NI CAN Demo Box

This document discusses the architecture and use of the
NI CAN Demo Box, and provides examples for software.

Introduction

The NI CAN Demo Box, when communicating with National Instruments
Controller Area Network (CAN) and National Instruments Data
Acquisition (DAQ) hardware on a PC, provides a tool to demonstrate
concepts of CAN communication, DAQ, and CAN/DAQ synchronization.

The NI CAN Demo Box has a function generator, one CAN interface, one
CAN monitor connector, a 68-pin DAQ connector, access to the DAQ
interface TRIG1, TRIG2, and FREQOUT pins, and digital input switches.

What You Need to Get Started

To set up the NI CAN Demo Box, you will need the following hardware
and documentation.

❑   NI CAN Demo Box

❑   *NI CAN Demo Box User Guide*

❑   Power supply (+9 VDC to +12 VDC)

❑   1 port (minimum) High-Speed CAN board (2 port optional for
    monitoring)

❑   1 single termination CAN cable (second single termination cable
    optional for monitoring)

❑   68-pin Multifunction Data Acquisition board

❑   68-pin Data Acquisition cable

❑   Jumper wires

Unpacking

⚠️ **Cautions**   Your NI CAN Demo Box is shipped in an antistatic package to prevent electrostatic damage. Electrostatic discharge can damage several components on the device. To avoid such damage in handling the device, take the following precautions.

Ground yourself through a grounding strap or by touching a grounded object.

Touch the antistatic package to a metal part of the computer chassis before removing the NI CAN Demo Box from the package.

Remove the NI CAN Demo Box from the package and inspect it for loose components or any other sign of damage. Notify National Instruments if the unit appears to be damaged in any way. Do *not* use a damaged NI CAN Demo Box with a computer.

Never touch the exposed pins of connectors.

Installation

This section explains how to set up your NI CAN Demo Box for communication. Refer to Figure 1, for the layout of the parts on the NI CAN Demo Box.
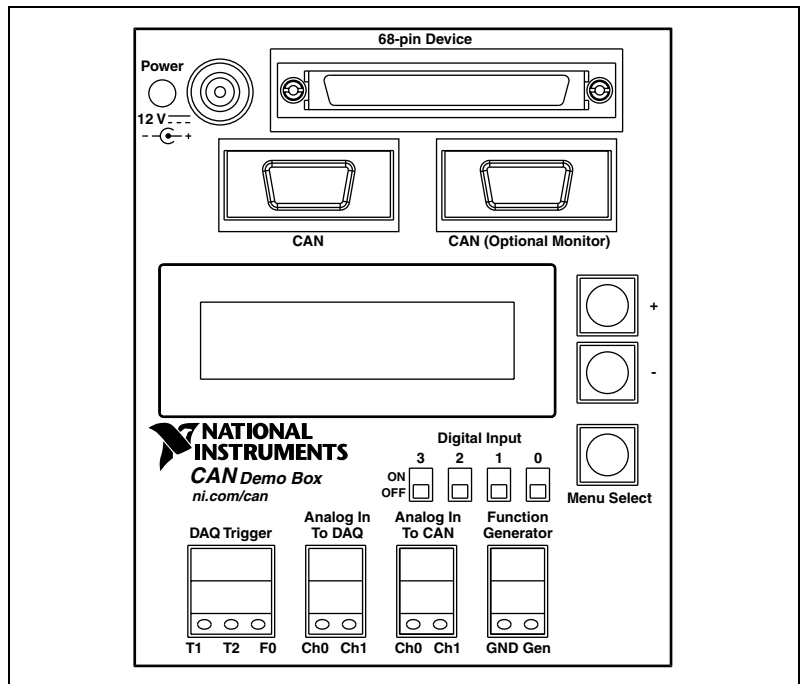
Figure 1. NI CAN Demo Box Parts Locator Diagram.

Complete the following steps to install the NI CAN Demo Box hardware, and configure it for use.

1. Install the application development environment according to its installation instructions. To utilize the examples listed in the *Examples* section, install LabVIEW 6.1 or later, along with its documentation.

2. Install the driver software for the CAN and DAQ hardware according to instructions. To utilize the examples listed in the *Examples* section, install NI-CAN 2.2 or later, NI-DAQ 7.0 or later (only for CAN and DAQ synchronization examples), and documentation for each.

3. Install your CAN and DAQ hardware according to the provided instructions.

4. Connect one single termination CAN cable between the **CAN** port on the NI CAN Demo Box and Port 1 on the CAN hardware.

5. For optional monitoring, connect a second single termination CAN cable between the **CAN (Optional Monitor)** port on the NI CAN Demo Box and Port 2 on the CAN hardware.

6. Connect a jumper wire between the **Function Generator Gen** terminal and the **Analog In To CAN Ch0** terminal.

7. Connect a second jumper wire between the **Function Generator Gen** terminal and the **Analog In To CAN Ch1** terminal.

8. Connect a 68-pin DAQ cable between the **68-pin DAQ Connector** on the NI CAN Demo Box and the 68-pin port on the DAQ hardware.

9. Connect a jumper wire between the **Function Generator Gen** terminal and the **Analog In To DAQ Ch0** terminal.

10. Connect a second jumper wire between the **Function Generator Gen** terminal and the **Analog In To DAQ Ch1** terminal.

11. Connect the DC power supply to the box. At power up, the box will begin transmitting the WAVEFORM0_SAW0_SWITCHES_FROM_CDB and WAVEFORM1_SAW1_FROM_CDB messages at the NI-CAN default baud rate of 125 K. For more information on these messages, refer to the *CAN Communication* section.

12. If using NI-CAN, verify that the CAN messages are being transmitted by running the Bus Monitor in the Measurement & Automation Explorer (MAX). To run the Bus Monitor, right-click the port connected to the **Port** connector on the NI CAN Demo Box and select Bus Monitor.

13. Load the CAN Demo Box.ncd file into the CAN Channels in MAX. To load the .ncd file, right-click **CAN Channels** under **Data Neighborhood**. Select **Load Channel Configuration**. Open CAN Demo Box.ncd from its location. Select **Add All Messages and Channels**. Click **Load**, and then click **Done**.

Operation

The following sections explain the functions and communication of the NI CAN Demo Box.

Functional Overview

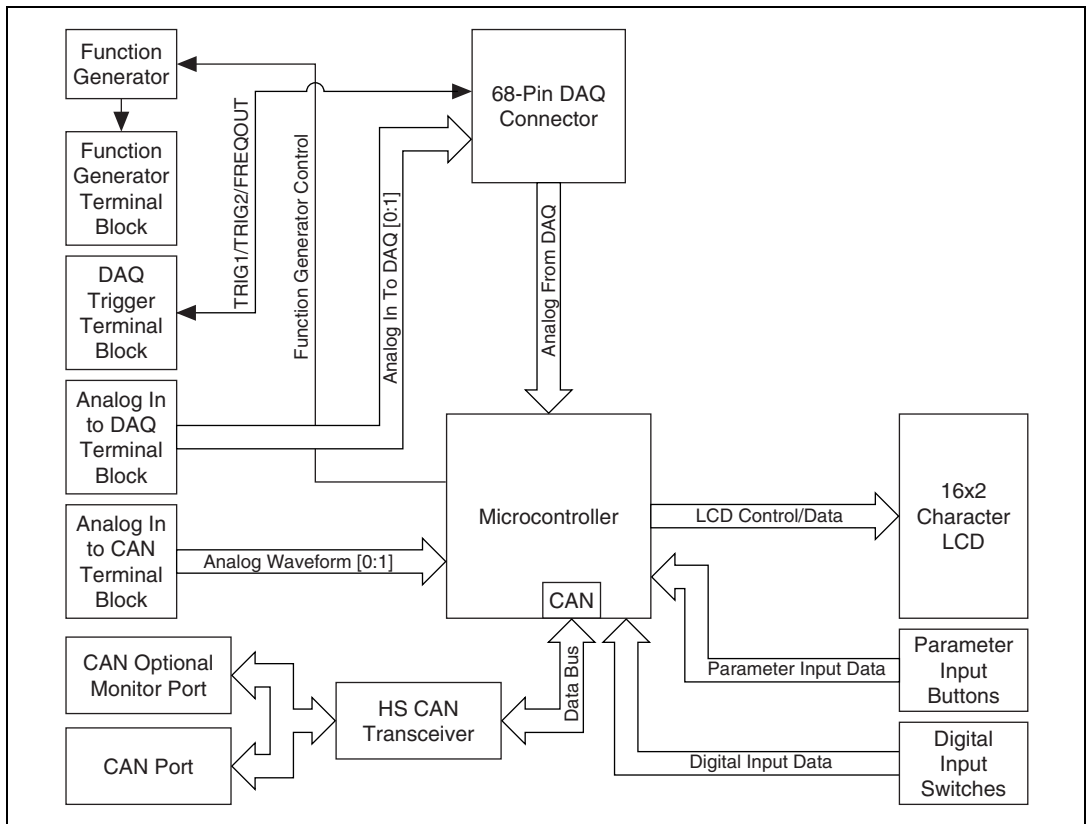Figure 2 is a block diagram overview of the NI CAN Demo Box architecture.

Figure 2. NI CAN Demo Box Architecture

Function Generator

The Function Generator provides a sine, square, or triangle output waveform. The waveform type and frequency are user-adjustable through the parameter input buttons or CAN messages. The negative and positive peak values of the sine and triangle waveforms are 0.2 V and 3.6 V, respectively, on the function generator terminal block output. The output voltage range of the square waveform is 0 to 5 V.

The Function Generator Terminal Block provides a way to connect to the function generator output.

DAQ

The 68-Pin DAQ Connector connects the DAQ interface analog in, analog out, and trigger pins to the box.

The DAQ Trigger Terminal Block provides a way to connect to the DAQ interface TRIG1, TRIG2, and FREQOUT pins.

The Analog In To DAQ Terminal Block provides a way to connect to the DAQ interface ACH0 and ACH1 pins.

The Analog From DAQ connection routes the analog output from AO0 of your data acquisition hardware to the NI CAN Demo Box.

Table 1 provides a mapping of the pins on a National Instruments MIO board to the connectors on the NI CAN Demo Box.

Table 1. Pin Mapping

NI CAN Demo Box	MIO Pin Number
Analog From DAQ	22*—AO 0
Analog In To DAQ Ch1	33—AI 1
Analog In To DAQ Ch0	68—AI 0
TRIG1/T1	11—PFI 0/AI START TRIG
TRIG2/T2	10—PFI 1/AI REF TRIG
FREQOUT/F0	1—FREQOUT
* This pin is only available on NI DAQ hardware that has Analog Output.	

CAN

The Analog In To CAN Terminal Block provides a way to connect to the CAN CH0 and CH1 pins of the microcontroller. A signal may be sampled and have its waveform transmitted through CAN messages from the box.

The CAN Port connects the CAN interface card in the PC to the box.

The CAN (Optional Monitor) Port is wired in parallel with the CAN Port. It allows another CAN interface port to monitor the CAN bus activity of the NI CAN Demo Box.

Parameter Input Buttons

The Parameter Input Buttons are used to input various operating parameters. Refer to the *LCD Menu* section for more information on the parameters.

Digital Input Switches

The states of the Digital Input Switches can be transmitted through CAN messages from the box.

LCD Menu

The **LCD**, **Menu Select**, and **+/–** push buttons provide an intuitive interface for controlling box parameters. The box powers up with the CAN/DAQ menu active.

To cycle through the menus, click the **Menu Select** button. The **+/–** push buttons allow adjustment of the associated parameter within each menu. The **Menu Select** and **+/–** push buttons can be clicked, or held to adjust menus or parameters at a slow, then increased, rate. The menus and parameters for each are as follows:

- **CAN/DAQ** (power up default)
    - No parameters adjustable using **+/–** push buttons
- **Function Generator Output**
    - **Sine** (power up default)
    - **Square**
    - **Triangle**
- **Function Generator Frequency**
    - 0.1 Hz–1 KHz (power up default is 0.5 Hz)
- **LCD Contrast**
    - **–** Lower
    - **+** Higher
- **CAN Baud Rate**
    - **125 K** (power up default)
    - **250 K**
    - **500 K**
    - **1 M**
- **CAN Transmit**
    - **Disable All**
    - **Ch0/Saw0/Sw Only**
    - **Ch1/Saw1 Only**
    - **Enable All** (power up default)

CAN Communication

Refer to the following tables for a description of the Messages and Channels provided by the `CAN Demo Box.ncd` file to communicate with the NI CAN Demo Box.

Message and Channel Descriptions

Table 2. WAVEFORM0_SAW0_SWITCHES_FROM_CDB

Channel Names	Description
AnalogInToCANCh0	A 10-bit sample of the signal on the Analog In To CAN terminal block Ch0 input.
Sawtooth0	An 8-bit value of a sawtooth waveform generated by the box microprocessor.
Switch0..3	A 1-bit sample of each of the Digital Input 3 2 1 0 switch states.

Table 3. WAVEFORM1_SAW1_FROM_CDB

Channel Names	Description
AnalogInToCANCh1	A 10-bit sample of the signal on the Analog In To CAN terminal block Ch1 input.
Sawtooth1	An 8-bit value of a second sawtooth waveform generated by the box microprocessor.

Table 4. STRING_REQUEST_TO_CDB

Channel Names	Description
StringRequest	Queries the box to return a message containing the string "NI-CAN" as 6 ASCII characters in 6 byte-wide channels. The box ignores the data and data length code. It simply responds with STRING_RESPONSE_FROM_CDB when it receives this message.

Table 5. STRING_RESPONSE_FROM_CDB

Channel Names	Description
StringCharacter0..5	Response to STRING_REQUEST_TO_CDB. The string "NI-CAN" is returned as 6 ASCII characters in 6 byte-wide channels.

Table 6. WAVEFORM_DIGITAL_TO_CDB

Channel Names	Description
CAN-DAQDisplayCANBargraph	A 10-bit sample of waveform data to display on the CAN bar graph in the **CAN/DAQ** menu.
CAN-DAQDisplayDigital0..3	A 1-bit sample of digital data to be displayed for each of the 3 2 1 0 indicators in the **CAN/DAQ** menu.

Table 7. SET_CDB_TRANSMIT

Channel Names	Description
TransmitType	Control transmission of the WAVEFORM0_SAW0_SWITCHES_FROM_CDB and WAVEFORM1_SAW1_FROM_CDB messages. Values: 0—Disable all 1—Waveform0-Sawtooth0-Switches only 2—Waveform1-Sawtooth1 only 3—Enable all Default = 3

Table 8. SET_BAR_GRAPH_MODE

Channel Names	Description
CAN-DAQDisplayBargraphMode	Set the display mode for the CAN and DAQ bar graphs in the **CAN/DAQ** menu. Values: 0—Dot mode 1—Bar mode Default = 1

Table 9. SET_PERIODIC_RATE

Channel Names	Description
DelayMultiplier	The periodic transmission rate of `WAVEFORM0_SAW0_SWITCHES_FROM_CDB` equals `DelayMultiplier * 200 nanoseconds`.
	Since the Analog In To CAN terminal block Ch0 input is sampled at each transmission of the `WAVEFORM0_SAW0_SWITCHES_FROM_CDB` message, the sample rate for the **AnalogInToCANCh0** channel is equal to the periodic transmission rate of `WAVEFORM0_SAW0_SWITCHES_FROM_CDB`. **DelayMultiplier** does not affect the periodic transmission rate of `WAVEFORM1_SAW1_FROM_CDB`.
	Values:
	Range is 0 to 65,535
	Default = 50,000 (10 milliseconds)

Table 10. SET_BAUD_RATE

Channel Names	Description
BaudRateType	Set the baud rate of the CAN controller.
	Values:
	2—125 Kbps 3—250 Kbps 4—500 Kbps 5—1 Mbps
	Default = 2

Table 11. SET_FUNC_GEN_OUTPUT

Channel Names	Description
FunctionGeneratorOutput	Set the output waveform type of the function generator. Values: 0—Sine 1—Square 2—Triangle Default = 0

Table 12. SET_FUNC_GEN_FREQ

Channel Names	Description
FunctionGeneratorFrequency	Set the frequency of the function generator. Values: 0 to 9—0.1 Hz to 1 Hz in 0.1 Hz increments 9 to 18—1 Hz to 10 Hz in 1 Hz increments 18 to 117—10 Hz to 1,000 Hz in 10 Hz increments Default = 4 (0.5 Hz)

Table 13. SET_LCD_CONTRAST

Channel Names	Description
LCDContrast	Adjust the contrast of the LCD. Values: 0—Contrast decrease 1—Contrast increase

Table 14. SET_LCD_DISPLAY

Channel Names	Description
LCDMenu	Select the menu to be displayed on the LCD. Values: 0—CAN baud rate 1—CAN transmit status 2—CAN/DAQ 3—Function generator output 4—Function generator frequency 5—LCD contrast Default = 2

Examples

The following section describes how to use the NI-CAN examples with LabVIEW. For more examples, refer to KnowledgeBase **3B8DEVHR**.

NI-CAN Examples

📝 **Note** The **Waveform Input.vi** example is listed twice. The first example deals with reading a terminal block input and the internally generated sawtooth waveform, and the second example deals with reading the status of the switches.

Example Name	Waveform Input.vi
Description	Read the Analog In To CAN Ch0 terminal block input and internally generated sawtooth waveform through CAN.
Instructions	1. Open the **Waveform Input.vi** example. 2. In the channel list, change *TransmissionOilPressure* to *AnalogInToCANCh0*, and *TransmissionFilterPressure* to *Sawtooth0*. 3. Change the sample rate to 250.0. 4. Right click the **Waveform Chart**, select **Y Scale**, and check **Autoscale Y**. 5. Run the VI.
Notes	The waveform chart will display white sine (*AnalogInToCANCh0*) and red sawtooth (*Sawtooth0*) waveforms. The frequency of the sawtooth waveform is fixed, but the sine waveform frequency may be adjusted using the box push buttons. The sine waveform may also be changed to triangle or square using the push buttons.

Example Name	Waveform Input.vi
Description	Read the states of switches 0 and 1 through CAN.
Instructions	1. Open the **Waveform Input.vi** example. 2. In the channel list, change *TransmissionOilPressure* to **Switch0**, and *TransmissionFilterPressure* to **Switch1**. 3. Change the sample rate to 250.0. 4. Run the VI.
Notes	The waveform chart provides a logic analyzer type display. The white waveform represents the state of switch 0 (scaled such that ON = 40 and OFF = 35). The red waveform represents the state of switch 1 (scaled such that ON = 30 and OFF = 25). Observe the waveform changes as you toggle switches 0 and 1 on the box.

Example Name	Single Sample Periodic Output.vi
Description	Write the CAN bar graph and digital 0 indicator in the **LCD CAN/DAQ** menu through CAN.
Instructions	1. Open the **Single Sample Periodic Output.vi** example. 2. In the channel list, change *TransmissionOilPressure* to *CAN-DAQDisplayCANBargraph*, and *TransmissionFilterPressure* to *CAN-DAQDisplayDigital0.* 3. Right click the **Channel 0** knob, and select **Data Range**. Click the **Scale** tab and change the **Scale Range Maximum** value to 5.5. 4. Use the **Menu Select** push button to select the **LCD CAN/DAQ** menu. 5. Run the VI.
Notes	Turn the **Channel 0** knob and notice the LCD CAN bar graph change. Move the **Channel 1** slider from 0 to 40 and notice the LCD digital 0 indicator change. The *CAN-DAQDisplayDigital0* channel is scaled such that OFF = 0 (no asterisk) and ON = 40 (asterisk).

NI-CAN & NI-DAQ Examples

Example Name	CAN Waveform Input and AI Waveform Input.vi
Description	Read the Analog In To DAQ and Analog In To CAN Ch0 and Ch1 terminal block inputs through CAN and DAQ.
Instructions	1. Open the **CAN Waveform Input and AI Waveform Input.vi** example. 2. In the channel list, change *TransmissionOilPressure* to *AnalogInToCANCh0*, and *TransmissionFilterPressure* to *AnalogInToCANCh1*. 3. Change the sample rate to `250.0`. 4. Right click the **Waveform Chart**, select **Y Scale**, and check **Autoscale Y**. 5. Run the VI.
Notes	The waveform chart will display red (*AnalogInToCANCh1*), white (*AnalogInToCANCh0*) and green overlapping blue sine waveforms (*Analog In To DAQ Ch0* and *Analog In To DAQ Ch1* are connected to the same signal, with no scaling). Notice how the white and red (*Analog In To CAN channel*), and green and blue (*Analog In To DAQ channel*) waveforms remain synchronized through RTSI. Notice that the red waveform shows more stair stepping than the white waveform, since the *AnalogInToCANCh1* channel message is transmitted at a 50 ms periodic rate, while the *AnalogInToCANCh0* channel message is transmitted at a 10 ms rate. The sine waveform frequency may be adjusted using the box push buttons. The sine waveform may also be changed to triangle or square using the push buttons.

Example Name	CAN Waveform Output and AO Waveform Output.vi
Description	Write the CAN bar graph in the **LCD CAN/DAQ** menu through CAN. Write the DAQ bar graph in the **LCD CAN/DAQ** menu through DAQ.
Instructions	1. Open the **CAN Waveform Output and AO Waveform Output.vi** example. 2. In the channel list, change *TransmissionOilPressure* to *CAN-DAQDisplayCANBargraph* and delete *TransmissionFilterPressure*. Right-click the entry, go to **Data Operations**, and select **Delete Element**. 3. Open the **CAN Waveform Output and AO Waveform Output.vi** diagram and change the amplitude and offset constants in the sinewave generator For Loop, from 5.0 to 2.75. 4. Use the **Menu Select** push button to select the **LCD CAN/DAQ** menu. 5. Run the VI. Notice the behavior of the LCD CAN and DAQ bar graphs. Notice that the waveforms are synchronized with a 90-degree phase shift relative to one another.
Notes	This example requires a data acquisition board with analog output capabilities.

Example Name	Single Sample Periodic Output.vi (Uses MAX)
Description	Adjust the function generator frequency and output via CAN, and observe the resulting waveform changes through DAQ using a MAX test panel.
Instructions	1. Open the **Single Sample Periodic Output.vi** example. 2. In the channel list, change *TransmissionOilPressure* to *FunctionGeneratorFrequency*, and *TransmissionFilterPressure* to *FunctionGeneratorOutput*. 3. Right click the **Channel 0** knob, and select **Data Range**. Click the **Scale** tab and change the **Scale Range Maximum** value to 117. 4. Right click the **Channel 1** slider, and select **Data Range**. Click the **Scale** tab and change the **Scale Range Maximum** value to 2. 5. Open the MAX Test Panel for your DAQ device. Click the **Analog Input** tab and set the following: Channel = 0 Input Limits High = 5 Input Limits Low = 0 Data Mode = Continuous Sample Rate = 4000.0 Hz Click the **Start** button. 6. Run the VI.
Notes	Position the Test Panel and VI such that both are visible on the desktop. Turn the **Channel 0** knob and notice the Test Panel Analog Input waveform display reflect the frequency change. Move the **Channel 1** slider slowly from 0 to 1 then 2, and notice the Test Panel Analog Input waveform display reflect the change from sine to square, then triangle waveforms.

Specifications

This section describes the physical characteristics of the NI CAN Demo Box, along with the recommended operating conditions.

Electrical

Functional Generator Gen Terminal

    Maximum output current .... 12 mA

    Maximum capacitive load............... 200 pF

Typical output voltage

    Square waveform......................5 V_{pp}, 2.5 VDC offset

    Sine and Triangle waveforms...3.38 V_{pp}, 1.9 VDC offset

Analog In To CAN Terminal

    Voltage range....................................0 to 5 V

Note For information on the DAQ Trigger Terminal and Analog In To DAQ Terminal, refer to the documentation for the data acquisition hardware.

Power Requirement

+9 to +12 VDC ....100 mA typical
200 mA maximum

Physical

Dimensions ....12.95 cm × 12.95 cm × 4.83 cm
(5.1 in. × 5.1 in. × 1.9 in.)

I/O connectors..9-pin male D-SUB for CAN port

9-pin male D-SUB for CAN (Optional Monitor) port

68-pin male SCSI for DAQ port

3-pin terminal block for DAQ Trigger connections

2-pin terminal block for Analog In To DAQ connections

2-pin terminal block for Analog In To CAN connections

2-pin terminal block for Function Generator connections

2 mm, center-positive radial connector for DC power

Operating Environment

Ambient temperature.............................. 0 to 40 °C

Relative humidity.................................. 10 to 90%, noncondensing

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

Indoor use only.

Pollution Degree 2

Altitude... 2,000 m

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.)

High-Speed CAN

Transceiver... Philips TJA1041

Maximum baud rate .... 1 Mbps

CAN_H, CAN_L bus lines .... –27 to +40 VDC

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1
- CAN/CSA-C22.2 No. 61010-1

Note For UL and other safety certifications, refer to the product label or to `ni.com/certification`, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

Emissions...EN 55011 Class A at 10 m
FCC Part 15A above 1 GHz

Immunity ....EN 61326:1997 + A2:2001,
Table 1

EMC...CE, C-Tick, and FCC Part 15
(Class A) compliant

Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European
Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety)..............73/23/EEC

Electromagnetic Compatibility
Directive (EMC) 89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional
regulatory compliance information. To obtain the DoC for this product, visit
ni.com/certification, search by model number or product line, and click the
appropriate link in the Certification column.

Where to Go for Support

The National Instruments Web site is your complete resource for technical
support. At ni.com/support you have access to everything from
troubleshooting and application development self-help resources to email
and phone assistance from NI Application Engineers.

A Declaration of Conformity (DoC) is our claim of compliance with the
Council of the European Communities using the manufacturer's
declaration of conformity. This system affords the user protection for
electronic compatibility (EMC) and product safety. You can obtain the DoC
for your product by visiting ni.com/certification. If your product
supports calibration, you can obtain the calibration certificate for your
product at ni.com/calibration.

National Instruments corporate headquarters is located at
11500 North Mopac Expressway, Austin, Texas, 78759-3504.
National Instruments also has offices located around the world to help
address your support needs. For telephone support in the United States,

create your service request at `ni.com/support` and follow the calling instructions or dial 512 795 8248. For telephone support outside the United States, contact your local branch office:

Australia 1800 300 800, Austria 43 0 662 45 79 90 0,
Belgium 32 0 2 757 00 20, Brazil 55 11 3262 3599,
Canada 800 433 3488, China 86 21 6555 7838,
Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 385 0 9 725 725 11, France 33 0 1 48 14 24 24,
Germany 49 0 89 741 31 30, India 91 80 51190000,
Israel 972 0 3 6393737, Italy 39 02 413091, Japan 81 3 5472 2970,
Korea 82 02 3451 3400, Lebanon 961 0 1 33 28 28,
Malaysia 1800 887710, Mexico 01 800 010 0793,
Netherlands 31 0 348 433 466, New Zealand 0800 553 322,
Norway 47 0 66 90 76 60, Poland 48 22 3390150,
Portugal 351 210 311 210, Russia 7 095 783 68 51,
Singapore 1800 226 5886, Slovenia 386 3 425 4200,
South Africa 27 0 11 805 8197, Spain 34 91 640 0085,
Sweden 46 0 8 587 895 00, Switzerland 41 56 200 51 51,
Taiwan 886 02 2377 2222, Thailand 662 992 7519,
United Kingdom 44 0 1635 523545