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FCC/Canada Radio Frequency Interference Compliance

Determining FCC Class
The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). Depending on where it is operated, this 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. By examining the product you purchased, you can determine the FCC Class and therefore which of the two FCC/DOC Warnings apply in the following sections. (Some products may not be labeled at all for FCC; if so, the reader should then assume these are Class A devices.)

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

FCC Class B products display either a FCC ID code, starting with the letters EXN, or the FCC Class B compliance mark that appears as shown here on the right. Consult the FCC Web site at http://www.fcc.gov for more information.

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This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE Marking Declaration of Conformity*, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

Changes or modifications not expressly approved by National Instruments 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 will be required to correct the interference at his own expense.

Canadian Department of Communications
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Class B
Federal Communications Commission
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.
**Canadian Department of Communications**

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations. Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

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Readers in the European Union (EU) must refer to the Manufacturer’s Declaration of Conformity (DoC) for information* pertaining to the CE Marking compliance scheme. The Manufacturer includes a DoC for most every hardware product except for those bought for OEMs, if also available from an original manufacturer that also markets in the EU, or where compliance is not required as for electrically benign apparatus or cables.

To obtain the DoC for this product, click Declaration of Conformity at ni.com/hardref.nsf/. This Web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.

* The CE Marking Declaration of Conformity will contain important supplementary information and instructions for the user or installer.
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About This Manual

This manual is a description of the National Instruments Controller Area Network (CAN) hardware and NI-CAN software features as well as a programming reference for VIs and functions in the NI-CAN software.

The authors of this manual assume you are already familiar with your operating system.

How to Use the Manual Set

Use the CAN Hardware and NI-CAN Software for Windows Installation Guide in the jewel case of your program CD to install and configure your 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 features of the hardware. Unless otherwise noted, this manual applies to the NI-CAN hardware products, which include the following.

PCI-CAN
- PCI-CAN (high-speed; one port)
- PCI-CAN/2 (high-speed; two port)
- PCI-CAN/LS (low-speed, fault-tolerant; one port)
- PCI-CAN/LS2 (low-speed, fault-tolerant; two port)

PXI-846x
- PXI-8460 (low-speed, fault-tolerant; one or two port)
- PXI-8461 (high-speed; one or two port)
- PXI-8462 (dual-speed: port one high-speed, port two low-speed)

PCMCIA-CAN
- PCMCIA-CAN (high-speed; one port)
- PCMCIA-CAN/2 (high-speed; two port)
- PCMCIA-CAN/LS (low-speed, fault-tolerant; one port)
About This Manual

- PCMCIA-CAN/LS2 (low-speed, fault-tolerant; one port)
- PCMCIA-CAN/DS (dual-speed: one port high-speed, one port low-speed, fault-tolerant)

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 on 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, and code excerpts.

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

Related Documentation

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

About This Manual

- *CiA Draft Standard 102*, Version 2.0, CAN Physical Layer for Industrial Applications
- *CompactPCI Specification*, Revision 2.0, PCI Industrial Computers Manufacturers Group
- *PXI Specification*, Revision 1.0, National Instruments Corporation
- LabVIEW Online Reference
- Measurement and Automation Explorer (MAX) Online Reference
- Microsoft Win32 Software Development Kit (SDK) Online Help
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.

![Simplified CAN Data Frame](image)

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 F, Summary of the CAN Standard.
NI-CAN Hardware Overview

The National Instruments CAN hardware covered in this manual includes the PCI-CAN, PCI-CAN/2, PCI-CAN/LS (low-speed CAN), PCI-CAN/LS2, PCI-CAN/DS (dual-speed CAN), PCMCIA-CAN, PCMCIA-CAN/2, PXI-8460 (low-speed: one or two port), PXI-8461 (high-speed: one or two port) and PXI-8462 (dual-speed: port one high-speed, port two low-speed).

The PCI-CAN, PCI-CAN/LS and PCI-CAN/DS series cards are completely software configurable and compliant with the PCI Local Bus Specification. With a PCI-CAN, PCI-CAN/LS or PCI-CAN/DS series card, you can make your PC-compatible computer with PCI Local Bus slots communicate with and control CAN devices.

The PCMCIA-CAN series cards are Type II PC Cards that are completely software configurable and compliant with the PCMCIA standards for 16-bit PC Cards. With a PCMCIA-CAN series card, you can make your PC-compatible notebook with PCMCIA sockets communicate with and control CAN devices.

The PXI-8460, PXI-8461, and PXI-8462 are software configurable and compliant with the PXI Specification and CompactPCI Specification. With the PXI-846x cards you can make your PXI or CompactPCI chassis communicate with and control CAN devices.

The CAN hardware supports a wide variety of transfer rates up to 1 Mb/s. CAN interfacing is accomplished using the Intel 82527 CAN controller chip. The high-speed CAN physical layer fully conforms to the ISO 11898 physical layer specification for CAN and is optically isolated to 500 V. The low-speed CAN physical layer conforms to the ISO 11898 physical layer specification for CAN and is also optically isolated to 500 V.

The PCI-CAN and PXI-8461 series cards are available with two physical connector types: DB-9 D-Sub and Combicon-style pluggable screw terminals. Low-speed PCI-CAN/LS, PCI-CAN/DS, PXI-8460, and PXI-8462 boards are available with DB-9 D-Sub connectors. PCMCIA-CAN, PCMCIA-CAN/LS and PCMCIA-CAN/DS cables include both a DB-9 D-Sub and a pluggable screw terminal.

The CAN physical layer on PCI-CAN, PXI-8460 and PXI-846x series cards can be powered either internally (from the card) or externally (from the bus cable power). The power source for the CAN physical layer for each port is configured with a jumper.
There are four types of cables available for the PCMCIA-CAN cards:

- PCMCIA-CAN bus powered transceiver cables. The CAN physical layer is powered externally (from the bus cable power).
- PCMCIA-CAN internally powered transceiver cables. The CAN physical layer is powered internally (from the card).
- PCMCIA-CAN/LS cables. The low-speed CAN physical layer and the V-BAT pin of the low-speed transceiver are powered internally. This cable also requires that only the V–, CAN_L and CAN_H be connected to the bus.
- PCMCIA-CAN/DS cables. The high-speed port (port 1) physical layer is powered internally. The low-speed port (port 2) physical layer is identical to the PCMCIA-CAN/LS cable.

The PXI-846x and PCI-CAN cards use the Real-Time System Integration (RTSI) bus to solve the problem of synchronizing several functions across multiple cards to a common trigger or timing event. For PCI-CAN, the RTSI bus consists of the National Instruments RTSI bus interface and ribbon cable to route timing and trigger signals between the CAN hardware and National Instruments DAQ, IMAQ, NI-Motion, or additional CAN hardware. For the PXI-846x, the RTSI bus is implemented by using the National Instruments PXI trigger bus to route timing and trigger signals between the CAN hardware and National Instruments DAQ, IMAQ, NI-Motion, or additional CAN hardware. Although the PXI-846x series cards with RTSI bus are available in a PXI chassis, there are important issues to consider when using RTSI in a CompactPCI chassis.

Refer to Appendix E, RTSI Bus, for detailed information about the RTSI interface. Also refer to the RTSI Bus Overview and The RTSI Solution sections later in this chapter.

All of the CAN hardware uses the Intel 386EX embedded processor to implement time-critical features provided by the NI-CAN software. The CAN hardware communicates with the NI-CAN driver through on-card shared memory and an interrupt.

**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 your test and simulation requirements.
MAX

The NI-CAN features within MAX enable you to:
• verify the installation of your NI-CAN hardware
• configure software properties for each CAN port
• create or import configuration information for the Channel API
• interact with your 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 7, *Using the Frame API*.

Channel API

A typical CAN data frame contains multiple values encoded as raw fields. Figure 1-2 shows an example set of fields for a 6-byte data frame.
Bytes 1 to 2 contain a **CruiseCtrlSetSpeed** field that represents a vehicle speed in kilometers per hour (km/h). Most CAN devices do not transmit values as floating-point units such as 115.6 km/h. Therefore, this field consists of a 16-bit unsigned integer in which each increment represents 0.0039 km/h. For example, if the field contains the value 25000, that represents $(25000 \times 0.0039) = 97.5$ 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 your application to convert each raw field to physical units such as km/h. The NI-CAN Channel API enables you to specify this conversion information at configuration-time instead of within your application. This configuration information can be imported from Vector CANdb files, or specified directly in MAX.

For each ID you read or write on the CAN network, you specify a number of fields. For each field, you specify its location in the frame, size in bits, and a formula to convert to/from floating-point units. In other words, you...
specify the meaning of various fields in each CAN data frame. In NI-CAN terminology, a data frame for which the individual fields are described is called a message.

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

For more information, refer to Chapter 4, Using the Channel API.

**RTSI Bus Overview**

RTSI is an acronym for Real-Time System Integration. It is the National Instruments timing bus that connects CAN and DAQ boards directly. This is done via connectors on top of the PCI-CAN series boards, and the PXI trigger bus on the PXI-846x series boards, for precise synchronization of functions.

**The RTSI Solution**

A common problem with interface boards is that you cannot easily synchronize several functions across multiple boards to a common trigger or timing event. CAN boards use the RTSI bus to solve this problem.

For PCI-CAN series boards, the RTSI bus consists of connecting the National Instruments RTSI bus interface with RTSI ribbon cable to route timing and trigger signals between the CAN board and other National Instruments RTSI-equipped hardware. Refer to Appendix E, RTSI Bus, for detailed information about the PCI-CAN and AT-CAN series RTSI interfaces.

For the PXI-846x series CAN boards, the RTSI bus consists of using the National Instruments PXI trigger bus to route timing and trigger signals between the PXI-846x series board and other National Instruments RTSI-equipped PXI boards. Regarding the RTSI interface on your PXI-846x series board, there are important issues to consider when using
it in a CompactPCI chassis. Refer to Appendix E, *RTSI Bus*, for detailed information about the PXI-846x series RTSI interface.

For information on RTSI programming, refer to the *Synchronization* section of Chapter 4, *Using the Channel API*, and the *RTSI* section in Chapter 7, *Using the Frame API*.
The Measurement & Automation Explorer (MAX) provides access to all of your 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 your desktop, or within your Windows Programs menu under National Instruments»Measurement & Automation.

For information on the NI-CAN software within MAX, consult the online help within MAX.

A reference is located 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 Your 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.
Chapter 2  Installation and Configuration

NI-CAN Hardware and Software Manual 2-2 ni.com

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

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

To verify installation of your CAN hardware, right-click the CAN card, then select Self-test. If the self-test passes, the card’s icon shows a checkmark. If the self-test fails, the card’s 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 on resolving hardware installation problems.

Configure CAN Ports

The physical ports of each CAN card are listed under the card’s name. 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](image)

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

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

After you have installed your PXI CAN cards and downloaded the NI-CAN software to your LabVIEW RT system, you need to verify the installation. Within the Tools menu in MAX, select NI-CAN»RT Hardware Configuration. The RT Hardware Configuration tool provides features similar to Devices & Interfaces on your 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 your 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 your LabVIEW RT system, so you can execute the same LabVIEW VIs on your LabVIEW RT system as your Windows system.

**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 your application. Launch this tool from the MAX Tools menu.
- **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).
Developing Your Application

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

Choose Your Programming Language

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

**LabVIEW**

The NI-CAN software supports LabVIEW version 6.0 and later. NI-CAN support for LabVIEW RT requires version 6.0.3 or later.

NI-CAN functions and controls are available in the LabVIEW palettes. The top level of the NI-CAN function palette contains the most commonly used functions of the Channel API. Subpalettes contain the Frame API functions and advanced Channel API functions.

The reference for each NI-CAN Channel API function is in Chapter 5, *Channel API for LabVIEW*. The reference for each NI-CAN Frame API function is in Chapter 8, *Frame API for LabVIEW*. To access a function’s reference from within LabVIEW, press <Ctrl-H> to open the help window, click on 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.

In LabVIEW 6.0, the NI-CAN example help is in Help»Examples»Other NI Products»Controller Area Network (CAN).

In LabVIEW 6.1, the NI-CAN example help is in Help»Find Examples»Hardware Input and Output»CAN.
LabWindows/CVI

The NI-CAN software supports LabWindows™/CVI™ version 5.5 and later.

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 6, Channel API for C. The reference for each NI-CAN Frame API function is in Chapter 9, Frame API for C. You can access each function’s reference 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
ican.

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 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 your 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 your code, such as:

#include "nican.h"
For C++ applications (files with .cpp extension), define \_cplusplus before including the header, such as:

```cpp
#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 6, *Channel API for C*. The reference for each NI-CAN Frame API function is in Chapter 9, *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 NI-CAN software supports Borland C/C++ version 5 and later.

The header file and library for Visual C/C++ 6 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 your 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 your code, such as:

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

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

```cpp
#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 6, *Channel API for C*. The reference for each NI-CAN Frame API function is in Chapter 9, *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.

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

If your programming language supports the Microsoft Win32 APIs, you can load pointers to NI-CAN functions in your 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 NI-CAN Channel API’s DLL:

```c
#include <windows.h>
#include "nican.h"
HINSTANCE NicanLib = NULL;
NicanLib = LoadLibrary("nican.dll");
```

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

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

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.

• Your 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 7, 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 7, Using the Frame 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 your applications. This channel configuration describes how the NI-CAN software converts raw data in messages to/from the physical units of each channel.

The NI-CAN software provides various methods to create the channel configuration. The flowchart in Figure 4-1 shows a process you can use to decide the source of your channel configuration. A description of each step in the decision process follows the flowchart.

![Figure 4-1. Decision Process for Choosing Source of Channel Configuration](image-url)
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 your CAN database file contains a large number of channel descriptions (1,000 or more), does your 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.

Import CAN Database into MAX

The benefits of importing channels into MAX include:

• You can initialize the channel name alone within the Channel API. No path to the CAN database file is required.
• You can use the Test Panel in MAX to read and write the channels.

You can download the channel configuration to a LabVIEW RT system using Send to RT System.

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.
Access CAN Database within Application

To access the CAN database within your 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.

If you are using a LabVIEW RT system, you must copy the CAN database file to the hard drive of that system, then access that file path within your application.

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 your 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, your 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.
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.

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 your application, you can deploy your application to a variety of users.

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 4-2 describes the basic programming model for the NI-CAN Channel API. Within your application, you repeat this basic programming model for each task. The diagram is followed by a description of each step in the model.

![Figure 4-2. Basic Programming Model for Channel API](image)
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 interface’s properties 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 your 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 your application, you must call Create Message and Start in sequence. For assistance is deciding whether Create Message is appropriate for your 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, your application must call the Read function to obtain floating-point samples. Your 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 4-3 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.

**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, you can compare CAN and DAQ samples over time.
Figure 4-4 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.

**Read Timestamped**

If the Init Start mode is Timestamped Input, your application must call the Read Timestamped function to obtain floating-point samples. Your 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 & 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. $At$, $Bt$, and $Ct$ represent the times when each message was received.
Write

If the Init Start mode is Output, your application must call the Write function to output floating-point samples. Your 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 message’s data bytes. One sample must be specified for every channel in the Init Start list.

Figure 4-6 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.
**sample rate > 0**

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 message’s data bytes. 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, you can output synchronized CAN and DAQ samples over time.

Figure 4-7 shows an example of Write with sample rate > 0. A, B, C and D represent messages for the initialized channels. \(<\text{delta-t}\>\) represents the time between message transmission as specified by the sample rate.
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 your 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 your application. Ideally, you want your 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. Your 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, your application can pass the resulting list to InitStart.

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.

### 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 your 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 your 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 can also 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.
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 5-1.** Channel API for LabVIEW VIs

<table>
<thead>
<tr>
<th>Function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN Clear</td>
<td>Stop communication for the task and then clear the configuration.</td>
</tr>
<tr>
<td>CAN Clear with NI-DAQ</td>
<td>Stop and clear the CAN task and the NI-DAQ task synchronized with <strong>CAN Sync Start with NI-DAQ.vi.</strong></td>
</tr>
<tr>
<td>CAN Clear Multiple with NI-DAQ</td>
<td>Stop and clear the list of CAN tasks and the list of NI-DAQ tasks synchronized with <strong>CAN Sync Start Multiple with NI-DAQ.vi.</strong></td>
</tr>
<tr>
<td>CAN Connect Terminals</td>
<td>Connect terminals in the CAN hardware.</td>
</tr>
<tr>
<td>CAN Create Message</td>
<td>Create a message configuration and associated channel configurations within your LabVIEW application.</td>
</tr>
<tr>
<td>CAN Disconnect Terminals</td>
<td>Disconnect terminals in the CAN hardware.</td>
</tr>
<tr>
<td>CAN Get Names</td>
<td>Get an array of CAN channel names or message names from MAX or a CAN database file.</td>
</tr>
<tr>
<td>CAN Get Property</td>
<td>Get a property for the task, or a single channel within the task. The poly VI selection determines the property to get.</td>
</tr>
<tr>
<td>CAN Initialize</td>
<td>Initialize a task for the specified channel list.</td>
</tr>
<tr>
<td>CAN Init Start</td>
<td>Initialize a task for the specified channel list, then start communication.</td>
</tr>
<tr>
<td>CAN Read</td>
<td>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.</td>
</tr>
<tr>
<td>CAN Set Property</td>
<td>Set a property for the task, or a single channel within the task. The poly VI selection determines the property to set.</td>
</tr>
<tr>
<td>CAN Start</td>
<td>Start communication for the specified task.</td>
</tr>
<tr>
<td>CAN Stop</td>
<td>Stop communication for the specified task.</td>
</tr>
</tbody>
</table>
### Table 5-1. Channel API for LabVIEW VIs (Continued)

<table>
<thead>
<tr>
<th>Function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAN Sync Start with NI-DAQ</td>
<td>Synchronize and start the specified CAN task and NI-DAQ task.</td>
</tr>
<tr>
<td>CAN Sync Start Multiple with NI-DAQ</td>
<td>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 NI-DAQ hardware products.</td>
</tr>
<tr>
<td>CAN Write</td>
<td>Write samples to a CAN task initialized as Output. (Refer to the <code>mode</code> parameter of CAN Init Start.vi.) Samples are placed into transmitted CAN messages. The poly VI selection determines the data type to write.</td>
</tr>
</tbody>
</table>
Chapter 5  Channel API for LabVIEW — CAN Clear.vi

CAN Clear.vi

Purpose
Stop communication for the task and then clear the configuration.

Format

<table>
<thead>
<tr>
<th>Input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>task reference in</td>
<td>is the task reference from the previous NI-CAN VI. The task reference is</td>
</tr>
<tr>
<td></td>
<td>originally returned from CAN Init Start.vi, CAN Initialize.vi, or CAN</td>
</tr>
<tr>
<td></td>
<td>Create Message.vi, and then wired through subsequent VIs.</td>
</tr>
<tr>
<td>Error in</td>
<td>describes error conditions occurring before the VI executes. If an error</td>
</tr>
<tr>
<td></td>
<td>has already occurred, the VI returns the value of the Error in cluster in</td>
</tr>
<tr>
<td></td>
<td>Error out.</td>
</tr>
<tr>
<td>status</td>
<td>is TRUE if an error occurred. Unlike other VIs, this VI will execute when</td>
</tr>
<tr>
<td></td>
<td>status is TRUE.</td>
</tr>
<tr>
<td>code</td>
<td>is the error code number identifying an error. A value of 0 means success.</td>
</tr>
<tr>
<td></td>
<td>A negative value means error: VI did not execute the intended operation. A</td>
</tr>
<tr>
<td></td>
<td>positive value means warning: VI executed intended operation, but an</td>
</tr>
<tr>
<td></td>
<td>informational warning is returned. For a description of the code, wire the</td>
</tr>
<tr>
<td></td>
<td>error cluster to a LabVIEW error-handling VI, such as the Simple Error</td>
</tr>
<tr>
<td></td>
<td>Handler.</td>
</tr>
<tr>
<td>source</td>
<td>identifies the VI where the error occurred.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error out</td>
<td>describes error conditions. If the Error in cluster indicated an error, the</td>
</tr>
<tr>
<td></td>
<td>Error out cluster contains the same information. Otherwise, Error out</td>
</tr>
<tr>
<td></td>
<td>describes the error status of this VI.</td>
</tr>
<tr>
<td>status</td>
<td>is TRUE if an error occurred.</td>
</tr>
</tbody>
</table>

ni.com
**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 interface’s CAN controller 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 task and start again, use CAN Stop.vi.
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

\[
\begin{array}{c}
\text{task reference in} \\
\text{error in (no error)} \\
\text{NI-DAQ task ID} \\
\text{error out}
\end{array}
\]

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

Both tasks are cleared to their state prior to CAN Sync Start 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 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 your own editing.
### CAN Clear Multiple with NI-DAQ.vi

#### Purpose
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.

#### Format

```
CAN task reference list
error in (no error)
NI-DAQ task ID list
error out
```

#### 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.
- **NI-DAQ task ID list** is the same array of NI-DAQ task IDs 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 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 your own editing.
CAN Connect Terminals.vi

Purpose

Connect terminals in the CAN hardware.

Format

<table>
<thead>
<tr>
<th>task reference in</th>
<th>source terminal</th>
<th>destination terminal</th>
<th>error in (no error)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>task reference out</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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 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.

**10 Hz Resync Event**

**10 Hz Resync Event** 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 Series 1 CAN cards.

10 Hz Resync Event 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.

Start Trigger Event

Start Trigger Event 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 Event 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.

10 Hz Resync

10 Hz Resync 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 pulse 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\texttt{RTSI0} to \texttt{RTSI6} as the \textit{source terminal}, then use NI-DAQ functions to program the MIO card’s Counter 0 to generate a 10 Hz 50 percent duty cycle clock on the RTSI line. For an example, refer to \texttt{CAN Sync Start with NI-DAQ.vi}.

When synchronizing to a CAN card, a typical use of this value is to use \texttt{RTSI0} to \texttt{RTSI6} as the \textit{source terminal}, then route the other CAN card’s 10 Hz Resync Event as the \textit{source terminal} to the same RTSI line.

\textbf{10 Hz Resync} 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 \texttt{interface} input to \texttt{CAN Initialize.vi}.

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

\textbf{Start Trigger}

\textbf{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 \texttt{interface} input to \texttt{CAN Initialize.vi}.

By selecting \texttt{RTSI0} to \texttt{RTSI6} as the \textit{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 MIO card’s \texttt{AI start trigger} to a RTSI line and then routing the same RTSI line with \textbf{Start Trigger} as the \textit{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.

\textbf{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 \textbf{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 the **CAN Sync Start with NI-DAQ.vi** and **CAN Sync Start Multiple with NI-DAQ.vi** example VIs. 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 your application.

For a list of valid source/destination pairs, refer to the following section.

**Valid Combinations of Source/Destination**

Table 5-2 lists all valid combinations of source terminal and destination terminal.

NI-CAN hardware has the following limitations.

- PXI cards do not support RTSI 6.
- 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.

<table>
<thead>
<tr>
<th>Source</th>
<th>RTSI0 to RTSI6</th>
<th>10 Hz Resync</th>
<th>Start Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTSI0 to RTSI6</td>
<td>—</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10 Hz Resync Event</td>
<td>X</td>
<td>—</td>
<td>X</td>
</tr>
<tr>
<td>Start Trigger Event</td>
<td>X</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
CAN Create Message.vi

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

Format

Inputs

- **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.

  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.

- **mode** specifies the I/O mode for the task, as follows:
  
  **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 can also use this input mode to read a single point from the most recent message, such as for control or simulation.
Chapter 5  Channel API for LabVIEW — CAN Create Message.vi

Output

Output channel data to CAN messages for transmit. Use CAN Write.vi to write output samples as single-point, array, or waveform.

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.

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 ID is Extended? property 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 0 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 0 to 64.

byte order

Configures the channel’s byte order in the message.

The value of byte order is an enumeration:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Intel Bytes are in little-endian order, with most-significant first.</td>
</tr>
<tr>
<td>1</td>
<td>Motorola Bytes are in big-endian order, with least-significant first.</td>
</tr>
</tbody>
</table>

data type

Configures the channel’s data type in the message.

The value of Channel Data Type is an enumeration:

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Signed Raw data in the message is a signed integer.</td>
</tr>
<tr>
<td>1</td>
<td>Unsigned Raw data in the message is an unsigned integer.</td>
</tr>
<tr>
<td>2</td>
<td>IEEE Float Raw data in the message is floating-point; no scaling required.</td>
</tr>
</tbody>
</table>
**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 channel’s samples.
**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 your 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 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 your 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.
**Purpose**
Get an array of CAN channel names or message names from MAX or a CAN database file.

**Format**

<table>
<thead>
<tr>
<th>mode</th>
<th>filepath</th>
<th>message name</th>
<th>channel list</th>
<th>error out</th>
</tr>
</thead>
</table>

**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 or FP 1300 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 **filepath** is wired, **CAN Get Names** prepends the file path to the first name in **channel list**, with a double colon separating the file path and channel name.

- 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 can also wire **channel list** to the **property nodes** of a front panel control such as a ring or list box. The user of your 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.

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**

**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**.

**Timeout**

Returns the **Timeout** property, which is used with some input task configurations. For more information, refer to the **Timeout** property in **CAN Set Property**.
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.

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.

Interface

Returns the interface initialized for the task, such as with the CAN Init Start VI.

Mode

Returns the mode initialized for the task, such as with the CAN Init Start VI.

Sample Rate

Returns the sample rate initialized for the task, such as with the CAN Init Start VI.

Message ID

Returns the arbitration ID of the channel’s 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’s 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 Number of Data Bytes

Returns the number of data bytes in the channel’s message. The range is 0 to 8.

The value of this property cannot be changed using CAN Set Property.

Message Name

Returns the name of the channel’s message. The string is no more than 80 characters in length.

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 Number of Bits

Returns the number of bits in the message. The range is 0 to 64.

The value of this property cannot be changed using CAN Set Property.

Channel Byte Order

Returns the channel’s byte order 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 channel’s data type 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.
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 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 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 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 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 or Can Create Message.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 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 channel’s samples.

The value of this property cannot be changed using CAN Set Property.

Hardware Serial Number

Returns the hardware serial number for the NI-CAN hardware that contains Interface.

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 Transceiver

Returns the hardware form factor for the NI-CAN hardware that contains Interface.
The value of **Hardware Transceiver** is an enumeration:

0   HS
1   LS

This property is not supported on the PCMCIA form factor.

**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 Update**

Returns the update version of the NI-CAN software, such as the 5 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
1   Beta
1   Release

Versions of NI-CAN in hardware kits or on ni.com will always be Release.

**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.
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 8000XXYY 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.
**CAN Initialize.vi**

**Purpose**
Initialize a task for the specified channel list.

**Format**

```
channel list
interface
mode
sample rate
error in (no error)
```

- **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 65535, which means to use the default interface as defined in the MAX configuration. If the default interface in MAX is All, or if one or more channels in channel list specifies a filepath, 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.

- **mode** specifies the I/O mode for the task:
  
  **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 can also 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.

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 Timestamped Input, sample rate 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

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 task’s properties, 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.
Chapter 5  Channel API for LabVIEW — CAN Init Start.vi

CAN Init Start.vi

Purpose
Initialize a task for the specified channel list, then start communication.

Format

Inputs

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.

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.

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 array 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).
**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**).

The following examples demonstrate the channel list syntax:

1. List of channels from MAX, each channel name unique across all messages.
   - myChan1
   - myChan2
   - myChan3

2. List of channels from a CANdb file, each channel name unique across all messages.
   - C:\MyCandbFiles\MyChannels.DBC::myChan1
   - myChan2
   - myChan3

3. 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

4. List of two channels from a CANdb file, then two channels from MAX.
   - C:\MyCandbFiles\MoreChannels.DBC::myChan1
   - myChan2
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 65535, which means to use the default interface as defined in the MAX configuration. If the default interface in MAX is All, or if one or more channels in channel list specifies a filepath, 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.

mode specifies the I/O mode for the task, as follows:

**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 can also 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.

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 Timestamped Input**, sample rate 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**

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, 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.
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 an overview of CAN Read, refer to the Read and Read Timestamped sections of Chapter 4, 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 word *Dbl* indicates double-precision (64-bit) floating point. The word *Wfm* indicates the waveform data type. The words *1D* and *2D* indicate one and two-dimensional arrays, respectively. The words *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 3FF60009 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).

The Timeout property is not used with this poly VI type.

**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 3FF60009 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 each channel’s entry contains a single sample.

The `Timeout` property 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.

**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.

If the initialized `sample rate` is zero, this poly VI returns an error. If your 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 3FF60009 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`.

The `Timeout` property is not used with this poly VI type.

**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.

If the initialized sample rate is zero, this poly VI returns an error. If your intent is simply to read the most recent samples for a task, use the Multi-Chan Single-Samp 1D Db1 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 3FF60009 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.

The Timeout property 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.

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.

The waveform’s start time indicates the time of the first CAN sample in the array. The waveform’s delta time 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 your 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 3FF60009 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.

The Timeout property is not used with this poly VI type.

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 waveform’s 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.

Each waveform’s start time indicates the time of the first CAN sample in the array. The waveform’s delta time 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 your 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 3FF60009 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.

The Timeout property 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.

**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 seconds.

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.

Format

```
channel name

+-------------------+-------------------+-------------------+
| task reference in | task reference out |
| value             | error in (no error) |

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 can also change a property by calling CAN Stop.vi, followed by CAN Set Property, and then CAN Start again.
Poly VI Types

**Timeout**

Sets a time in milliseconds to wait for samples. The default value is zero.

Use of the **Timeout** property depends on the initialized **mode** of the task:

- The timeout value does *not* apply to an **Output** task.
- The timeout value does *not* apply to an **Input** task. 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.
- The timeout value *does* apply to a **Timestamped Input** task. 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.

**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 final sample’s data 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.vi**.
If there is significant delay between subsequent calls to CAN Write, this value means that periodic messages cease between CAN Write calls, and the final sample’s data 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, but it can be changed using CAN Set Property.

**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: 83333, 100000, 125000, 200000, 250000, 400000, 500000, 800000, and 1000000.

You can specify advanced baud rates as 8000XXYY 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, but it can be changed using CAN Set Property.
CAN Start.vi

Purpose
Start communication for the specified task.

Format

<table>
<thead>
<tr>
<th>task reference</th>
<th>task reference out</th>
</tr>
</thead>
<tbody>
<tr>
<td>error in (no error)</td>
<td>error out</td>
</tr>
</tbody>
</table>

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 task’s configuration with **CAN Set Property.vi** or **CAN Connect Terminals.vi**.
CAN Stop.vi

Purpose
Stop communication for the specified task.

Format

<table>
<thead>
<tr>
<th>task reference in</th>
<th>task reference out</th>
</tr>
</thead>
<tbody>
<tr>
<td>error in (no error)</td>
<td>error out</td>
</tr>
</tbody>
</table>

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 task’s configuration, 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 your 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

```
<table>
<thead>
<tr>
<th>Inputs</th>
<th></th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>task reference in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RTSI terminal</td>
<td>task reference out</td>
</tr>
<tr>
<td></td>
<td>error in (no error)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NI-DAQ task ID</td>
<td>error out</td>
</tr>
</tbody>
</table>
```

**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** on your behalf, 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.
Chapter 5  Channel API for LabVIEW — CAN Sync Start with NI-DAQ.vi

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 your 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 and/or multiple NI-DAQ cards, 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 your own editing.
Chapter 5   Channel API for LabVIEW — CAN Sync Start with NI-DAQ.vi

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 Multiple with NI-DAQ.vi

Purpose
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 NI-DAQ hardware products.

Format

<table>
<thead>
<tr>
<th>CAN task reference list</th>
<th>RTSI terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>error in (no error)</td>
<td>error out</td>
</tr>
<tr>
<td>NI-DAQ task ID list</td>
<td></td>
</tr>
</tbody>
</table>

Inputs

**CAN task reference list** 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 list** is an array of NI-DAQ task IDs. Each task ID is originally returned from an NI-DAQ configuration VI, such as AI Config or AO Config.

This VI assumes that each task in **NI-DAQ task ID list** is on a different NI-DAQ card.

When this VI returns, do not call an NI-DAQ start VI for each task. The LabVIEW diagram of this VI starts each task in **NI-DAQ task ID list** on your behalf, 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

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 your 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 your own editing.
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 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 an overview of CAN Write, refer to the Write section of Chapter 4, Using the Channel API.

Format

<table>
<thead>
<tr>
<th>Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>task reference in</td>
</tr>
<tr>
<td>number of samples to write</td>
</tr>
<tr>
<td>samples</td>
</tr>
<tr>
<td>error in (no error)</td>
</tr>
<tr>
<td>task reference out</td>
</tr>
<tr>
<td>error out</td>
</tr>
</tbody>
</table>

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.

- The third term indicates the data type used for each sample. The word Dbl indicates double-precision (64-bit) floating point. The word Wfm indicates the waveform data type. The words 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.

 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 Output task.
 - You can write more than one message in a single Output task.
 - You can write a subset of channels for a message in a single Output 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 Output 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.

 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 Output task.
- You can write more than one message in a single Output task.
- You can write a subset of channels for a message in a single Output 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 Output 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.

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.

NI-CAN uses a queue to store pending messages prior to transmission. CAN Write returns after the final message is written to this queue. This provides some time for you to call CAN Write again to provide a continual stream of samples. In LabVIEW RT, because the time between successive CAN Write calls is deterministic, you can ensure unique sample values in each message.

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 Output task.
- You can write more than one message in a single Output task.
- You can write a subset of channels for a message in a single Output 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 Output 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.

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 each channel’s array, 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 each channel’s array. After the final sample in each channel’s 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, the task transmits associated messages immediately for each entry in each channel’s 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.

NI-CAN uses a queue to store pending messages prior to transmission. CAN Write returns after the final message is written to this queue. This provides some time for you to call CAN Write again to provide a continual stream of samples. In LabVIEW RT, since the time between successive CAN Write calls is deterministic, you can ensure unique sample values in each message.

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 Output task.
- You can write more than one message in a single Output task.
- You can write a subset of channels for a message in a single Output 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 Output 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.
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>
<thead>
<tr>
<th>Data Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>i8</td>
<td>8-bit signed integer</td>
</tr>
<tr>
<td>i16</td>
<td>16-bit signed integer</td>
</tr>
<tr>
<td>i32</td>
<td>32-bit signed integer</td>
</tr>
<tr>
<td>u8</td>
<td>8-bit unsigned integer</td>
</tr>
<tr>
<td>u16</td>
<td>16-bit unsigned integer</td>
</tr>
<tr>
<td>u32</td>
<td>32-bit unsigned integer</td>
</tr>
<tr>
<td>f32</td>
<td>32-bit floating point number</td>
</tr>
<tr>
<td>f64</td>
<td>64-bit floating point number</td>
</tr>
<tr>
<td>str</td>
<td>ASCII string represented as an array of characters terminated by null character (\0). This type is used with output strings.</td>
</tr>
<tr>
<td>cstr</td>
<td>ASCII string represented as an array of characters terminated by null character (\0). This type is used with input strings.</td>
</tr>
<tr>
<td>nctTypeTaskRef</td>
<td>Reference to an initialized task. Refer to nctInitStart for more information.</td>
</tr>
<tr>
<td>nctTypeStatus</td>
<td>Status returned from NI-CAN functions. Refer to ncStatusToString in the Frame API for more information.</td>
</tr>
<tr>
<td>nctTypeTimestamp</td>
<td>Timestamp. Refer to nctReadTimestamped for more information.</td>
</tr>
</tbody>
</table>
# List of Functions

The following table contains an alphabetical list of the NI-CAN Channel API for C functions.

<table>
<thead>
<tr>
<th>Function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>nctClear</td>
<td>Stop communication for the task and then clear the configuration.</td>
</tr>
<tr>
<td>nctConnectTerminals</td>
<td>Connect terminals in the CAN hardware.</td>
</tr>
<tr>
<td>nctCreateMessage</td>
<td>Create a message configuration and associated channel configurations.</td>
</tr>
<tr>
<td>nctDisconnectTerminals</td>
<td>Disconnect terminals in the CAN hardware.</td>
</tr>
<tr>
<td>nctGetNames</td>
<td>Get an array of CAN channel names or message names from MAX or a CAN database file.</td>
</tr>
<tr>
<td>nctGetProperty</td>
<td>Get a property for the task, or a single channel within the task.</td>
</tr>
<tr>
<td>nctInitialize</td>
<td>Initialize a task for the specified channel list.</td>
</tr>
<tr>
<td>nctInitStart</td>
<td>Initialize a task for the specified channel list, then start communication.</td>
</tr>
<tr>
<td>nctRead</td>
<td>Read samples from a CAN task initialized with Mode of nctModeInput. Samples are obtained from received CAN messages.</td>
</tr>
<tr>
<td>nctReadTimestamped</td>
<td>Read samples from a CAN task initialized with Mode of nctModeTimestampedInput.</td>
</tr>
<tr>
<td>nctSetProperty</td>
<td>Set a property for the task, or a single channel within the task.</td>
</tr>
<tr>
<td>nctStart</td>
<td>Start communication for the specified task.</td>
</tr>
<tr>
<td>nctStop</td>
<td>Stop communication for the specified task.</td>
</tr>
<tr>
<td>nctWrite</td>
<td>Write samples to a CAN task initialized as NctModeOutput. Samples are placed into transmitted CAN messages.</td>
</tr>
</tbody>
</table>
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 your 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 interface’s CAN controller 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 task and start again, use nctStop.
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.

nctSrcTerm10HzResyncEvent
   nctSrcTerm10HzResyncEvent 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 RTSI0-6 as the DestinationTerminal, you route the 10 Hz clock to synchronize with other 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.
nctSrcTerm10HzResyncEvent 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.

nctSrcTermStartTrigEvent

nctSrcTermStartTrigEvent 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 nctDestTermStartTrig destination, the start trigger occurs when communication begins on the interface.

By selecting RTSI0-6 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 nctSrcTermStartTrigEvent as the SourceTerminal on one CAN card, and then routing nctDestTermStartTrig 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.

nctDestTerm10HzResync

nctDestTerm10HzResync 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 pulse 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 RTSI0-6 as the SourceTerminal, then use NI-DAQ functions to program the MIO card’s Counter 0 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 RTSI0-6 as the SourceTerminal, then route the other CAN card’s nctSrcTerm10HzResyncEvent as the SourceTerminal to the same RTSI line.

nctDestTerm10HzResync 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.

nctDestTermStartTrig

nctDestTermStartTrig 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.

By selecting RTSI0-6 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 MIO card’s AI start trigger to a RTSI line and then routing the same RTSI line with nctDestTermStartTrig 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 your 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 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 terminals remain connected after the tasks are cleared, so you must disconnect NI-DAQ terminals manually at the end of your application.

For a list of valid source/destination pairs, refer to the following section.

Valid Combinations of Source/Destination

Table 6-3 lists all valid combinations of SourceTerminal and DestinationTerminal.

NI-CAN hardware have the following limitations.

- PXI cards do not support RTSI 6.
- 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.

Table 6-3. Valid Combinations of Source/Destination

<table>
<thead>
<tr>
<th>Source</th>
<th>RTSI0 to RTSI6</th>
<th>10 Hz Resync</th>
<th>Start Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTSI0 to RTSI6</td>
<td>—</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>10 Hz Resync Event</td>
<td>X</td>
<td>—</td>
<td>X</td>
</tr>
<tr>
<td>Start Trigger Event</td>
<td>X</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
nctCreateMessage

Purpose
Create a message configuration and associated channel configurations within your application.

Format
```
nctTypeStatus nctCreateMessage(  
nctTypeMessageConfig MessageConfig,  
u32 NumberOfChannels,  
nctTypeChannelConfig * ChannelConfigList,  
u32 Interface,  
u32 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` property 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:

<table>
<thead>
<tr>
<th>Type</th>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>u32</td>
<td>StartBit</td>
<td>Configures the starting bit position in the message. The range is 0 (lowest bit in first byte), to 63 (highest bit in last byte).</td>
</tr>
<tr>
<td>u32</td>
<td>NumBits</td>
<td>Configures the number of bits in the message. The range is 0 to 64.</td>
</tr>
<tr>
<td>u32</td>
<td>DataType</td>
<td>Configures the channel’s data type in the message. Values are nctDataSigned, nctDataUnsigned, and nctDataFloat.</td>
</tr>
<tr>
<td>u32</td>
<td>ByteOrder</td>
<td>Configures the channel’s byte order in the message. Values are nctOrderIntel (little-endian), and nctOrderMotorola (big-endian).</td>
</tr>
<tr>
<td>f64</td>
<td>ScalingFactor</td>
<td>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.</td>
</tr>
<tr>
<td>f64</td>
<td>ScalingOffset</td>
<td>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.</td>
</tr>
</tbody>
</table>
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 your 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 your 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 channel's samples.

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`.

**Mode**

Specifies the I/O mode for the task:

- **nctModeInput**
  - Input channel data from received CAN messages. Use the `nctRead` function 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 can also 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.

- **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 NctModeTimestampedInput, SampleRate is ignored.

**Outputs**

<table>
<thead>
<tr>
<th>TaskRef</th>
</tr>
</thead>
</table>

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 your 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 your 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.
ntcDisconnectTerminals

Purpose
Disconnect terminals in the CAN hardware.

Format
ntcDisconnectTerminals(
    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 your attention.

Use the ntcStatusToString function of the Frame API to obtain a descriptive string for the return value. The ntcStatusToString 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 your 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 or FP1300 Config 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 FilePath is wired, nctGetNames prepends the file path to the first name in ChannelList, with a double colon separating the file path and channel name.
- 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 can also use ChannelList with a user-interface control such as a ring or list box. The user of your 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 your 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.
**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`.
Outpus

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 your 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**
```c
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 property’s description.
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 your 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 nctPropNumChannels

Returns the number of channels initialized in channel list. This is the number of array entries required when using nctRead or nctWrite.

f64 nctPropTimeout

Returns the nctPropTimeout property, which is used with some input task configurations. For more information, refer to the nctPropTimeout property in nctSetProperty.

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.

u32 nctPropBehaviorAfterFinalOut

Returns the nctPropBehaviorAfterFinalOut property, which is used with some output task configurations. For more information, refer to the nctPropBehaviorAfterFinalOut property in nctSetProperty.

u32 nctPropInterface

Returns the Interface initialized for the task, such as with the nctInitStart function.
u32 nctPropMode
Returns the Mode initialized for the task, such as with the nctInitStart function.

f64 nctPropSampleRate
Returns the SampleRate initialized for the task, such as with the nctInitStart function.

u32 nctPropMsgArbitrationId
Returns the arbitration ID of the channel's 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 nctPropMsgIsExtended
Returns a Boolean value that indicates whether the arbitration ID of the channel’s 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.

u32 nctPropMsgByteLength
Returns the number of data bytes in the channel’s 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.

str nctPropMsgName
Returns the name of the channel’s 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 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.

u32 nctPropChanNumBits
Returns the number of bits in the message. 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.

u32 nctPropChanByteOrder
Returns the channel’s byte order 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 channel’s data type 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 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.

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 your 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.
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 your 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`.

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`.

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 channel’s samples.

The value of this property is originally set within MAX or the CAN database and cannot be changed using `nctSetProperty`.

Returns the hardware serial number for the NI-CAN hardware that contains Interface.

Returns the hardware form factor for the NI-CAN hardware that contains Interface.
Values are `nctHwFormFactorPCI`, `nctHwFormFactorPXI`, `nctHwFormFactorPCMCIA`, and `nctHwFormFactorAT`.

Returns the hardware form factor for the NI-CAN hardware that contains Interface.
Values are `nctHwTransceiverHS`, and `nctHwTransceiverLS`.
This property is not supported on the PCMCIA form factor.

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   nctPropVersionUpdate
Returns the update version of the NI-CAN software, such as the 5 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   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   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 8000XYYY 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.
nctInitialize

**Purpose**
Initialize a task for the specified channel list.

**Format**
```
nctTypeStatus nctInitialize(
    cstr ChannelList,
    u32 Interface,
    u32 BaudRate,
    u32 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 65535 to Interface, this function uses the default interface as defined in the MAX configuration. 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.
- **Mode**: Specifies the I/O mode for the task:
  - **nctModeInput**: Input channel data from received CAN messages. Use the nctRead function 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 can also 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.

`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.

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.
Chapter 6  Channel API for C — nctInitialize

**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 your attention.

The nctStatusToString function of the Frame API to obtain a descriptive string for the return value. The nctStatusToString 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 task’s properties, 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

```c
nctTypeStatus nctInitStart(
    cstr ChannelList,
    u32 Interface,
    u32 BaudRate,
    u32 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.
  
  You can initialize the same `ChannelList` with different `Interface`, `Mode`, or `SampleRate`, because each task reference is unique.
  
  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).
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:\MyCan\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:\MyCan\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 65535 to Interface, this function uses the default interface as defined in the MAX configuration.

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.

**Mode**

Specifies the I/O mode for the task:

- **nctModeInput**
  
  Input channel data from received CAN messages. Use the \texttt{nctRead} function 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 can also 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 \texttt{ChannelList} can be contained in multiple messages.

- **nctModeOutput**

  Output channel data to CAN messages for transmit. Use the \texttt{nctWrite} function to write output samples as single-point, array, or waveform.

  For this mode, there are restrictions on using channels in \texttt{ChannelList} that are contained in multiple messages. Refer to \texttt{nctWrite} for more information.

- **nctModeTimestampedInput**

  Input channel data from received CAN messages. Use the \texttt{nctRead} function to obtain input samples as an array of sample/timestamp pairs (refer to \texttt{nctReadTimestamped}).

  For this mode, the channels in \texttt{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.

**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 your 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 or NI-DAQ cards, use nctInitialize, then nctConnectTerminals to synchronize, the nctStart to start communication.

- If you need to create channel configurations entirely within your application, without using MAX or a CAN database file, use nctCreateMessage, then nctStart. The nctInitStart function accepts only channel names defined in MAX or a CAN database file.
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 4, 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 **SampleRate** is zero, you must pass **NumberOfSamplesToRead** no greater than 1. SampleRate of zero means nctRead 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 **SampleRate** 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 your 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 your 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 `SampleRate` is greater than zero, the `DeltaTime` is determined by the sample timing.

If the initialized `SampleRate` 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`. Each channel’s array 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:

```c
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 your 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.

If the initialized SampleRate is zero, nctRead returns a single sample from the most recent message(s) received. To 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.

The nctPropTimeout property is not used with nctRead.
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 4, 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.

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. Each channel’s array 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:
```
f64 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 your 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 your 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. Each channel’s array 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 your 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 SampleRate 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 property’s description.

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 your 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 can also change a property by calling `nctStop`, followed by `nctSetProperty`, and then `nctStart` again.

Properties

```c
f64 nctPropTimeout
```
Sets a time in milliseconds to wait for samples. The default value is zero.
Usage of the `nctPropTimeout` property depends on the initialized `Mode` of the task:

- The timeout value does not apply to an `NctModeOutput` task.
- The timeout value does not apply to an `NctModeInput` task. 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.
- The timeout value does apply to a `NctModeTimestampedInput` task. 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.

```c
u32 nctPropBehaviorAfterFinalOut
```
The `nctPropBehaviorAfterFinalOut` property applies only to tasks initialized with `Mode` of `NctModeOutput`, and `SampleRate` greater than zero. The value specifies the behavior to perform after the final periodic sample is transmitted.
nctPropBehaviorAfterFinalOut 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 final sample’s data are repeated on the network.
  `nctOutBehavRepeatFinalSample` is the default value of the `nctPropBehaviorAfterFinalOut` 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 final sample’s data 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 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: 83333, 100000, 125000, 200000, 250000, 400000, 500000, 800000, and 1000000.
You can specify advanced baud rates as 8000XXYY 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`.
ncStart

Purpose
Start communication for the specified task.

Format
\[
\text{nctTypeStatus} \quad \text{ncStart}(\text{nctTypeTaskRef} \quad \text{TaskRef});
\]

Inputs
\begin{itemize}
\item TaskRef
\end{itemize}
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 your 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 task’s configuration 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 your 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 task's configuration, 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 your 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 4, *Using the Channel API*.

**Format**
```
nctypeStatus 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. Each channel’s array 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 your 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 `SampleRate` 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 each channel’s array, 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 each channel’s array. After the final sample in each channel’s array has been transmitted, subsequent behavior is determined by the `nctPropBehaviorAfterFinalOut` property. The default `nctPropBehaviorAfterFinalOut` 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 each channel’s array, 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 `nctPropBehaviorAfterFinalOut` property.

NI-CAN uses a queue to store pending messages prior to transmission. `nctWrite` returns after the final message is written to this queue. This provides some time for you to call `nctWrite` again to provide a continual stream of samples.

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`. 
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 your 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 can also 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. Your 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 CAN Object’s read queue. 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.

### Programming Model

The following steps demonstrate how to use the Frame API functions in your application. The steps are shown in Figure 7-1 in flowchart form.
Figure 7-1. Programming Model for NI-CAN Frame API
Chapter 7   Using the Frame API

Step 1. Configure Objects

Prior to opening the objects used in your application, you must configure the objects with their initial attribute settings. Each object is configured within your 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 your 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 your objects to transfer data.

If you configured your 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 your 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.

If you want to reset the CAN hardware completely to clear a pending Error Passive state, you can use the CAN Network Interface Object to call the `ncAction` function with the Opcode parameter set to `NC_OP_RESET`. This reset must be done prior to starting communication.

Step 4. Communicate Using Objects

After you open your 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 object’s read queue.

When receiving data from the device, if your 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 your application.
Additional Programming Topics

The following sections outline changes to the Frame API as compared to NI-CAN 1.6.

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 pulses. 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 pulses. This allows you to transmit based on a functional unit in another product, such as a counter in an NI-DAQ E-series MIO product.

For more information on RTSI configuration, refer to the `ncConfig` 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.
- NI-CAN hardware uses the Intel 82527 CAN controller, which cannot receive arbitrary remote frames. The CAN Network Interface Object cannot receive 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 7-2 shows the steps performed by the Frame API when a CAN frame is received.
The decisions in Figure 7-2 are generally performed by the on-board 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 \texttt{NC\_CAN\_ARBID\_NONE} (hex \texttt{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 your application must wait for a specific state before proceeding. For example, if you call ncWrite to write a frame, and your 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 your 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. Your application can then perform any tasks desired, and process the CAN data only as needed.

Use the ncCreateOccurrence function in LabVIEW when your 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.
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.

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<tr>
<th>Function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
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<td>ncAction.vi</td>
<td>Perform an action on an object.</td>
</tr>
<tr>
<td>ncCloseObject.vi</td>
<td>Close an object.</td>
</tr>
<tr>
<td>ncConfigCANNet.vi</td>
<td>Configure a CAN Network Interface Object before opening it.</td>
</tr>
<tr>
<td>ncConfigCANNetLS.vi</td>
<td>Configure a CAN Network Interface Object with logging of low-speed faults enabled.</td>
</tr>
<tr>
<td>ncConfigCANNetLS-RTSI.v</td>
<td>Configure a CAN Network Interface Object with RTSI features, and with logging of low-speed faults enabled.</td>
</tr>
<tr>
<td>ncConfigCANNetRTSI.v</td>
<td>Configure a CAN Network Interface Object with RTSI features.</td>
</tr>
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<td>ncConfigCANObj.vi</td>
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<td>ncConfigCANObjRTSI.v</td>
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<td>ncCreateOccur.vi</td>
<td>Create a LabVIEW occurrence for an object.</td>
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<td>Get NI-CAN hardware information.</td>
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<td>Read single frame from a CAN Object.</td>
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<tr>
<td>ncReset.vi</td>
<td>Reset the CAN card.</td>
</tr>
<tr>
<td>ncSetAttr.vi</td>
<td>Set the value of an object attribute.</td>
</tr>
</tbody>
</table>
### Table 8-1. Frame API for LabVIEW VIs (Continued)

<table>
<thead>
<tr>
<th>Function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ncWait.vi</td>
<td>Wait for one or more states to occur in an object.</td>
</tr>
<tr>
<td>ncWriteNet.vi</td>
<td>Write the data value of an object.</td>
</tr>
<tr>
<td>ncWriteObj.vi</td>
<td>Write a single frame to a CAN Object.</td>
</tr>
</tbody>
</table>
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 the ncOpenObject VI.

Opcode is the operation code indicating which action to perform. Refer to Tables 8-2 and 8-3.

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** 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 **ncOpenObject** and **ncRead** for the most frequently used and/or complex actions. **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 8-2 describes the actions supported by the CAN Network Interface Object.
Table 8-2. Actions Supported by the CAN Network Interface Object

<table>
<thead>
<tr>
<th>Opcode</th>
<th>Param</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start CAN Network Interface</td>
<td>N/A (ignored)</td>
<td>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.</td>
</tr>
<tr>
<td>Stop CAN Network Interface</td>
<td>N/A (ignored)</td>
<td>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. 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.</td>
</tr>
<tr>
<td>Reset CAN Network Interface</td>
<td>N/A (ignored)</td>
<td>Resets network interface. Stops network interface, then resets the CAN controller to clear the CAN error counters (clear error passive state). Resetting includes clearing all entries from read and write queues. The reset action is propagated up to all open higher-level CAN Objects.</td>
</tr>
<tr>
<td>Output on RTSI line</td>
<td>N/A (ignored)</td>
<td>Output a pulse or toggle on the RTSI line depending upon the RTSI Behavior attribute.</td>
</tr>
</tbody>
</table>

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 8-3 describes the actions supported by the CAN Object.

Table 8-3. Actions Supported by the CAN Object

<table>
<thead>
<tr>
<th>Opcode</th>
<th>Param</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output on RTSI line</td>
<td>N/A (ignored)</td>
<td>Output a pulse or toggle on the RTSI line depending upon the RTSI Behavior attribute.</td>
</tr>
</tbody>
</table>
ncCloseObject.vi

Purpose
Close an object.

Format

```
ObjHandle in   Error in
    Close
    Error out
```

Input
- **ObjHandle in** is the object handle from the previous NI-CAN VI. The handle originates from the **ncOpenObject** 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.
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**

**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 RTSI configuration for the object, and your 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**

```
ObjName  -- Config
CAN Network Interface Config
    Error in  --- Config
    Error out
```

**Input**

- **ObjName** is the name of the CAN Network Interface Object to configure. This name uses the syntax “CANx”, 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.

- **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 your 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 `ncOpenObject`. The default is TRUE, which starts communication when `ncOpenObject` is called. If you set **Start On Open** to FALSE, you can call `ncSetAttribute` after opening the interface, then `ncAction` to start communication. The `ncSetAttribute` VI can be used to set attributes that are not contained within the `ncConfigCANNet` VI.

  - **Baud Rate** is the baud rate to use for communication. Basic baud rates are supported, including 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 the ncConfigCANNet VI.

**Read Queue Length** is the maximum number of unread frames for the read queue of the CAN Network Interface Object. A typical value is 100. For more information, refer to ncReadNetMult.

**Write Queue Length** is the maximum number of frames for the write queue of the CAN Network Interface Object awaiting transmission. A typical value is 10. For more information, refer to ncWriteNet.

**Standard Comparator** is the CAN arbitration ID for the standard (11-bit) frame comparator. For information on how this attribute is used to filter standard 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 intend to open the Network Interface, most applications can set this attribute and the **Standard Comparator** to 0 in order to receive all standard frames.

If you set the **Standard Comparator** to CFFFFFFF hex, this attribute is ignored, because all standard frame reception is disabled for the Network Interface.

**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 intend to open the Network Interface, most applications can set this attribute and the **Extended Comparator** to 0 in order to receive all extended frames.

If you set the **Extended Comparator** to CFFFFFFF hex, this attribute is ignored, because all extended frame reception is disabled for the Network Interface.

**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 the ncConfigCANNetRTSI VI.

If you need to log low-speed (LS) fault indications to the Network Interface read queue, refer to the ncConfigCANNetLS VI or ncConfigCANNetLS-RTSI VI. These VIs are not required if you simply need to communicate on a LS CAN interface.

The first NI-CAN VI in your application will normally be ncConfigCANNet.
ncConfigCANNetLS.vi

Purpose
Configure a CAN Network Interface Object with logging of low-speed faults enabled.

Format

<table>
<thead>
<tr>
<th>ObjName</th>
<th>Error in</th>
<th>Error out</th>
</tr>
</thead>
</table>

ObjName is the name of the CAN Network Interface Object to configure. This name uses the syntax “CANx”, 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 - LS provides the core configuration attributes of the CAN Network Interface Object, plus the low-speed logging attribute. This cluster uses the typedef ncNetAttrLS.ctl. You can wire in the cluster by first placing it on your 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 ncOpenObject. The default is TRUE, which starts communication when ncOpenObject is called. If you set Start On Open to FALSE, you can call ncSetAttribute after opening the interface, then ncAction to start communication. The ncSetAttribute VI can be used to set attributes that are not contained within the ncConfigCANNet VI.

Baud Rate is the baud rate to use for communication. Basic baud rates are supported, including 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 \( z \) 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 the **ncConfigCANNet** VI.

**Read Queue Length** is the maximum number of unread frames for the read queue of the CAN Network Interface Object. A typical value is 100. For more information, refer to \texttt{ncReadNetMult}.

**Write Queue Length** is the maximum number of frames for the write queue of the CAN Network Interface Object awaiting transmission. A typical value is 10. For more information, refer to \texttt{ncWriteNet}.

**Standard Comparator** is the CAN arbitration ID for the standard (11-bit) frame comparator. For information on how this attribute is used to filter standard 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 upper three bits of the 11-bit standard ID.

If you intend to open the Network Interface, most applications can set this attribute and the **Standard Comparator** to 0 in order to receive all standard frames.
If you set the **Standard Comparator** to CFFFFFFF hex, this attribute is ignored, because all standard frame reception is disabled for the Network Interface.

**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 upper five bits of the 29-bit extended ID.

If you intend to open the Network Interface, most applications can set this attribute and the **Extended Comparator** to 0 in order to receive all extended frames.

If you set the **Extended Comparator** to CFFFFFFF hex, this attribute is ignored, because all extended frame reception is disabled for the Network Interface.

**Log Comm Warnings** specifies whether to log communication warnings (including LS faults) to the Network Interface read queue.

When set to FALSE (default), the Network Interface reports CAN communication warnings (including LS faults) in **Error out** of the
read VIs. For more information, refer to \texttt{ncReadNetMult}. Using FALSE is equivalent to calling \texttt{ncConfigCANNet}.

When set to TRUE, the Network Interface reports CAN communication warnings (including LS faults) by storing a special frame in the read queue. The communication warnings are not reported in \texttt{Error out}. For more information on communication warnings and errors, refer to \texttt{ncReadNetMult}. The special communication warning frame uses the following format:

\begin{itemize}
\item Arbitration ID: Error/warning ID (refer to \texttt{ncReadNetMult})
\item Timestamp: Time when error/warning occurred
\item IsRemote: 2
\item DataLength: 0
\item Data: N/A (ignore)
\end{itemize}

When calling \texttt{ncReadNet} or \texttt{ncReadNetMult} to read frames from the Network Interface, you typically use the IsRemote field to differentiate communications warnings from CAN frames. Refer to \texttt{ncReadNetMult} for more information.

\textbf{Error in} describes error conditions occurring before the VI executes. If an error has already occurred, the VI returns the value of the \texttt{Error in} cluster in \texttt{Error out}.

\begin{itemize}
\item \texttt{status} is TRUE if an error occurred. If \texttt{status} is TRUE, the VI does not perform any operations.
\item \texttt{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 \texttt{code}, wire the error cluster to a LabVIEW error-handling VI, such as the Simple Error Handler.
\item \texttt{source} identifies the VI where the error occurred.
\end{itemize}
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

This VI is not required if you simply need to communicate on a LS CAN interface. Use **ncConfigCANNet** or **ncConfigCANNetRTSI** instead.

If you intend to use RTSI features to synchronize the Network Interface with other National Instruments cards, refer to the **ncConfigCANNetRTSI-LS VI**.
ncConfigCANNetLS-RTSI.vi

Purpose
Configure a CAN Network Interface Object with RTSI features, and with logging of low-speed faults enabled.

Format

<table>
<thead>
<tr>
<th>Input</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ObjName</strong></td>
</tr>
<tr>
<td><strong>Error in</strong></td>
</tr>
</tbody>
</table>

**ObjName** is the name of the CAN Network Interface Object to configure. This name uses the syntax “CANx”, 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 - LS** provides the core configuration attributes of the CAN Network Interface Object, plus the low-speed logging attribute. This cluster uses the typedef **ncNetAttrLS.ctl**. You can wire in the cluster by first placing it on your 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 **ncConfigCANNetLS.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 your 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 **ncConfigCANNetRTSI.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

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 not required if you simply need to communicate on a LS CAN interface. (Use ncConfigCANNetRTSI instead.)

If you are not using RTSI features to synchronize the Network Interface with other National Instruments cards, refer to the ncConfigCANNetLS VI.
Chapter 8  Frame API for LabVIEW — ncConfigCANNetRTSI.vi

ncConfigCANNetRTSI.vi

Purpose

Configure a CAN Network Interface Object with RTSI features.

Format

```
ObjName

CAN Object Config

Error in

Error out
```

Input

**ObjName** is the name of the CAN Network Interface Object to configure. This name uses the syntax “CANx”, 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 your 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 your 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`. 
On RTSI Input - Transmit CAN Frame

The Network Interface will transmit a frame from its write queue when the RTSI input pulses. To begin transmission, at least one data frame must be written using ncWriteNet. 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.

On RTSI Input - Timestamp RTSI event

When the RTSI input pulses, 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 pulsed
- IsRemote: 3
- DataLength: RTSI signal detected (RTSI Signal)
- Data: N/A (ignore)

When calling ncReadNet or ncReadNetMult to read frames from the Network Interface, you typically use the IsRemote field to differentiate RTSI timestamps from CAN frames. Refer to ncReadNetMult 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.

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 call

The Network Interface will output the RTSI signal whenever the ncAction VI is called with Opcode Output on RTSI line. This RTSI mode can be used to manually toggle/pulse a RTSI output within your application.

RTSI Signal defines the RTSI signal associated with the RTSI Mode. Valid values are 0 to 7, corresponding to RTSI 0 to RTSI 7 on other National Instruments cards.

Note For CAN cards with high-speed (HS) ports only, four (4) RTSI signals are available for input, and four (4) RTSI signals are available for output. Since each RTSI signal is assigned to a Network Interface or CAN Object, this means that at most four NI-CAN objects can use RTSI inputs (or outputs). For example, if you configure five (5) RTSI signals for input, NI-CAN returns an error, regardless of which RTSI Signal numbers were used for each.

Note For CAN cards with one or more low-speed (LS) ports, two (2) RTSI signals are available for input, and three (3) RTSI signals are available for output.

Note For PXI-CAN cards, RTSI Signal 6 is unavailable.

Note Many NI-DAQ cards use RTSI Signal 7 as the 20MHz clock, so this signal number should be avoided for other uses.

RTSI Behavior specifies whether to pulse or toggle a RTSI output. This attribute is ignored when RTSI Mode specifies input:

Output RTSI Pulse: Pulse the RTSI output for at least 100 microseconds.

Toggle RTSI Line: If the previous state was high, the output toggles low, then vice-versa.

RTSI Skip specifies the number of RTSI inputs 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 pulses 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, NI-Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, NI-Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. PCI/AT boards require a ribbon cable for the connections, but for PXI boards the connections are available on the PXI chassis backplane. Refer to the NI-CAN User Manual for more details on the hardware connector.

If you are not using RTSI features to synchronize the Network Interface with other National Instruments cards, refer to the ncConfigCANNet VI.

If you need to log low-speed (LS) fault indications to the Network Interface read queue, refer to the ncConfigCANNetLS-RTSI VI. This VI is not required if you simply need to communicate on a LS CAN interface.
ncConfigCANObj.vi

Purpose
Configure a CAN Object before using it.

Format

```
ObjName  CAN Object Config  Error in  Error out
```

Input

- **ObjName** is the name of the CAN Object to configure. This name uses the syntax “CANx::STDy” or “CANx::XTDy”. CANx is the name of the CAN network interface that you used for the preceding ncConfigCANNet VI. 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 can also 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 your 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.

    If you wish to specify the Period in Hertz instead of milliseconds, you can use the special hexadecimal format 800000xx, where xx is the desired rate in Hertz. For example, 80000020 hex specifies 32 Hz.

    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** 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**.

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**.

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 CAN Object’s ID, 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.

**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**. 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`. 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`.

This is the most commonly used CAN Object type. If you are not using remote frames, you can use multiple CAN Objects of this type, and the Network Interface for all other access (event-driven transmit and all receive).

**Period** specifies the periodic rate, and **Transmit by Response** specifies whether to transmit the previous period's data in response to a remote frame. **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`, 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` is called. When `ncWriteObj` 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 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 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.

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.
Data Length specifies the number of bytes in the data frames for this CAN Object's 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 ncReadObj 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 8-1 shows a CAN Object that periodically transmits data to another CAN Object. The receiving CAN Object can queue up to five data values.

![Figure 8-1. Example of Periodic Transmission](image)

Figure 8-2 shows a CAN Object that polls data from another CAN Object. NI-CAN transmits the CAN remote frame when you call ncWriteObj.vi.
Figure 8-2. Example of Polling Remote Data Using ncWriteObj.vi

Figure 8-3 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 8-3. 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 before this VI in order to configure the Network Interface attributes, then call ncConfigCANObj for each CAN Object desired.

If you intend to use RTSI features to synchronize the CAN Object with other National Instruments cards, refer to the 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 the ncReadObj and ncWriteObj VIs 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 “CANx::STDy” or “CANx::XTDy”. CANx is the name of the CAN network interface that you used for the preceding ncConfigCANNet VI. 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 can also 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 your 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 your 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`.

On RTSI Input - Transmit CAN Frame

The CAN Object will transmit a frame from its write queue when the RTSI input pulses. To begin transmission, at least one data frame must be written using `ncWriteObj`. 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`.

In order to use this RTSI Mode, you must configure the CAN Object’s 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.

On RTSI Input - Timestamp RTSI event

When the RTSI input pulses, 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 pulsed
- 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 CAN Object’s Communication Type 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 CAN Object’s Communication Type to either Transmit Data by Call, Transmit Data Periodically, or Transmit Periodic Waveform.

RTSI Output on ncAction call

The CAN Object will output the RTSI signal whenever the ncAction VI is called with Opcode Output on RTSI line. This RTSI mode can be used to manually toggle/pulse a RTSI output within your application.

**RTSI Signal** defines the RTSI signal associated with the RTSI Mode. Valid values are 0 to 7, corresponding to RTSI 0 to RTSI 7 on other National Instruments cards.

**Note** For CAN cards with high-speed (HS) ports only, four (4) RTSI signals are available for input, and four (4) RTSI signals are available for output. Since each RTSI signal is assigned to a Network Interface or CAN Object, this means that at most four NI-CAN objects can use RTSI inputs (or outputs). For example, if you configure five (5) RTSI signals for input, NI-CAN returns an error, regardless of which RTSI Signal numbers were used for each.

**Note** For CAN cards with one or more low-speed (LS) ports, two (2) RTSI signals are available for input, and three (3) RTSI signals are available for output. The unavailable signals are used for low-speed fault detection.

**Note** For PXI-CAN cards, RTSI Signal 6 is unavailable.

**Note** Many NI-DAQ cards use RTSI Signal 7 as the 20MHz clock, so this signal number should be avoided for other uses.

**RTSI Behavior** specifies whether to pulse or toggle a RTSI output. This attribute is ignored when RTSI Mode specifies input.

**Output RTSI Pulse:** Pulse the RTSI output for at least 100 microseconds.

**Toggle RTSI Line:** If the previous state was high, the output toggles low, then vice-versa.
Chapter 8  Frame API for LabVIEW — ncConfigCANObjRTSI.vi

RTSI Skip specifies the number of RTSI inputs 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 pulses every 1ms, RTSI Skip of 9 means that a timestamp will be stored in the read queue every 10ms.

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. 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, NI-Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, NI-Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. PCI/AT boards require a ribbon cable for the connections, but for PXI boards the connections are available on the PXI chassis backplane. Refer to the NI-CAN User Manual for more details on the hardware connector.

If you are not using RTSI features to synchronize the CAN Object with other National Instruments cards, refer to the ncConfigCANObj VI.
ncCreateOccur.vi

Purpose
Create a LabVIEW occurrence for an object.

Format

```
<table>
<thead>
<tr>
<th>ObjHandle in</th>
<th>DesiredState</th>
<th>Occurrence</th>
<th>ObjHandle out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error in</td>
<td>Error out</td>
<td>Occurrence</td>
<td>Error out</td>
</tr>
</tbody>
</table>
```

Input

**ObjHandle in** is the object handle from the previous NI-CAN VI. The handle originates from the **ncOpenObject** VI.

**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 via 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.

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 communication starts the Write Success state is true by default.

00000008 hex Read Multiple

A specified number of frames are available, which you can obtain using either `ncReadNetMult` or `ncReadObjMult`. The number of frames is configured using the ReadMult Size for Notification attribute of `ncSetAttr`.

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.

**Iteration** is an optional loop iteration count. If `ncCreateOccur` 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` 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.
**Description**

`ncCreateOccur` creates a notification occurrence for the object specified by `ObjHandle`. The NI-CAN driver uses the occurrence callback to communicate state changes to your application.

The `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, the `ncWait` VI offers better overall performance. The `ncWait` VI cannot be used at the same time as `ncCreateOccur`.

Upon successful return from `ncCreateOccur`, the occurrence is set whenever one of the states specified by `DesiredState` 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` or `ncReadObj` to read the available data.
- If `DesiredState` is `Read Multiple`, you should call `ncReadNetMult` or `ncReadObjMult` 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 your application), call `ncCreateOccur` with **DesiredState** zero.
ncGetAttr.vi

Purpose
Get the value of an object attribute.

Format

<table>
<thead>
<tr>
<th>ObjHandle in</th>
<th>ObjHandle out</th>
</tr>
</thead>
<tbody>
<tr>
<td>AttrId</td>
<td>AttrValue</td>
</tr>
<tr>
<td>Error in</td>
<td>Error out</td>
</tr>
</tbody>
</table>

Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from the ncOpenObject VI.

AttrId specifies the attribute to get.

Protocol
For NI-CAN, this always returns 1.
For NI-DNET, this always returns 2.
This attribute is available only from the Network Interface, not CAN Objects.

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.

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 available only from the Network Interface, not CAN Objects.

This attribute is provided for backward compatibility. *ncGetHardwareInfo* VI provides more complete version information.

**Object State**

Returns the object’s current state bit mask. Polling with *ncGetAttr* provides an alternative method of state detection than *ncWait* or *ncCreateOccur*. For more information on the states returned from this attribute, refer to the DesiredState input of *ncWait*.

**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 *ncWait* and *ncCreateOccur* VIs.

**Write Entries Pending**

Returns the number of frames pending transmission in the write queue. If your intent is to verify that all pending frames have been transmitted successfully, waiting for the Write Success state is preferable to this attribute.

**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*.

**Serial Number**

Returns the serial number of the card on which the Network Interface or CAN Object is located.

**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.

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>PCI</td>
</tr>
<tr>
<td>1</td>
<td>PXI</td>
</tr>
</tbody>
</table>
Chapter 8 — Frame API for LabVIEW — ncGetAttr.vi

2 PCMCIA
3 AT

Transceiver

Returns the CAN transceiver of the port on which the Network Interface or CAN Object is located.

The returned Transceiver is an enumeration.

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>HS</td>
</tr>
<tr>
<td>1</td>
<td>LS</td>
</tr>
</tbody>
</table>

This attribute is not supported on the PCMCIA form factor.

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.

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 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

card number specifies the CAN card number from 1 to Number of Cards, where Number of Cards is the number of CAN cards in your system. You can determine the number of cards in your 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 major 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 major 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 your 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 card’s For loop, 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

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

Port-wide attribute that returns the CAN transceiver of the port in the number output. Use the desired card number and port number as inputs.

The returned Transceiver is an enumeration.

0 HS
1 LS

This attribute is not supported on the PCMCIA form factor.
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 (i.e., “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 can also 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

```
ObjHandle in  Error in  ObjHandle out  Timestamp  Error out
```

Input

- **ObjHandle in**: the object handle from the previous NI-CAN VI. The handle originates from the **ncOpenObject** 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**: 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**: 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 can also 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, convert to milliseconds, then subtract off the non-fractional part (seconds and milliseconds), then convert to microseconds.

\[
\text{Timestamp} = \text{Timestamp} \times 1000 \\
\text{Microseconds} = (\text{TimeStamp} - \lfloor\text{Timestamp}\rfloor) \times 1000
\]

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.
ncOpenObject.vi

Purpose
Open an object.

Format

```
ObjName  
Error in  
ObjHandle out  
Error out
```

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 “CANx”, 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 Object**

This name uses the syntax “CANx::STDy” or “CANx::XTDy”. CANx is the name of the CAN network interface that you used for the preceding ncConfigCANNet VI. 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 can also 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.

**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.
**Description**

`ncOpenObject.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.

Although NI-CAN can generally be used by multiple applications simultaneously, it does not allow more than one application to open the same object. For example, if one application opens `CAN0`, and another application attempts to open `CAN0`, the second `ncOpenObject.vi` returns the error `CanErr AlreadyOpen`. It is legal for one application to open `CAN0::STD14` and another application to open `CAN0::STD21`, because the two objects are considered distinct.

If `ncOpenObject.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 the **ncOpenObject** 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.
- **ArbitrationId** returns the arbitration ID of the received frame. A standard ID (11-bit) is specified by default. An extended ID (29-bit) is specified with the bit mask 20000000 hex ORed with the ID.
The Network Interface receives frames based on the comparators and masks configured in \texttt{ncConfigCANNet}.

\textbf{IsRemote} indicates the type of frame:

\begin{itemize}
  \item 0 Data frame
    \begin{itemize}
      \item CAN data frame from network.
    \end{itemize}
  \item 2 Communication warning or error
    \begin{itemize}
      \item Indicates a communications problem reported by the CAN controller or the low-speed CAN transceiver. This frame type occurs only when you set the \texttt{Log Comm Warnings} attribute to TRUE (refer to \texttt{ncConfigCANNetLS} for details).
    \end{itemize}
\end{itemize}

\texttt{ArbitrationId} indicates the type of communication problem:

\begin{itemize}
  \item 8000000B hex: Comm. error: General
  \item 4000000B hex: Comm. warning: General
  \item 8001000B hex: Comm. error: Stuff
  \item 4001000B hex: Comm. warning: Stuff
  \item 8002000B hex: Comm. error: Format
  \item 4002000B hex: Comm. warning: Format
  \item 8003000B hex: Comm. error: No Ack
  \item 4003000B hex: Comm. warning: No Ack
  \item 8004000B hex: Comm. error: Tx 1 Rx 0
  \item 4004000B hex: Comm. warning: Tx 1 Rx 0
  \item 8005000B hex: Comm. error: Tx 0 Rx 1
  \item 4005000B hex: Comm. warning: Tx 0 Rx 1
  \item 8006000B hex: Comm. error: Bad CRC
  \item 4006000B hex: Comm. warning: Bad CRC
  \item 0000000B hex: Comm. errors/warnings cleared
  \item 4000000C hex: LS fault warning
  \item 0000000C hex: LS fault cleared
\end{itemize}

\textbf{DataLength} and \textbf{Data} are not applicable, and should be ignored.

For more information on communication problems, refer to \textbf{Description}.
3  RTSI frame

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 RTSI event (refer to ncConfigCANNetRTSI for details).

ArbitrationId is the special value 40000001 hex. DataLength returns the RTSI signal detected. The Data array is not applicable, and should be ignored.

DataLength returns the number of data bytes.

Data array returns the data bytes (8 maximum).

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 can also 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, convert to milliseconds, then subtract off the non-fractional part (seconds and milliseconds), then convert to microseconds.

\[
\text{Timestamp} = \text{Timestamp} \times 1000 \\
\text{Microseconds} = (\text{TimeStamp} - \lfloor\text{Timestamp}\rfloor) \times 1000
\]

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 `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 the `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`, first wait for the Read Available state using `ncWait`.

When you call `ncReadNet` for an empty read queue (Read Available state false), the frame from the previous call to `ncReadNet` 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` returns the error `CanErrOverflowRead` (`status=T, code=BFF62028 hex`). If you detect this overflow, switch to using `ncReadNetMult` 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. 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 `ncConfigCANNets`. 
ncReadNetMult.vi

Purpose
Read multiple frames from a CAN Network Interface Object.

Format

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>ObjHandle in</td>
<td>ObjHandle out</td>
</tr>
<tr>
<td>RequestedDataBufSize</td>
<td>ActualDataSize (Frames)</td>
</tr>
<tr>
<td>Error in</td>
<td>Error out</td>
</tr>
</tbody>
</table>

Input
ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from the ncOpenObject 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 ncReadNetMult.

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.

ArbitrationId returns the arbitration ID of the received frame. A standard ID (11-bit) is specified by default. An extended ID (29-bit) is specified with the bit mask 20000000 hex ORed with the ID.

The Network Interface receives frames based on the comparators and masks configured in ncConfigCANNet.

IsRemote indicates the type of frame.

0   Data frame
    CAN data frame from network.

ArbitrationId is the ID of the received data frame. DataLength indicates the number of data bytes received into the Data array.

2   Communication warning or error
    Indicates a communications 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 (refer to ncConfigCANNetLS for details).

ArbitrationId 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
DataLength and Data are not applicable, and should be ignored.

For more information on communication problems, refer to Description.

3 RTSI frame

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 RTSI event (refer to ncConfigCANNetRTSI for details).

ArbitrationId is the special value 40000001 hex.

DataLength returns the RTSI signal detected. The Data array is not applicable, and should be ignored.

DataLength returns the number of data bytes.

Data array returns the data bytes (8 maximum).

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 can also 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 ncReadNetMult, first wait for the Read Available state or Read Multiple state using ncWait.

When you call ncReadNetMult 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 ncReadNet 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. 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 ncConfigCANNetLS.
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 the **ncOpenObject** 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**.
  - If the CAN Object **Communication Type** specifies Transmit, data frames are transmitted, not received, so the **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**.

**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 can also 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, convert to milliseconds, then subtract off the non-fractional part (seconds and milliseconds), then convert to microseconds.

\[
\text{Timestamp} = \text{Timestamp} \times 1000 \\
\text{Microseconds} = (\text{Time} - \text{ITimestamp}) \times 1000
\]

**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 **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 the **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**, first wait for the Read Available state using **ncWait**.
When you call `ncReadObj` for an empty read queue (Read Available state false), the frame from the previous call to `ncReadObj` 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` returns the error `CanErrOverflowRead` (status=T, code= BFF62028 hex). If you detect this overflow, switch to using `ncReadObjMult` 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. 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

<table>
<thead>
<tr>
<th>Input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ObjHandle in</td>
<td>is the object handle from the previous NI-CAN VI. The handle originates from the ncOpenObject VI.</td>
</tr>
<tr>
<td>RequestedDataBufSize</td>
<td>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.</td>
</tr>
<tr>
<td>Error in</td>
<td>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.</td>
</tr>
</tbody>
</table>

Output

<table>
<thead>
<tr>
<th>Output</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ObjHandle out</td>
<td>is the object handle for the next NI-CAN VI.</td>
</tr>
<tr>
<td>ActualDataSize (Frames)</td>
<td>specifies the number of frames returned in Data. This number is less than or equal to RequestedDataBufSize.</td>
</tr>
</tbody>
</table>

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.
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.

If the CAN Object Communication Type specifies Transmit, data frames are transmitted, not received, so Data always contains zero valid bytes. For this Communication Type, the 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.

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 can also 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, first wait for the Read Available state or Read Multiple state using ncWait.

When you call ncReadObjMult 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 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).

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. If the frame passes that filter, NI-CAN places the frame into the read queue of the Network Interface.
**ncReset.vi**

**Purpose**
Reset the CAN card.

**Format**

```
ObjName  Error in  Error out
Reset
```

**Input**

- **ObjName** is the name of the CAN Network Interface Object to reset. This name uses the same “CANx” syntax as `ncConfigCANNet`, but the reset applies to the entire CAN card.

  For example, if a 2-port card contains “CAN0” and “CAN1”, calling `ncReset.vi` with **ObjName** “CAN1” resets all hardware/software associated with both “CAN0” and “CAN1”.

- **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**.

**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.
**Description**

This VI completely resets the CAN card and ensures that all handles for that card are closed.

The `ncReset` VI resets handles for the NI-CAN Frame API only. Do not use this function to debug applications that use the NI-CAN Channel API.

If an NI-CAN application is terminated prior to closing all handles, the `CanErrNotStopped` or `CanErrAlreadyOpen` error might occur when the application is restarted. This often occurs in LabVIEW when the toolbar `Stop` button is used, or when a wiring problem with `ObjHandle` exists. By making this the first NI-CAN VI called in your application (preceding all `ncConfig.vi`), you can avoid problems related to improper termination.

You can only use `ncReset.vi` if you plan to run a single NI-CAN application. If you run more than one NI-CAN application, each with `ncReset`, the second `ncReset` call will close all handles for the first application. You should only use `ncReset.vi` as a temporary measure. After you update your application so that it successfully closes NI-CAN handles on termination, it should no longer be used.

**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.
ncSetAttr.vi

Purpose
Set the value of an object attribute.

Format

```
ObjHandle in

AttrId

AttrValue

Error in

ObjHandle out

ObjHandle in

AttrId

AttrValue

Error in

```

Input

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from the ncOpenObject VI.

AttrId specifies the attribute to get.

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 ncWait.

The default value is one half of Read Queue Length.

User RTSI Frame

Sets the user RTSI frame. This attribute is normally configured using the UserRTSIFrame input of ncConfigCANObjRTSI. This attribute allows that value to be changed while running. For more information, refer to ncConfigCANObjRTSI.

This attribute is available only for CAN Objects, not the Network Interface.

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.
**ncWait.vi**

**Purpose**
Wait for one or more states to occur in an object.

**Format**

<table>
<thead>
<tr>
<th>Input</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ObjHandle in</strong> is the object handle from the previous NI-CAN VI. The handle originates from the <strong>ncOpenObject</strong> VI.</td>
</tr>
<tr>
<td><strong>DesiredState</strong> specifies a bit mask of states for which notification is desired. You can use a single state alone, or you can OR them together:</td>
</tr>
<tr>
<td>00000001 hex</td>
</tr>
<tr>
<td>At least one frame is available, which you can obtain using an appropriate read VI.</td>
</tr>
<tr>
<td>The state is set whenever a frame arrives for the object. The state is cleared when the read queue is empty.</td>
</tr>
<tr>
<td>00000002 hex</td>
</tr>
<tr>
<td>All frames provided via write VIs have been successfully transmitted onto the network. Successful transmit means that the frame won arbitration, and was acknowledged by a remote device.</td>
</tr>
<tr>
<td>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.</td>
</tr>
<tr>
<td>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</td>
</tr>
</tbody>
</table>
continues. When communication starts, the Write Success state is true by default.

00000008 hex       Read Multiple

A specified number of frames are available, which you can obtain using either \( \text{ncReadNetMult} \) or \( \text{ncReadObjMult} \). The number of frames is configured using the \text{ReadMult Size for Notification} attribute of \( \text{ncSetAttr} \).

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.

\text{Timeout} specifies the maximum number of milliseconds to wait for one of the states in \text{DesiredState}. If the \text{Timeout} expires before a state occurs, the error \text{CanErrFunctionTimeout} is returned in \text{Error out} (status=T, code= BFF62001 hex).

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

\text{status} is TRUE if an error occurred. If \text{status} is TRUE, the VI does not perform any operations.

\text{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 \text{code}, wire the error cluster to a LabVIEW error-handling VI, such as the Simple Error Handler.

\text{source} identifies the VI where the error occurred.

\text{Output}

\text{ObjHandle out} is the object handle for the next NI-CAN VI.

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

\text{status} is TRUE if an error occurred.
**Description**

Use `ncWait.vi` to wait for one or more states to occur in the object specified by `ObjHandle`.

While waiting for the desired states, `ncWait.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 `ncWait`, but `ncCreateOccur` allows other code in the thread to execute.

The **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.
ncWriteNet.vi

Purpose
Write the data value of an object.

Format

ObjHandle in is the object handle from the previous NI-CAN VI. The handle originates from the ncOpenObject VI.

ArbitrationId specifies the arbitration ID of the frame to transmit. 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.

IsRemote indicates the type of frame.

0 Data frame
  Transmit CAN data frame.
  ArbitrationId is the ID of the data frame to transmit.
  DataLength indicates the number of data bytes in the Data array.

1 Remote frame
  Transmit CAN remote frame.
  ArbitrationId is the ID of the remote frame to transmit.
  DataLength is encoded in the remote frame Data Length Code, but the Data array is not used.

Data provides an array of data bytes to write.

DataLength specifies the number of data bytes.

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 ncWriteNet 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.

If your goal is to transmit a set of frames as quickly as possible, simply call ncWriteNet once per frame, without using ncWait 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 to be transmitted successfully, use ncWait 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**.

Sporadic, recoverable errors on the network are handled automatically by the CAN protocol. As such, after **ncWriteNet** 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** returns the error CanErrOverflowWrite (status=T, code= BFF62008 hex). In many cases, this error is recoverable, so you should not exit your application when it occurs. For example, if you want to transmit thousands of frames in succession (i.e., downloading code), your 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** again. If the second call to **ncWriteNet** 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.
ncWriteObj.vi

Purpose
Write a single frame to a CAN Object.

Format

\[ 
\text{ObjHandle in} \quad \text{Data} \quad \text{Errr in} \quad \text{objHandle out} \quad \text{Error out} 
\]

Input

\textbf{ObjHandle in} is the object handle from the previous NI-CAN VI. The handle originates from the \textbf{ncOpenObject} VI.

\textbf{Data} array specifies the data bytes (8 maximum).

\textbf{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 \textbf{Error out}.

\textbf{status} is TRUE if an error occurred. If \textbf{status} is TRUE, the VI does not perform any operations.

\textbf{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 \textbf{code}, wire the error cluster to a LabVIEW error-handling VI, such as the Simple Error Handler.

\textbf{source} identifies the VI where the error occurred.

Output

\textbf{ObjHandle out} is the object handle for the next NI-CAN VI.

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

\textbf{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 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 to be transmitted successfully, use ncWait 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.

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 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 returns the error CanErrOverflowWrite (status=T, code= BFF62008 hex). In many cases, this error is recoverable, so you should not exit your application when it occurs. For example, if you want to transmit thousands of frames in succession (i.e., large waveform transmitted periodically), your 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 again. If the second call to ncWriteObj 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, you can set the Write Queue Length to zero.
If the CAN Object **Communication Type** specifies Receive behavior, the `ncWriteObj` VI can be used to transmit a remote frame. When using `ncWriteObj` to transmit a remote frame, the **Data** input can be left unwired.
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>
<thead>
<tr>
<th>Data Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCTYPE_INT8</td>
<td>8-bit signed integer</td>
</tr>
<tr>
<td>NCTYPE_INT16</td>
<td>16-bit signed integer</td>
</tr>
<tr>
<td>NCTYPE_INT32</td>
<td>32-bit signed integer</td>
</tr>
<tr>
<td>NCTYPE_UINT8</td>
<td>8-bit unsigned integer</td>
</tr>
<tr>
<td>NCTYPE_UINT16</td>
<td>16-bit unsigned integer</td>
</tr>
<tr>
<td>NCTYPE_UINT32</td>
<td>32-bit unsigned integer</td>
</tr>
<tr>
<td>NCTYPE_BOOL</td>
<td>Boolean value. Constants NC_TRUE (1) and NC_FALSE (0) are used for comparisons.</td>
</tr>
<tr>
<td>NCTYPE_STRING</td>
<td>ASCII string represented as an array of characters terminated by null character ('\0').</td>
</tr>
<tr>
<td>NCTYPE_type_P</td>
<td>Pointer to a variable of type type.</td>
</tr>
<tr>
<td>NCTYPE_ANY_P</td>
<td>Pointer to a variable of any type, used in cases where actual data type can vary depending on the object in use.</td>
</tr>
<tr>
<td>NCTYPE_OBJH</td>
<td>32-bit unsigned integer used to reference an open object in the Frame API.</td>
</tr>
<tr>
<td>NCTYPE_ATTRID</td>
<td>Attribute identifier. Uses constants with prefix NC_ATTR_.</td>
</tr>
<tr>
<td>NCTYPE_OPCODE</td>
<td>Operation code for ncAction function. Uses constants with prefix NC_OP_.</td>
</tr>
<tr>
<td>NCTYPE_STATE</td>
<td>Object states, encoded as a 32-bit mask, one bit for each state. Refer to ncWaitForState for more information.</td>
</tr>
</tbody>
</table>
List of Functions

The following table contains an alphabetical list of the NI-CAN Frame API for C functions.

Table 9-2. NI-CAN Frame API for C Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ncAction</td>
<td>Perform an action on an object.</td>
</tr>
<tr>
<td>ncCloseObject</td>
<td>Close an object.</td>
</tr>
<tr>
<td>ncConfig</td>
<td>Configure an object before using it.</td>
</tr>
<tr>
<td>ncCreateNotification</td>
<td>Create a notification callback for an object.</td>
</tr>
<tr>
<td>ncGetAttribute</td>
<td>Get the value of an object attribute.</td>
</tr>
<tr>
<td>ncGetHardwareInfo</td>
<td>Get NI-CAN hardware information.</td>
</tr>
<tr>
<td>ncOpenObject</td>
<td>Open an object.</td>
</tr>
<tr>
<td>ncRead</td>
<td>Read the data value of an object.</td>
</tr>
<tr>
<td>ncReadMult</td>
<td>Read multiple data values from the queue of an object.</td>
</tr>
<tr>
<td>ncReset</td>
<td>Reset CAN interface.</td>
</tr>
<tr>
<td>ncSetAttribute</td>
<td>Set the value of an object attribute.</td>
</tr>
<tr>
<td>ncStatusToString</td>
<td>Convert status code into a descriptive string.</td>
</tr>
</tbody>
</table>
### Table 9-2. NI-CAN Frame API for C Functions (Continued)

<table>
<thead>
<tr>
<th>Function</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>ncWaitForState</code></td>
<td>Wait for one or more states to occur in an object.</td>
</tr>
<tr>
<td><code>ncWrite</code></td>
<td>Write the data value of an object.</td>
</tr>
</tbody>
</table>
ncAction

Purpose

Perform an action on an object.

Format

\[
\text{NCTYPE\_STATUS \ ncAction(}
\quad \text{NCTYPE\_OBJH ObjHandle,}
\quad \text{NCTYPE\_OPCODE Opcode,}
\quad \text{NCTYPE\_UINT32 Param})
\]

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 your 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 9-3 describes the actions supported by the CAN Network Interface Object.

Table 9-3. Actions Supported by the CAN Network Interface Object

<table>
<thead>
<tr>
<th>Opcode</th>
<th>Param</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC_OP_START</td>
<td>N/A (ignored)</td>
<td>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.</td>
</tr>
<tr>
<td>NC_OP_STOP</td>
<td>N/A (ignored)</td>
<td>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. 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.</td>
</tr>
<tr>
<td>NC_OP_RESET</td>
<td>N/A (ignored)</td>
<td>Resets network interface. Stops network interface, then resets the CAN controller to clear the CAN error counters (clear error passive state). Resetting includes clearing all entries from read and write queues. NC_OP_RESET is propagated up to all open higher-level CAN Objects.</td>
</tr>
<tr>
<td>NC_OP_RTSI_OUT</td>
<td>N/A (ignored)</td>
<td>Output a pulse or toggle on the RTSI line depending upon the NC_ATTR_RTSI_SIG_BEHAV.</td>
</tr>
</tbody>
</table>
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 9-4 describes the actions supported by the CAN Object.

<table>
<thead>
<tr>
<th>Opcode</th>
<th>Param</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC_OP_RTSI_OUT</td>
<td>N/A (ignored)</td>
<td>Output a pulse or toggle on the RTSI line depending upon the NC_ATTR_RTSI_SIG_BEHAV</td>
</tr>
</tbody>
</table>
ncCloseObject

Purpose
Close an object.

Format
NCTYPE_STATUS ncCloseObject(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 your 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 RTSI configuration for the object, and you can no longer use the ObjHandle in your 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**

```c
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 your 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 your 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 following attribute IDs are commonly used for Network Interface configuration.

**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_BAUD_RATE** (Baud Rate)

Baud Rate is the baud rate to use for communication. Common baud rates are supported, including 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\tt\t\zz`, where \(\tt\) is the desired value for register 0 (BTR0), and \(\zz\) is the desired value for register 1 (BTR1) of the CAN controller.

**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 Network Interface Object. A typical value is 100. For more information, refer to `ncRead`.

**NC_ATTR_WRITE_Q_LEN** (Write Queue Length)

Write Queue Length is the maximum number of frames for the write queue of the CAN Network Interface Object awaiting transmission. A typical value is 10. For more information, refer to `ncWrite`. 
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 standard 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_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 intend to open the Network Interface, most applications can set this attribute and the Standard Comparator to 0 in order to receive all standard frames.

If you set the Standard Comparator to CFFFFFFF hex, this attribute is ignored, because all standard frame reception is disabled for the Network Interface.

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_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 intend to open the Network Interface, most applications can set this attribute and the Extended Comparator to 0 in order to receive all extended frames.

If you set the Extended Comparator to CFFFFFFF hex, this attribute is ignored, because all extended frame reception is disabled for the Network Interface.

**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.

The following attribute ID is used to enable logging of low-speed (LS) faults.

**NC_ATTR_LOG_COMM_ERRS** (Log Comm Warnings)

Log Comm Warnings specifies whether to log communication warnings (including LS faults) to the Network Interface read queue.
When set to NC_FALSE (default), the Network Interface reports CAN communication warnings (including LS 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 LS 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, NI-Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, NI-Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. PCI/AT boards require a ribbon cable for the connections, but for PXI boards the connections are available on the PXI chassis backplane. Refer to the *NI-CAN User Manual* for more details on the 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_TX_ON_IN

The Network Interface will transmit a frame from its write queue when the RTSI input pulses. 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`.

NC_RTSI_TIME_ON_IN

When the RTSI input pulses, 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 pulsed
- 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.

⚠️ **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 (i.e. lost data frames).

NC_RTSI_OUT_ON_RX

The Network Interface will output the RTSI signal whenever a CAN frame is stored in the read queue.

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_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 your application.

NC_ATTR_RTSI_SIGNAL (RTSI Signal)

RTSI Signal defines the RTSI signal associated with the RTSI Mode. Valid values are 0 to 7, corresponding to RTSI 0 to RTSI 7 on other National Instruments cards.

Note For CAN cards with high-speed (HS) ports only, four (4) RTSI signals are available for input, and four (4) RTSI signals are available for output. Since each RTSI signal is assigned to a Network Interface or CAN Object, this means that at most four NI-CAN objects can use RTSI inputs (or outputs). For example, if you configure five (5) RTSI signals for input, NI-CAN returns an error, regardless of which RTSI Signal numbers were used for each.

Note For CAN cards with one or more low-speed (LS) ports, two (2) RTSI signals are available for input, and three (3) RTSI signals are available for output.

Note For PXI-CAN cards, RTSI Signal 6 is unavailable.

Note Many NI-DAQ cards use RTSI Signal 7 as the 20 MHz clock, so this signal number should be avoided for other uses.

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:

RTSI_SIG_PULSE
Pulse the RTSI output for at least 100 microseconds.

RTSI_SIG_TOGGLE
If the previous state was high, the output toggles low, then vice-versa.
NC_ATTR_RTSI_SKIP (RTSI Skip)

RTSI Skip specifies the number of RTSI inputs 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 pulses every 1 ms, RTSI Skip of 9 means that a timestamp will be stored in the read queue every 10ms.

CAN Object

ObjName is the name of the CAN Object to configure. This string uses the syntax “CANx::STDy” or “CANx::XTDy”. CANx 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 can also 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 following attribute IDs are commonly used for CAN Object configuration:

NC_ATTR_PERIOD (Period)

Period specifies the rate of periodic behavior in milliseconds.

If you wish to specify the Period in Hertz instead of milliseconds, you can use the special hexadecimal format 800000xx, where xx is the desired rate in Hertz. For example, 80000020 hex specifies 32 Hz.

The behavior depends on the Communication Type as follows:

NC_CAN_COMM_TX_PERIODIC

NC_CAN_COMM_TX_WAVEFORM

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_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_BY_CALL

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_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_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.

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_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_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_RX_PERIODIC** (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.

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_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_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 \texttt{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 \texttt{ncWrite}.

This is the most commonly used CAN Object type. If you are not using remote frames, you can use multiple CAN Objects of this type, and the Network Interface for all other access (event-driven transmit and all receive).

Period specifies the periodic rate, and
Transmit by Response specifies whether to transmit the previous period data in response to a remote frame. 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 \texttt{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 \texttt{TRUE} regardless of the attribute setting. Receive Changes Only 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_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.

Period specifies the periodic rate. Transmit by Response and Receive Changes Only are ignored.

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_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.

RTSI is a bus that interconnects National Instruments DAQ, IMAQ, NI-Motion, and CAN boards. This feature allows synchronization of DAQ, IMAQ, NI-Motion, and CAN boards by allowing exchange of timing signals. Using RTSI, a device (board) can control one or more slave devices. PCI/AT boards require a ribbon cable for the connections, but for PXI boards the connections are available on the PXI chassis backplane. Refer to the NI-CAN User Manual for more details on the 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 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_TX_ON_IN**
  The CAN Object will transmit a frame from its write queue when the RTSI input pulses. 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.

- **NC_RTSI_TIME_ON_IN**
  When the RTSI input pulses, 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 pulsed
  - **Data:** User-defined 4 byte data pattern (refer to RTSI Frame 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 1 kHz on a consistent basis, CAN performance will be adversely affected (i.e. lost data frames).
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_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 your application.

NC_ATTR_RTSI_SIGNAL (RTSI Signal)
RTSI Signal defines the RTSI signal associated with the RTSI Mode. Valid values are 0 to 7, corresponding to RTSI 0 to RTSI 7 on other National Instruments cards.

Note For CAN cards with high-speed (HS) ports only, four (4) RTSI signals are available for input, and four (4) RTSI signals are available for output. Since each RTSI signal is assigned to a Network Interface or CAN Object, this means that at most four NI-CAN objects can use RTSI inputs (or outputs). For example, if you configure five (5) RTSI signals for input, NI-CAN returns an error, regardless of which RTSI Signal numbers were used for each.

Note For CAN cards with one or more low-speed (LS) ports, two (2) RTSI signals are available for input, and three (3) RTSI signals are available for output.

Note For PXI-CAN cards, RTSI Signal 6 is unavailable.
**Note**  Many NI-DAQ cards use RTSI Signal 7 as the 20 MHz clock, so this signal number should be avoided for other uses.

**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:

- **RTSI_SIG_PULSE**
  Pulse the RTSI output for at least 100 microseconds.

- **RTSI_SIG_TOGGLE**
  If the previous state was high, the output toggles low, then vice-versa.

**NC_ATTR_RTSI_SKIP** (RTSI Skip)

RTSI Skip specifies the number of RTSI inputs 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 pulses every 1 ms, RTSI Skip of 9 means that a timestamp will be stored in the read queue every 10 ms.

**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, AABBCDhex 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.

**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 9-1 shows a CAN Object that periodically transmits data to another CAN Object. The receiving CAN Object can queue up to five data values.

![Diagram of Periodic Transmission]

**Figure 9-1.** Example of Periodic Transmission

Figure 9-2 shows a CAN Object that polls data from another CAN Object. NI-CAN transmits the CAN remote frame when you call `ncWrite`.

![Diagram of Polling Remote Data Using ncWrite]

**Figure 9-2.** Example of Polling Remote Data Using ncWrite
Figure 9-3 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 9-3. Example of Periodic Polling of Remote Data
ncCreateNotification

Purpose

Create a notification callback for an object.

Format

```c
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 your 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 your 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 your 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`.

Upon successful return from `ncCreateNotification`, the notification callback is invoked whenever one of the states specified by `DesiredState` 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_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.

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 communication starts, the NC_ST_WRITE_SUCCESS state is true by default.

**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.

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 your 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**

```c
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 your 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 your callback.

The `Callback` function executes in a separate thread in your 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 your 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, 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.
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 your 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_PROTOCOL (Protocol)
  For NI-CAN, this always returns 1.
For NI-DNET, this always returns 2.

This attribute is available only from the Network Interface, not CAN Objects.

**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_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.

This attribute is available only from the Network Interface, not CAN Objects.

**NC_ATTR_STATE (Object State)**

Returns the current state bit mask of the object. Polling with `ncGetAttr` 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_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_WRITE_PENDING (Write Entries Pending)**

Returns the number of frames pending transmission in the write queue. If your 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_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 \texttt{ncSetAttribute}. 

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 100ns intervals that have elapsed since 12:00 a.m., January 1, 1601.

Since the timestamp returned by \texttt{ncRead} (and this attribute) is compatible with Win32 FILETIME, you can pass it into the Win32 FileTimeToLocalFileTime function to convert it to your 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 your Microsoft Win32 documentation.

Since the absolute timestamp type is 64 bits (NCTYPE_ABS_TIME), you must use \texttt{AttrSize} of 8.

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_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.

\begin{verbatim}
NC_HW_FORMFACTOR_PCI         PCI
NC_HW_FORMFACTOR_PXI         PXI
NC_HW_FORMFACTOR_PCMCIA      PCMCIA
NC_HW_FORMFACTOR_AT          AT
\end{verbatim}
NC_ATTR_HW_TRANSCEIVER  (Transceiver)

Returns the CAN transceiver of the port on which the Network Interface or CAN Object is located.

The returned Transceiver is an enumeration.

NC_HW_TRANSCEIVER_HS   HS
NC_HW_TRANSCEIVER_LS   LS

This attribute is not supported on the PCMCIA form factor.

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.
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 your 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_VERSION_MAJOR (Version Major)
Returns the major version of the NI-CAN software. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. 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. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. Use CardNumber 1 and PortNumber 1 as inputs.

The major version is the ‘Y’ in X.Y.Z.
NC_ATTR_VERSION_UPDATE (Version Update)

Returns the update version of the NI-CAN software. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. Use CardNumber 1 and PortNumber 1 as inputs.

The major version is the ‘Z’ in X.Y.Z.

NC_ATTR_VERSION_PHASE (Version Phase)

Returns the phase of the NI-CAN software. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. 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_BUILD (Version Build)

Returns the build of the NI-CAN software. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. 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_NUM_CARDS (Number of Cards)

Returns the number of NI-CAN cards in your system. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. 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 card For loop, you get all card-wide attributes including Number Of Ports, then use another For loop to get port-wide attributes.

NC_ATTR_HW_SERIAL_NUM (Serial Number)
Card-wide attribute that returns the serial number of the card.
AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. Use the desired CardNumber, and PortNumber 1 as inputs.

NC_ATTR_HW_FORMFACTOR (Form Factor)
Card-wide attribute that returns the form factor of the card. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. 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_NUM_PORTS (Number of Ports)
Card-wide attribute that returns the number of ports on the card. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. 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_HW_TRANSCEIVER (Transceiver)
Port-wide attribute that returns the CAN transceiver of the port. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. Use the desired CardNumber and PortNumber as inputs.

The returned Transceiver is an enumeration.

NC_HW_TRANSCEIVER_HS HS
NC_HW_TRANSCEIVER_LS LS
This attribute is not supported on the PCMCIA form factor.

**NC_ATTR_INTERFACE_NUM (Interface Number)**

Port-wide attribute that returns the interface number of the port. AttrPtr must point to NCTYPE_UINT32, and AttrSize must be 4. 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 (i.e. “CAN0”). The interface number is used for the Interface input in the Channel API.

<table>
<thead>
<tr>
<th>AttrSize</th>
<th>Size of the attribute in bytes.</th>
</tr>
</thead>
</table>

**Output**

<table>
<thead>
<tr>
<th>AttrPtr</th>
<th>Pointer used to return attribute value.</th>
</tr>
</thead>
</table>

**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 your 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 can also 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 your 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.

Although NI-CAN can generally be used by multiple applications simultaneously, it does not
allow more than one application to open the same object. For example, if one application
opens CAN0, and another application attempts to open CAN0, the second ncOpenObject
returns the error CanErrAlreadyOpen. It is legal for one application to open CAN0::STD14
and another application to open CAN0::STD21, because the two objects are considered
distinct.

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 “CANx”, 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 Object**

`ObjName` is the name of the CAN Object to configure. This string uses the syntax “CANx::STDy” or “CANx::XTDy”. CANx 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 can also 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.
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 your 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_FRAME_STRUCT. When calling ncRead, you should pass sizeof (NCTYPE_FRAME_STRUCT) for the DataSize parameter.

Within the NCTYPE_FRAME_STRUCT structure, the FrameType field determines the meaning of all other fields. The following tables, 9-5 through 9-7, describe the fields of NCTYPE_FRAME_STRUCT for each value of FrameType.

**Table 9-5. NCTYPE_FRAME_STRUCT Fields for FrameType NC_FRMTYPE_DATA (0)**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FrameType</td>
<td>NCTYPE_UINT8</td>
<td>NC_FRMTYPE_DATA (0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This value indicates a CAN data frame.</td>
</tr>
<tr>
<td>ArbitrationId</td>
<td>NCTYPE_CAN_ARBID</td>
<td>Returns the arbitration ID of the received data frame.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The NCTYPE_CAN_ARBID type is an unsigned 32-bit integer that uses the bit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mask NC_FL_CAN_ARBID_XTD (0x20000000) to indicate an extended ID. A standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ID (11-bit) is specified by default.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Network Interface receives data frames based on the comparators and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>masks configured in ncConfig.</td>
</tr>
<tr>
<td>Data</td>
<td>Array of 8</td>
<td>Returns the data bytes of the frame.</td>
</tr>
<tr>
<td></td>
<td>NCTYPE_UINT8</td>
<td></td>
</tr>
</tbody>
</table>
Table 9-5. NCTYPE_FRAME_STRUCT Fields for FrameType NC_FRMTYPE_DATA (0) (Continued)

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DataLength</td>
<td>NCTYPE_UINT8</td>
<td>Returns the number of data bytes received in the frame. This specifies the number of valid data bytes in <code>Data</code>.</td>
</tr>
<tr>
<td>Timestamp</td>
<td>NCTYPE_ABS_TIME</td>
<td>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 <code>Timestamp</code> is compatible with Win32 FILETIME, you can pass it into the Win32 FileTimeToLocalFileTime function to convert it to your 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 your Microsoft Win32 documentation.</td>
</tr>
</tbody>
</table>
Table 9-6. NCTYPE_FRAME_STRUCT Fields for FrameType NC_FRMTYPE_COMM_ERR (2)

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FrameType</td>
<td>NCTYPE_UINT8</td>
<td>NC_FRMTYPE_COMM_ERR (2)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This value indicates a logged communication warning or error as reported by the CAN hardware.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This frame type occurs only when you set the Log Comm Warnings attribute to TRUE. Refer to ncConfig for details.</td>
</tr>
<tr>
<td>ArbitrationId</td>
<td>NCTYPE_CAN_ARBID</td>
<td>Indicates the type of communication problem:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8000000B hex:Comm. error: General</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000000B hex:Comm. warning: General</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8001000B hex:Comm. error: Stuff</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4001000B hex:Comm. warning: Stuff</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8002000B hex:Comm. error: Format</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4002000B hex:Comm. warning: Format</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8003000B hex:Comm. error: No Ack</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4003000B hex:Comm. warning: No Ack</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8004000B hex:Comm. error: Tx 1 Rx 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4004000B hex:Comm. warning: Tx 1 Rx 0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8005000B hex:Comm. error: Tx 0 Rx 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4005000B hex:Comm. warning: Tx 0 Rx 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8006000B hex:Comm. error: Bad CRC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4006000B hex:Comm. warning: Bad CRC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000000B hex:Comm. errors/warnings cleared</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000000C hex:LS fault warning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0000000C hex:LS fault cleared</td>
</tr>
<tr>
<td>Data</td>
<td>Array of 8</td>
<td>This field is not applicable to this frame type, and should be ignored.</td>
</tr>
<tr>
<td></td>
<td>NCTYPE_UINT8</td>
<td></td>
</tr>
<tr>
<td>DataLength</td>
<td>NCTYPE_UINT8</td>
<td>This field is not applicable to this frame type, and should be ignored.</td>
</tr>
<tr>
<td>Timestamp</td>
<td>NCTYPE_ABS_TIME</td>
<td>Returns the absolute timestamp when the communications problem occurred.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For information on the timestamp data type, refer to Table 9-5.</td>
</tr>
</tbody>
</table>
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, the NC_ST_ERROR and NC_ST_STOPPED states are set in the NC_ATTR_STATE attribute of the CAN Network Interface Object and all of its higher level CAN Objects. The background status attribute (NC_ATTR_STATUS) is set with the CanWarnComm status 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.

Because the error counters in the CAN controller reflect the status of the CAN network, and not necessarily your CAN application, a given CanWarnComm status code will often remain from one run of your application to the next. If you want to clear the CAN controller error counters (and the CanWarnComm warning) completely when your application starts, use

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FrameType</td>
<td>NCTYPE_UINT8</td>
<td>NC_FRMTYPE_RTSI (3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indicates when a RTSI input pulse occurred relative to incoming CAN frames.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This frame type occurs only when you set the RTSI Mode attribute to NC_RTSI_TIME_ON_IN (refer to ncConfig for details).</td>
</tr>
<tr>
<td>ArbitrationId</td>
<td>NCTYPE_CAN_ARBID</td>
<td>Returns the special value 40000001 hex.</td>
</tr>
<tr>
<td>Data</td>
<td>Array of 8 NCTYPE_UINT8</td>
<td>This field is not applicable to this frame type, and should be ignored.</td>
</tr>
<tr>
<td>DataLength</td>
<td>NCTYPE_UINT8</td>
<td>Returns the RTSI signal number detected.</td>
</tr>
<tr>
<td>Timestamp</td>
<td>NCTYPE_ABS_TIME</td>
<td>Returns the absolute timestamp when the RTSI input occurred.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For information on the timestamp data type, refer to Table 9-5.</td>
</tr>
</tbody>
</table>
ncAction of NC_OP_RESET to reset the CAN controller, then use ncAction of NC_OP_START to resume communication.

For more information about low-speed communication error 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 sizeof(NCTYPE_CAN_DATA_TIMED) for the DataSize parameter. Table 9-8 describes the fields of NCTYPE_CAN_DATA_TIMED.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Array of 8 NCTYPE_UINT</td>
<td>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 always contains zero valid bytes. 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.</td>
</tr>
</tbody>
</table>
Table 9-8. NCTYPE_CAN_DATA_TIMED Field Names (Continued)

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timestamp</td>
<td>NCTYPE_ABS_TIME</td>
<td>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 your 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 your Microsoft Win32 documentation.</td>
</tr>
</tbody>
</table>
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 your 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`. 
ncReset

Purpose
Reset the CAN card.

Format
NCTYPE_STATUS_NCFUNC_ncReset(
    NCTYPE_STRING ObjName,
    NCTYPE_UINT32 Param);

Input
ObjName  ASCII name of the interface (card) to reset
Param    Reserved for future use (set to 0)

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 your attention. For more information, refer to
ncStatusToString.

Description
This function completely resets the CAN card and ensures that all handles for that card are
closed.

ObjName is the name of the CAN Network Interface Object that indicates the card to reset.
This name uses the same “CANx” syntax as ncConfig, but the reset applies to the entire
CAN card. For example, if a 2-port card contains “CAN0” and “CAN1”, calling ncReset
with ObjName “CAN1” resets all hardware/software associated with both “CAN0” and
“CAN1”.

If an NI-CAN application is terminated prior to closing all handles, the CanErrNotStopped
or CanErrAlreadyOpen error might occur when the application is restarted. By making this
the first NI-CAN function called in your application (preceding all ncConfig), you can avoid
problems related to improper termination.

You can only use the ncReset function if you plan to run a single NI-CAN application. If you
run more than one NI-CAN application, each with ncReset, the second ncReset call will
close all handles for the first application. You should only use the ncReset function as a
temporary measure. After you update your application so that it successfully closes NI-CAN
handles on termination, it should no longer be used.
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 your 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.

For a listing of valid 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.
**Purpose**
Convert status code into a descriptive string.

**Format**
```c
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 your application, you can use the Explain.exe utility. This console application is located in the NI-CAN installation folder, which is typically `\Program Files\National Instruments\NI-CAN`. You enter an NI-CAN status code in the command line, for example, `Explain 0XBFF62201` for explanation, 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 9-9 summarizes the NI-CAN use of this status.
Your 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.

```c
status= ncOpenObject ("CAN0", &MyObjHandle);
PrintStat (status, "ncOpen CAN0");
```

where the function `PrintStat` has been defined at the top of the program as:

```c
void PrintStat(NCTYPE_STATUS status, char *source)
{
    char statusString[300];
    if(status !=0)
    {
        ncStatusToString(status, sizeof(statusString),
                         statusString);
        printf("%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 your 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:

```c
if (status == CanErrFunctionTimeout)
```

<table>
<thead>
<tr>
<th>Status Code</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>Error—Function did not perform expected behavior.</td>
</tr>
<tr>
<td>Positive</td>
<td>Warning—Function performed as expected, but a condition arose that may require your attention.</td>
</tr>
<tr>
<td>Zero</td>
<td>Success—Function completed successfully.</td>
</tr>
</tbody>
</table>
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 your 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_WRITE_SUCCESS (00000002 hex)**

All frames provided via 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.

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 communication starts, the **NC_ST_WRITE_SUCCESS** state is true by default.

**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.

When the states in DesiredState are detected, the function returns the current value of the NC_ATTR_STATE attribute. If an error occurs, the state returned is zero.

While waiting for the desired states, `ncWaitForState` suspends the current thread execution. Other Win32 threads in your application can still execute.

If you want to allow other code in your application to execute while waiting for NI-CAN states, refer to the `ncCreateNotification` function.
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 your 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 sizeof(NCTYPE_CAN_FRAME) for the DataSize parameter.

Within the NCTYPE_CAN_FRAME structure, the FrameType field determines the meaning of all other fields. Tables 9-10 and 9-11 describe the fields of NCTYPE_CAN_FRAME for each value of FrameType.

**Table 9-10. NCTYPE_CAN_FRAME Fields for FrameType NC_FRMTYPE_DATA (0)**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FrameType</td>
<td>NCTYPE_UINT8</td>
<td>NC_FRMTYPE_DATA (0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transmit a CAN data frame.</td>
</tr>
<tr>
<td>ArbitrationId</td>
<td>NCTYPE_CAN_ARBID</td>
<td>Specifies the arbitration ID of the frame to transmit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The NCTYPE_CAN_ARBID type is an unsigned 32-bit integer that uses the bit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>mask NC_FL_CAN_ARBID_XTD (0x20000000) to indicate an extended ID. A standard</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ID (11-bit) is specified by default. In order to specify an extended ID</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(29-bit), OR in the bit mask NC_FL_CAN_ARBID_XTD.</td>
</tr>
</tbody>
</table>

For information on the proper data type to use with DataPtr, refer to the CAN Network Interface Object and CAN Object descriptions below.
Table 9-10. NCTYPE_CAN_FRAME Fields for FrameType NC_FRMTYPE_DATA (0) (Continued)

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Array of 8 NCTYPE_UINT8</td>
<td>Specifies the data bytes of the frame.</td>
</tr>
<tr>
<td>DataLength</td>
<td>NCTYPE_UINT8</td>
<td>Specifies the number of data bytes to transmit. This number of valid data bytes must be provided in Data.</td>
</tr>
</tbody>
</table>

Table 9-11. NCTYPE_CAN_FRAME Fields for FrameType NC_FRMTYPE_REMOTE (1)

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FrameType</td>
<td>NCTYPE_UINT8</td>
<td>NC_FRMTYPE_REMOTE (1)</td>
</tr>
<tr>
<td>ArbitrationId</td>
<td>NCTYPE_CAN_ARBID</td>
<td>Specifies the arbitration ID of the frame to transmit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Data</td>
<td>Array of 8 NCTYPE_UINT8</td>
<td>Remote frames do not contain data, so this array is empty.</td>
</tr>
<tr>
<td>DataLength</td>
<td>NCTYPE_UINT8</td>
<td>Specifies the Data Length Code to transmit in the remote frame.</td>
</tr>
</tbody>
</table>
**CAN Object**

The data type that you use with `ncWrite` of the CAN Object is `NCTYPE_CAN_DATA`. When calling `ncWrite`, you should pass `sizeof(NCTYPE_CAN_DATA)` for the `DataSize` parameter. Table 9-12 describes the fields of `NCTYPE_CAN_DATA`.

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data</td>
<td>Array of 8</td>
<td>Data array specifies the data bytes (8 maximum). The actual number of valid data bytes depends on the CAN Object configuration specified in <code>ncConfig</code>.</td>
</tr>
<tr>
<td></td>
<td><code>NCTYPE_UINT8</code></td>
<td>If the CAN Object’s Communication Type specifies Receive, data frames are received, not transmitted, so Data always contains zero valid bytes. For this Communication Type, the <code>ncWrite</code> function is used solely for transmission of a remote frame.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If the CAN Object’s Communication Type specifies Transmit, Data must always contain Data Length valid bytes, where Data Length was configured using <code>ncConfig</code>.</td>
</tr>
</tbody>
</table>

Table 9-12. NCTYPE_CAN_DATA Field Name
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 your system. To start MAX, double-click on the Measurement & Automation icon on your desktop. Your NI-CAN cards are listed in the left pane (Configuration) under Devices and Interfaces.

You can test your NI-CAN cards by choosing Tools\NI-CAN\Test all Local NI-CAN 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.

If there is no National Instruments CAN Interfaces item, and you have an NI-CAN card installed, refer to the Missing NI-CAN Card 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 the <F5> key 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 your 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 using the NI-CAN card. The self test aborts in order to avoid adversely affecting your application. Before running the self test, exit all applications that use NI-CAN. If you are using LabVIEW, you may need to exit LabVIEW in order 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 your system contains legacy boards that use resources not properly reserved with the Device Manager. If a resource conflict exists, write down the memory resource that caused the conflict and refer to the documentation for your Windows operating system for instructions on how to use the Device Manager to reserve memory resources for legacy boards. After the conflict has been resolved, run the 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 your system contains legacy boards that use resources not properly reserved with the Device Manager. If a resource conflict exists, write down the interrupt resource that caused the conflict and refer to the documentation for your Windows operating system for instructions on how to use the Device Manager to reserve interrupt resources for legacy boards. After the conflict has been resolved, run the 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 your 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, select Help Topics>NI-CAN within the Help menu. The version is displayed at the top of the help text. The NI-CAN entry provides version information.

**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 can I use non-standard baud rates?**

Open MAX and right-click on the port of the baud rate you want to change. Choose Properties and then press the Advanced button.

**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 Appendix B, *Cabling Requirements for High-Speed CAN*, and Appendix C, *Cabling Requirements for Low-Speed CAN*, for more information.
Appendix A  Troubleshooting and Common Questions

Does the NI-CAN card provide power to the CAN bus?
No. In order 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.

Since 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 on 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. You can however 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?
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. Refer to Appendix B, Cabling Requirements for High-Speed CAN, and Appendix C, Cabling Requirements for Low-Speed CAN, for more information.
If the jumper settings are correct, your network may have a cabling or termination problem. Refer again to Appendix B, *Cabling Requirements for High-Speed CAN*, and Appendix C, *Cabling Requirements for Low-Speed CAN*, for more information.

**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 yourself.
Cabling Requirements for High-Speed CAN

This section describes the cabling requirements for high-speed CAN hardware.

Cables should be constructed to meet these requirements, as well as the requirements of the other CAN or DeviceNet devices in the network.

Connector Pinouts

Depending on the type of CAN interface you are installing, the CAN hardware has DB-9 D-Sub connectors(s), or Combicon-style pluggable screw terminal connector(s), or both.

The 9-pin D-Sub follows the pinout recommended by CiA DS 102. Figure B-1 shows the pinout for this connector.

![Figure B-1. Pinout for 9-Pin D-Sub Connector](image-url)
The 5-pin Combicon-style pluggable screw terminal follows the pinout required by the DeviceNet specification. Figure B-2 shows the pinout for this connector.

Figure B-2. Pinout for 5-Pin Combicon-Style Pluggable Screw Terminal

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.

The V+ and V– pins are used to supply bus power to the CAN physical layer if external power is required for the CAN physical layer. If internal power for the CAN physical layer is used, the V– pin serves as the reference ground for CAN_H and CAN_L. Refer to the next section, Power Supply Information for the High-Speed CAN Ports, for more information.
Figure B-3 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 Combicon-style pluggable screw terminal are connected directly to the corresponding pins on the 9-pin D-Sub.
Power Supply Information for the High-Speed CAN Ports

For the PCI-CAN and PXI-846x series cards, the power source for the CAN physical layer is configured with a jumper. The location of this jumper is shown in Figure B-4.

![Figure B-4. Parts Locator Diagram](image-url)
For the PCI-CAN and port one of the PCI-CAN/2 power is configured with jumper J6. For port two of the PCI-CAN/2, power is configured with jumper J5. These jumpers are shown in Figure B-5.

![Figure B-5. PCI-CAN/2 Parts Locator Diagram](image-url)
For port one of the PXI-8461, power is configured with jumper J5. For port two of the PXI-8461, power is configured with jumper J6. The location of these jumper is shown in Figure B-6.

**Figure B-6. PXI-8461 Parts Locator Diagram**

Connecting pins 1 and 2 of a jumper configures the CAN physical layer to be powered externally (from the bus cable power). In this configuration, the power must be supplied on the V+ and V– pins on the port connector.

Connecting pins 2 and 3 of a jumper configures the CAN physical layer to be powered internally (from the card). In this configuration, the V– signal serves as the reference ground for the isolated signals.
Figure B-7 shows how to configure your jumpers for internal or external power supplies.

The CAN physical layer is still isolated regardless of the power source chosen.

The PCMCIA-CAN series cards are available with two types of cable. The DeviceNet (bus powered) cable requires that the CAN physical layer be powered from the bus cable power.

The internal-powered cable supplies power to the CAN physical layer from the host computer. The V+ pin is not connected to any internal signals, but the corresponding pins on the 9-pin D-Sub and the 5 pin Combicon-style connectors are still connected. The V– pins serves as the reference ground for the isolated signals.

The CAN physical layer is isolated from the computer in both types of cable.

### Bus Power Supply Requirements

If the CAN physical layer is powered from a bus power supply, the power supply should be a DC power supply with an output of 10 to 30 V. The power requirements for the CAN ports for Bus-Powered configurations are shown in Table B-1. You should take these requirements into account when determining requirements of the bus power supply for the system.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage requirement</td>
<td>V+ 10–30 VDC</td>
</tr>
</tbody>
</table>
| Current requirement    | 40 mA typical
                          | 100 mA maximum           |

Table B-1. Power Requirements for the CAN Physical Layer for Bus-Powered Versions
Cable Specifications

Cables should meet the physical medium requirements specified in ISO 11898, shown in Table B-2.

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

Table B-2. ISO 11898 Specifications for Characteristics of a CAN_H and CAN_L Pair of Wires

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impedance</td>
<td>108 $\Omega$ minimum, 120 $\Omega$ nominal, 132 $\Omega$ maximum</td>
</tr>
<tr>
<td>Length-related resistance</td>
<td>70 m$\Omega$/m nominal</td>
</tr>
<tr>
<td>Specific line delay</td>
<td>5 ns/m nominal</td>
</tr>
</tbody>
</table>

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 B-3 lists the DeviceNet cable length specifications.

Table B-3. DeviceNet Cable Length Specifications

<table>
<thead>
<tr>
<th>Bit Rate</th>
<th>Thick Cable</th>
<th>Thin Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 kb/s</td>
<td>100 m</td>
<td>100 m</td>
</tr>
<tr>
<td>250 kb/s</td>
<td>200 m</td>
<td>100 m</td>
</tr>
<tr>
<td>100 kb/s</td>
<td>500 m</td>
<td>100 m</td>
</tr>
</tbody>
</table>
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 B-8 for an example of where termination resistors should be placed in a system with more than two devices.

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 B-9 shows an example of a cable to connect two CAN devices. For the internal power configuration, no V+ connection is required.

![Cabling Example Diagram]

**Figure B-9.** Cabling Example
Cabling Requirements for
Low-Speed CAN

This appendix describes the cabling requirements for the low-speed CAN hardware.

Cables should be constructed to meet these requirements, as well as the requirements of the other CAN devices in the network.

Connector Pinouts

The low-speed CAN hardware has DB-9 D-Sub connector(s). The 9-pin D-Sub follows the pinout recommended by CiA DS 102. Figure C-1 shows the pinout for this connector.

![Figure C-1. Pinout for 9-Pin D-Sub Connector](image-url)
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.

The V+ and V– pins are used to supply bus power to the CAN physical layer if external power is required for the CAN physical layer. If internal power for the CAN physical layer is used, the V– pin serves as the reference ground for CAN_H and CAN_L. Refer to the next section, *Power Supply Information for the Low-Speed CAN Ports*, for more information.

Figure C-2 shows the end of a PCMCIA-CAN/LS cable. The arrow points to pin 1 of the 7-pin screw terminal block. All of the signals on the 7-pin pluggable screw terminal, except RTL and RTH, are connected directly to the corresponding pins on the 9-pin D-Sub.

![Figure C-2. PCMCIA-CAN/LS Cable](image-url)
Power Supply Information for the Low-Speed CAN Ports

For the PCI-CAN/LS and port one of the PCI-CAN/LS2, power is configured with jumper J6. For port two of the PCI-CAN/LS2, power is configured with jumper J5. These jumpers are shown in Figure C-3.

<table>
<thead>
<tr>
<th>1</th>
<th>Power Supply Jumper J6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Product Name</td>
</tr>
<tr>
<td>3</td>
<td>Serial Number</td>
</tr>
<tr>
<td>4</td>
<td>Assembly Number</td>
</tr>
<tr>
<td>5</td>
<td>Power Supply Jumper J5</td>
</tr>
<tr>
<td>6</td>
<td>Termination Resistor Sockets</td>
</tr>
</tbody>
</table>

Figure C-3. PCI-CAN/LS2 Parts Locator Diagram
For port one of the PXI-8460, power is configured with jumper J5. For port two of the PXI-8460, power is configured with jumper J6. These jumpers are shown in Figure C-4.

Connecting pins 1 and 2 of a jumper configures the CAN physical layer to be powered externally (from the bus cable power). In this configuration, the power must be supplied on the V+ and V– pins on the port connector.

Connecting pins 2 and 3 of a jumper configures the CAN physical layer to be powered internally (from the card). In this configuration, the V– signal serves as the reference ground for the isolated signals. Even if the CAN physical layer is powered internally, the fault-tolerant CAN transceiver still requires bus power to be supplied in order for it to monitor the power supply (battery) voltage.

**Figure C-4.** PXI-8460 Parts Locator Diagram

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Power Supply Jumper J6</td>
</tr>
<tr>
<td>2</td>
<td>Power Supply Jumper J5</td>
</tr>
<tr>
<td>3</td>
<td>Assembly Number</td>
</tr>
<tr>
<td>4</td>
<td>Product Name</td>
</tr>
<tr>
<td>5</td>
<td>Serial Number</td>
</tr>
<tr>
<td>6</td>
<td>Termination Resistor Sockets</td>
</tr>
</tbody>
</table>
Figure C-5 shows how to configure your jumpers for internal or external power supplies.

![Power Source Jumpers](image)

**Figure C-5.** Power Source Jumpers

The CAN physical layer is still isolated regardless of the power source chosen.

### Bus Power Supply Requirements

If the CAN physical layer is powered from a bus power supply, the power supply should be a DC power supply with an output of 8 to 27 V. The power requirements for the CAN ports for Bus-Powered configurations are shown in Table C-1. You should take these requirements into account when determining requirements of the bus power supply for the system.

**Table C-1.** Power Requirements for the Low-Speed CAN Physical Layer for Bus-Powered Versions

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage requirement</td>
<td>V+ 8–27 VDC</td>
</tr>
<tr>
<td>Current requirement</td>
<td>40 mA typical</td>
</tr>
<tr>
<td></td>
<td>100 mA maximum</td>
</tr>
</tbody>
</table>
Cable Specifications

Cables should meet the physical medium requirements shown in Table C-2.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length-related resistance</td>
<td>90 mΩ/m nominal</td>
</tr>
<tr>
<td>Length-related capacitance: CAN_L and ground, CAN_H and ground, CAN_L and CAN_H</td>
<td>30 pF/m nominal</td>
</tr>
</tbody>
</table>

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, at least 20 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.
Low-Speed Termination

Every device on the low-speed CAN network requires a termination resistor for each CAN data line: $R_{TH}$ for CAN_H and $R_{TL}$ for CAN_L. Figure C-6 shows termination resistor placement in a low-speed CAN network.

![Figure C-6. Termination Resistor Placement for Low-Speed CAN](image)

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

**Determining the Necessary Termination Resistance for Your Board**

Unlike high-speed CAN, low-speed CAN requires termination at the low-speed CAN transceiver instead of on the cable. The termination requires one resistor: $R_{TH}$ for CAN_H and $R_{TL}$ for CAN_L. This configuration allows the Philips fault-tolerant CAN transceiver to detect any of seven network faults. You can use your PCI-CAN/LS or PXI-8460 to connect to a low-speed CAN network having from two to 32 nodes as specified by Philips (including the port on the PCI-CAN/LS or PXI-8460 as a node). You can also use the PCI-CAN/LS or PXI-8460 to communicate with individual low-speed CAN devices. It is important to determine the overall termination of your existing network, or the termination of your individual device, before connecting it to a PCI-CAN/LS or PXI-8460 port. Philips recommends an overall $R_{TH}$ and $R_{TL}$ termination of 100 to 500 $\Omega$ (each) for a properly terminated low-speed network. The overall network termination may be determined as follows:

$$\frac{1}{R_{TH\ overall}} = \frac{1}{R_{TH\ node\ 1}} + \frac{1}{R_{TH\ node\ 2}} + \frac{1}{R_{TH\ node\ 3}} + \ldots + \frac{1}{R_{TH\ node\ n}}$$
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 mounted RTH and RTL values of 510 Ω ±5% per port. 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 your existing network or device, you can use the following formula to indicate which value should be placed on your 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:

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

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

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

† \(R_{\text{RTH}} = R_{\text{RTL}}\)

As the formula indicates, the 510 Ω ±5% shipped on your 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 next section, Replacing the Termination Resistors on Your PCI-CAN/LS Board.

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 your existing network or device, you can use the formula below to indicate which configuration should be used on your PCMCIA-CAN/LS cable to produce the proper overall RTH and RTL termination of 100 to 500 Ω upon connection of the cable:

\[
R_{\text{RTH overall}^{*}} = \frac{1}{\left(\frac{1}{R_{\text{RTH of PCMCIA-CAN/LS}^{**}}} + \frac{1}{R_{\text{RTH of existing network or device}}}\right)}
\]
Appendix C  Cabling Requirements for Low-Speed CAN

*R<sub>RTH</sub><sub>overall</sub> should be between 100 and 500 Ω

**R<sub>RTH of PCMCIA-CAN/LS</sub> = 494 Ω (510 Ω ± 5% (external) in parallel with 15.8 KΩ ± 1% (internal)), or 15.8 KΩ ± 1% (internal) only

†R<sub>RTH</sub> = R<sub>RTL</sub>

As the formula indicates, the 510 Ω ± 5% in parallel with 15.8 KΩ ± 1% shipped on your 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:

\[
R_{\text{External RTH of PCMCIA-CAN/LS}} = \frac{1}{\left(\frac{1}{R_{\text{Desired RTH of PCMCIA-CAN/LS}}} - \frac{1}{R_{\text{Internal RTH of PCMCIA-CAN/LS}}}\right)}
\]

***R<sub>Internal RTH of PCMCIA-CAN/LS</sub> = 15.8 KΩ ± 1%

†R<sub>RTH</sub> = R<sub>RTL</sub>

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

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

1. Remove the termination resistors on your low-speed CAN card. Figure C-7 shows the location of the termination resistor sockets on a PCI-CAN/LS2 card.

![Figure C-7. Location of Termination Resistors on PCI-CAN/LS2 Board](image)

2. Cut and bend the lead wires of the resistors you want to install. Refer to Figure C-8.

![Figure C-8. Preparing Lead Wires of Replacement Resistors](image)
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 your program CD to complete the hardware installation.

**Replacing the Termination Resistors on Your PXI-8460 Board**

Follow these steps to replace the termination resistors, after you have determined the correct value in the previous section, *Determining the Necessary Termination Resistance for Your Board*.

1. Remove the termination resistors on your PXI-8460. Figure C-9 shows the location of the termination resistor sockets on a PXI-8460.

![Figure C-9. Location of Termination Resistors on a PXI-8460](image)
2. Cut and bend the lead wires of the resistors you want to install. Refer to Figure C-10.

![Figure C-10. Preparing Lead Wires of Replacement Resistors](image)

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 your program CD to complete the hardware installation.

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

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

1. Remove the two termination resistors on your 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 C-11.

![Figure C-11. Preparing Lead Wires of PCMCIA-CAN/LS Cable Replacement Resistors](image)
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 your program CD to complete the hardware installation.

## Cabling Example

Figure C-12 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.

![Cabling Diagram](image-url)
Cabling Requirements for Dual-Speed CAN

This section describes the cabling requirements for the dual-speed CAN hardware.

Port Identification

The PCI-CAN/DS card, PXI-8462 card, and PCMCIA-CAN/DS cable each provide a high-speed CAN port (port one), and a low-speed CAN port (port two). Port one of the PCI-CAN/DS is identical to port one of the PCI-CAN and PCI-CAN/2, and port two is identical to port two of the PCI-CAN/LS2.

Port one of the PXI-8462 is identical to port one of the PXI-8461 one-port and PXI-8461 two-port cards. Port two of the PXI-8462 is identical to port two of the PXI-8460 two-port card.

Port one of the PCMCIA-CAN/DS cable is identical to port one of the PCMCIA-CAN and PCMCIA-CAN/2 cables, and port two is identical to port two of the PCMCIA-CAN/LS2 cable. The PCI-CAN/DS card, PXI-8462 card and PCMCIA-CAN/DS cable allow simultaneous communication with both a high-speed and low-speed bus, each with its own specific cabling and termination requirements. For cabling requirements and port information for the high-speed CAN port, refer to Appendix B, Cabling Requirements for Dual-Speed CAN, in this manual. For cabling requirements and port information for the low-speed CAN port, refer to Appendix C, Cabling Requirements for Low-Speed CAN.
RTSI Bus

This appendix describes the RTSI interface on your CAN card.

RTSI and PCI

Figure E-1 shows the RTSI connector pinout for the PCI-CAN series cards.

<table>
<thead>
<tr>
<th>PCI-CAN Series Trigger</th>
<th>PCI-CAN Series Pin Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTSI Trigger &lt;0&gt;</td>
<td>20</td>
</tr>
<tr>
<td>RTSI Trigger &lt;1&gt;</td>
<td>22</td>
</tr>
<tr>
<td>RTSI Trigger &lt;2&gt;</td>
<td>24</td>
</tr>
<tr>
<td>RTSI Trigger &lt;3&gt;</td>
<td>26</td>
</tr>
<tr>
<td>RTSI Trigger &lt;4&gt;</td>
<td>28</td>
</tr>
<tr>
<td>RTSI Trigger &lt;5&gt;</td>
<td>30</td>
</tr>
<tr>
<td>RTSI Trigger &lt;6&gt;</td>
<td>32</td>
</tr>
<tr>
<td>RTSI Oscillator</td>
<td>34</td>
</tr>
<tr>
<td>GND</td>
<td>19, 21, 23, 25, 27, 29, 31, 33</td>
</tr>
</tbody>
</table>

Figure E-1. PCI-CAN Series RTSI Connector Pinout

Using the National Instruments RTSI bus with your CAN card consists of connecting it to other RTSI-equipped cards with RTSI ribbon cable, to route timing and trigger signals between the cards. Using the RTSI bus, your CAN card can be synchronized with multiple National Instruments DAQ cards in your computer. The RTSI bus can also be used to synchronize multiple CAN cards.
The PCI-CAN and PCI-CAN/2 cards allow for the connection of four RTSI input signals and four RTSI output signals. In order to fully support the fault reporting capabilities of the low-speed transceivers used on the PCI-CAN/LS, PCI-CAN/LS2, and PCI-CAN/DS, three RTSI lines on those cards are reserved for low-speed CAN fault reporting. This allows for the connection of three RTSI input signals and two RTSI output signals to the cards, providing them the real time synchronization benefits of RTSI without sacrificing low-speed CAN fault reporting.

RTSI, PXI and CompactPCI

Using PXI-compatible products with standard CompactPCI products is an important feature provided by the *PXI Specification*, Revision 1.0. If you use a PXI-compatible plug-in device in a standard CompactPCI chassis, you will be unable to use PXI-specific functions, but you can still use the basic plug-in device functions. For example, the RTSI bus on your PXI-846x series card is available in a PXI chassis, but not in a CompactPCI chassis. The CompactPCI specification permits vendors to develop sub-buses that coexist with the basic PCI interface on the CompactPCI bus. Compatible operation is not guaranteed between CompactPCI devices with different sub-buses nor between CompactPCI devices with sub-buses and PXI. The standard implementation for CompactPCI does not include these sub-buses. Your PXI-846x device will work in any standard CompactPCI chassis adhering to the *PICMG 2.0 R2.1 CompactPCI* core specification using the 64-bit definition for J2. PXI specific features are implemented on the J2 connector of the CompactPCI bus. Table E-1 lists the J2 pins your PXI-846x series card uses. Your PXI card is compatible with any CompactPCI chassis with a sub-bus that does not drive these lines. Even if the sub-bus is capable of driving these lines, the card is still compatible as long as those pins on the sub-bus are disabled by default and not ever enabled. Damage may result if these lines are driven by the sub-bus.

The PXI-8461 one-port and two-port cards allow for the connection of four RTSI input signals and four RTSI output signals. In order to fully support the fault reporting capabilities of the low-speed transceivers used on the PXI-8460 one port, PXI-8460 two port, and PXI-8462, three RTSI lines on those cards are reserved for low-speed CAN fault reporting. This allows for the connection of three RTSI input signals and two RTSI output signals to the cards, providing them the real time synchronization benefits of RTSI without sacrificing low-speed CAN fault reporting.
RTSI Cables

National Instruments offers a variety of RTSI bus cables for connecting your CAN card to other CAN or DAQ hardware. For more specific information about these cables, you can refer to the National Instruments catalog, or our Web site ni.com.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

RTSI Programming

For more information on RTSI programming, refer to the Synchronization section of Chapter 4, Using the Channel API, and the RTSI section of Chapter 7, Using the Frame API. Refer to the RTSI Bus Overview section of Chapter 1, Introduction, for more information on the RTSI bus.

<table>
<thead>
<tr>
<th>PXI Pin Name</th>
<th>PXI J2 Pin Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>PXI Star</td>
<td>D17</td>
</tr>
<tr>
<td>PXI Trigger &lt;0&gt;</td>
<td>B16</td>
</tr>
<tr>
<td>PXI Trigger &lt;1&gt;</td>
<td>A16</td>
</tr>
<tr>
<td>PXI Trigger &lt;2&gt;</td>
<td>A17</td>
</tr>
<tr>
<td>PXI Trigger &lt;3&gt;</td>
<td>A18</td>
</tr>
<tr>
<td>PXI Trigger &lt;4&gt;</td>
<td>B18</td>
</tr>
<tr>
<td>PXI Trigger &lt;5&gt;</td>
<td>C18</td>
</tr>
<tr>
<td>PXI Trigger &lt;7&gt;</td>
<td>E16</td>
</tr>
</tbody>
</table>
Summary of the CAN Standard

History and Use of CAN

In the past few decades, the need for improvements in automotive technology has led to increased use of electronic control systems for functions such as engine timing, anti-lock brake systems, and distributorless ignition. With conventional wiring, data is exchanged in these systems using dedicated signal lines. As the complexity and number of devices has increased, using dedicated signal lines has become increasingly difficult and expensive.

To overcome the limitations of conventional automotive wiring, Bosch developed the Controller Area Network (CAN) in the mid-1980s. Using CAN, devices (controllers, sensors, and actuators) are connected on a common serial bus. 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, and CAN chips were created by major semiconductor manufacturers such as Intel, Motorola, and Philips. With these developments, many 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 many 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 industrial applications such as textile machinery, packaging machines, and production line equipment such as photoelectric sensors and motion controllers. 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 systems such as agricultural equipment, nautical machinery, medical apparatus, semiconductor manufacturing equipment, and machine tools testify to the incredible 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 F-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 cease 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 CAN’s 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.
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 F-2 shows the essential fields of the standard and extended frame formats, and the following sections describe each field.

![Figure F-2. Standard and Extended Frame Formats](image)

**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 on its own.

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 is again possible.

CAN devices detect the following errors, which are described in the following sections:

- Bit error
- Stuff error
- CRC error
Appendix F  Summary of the CAN Standard

- 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 for 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. Since 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 is that 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 your 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 impact 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 Appendix C, Cabling Requirements for Low-Speed CAN.

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.
Specifications

This appendix describes the physical characteristics of the CAN hardware, along with the recommended operating conditions.

PCI-CAN Series

Dimensions................................. 10.67 by 17.46 cm
                                               (4.2 by 6.9 in.)
Power requirement ............................. +5 VDC, 775 mA typical
I/O connector.................................. 9-pin D-Sub for each port
                                               (standard)
or
                                               5-pin Combicon-style pluggable DeviceNet screw terminal
                                               (high-speed CAN only)

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 90%, noncondensing

PCMCIA-CAN Series

Dimensions......................................................... 8.56 by 5.40 by 0.5 cm
                                               (3.4 by 2.1 by 0.4 in.)
Power requirement .......................... 500 mA typical
I/O connector........................................... Cable with 9-pin D-Sub and
                                               pluggable screw terminal 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 90%, noncondensing

**PXI-CAN Series**

Dimensions ......................................... 16.0 by 10.0 cm
(6.3 by 3.9 in.)

Power requirement ............................ +5 VDC, 775 mA typical

I/O connector ................................. 9-pin D-Sub for each port
(standard)

or

5-pin Combicon-style pluggable
DeviceNet screw terminal
(high-speed CAN only)

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
( Tested in accordance with IEC-60068-2-1, IEC-60068-2-2,
IEC-60068-2-56.)

Functional Shock ............................. 30 g peak, half-sine, 11ms 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.)
High-Speed CAN Port Characteristics

Bus power .............................................. 0 to 30 V, 40 mA typical, 100mA maximum

CAN-H, CAN-L........................................... –8 to +18V, DC or peak, CATI

Low-Speed CAN Port Characteristics

Bus Power .............................................. 8 to 27 V, 40 mA typical, 100 mA maximum

CAN-H, CAN-L........................................... –10 to +27V, DC or peak, CATI

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 3121-1
- CAN/CSA C22.2 No. 1010.1

Electromagnetic Compatibility

EMC/EMI............................................... CE, C-Tick, and FCC Part 15 (Class A) Compliant

Electrical emissions............................... EN 55011 Class A at 10 m

FCC Part 15A above 1 GHz

Electrical immunity............................... Evaluated to EN 61326:1997/

A1:1998, Table 1

Note For full EMC compliance, you must operate this device with shielded cabling. In addition, all covers and filler panels must be installed. Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, click Declaration of Conformity at ni.com/hardref.nsf/. This Web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.
Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Online technical support resources include the following:
  - **Self-Help Resources**—For immediate answers and solutions, visit our extensive library of technical support resources available in English, Japanese, and Spanish at ni.com/support. These resources are available for most products at no cost to registered users and include software drivers and updates, a KnowledgeBase, product manuals, step-by-step troubleshooting wizards, hardware schematics and conformity documentation, example code, tutorials and application notes, instrument drivers, discussion forums, a measurement glossary, and so on.
  - **Assisted Support Options**—Contact NI engineers and other measurement and automation professionals by visiting ni.com/ask. Our online system helps you define your question and connects you to the experts by phone, discussion forum, or email.

- **Training**—Visit ni.com/custed for self-paced tutorials, videos, and interactive CDs. You also can register for instructor-led, hands-on courses at locations around the world.

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

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.
**Glossary**

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Meanings</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-</td>
<td>nano-</td>
<td>$10^{-9}$</td>
</tr>
<tr>
<td>m-</td>
<td>milli-</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>k-</td>
<td>kilo-</td>
<td>$10^3$</td>
</tr>
<tr>
<td>M-</td>
<td>mega-</td>
<td>$10^6$</td>
</tr>
</tbody>
</table>

**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 ship 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 and the Philips SJA1000.

CANdb

CAN database format defined by Vector Informatik. CANdb files use the .dbc file extension.

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 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 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).

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’s 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 its own 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.
Glossary

**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.
### Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>extended arbitration ID</td>
<td>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).</td>
</tr>
<tr>
<td>FCC</td>
<td>Federal Communications Commission.</td>
</tr>
<tr>
<td>filepath</td>
<td>Complete path to a filename using Windows conventions, such as:</td>
</tr>
<tr>
<td></td>
<td>C:\Program Files\National Instruments\NI-CAN\MyDatabase.ncd</td>
</tr>
<tr>
<td>frame</td>
<td>A unit of information transferred across a network from one node to another. From an OSI perspective, NI-CAN’s usage of the term frame refers to a Data Link Layer unit, because individual fields are not specified.</td>
</tr>
<tr>
<td>Frame API</td>
<td>NI-CAN API that you use to read and write frames.</td>
</tr>
<tr>
<td>hex</td>
<td>Hexadecimal.</td>
</tr>
<tr>
<td>Hz</td>
<td>Hertz; cycles per second.</td>
</tr>
<tr>
<td>instance</td>
<td>An abstraction of a specific real-world thing; for example, John is an instance of the class Human. Also known as object.</td>
</tr>
<tr>
<td>Interface Baud Rate</td>
<td>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.</td>
</tr>
</tbody>
</table>
**Glossary**

| **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. |
| **Interface** | See interface. |
| **ISO** | International Standards Organization. |
| **K** | Kilobytes of memory. |
| **KB** | Kilobytes of memory. |
| **L** | Megabytes of memory. |
| **LabVIEW** | Laboratory Virtual Instrument Engineering Workbench. |
| **local** | Within NI-CAN, anything that exists on the same host (personal computer) as the NI-CAN driver. |
| **Low-speed CAN** | Fault-tolerant CAN transceiver specification as defined in ISO 11898. |
| **M** | 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. |
| **MAX** | Megabytes of memory. |
| **MB** | 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. |
| **message** | }
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.

Mode  See mode.

multi-drop  A physical connection in which multiple devices communicate with one another along a single cable.

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 your 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 your 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 your 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 your 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).

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 a CAN card’s sync cable and a DAQ card’s terminal block.
Glossary

S

s

Seconds.

data

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 \texttt{nctInitStart} for C.

SampleRate

\textit{See} sample rate.

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 \textit{transmitter}.

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.
Glossary

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 your LabVIEW documentation.

The Read and Write functions of the Channel API support the LabVIEW waveform data type.
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