous frame in the read queue.

`NC_ATTR_TX_RESPONSE` (Transmit By Response)

`Transmit By Response` applies only to `Communication Type` of `Transmit Data by Call` and `Transmit Data Periodically` (ignored for other types). For those configurations, `Transmit By Response` specifies whether the CAN Object should automatically respond with the previously transmitted data frame when it receives a remote frame. When set to `NC_FALSE` (default), the CAN Object transmits data frames only as configured, and ignores all remote frames for its ID. When set to `NC_TRUE`, the CAN Object responds to incoming remote frames.

`NC_ATTR_WRITE_Q_LEN` (Write Queue Length)

`Write Queue Length` is the maximum number of frames for the write queue of the CAN Object awaiting transmission. For more information, refer to `ncWrite`.

If `Communication Type` is set to receive data, a typical value is `0`. If `Communication Type` is set to transmit data, a typical value is `10`.

RTSI is a bus that interconnects National Instruments DAQ, IMAQ, Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. Refer to Chapter 3, *NI CAN Hardware*, for more details on the RTSI hardware connector.

The following attribute IDs are used to enable RTSI synchronization between two or more National Instruments cards:

NC_ATTR_RTSI_FRAME (RTSI Frame)

RTSI Frame specifies a 4-byte pattern used to differentiate RTSI timestamps from CAN data frames. It is provided as a U32, and the high byte is stored as byte 0 from ncRead. For example, AABBCCDD hex is returned as AA in byte 0, BB in byte 1, and so on.

This attribute is used only for RTSI Mode NC_RTSI_TIME_ON_IN. It is ignored for all other RTSI Mode values.

NC_ATTR_RTSI_MODE (RTSI Mode)

RTSI Mode specifies the behavior of the CAN Object with respect to RTSI, including whether the RTSI signal is an input or output:

NC_RTSI_NONE

Disables RTSI behavior for the CAN Object (default). All other RTSI attributes are ignored.

NC_RTSI_OUT_ACTION_ONLY

The CAN Object will output the RTSI signal whenever the ncAction function is called with Opcode NC_OP_RTSI_OUT. This RTSI mode can be used to manually toggle/pulse a RTSI output within the application.

NC_RTSI_OUT_ON_RX

The CAN Object will output the RTSI signal whenever a CAN frame is stored in its read queue.

In order to use this RTSI Mode, you must configure the CAN Object Communication Type to Receive Unsolicited.

NC_RTSI_OUT_ON_TX

The CAN Object will output the RTSI signal whenever a CAN frame is successfully transmitted.

In order to use this RTSI Mode, you must configure the CAN Object Communication

Type to either Transmit Data by Call, Transmit Data Periodically, or Transmit Periodic Waveform.

NC_RTSI_TIME_ON_IN

When the RTSI input transitions from low to high, a timestamp is measured and stored in the read queue of the CAN Object. The special RTSI frame uses the following format:

Timestamp: Time when RTSI input transitioned from low to high

Data: User-defined 4 byte data pattern (refer to RTSI Frame for details)

NC_RTSI_TX_ON_IN

The CAN Object will transmit a frame from its write queue when the RTSI input transitions from low to high. To begin transmission, at least one data frame must be written using ncWrite. If the write queue becomes empty due to frame transmissions, the last frame will be retransmitted on each RTSI pulse until another frame is provided using ncWrite.

In order to use this RTSI Mode, you must configure the CAN Object Communication Type to either Transmit Data by Call, Transmit Data Periodically, or Transmit Periodic Waveform. The Period attribute is ignored when this RTSI mode is selected.

Note When you configure a DAQ card to pulse the RTSI signal periodically, do not exceed 1,000 Hertz (pulse every millisecond). If the RTSI input is pulsed faster than 1 kHz on a consistent basis, CAN performance will be adversely affected (for example, lost data frames).

NC_ATTR_RTSI_SIG_BEHAV (RTSI Behavior)

RTSI Behavior specifies whether to pulse or toggle a RTSI output. This attribute is ignored when RTSI Mode specifies input (detected low to high):

RTSI_SIG_PULSE

Pulse the RTSI output. For Series 1 CAN cards, the pulse is at least 100 µs. For Series 2 CAN cards, the pulse is at least 100 ns.

RTSI_SIG_TOGGLE

If the previous state was high, the output toggles low, then vice-versa.

NC_ATTR_RTSI_SIGNAL (RTSI Signal)

RTSI Signal defines the RTSI signal associated with the RTSI Mode. Valid values are 0 to 6, corresponding to **RTSI0–RTSI6** on other National Instruments cards.

Series 1 and 2 CAN cards each have limitations regarding RTSI. For information on these limitations, refer to the *Valid Combinations of Source/Destination* section in the **CAN Connect Terminals.vi** function of the Channel API for LabVIEW.

NC_ATTR_RTSI_SKIP (RTSI Skip)

RTSI Skip specifies the number of RTSI inputs (low-to-high transitions) to skip for RTSI input modes. It is ignored for RTSI output modes. For example, for RTSI Mode NC_RTSI_TIME_ON_IN, if the RTSI input transitions from low to high every 1 ms, RTSI Skip of 9 means that a timestamp will be stored in the read queue every 10 ms.

Examples of Different Communication Types

The following figures demonstrate how you can use the Communication Type attribute for actual network data transfer. Each figure shows two separate NI-CAN applications that are physically connected across a CAN network.

Figure 11-5 shows a CAN Object that periodically transmits data to another CAN Object. The receiving CAN Object can queue up to five data values.

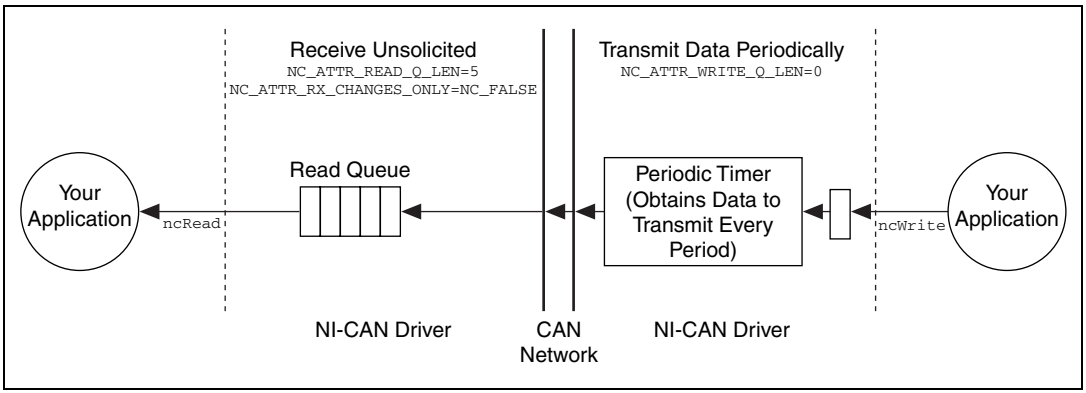


Figure 11-5. Example of Periodic Transmission

Figure 11-6 shows a CAN Object that polls data from another CAN Object. NI-CAN transmits the CAN remote frame when you call `ncWrite`.

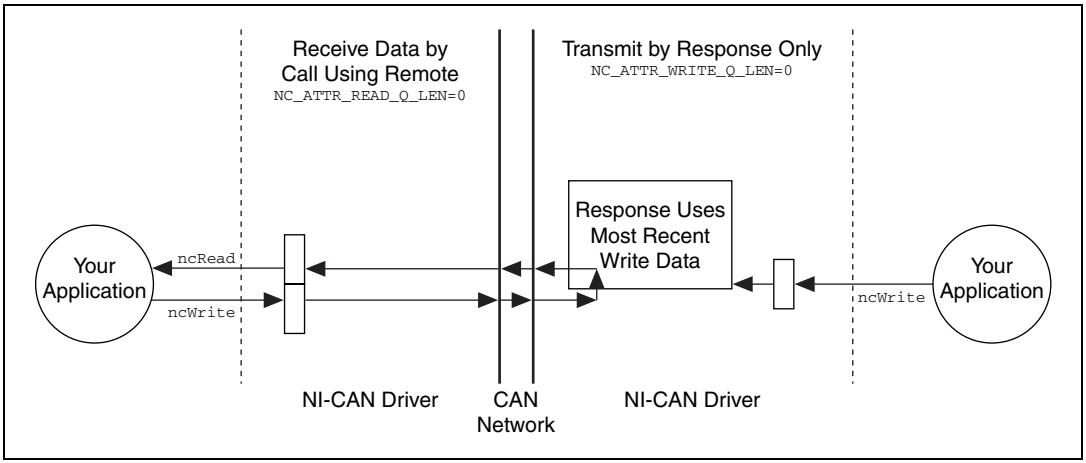


Figure 11-6. Example of Polling Remote Data Using `ncWrite`

Figure 11-7 shows a CAN Object that polls data from another CAN Object. NI-CAN transmits the remote frame periodically and places only changed data into the read queue.

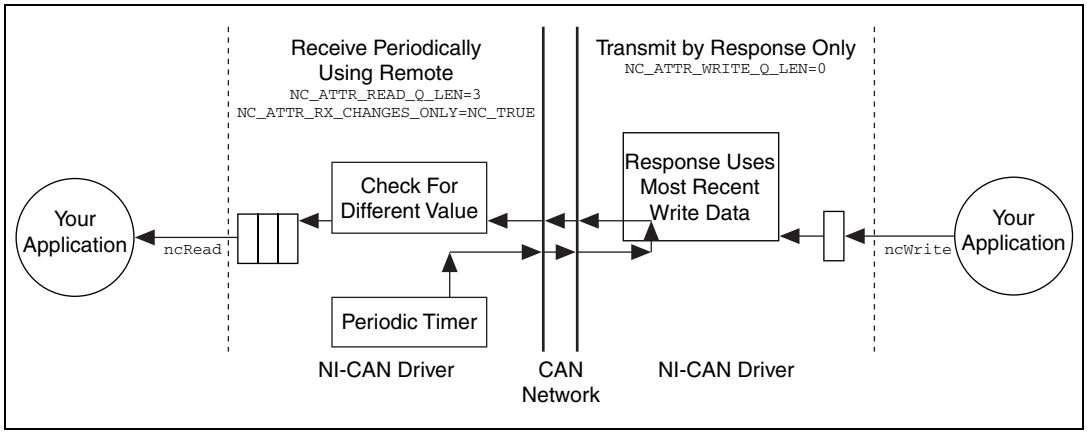


Figure 11-7. Example of Periodic Polling of Remote Data

ncConnectTerminals

Purpose

Connect terminals in the CAN hardware.

Format

```
NCTYPE_STATUS    ncConnectTerminals(
                     NCTYPE_OBJH       ObjHandle,
                     NCTYPE_UINT32     SourceTerminal,
                     NCTYPE_UINT32     DestinationTerminal,
                     NCTYPE_UINT32     Modifiers);
```

Inputs

`ObjHandle`

The object handle from the previous NI-CAN function. The `ObjHandle` is originally returned from `ncOpenObject`.

`SourceTerminal`

Specifies the connection source.

Once the connection is successfully created, behavior flows from `SourceTerminal` to `DestinationTerminal`.

For a list of valid source/destination pairs, refer to the *Valid Combinations of Source/Destination* section.

The following list describes each value of `SourceTerminal`:

`NC_SRC_TERM_10HZ_RESYNC_CLOCK`

`NC_SRC_TERM_10HZ_RESYNC_CLOCK` selects a 10 Hz, 50 percent duty cycle clock. This slow rate is required for resynchronization of CAN cards. On each pulse of the resync clock, the other CAN card brings its clock into sync.

By selecting **RTSI0–RTSI6** as the `DestinationTerminal`, you route the 10 Hz clock to synchronize with other CAN cards. NI-DAQ and NI-DAQmx cards cannot use the 10 Hz resync clock, so this selection is limited to synchronization of two or more CAN cards.

`NC_SRC_TERM_10HZ_RESYNC_CLOCK` applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the `ObjName` input to `ncOpenObject`.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are using a mix of Series 1 and Series 2 CAN cards, you must use NC_SRC_TERM_10HZ_RESYNC_CLOCK.

NC_SRC_TERM_20MHZ_TIMEBASE

NC_SRC_TERM_20MHZ_TIMEBASE selects the local 20 MHz oscillator of the CAN card.

The only valid DestinationTerminal for this source is NC_DEST_TERM_RTSI_CLOCK. This routes the local 20 MHz clock of the CAN card for use as a timebase by other NI cards. For example, you can synchronize two CAN cards by connecting NC_SRC_TERM_20MHZ_TIMEBASE to NC_DEST_TERM_RTSI_CLOCK on one CAN card, and then connecting NC_SRC_TERM_RTSI_CLOCK to NC_DEST_TERM_MASTER_TIMEBASE on the other CAN card.

NC_SRC_TERM_20MHZ_TIMEBASE applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the ObjName input to ncOpenObject.

This value applies to Series 2 PXI or PCI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCMCIA CAN card, selecting this value results in an error.

NC_SRC_TERM_INTF_RECEIVE_EVENT

NC_SRC_TERM_INTF_RECEIVE_EVENT selects the dedicated receive interrupt output on the Philips SJA1000 CAN controller. When a received frame successfully passes the acceptance filter, a pulse with the width of one bit time is output during the last bit of the end of frame position of the CAN frame. Incoming CAN frames can be filtered using the NC_ATTR_SERIES2_FILTER_MODE attribute. The CAN controller is specified by the ObjName input to ncOpenObject.

NC_SRC_TERM_INTF_RECEIVE_EVENT can be used as the start trigger for other NI cards, or for external instruments.

Since this value requires the Philips SJA1000 CAN controller, it applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

NC_SRC_TERM_INTF_TRANSCEIVER_EVENT

NC_SRC_TERM_INTF_TRANSCEIVER_EVENT selects the NERR signal from the CAN transceiver. The Low-Speed/Fault-Tolerant transceiver and the High-Speed transceiver provide the NERR signal. This signal asserts when a fault is detected by the transceiver. The default value of NERR is logic-high, which indicates no error.

The CAN card is specified by the ObjName input to ncOpenObject.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

NC_SRC_TERM_PXI_CLK10

NC_SRC_TERM_PXI_CLK10 selects the 10 MHz backplane clock.

The only valid DestinationTerminal for this source is NC_DEST_TERM_MASTER_TIMEBASE. This routes the 10 MHz PXI backplane clock for use as the timebase of the CAN card. When you use **PXI_Clk10** as the timebase for the CAN card, you must also use **PXI_Clk10** as the timebase for other PXI cards to perform synchronized input/output.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

NC_SRC_TERM_PXI_STAR

NC_SRC_TERM_PXI_STAR selects the PXI star trigger signal.

Within a PXI chassis, some PXI products can source star trigger from Slot 2 to all higher-numbered slots. **PXI_Star** enables the PXI CAN card to receive the star trigger when it is in Slot 3 or higher.

This value applies to Series 2 PXI CAN cards only. If you are using a Series 1 CAN card or Series 2 PCI or PCMCIA CAN card, selecting this value results in an error.

NC_SRC_TERM_RTSI_CLOCK

Selects the RTSI clock line as source (input) of the connection. This terminal is also RTSI line 7. **RTSI7** is dedicated for routing of a timebase (10 MHz or 20 MHz).

The only valid DestinationTerminal for this source is NC_DEST_TERM_MASTER_TIMEBASE.

For PCI and PXI form factors, this receives a 20 MHz (default) timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting the 20 MHz oscillator (board clock) of the DAQ card to NC_SRC_TERM_RTSI_CLOCK, and then connecting NC_SRC_TERM_RTSI_CLOCK to NC_DEST_TERM_MASTER_TIMEBASE on the CAN card.

For PCMCIA form factor, a 10 MHz timebase is required on NC_SRC_TERM_RTSI_CLOCK. For synchronization with a PCMCIA DAQcard, this is done by programming the **FREQOUT** signal of the DAQ card to 10 MHz, then wiring **FREQOUT** to the NC_SRC_TERM_RTSI_CLOCK of the CAN card.

This value applies to Series 2 cards only (returns error for Series 1).

NC_SRC_TERM_RTSI0 … NC_SRC_TERM_RTSI6

Selects a general-purpose RTSI line as source (input) of the connection.

NC_SRC_TERM_START_TRIGGER

NC_SRC_TERM_START_TRIGGER selects the start trigger, the event that begins sampling for CAN objects.

The start trigger is the same for all CAN objects using a given interface, such as the ObjName input to ncOpenObject.

In the default (disconnected) state of the NC_DEST_TERM_START_TRIGGER destination, the start trigger occurs when communication begins on the interface.

By selecting **RTSI0**–**RTSI6** as the DestinationTerminal, you route the start trigger of this CAN card to the start trigger of other CAN or DAQ cards. This ensures that sampling begins at the same time on both cards. For example, you can synchronize two CAN cards by routing NC_SRC_TERM_START_TRIGGER as the SourceTerminal on one CAN card, and then routing NC_DEST_TERM_START_TRIGGER as the DestinationTerminal on the other CAN card, with both cards using the same RTSI line for the connections.

DestinationTerminal Specifies the destination of the connection.

The following list describes each value of DestinationTerminal:

NC_DEST_TERM_10HZ_RESYNC_CLOCK

NC_DEST_TERM_10HZ_RESYNC_CLOCK instructs the CAN card to use a 10 Hz, 50 percent duty cycle clock to resynchronize its local timebase. This slow rate is required for resynchronization of CAN cards. On each low-to-high transition of the resync clock, this CAN card brings its local timebase into sync.

When synchronizing to an E Series MIO card, a typical use of this value is to use **RTSI0**–**RTSI6** as the SourceTerminal, then use NI-DAQ or NI-DAQmx functions to program the Counter 0 of the MIO card to generate a 10 Hz 50 percent duty cycle clock on the RTSI line.

When synchronizing to a CAN card, a typical use of this value is to use **RTSI0–RTSI6** as the SourceTerminal, then route the NC_SRC_TERM_10HZ_RESYNC_CLOCK of the other CAN card as the SourceTerminal to the same RTSI line.

NC_DEST_TERM_10HZ_RESYNC_CLOCK applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the ObjName input to ncOpenObject.

The default (disconnected) state of this destination means the CAN card does not resynchronize its local timebase.

This value is typically used with Series 1 CAN cards only. If all of the CAN cards are Series 2, the 20 MHz timebase is preferable due to the lack of drift. If you are using a mix of Series 1 and Series 2 CAN cards, you must use NC_DEST_TERM_10HZ_RESYNC_CLOCK.

NC_DEST_TERM_MASTER_TIMEBASE

NC_DEST_TERM_MASTER_TIMEBASE instructs the CAN card to use the source of the connection as the master timebase. The CAN card uses this master timebase for input sampling (including timestamps of received messages) as well as periodic output sampling.

For PCI and PXI form factors, you can use NC_SRC_TERM_RTSI_CLOCK as the SourceTerminal. By default this receives a 20 MHz timebase from another CAN or DAQ card. For example, you can synchronize a CAN and DAQ E Series MIO card by connecting the 20 MHz oscillator (board clock) of the DAQ card to **RTSI Clock** (**RTSI7**), and then connecting NC_SRC_TERM_RTSI_CLOCK to NC_DEST_TERM_MASTER_TIMEBASE on the CAN card. To change the **Master Timebase Rate** to 10 MHz, use ncSetAttribute to change the NC_ATTR_MASTER_TIMEBASE_RATE attribute.

For PXI form factor, you also can use NC_SRC_TERM_PXI_CLK10 as the SourceTerminal.

This receives the PXI 10 MHz backplane clock for use as the master timebase.

For PCMCIA form factor, you can use NC_SRC_TERM_RTSI_CLOCK as the SourceTerminal. Unlike PCI and PXI, the PCMCIA CAN card requires a 10 MHz timebase on NC_SRC_TERM_RTSI_CLOCK (TRIG7_CLK). For synchronization with a PCMCIA DAQcard, this is done by programming the **FREQOUT** signal of the DAQcard to 10 MHz, then wiring **FREQOUT** to the NC_SRC_TERM_RTSI_CLOCK of the CAN card.

NC_DEST_TERM_MASTER_TIMEBASE applies to the entire CAN card, including both interfaces of a 2-port CAN card. The CAN card is specified by the ObjName input to ncOpenObject.

The default (disconnected) state of this destination means the CAN card uses its local 20 MHz timebase as the master timebase.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

NC_DEST_TERM_RTSI_CLOCK

Selects the RTSI clock line as destination (output) of the connection. This terminal is also RTSI line 7. **RTSI7** is dedicated for routing of a timebase (10 MHz or 20 MHz). The CAN card can import a 10 MHz or 20 MHz timebase, but can export only a 20 MHz timebase.

The only valid SourceTerminal for this source is NC_SRC_TERM_20MHZ_TIMEBASE.

This value applies to Series 2 CAN cards only. If you are using a Series 1 CAN card, selecting this value results in an error.

NC_DEST_TERM_RTSI0 … NC_DEST_TERM_RTSI6

Selects a general-purpose RTSI line as destination (output) of the connection.

NC_DEST_TERM_START_TRIGGER

NC_DEST_TERM_START_TRIGGER selects the start trigger, the event that starts communication for all CAN objects on the same port. The start trigger occurs on the first low-to-high transition of the source terminal.

The start trigger is the same for all CAN objects using a given interface, such as the ObjName input to ncOpenObject.

By selecting **RTSI0**–**RTSI6**, or NC_SRC_TERM_PXI_STAR for PXI hardware, as the SourceTerminal, you route the start trigger from another CAN or DAQ card. This ensures that sampling begins at the same time on both cards. For example, you can synchronize with an E Series DAQ MIO card by routing the AI start trigger of the MIO card to a RTSI line and then routing the same RTSI line with NC_DEST_TERM_START_TRIGGER as the DestinationTerminal on the CAN card.

The default (disconnected) state of this destination means the start trigger occurs when communication begins on the interface.

Modifiers — Provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so you must pass Modifiers as zero.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require attention.

Use the ncStatusToString function to obtain a descriptive string for the return value.

Description

This VI connects a specific pair of source/destination terminals. One of the terminals is typically a RTSI signal, and the other terminal is an internal terminal in the CAN hardware.

By connecting internal terminals to RTSI, you can synchronize the CAN card with another hardware product such as an NI-DAQ or NI-DAQmx card.

When the final CAN object for a given port is closed with `ncCloseObject`, NI-CAN disconnects all terminal connections for that port. Therefore, the `ncDisconnectTerminals` function is not required for most applications. NI-DAQ and NI-DAQmx terminals remain connected after the CAN objects are cleared, so you must disconnect NI-DAQ and NI-DAQmx terminals manually at the end of the application.

For a list of valid source/destination pairs, refer to the following section.

Valid Combinations of Source/Destination

Table 11-5 lists all valid combinations of `SourceTerminal` and `DestinationTerminal`.

The series of the NI CAN hardware determines what combinations of `SourceTerminal` to `DestinationTerminal` are valid. Within Table 11-5, 1 indicates Series 1 hardware, and 2 indicates Series 2 hardware. You can determine the series of the NI CAN hardware by selecting the name of the card within the **Devices and Interfaces** view in the left pane of MAX.

Series 1 hardware has the following limitations:

- PXI cards do not support **RTSI6**.
- Signals received from a RTSI source cannot occur faster than 1 kHz. This prevents the card from receiving a 10 MHz or 20 MHz timebase, such as provided by NI E Series MIO hardware.
- Signals received from a RTSI source must be at least 100 µs in length to be detected. This prevents the card from receiving triggers in the nanoseconds range, such as the AI trigger provided by NI E Series MIO hardware. Series 2 CAN cards also send RTSI pulses in the nanoseconds range, so Series 1 CAN cards cannot receive RTSI input from Series 2 CAN cards.
- For CAN cards with High-Speed (HS) ports only, four RTSI signals are available for input (source), and four RTSI signals are available for output (destination). This limitation applies to the number of signals per direction, not the RTSI signal number. For example, if you connect **RTSI0**, **RTSI1**, **RTSI3**, and **RTSI5** as input, connecting **RTSI4** as input will return an error.
- For CAN cards with one or more Low-Speed (LS) ports, two RTSI signals are available for input (source), and three RTSI signals are available for output (destination).

Series 2 hardware has the following limitations:

- For all form factors (PCI, PXI, PCMCIA), the connection of Interface Transceiver Event to a RTSI destination is dependent on the physical port location. If the interface is located on Port 1, you can connect to even-numbered RTSI lines only (**RTSI0**, **RTSI2**, **RTSI4**,

RTSI6). If the interface is located on Port 2, you can connect to odd-numbered RTSI lines only (**RTSI1**, **RTSI3**, **RTSI5**). You can determine the location by selecting the name of the interface in MAX.

- PCI cards do not support the **PXI_Star** and **PXI_Clk10** terminals, as those signals exist on the PXI backplane.
- PCMCIA cards do not support the **20 MHz Timebase**, **PXI_Star**, and **PXI_Clk10** terminals. Because **20 MHz Timebase** is not supported, you cannot synchronize the timebases of two PCMCIA CAN cards.
- On PCMCIA cards, **RTSI4**, **RTSI5** and **RTSI6** are not available.

Table 11-5. Valid Combinations of Source/Destination

Source	Destination				
	RTSI0 to RTSI6	**RTSI_Clock**	**Master Timebase**	**10 Hz Resync Clock**	**Start Trigger**
RTSI0 to RTSI6	—	—	—	1,2	1,2
RTSI_Clock	—	—	2	—	—
PXI_Star	—	—	—	—	2
PXI_Clk10	—	—	2	—	—
20 MHz Timebase	—	2	—	—	—
10 Hz Resync Clock	1,2	—	—	—	1,2
Interface Receive Event	2	—	—	—	2
Interface Transceiver Event	2	—	—	—	—
Start Trigger	1,2	—	—	—	—

1—Valid Connection for Series 1 Hardware

2—Valid Connection for Series 2 Hardware

ncCreateNotification

Purpose

Create a notification callback for an object.

Format

```
NCTYPE_STATUS    ncCreateNotification(
                         NCTYPE_OBJH ObjHandle,
                         NCTYPE_STATE DesiredState,
                         NCTYPE_UINT32 Timeout,
                         NCTYPE_ANY_P RefData,
                         NCTYPE_NOTIFY_CALLBACK
                            Callback)
```

Input

`ObjHandle`	Object handle.
`DesiredState`	States for which notification is sent.
`Timeout`	Length of time to wait in milliseconds.
`RefData`	Pointer to user-specified reference data.
`Callback`	Address of the callback function.

Output

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

`ncCreateNotification` creates a notification callback for the object specified by `ObjHandle`. The NI-CAN driver uses the notification callback to communicate state changes to the application.

This function is normally used when you want to allow other code to execute while waiting for NI-CAN states, especially when the other code does not call NI-CAN functions. If such background execution is not needed, the `ncWaitForState` function offers better overall performance. The `ncWaitForState` function cannot be used at the same time as `ncCreateNotification`.

The functions ncWaitForState and ncCreateNotification use the same underlying implementation. Therefore, for each object handle, only one of these functions can be pending at a time. For example, you cannot invoke ncWaitForState or ncCreateNotification twice from different threads for the same object. For different object handles, these functions can overlap in execution.

This function is not supported for Visual Basic 6.

Upon successful return from ncCreateNotification, the notification callback is invoked whenever one of the states specified by DesiredState occurs in the object, or if an error occurs in the object. If DesiredState is zero, notifications are disabled for the object specified by ObjHandle. DesiredState specifies a bit mask for which notification is desired. You can use a single state alone, or you can OR them together.

NC_ST_READ_AVAIL (00000001 hex)

At least one frame is available, which you can obtain using an appropriate read function.

The state is set whenever a frame arrives for the object. The state is cleared when the read queue is empty.

NC_ST_READ_MULT (00000008 hex)

A specified number of frames are available, which you can obtain using ncReadMult. The number of frames is one half the Read Queue Length by default, but you can change it using the ReadMult Size for Notification attribute of ncSetAttribute.

The state is set whenever the specified number of frames are stored in the read queue of the object. The state is cleared when you call the read function, and less than the specified number of frames exist in the read queue.

NC_ST_REMOTE_WAKEUP (00000040 hex, Remote Wakeup)

Remote wakeup occurred, and **Transceiver Mode** (NC_ATTR_TRANSCEIVER_MODE) has changed from **Sleep** to **Normal**. For more information on remote wakeup, refer to NC_ATTR_TRANSCEIVER_MODE (Transceiver Mode).

This state is set when a remote wakeup occurs (end of wakeup frame). This state is not set when the application changes **Transceiver Mode** from **Sleep** to **Normal** (local wakeup).

This state is cleared when:

- You open the Network Interface, such as when the application begins.
- You stop the Network Interface.
- You set the **Transceiver Mode**, such as each time you set **Sleep** mode.

For as long as this state is true, the **Transceiver Mode** is **Normal**. The **Transceiver Mode** also can be **Normal** when this state is false, such as when you perform a local wakeup.

`NC_ST_WRITE_MULT` (`00000080` hex)

The state is set whenever there is free space in the write queue to accept at least 512 frames to write. The state is cleared when you call the `ncWrite` or `ncWriteMult` function, and less than 512 frames can be accepted to write in the write queue.

This state is valid only on the Network Interface.

`NC_ST_WRITE_SUCCESS` (`00000002` hex)

All frames provided with a write function have been successfully transmitted onto the network. Successful transmit means that the frame won arbitration, and was acknowledged by a remote device.

The state is set when the last frame in the write queue is transmitted successfully. The state is cleared when a write function is called.

When communication starts, the `NC_ST_WRITE_SUCCESS` state is true by default.

For CAN Objects, Write Success does not always mean that transmission has stopped. For example, if a CAN Object is configured for `Transmit Data Periodically`, Write Success occurs when the write queue has been emptied, but periodic transmit of the last frame continues.

The NI-CAN driver waits up to `Timeout` for one of the bits set in `DesiredState` to become set in the attribute `NC_ATTR_STATE`. You can use the special `Timeout` value `NC_DURATION_INFINITE` to wait indefinitely.

The `Callback` parameter provides the address of a callback function in the application. Within the `Callback` function, you can call any of the NI-CAN functions except `ncCreateNotification` and `ncWaitForState`.

With the RefData parameter, you provide a pointer that is sent to all notifications for the given object. This pointer normally provides reference data for use within the Callback function. For example, when you create a notification for the NC_ST_READ_AVAIL state, RefData is often the data pointer that you pass to ncRead to read available data. If the callback function does not need reference data, you can set RefData to NULL.

Callback Prototype

```
NCTYPE_STATE        _NCFUNC_ Callback (NCTYPE_OBJH ObjHandle,
                         NCTYPE_STATE State,
                         NCTYPE_STATUS Status,
                         NCTYPE_ANY_P RefData);
```

Callback Parameters

ObjHandle	Object handle.
State	Current state of object.
Status	Object status.
RefData	Pointer to the reference data.

Callback Return Value

The value you return from the callback indicates the desired states to re-enable for notification. If you no longer want to receive notifications for the callback, return a value of zero.

If you return a state from the callback, and that state is still set in the NC_ATTR_STATE attribute, the callback is invoked again immediately after it returns. For example, if you return NC_ST_READ_AVAIL when the read queue has not been emptied, the callback is invoked again.

Callback Description

In the prototype for Callback, _NCFUNC_ ensures a proper calling scheme between the NI-CAN driver and the callback.

The Callback function executes in a separate thread in the process. Therefore, it has access to any process global data, but not to thread local data. If the callback needs to access global data, you must protect that access using synchronization primitives (such as semaphores), because the callback is running in a different thread context. Alternatively, you can avoid the issue of data protection entirely if the callback simply posts a message to the application using the Win32 PostMessage function. For complete information on multithreading issues, refer to the Win32 Software Development Kit (SDK) online help.

In LabWindows/CVI, you cannot access User Interface library functions within the callback thread. To defer a callback for User Interface interaction, use the CVI `PostDeferredCall` function. For more information, refer to the LabWindows/CVI documentation.

The `ObjHandle` is the same object handle passed to `ncCreateNotification`. It identifies the object generating the notification, which is useful when you use the same callback function for notifications from multiple objects.

The `State` parameter holds the current state(s) of the object that generated the notification (`NC_ATTR_STATE` attribute). If the `Timeout` passed to `ncCreateNotification` expires before the desired states occur, or if any other error occurs in the object, the NI-CAN driver invokes the callback with `State` equal to zero.

The `Status` parameter holds the current status of the object. If an error occurs, `State` is zero and `Status` holds the error status. The most common notification error occurs when the `Timeout` passed to `ncCreateNotification` expires before the desired states occur (`CanErrFunctionTimeout` status code). If no error is reported, `Status` is `CanSuccess`.

The `RefData` parameter is the same pointer passed to `ncCreateNotification`, and it accesses reference data for the `Callback` function.

ncDisconnectTerminals

Purpose

Disconnect terminals in the CAN hardware.

Format

```
NCTYPE_STATUS    ncDisconnectTerminals(
                     NCTYPE_OBJH       ObjectHandle,
                     NCTYPE_UINT32     SourceTerminal,
                     NCTYPE_UINT32     DestinationTerminal,
                     NCTYPE_UINT32     Modifiers);
```

Inputs

`ObjectHandle`	The object handle from the previous NI-CAN function. The `ObjHandle` is originally returned from `ncOpenObject`.
`SourceTerminal`	Specifies the source of the connection. For a description of values for `SourceTerminal`, refer to `ncConnectTerminals`.
`DestinationTerminal`	Specifies the destination of the connection. For a description of values for `DestinationTerminal`, refer to `ncConnectTerminals`.
`Modifiers`	Provides optional connection information for certain source/destination pairs. The current release of NI-CAN does not use this information for any source/destination pair, so you must pass `Modifiers` as zero.

Outputs

Return Value

The return value indicates the status of the function call as a signed 32-bit integer. Zero means the function executed successfully. A negative value specifies an error, which means the function did not perform the expected behavior. A positive value specifies a warning, which means the function performed as expected, but a condition arose that may require the attention.

Use the `ncStatusToString` function to obtain a descriptive string for the return value.

Description

This function disconnects a specific pair of source/destination terminals you previously connected with ncConnectTerminals.

When the final CAN object for a given port is closed with ncCloseObject, NI-CAN disconnects all terminal connections for that port. Therefore, the ncDisconnectTerminals function is not required for most applications. You typically use this function to change RTSI connections dynamically while the application is running. First use ncAction with the NC_OP_STOP opcode to stop all CAN objects for the port, then use ncDisconnectTerminals and ncConnectTerminals to adjust RTSI connections, then use ncAction with the NC_OP_START opcode to start the network interface and restart sampling.

ncGetAttribute

Purpose

Get the value of an object attribute.

Format

```
NCTYPE_STATUS    ncGetAttribute(
                                NCTYPE_OBJH ObjHandle,
                                NCTYPE_ATTRID AttrId,
                                NCTYPE_UINT32 AttrSize,
                                NCTYPE_ANY_P AttrPtr)
```

Input

ObjHandle	Object handle.
AttrId	Identifier of the attribute to get.
AttrSize	Size of the attribute in bytes.

Output

AttrPtr	Pointer used to return attribute value.

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to ncStatusToString.

Description

ncGetAttribute gets the value of the attribute specified by AttrId from the object specified by ObjHandle. Within NI-CAN objects, you use attributes to access configuration settings, status, and other information about the object, but not data.

AttrPtr points to the variable used to receive the attribute value. Its type is undefined so that you can use the appropriate host data type for AttrId. AttrSize indicates the size of the variable that AttrPtr points to. AttrSize is typically 4, and AttrPtr references a 32-bit unsigned integer.

You can get any of the AttrId mentioned in ncConfig using ncGetAttribute. The following list describes other AttrId you can get using ncGetAttribute:

NC_ATTR_ABS_TIME (Absolute Timestamp)

Returns the absolute timestamp value. The timestamp format is a 64-bit unsigned integer compatible with the Win32 FILETIME type (NCTYPE_ABS_TIME). This absolute time is kept in a Coordinated Universal Time (UTC) format. UTC time is loosely defined as the current date and time of day in Greenwich, England. Microsoft defines its UTC time (FILETIME) as a 64-bit counter of 100 ns intervals that have elapsed since 12:00 a.m., January 1, 1601.

Since the timestamp returned by ncRead (and this attribute) is compatible with Win32 FILETIME, you can pass it into the Win32 FileTimeToLocalFileTime function to convert it to the local time zone, then pass the resulting local time to the Win32 FileTimeToSystemTime function to convert to the Win32 SYSTEMTIME type. SYSTEMTIME is a struct with fields for year, month, day, and so on. For more information on Win32 time types and functions, refer to the Microsoft Win32 documentation.

Since the absolute timestamp type is 64 bits (NCTYPE_ABS_TIME), you must use AttrSize of 8.

NC_ATTR_HW_FORMFACTOR (Form Factor)

Returns the form factor of the card on which the Network Interface or CAN Object is located.

The returned Form Factor is an enumeration.

NC_HW_FORMFACTOR_PCI	PCI
NC_HW_FORMFACTOR_PXI	PXI
NC_HW_FORMFACTOR_PCMCIA	PCMCIA
NC_HW_FORMFACTOR_AT	AT

NC_ATTR_HW_SERIAL_NUM (Serial Number)

Returns the serial number of the card on which the Network Interface or CAN Object is located.

NC_ATTR_HW_SERIES (Series)

Returns the series of the card on which the Network Interface or CAN Object is located.

Series 1 hardware products use the Intel 82527 CAN controller.

Series 2 hardware products use the Philips SJA1000 CAN controller, plus improved RTSI synchronization features.

The returned Series is an enumeration.

NC_HW_SERIES_1	Series 1
NC_HW_SERIES_2	Series 2

NC_ATTR_INTERFACE_NUM (Interface Number)

Returns the interface number of the port on which the Network Interface or CAN Object is located.

This is the same number that you used in the ObjName string of the previous ncConfig and ncOpenObject functions.

NC_ATTR_LISTEN_ONLY (Listen Only)

Returns the NC_ATTR_LISTEN_ONLY (Listen Only) attribute as configured with ncConfig.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

NC_ATTR_LOG_COMM_ERRS (Log Comm Warnings)

Returns TRUE or FALSE depending on whether communication warnings (including transceiver faults) were logged to the Network Interface read queue. For more information, refer to this attribute in ncConfig.

NC_ATTR_LOG_START_TRIGGER (Log Start Trigger)

Returns the Log Start Trigger attribute as configured with ncSetAttribute.

NC_ATTR_MASTER_TIMEBASE_RATE (Master Timebase Rate)

Returns the present Master Timebase Rate in MHz, programmed into the CAN hardware. For PCMCIA, this attribute will always return 10 MHz.

NC_ATTR_NOTIFY_MULT_LEN (ReadMult Size for Notification)

Returns the number of frames used as a threshold for the Read Multiple state. For more information, refer to this attribute in ncSetAttribute.

NC_ATTR_PROTOCOL_VERSION (Protocol Version)

For NI-CAN, this returns 02000200 hex, which corresponds to version 2.0B of the Bosch CAN specifications. For more information on the encoding of the version, refer to Software Version.

This attribute is available only from the Network Interface, not CAN Objects.

NC_ATTR_READ_PENDING (Read Entries Pending)

Returns the number of frames available in the read queue. Polling the available frames with this attribute can be used as an alternative to the ncWaitForState and ncCreateNotification functions.

NC_ATTR_RTSI_FRAME (RTSI Frame)

Returns the RTSI Frame attribute as configured with ncConfig.

NC_ATTR_RX_ERROR_COUNTER (Receive Error Counter)

Returns the Receive Error Counter from the Philips SJA1000 CAN controller. This Receive Error Counter is specified in the Bosch CAN standard as well as ISO CAN standards.

This attribute is unsupported for Series 1 hardware (returns error).

This attribute is available only from the Network Interface, not CAN Objects.

NC_ATTR_SELF_RECEPTION (Self Reception)

Returns the NC_ATTR_SELF_RECEPTION (Self Reception) attribute as configured with ncConfig.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

NC_ATTR_SERIES2_COMP (Series 2 Comparator)

Returns the NC_ATTR_SERIES2_COMP (Series 2 Comparator) attribute as configured with ncConfig.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

NC_ATTR_SERIES2_ERR_ARB_CAPTURE (Series 2 Error/Arb Capture)

Returns the current values of the Error Code Capture register and Arbitration Lost Capture register from the Philips SJA1000 CAN controller chip.

The Error Code Capture register provides information on bus errors that occur according to the CAN standard. A bus error increments either the Transmit Error Counter or the Receive Error Counter. When communication starts on the interface, the first bus error is captured into the Error Code Capture register, and retained until you get this attribute. After you get this attribute, the Error Code Capture register is again enabled to capture information for the next bus error.

The Arbitration Lost Capture register provides information on a loss of arbitration during transmits. Loss of arbitration is not considered an error. When communication starts on the interface, the first arbitration loss is captured into the Arbitration Lost Capture register, and retained until you get this attribute. After you get this attribute, the Arbitration Lost Capture register is again enabled to capture information for the next arbitration loss.

For each of the capture registers, a single-bit New flag indicates whether a new error has occurred since the last Get. If the New flag of a register is set, the associated fields contain new information. If the New flag of a register is clear, the associated fields are the same as the previous Get.

This attribute is commonly used with the NC_ATTR_SINGLE_SHOT_TX attribute. When a Write function is used to transmit the single frame, you can get this attribute to determine if the transmit was successful. If the single shot transmit was not successful, this attribute provides detailed information regarding the failure.

This attribute is supported for Series 2 hardware only (returns error for Series 1). Since the information and bit format is very specific to the Philips SJA1000 CAN controller on Series 2 hardware, National Instruments cannot guarantee compatibility for this attribute on future hardware series. When using this attribute in the application, it is best to get the NC_ATTR_HW_SERIES (Series) attribute to verify that the CAN hardware is Series 2.

Figure 11-8 and the associated tables describe the format of bit fields in this attribute. The lowest byte (bits 0–7) corresponds to the Error

Code Capture register. The next byte (bits 8–15) corresponds to the Arbitration Lost Capture register. Bit 16 (`00010000` hex) is the New flag for the Error Code Capture fields. Bit 17 (`00020000` hex) is the New flag for the Arbitration Lost Capture field. Bits marked as "X" are reserved, and should be ignored by the application.

The C/C++ header file `nican.h` provides the following macros to accept the attribute value as input and return a value as listed in the tables:

- `NC_GET_ERRARB_SEG(value)`
- `NC_GET_ERRARB_DIR(value)`
- `NC_GET_ERRARB_ERRC(value)`
- `NC_GET_ERRARB_ALC(value)`
- `NC_GET_ERRARB_NEWECC(value)`
- `NC_GET_ERRARB_NEWALC(value)`

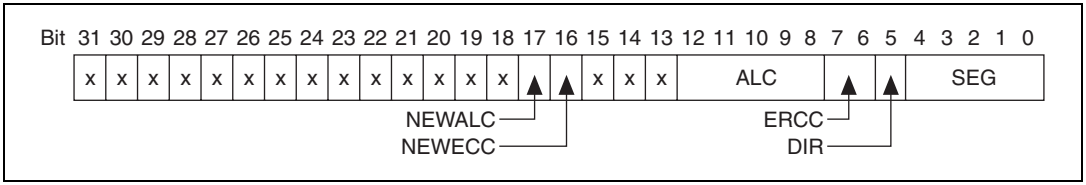


Figure 11-8. Series 2 Error/Arb Capture Format

Table 11-6. SEG Field of the Error Code Capture Register

Value in SEG Field	Meaning
0	No error (ignore DIR and ERRC as well)
2	ID.28 to ID.21 (most significant bits of identifier)
3	Start of frame
4	Bit SRTR (RTR for standard frames)
5	Bit IDE
6	ID.20 to ID.18
7	ID.17 to ID.13
8	CRC sequence

Table 11-6. SEG Field of the Error Code Capture Register (Continued)

Value in SEG Field	Meaning
9	Reserved bit 0
10	Data field
11	Data length code
12	Bit RTR (RTR for extended frames)
13	Reserved bit 1
14	ID.4 to ID.0
15	ID.12 to ID.5
17	Active error flag
18	Intermission
19	Tolerate dominant bits
22	Passive error flag
23	Error delimiter
24	CRC delimiter
25	Acknowledge slot
26	End of frame
27	Acknowledge delimiter
28	Overload flag

Table 11-7. DIR Field of the Error Code Capture Register

Value in DIR Field	Meaning
0	TX; error occurred during transmission
1	RX; error occurred during reception

Table 11-8. ERRC Field of the Error Code Capture Register

Value in ERRC Field	Meaning
0	Bit error
1	Form error
2	Stuff error
3	Other type of error

Table 11-9. ALC Field Contains the Arbitration Lost Capture Register

Value in ALC Field	Meaning
0	ID.28 (most significant bit of identifier; first ID bit in frame)
1	ID.27
2	ID.26
3	ID.25
4	ID.24
5	ID.23
6	ID.22
7	ID.21
8	ID.20
9	ID.19
10	ID.18
11	SRTR (RTR for standard frames)
12	IDE
13	ID.17 (extended frames only)

Table 11-9. ALC Field Contains the Arbitration Lost Capture Register (Continued)

Value in ALC Field	Meaning
14	ID.16 (extended frames only)
15	ID.15 (extended frames only)
16	ID.14 (extended frames only)
17	ID.13 (extended frames only)
18	ID.12 (extended frames only)
19	ID.11 (extended frames only)
20	ID.10 (extended frames only)
21	ID.9 (extended frames only)
22	ID.8 (extended frames only)
23	ID.7 (extended frames only)
24	ID.6 (extended frames only)
25	ID.5 (extended frames only)
26	ID.4 (extended frames only)
27	ID.3 (extended frames only)
28	ID.2 (extended frames only)
29	ID.1 (extended frames only)
30	ID.0 (extended frames only)
31	SRTR (RTR for extended frames)

Table 11-10. NEWECC Field is the New Flag for the Error Code Capture Register

Value in NEWECC Field	Meaning
0	SEG, DIR, and ERRC fields contain the same value as the last Get of this attribute. If no error has occurred since the start of communication, all fields are zero.
1	SEG, DIR, and ERRC fields contain information for a new bus error.

Table 11-11. NEWALC Field is the New Flag for the Arbitration Lost Capture Register

Value in NEWALC Field	Meaning
0	ALC field contains the same value as the last Get of this attribute.
1	ALC field contains information for a new arbitration loss.

`NC_ATTR_SERIES2_FILTER_MODE` (Series 2 Filter Mode)

Returns the `NC_ATTR_SERIES2_FILTER_MODE (Series 2 Filter Mode)` attribute as configured with `ncConfig`.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

`NC_ATTR_SERIES2_MASK` (Series 2 Mask)

Returns the `NC_ATTR_SERIES2_MASK (Series 2 Mask)` attribute as configured with `ncConfig`.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

NC_ATTR_SINGLE_SHOT_TX (Single Shot Transmit)

Returns the NC_ATTR_SINGLE_SHOT_TX (Single Shot Transmit) attribute as configured with ncConfig.

This attribute is supported on Series 2 NI CAN hardware only (returns error for Series 1).

NC_ATTR_SOFTWARE_VERSION (Software Version)

Version of the NI-CAN software, with major, minor, update, and beta build numbers encoded in the U32 from high to low bytes. For example, 2.0.1 would be 02000100 hex, and 2.1beta5 would be 02010005 hex.

NC_ATTR_STATE (Object State)

Returns the current state bit mask of the object. Polling with ncGetAttribute provides an alternative method of state detection than ncWaitForState or ncCreateNotification. For more information on the states returned from this attribute, refer to the DesiredState input of ncWaitForState.

NC_ATTR_TIMELINE_RECOVERY (Timeline Recovery)

Returns the Timeline Recovery attribute for the CAN Network Interface Object.

NC_ATTR_TIMESTAMP_FORMAT (Timestamp Format)

Returns the present Timestamp Format programmed into the CAN hardware. This property applies to the entire card.

NC_ATTR_TRANSCEIVER_EXTERNAL_IN (Transceiver External Inputs)

Returns the transceiver external inputs for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this attribute allows you to determine the input voltage on the STATUS pin of the CAN port.

For many models of CAN transceiver, an NERR pin is provided for detection of faults and other status. For such transceivers, you can wire the NERR pin to the STATUS pin of the CAN port.

This attribute is supported for Series 2 XS cards only (returns error for non-XS).

This attribute uses a bit mask. When using the attribute, use bitwise AND operations to check for values, not equality checks (equal, greater than, and so on).

`NC_TRANSCEIVER_IN_STATUS` (`00000001` hex, STATUS pin)

This bit is set when 5 V exists on the STATUS pin.

This bit is clear when 0 V exists on the STATUS pin.

`NC_ATTR_TRANSCEIVER_EXTERNAL_OUT` (Transceiver External Outputs)

Returns the transceiver external outputs for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this attribute allows you to determine the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you to determine if the CAN controller chip is sleeping.

For more information on the format of the value returned in this attribute, refer to the description of `NC_ATTR_TRANSCEIVER_EXTERNAL_OUT (Transceiver External Outputs)` in `ncSetAttribute`.

This attribute is supported for Series 2 XS cards only (returns error for non-XS).

`NC_ATTR_TRANSCEIVER_MODE` (Transceiver Mode)

Returns the transceiver mode for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

This attribute is supported for Series 2 cards only (returns error for Series 1).

The transceiver mode changes when you set the mode within the application, or when a remote wakeup transitions the interface from

Sleep to **Normal** mode. For more information, refer to ncSetAttribute.

This property uses the following values:

NC_TRANSCEIVER_MODE_NORMAL (Normal)

Transceiver is awake in **Normal** communication mode.

NC_TRANSCEIVER_MODE_SLEEP (Sleep)

Transceiver and the CAN controller chip are both in **Sleep** mode.

NC_TRANSCEIVER_MODE_SW_WAKEUP (Single Wire Wakeup)

Single Wire transceiver is in **Wakeup Transmission** mode.

NC_TRANSCEIVER_MODE_SW_HIGHSPEED (Single Wire High-Speed)

Single Wire transceiver is in **High-Speed Transmission** mode.

NC_ATTR_TRANSCEIVER_TYPE (Transceiver Type)

Returns the type of transceiver for the Network Interface. For hardware other than Series 2 XS cards, the transceiver type is fixed. For Series 2 XS cards, the transceiver type reflects the most recent value specified by MAX or ncSetAttribute.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

This attribute is not supported on the PCMCIA form factor.

This attribute uses the following values:

NC_TRANSCEIVER_TYPE_DISC (Disconnect)

Transceiver type is **Disconnect**. This transceiver type is available on Series 2 XS cards only. For more information, refer to ncSetAttribute.

NC_TRANSCEIVER_TYPE_EXT (External)

Transceiver type is **External**. This transceiver type is available on Series 2 XS cards only. For more information, refer to ncSetAttribute.

NC_TRANSCEIVER_TYPE_HS (High-Speed)

Transceiver type is **High-Speed** (HS).

NC_TRANSCEIVER_TYPE_LS (Low-Speed/Fault-Tolerant)

Transceiver type is **Low-Speed/Fault-Tolerant** (LS).

NC_TRANSCEIVER_TYPE_SW (Single Wire)

Transceiver type is **Single Wire** (SW).

NC_ATTR_TRANSMIT_MODE (Transmit Mode)

Returns the Transmit Mode the CAN Network Interface Object is presently configured for.

The returned Transmit Mode is a Boolean value.

0	Immediate Transmit
1	Timestamped Transmit

NC_ATTR_TX_ERROR_COUNTER (Transmit Error Counter)

Returns the Transmit Error Counter from the Philips SJA1000 CAN controller. This Transmit Error Counter is specified in the Bosch CAN standard as well as ISO CAN standards.

This attribute is unsupported for Series 1 hardware (returns error).

This attribute is available only from the Network Interface, not CAN Objects.

NC_ATTR_VIRTUAL_BUS_TIMING (Virtual Bus Timing)

Returns a Boolean value of TRUE or FALSE to indicate whether Virtual Bus Timing has been set or not for the specified virtual interface. This attribute is applicable to all CAN objects opened on the virtual interface.

NC_ATTR_WRITE_ENTRIES_FREE (Write Entries Free)

Returns the number of frames pending transmission in the write queue. If the intent is to verify that all pending frames have been transmitted successfully, waiting for the Write Success state is preferable to this attribute.

`NC_ATTR_WRITE_PENDING` (Write Entries Pending)

Returns the number of frames pending transmission in the write queue. If the intent is to verify that all pending frames have been transmitted successfully, waiting for the Write Success state is preferable to this attribute.

ncGetHardwareInfo

Purpose

Get NI-CAN hardware information.

Format

```
NCTYPE_STATUS _NCFUNC_ ncGetHardwareInfo(
                          NCTYPE_UINT32 CardNumber,
                          NCTYPE_UINT32 PortNumber,
                          NCTYPE_ATTRID AttrId,
                          NCTYPE_UINT32 AttrSize,
                          NCTYPE_ANY_P AttrPtr);
```

Input

`CardNumber` Specifies the CAN card number from 1 to `Number of Cards`, where `Number of Cards` is the number of CAN cards in the system. You can obtain `Number of Cards` using this function with `CardNumber` = `1`, `PortNumber` = `1`, and `AttrID` = `Number of Cards`.

`PortNumber` Specifies the CAN port number from `1` to `Number of Ports`, where `Number of Ports` is the number of CAN ports on this CAN card. You can obtain `Number of Ports` using this function with `PortNumber` = `1`, and `AttrID` = `Number of Ports`.

`AttrID` Specifies the attribute to get:

`NC_ATTR_HW_FORMFACTOR` (Form Factor)

Card-wide attribute that returns the form factor of the card. Use the desired `CardNumber`, and `PortNumber 1` as inputs.

The returned Form Factor is an enumeration.

`NC_HW_FORMFACTOR_PCI`	PCI
`NC_HW_FORMFACTOR_PXI`	PXI
`NC_HW_FORMFACTOR_PCMCIA`	PCMCIA
`NC_HW_FORMFACTOR_AT`	AT

`NC_ATTR_HW_SERIAL_NUM` (Serial Number)

Card-wide attribute that returns the serial number of the card. Use the desired `CardNumber`, and `PortNumber 1` as inputs.

NC_ATTR_HW_SERIES (Series)

Card-wide attribute that returns the series of the card. Use the desired CardNumber, and PortNumber 1 as inputs.

Series 1 hardware products use the Intel 82527 CAN controller.

Series 2 hardware products use the Philips SJA1000 CAN controller, plus improved RTSI synchronization features.

The returned Series is an enumeration.

NC_HW_SERIES_1	Series 1
NC_HW_SERIES_2	Series 2

NC_ATTR_INTERFACE_NUM (Interface Number)

Port-wide attribute that returns the interface number of the port. Use the desired CardNumber and PortNumber as inputs.

The interface number is assigned to a physical port using the Measurement and Automation Explorer (MAX). The interface number is used as a string in the Frame API (for example, “CAN0”). The interface number is used for the Interface input in the Channel API.

NC_ATTR_NUM_CARDS (Number of Cards)

Returns the number of NI-CAN cards in the system. Use CardNumber 1 and PortNumber 1 as inputs.

If you are displaying all hardware information, you get this attribute first, then iterate through all CAN cards with a For loop. Inside the For loop, get all card-wide attributes including Number Of Ports, then use another For loop to get port-wide attributes.

NC_ATTR_NUM_PORTS (Number of Ports)

Card-wide attribute that returns the number of ports on the card. Use the desired CardNumber, and PortNumber 1 as inputs.

If you are displaying all hardware information, you get this attribute within the For loop for all cards, then iterate through all CAN ports to get port-wide attributes.

NC_ATTR_TRANSCEIVER_TYPE (Transceiver Type)

This port-wide attribute returns the type of transceiver. Use the desired CardNumber and PortNumber as inputs.

For hardware other than Series 2 XS cards, the transceiver type is fixed. For Series 2 XS cards, the transceiver type reflects the most recent value specified by MAX or ncSetAttribute.

This attribute is not supported on the PCMCIA form factor.

This attribute uses the following values:

0 (High-Speed)

Transceiver type is **High-Speed** (HS).

1 (Low-Speed/Fault-Tolerant)

Transceiver type is **Low-Speed/Fault-Tolerant** (LS).

2 (Single Wire)

Transceiver type is **Single Wire** (SW).

3 (External)

Transceiver type is **External**. This transceiver type is available on Series 2 XS cards only. For more information, refer to ncSetAttribute.

4 (Disconnect)

Transceiver type is **Disconnect**. This transceiver type is available on Series 2 XS cards only. For more information, refer to ncSetAttribute.

NC_ATTR_VERSION_BUILD (Version Build)

Returns the build of the NI-CAN software. Use CardNumber 1 and PortNumber 1 as inputs.

With each software development phase, subsequent NI-CAN builds are numbered sequentially. A given Final release version always uses the same build number, so unless you are participating in an NI-CAN beta program, this build number is not relevant.

NC_ATTR_VERSION_COMMENT (Version Comment)

Returns any special comment on the NI-CAN software. AttrPtr must point to a buffer for the string, and AttrSize specifies the number of characters in that buffer. Use CardNumber 1 and PortNumber 1 as inputs.

This string is normally empty for a Final release. In rare circumstances, an NI-CAN prototype or patch may be released to a specific customer. For these special releases, the version comment describes the special features of the release.

`NC_ATTR_VERSION_MAJOR` (Version Major)

Returns the major version of the NI-CAN software. Use `CardNumber 1` and `PortNumber 1` as inputs.

The major version is the ‘X’ in X.Y.Z.

`NC_ATTR_VERSION_MINOR (Version Minor)`

Returns the minor version of the NI-CAN software. Use `CardNumber 1` and `PortNumber 1` as inputs.

The minor version is the ‘Y’ in X.Y.Z.

`NC_ATTR_VERSION_PHASE` (Version Phase)

Returns the phase of the NI-CAN software. Use `CardNumber 1` and `PortNumber 1` as inputs.

Phase 1 specifies Alpha, phase 2 specifies Beta, and phase 3 specifies Final release. Unless you are participating in an NI-CAN beta program, you will always see `3`.

`NC_ATTR_VERSION_UPDATE` (Version Update)

Returns the update version of the NI-CAN software. Use `CardNumber 1` and `PortNumber 1` as inputs.

The update version is the ‘Z’ in X.Y.Z.

`AttrSize` Size of the attribute in bytes. Unless stated otherwise, `AttrSize` must be `4`.

Output

`AttrPtr` Pointer used to return attribute value. Unless stated otherwise, `AttrPtr` must point to `NCTYPE_UINT32`.

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected,

but a condition arose that might require attention. For more information, refer to ncStatusToString.

Description

This function provides information about available CAN cards, but does not require you to open/start sessions. First get Number of Cards, then loop for each card. For each card, you can get card-wide attributes (such as Form Factor), and you also can get the Number of Ports. For each port, you can get port-wide attributes such as the Transceiver.

ncOpenObject

Purpose

Open an object.

Format

```
NCTYPE_STATUS    ncOpenObject(
                              NCTYPE_STRING ObjName,
                              NCTYPE_OBJH_P ObjHandlePtr)
```

Input

`ObjName`	ASCII name of the object to open.

Output

`ObjHandlePtr`	Pointer used to return Object handle. Used with all subsequent NI-CAN function calls.

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

`ncOpenObject` takes the name of an object to open and returns a handle to that object that you use with subsequent NI-CAN function calls.

The Frame API and Channel API cannot use the same CAN network interface simultaneously. If the CAN network interface is already initialized in the Channel API, this function returns an error.

If `ncOpenObject` is successful, a handle to the newly opened object is returned. You use this object handle for all subsequent function calls for the object.

The following sections describe how to use `ncOpenObject` with the Network Interface and Can Object.

Network Interface

`ObjName` is the name of the CAN Network Interface Object to configure. This string uses the syntax "CAN*x*", where *x* is a decimal number starting at zero that indicates the CAN network interface (**CAN0**, **CAN1**, up to **CAN63**). CAN network interface names are associated with physical CAN ports using the Measurement and Automation Explorer (MAX).

The special `ObjName` values 256 and 257 refer to virtual interfaces. For more information on usage of virtual interfaces, refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*.

CAN Object

`ObjName` is the name of the CAN Object to configure. This string uses the syntax "CAN*x*::STD*y*" or "CAN*x*::XTD*y*". CAN*x* is the name of the CAN network interface that you used for the preceding `ncConfig` function. STD indicates that the CAN Object uses a standard (11-bit) arbitration ID. XTD indicates that the CAN Object uses an extended (29-bit) arbitration ID. The number *y* specifies the actual arbitration ID of the CAN Object. The number *y* is decimal by default, but you also can use hexadecimal by adding `0x` to the beginning of the number. For example, "CAN0::STD25" indicates standard ID 25 decimal on **CAN0**, and "CAN1::XTD0x0000F652" indicates extended ID F652 hexadecimal on CAN1.

The special virtual interface names "CAN256" and "CAN257" are not supported for CAN Objects.

ncRead

Purpose

Read single frame from an object.

Format

```
NCTYPE_STATUS    ncRead(
                        NCTYPE_OBJH ObjHandle,
                        NCTYPE_UINT32 DataSize,
                        NCTYPE_ANY_P DataPtr)
```

Input

ObjHandle	Object handle.
DataSize	Size of the data in bytes.

Output

DataPtr	Pointer used to return the frame.

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to ncStatusToString.

Description

ncRead reads a single frame from the object specified by ObjHandle.

DataPtr points to the variable that holds the data. Its type is undefined so that you can use the appropriate host data type. DataSize indicates the size of variable pointed to by DataPtr, and is used to verify that the size you have available is compatible with the configured read size for the object.

For information on the data type to use with DataPtr, refer to the following Network Interface and CAN Object descriptions.

You use ncRead to obtain data from the read queue of an object. Because NI-CAN handles the read queue in the background, this function does not wait for new data to arrive. To ensure that new data is available before calling ncRead, first wait for the NC_ST_READ_AVAIL state. The NC_ST_READ_AVAIL state transitions from false to true when NI-CAN places a new data item into an empty read queue, and remains true until you read the last data item from the queue.

The ncRead function is useful when you need to process one frame at a time. In order to read multiple frames, such as for bus analyzer applications, use the ncReadMult function.

When you call ncRead for an empty read queue (NC_ST_READ_AVAIL false), the data from the previous call to ncRead is returned to you again, along with the CanWarnOldData warning. If no data item has yet arrived for the read queue, a default data item is returned, which consists of all zeros.

When a new data item arrives for a full queue, NI-CAN discards the item, and the next call to ncRead returns the CanErrOverflowRead error. You can avoid this overflow behavior by setting the read queue length to zero. When a new data item arrives for a zero length queue, it simply overwrites the previous item without indicating an overflow. The NC_ST_READ_AVAIL state and CanWarnOldData warning still behave as usual, but you can ignore them if you only want the most recent data. You can use the NC_ATTR_READ_Q_LEN attribute to configure the read queue length.

CAN Network Interface Object

The data type that you use with ncRead of the Network Interface is NCTYPE_CAN_STRUCT. When calling ncRead, you should pass size of (NCTYPE_CAN_STRUCT) for the DataSize parameter.

Within the NCTYPE_CAN_STRUCT structure, the FrameType field determines the meaning of all other fields. The following tables, 11-12 through 11-15, describe the fields of NCTYPE_CAN_STRUCT for each value of FrameType.

Table 11-12. NCTYPE_CAN_STRUCT Fields for FrameType NC_FRMTYPE_DATA (0)

Field Name	Data Type	Description
FrameType	NCTYPE_UINT8	NC_FRMTYPE_DATA (0) This value indicates a CAN data frame.
ArbitrationId	NCTYPE_CAN_ARBID	Returns the arbitration ID of the received data frame. The NCTYPE_CAN_ARBID type is an unsigned 32-bit integer that uses the bit mask NC_FL_CAN_ARBID_XTD (0x20000000) to indicate an extended ID. A standard ID (11-bit) is specified by default. The Network Interface receives data frames based on the comparators and masks configured in ncConfig (including the Series 2 Filter Mode attributes).

Table 11-12. NCTYPE_CAN_STRUCT Fields for FrameType NC_FRMTYPE_DATA (0) (Continued)

Field Name	Data Type	Description
Data	Array of 8 NCTYPE_UINT8	Returns the data bytes of the frame.
DataLength	NCTYPE_UINT8	Returns the number of data bytes received in the frame. This specifies the number of valid data bytes in Data.
Timestamp	NCTYPE_ABS_TIME	Returns the absolute timestamp when the data frame was received from the CAN network. The timestamp data type NCTYPE_ABS_TIME is a 64-bit unsigned integer compatible with the Win32 FILETIME type. This absolute time is kept in a Coordinated Universal Time (UTC) format. UTC time is loosely defined as the current date and time of day in Greenwich, England. Microsoft defines its UTC time (FILETIME) as a 64-bit counter of 100 ns intervals that have elapsed since 12:00 a.m., January 1, 1601. Since Timestamp is compatible with Win32 FILETIME, you can pass it into the Win32 FileTimeToLocalFileTime function to convert it to the local time zone, then pass the resulting local time to the Win32 FileTimeToSystemTime function to convert to the Win32 SYSTEMTIME type. SYSTEMTIME is a struct with fields for year, month, day, and so on. For more information on Win32 time types and functions, refer to the Microsoft Win32 documentation.

Table 11-13. NCTYPE_CAN_STRUCT Fields for FrameType NC_FRMTYPE_REMOTE (1)

Field Name	Data Type	Description
FrameType	NCTYPE_UINT8	NC_FRMTYPE_REMOTE (1) This value indicates a CAN remote frame. Only Series 2 hardware or later can receive remote frames using the Network Interface. For Series 1 hardware, you must handle incoming remote frames with CAN Objects only.
ArbitrationId	NCTYPE_CAN_ARBID	Returns the arbitration ID of the received remote frame. The NCTYPE_CAN_ARBID type is an unsigned 32-bit integer that uses the bit mask NC_FL_CAN_ARBID_XTD (0x20000000) to indicate an extended ID. A standard ID (11-bit) is specified by default. The Network Interface receives remote frames based on the comparators and masks configured in ncConfig (including the Series 2 Filter Mode attributes).
Data	Array of 8 NCTYPE_UINT8	Remote frames do not contain data, so this array is empty.
DataLength	NCTYPE_UINT8	Returns the Data Length Code in the remote frame.
Timestamp	NCTYPE_ABS_TIME	Returns the absolute timestamp when the remote frame was received from the CAN network. For information on the timestamp data type, refer to Table 11-12.

Table 11-14. NCTYPE_CAN_STRUCT Fields for FrameType NC_FRMTYPE_COMM_ERR (2)

Field Name	Data Type	Description
FrameType	NCTYPE_UINT8	NC_FRMTYPE_COMM_ERR (2) This value indicates a logged communication warning or error as reported by the CAN hardware. This frame type occurs only when you set the Log Comm Warnings attribute to TRUE and the CAN controller is in the error passive state. Refer to ncConfig for details. For more information on CAN error handling, refer to the *CAN Error Detection and Confinement* section of Appendix B, *Summary of the CAN Standard*.
ArbitrationId	NCTYPE_CAN_ARBID	Indicates the type of communication problem: 8000000B hex:Comm. error: General 4000000B hex:Comm. warning: General 8001000B hex:Comm. error: Stuff 4001000B hex:Comm. warning: Stuff 8002000B hex:Comm. error: Format 4002000B hex:Comm. warning: Format 8003000B hex:Comm. error: No Ack 4003000B hex:Comm. warning: No Ack 8004000B hex:Comm. error: Tx 1 Rx 0 4004000B hex:Comm. warning: Tx 1 Rx 0 8005000B hex:Comm. error: Tx 0 Rx 1 4005000B hex:Comm. warning: Tx 0 Rx 1 8006000B hex:Comm. error: Bad CRC 4006000B hex:Comm. warning: Bad CRC 0000000B hex:Comm. errors/warnings cleared 8000000C hex:Transceiver fault warning 0000000C hex:Transceiver fault cleared
Data	Array of 8 NCTYPE_UINT8	This field is not applicable to this frame type, and should be ignored.
DataLength	NCTYPE_UINT8	This field is not applicable to this frame type, and should be ignored.

Table 11-14. NCTYPE_CAN_STRUCT Fields for FrameType NC_FRMTYPE_COMM_ERR (2) (Continued)

Field Name	Data Type	Description
Timestamp	NCTYPE_ABS_TIME	Returns the absolute timestamp when the communications problem occurred. For information on the timestamp data type, refer to Table 11-12.

Table 11-15. NCTYPE_CAN_STRUCT Fields for FrameType NC_FRMTYPE_RTSI (3)

Field Name	Data Type	Description
FrameType	NCTYPE_UINT8	NC_FRMTYPE_RTSI (3) Indicates when a RTSI input pulse occurred relative to incoming CAN frames. This frame type occurs only when you set the RTSI Mode attribute to NC_RTSI_TIME_ON_IN (refer to ncConfig for details).
ArbitrationId	NCTYPE_CAN_ARBID	Returns the special value 40000001 hex.
Data	Array of 8 NCTYPE_UINT8	This field is not applicable to this frame type, and should be ignored.
DataLength	NCTYPE_UINT8	Returns the RTSI signal number detected.
Timestamp	NCTYPE_ABS_TIME	Returns the absolute timestamp when the RTSI input occurred. For information on the timestamp data type, refer to Table 11-12.

Table 11-16. NCTYPE_CAN_STRUCT Fields for FrameType NC_FRMTYPE_TRIG_START (4)

Field Name	Data Type	Description
IsRemote	NCTYPE_UINT8	Value 4 specifies a start trigger frame. When the Log Start Trigger attribute is set to 1 (True), this frame indicates the time when the start trigger occurs. For example, if you use ncConnectTerminals to connect a RTSI input to the start trigger, this frame occurs when the RTSI input pulse for the first time. Another use case for logging the start trigger would be for logging the received CAN frames in a file. This ensures that the first frame in the logfile is a start trigger frame, which specifies the absolute time (date/time) at which CAN communication started.
ArbitrationId	NCTYPE_CAN_ARBID	Value 0 is required.
Data	Array of 8 NCTYPE_UINT8	The single data byte in the array specifies the **Timestamp Format** (defined in ncSetAttribute) used for all subsequent CAN frames. The value is 0 for absolute timestamps, and 1 for relative timestamps.
DataLength	NCTYPE_UINT8	Value 1 is required.
Timestamp	NCTYPE_ABS_TIME	Absolute timestamp of the start trigger. Within a logfile, this timestamp indicates the date and time at which CAN communication started. The format of this timestamp is always absolute, even when Data byte 0 specifies relative timestamp format. This absolute timestamp provides data/time information even when the CAN frames use the relative format.

Error Active, Error Passive, and Bus Off States

When the CAN communication controller transfers into the error passive state, NI-CAN returns the warning `CanCommWarning` from read functions.

When the transmit error counter of the CAN communication controller increments above 255, the network interface transfers into the **bus off** state as dictated by the CAN protocol. The network interface stops communication so that you can correct the defect in the network, such as a malfunctioning cable or device. When **bus off** occurs, NI-CAN returns the `CanErrComm` error code.

If no CAN devices are connected to the network interface port, and you attempt to transmit a frame, the `CanWarnComm` status occurs. This warning occurs because the missing acknowledgment bit increments the transmit error counter until the network interface reaches the error passive state, but **bus off** state is never reached.

For more information about transceiver fault handling, refer to the description of the `NC_ATTR_LOG_COMM_ERRS (Log Comm Warnings)` attribute ID in the `ncConfig` function description in this chapter.

CAN Object

The data type that you use with `ncRead` of the CAN Object is `NCTYPE_CAN_DATA_TIMED`. When calling `ncRead`, you should pass size of `NCTYPE_CAN_DATA_TIMED` for the `DataSize` parameter. Table 11-17 describes the fields of `NCTYPE_CAN_DATA_TIMED`.

Table 11-17. `NCTYPE_CAN_DATA_TIMED` Field Names

Field Name	Data Type	Description
`Data`	Array of 8 `NCTYPE_UINT`	`Data` array returns 8 data bytes. The actual number of valid data bytes depends on the CAN Object configuration specified in `ncConfig`. If the CAN Object `Communication Type` specifies Transmit, data frames are transmitted, not received, so `Data` is ignored. For this `Communication Type`, the `ncRead` function has no effect. If the CAN Object `Communication Type` specifies Receive, `Data` always contains `Data Length` valid bytes, where `Data Length` was configured using `ncConfig`.

Table 11-17. NCTYPE_CAN_DATA_TIMED Field Names (Continued)

Field Name	Data Type	Description
Timestamp	NCTYPE_ABS_TIME	Returns the absolute timestamp value. The timestamp data type NCTYPE_ABS_TIME is a 64-bit unsigned integer compatible with the Win32 FILETIME type. This absolute time is kept in a Coordinated Universal Time (UTC) format. UTC time is loosely defined as the current date and time of day in Greenwich, England. Microsoft defines its UTC time (FILETIME) as a 64-bit counter of 100 ns intervals that have elapsed since 12:00 a.m., January 1, 1601. Since Timestamp is compatible with Win32 FILETIME, you can pass it into the Win32 FileTimeToLocalFileTime function to convert it to the local time zone, then pass the resulting local time to the Win32 FileTimeToSystemTime function to convert to the Win32 SYSTEMTIME type. SYSTEMTIME is a struct with fields for year, month, day, and so on. For more information on Win32 time types and functions, refer to the Microsoft Win32 documentation.

ncReadMult

Purpose

Read multiple frames from an object.

Format

```
NCTYPE_STATUS ncReadMult(
                          NCTYPE_OBJH ObjHandle,
                          NCTYPE_UINT32  DataSize,
                          NCTYPE_ANY_P  DataPtr,
                          NCTYPE_UINT32_P  ActualDataSize);
```

Input

ObjHandle	Object handle.
DataSize	The size of the data buffer in bytes.
DataPtr	Points to data buffer in which the data returned.

Output

ActualDataSize	The number of bytes actually returned.

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to ncStatusToString.

Description

This function returns multiple frames from the read queue of the object specified by ObjHandle. When used with the Network Interface, ncReadMult is useful in analyzer applications where data frames need to be acquired at a high speed and stored for analysis in the future. For single frame and most recent data frame acquisition, you should use ncRead.

DataPtr points to an array of either NCTYPE_CAN_STRUCT or NCTYPE_CAN_DATA_TIMED. DataSize indicates the size of the array pointed to by DataPtr (in bytes). This size is specified in bytes in order to verify that the proper data type and alignment is used. When ncReadMult returns, the number of bytes copied into DataPtr is provided in ActualDataSize.

Because NI-CAN handles the read queue in the background, this function does not wait for new data to arrive. To ensure that new data is available before calling ncReadMult, first wait for the NC_ST_READ_MULT state. Refer to NC_ST_READ_MULT (00000008 hex)

in the ncCreateNotification function description in this chapter for more information on this state.

Unlike the ncRead function, the ncReadMult function does not return the CanWarnOldData warning to indicate zero frames. If there is no new data, the function returns with an ActualDataSize of zero.

The description for CanErrOverflowRead and the host data types is identical to that of ncRead with the exception of CanWarnOldData, described above.

Refer to the ncRead function description for more details on the structures used with ncReadMult.

ncSetAttribute

Purpose

Set the value of an object attribute.

Format

```
NCTYPE_STATUS    ncSetAttribute(
                                NCTYPE_OBJH ObjHandle,
                                NCTYPE_ATTRID AttrId,
                                NCTYPE_UINT32 AttrSize,
                                NCTYPE_ANY_P AttrPtr)
```

Input

`ObjHandle`	Object handle.
`AttrId`	Identifier of the attribute to set.
`AttrSize`	Size of the attribute in bytes.
`AttrPtr`	New attribute value. You provide the attribute value using the pointer `AttrPtr`.

Output

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

`ncSetAttribute` sets the value of the attribute specified by `AttrId` in the object specified by `ObjHandle`.

`AttrPtr` points to the variable that holds the attribute value. Its type is undefined so that you can use the appropriate host data type for `AttrId`. `AttrSize` indicates the size of variable pointed to by `AttrPtr`. `AttrSize` is typically `4`, and `AttrPtr` references a 32-bit unsigned integer.

The `ncSetAttribute` function allows for additional configuration beyond the original attributes used with `ncConfig`. For a listing of other attributes for the Network Interface and CAN Object, refer to `ncConfig`. Unless stated otherwise, communication must be stopped prior to changing an attribute with `ncSetAttribute`. While the Network Interface and all

CAN Objects are stopped, you can set any of the AttrId mentioned in ncConfig using ncSetAttribute.

CAN Network Interface Object

The following attributes are available only for the Network Interface, not CAN Objects. Nevertheless, the attributes apply to communication by CAN Objects as well as the associated Network Interface.

NC_ATTR_LOG_START_TRIGGER (Log Start Trigger)

Set this attribute to true if you wish to log the start trigger into the read queue of the CAN network interface object.

The values for this attribute are:

NC_FALSE

Disables the logging of the start trigger (default) in the read queue of the Network Interface Object.

NC_TRUE

Enables the logging of the start trigger in the read queue of the Network Interface Object. The start trigger is logged when the CAN chip starts communication.

This attribute should be set prior to starting the CAN network interface object. This attribute is applicable only to the CAN network interface object and setting this attribute on CAN objects will result in a NI-CAN error.

It is highly recommended that the start trigger frame be logged for applications that create a log file of all the received CAN frames and then play back the log file. By replaying a log file that contains a start trigger frame, you can space the transmission of the first data frame from the time the CAN chip starts communication.

Note Setting this attribute to true in applications that only transmit CAN frames has no effect.

NC_ATTR_MASTER_TIMEBASE_RATE (Master Timebase Rate)

Sets the rate (in MHz) of the external clock that is exported to the CAN card.

The values for this attribute are:

NC_TIMEBASE_RATE_20 (20)

When synchronizing 2 CAN cards or synchronizing a CAN card with an E-Series DAQ card, the 20 Mhz master timebase rate is to be used. By default, this attribute is set to 20 Mhz.

NC_TIMEBASE_RATE_10 (10)

The master timebase rate should be set to 10 Mhz when synchronizing a CAN card with an M-Series DAQ card. The M-Series DAQ card can export a 20 Mhz clock but it does this by using one of its two counters.

If your CAN-DAQ application does not use the 2 DAQ counters then, you can leave the timebase rate set to 20 Mhz (default).

This attribute can be set either before or after calling **ncConnectTerminals** to connect the **RTSI_CLK** to **Master Timebase**. However, this attribute must always be called prior to starting the task.

This attribute is applicable only to PCI and PXI Series 2 cards. For PCMCIA cards, setting this attribute will return an error. On PXI cards, if **PXI_CLK10** is routed to the **Master Timebase**, then the rate is fixed at 10 MHz (it over rides any previous setting of this attribute). Setting this attribute for Series 1 cards will also result in a NI-CAN error.

NC_ATTR_TIMELINE_RECOVERY (Timeline Recovery)

Specifies whether to configure the CAN Network Interface Object to recover the original timeline when a timestamped transmit is late.

This attribute is applicable only when the Transmit Mode attribute (NC_ATTR_TRANSMIT_MODE) is set to Timestamped Transmit (1).

Due to factors such as CAN bus arbitration, the time that a frame transmits successfully may be later than the original time specified. When a timestamped transmit is late, this attribute determines how NI-CAN will adjust transmit times for subsequent frames.

The values for this attribute are:

NC_FALSE

Do not recover the original timeline. Frames always transmit with the original gap or greater. This behavior is useful when you need to maintain a minimum gap between frames. Figure 11-9 shows an original timeline of three frames with a 10 ms gap. When frame B transmits 3 ms late, frame C continues to transmit 10ms later, so the actual timeline slips.

`NC_TRUE`

Recover the original timeline. When a timestamped transmit is late, the subsequent frame will transmit with a reduced gap. This behavior is useful when you need to maintain a timeline, such as when synchronizing CAN output with analog or digital output. Figure 11-10 shows an original timeline of three frames with a 10 ms gap. When frame B transmits 3 ms late, frame C transmit 7 ms later in order to recover the timeline.

The default value for this attribute is zero (disable).

This attribute has to be set prior to starting the CAN Network Interface Object.

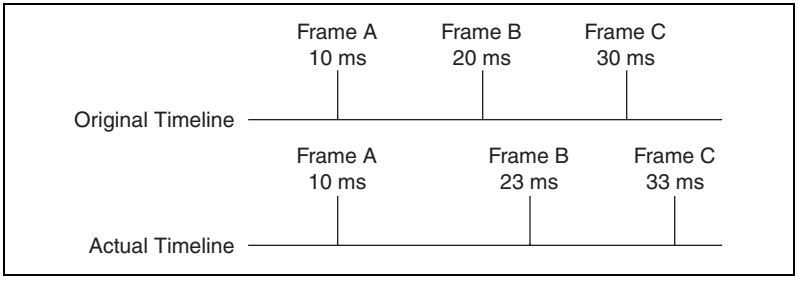


Figure 11-9. Example with Time Recovery Disabled

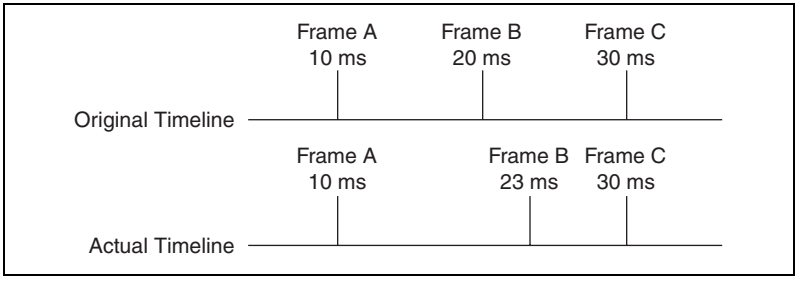


Figure 11-10. Example with Time Recovery Enabled

NC_ATTR_TIMESTAMP_FORMAT (Timestamp Format)

Sets the format of the timestamps reported by the on-board timer on the CAN card.

The default value for this attribute is Absolute.

The values for this attribute are:

NC_TIME_FORMAT_ABSOLUTE (0)

Sets the timestamp format to absolute. In the absolute format, the timestamp returned by NI-CAN read functions is the LabVIEW date/time format (DBL representing the number of seconds elapsed since 12:00 a.m., Friday, January 1, 1904).

NC_TIME_FORMAT_RELATIVE (1)

Sets the timestamp format to relative. In the relative format, the timestamp returned by the NI-CAN read functions will be zero based (DBL representing the number of seconds since the starting the task).

A typical use case for this attribute would be if data received from two RTSI synchronized CAN cards is to be correlated. For that use case, this attribute must be set to 1 for all of the CAN cards being synchronized. Setting this attribute on one port of a 2-port card will also reset the timestamp of the second port, since resetting the timestamp on the CAN port involves resets the on-board timer. This attribute should be set prior to starting any communication on the CAN card.

NC_ATTR_TRANSCEIVER_EXTERNAL_OUT (Transceiver External Outputs)

Sets the transceiver external outputs for the Network Interface.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

Series 2 XS cards enable connection of an external transceiver. For an external transceiver, this attribute allows you to set the output voltage on the MODE0 and MODE1 pins of the CAN port, and it allows you control the sleep mode of the on-board CAN controller chip.

For many models of CAN transceiver, EN and NSTB pins control the transceiver mode, such as whether the transceiver is sleeping, or communicating normally. For such transceivers, you can wire the EN and NSTB pins to the MODE0 and MODE1 pins of the CAN port.

The default value of this attribute is `00000003` hex. For many models of transceiver, this specifies normal communication mode for the transceiver and CAN controller chip. If the transceiver requires a different MODE0/MODE1 combination for normal mode, you can use external inverters to change the default 5 V to 0 V.

This attribute is supported for Series 2 XS cards only. This attribute is not supported when the `NC_ATTR_TRANSCEIVER_TYPE (Transceiver Type)` is any value other than `External`. To control the mode of an internal transceiver, use the `NC_ATTR_TRANSCEIVER_MODE (Transceiver Mode)` attribute.

This attribute uses a bit mask. Use bitwise OR operations to set multiple values.

`NC_TRANSCEIVER_OUT_MODE0`(`00000001` hex, MODE0 pin)

Set this bit to drive 5 V on the MODE0 pin. This is the default value. This bit is set automatically when a remote wakeup is detected.

Clear this bit to drive 0 V on the MODE0 pin.

`NC_TRANSCEIVER_OUT_MODE1`(`00000002` hex, MODE1 pin)

Set this bit to drive 5 V on the MODE1 pin. This is the default value. This bit is set automatically when a remote wakeup is detected.

Clear this bit to drive 0 V on the MODE1 pin.

`NC_TRANSCEIVER_OUT_SLEEP`(`00000100` hex, Sleep CAN controller chip)

Set this bit to place the CAN controller chip into sleep mode. This bit controls the mode of the CAN controller chip (sleep or normal), and the independent MODE0/MODE1 bits control the mode of the external transceiver. When you set this bit to place the CAN controller into sleep mode, you typically specify MODE0/MODE1 bits that place the external transceiver into sleep mode as well.

When the CAN controller is asleep, a remote wakeup will automatically place the CAN controller into its normal mode of communication. In addition, the MODE0/MODE1 pins are restored to their default values of 5 V. Therefore, a remote wakeup causes this attribute to change from the value that you set for sleep mode, back to its default `00000003` hex. You can determine when this has occurred by getting `NC_ATTR_TRANSCEIVER_EXTERNAL_OUT (Transceiver External Outputs)` using `ncGetAttribute`. For more information on remote wakeup, refer to the `NC_ATTR_TRANSCEIVER_MODE (Transceiver Mode)` attribute for internal transceivers.

Clear this bit to place the CAN controller chip into normal communication mode. If the CAN controller was previously in sleep mode, this performs a local wakeup to restore communication.

`NC_ATTR_TRANSCEIVER_MODE` (Transceiver Mode)

Sets the transceiver mode for the Network Interface. The transceiver mode controls whether the transceiver is asleep or communicating, as well as other special modes.

This attribute is available only for the Network Interface, not CAN Objects. Nevertheless, the attribute applies to communication by CAN Objects as well as the associated Network Interface.

This attribute is supported on Series 2 cards only.

For Series 2 cards for the PCMCIA form factor, this property requires a corresponding Series 2 cable (dongle). For information on how to identify the series of the PCMCIA cable, refer to the *Series 2 versus Series 1* subsection of the *NI CAN Hardware Overview* section of Chapter 1, *Introduction*.

For Series 2 XS cards, this attribute is not supported when the `NC_ATTR_TRANSCEIVER_TYPE (Transceiver Type)` is **External**. To control the mode of an external transceiver, use the `NC_ATTR_TRANSCEIVER_EXTERNAL_OUT (Transceiver External Outputs)` attribute.

The default value for this attribute is **Normal**.

This attribute uses the following values:

`NC_TRANSCEIVER_MODE_NORMAL` (Normal)

Set transceiver to **Normal** communication mode. If you set **Sleep** mode previously, this performs a local wakeup of the transceiver and CAN controller chip.

`NC_TRANSCEIVER_MODE_SLEEP` (Sleep)

Set transceiver and the CAN controller chip to sleep (or standby) mode.

If the transceiver supports multiple sleep/standby modes, the NI CAN hardware implementation ensures that all of those modes are equivalent with regard to the behavior of a transceiver on the network. For more information on the physical specifications of the **Normal** and **Sleep** modes of each transceiver, refer to Chapter 3, *NI CAN Hardware*.

You can set **Sleep** mode only while the interface is communicating. If the Network Interface has not been started, setting the transceiver mode to **Sleep** will return an error.

When the interface enters sleep mode, communication is not possible until a wakeup occurs. All pending frame transmissions are deferred until the wakeup occurs. The transceiver and CAN controller wake from **Sleep** mode when either a local wakeup or remote wakeup occurs.

A *local wakeup* occurs when the application sets the transceiver mode to **Normal** (or some other communication mode).

A *remote wakeup* occurs when a remote node transmits a CAN frame (referred to as the *wakeup frame*). The wakeup frame wakes up the transceiver and CAN controller chip of the NI CAN interface. The wakeup frame is not received or acknowledged by the CAN controller chip. When the wakeup frame ends, the NI CAN interface enters **Normal** mode, and again receives and transmits CAN frames. If the node that transmitted the wakeup frame did not detect an acknowledgement (such as if other nodes were also waking), it will retry the transmission, and the retry will be received by the NI CAN interface.

For a remote wakeup to occur for Single Wire transceivers, the node that transmits the wakeup frame must first place the network into the **Single Wire Wakeup Transmission** mode by asserting a higher voltage (typically 12 V). For more information, refer to

NC_TRANSCEIVER_MODE_SW_WAKEUP (Single Wire Wakeup) mode.

When the local or remote wakeup occurs, frame transmissions resume from the point at which the original **Sleep** was set.

You can detect when a remote wakeup occurs by using ncGetAttribute with the Transceiver Mode attribute. If you need to suspend the application while waiting for the remote wakeup, use the Remote Wakeup state of ncWaitForState or ncCreateNotification.

NC_TRANSCEIVER_MODE_SW_HIGHSPEED (Single Wire High-Speed)

Set Single Wire transceiver to **High-Speed Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire High-Speed Transmission** mode disables the internal waveshaping function of the transceiver, which allows baud rates up to 100 kbytes/s to be used. The disadvantage versus **Normal** (which allows up to 40 kbytes/s baud) is degraded EMC performance. Other than the disabled waveshaping, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

This mode has no relationship to High-Speed (HS) transceivers. It is merely a higher speed mode of the Single Wire (SW) transceiver, typically used for downloading large amounts of data to a node.

The Single Wire transceiver does not support use of this mode in conjunction with **Sleep** mode. For example, a remote wakeup cannot transition from **Sleep** to this **Single Wire High-Speed** mode.

NC_TRANSCEIVER_MODE_SW_WAKEUP (Single Wire Wakeup)

Set Single Wire transceiver to **Wakeup Transmission** mode.

This mode is supported on Single Wire (SW) ports only.

The **Single Wire Wakeup Transmission** mode drives a higher voltage level on the network to wakeup all sleeping nodes. Other than this higher voltage, this mode is similar to **Normal** mode. CAN frames can be received and transmitted normally.

Since you use the **Single Wire Wakeup** mode to wakeup other nodes on the network, it is not typically used in combination with **Sleep** mode for a given interface.

The timing of how long the wakeup voltage is driven is controlled entirely by the application. The application will typically change to **Single Wire Wakeup** mode, transmit a wakeup frame, then return to **Normal** mode.

The following sequence demonstrates a typical sequence of steps for sleep and wakeup between two Single Wire NI CAN interfaces. The sequence assumes that **CAN0** is the sleeping node, and **CAN1** originates the wakeup.

1. Start both **CAN0** and **CAN1**. Both use the default Normal mode.
2. Set **Transceiver Mode** of **CAN0** to **Sleep**.
3. Set **Transceiver Mode** of **CAN1** to **Single Wire Wakeup**.
4. Write data to **CAN1** to transmit a wakeup frame to **CAN0**.
5. Set **Transceiver Mode** of **CAN1** to **Normal**.
6. Now both **CAN0** and **CAN1** are in **Normal** mode again.

`NC_ATTR_TRANSCEIVER_TYPE` (Transceiver Type)

For XS Software Selectable Physical Layer cards that provide a software-switchable transceiver, the `Transceiver Type` attribute sets the type of transceiver. When the transceiver is switched from one type to another, NI-CAN ensures that the switch is undetectable from the perspective of other nodes on the network.

The value of this attribute can be changed using the `ncSetAttribute` function only. You cannot use this attribute in the `ncConfig` function.

The default value for this attribute is specified within MAX. If you change the transceiver type in MAX to correspond to the network in use, you can avoid setting this attribute within the application.

Communication for all objects on the Network Interface must be stopped prior to setting this attribute. You typically do this by calling `ncConfig` with `Start On Open` set to `False`, then `ncOpenObject`, then `ncSetAttribute` to set `Transceiver Type`, then `ncAction` to start communication. Prior to changing the `Transceiver Type` again, you must use `ncAction` to stop communication.

You cannot set this attribute for Series 1 hardware, or for Series 2 hardware other than XS (fixed HS, LS, or SW cards).

This attribute uses the following values:

`NC_TRANSCEIVER_TYPE_DISC` (Disconnect)

Disconnect the CAN controller chip from the connector. This value is used when you physically switch an external transceiver. You first set `Transceiver Type` to **Disconnect**, then switch from one external transceiver to another, then set `Transceiver Type` to **External**. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

`NC_TRANSCEIVER_TYPE_EXT` (External)

Switch the transceiver to **External**. The **External** type allows you to connect a transceiver externally to the interface. For more information on connecting transceivers externally, refer to Chapter 3, *NI CAN Hardware*.

When this transceiver type is selected, you can use the `Transceiver External Outputs` and `Transceiver External Inputs` attributes to access the external mode and status pins of the connector.

`NC_TRANSCEIVER_TYPE_HS` (High-Speed)

Switch the transceiver to **High-Speed** (HS).

`NC_TRANSCEIVER_TYPE_LS` (Low-Speed/Fault-Tolerant)

Switch the transceiver to **Low-Speed/Fault-Tolerant** (LS).

`NC_TRANSCEIVER_TYPE_SW` (Single Wire)

Switch the transceiver to **Single Wire** (SW).

`NC_ATTR_TRANSMIT_MODE` (Transmit Mode)

Specifies whether to configure the CAN Network Interface Object to Immediate Transmit mode or Timestamped Transmit mode.

The default value for this attribute is zero (Immediate Transmit).

The values for this attribute are:

`NC_TX_IMMEDIATE (0)`

Configures the Network Interface Object in the Immediate Transmit mode. In the Immediate Transmit mode, the CAN frames are transmitted as and when frames are written into the Network Interface Object's write queue. CAN frames can be written into the Network Interface Objects write queue by either using **ncWrite** or **ncWriteMult**. Timestamps are ignored by NI-CAN when the Network Interface Object is configured in this mode.

`NC_TX_TIMESTAMPED (1)`

Configures the Network Interface Object in the Timestamped Transmit mode. In this mode, NI-CAN spaces the frame transmission according to the difference in timestamps between consecutive frames. If the timestamp of the CAN frame to be transmitted is less than the timestamp of the previous CAN frame, time stamped transmit is reset and the CAN frame will be transmitted immediately on the bus without adding any delay.

Use **ncWriteMult** to write CAN frames with timestamps into the write queue of the Network Interface Object.

This attribute has to be set prior to starting the CAN Network Interface Object.

`NC_ATTR_VIRTUAL_BUS_TIMING` (Virtual Bus Timing)

Sets the Virtual Bus Timing of the virtual device.

`NC_TRUE`

Enables Virtual Bus Timing (default). By turning Virtual Bus Timing on, frame timestamps are recalculated as they transfer across the virtual bus. This mode is useful when you want the virtual bus to behave as much like a real bus as possible.

`NC_FALSE`

Disables Virtual Bus Timing. By turning Virtual Bus Timing off, the CAN bus simulation is disabled and CAN frames are copied from the write queue of one virtual interface to the read queue of the second virtual interface. This setting is useful if you desire to

only convert frames to channels or vice versa and not simulate actual CAN bus communication.

If this attribute is set on real hardware, an error will be returned.

The Virtual Bus Timing has to be set to the same value on both virtual interfaces.

This attribute must be set prior to starting the virtual interface. Refer to the *Frame to Channel Conversion* section of Chapter 6, *Using the Channel API*, for more information.

ncStatusToString

Purpose

Convert status code into a descriptive string.

Format

```
void              ncStatusToString(
                                   NCTYPE_STATUS Status,
                                   NCTYPE_UINT32 SizeofString,
                                   NCTYPE_STRING String)
```

Input

`Status`	Nonzero status code returned from NI-CAN function.
`SizeofString`	Size of `String` buffer (in bytes).

Output

`String`	ASCII string that describes `Status`.

Description

When the status code returned from an NI-CAN function is nonzero, an error or warning is indicated. This function is used to obtain a description of the error/warning for debugging purposes.

If you want to avoid displaying error messages while debugging the application, you can use the `Explain.exe` utility. This console application is located in the `Utilities` subfolder of the `NI-CAN` installation folder, which is typically `\Program Files\National Instruments\NI-CAN\Utilities`. You enter an NI-CAN status code in the command line, `Explain 0XBFF62201` for example, and the utility displays the description.

The return code is passed into the `Status` parameter. The `SizeofString` parameter indicates the number of bytes available in `String` for the description. The description will be truncated to size `SizeofString` if needed, but a size of 300 characters is large enough to hold any description. The text returned in `String` is null-terminated, so it can be used with ANSI C functions such as `printf`.

For applications written in C or C++, each NI-CAN function returns a status code as a signed 32-bit integer. Table 11-18 summarizes the NI-CAN use of this status.

Table 11-18. NI-CAN Status Codes

Status Code	Meaning
Negative	Error—Function did not perform expected behavior.
Positive	Warning—Function performed as expected, but a condition arose that may require attention.
Zero	Success—Function completed successfully.

The application code should check the status returned from every NI-CAN function. If an error is detected, you should close all NI-CAN handles, then exit the application. If a warning is detected, you can display a message for debugging purposes, or simply ignore the warning.

The following piece of code shows an example of handling NI-CAN status during application debugging.

```
status= ncOpenObject ("CAN0", &MyObjHandle);
PrintStat (status, "ncOpen CAN0");
```

where the function `PrintStat` has been defined at the top of the program as:

```
void PrintStat(NCTYPE_STATUS status, char *source)
{
    char statusString[300];
    if(status !=0)
    {
        ncStatusToString(status, sizeof(statusString), statusString);
        printf("\n%s\nSource = %s\n", statusString, source);
        if (status < 0)
        {
            ncCloseObject(MyObjHandle);
            exit(1);
        }
    }
}
```

In some situations, you may want to check for specific errors in the code. For example, when `ncWaitForState` times out, you may want to continue communication, rather than exit the application. To check for specific errors, use the constants defined in `nican.h`. These constants have the same names as described in this manual. For example, to check for a function timeout, use:

```
if (status == CanErrFunctionTimeout)
```

Note The function `ncStatusToString` returns the string results as an array of `char (* char)`. VB is not able to convert this array to a string automatically. Therefore, VB users should call the wrapper function `ncStatToStr`.

ncWaitForState

Purpose

Wait for one or more states to occur in an object.

Format

```
NCTYPE_STATUS    ncWaitForState(
                                NCTYPE_OBJH ObjHandle,
                                NCTYPE_STATE DesiredState,
                                NCTYPE_UINT32 Timeout,
                                NCTYPE_STATE_P StatePtr)
```

Input

`ObjHandle`	Object handle.
`DesiredState`	States to wait for.
`Timeout`	Length of time to wait in milliseconds.

Output

`StatePtr`	Current state of object when desired states occur. The state is returned to you using the pointer `StatePtr`.

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

You use `ncWaitForState` to wait for one or more states to occur in the object specified by `ObjHandle`.

This function waits up to `Timeout` for one of the bits set in `DesiredState` to become set in the attribute `NC_ATTR_STATE`. You can use the special `Timeout` value `NC_DURATION_INFINITE` (`FFFFFFFF` hex) to wait indefinitely.

`DesiredState` specifies a bit mask of states for which the wait should return. You can use a single state alone, or you can OR them together.

NC_ST_READ_AVAIL (00000001 hex)

At least one frame is available, which you can obtain using an appropriate read function.

The state is set whenever a frame arrives for the object. The state is cleared when the read queue is empty.

NC_ST_READ_MULT (00000008 hex)

A specified number of frames are available, which you can obtain using ncReadMult. The number of frames is one half the Read Queue Length by default, but you can change it using the ReadMult Size for Notification attribute of ncSetAttribute.

The state is set whenever the specified number of frames are stored in the read queue of the object. The state is cleared when you call the read function, and less than the specified number of frames exist in the read queue.

NC_ST_REMOTE_WAKEUP (00000040 hex)

Remote wakeup occurred, and **Transceiver Mode** (NC_ATTR_TRANSCEIVER_MODE) has changed from **Sleep** to **Normal**. For more information on remote wakeup, refer to NC_ATTR_TRANSCEIVER_MODE (Transceiver Mode).

This state is set when a remote wakeup occurs (end of wakeup frame). This state is not set when the application changes **Transceiver Mode** from **Sleep** to **Normal** (local wakeup).

This state is cleared when:

- You open the Network Interface, such as when the application begins.
- You stop the Network Interface.
- You set the **Transceiver Mode**, such as each time you set **Sleep** mode.

For as long as this state is true, the transceiver mode is **Normal**. The transceiver mode also can be **Normal** when this state is false, such as when you perform a local wakeup.

NC_ST_WRITE_MULT (00000080 hex)

The state is set whenever there is free space in the write queue to accept at least 512 frames to write. The state is cleared when you call the ncWrite or ncWriteMult function, and less than 512 frames can be accepted to write in the write queue.

This state is valid only on the Network Interface.

NC_ST_WRITE_SUCCESS (00000002 hex)

All frames provided through write function have been successfully transmitted onto the network. Successful transmit means that the frame won arbitration, and was acknowledged by a remote device.

The state is set when the last frame in the write queue is transmitted successfully. The state is cleared when a write function is called.

When communication starts, the NC_ST_WRITE_SUCCESS state is true by default.

For CAN Objects, Write Success does not always mean that transmission has stopped. For example, if a CAN Object is configured for Transmit Data Periodically, Write Success occurs when the write queue has been emptied, but periodic transmit of the last frame continues.

When the states in DesiredState are detected, the function returns the current value of the NC_ATTR_STATE attribute. If an error occurs, the function returns immediately, and the state returned is zero.

While waiting for the desired states, ncWaitForState suspends the current thread execution. Other Win32 threads in the application can still execute.

If you want to allow other code in the application to execute while waiting for NI-CAN states, refer to the ncCreateNotification function.

The functions ncWaitForState and ncCreateNotification use the same underlying implementation. Therefore, for each object handle, only one of these functions can be pending at a time. For example, you cannot invoke ncWaitForState twice from different threads for the same object. For different object handles, these functions can overlap in execution.

ncWrite

Purpose

Write a single frame to an object.

Format

```
NCTYPE_STATUS    ncWrite(
                         NCTYPE_OBJH ObjHandle,
                         NCTYPE_UINT32 DataSize,
                         NCTYPE_ANY_P DataPtr)
```

Input

ObjHandle	Object handle.
DataSize	Size of the data in bytes.
DataPtr	Data written to the object. You provide the data using the pointer DataPtr.

Output

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to ncStatusToString.

Description

ncWrite writes a single frame to the object specified by ObjHandle.

DataPtr points to the variable from which the data is written. Its type is undefined so that you can use the appropriate host data type. DataSize indicates the size of variable pointed to by DataPtr, and is used to verify that the size you provide is compatible with the configured write size for the object.

You use ncWrite to place data into the write queue of an object. Because NI-CAN handles the write queue in the background, this function does not wait for data to be transmitted on the network. To make sure that the data is transmitted successfully after calling ncWrite, wait for the NC_ST_WRITE_SUCCESS state. The NC_ST_WRITE_SUCCESS state transitions from false to true when the write queue is empty, and NI-CAN has successfully transmitted the last data item onto the network. The NC_ST_WRITE_SUCCESS state remains true until you write another data item into the write queue.

When communication starts, the NC_ST_WRITE_SUCCESS state is true by default.

When you configure an object to transmit data onto the network periodically, it obtains data from the object write queue each period. If the write queue is empty, NI-CAN transmits the data of the previous period again. NI-CAN transmits this data repetitively until the next call to ncWrite.

If an object write queue is full, a call to ncWrite returns the CanErrOverflowWrite error and NI-CAN discards the data you provide. One way to avoid this overflow error is to set the write queue length to zero. When ncWrite is called for a zero length queue, the data item you provide with ncWrite simply overwrites the previous data item without indicating an overflow. A zero length write queue is often useful when an object is configured to transmit data onto the network periodically, and you simply want to transmit the most recent data value each period. It is also useful when you plan to always wait for NC_ST_WRITE_SUCCESS after every call to ncWrite. You can use the NC_ATTR_WRITE_Q_LEN attribute to configure the write queue length.

For information on the proper data type to use with DataPtr, refer to the CAN Network Interface Object and CAN Object descriptions below.

CAN Network Interface Object

The data type that you use with ncWrite of the Network Interface is NCTYPE_CAN_FRAME. When calling ncWrite, you should pass size of NCTYPE_CAN_FRAME for the DataSize parameter.

Within the NCTYPE_CAN_FRAME structure, the IsRemote (frame type) field determines the meaning of all other fields. Tables 11-19 and 11-20 describe the fields of NCTYPE_CAN_FRAME for each value of IsRemote.

Table 11-19. NCTYPE_CAN_FRAME Fields for IsRemote NC_FRMTYPE_DATA (0)

Field Name	Data Type	Description
IsRemote	NCTYPE_UINT8	NC_FRMTYPE_DATA (0) Transmit a CAN data frame.
ArbitrationId	NCTYPE_CAN_ARBID	Specifies the arbitration ID of the frame to transmit. The NCTYPE_CAN_ARBID type is an unsigned 32-bit integer that uses the bit mask NC_FL_CAN_ARBID_XTD (0x20000000) to indicate an extended ID. A standard ID (11-bit) is specified by default. In order to specify an extended ID (29-bit), OR in the bit mask NC_FL_CAN_ARBID_XTD.

Table 11-19. NCTYPE_CAN_FRAME Fields for IsRemote NC_FRMTYPE_DATA (0) (Continued)

Field Name	Data Type	Description
Data	Array of 8 NCTYPE_UINT8	Specifies the data bytes of the frame.
DataLength	NCTYPE_UINT8	Specifies the number of data bytes to transmit. This number of valid data bytes must be provided in Data.

Table 11-20. NCTYPE_CAN_FRAME fields for IsRemote NC_FRMTYPE_REMOTE (1)

Field Name	Data Type	Description
IsRemote	NCTYPE_UINT8	NC_FRMTYPE_REMOTE (1) Transmit a CAN remote frame. Both Series 1 and Series 2 hardware can transmit remote frames using the Network Interface.
ArbitrationId	NCTYPE_CAN_ARBID	Specifies the arbitration ID of the frame to transmit. The NCTYPE_CAN_ARBID type is an unsigned 32-bit integer that uses the bit mask NC_FL_CAN_ARBID_XTD (0x20000000) to indicate an extended ID. A standard ID (11-bit) is specified by default. In order to specify an extended ID (29-bit), OR in the bit mask NC_FL_CAN_ARBID_XTD.
Data	Array of 8 NCTYPE_UINT8	Remote frames do not contain data, so this array is empty.
DataLength	NCTYPE_UINT8	Specifies the Data Length Code to transmit in the remote frame.

CAN Object

The data type that you use with ncWrite of the CAN Object is NCTYPE_CAN_DATA. When calling ncWrite, you should pass size of (NCTYPE_CAN_DATA) for the DataSize parameter. Table 11-21 describes the fields of NCTYPE_CAN_DATA.

Table 11-21. NCTYPE_CAN_DATA Field Name

Field Name	Data Type	Description
Data	Array of 8 NCTYPE_UINT8	Data array specifies the data bytes (8 maximum). The actual number of valid data bytes depends on the CAN Object configuration specified in ncConfig. If the Communication Type of the CAN Object specifies **Receive**, data frames are received, not transmitted, so Data is ignored. For this Communication Type, the ncWrite function is used solely for transmission of a remote frame. If the Communication Type of the CAN Object specifies Transmit, Data must always contain Data Length valid bytes, where Data Length was configured using ncConfig.

ncWriteMult

Purpose

Write multiple frames to a CAN Network Interface Object.

Format

```
NCTYPE_STATUS    ncWriteMult(
                         NCTYPE_OBJH ObjHandle,
                         NCTYPE_UINT32 DataSize,
                         NCTYPE_ANY_P DataPtr)
```

Input

`ObjHandle`	Object handle for a CAN Network Interface Object.
`DataSize`	Size of the data in bytes.
`DataPtr`	Pointer to the data to be written to the CAN Network Interface The data consists of an array of structures, each of type `NCTYPE_CAN_STRUCT`. Within each structure, `FrameType` indicates the frame type. The frame type determines the interpretation of the remaining fields. For a description of each frame type, refer to the *Frame Types* topic in the Description section. The maximum number of structures you can provide to each `ncWriteMult` is 512. For more information, refer to the *Writing Large Numbers of Frames* topic in the Description section.

Output

Return Value

Status of the function call, returned as a signed 32-bit integer. Zero means the function executed successfully. Negative specifies an error, meaning the function did not perform expected behavior. Positive specifies a warning, meaning the function performed as expected, but a condition arose that might require attention. For more information, refer to `ncStatusToString`.

Description

You use `ncWriteMult` to place one or more frames into the Network Interface write queue. This function does not wait for the frames to be transmitted on the network.

This function is not supported for CAN Objects.

Timestamped Transmit

In addition to supporting multiple frames, this function is preferable to ncWrite in that it supports timestamped frames. To enable timestamped transmit, use ncSetAttribute to set the NC_ATTR_TRANSMIT_MODE (Transmit Mode) attribute to Timestamped Transmit mode (1).

In Timestamped Transmit mode, NI-CAN times the transmission according to the difference in timestamps between consecutive frames. For example, if every frame provided to ncWriteMult increments by 10 milliseconds, the frames will be transmitted with a 10 millisecond gap.

If the timestamp of one frame is less than the timestamp of the preceding frame, the timeline is reset, and both frames transmit back to back. For example, if you write a frame with relative timestamp 30ms followed by a frame with timestamp 15ms, the two frames will be transmitted back to back. This sort of behavior can occur when you transmit a logfile of timestamped frames repeatedly, because on the second traversal of the logfile, the timestamp of the first frame will be less than the timestamp of the last frame.

The first frame that you provide to ncWriteMult always transmits immediately, regardless of its timestamp. If you need to delay transmission of first frame after start, you can write a Delay frame or Start Trigger frame as described in *Frame Types*.

Immediate Transmit

The default value for the NC_ATTR_TRANSMIT_MODE (Transmit Mode) attribute is Immediate Transmit mode (0). You can also use ncSetAttribute to set the NC_ATTR_TRANSMIT_MODE attribute to Immediate Transmit mode.

In Immediate Transmit mode, NI-CAN ignores the timestamp in each frame, and transmits the frames as fast as possible. This behavior is equivalent to the ncWrite function, except that you can write multiple frames for transmission in quick succession.

Writing Large Numbers of Frames

Although NI-CAN provides a large write queue to store frames pending transmission, writing timestamped frames from a logfile with thousands of frames can eventually fill this queue.

When the Network Interface write queue cannot hold all frames provided, ncWriteMult returns an overflow error. When this overflow error is returned, none of the frames provided in the array referenced by DataPtr have been written. This enables your application to try the same array again at a later time.

To determine when adequate space is available in the write queue to retry ncWriteMult after an overflow, you can use ncWaitForState with the NC_ST_WRITE_MULT (Write Multiple) state. The NC_ST_WRITE_MULT state will transition from false to true when space is available

for at least 512 frames. Since you must limit the array passed to ncWriteMult to 512 frames or less, the NC_ST_WRITE_MULT state indicates that a retry will succeed.

Another technique to recover from a write queue overflow is to use ncGetAttribute with the NC_ATTR_WRITE_ENTRIES_FREE (Write Entries Free) attribute. Although this technique requires you to call ncGetAttribute periodically until the desired number of frame entries is available, it avoids the need to determine a proper Timeout for ncWaitForState. When the time difference between frames varies from milliseconds to seconds, it may be difficult to determine how long to wait for entries to become available.

After writing a sequence of timestamped frames with ncWriteMult, you cannot close the Network Interface, because you must wait for the last timestamped frame to transmit onto the network. You can wait for the final transmit to complete using ncWaitForState with the NC_ST_WRITE_SUCCESS (Write Success) state. You can also use ncGetAttribute with the NC_ATTR_WRITE_PENDING (Write Entries Pending) attribute to query periodically, which provides the option of aborting the timestamped transmission by closing the Network Interface.

Frame Types

Within each structure (type NCTYPE_CAN_STRUCT) of the array referenced by DataPtr, FrameType indicates the frame type. The frame type determines the interpretation of the remaining fields. The following tables describe the fields of the structure for each value of FrameType.

Table 11-22. Structure with FrameType value NC_FRMTYPE_DATA (0): CAN Data Frame

Field Name	Data Type	Description
FrameType	NCTYPE_UINT8	Value NC_FRMTYPE_DATA (0) specifies a CAN data frame. The CAN data frame transfers data on the network.
ArbitrationId	NCTYPE_CAN_ARBID	Specifies the arbitration ID to transmit in the CAN data frame. A standard ID (11-bit) is specified by default. In order to specify an extended ID (29-bit), OR in the bit mask NC_FL_CAN_ARBID_XTD (20000000 hex).
DataLength	NCTYPE_UINT8	Specifies the number of bytes in the Data array to transmit in the CAN data frame.
Data	Array of 8 NCTYPE_UINT8	Data bytes to transmit in the CAN data frame.

Table 11-22. Structure with FrameType value NC_FRMTYPE_DATA (0): CAN Data Frame (Continued)

Field Name	Data Type	Description
Timestamp	NCTYPE_ABS_TIME	If the NC_ATTR_TRANSMIT_MODE (Transmit Mode) attribute is **Immediate Transmit** (default), this field is ignored, and CAN frames transmit as quickly as possible. If the NC_ATTR_TRANSMIT_MODE attribute is **Timestamped Transmit** (1), this field specifies a timestamp. The timestamp is used to time transmission of CAN frames as described in the preceding Timestamped Transmit topic. The timestamp data type NCTYPE_ABS_TIME is a 64-bit unsigned integer in 100 nanosecond increments. The format of the time is absolute (time and date) or relative (zero based) depending on the NC_ATTR_TIMESTAMP_FORMAT (Timestamp Format) attribute. Refer to ncSetAttribute for more information on timestamps.

Table 11-23. Structure with FrameType value NC_FRMTYPE_REMOTE (1): CAN Remote Frame

Field Name	Data Type	Description
FrameType	NCTYPE_UINT8	Value NC_FRMTYPE_REMOTE (1) specifies a CAN remote frame. The CAN remote frame requests data for its arbitration ID.
ArbitrationId	NCTYPE_CAN_ARBID	Specifies the arbitration ID to transmit in the CAN remote frame. A standard ID (11-bit) is specified by default. In order to specify an extended ID (29-bit), OR in the bit mask NC_FL_CAN_ARBID_XTD (20000000 hex).
DataLength	NCTYPE_UINT8	Specifies the number of bytes requested. The value is transmitted in the CAN remote frame, but with no data.
Data	Array of 8 NCTYPE_UINT8	Ignored. No data bytes are contained in a CAN remote frame.

Table 11-23. Structure with FrameType value NC_FRMTYPE_REMOTE (1): CAN Remote Frame (Continued)

Field Name	Data Type	Description
Timestamp	NCTYPE_ABS_TIME	If the NC_ATTR_TRANSMIT_MODE (Transmit Mode) attribute is **Immediate Transmit** (default), this field is ignored, and CAN frames transmit as quickly as possible. If the NC_ATTR_TRANSMIT_MODE attribute is **Timestamped Transmit** (1), this field specifies a timestamp. The timestamp is used to time transmission of CAN frames as described in the preceding *Timestamped Transmit* topic. The timestamp data type NCTYPE_ABS_TIME is a 64-bit unsigned integer in 100 nanosecond increments. The format of the time is absolute (time and date) or relative (zero based) depending on the NC_ATTR_TIMESTAMP_FORMAT (Timestamp Format) attribute. Refer to ncSetAttribute for more information on timestamps.

Table 11-24. Structure with FrameType value NC_FRMTYPE_START_TRIG (4): Start Trigger Frame

Field Name	Data Type	Description
FrameType	NCTYPE_UINT8	Value NC_FRMTYPE_START_TRIG (4) specifies a start trigger frame. When you use ncWriteMult to write frames from a logfile for timestamped transmit, you can write the start trigger frame as the first frame. The start trigger frame reproduces the delay from start of communication to the first CAN frame. For example, if you write a start trigger frame followed by a CAN data frame with relative timestamp 20 ms, NI-CAN will delay 20 ms before transmitting the CAN data frame. If you write the CAN data frame without the start trigger frame, NI-CAN will transmit the CAN data frame immediately.
ArbitrationId	NCTYPE_CAN_ARBID	Value 0 is required.

Table 11-24. Structure with `FrameType` value `NC_FRMTYPE_START_TRIG` (`4`): Start Trigger Frame (Continued)

Field Name	Data Type	Description
`DataLength`	`NCTYPE_UINT8`	Value `1` is required.
`Data`	Array of 8 `NCTYPE_UINT8`	The single data byte in the array specifies the **Timestamp Format** `NC_ATTR_TIMESTAMP_FORMAT` (defined in `ncSetAttribute`) used for all subsequent CAN frames. The value is `0` for absolute timestamps, and `1` for relative timestamps. In order for NI-CAN to delay the proper time for the start trigger, this timestamp format must match the format used in all subsequent frames provided to `ncWriteMult`.
`Timestamp`	`NCTYPE_ABS_TIME`	Absolute timestamp of the start trigger. Within a logfile, this timestamp indicates the date and time at which CAN communication started. The timestamp data type `NCTYPE_ABS_TIME` is a 64-bit unsigned integer in 100 nanosecond increments. The format of this timestamp is always absolute, even when `Data` byte 0 specifies relative timestamp format. This absolute timestamp provides data/time information even when the CAN frames of a logfile use the relative format. When `Data` byte 0 specifies absolute format (`0`), the difference between this timestamp and the absolute timestamp of the subsequent CAN frame is used as the delay for transmit of that CAN frame. When `Data` byte 0 specifies relative format (`1`), this timestamp is ignored by NI-CAN, and the relative timestamp of the subsequent CAN frame is used as the transmit delay.

Table 11-25. Structure with `FrameType` value `NC_FRMTYPE_DELAY` (`5`): Delay Frame

Field Name	Data Type	Description
`FrameType`	`NCTYPE_UINT8`	Value `NC_FRMTYPE_DELAY` (`5`) specifies a delay frame. Use the delay frame to insert an additional delay between any two timestamped frames. For example, if you write a CAN frame with relative timestamp 20 ms, followed by a delay frame of 30 ms, followed by a CAN frame with timestamp 55 ms, NI-CAN will transmit the CAN frames 65 ms apart.
`ArbitrationId`	`NCTYPE_CAN_ARBID`	Value 0 is required.
`DataLength`	`NCTYPE_UINT8`	Value 0 is required.
`Data`	Array of 8 `NCTYPE_UINT8`	Ignored.
`Timestamp`	`NCTYPE_ABS_TIME`	Specifies the delay to insert (not a timestamp). The delay is a 64-bit unsigned integer in 100 nanosecond increments. For example, a delay of 10 ms would be specified as the number `100000` in the low 32 bits of `Timestamp`. The maximum delay supported is 180.0 seconds (3 minutes).

A

Troubleshooting and Common Questions

This appendix describes how to troubleshoot problems with the NI-CAN software and answers some common questions.

Troubleshooting with the Measurement & Automation Explorer (MAX)

MAX contains configuration information for all CAN hardware installed on the system. To start MAX, double-click on the **Measurement & Automation** icon on the desktop. The NI-CAN cards are listed in the left pane (Configuration) under **Devices and Interfaces**.

You can test the NI-CAN cards by choosing **Tools»NI-CAN»Test All Local Cards** from the menu, or you can right-click on an NI-CAN card and choose **Self Test**. If the Self Test fails, refer to the *Troubleshooting Self Test Failures* section of this appendix.

Missing NI-CAN Card

If you have an NI-CAN card installed, but no NI-CAN card appears in the configuration section of MAX under **Devices and Interfaces**, you need to search for hardware changes by pressing <F5> or choosing the **Refresh** option from the **View** menu in MAX.

If the NI-CAN card still doesn't show up, you may have a resource conflict in the Windows Device Manager. Refer to the documentation for the Windows operating system for instructions on how to resolve the problem using the Device Manager.

Troubleshooting Self Test Failures

The following topics explain common error messages generated by the NI-CAN Self Test.

Application In Use

This error occurs if you are running an application that is already using the NI-CAN card. The self test aborts to avoid adversely affecting the application. Before running the self test, exit all applications that use NI-CAN. 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 card conflicts with the memory resources being used by other devices in the system. Resource conflicts typically occur when the 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 the 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 NI-CAN Self Test again.

Interrupt Resource Conflict

This error occurs if the interrupt resource assigned to a CAN card conflicts with the interrupt resources being used by other devices in the system. Resource conflicts typically occur when the 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 the 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 NI-CAN Self Test again.

NI-CAN Software Problem Encountered

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

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

NI-CAN Hardware Problem Encountered

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

Common Questions

How can I determine which version of the NI-CAN software is installed on my system?

Within MAX, open the **Software** branch and select NI-CAN. The version is displayed in the right pane of MAX.

How many CAN cards can I configure for use with my NI-CAN software?

The NI-CAN software can be configured to communicate with up to 32 NI-CAN cards on all supported operating systems.

Are interrupts required for the NI-CAN cards?

Yes, one interrupt per card is required. However, PCI and PXI CAN cards can share interrupts with other devices in the system.

How do I use a baud rate that is not listed by NI-CAN?

Within MAX, you select the baud rate in the **Properties** of each CAN port. Select the **Advanced** button to specify an unlisted rate.

Within the application, you can use the hexadecimal baud rate of `0x8000`*zzyy*, where *yy* is the desired value for Bit Timing Register 0 (BTR0), and *zz* is the desired value for Bit Timing Register 1 (BTR1) of the CAN controller. For assistance with creating BTR values, use the **Advanced** dialog referenced for MAX.

Can I use the Channel API and the Frame API at the same time?

Yes, you can use the Channel API and the Frame API at the same time, but only on different ports. For example, you can use the Frame API on port 1 of a 2-port NI-CAN card and the Channel API on port 2 of that card.

Can High-Speed NI-CAN cards and low-speed NI-CAN cards be used on the same network?

No. This is not possible due to different termination requirements of High-Speed and low-speed CAN devices. Refer to Chapter 4, *Connectors and Cables*, for more information.

Do NI-CAN cards support a listen-only mode?

Yes, Series 2 NI-CAN cards support a listen-only mode, where the NI-CAN card does not interact with the CAN bus (that is, does not acknowledge incoming CAN frames).

Does the NI-CAN card provide power to the CAN bus?

No. To provide power to the CAN bus, you need an external power supply.

Can I use multiple PCMCIA cards in one computer?

Yes, but make sure there are enough free resources available. Unlike PCI or PXI CAN cards, PCMCIA CAN cards cannot share resources, such as IRQs, with other devices.

I have problems with my NI PCMCIA CAN card under Windows NT. How can I resolve them?

Windows NT offers minimal support for plug and play and there are several things to consider.

Because Windows NT does not automatically assign resources to PCMCIA cards, the PCMCIA CAN cards are configured to use default values for the IRQ and the memory range. If those resources are already in use by other devices, it might be necessary to manually change those values.

To do so, right-click the PCMCIA CAN card in MAX and choose **Properties**. Assign resource values that do not conflict with other device resources for either the Interrupt Request (IRQ) or the Memory Range.

Initially, all NI PCMCIA CAN cards will have the same resources assigned. If you have more than one PCMCIA CAN card installed, the Self Test will fail. You must change the resources of one of the cards manually.

Windows NT does not allow more than one PCMCIA card of the same type installed. Thus, you cannot use two NI PCMCIA CAN/2 cards in the same system. However, you can use an NI PCMCIA CAN card and an NI PCMCIA CAN/2 card together.

Why can't I communicate with other devices on the CAN bus, even though the Self Test in MAX passed?

If you have a Series1 card, check the settings for the Power Source Jumper. The position **EXT** is required for low-speed cards. High-Speed cards should have it set to **INT**. For further information, refer Chapter 4, *Connectors and Cables*.

If the jumper settings are correct, or you are using Series 2 CAN cards, the network may have a cabling or termination problem. If you believe this may be true, refer Chapter 3, *NI CAN Hardware*.

In addition, consult the documentation for the CAN nodes to ensure that the baud rate is exactly the same as you specify in MAX and/or the application code.

Why are some components left after the NI-CAN software is uninstalled?

The uninstall program removes only items that the installation program installed. If you add anything to a directory that was created by the installation program, the uninstall program does not delete that directory, because the directory is not empty after the uninstallation. You must remove any remaining components manually.

B

Summary of the CAN Standard

History and Use of CAN

In the past few decades, advances in automotive technology have led to increased use of electronic control systems for 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 becomes 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. This network of devices can be thought of as a scaled-down, real-time, low-cost version of networks used to connect personal computers. Any device on a CAN network can communicate with any other device using a common pair of wires.

As CAN implementations increased in the automotive industry, CAN was standardized internationally as ISO 11898. CAN chips were created by major semiconductor manufacturers such as Intel, Motorola, and Philips. With these developments, manufacturers of industrial automation equipment began to consider CAN for use in industrial applications. Comparison of the requirements for automotive and industrial device networks showed numerous similarities, including the transition away from dedicated signal lines, low cost, resistance to harsh environments, and high real-time capabilities.

Because of these similarities, CAN became widely used in photoelectric sensors and motion controllers for textile machinery, packaging machines, and production line equipment. By the mid-1990s, CAN was specified as the basis of many industrial device networking protocols, including DeviceNet, and CANopen.

With its growing popularity in automotive and industrial applications, CAN has been increasingly used in a wide variety of diverse applications. Use in agricultural equipment, nautical machinery, medical apparatus,

semiconductor manufacturing equipment, and machine tools testify to the versatility of CAN.

CAN Identifiers and Message Priority

When a CAN device transmits data onto the network, an identifier that is unique throughout the network precedes the data. The identifier defines not only the content of the data, but also the priority.

When a device transmits a message onto the CAN network, all other devices on the network receive that message. Each receiving device performs an acceptance test on the identifier to determine if the message is relevant to it. If the received identifier is not relevant to the device (such as RPM received by an air conditioning controller), the device ignores the message.

When more than one CAN device transmits a message simultaneously, the identifier is used as a priority to determine which device gains access to the network. The lower the numerical value of the identifier, the higher its priority.

Figure B-1 shows two CAN devices attempting to transmit messages, one using identifier 647 hex, and the other using identifier 6FF hex. As each device transmits the 11 bits of its identifier, it examines the network to determine if a higher-priority identifier is being transmitted simultaneously. If an identifier collision is detected, the losing device(s) immediately stop transmission, and wait for the higher priority message to complete before automatically retrying. Because the highest priority identifier continues its transmission without interruption, this scheme is referred to as *nondestructive bitwise arbitration*, and the CAN identifier is often referred to as an *arbitration ID*. This ability to resolve collisions and continue with high-priority transmissions is one feature that makes CAN ideal for real-time applications.

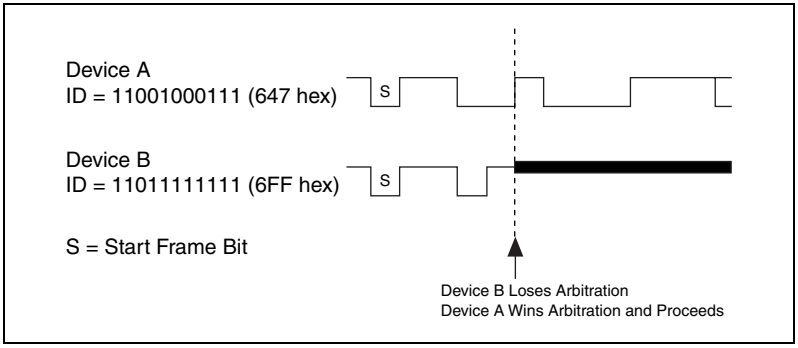


Figure B-1. Example of CAN Arbitration

CAN Frames

In a CAN network, the messages transferred across the network are called frames. The CAN protocol supports two frame formats as defined in the Bosch version 2.0 specifications, the essential difference being in the length of the arbitration ID. In the standard frame format (also known as 2.0A), the length of the ID is 11 bits. In the extended frame format (also known as 2.0B), the length of the ID is 29 bits. Figure B-2 shows the essential fields of the standard and extended frame formats, and the following sections describe each field.

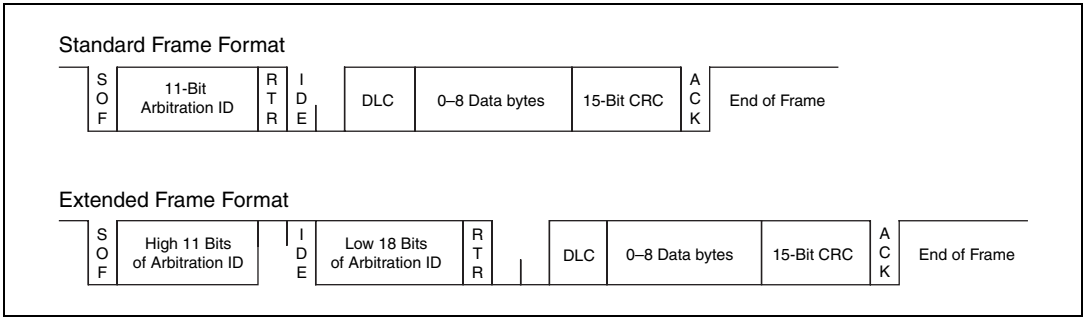


Figure B-2. Standard and Extended Frame Formats

Start of Frame (SOF)

Start of Frame is a single bit (0) that marks the beginning of a CAN frame.

Arbitration ID

The arbitration ID fields contain the identifier for a CAN frame. The standard format has one 11-bit field, and the extended format has two fields, which are 11 and 18 bits in length. In both formats, bits of the arbitration ID are transmitted from high to low order.

Remote Transmit Request (RTR)

The Remote Transmit Request bit is dominant (0) for data frames, and recessive (1) for remote frames. Data frames are the fundamental means of data transfer on a CAN network, and are used to transmit data from one device to one or more receivers. A device transmits a remote frame to request transmission of a data frame for the given arbitration ID. The remote frame is used to request data from its source device, rather than waiting for the data source to transmit the data.

Identifier Extension (IDE)

The Identifier Extension bit differentiates standard frames from extended frames. Because the IDE bit is dominant (0) for standard frames and recessive (1) for extended frames, standard frames are always higher priority than extended frames.

Data Length Code (DLC)

The Data Length Code is a 4-bit field that indicates the number of data bytes in a data frame. In a remote frame, the Data Length Code indicates the number of data bytes in the requested data frame. Valid Data Length Codes range from zero to eight.

Data Bytes

For data frames, this field contains from 0 to 8 data bytes. Remote CAN frames always contain zero data bytes.

Cyclic Redundancy Check (CRC)

The 15-bit Cyclic Redundancy Check detects bit errors in frames. The transmitter calculates the CRC based on the preceding bits of the frame, and all receivers recalculate it for comparison. If the CRC calculated by a receiver differs from the CRC in the frame, the receiver detects an error.

Acknowledgment Bit (ACK)

All receivers use the Acknowledgment Bit to acknowledge successful reception of the frame. The ACK bit is transmitted recessive (1) and is overwritten as dominant (0) by all devices that receive the frame successfully. The receivers acknowledge correct frames regardless of the acceptance test performed on the arbitration ID. If the transmitter of the frame detects no acknowledgment, it could mean that the receivers detected an error (such as a CRC error), the ACK bit was corrupted, or there are no receivers (for example, only one device on the network). In such cases, the transmitter automatically retransmits the frame.

End of Frame

Each frame ends with a sequence of recessive bits. After the required number of recessive bits, the CAN bus is idle, and the next frame transmission can begin.

CAN Error Detection and Confinement

One of the most important and useful features of CAN is its high reliability, even in extremely noisy environments. CAN provides a variety of mechanisms to detect errors in frames. This error detection is used to retransmit the frame until it is received successfully. CAN also provides an error confinement mechanism used to remove a malfunctioning device from the CAN network when a high percentage of its frames result in errors. This error confinement prevents malfunctioning devices from disturbing the overall network traffic.

Error Detection

Whenever any CAN device detects an error in a frame, that device transmits a special sequence of bits called an error flag. This error flag is normally detected by the device transmitting the invalid frame, which then retransmits to correct the error. The retransmission starts over from the start of frame, and thus arbitration with other devices can occur again.

CAN devices detect the following errors, which are described in the following sections:

- Bit error
- Stuff error
- CRC error

- Form error
- Acknowledgment error

Bit Error

During frame transmissions, a CAN device monitors the bus on a bit-by-bit basis. If the bit level monitored is different from the transmitted bit, a bit error is detected. This bit error check applies only to the Data Length Code, Data Bytes, and Cyclic Redundancy Check fields of the transmitted frame.

Stuff Error

Whenever a transmitting device detects five consecutive bits of equal value, it automatically inserts a complemented bit into the transmitted bit stream. This stuff bit is automatically removed by all receiving devices. The bit stuffing scheme is used to guarantee enough edges in the bit stream to maintain synchronization within a frame.

A stuff error occurs whenever six consecutive bits of equal value are detected on the bus.

CRC Error

A CRC error is detected by a receiving device whenever the calculated CRC differs from the actual CRC in the frame.

Form Error

A form error occurs when a violation of the fundamental CAN frame encoding is detected. For example, if a CAN device begins transmitting the Start Of Frame bit for a new frame before the End Of Frame sequence completes for a previous frame (does not wait for bus idle), a form error is detected.

Acknowledgment Error

An acknowledgment error is detected by a transmitting device whenever it does not detect a dominant Acknowledgment Bit (ACK).

Error Confinement

To provide error confinement, each CAN device must implement a transmit error counter and a receive error counter. The transmit error counter is incremented when errors are detected for transmitted frames, and decremented when a frame is transmitted successfully. The receive

error counter is used for received frames in much the same way. The error counters are increased more for errors than they are decreased for successful reception/transmission. This ensures that the error counters will generally increase when a certain ratio of frames (roughly 1/8) encounter errors. By maintaining the error counters in this manner, the CAN protocol can generally distinguish temporary errors (such as those caused by external noise) from permanent failures (such as a broken cable). For complete information on the rules used to increment/decrement the error counters, refer to the CAN specification (ISO 11898).

With regard to error confinement, each CAN device may be in one of three states: error active, error passive, and bus off.

Error Active State

When a CAN device is powered on, it begins in the error active state. A device in error active state can normally take part in communication, and transmits an active error flag when an error is detected. This active error flag (sequence of dominant 0 bits) causes the current frame transmission to abort, resulting in a subsequent retransmission. A CAN device remains in the error active state as long as the transmit and receive error counters are both below 128. In a normally functioning network of CAN devices, all devices are in the error active state.

Error Passive State

If either the transmit error counter or the receive error counter increments above 127, the CAN device transitions into the error passive state. A device in error passive state can still take part in communication, but transmits a passive error flag when an error is detected. This passive error flag (sequence of recessive 1 bits) generally does not abort frames transmitted by other devices. Because passive error flags cannot prevail over any activity on the bus line, they are noticed only when the error passive device is transmitting a frame. Thus, if an error passive device detects a receive error on a frame which is received successfully by other devices, the frame is not retransmitted.

One special rule to keep in mind: When an error passive device detects an acknowledgment error, it does not increment its transmit error counter. Thus, if a CAN network consists of only one device (for example, if you do not connect a cable to the National Instruments CAN interface), and that device attempts to transmit a frame, it retransmits continuously but never goes into bus off state (although it eventually reaches error passive state).

Bus Off State

If the transmit error counter increments above 255, the CAN device transitions into the bus off state. A device in the bus off state does not transmit or receive any frames, and thus cannot have any influence on the bus. The bus off state is used to disable a malfunctioning CAN device which frequently transmits invalid frames, so that the device does not adversely affect other devices on the network. When a CAN device transitions to bus off, it can be placed back into error active state (with both counters reset to zero) only by manual intervention. For sensor/actuator types of devices, this often involves powering the device off then on. For NI-CAN network interfaces, communication can be started again using an API function.

Low-Speed CAN

Low-speed CAN is commonly used to control “comfort” devices in an automobile, such as seat adjustment, mirror adjustment, and door locking. It differs from “High-Speed” CAN in that the maximum baud rate is 125 K and it utilizes CAN transceivers that offer fault-tolerant capability. This enables the CAN bus to keep operating even if one of the wires is cut or short-circuited because it operates on relative changes in voltage, and thus provides a much higher level of safety. The transceiver solves many common and frequent wiring problems such as poor connectors, and also overcomes short circuits of either transmission wire to ground or battery voltage, or the other transmission wire. The transceiver resolves the fault situation without involvement of external hardware or software. On the detection of a fault, the transceiver switches to a one-wire transmission mode and automatically switches back to differential mode if the fault is removed.

Special resistors are added to the circuitry for the proper operation of the fault-tolerant transceiver. The values of the resistors depend on the number of nodes and the resistance values per node. For guidelines on selecting the resistor, refer to Chapter 4, *Connectors and Cables*.

Because the low-speed transceiver switches to a fault-tolerant mode on fault detection and continues to maintain communications, NI-CAN provides a special attribute, Log Comm Warnings, which when set to true enables the reporting of such warnings in the Read queue of the Network Interface rather than in the status returned from a function call. The default value of this attribute is false, which enables the reporting of low-speed transceiver warnings in the status returned from a function call.

C

Specifications

This appendix describes the physical characteristics of the CAN hardware, along with the recommended operating conditions.

PCI-CAN Series 2

Power Requirement

+5 VDC (±5%)

PCI-CAN	800 mA typical
PCI-CAN/2	850 mA typical
PCI-CAN/LS	800 mA typical
PCI-CAN/LS2	850 mA typical
PCI-CAN/SW	750 mA typical
PCI-CAN/SW2	800 mA typical
PCI-CAN/XS	800 mA typical
PCI-CAN/XS2	900 mA typical

Physical

Dimensions	20.70 cm by 11.18 cm (8.150 in. by 4.4 in.)
I/O connector	9-pin male D-SUB for each port

Operating Environment

Ambient temperature	0 to 55 °C
Relative humidity	10 to 90%, noncondensing

Storage Environment

Ambient temperature	–20 to 70 °C
Relative humidity	5 to 95%, noncondensing

Optical Isolation

500 V each port

RTSI

Trigger lines.....7 input/output

Clock lines .....1 input/output

I/O compatibility.....TTL

Power-on state .....Input (High-Z)

Response .....Rising Edge Triggers

High-Speed CAN

Transceiver .....Philips TJA1041

Max baud rate .....1 Mbps

CAN_H, CAN_L bus lines.....–27 to +40 VDC

VBAT power requirement
(jumper set to EXT).....+8 to +27 VDC
on V+ connector pin
(referenced to V–)

Low-Speed/Fault-Tolerant CAN

Transceiver .....Philips TJA1054A

Max baud rate .....125 kbps

CAN_H, CAN_L bus lines.....–27 to +40 VDC

VBAT power requirement
(jumper set to EXT).....+8 to +27 VDC
on V+ connector pin
(referenced to V–)

Single Wire CAN

Transceiver ..... Philips AU5790

Max baud rate ..... 33.3 kbps (normal transmission mode), 83.3 kbps (High-Speed transmission mode)

CAH_H bus line ..... –10 to +18 VDC

VBAT power requirement
(always required) ..... +8 to +18 VDC (12 VDC recommended) on V+ connector pin (referenced to V–)

XS Software Selectable

Relay service life

Mechanical ..... 50,000,000 operations min. (at 36,000 operations per hour)

External mode digital I/O characteristics

MODE0, MODE1—digital outputs

STATUS—digital input

Level	Min	Max
V_{IL}	0.0 V	0.8 V
V_{IH}	2.0 V (typ)	5.0 V
V_{OL} (I_{OL} = 32 mA)	—	0.55 V
V_{OH} (I_{OH} = –32 mA)	3.8 V	—

PXI-846*x* Series 2

Power Requirement

+5 VDC (±5%)

PXI-8461 (1 port) ..... 800 mA typical

PXI-8461 (2 ports) ..... 850 mA typical

PXI-8460 (1 port) ..... 800 mA typical

PXI-8460 (2 ports) ..... 850 mA typical

PXI-8463 (1 port) .....800 mA typical
PXI-8463 (2 ports).....850 mA typical
PXI-8464 (1 port) .....850 mA typical
PXI-8464 (2 ports).....900 mA typical

Physical

Dimensions .....16.0 cm by 10.0 cm
(6.3 in. by 3.9 in.)

I/O connector .....9-pin male D-SUB for each port

Operating Environment

Ambient temperature .....0 to 55 °C

Relative humidity .....10 to 90%, noncondensing

(Tested in accordance with IEC-60068-2-1, IEC-60068-2-2, IEC-60068-2-56.)

Storage Environment

Ambient temperature .....–20 to 70 °C

Relative humidity .....5 to 95%, noncondensing

(Tested in accordance with IEC-60068-2-1, IEC-60068-2-2, IEC-60068-2-56.)

Functional Shock

30 g peak, half-sine, 11 ms pulse

(Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-T-28800E.)

Random Vibration

Operating .....5 to 500 Hz, 0.3 grms

Nonoperating .....5 to 500 Hz, 2.4 grms

(Tested in accordance with IEC-60068-2-64. Nonoperating test profile developed in accordance with MIL-T-28800E and MIL-STD-810E Method 514.)

Optical Isolation

500 V each port

PXI Trigger Bus

Trigger lines ..... 7 input/output

PXI_Star trigger ..... 1 input

Clock lines..... 1 input/output

PXI_Clk10 ..... 1 input

I/O compatibility ..... TTL

Power-on state..... Input (High-Z)

Response ..... Rising Edge Triggers

High-Speed CAN

Transceiver..... Philips TJA1041

Max baud rate..... 1 Mbps

CAN_H, CAN_L bus lines ..... –27 to +40 VDC

VBAT power requirement
(jumper set to EXT) ..... +8 to +27 VDC
on V+ connector pin
(referenced to V–)

Low-Speed/Fault-Tolerant CAN

Transceiver..... Philips TJA1054A

Max baud rate..... 125 kbps

CAN_H, CAN_L bus lines ..... –27 to +40 VDC

VBAT power requirement
(jumper set to EXT) ..... +8 to +27 VDC
on V+ connector pin
(referenced to V–)

Single Wire CAN

Transceiver .....Philips AU5790

Max baud rate .....33.3 kbps (normal transmission mode), 83.3 kbps (High-Speed transmission mode)

CAH_H bus line .....–10 to +18 VDC

VBAT power requirement
(always required) .....+8 to +18 VDC (12 VDC typical) on V+ connector pin (referenced to V–)

XS Software Selectable

Relay service life

Mechanical .....50,000,000 operations min. (at 36,000 operations per hour)

External mode digital I/O characteristics

MODE0, MODE1—digital outputs

STATUS—digital input

Level	Min	Max
V_{IL}	0.0 V	0.8 V
V_{IH}	2.0 V (typ)	5.0 V
V_{OL} (I_{OL} = 32 mA)	—	0.55 V
V_{OH} (I_{OH} = –32 mA)	3.8 V	—

PCMCIA-CAN Series 2

Power Requirement

+5 VDC (±5%)

PCMCIA-CAN .....350 mA typical; active

1-port PCMCIA-CAN
internal power cable .....+55 mA typical

PCMCIA-CAN/2 .....350 mA typical; active

2-port PCMCIA-CAN
internal power cable ..... +115 mA typical

Physical

Dimensions ..... 8.56 cm by 5.40 cm by 0.5 cm (3.4 in. by 2.1 in. by 0.2 in.)

I/O connector ..... PCMCIA-CAN cable with 9-pin male D-SUB and pluggable screw terminal for each port

Operating Environment

Ambient temperature ..... 0 to 55 °C

Relative humidity ..... 10 to 90%, noncondensing

(Tested in accordance with IEC-60068-2-1, IEC-60068-2-2, EC-60068-2-56.)

Storage Environment

Ambient temperature ..... –20 to 70 °C

Relative humidity ..... 5 to 95%, noncondensing

(Tested in accordance with IEC-60068-2-1, IEC-60068-2-2, EC-60068-2-56.)

Optical Isolation

500 V each port in PCMCIA-CAN cables

Synchronization Triggers

Trigger lines ..... 4 input/output (TRIG_0-TRIG_3)

Clock lines ..... 1 input (TRIG7_CLK)

I/O compatibility ..... TTL

Power-on state ..... Input (High-Z)

Response ..... Rising Edge Triggers

Level	Min	Max
V_{IL}	–0.5 V	0.8 V
V_{IH}	1.7 V	5.75 V
V_{OL} (I_{OL} = 8 mA)	—	0.45 V
V_{OH} (I_{OH} = 8 mA)	2.4 V	—

High-Speed Transceiver Cable

Transceiver .....Philips TJA1041

Max baud rate .....1 Mbps

CAN_H, CAN_L bus lines .....–27 to +40 VDC

Power requirements .....Internally powered

Low-Speed/Fault-Tolerant Transceiver Cable

Transceiver .....Philips TJA1054A

Max baud rate .....125 kbps

CAN_H, CAN_L bus lines .....–27 to +40 VDC

Power requirements .....Internally powered

Single-Wire Cable

Transceiver .....Philips AU5790

Max baud rate .....33.3 Kbps (normal transmission mode), 83.3 Kbps (High-Speed transmission mode)

CAN_H bus line .....–10 to +18 VDC

Power requirement (always required) .....+8 to +18 VDC (12 VDC recommended) on V+ connector pin (referenced to V–)

Safety

The NI-CAN hardware meets the requirements of the following standards for safety and electrical equipment for measurement, control, and laboratory use:

- EN 61010-1, IEC 61010-1
- UL 3111-1, UL 61010B-1
- CAN/CSA C22.2 No. 1010.1

Note For UL and other safety certifications, refer to the product label, or visit `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Pollution Degree 2

Maximum altitude ..... 2,000 m

Indoor use only.

Electromagnetic Compatibility

Emissions ..... EN 55011 Class A at 10 m FCC Part 15A above 1 GHz

Immunity ..... EN 61326:1997 +A2:2001, Table 1

CE, C-Tick, and FCC Part 15 (Class A) Compliant

Note For full EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety) 73/23/EEC

Electromagnetic Compatibility Directive (EMC) 89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit

ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

D

Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

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Glossary

Symbol	Prefix	Value
n	nano	10^{-9}
m	milli	10^{-3}
k	kilo	10^{3}
M	mega	10^{6}

A

action — *See* method.

actuator — A device that uses electrical, mechanical, or other signals to change the value of an external, real-world variable. In the context of device networks, actuators are devices that receive their primary data value from over the network; examples include valves and motor starters. Also known as *final control element*.

Application Programming Interface (API) — A collection of functions used by a user application to access hardware. Within NI-CAN, you use API functions to make calls into the NI-CAN driver. NI-CAN provides two different APIs: the Frame API and Channel API.

arbitration ID — An 11- or 29-bit ID transmitted as the first field of a CAN frame. The arbitration ID determines the priority of the frame, and is normally used to identify the data transmitted in the frame.

attribute — The Frame API provides attributes to access configuration settings or other information. In the Channel API, the term *property* is used for similar settings.

B

b	Bits.
Behavior After Final Output	Property in the Channel API that specifies the behavior to perform after the final periodic output sample is transmitted. For more information, refer to **CAN Set Property.vi** for LabVIEW, or `nctSetProperty` for C.
bus off	A CAN node goes into the bus off state when its transmit error counter increments above 255. The node does not participate in network traffic, because it assumes that a defect exists that must be corrected.

C

CAN	Controller Area Network.
CAN Channels	*See* channel.
CAN controller	Communications chip used to transmit and receive frames on a CAN network. The majority of the CAN specification is implemented within the CAN controller. Examples of CAN controllers include the Intel 82527 (used by Series 1 NI CAN hardware), and the Philips SJA1000 (used by Series 2 NI CAN hardware).
CAN data frame	Frame used to transmit the actual data of a CAN Object. The RTR bit is clear, and the data length indicates the number of data bytes in the frame.
CAN database	Database file that describes channels and associated messages for a collection of CAN nodes. NI-CAN supports two CAN database formats: CANdb and the NI-CAN database.
CAN frame	In addition to fields used for error detection/correction, a CAN frame consists of an arbitration ID, the RTR bit, a four-bit data length, and zero to eight bytes of data.
CAN/LS	*See* Low-speed CAN.
CAN Network Interface Object	Within the NI-CAN Frame API, an object that encapsulates a CAN interface on the host computer.
CAN Object	Within the NI-CAN Frame API, an object that encapsulates a specific CAN arbitration ID along with its raw data bytes.

CAN remote frame	Frame used to request data for a CAN Object from a remote node; the RTR bit is set, and the data length indicates the amount of data desired (but no data bytes are included).
CANdb	CAN database format defined by Vector Informatik. CANdb files use the `.dbc` file extension.
channel	Floating-point value in physical units (such as Volts, rpm, km/h, °C, and so on) that is converted to/from a raw value in measurement hardware. The NI-CAN Channel API `Read` and `Write` functions provide access to CAN channels. When a CAN message is received, NI-CAN converts raw fields in the message into physical units, which you then obtain using the Channel API Read function. When you call a 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 an example usage of the channel concept, refer to the Channel API section in Introduction.
Channel API	NI-CAN API that you use to read and write channels.
channel list	Input parameter of the CAN Init Start function. The channel list specifies the list of channels to read or write. For more information, refer to **CAN Init Start.vi** for LabVIEW, or `nctInitStart` for C.
ChannelList	*See* channel list.
class	A set of objects that share a common structure and a common behavior.
clock drift	When two or more hardware products are used to measure a common system, you typically need to compare data from the hardware products simultaneously. Since each hardware product contains a local oscillator to perform measurements, and all oscillators differ slightly in speed and tolerances, measurements on different hardware products can drift relative to one another. For example, if you measure the same sine wave on two different analog-input products, the measured sine waves typically drift out of phase after a few minutes. National Instruments products use RTSI to share timebases among different hardware products. Since the products share the same oscillator, clock drift is eliminated.

connection — With respect to networking, this term refers to an association between two or more nodes on a network that describes when and how data is transferred.

With respect to RTSI, this term refers to a connection between two or more terminals.

controller — With respect to CAN, this term often refers to a CAN controller.

With respect to real-time systems, this term refers to a device that receives input data and sends output data in order to hold one or more external, real-world variables at a certain level or condition. A thermostat is a simple example of a controller.

D

Default Value — Property in the Channel API that specifies the default value for a channel. For more information, refer to **CAN Get Property.vi** for LabVIEW, or `nctSetProperty` for C.

device — *See* node.

device network — Multi-drop digital communication network for sensors, actuators, and controllers.

DLL — Dynamic link library.

DMA — Direct memory access.

E

error active — A CAN node is in error active state when both the receive and transmit error counters are below 128.

error counters — Every CAN node keeps a count of how many receive and transmit errors have occurred. The rules for how these counters are incremented and decremented are defined by the CAN protocol specification.

error passive — A CAN node is in error passive state when one or both of its error counters increment above 127. This state is a warning that a communication problem exists, but the node is still participating in network traffic.

extended arbitration ID	A 29-bit arbitration ID. Frames that use extended IDs are often referred to as CAN 2.0 Part B (the specification that defines them).

F

FCC	Federal Communications Commission.
filepath	Complete path to a filename using Windows conventions, such as: `C:\Program Files\National Instruments\NI-CAN\MyDatabase.ncd`
frame	A unit of information transferred across a network from one node to another. From an OSI perspective, the NI-CAN usage of the term *frame* refers to a Data Link Layer unit, because individual fields are not specified.
Frame API	NI-CAN API that you use to read and write frames.

H

hex	Hexadecimal.
Hz	Hertz; cycles per second.

I

instance	An abstraction of a specific real-world thing; for example, John is an instance of the class Human. Also known as *object*.
Interface Baud Rate	Property in the Channel API that specifies the baud rate of the interface. For more information, refer to **CAN Set Property.vi** for LabVIEW, or `nctSetProperty` for C.
Interface Receive Error Counter	Every CAN node keeps a count of how many receive errors have occurred. The rules for how this counter is incremented and decremented are defined by the CAN protocol specification. This property in the Channel API returns the receive error counter. For more information, refer to **CAN Get Property.vi** for LabVIEW or `nctGetProperty` for C.
Interface Single Shot Transmit	Property in the Channel API that determines whether to retry failed frame transmissions or transmit as a single-shot. For more information, refer to **CAN Set Property.vi** for LabVIEW, or `nctSetProperty` for C.

Interface Transmit Error Counter	Every CAN node keeps a count of how many transmit errors have occurred. The rules for how this counter is incremented and decremented are defined by the CAN protocol specification. This property in the Channel API returns the transmit error counter. For more information, refer to **CAN Get Property.vi** for LabVIEW, or `nctGetProperty` for C.
interface	Reference to a specific CAN port in the NI-CAN software. NI-CAN interface names are assigned within MAX, and can range from **CAN0** to **CAN63**. In the Channel API, the interface is specified during initialization of the task. For more information, refer to **CAN Init Start.vi** for LabVIEW, or `nctInitStart` for C. In the Frame API, the interface is specified during configuration of the CAN Network Interface Object. For more information, refer to **ncConfigCANNet.vi** for LabVIEW, or `ncConfig` for C.
ISO	International Organization for Standardization.

K

KB	Kilobytes of memory.

L

LabVIEW	Laboratory Virtual Instrument Engineering Workbench.
local	Within NI-CAN, anything that exists on the same host (personal computer) as the NI-CAN driver.
local wakeup	Wakeup of the CAN transceiver from sleep mode caused by a call to an NI-CAN function, such as setting Transceiver Mode to Normal.
Low-speed CAN	Fault-tolerant CAN transceiver specification as defined in ISO 11898.

M

MAX	The Measurement & Automation Explorer provides a centralized location for configuration of National Instruments hardware products. MAX also provides many useful tools for interaction with hardware.
MB	Megabytes of memory.
message	CAN data frame for which the individual fields are described. From an OSI perspective, NI-CAN usage of the term frame refers to a User Layer unit, because the Application Layer is assumed (simple peer-to-peer protocol), and the channel configurations specify User Layer meaning.
method	An action performed on an instance to affect its behavior; the externally visible code of an object. Within NI-CAN, you use NI-CAN functions to execute methods for objects. Also known as *service*, *operation*, and *action*.
minimum interval	For a given connection, the minimum amount of time between subsequent attempts to transmit frames on the connection. Some protocols use minimum intervals to guarantee a certain level of overall network performance.
mode	Input parameter of the CAN Init Start function. The mode specifies the direction of data transfer (input or output), and the type of information provided (input or timestamped input). For more information, refer to **CAN Init Start.vi** for LabVIEW, or `nctInitStart` for C.
multi-drop	A physical connection in which multiple devices communicate with one another along a single cable.

N

network interface	A node's physical connection onto a network.
NI-CAN database	CAN database format defined by National Instruments. NI-CAN database files use the `.ncd` file extension.
NI-CAN driver	Device driver and/or firmware that implement all the specifics of a CAN network interface. Within NI-CAN, this software implements the CAN Network Interface Object as well as all objects above it in the object hierarchy.

node	A physical assembly, linked to a communication line (cable), capable of communicating across the network according to a protocol specification. Also known as *device*.
notification	Within NI-CAN, an operating system mechanism that the NI-CAN driver uses to communicate events to the application. You can think of a notification of as an API function, but in the opposite direction.

O

object	*See* instance.
object-oriented	A software design methodology in which classes, instances, attributes, and methods are used to hide all of the details of a software entity that do not contribute to its essential characteristics.
OSI	Open Systems Interconnection (OSI) is a collection of ISO standards for communication protocols. Most people reference OSI in the context of the layers that it specifies for all communication protocols. The Physical Layer refers to physical connectors, cabling, and signal characteristics. The Data Link Layer refers to the fundamental frame format. The Application Layer refers to connection establishment and other higher-level transactions between nodes. The User Layer is an informal term that refer to the definition of specific fields in Application Layer messages that define how an application uses the protocol.

P

peer-to-peer	Network connection in which data is transmitted from the source to its destination(s) without need for an explicit request. Although data transfer is generally unidirectional, the protocol often uses low level acknowledgments and error detection to ensure successful delivery.
periodic	Connections that transfer data on the network at a specific rate.
polled	Request/response connection in which a request for data is sent to a device, and the device sends back a response with the desired value.

poly VI — LabVIEW VI that accepts different data types for a single input or output terminal. In some cases, the data type can be selected based on the value that you wire to the poly input or output. To select a specific poly VI type, right-click the VI, go to **Select Type**, and select the desired type. For more information, refer to the LabVIEW documentation.

Like many other National Instruments APIs, the NI-CAN Channel API implements Read and Write as poly VIs in order to support a variety of data types.

polymorphic VI — *See* poly VI.

port — The physical CAN connector on the NI-CAN hardware product. You assign an interface name to each port using MAX.

property — The Channel API provides properties to access configuration settings or other information. LabVIEW also uses the term property for settings of front panel controls and indicators. In the Frame API, the term attribute is used for similar settings.

property nodes — In LabVIEW, you can use property nodes to change the appearance or behavior of front panel controls and indicators. For example, you can change the label, minimum value, and maximum value of an indicator. For more information, refer to the LabVIEW documentation.

protocol — A formal set of conventions or rules for the exchange of information among nodes of a given network.

R

RAM — Random-access memory.

remote — Within NI-CAN, anything that exists in another node of the device network (not on the same host as the NI-CAN driver).

Remote Transmission Request (RTR) bit — This bit follows the arbitration ID in a frame, and indicates whether the frame is the actual data of the CAN Object (CAN data frame), or whether the frame is a request for the data (CAN remote frame).

remote wakeup — Wakeup of the CAN transceiver from sleep mode caused from an event on the network.

A remote wakeup occurs when a remote node transmits a CAN frame (referred to as the wakeup frame). The wakeup frame wakes up the transceiver and CAN controller chip of the NI CAN interface. The wakeup frame is not received or acknowledged by the CAN controller chip. When the wakeup frame ends, the NI CAN interface enters Normal mode and again receives and transmits CAN frames. If the node that transmitted the wakeup frame did not detect an acknowledgement (such as if other nodes were also waking), it retries the transmission, and the retry is received by the NI CAN interface.

For a remote wakeup to occur for Single Wire transceivers, the node that transmits the wakeup frame must first place the network into the Single Wire Wakeup Transmission mode by asserting a higher voltage (typically 12 V).

request/response — Network connection in which a request is transmitted to one or more destination nodes, and those nodes send a response back to the requesting node. In industrial applications, the responding (slave) device is usually a sensor or actuator, and the requesting (master) device is usually a controller. Also known as *master/slave*.

resource — Hardware settings used by National Instruments CAN hardware, including an interrupt request level (IRQ) and an 8 KB physical memory range (such as D0000 to D1FFF hex).

RTSI — Real Time System Integration bus. National Instruments technology that can be used to synchronize multiple hardware products. For PCI products, this refers to the ribbon cable that is used to route signals between cards. For PXI products, the RTSI signals are provided on the backplane. For PCMCIA products, RTSI signals can be connected between the sync cable of a CAN card and the terminal block of a DAQ card.

S

s — Seconds.

sample — A floating-point value that represents physical units. In the NI-CAN Channel API, you Read and Write samples using channels.

sample rate	Input parameter of the CAN Init Start function. The sample rate specifies whether to transfer data in a periodic or event-driven manner. For periodic behavior, the rate specifies the number of read/write samples to perform per second. For more information, refer to **CAN Init Start.vi** for LabVIEW, or `nctInitStart` for C.
sensor	A device that measures electrical, mechanical, or other signals from an external, real-world variable; in the context of device networks, sensors are devices that send their primary data value onto the network; examples include temperature sensors and presence sensors. Also known as *transmitter*.
Series 1	National Instruments hardware for CAN that shipped prior to NI-CAN 2.0. NI-CAN supports this hardware series, but some new features require Series 2 hardware.
Series 2	National Instruments hardware for CAN that shipped after NI-CAN 2.0. Improvements relative to Series 1 include a superior CAN controller (Philips SJA1000), and improved RTSI features.
signal	Term used by other vendors of CAN products to refer to a CAN channel. For National Instruments products, this term usually refers to a physical voltage that represents a predefined behavior. For example, RTSI connections are used to exchange signals.
standard arbitration ID	An 11-bit arbitration ID. Frames that use standard IDs are often referred to as CAN 2.0 Part A; standard IDs are by far the most commonly used.
start trigger	When two or more hardware products are used to measure a common system, you typically need to compare data from the hardware products simultaneously. Since each hardware product starts its measurement independently, measurements on different hardware products can often be skewed in time relative to one another. For example, if you measure the same sine wave on two different analog-input products, the measured sine waves start off out of phase. National Instruments products use RTSI to share start triggers among different hardware products. Since the products share the same start trigger, measurements begin at the same time.

synchronize — Connection of two or more hardware products in order to measure a common system. For National Instruments products, RTSI connections are used to synchronize.

Although there are a variety of ways to synchronize National Instruments products, a common technique is to share a timebase and start trigger over RTSI in order to eliminate clock drift and startup skew.

T

task — A collection of channels that you can read or write.

The task is returned as an output parameter of the CAN Init Start function, and is used for all subsequent Channel API calls such as Read or Write. For more information, refer to **CAN Init Start.vi** for LabVIEW, or `nctInitStart` for C.

terminal — A physical pin on a hardware component. RTSI signals are one type of terminal. Internal connections within hardware products are another type of terminal.

timebase — The fundamental clock used to perform measurement. National Instruments synchronization features allow the timebase of one product to be shared with another in order to eliminate clock drift.

Timeout — Property in the Channel API that specifies the behavior the timeout in seconds for Read and Write functions. For more information, refer to **CAN Set Property.vi** for LabVIEW, or `nctSetProperty` for C.

U

unsolicited — Connections that transmit data on the network sporadically based on an external event. Also known as *nonperiodic*, *sporadic*, and *event driven*.

V

VI — Virtual Instrument.

W

watchdog timeout — A timeout associated with a connection that expects to receive network data at a specific rate. If data is not received before the watchdog timeout expires, the connection is normally stopped. You can use watchdog timeouts to verify that the remote node is still operational.

waveform data type — LabVIEW data type that represents a sequential list of samples in time. The data type includes the array of samples (each a DBL), a start time that specifies when the first sample was measured, and a delay time that specifies the time between samples (sample rate) or more information, refer to the LabVIEW documentation.

The Read and Write functions of the Channel API support the LabVIEW waveform data type.

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