
Keithley DDA-08/16

Using DriverLINX with Your Hardware

KEITHLEY

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Keithley DDA-08/16: Using DriverLINX with Your Hardware

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Preface

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About DriverLINX

Welcome to DriverLINX® for Microsoft® Windows™, the high-performance real-time data-acquisition device drivers for Windows application development.

DriverLINX is a language- and hardware-independent application programming interface designed to support hardware manufacturers' high-speed analog, digital, and counter/timer data-acquisition boards in Windows. DriverLINX is a multi-user and multitasking data-acquisition resource manager providing more than 100 services for foreground and background data acquisition tasks.

Included with your DriverLINX package are the following items:

- The DriverLINX API DLLs and drivers supporting your data-acquisition hardware
- Analog I/O Panel, a DriverLINX program that verifies the installation and configuration of DriverLINX for your analog input/output board and demonstrates several virtual bench-top instruments
- Learn DriverLINX, an interactive learning and demonstration program for DriverLINX that includes a Digital Storage Oscilloscope
- Source code for the sample programs
- The DriverLINX Application Programming Interface files for your compiler
- DriverLINX On-line Help System
- *DriverLINX 4.0 Installation and Configuration Guide*
- *DriverLINX Analog I/O Programming Guide*
- *DriverLINX Technical Reference Manual*
- Supplemental Documentation on DriverLINX and your data acquisition hardware

About This User's Guide

The purpose of this manual is to help you quickly learn how to configure and use the hardware features of Keithley's DDA-08/16 boards with DriverLINX.

- For help installing and configuring your hardware and DriverLINX, please see the manual that accompanied your hardware and the *DriverLINX 4.0 Installation and Configuration Guide* for your version of Windows.
- For more information on the DriverLINX API, please see the *DriverLINX Technical Reference Manual*.
- For additional help programming your board, please examine the source code examples on the Distribution Disks.

This manual contains the following chapters:

Configuring the DDA-08/16

Shows how to configure the DDA-08/16 using the *Configure DriverLINX Device* dialog box.

Using the DDA-08/16 with DriverLINX

Shows how to set up DriverLINX with the *Edit Service Request* dialog box to use DDA-08/16 hardware features.

Conventions Used in This Manual

The following notational conventions are used in this manual:

- A round bullet (●) identifies itemized lists.
- Numbered lists indicate step-by-step procedures.
- DriverLINX Application Programming Interface and Windows macro and function names are set in bold when mentioned in the text.
- **DriverLINX** indicates the exported function name of the device driver DLL while DriverLINX indicates the product as a whole.
- DriverLINX Application Programming Interface identifiers, menu items, and Dialog Box names are italicized when mentioned in the text.
- *Italics* are used for emphasis.
- Source code and data structure examples are displayed in Courier typeface and bounded by a box with a single line.

Code

- A box with a double line bounds a table of information.

Tables

Concept

- Important concepts and notes are printed in the left margin.

Configuring the DDA-08/16

Introduction


The installation program provides general instructions for installing and configuring DriverLINX. This manual explains the steps and special features that apply to Keithley's DDA-08/16 boards.

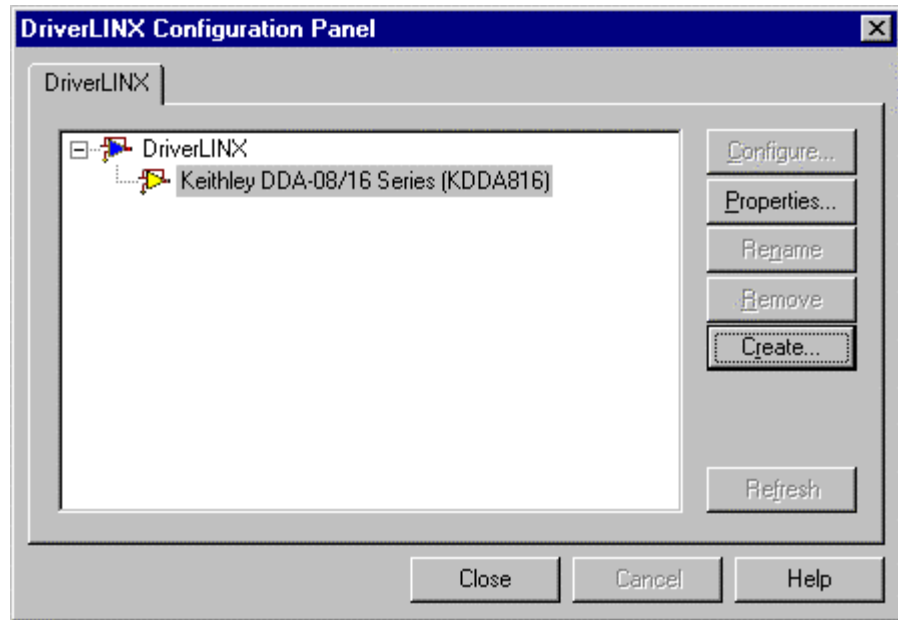
Installing and configuring DriverLINX for the Keithley DDA-08/16 boards requires three steps:

1. **Install DriverLINX.** Follow the instructions given by the installation program. The *Read Me First* instructions explain the components and drivers you can install.
2. **Configure DriverLINX.** See “Configure DriverLINX Device Dialog” on page 11 for configuration options specific to a Keithley DDA-08/16 model.
3. **Install your DDA-08/16 hardware,** read and follow the instructions in your hardware manual.

Configure DriverLINX Device Dialog

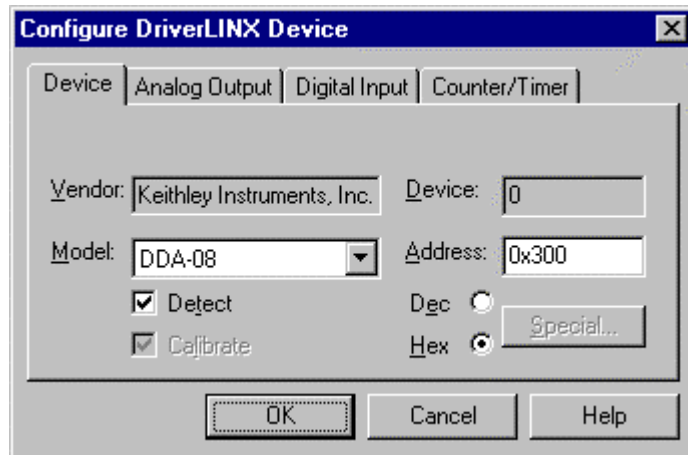
DriverLINX uses a standardized configuration protocol for all data-acquisition hardware. Configuration assigns a port address, interrupt resources and a DriverLINX Logical Device number to a specific DDA-08/16 board in your computer.

The installation program automatically starts the *DriverLINX Configuration Panel*. To start it again later, use the shortcut on the Windows Start Menu or click here .



When you click the *Configure...* button on the *DriverLINX Configuration Panel*, DriverLINX displays the *Configure DriverLINX Device* dialog. The dialog has a page for each subsystem on a Keithley DDA-08/16 model. The following sections describe your choices in configuring DriverLINX to work with your board.

Device Subsystem Page



Use the Device Subsystem page to tell DriverLINX the model name and address of your DDA-08/16 board.

Vendor

The *Vendor* property displays “Keithley Instruments, Inc.” It is a read-only property.

Device

The *Device* property designates the Logical Device you are configuring. It is a read-only property. To change it, first save (**OK**) or quit (**Cancel**) the current configuration. Then select or create a new Logical Device using the *DriverLINX Configuration Panel*.

Model

The *Model* property selects or indicates the hardware model of the board you’re configuring.

Windows NT

Select one of the following models:

DDA-08

DDA-16

Windows 95/98

Under Windows 95/98, DriverLINX displays the model you chose during installation. To install a different model, cancel the configuration and run *Add New Hardware* from the Windows Control Panel.

Address

Windows NT

The *Address* property records the I/O port address for the board. The default address used by DriverLINX is 768 decimal or 0x300 hex. If you have another peripheral board at that address, select a different base address. Note: you need a block of eight free addresses for a DDA-08/16 board.

Windows 95/98

Under Windows 95/98, *Add New Hardware* automatically selects an appropriate address. To change the address, see “Using the Windows 95/98 Device Manager” on page 14.

Detect

The *Detect* property enables and disables DriverLINX's hardware detection and testing algorithms. For maximum system reliability, always leave this check-box marked.

Calibrate

The *Calibrate* property enables and disables hardware auto-calibration. This option is grayed-out for the DDA-08/16 because it does not support automatic calibration.





Special...

The *Special...* button displays a dialog for configuring any special, hardware-specific settings. For the DDA-08/16, Logical Device configuration does not require any special settings so DriverLINX disables the *Special...* button.

Using the Windows 95/98 Device Manager

Under Windows 95/98, DriverLINX uses the address and interrupt settings maintained by the Windows Device Manager.

To view or change the settings for your board using the Device Manager:

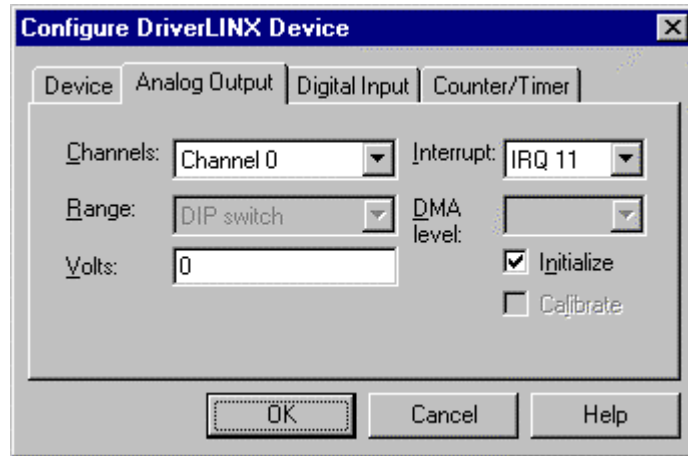
1. Start the Device Manger by right-clicking on My Computer and selecting *Properties* or click here .
2. Click the *Device Manger* tab.
3. Click the  next to  *DriverLINX drivers*, if necessary to expand the list.
4. Under *DriverLINX drivers*, select the entry for your board. (It may or may not have  next to it.)



5. Click the *Properties* button.
6. On the board's property page, click the *Resources* tab.
7. To configure the board with an interrupt, use *Setting based on "Basic configuration 0."* Or, to configure the board without an interrupt, use *Setting based on "Basic configuration 1."*
8. To change a setting, select it under *Resource Type* and click the *Change Setting* button. Windows will guide you in selecting an appropriate value.
9. When you are done, click *OK* to close the board's property page.

10. The board's address switches must match the address setting you select. If necessary shut down your computer and reposition them as described in your hardware manual.
11. Restart Windows to load the Logical Device for your board using the new settings.

Analog Output Subsystem Page



Use the Analog Output Subsystem page to change the default D/A initialization voltage or current values.

Channels

The *Channels* property allows you to select a Logical Channel for individual configuration of its initialization voltage or current value.

Range

The DDA-08/16 boards allow output range selections for each channel. DriverLINX automatically determines the channel's range from the board's switch settings.

Interrupt

Windows NT

For Windows NT, select a free interrupt request level to support interrupt mode transfers. Valid IRQ levels are: 3, 5, 7, 10, 11, 15 and None.

Windows 95/98

Under Windows 95/98, *Add New Hardware* automatically selects an appropriate interrupt. To change the address, see "Using the Windows 95/98 Device Manager" on page 14.

DMA level

The DDA-08/16 does not use system DMA channels. DriverLINX disables this property.

Volts

The *Volts* property allows you to specify an output voltage or current (in mA) for each channel that DriverLINX uses when it initializes the hardware. DriverLINX's default initialization value is zero. DriverLINX ignores this property unless you also check the *Initialize* property.

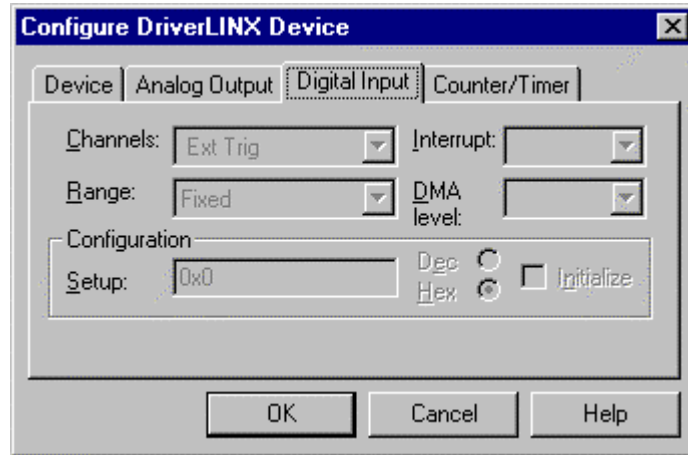
Initialize

Checking the *Initialize* check box instructs DriverLINX to use the *Volts* property, rather than the default value, for analog output initialization. The hardware initializes all analog outputs to 0 V or 4 mA upon power up.

Calibrate

The *Calibrate* property enables and disables hardware auto-calibration. DriverLINX disables this property as the DDA-08/16 DACs don't support auto-calibration.

Digital Input Subsystem Page



Channels

DriverLINX defines the following Logical Channels for the DDA-08/16 digital inputs:

| Logical Channel | DriverLINX Function | DDA-08/16 External Connector |
|-----------------|---------------------|------------------------------|
| 0 | External Trigger | TRIGGER IN |
| 1 | External Clock | CLOCK IN |

The *Channels* property allows you to select a Logical Channel for configuration or viewing the channel's range. The digital input channels on the DDA-08/16 boards have a fixed configuration.

Range

The *Range* property specifies the supported digital input range for the selected Logical Channel. This is a read-only property.

Interrupt

The DDA-08/16 uses the same interrupt for digital input as for analog output. Go to the Analog Output page to set it. DriverLINX disables this property and displays it as blank.

DMA level

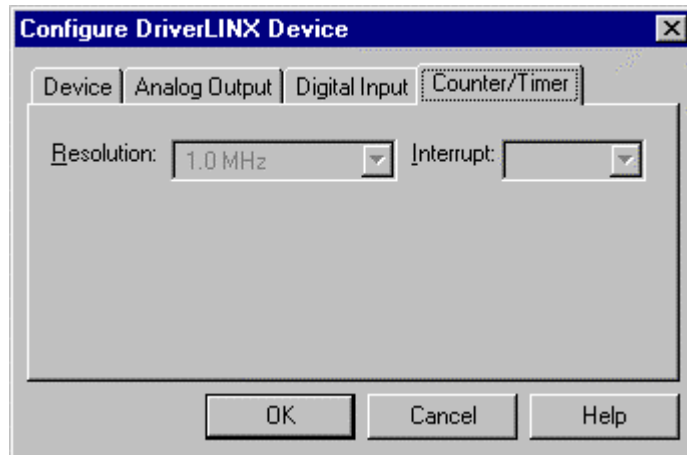
The DDA-08/16 does not use system DMA channels. DriverLINX disables this property and displays it as blank.

Configuration

The digital input channels on the DDA-08/16 boards have a fixed configuration. DriverLINX disable these Configuration properties.

Counter/Timer Subsystem Page

For the DDA-08/16, there are no configurable options on the Counter/Timer subsystem page.



Resolution

The *Resolution* property specifies the clock frequency of the master oscillator. All models have a 1 MHz clock source for pacing output tasks.

Interrupt

The DDA-08/16 does not support interrupts from counter/timers. DriverLINX disables this property and displays it as blank.

Using the DDA-08/16 with DriverLINX

Introduction

This chapter shows you how to set up and use DDA-08/16 hardware features with DriverLINX. See the *Analog I/O Programming Guide* for an overview of DriverLINX programming.

The descriptions here use the *Edit Service Request* dialogs for language and API independence. For the correct syntax with the language you're using, please see the *DriverLINX Technical Reference Manuals*. For DriverLINX examples in your programming language, please see the source code examples in the subfolders of your DriverLINX installation directory or on the original distribution media.

DriverLINX Hardware Model for DDA-08/16

DriverLINX provides a portable, hardware-independent API for data-acquisition boards while still allowing applications to access unique or proprietary hardware features of specific products. To achieve this goal, DriverLINX maps a hardware-independent, or abstract, data-acquisition model onto DDA-08/16 hardware capabilities.

The following sections describe how DriverLINX implements DDA-08/16 hardware features as Subsystems, Modes, Operations, Events, Logical Channels, Buffers, and Messages.

DriverLINX Subsystems

The DDA-08/16 supports four DriverLINX Logical Subsystems:

1. **Device**—refers to a DDA-08/16 model as a whole.
2. **Analog Output**—refers to the analog output channels, clocks, and control signals.
3. **Digital Input**—refers to the 8-bit digital input/output port as well as 1-bit digital input (TTL) control signals, such as CLOCK IN, etc.

- 4. **Counter/Timer**—refers to the internal clock channel for pacing input/output tasks.

DriverLINX Modes

Applications use modes in Service Requests to advise DriverLINX on their preferred hardware data-transfer technique. The DriverLINX modes fall into two general classes:

- **Foreground or synchronous modes.** The calling application doesn't regain control until DriverLINX completes the Service Request. DriverLINX supports this mode for simple, single-value I/O operations or software housekeeping functions that DriverLINX can complete without a significant delay.
- **Background or asynchronous modes.** The calling application regains control as soon as DriverLINX initiates the task. The calling application must synchronize with the data-acquisition task using status polling or DriverLINX's messages (preferred). DriverLINX supports this mode for buffered data-transfers or for commands that require a significant time to complete.

DriverLINX supports three modes with the DDA-08/16 for its commands (Service Requests).

- **Polled Mode**—This is a foreground or synchronous operation. DriverLINX supports this mode for simple, single-value I/O operations that the data-acquisition board can complete without significant delay.
- **Interrupt Mode**—This is a background or asynchronous operation. DriverLINX transfers data between the computer's memory and the data-acquisition board using hardware interrupts and programmed I/O transfers.
- **Other Mode**—This is a foreground or synchronous operation. DriverLINX supports this mode for initialization, configuration, calibration, data conversion, and timebase operations.

The following table summarizes the data acquisition modes that DriverLINX supports for each subsystem with the Keithley DDA-08/16.

| Subsystem | Polled | Interrupt | DMA | Other |
|----------------|--------|-----------|-----|-------|
| Analog Input | | | | |
| Analog Output | √ | √ | | √ |
| Digital Input | | | | √ |
| Digital Output | | | | |
| Counter/Timer | √ | | | √ |
| Device | | | | √ |

DDA-08/16 Supported DriverLINX Modes.

DriverLINX Operations and Events

Applications construct DriverLINX data-acquisition tasks by combining a small number of DriverLINX operations and events in many possible ways. The following table summarizes the operations and events that DriverLINX supports for the Keithley DDA-08/16. Later sections for each DriverLINX subsystem will describe the operations and events in more detail.

Note: All subsystems allow the *MESSAGE* operation and the Analog Output Subsystem allows the *CONVERT* operation, which are not shown in the table. DriverLINX allows any Mode setting for these operations.

| Subsystem | Operation | Events | | |
|-----------------------|-------------------------------------|---------------------|-----------|----------|
| | | Timing | Start | Stop |
| Mode | | | | |
| Analog Input | | | | |
| | | | | |
| Analog Output | | | | |
| Polled | Start | null | null, cmd | null, TC |
| Interrupt | Start, Stop, Status | dig, rate | cmd, dig | cmd, TC |
| Other | Initialize | | | |
| Digital Input | | | | |
| Other | Initialize | | | |
| Digital Output | | | | |
| | | | | |
| Counter/Timer | | | | |
| Polled | Start, Stop, Status | null, rate, CTSetup | null, cmd | null, TC |
| Interrupt | | | | |
| Other | Initialize, Configure | | | |
| Device | | | | |
| Other | Initialize, Configure, Capabilities | | | |

Allowed Operations and Events for DDA-08/16 Subsystems and Modes.

The following list explains the Event abbreviations in the preceding table:

- **null**—Null or None Event when a Service Request doesn't require an event
- **cmd**—Command Event when DriverLINX starts or stops a task on software command
- **TC**—Terminal Count Event when DriverLINX processes all data buffers once
- **rate**—Rate Event specifies how DriverLINX paces or clocks data transfer
- **dig**—Digital Event specifies a trigger, clock, or other control signal to pace, start, or stop a task

Logical Channels

DriverLINX designates the individually addressable hardware channels for each subsystem as “Logical Channels.” Generally, the zero-based Logical Channel numbering sequence closely follows the hardware manufacturer's channel numbering scheme.

In some cases, however, DriverLINX assigns Logical Channel numbers to hardware features that users don't commonly think of as “channels.” For instance, DriverLINX commonly models external hardware clock input lines, external hardware trigger input lines, and external interrupt inputs as 1-bit digital Logical Channels. In other cases, DriverLINX models subsystem-specific features, such as internal pacer clocks, as members of a more general purpose set of counter/timer channels.

For a list of DriverLINX assigned Logical Channel numbers, see the notes on each supported subsystem.

Buffers

Applications usually use data buffers to exchange data between the application and the data-acquisition hardware. When using data buffers, please note the following points about DriverLINX's data buffers:

- DriverLINX supports data-acquisition tasks with 1 to 255 data buffers per task.
- DriverLINX imposes no size limits on a single buffer, although the operating system or some hardware products may have size restrictions.
- User applications must allow DriverLINX to allocate all data buffers to guarantee application portability to different hardware and operating systems and to insure that the hardware can physically access the buffer memory.
- User applications usually don't have concurrent or immediate access to the in-use data buffer while DriverLINX is executing a data-acquisition task.

Connecting Signals to the DDA-08/16

The Keithley hardware manual describes the data and control signals for the DDA-08/16 and the connector pinouts for these signals. This section summarizes how DriverLINX numbers the I/O data signals and how DriverLINX uses several of these control connections for external clock and trigger inputs.

Analog Output Subsystem Signals

Keithley's DDA-08/16 has eight or sixteen 12-bit analog output DACs. DriverLINX maps these signals to Logical Channels as shown in the following table:

| Number of D/A Channels | Connector Name | Logical Channels |
|------------------------|----------------------------------|------------------|
| 8 | D/A 0 OUT, GND – D/A 7 OUT, GND | 0 - 7 |
| 16 | D/A 0 OUT, GND – D/A 15 OUT, GND | 0 - 15 |

How DriverLINX maps analog output hardware channels to Logical Channels.

The Analog Output Subsystem has an internal pacer clock, which DriverLINX designates as Logical Channel 0 of the Counter/Timer subsystem.

Digital Input Subsystem Signals

The Digital Input Subsystem has a trigger and an external clock which DriverLINX models as 1-bit logical digital input ports. DriverLINX maps these signals to Logical Channels as shown in the following table:

| Port | Connector Name | Logical Channels |
|------------------------|----------------|------------------|
| External trigger alias | TRIGGER IN | 0 |
| External clock alias | CLOCK IN | 1 |

How DriverLINX maps digital input hardware channels to Logical Channels.

Counter/Timer Subsystem Signals

The Counter/Timer subsystem has a single 8-bit internal hardware timer to pace tasks on the analog output subsystem. The DDA-08/16 also has an output clock, which provides a delayed pulse each time the board updates a D/A channel. DriverLINX maps the timers to Logical Channels as shown in the following table:

| Timer | Connector Name | Logical Channels |
|--------------|-------------------------------|------------------|
| Pacer Clock | GATE IN, CLOCK IN, TRIGGER IN | 0 |
| Output Clock | CLOCK OUT | 1 |

How DriverLINX maps counter/timer hardware channels to Logical Channels.

Applications can operate these timers in tandem to generate a frequency output while the analog output subsystem is idle.

Device Subsystem

The following sections describe how DriverLINX implements Device Subsystem features for the DDA-08/16.

Device Modes

The Device Subsystem only supports DriverLINX's *Other* mode for all operations.

Device Operations

The DDA-08/16 Device Subsystem supports the following DriverLINX operations:

If another application is using the same data-acquisition board, DriverLINX will prevent Device Initialization from interfering with the other application's data-acquisition tasks.

- **Initialize**—DriverLINX aborts all data-acquisition tasks for every subsystem controlled by the current application. DriverLINX then performs an initialization for each supported subsystem.
- **Configure**—DriverLINX displays the *Configure DriverLINX Device* dialog for the current Logical Device. Please use the *DriverLINX Configuration Panel* rather than this operation to configure DriverLINX.
- **Capabilities**—DriverLINX provides hardware-specific and configuration information in the form of a Logical Device Descriptor database.

Analog Output Subsystem

The following sections describe how DriverLINX implements Analog Output Subsystem features for the DDA-08/16.

Analog Output Modes

The Analog Output Subsystem supports the following modes:

- **Polled**—For single-value analog output samples.
- **Interrupt**—For buffered transfers using programmed I/O.
- **Other**—For subsystem initialization and data conversion.

Analog Output Operations

The DDA-08/16 Analog Output Subsystem supports the following DriverLINX operations:

- **Initialize**—aborts all active analog output data-acquisition tasks. However, DriverLINX prevents one application from interfering with another application's data-acquisition tasks.
- **Start**—initiates a data-acquisition task using the Mode, Timing, Start, and Stop Events, the Logical Channels, and the Buffers the application specified in the Service Request.
- **Status**—reports the buffer position of the next sample that DriverLINX will write into a buffer.
- **Stop**—terminates an analog output data-acquisition task.
- **Message**—DriverLINX displays a pop-up dialog box for the user containing the text for the current DriverLINX error message.

Analog Output Initialization

By default, the Analog Output Subsystem loads zero into all D/A channels forcing the initial output level to 0 V or 4 mA.

Analog Output Timing Events

Timing Events specify how the hardware paces or clocks the sample output. DriverLINX uses the Timing Event to program when the DDA-08/16 writes the next analog output sample to the DACs.

The DDA-08/16 supports the following Timing Events:

- **None**—Output requires no pacing as DriverLINX is writing only a single value.
- **Rate**—The DDA-08/16 supports only fixed rate analog output using internal and external clocks.
- **Digital**—DriverLINX uses an external digital input signal to pace the output of each sample.

None or Null Event

The Null Event specifies that the task does not need a clock to determine when to write the next sample.

Rate Event

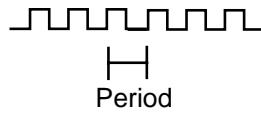
The DDA-08/16 supports one type of Rate Event for analog output:

- **Rate Generator**—Generates a fixed rate clock with equal time intervals between tics.

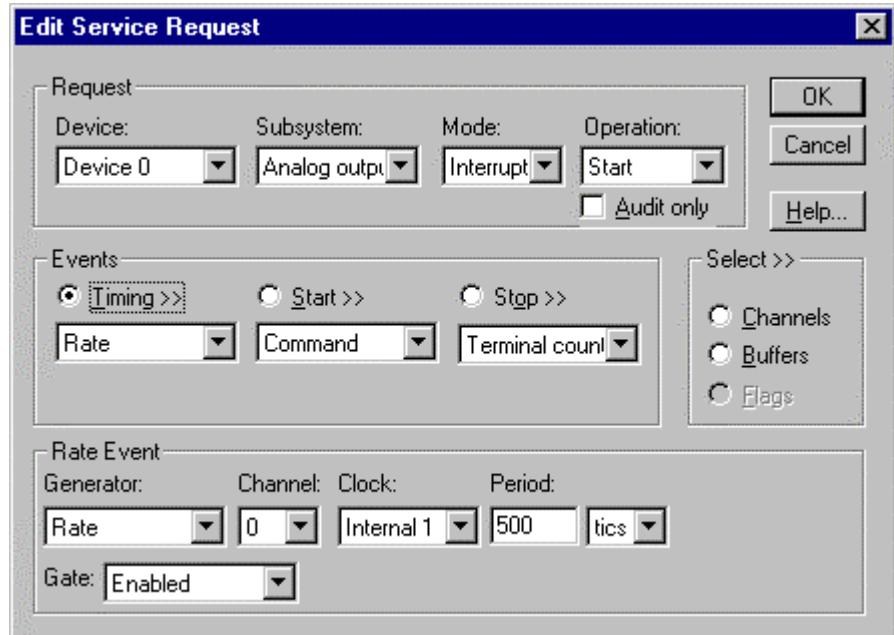


Rate Generator: Internal Clocking

An internally clocked Rate Generator produces a fixed rate clock with equal time intervals between tics.



Use an internally clocked rate generator when you want to write analog output samples at equally spaced time intervals. Note, the DDA-08/16 hardware can write the selected analog output channels simultaneously at each timing event, or individually, with one channel per timing event.



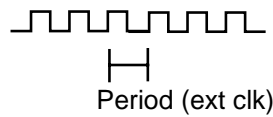
How to set up the DDA-08/16 for fixed rate sampling using an internal clock.

For hardware independence, specify the clock channel using the symbolic constant, `DEFAULTTIMER`, which always maps to the default Logical Channel for analog output timing.

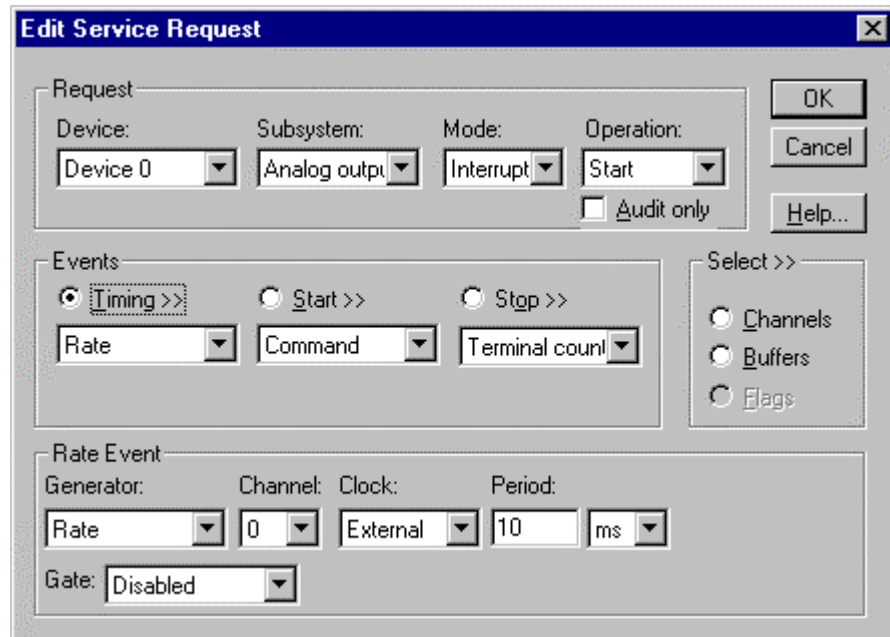
- Specify internal clocking using a **Rate Generator** on **Channel 0** with an **Internal 1 Clock** source.
- The *Period* property specifies the time interval between samples in tics, where a tic is 1 μ s, or 1 MHz. The minimum period is 20 tics, or 50 kHz. The maximum period is 25500 tics, or 0.004 Hz. See “Counter/Timer Subsystem” on page 38 for details on the counter/timer channels.
- The *Gate* property specifies how the GATE IN signal affects sampling. See “Counter/Timer Subsystem” on page 38 for details on the gate modes.

Rate Generator: External Clocking

An externally clocked Rate Generator produces a rate clock with unknown time intervals between tics.



Use an externally clocked rate generator when you want to synchronize analog output samples with a recurrent external signal. Note, the DDA-08/16 hardware can write the selected analog output channels simultaneously at each timing event, or individually, with one channel per timing event.



How to set up the DDA-08/16 for fixed rate sampling using an external clock.

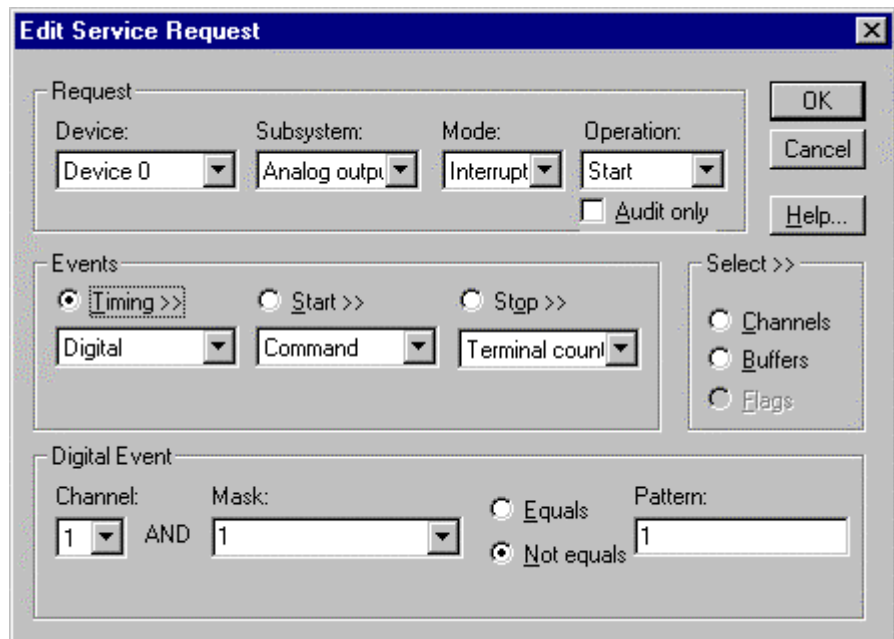
BE SURE that the external clock source is *TTL compatible, 0 V minimum to +5 V maximum!*

- Specify external clocking using a **Rate Generator** on **Channel 0** with an **External, External+** or **External-** Clock source. External and External+ both specify sampling on the rising, or positive, edge of the external clock signal.
- Users should connect the external clock signal to the **CLOCK IN** line.

- The *Period* may be any value ≥ 1 tic, or 1 μ s. The period value doesn't affect the external clock frequency, but DriverLINX requires a valid hardware value in case the application requests a timebase operation and to optimize data transfer between the driver and the application.
- The *Gate* property specifies how the GATE IN signal affects sampling. See "Counter/Timer Subsystem" on page 38 for details on the gate modes.

Digital Event

DriverLINX supports Digital Events as aliases for externally clocked Rate Generators. Use this technique for compatibility with data-acquisition boards that only support external clock sources. Note, the DDA-08/16 hardware can write the selected analog output channels simultaneously at each timing, or individually, with one channel per timing event.



How to set up the DDA-08/16 for external rate sampling using a digital event.

Digital Timing Events contain *mask*, *pattern*, and *match* fields. The mask is logically ANDed with the digital input data on the Logical Channel and then compared against the *pattern* for a match/mismatch.

BE SURE that the external clock source is TTL compatible, 0 V minimum to +5 V maximum!

- Specify external clocking using *Channel 1*. For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTCLK*.
- Users should connect the external clock signal to the CLOCK IN line.
- Specify the *Mask* property as **1**, or **Bit 0**, to indicate that DriverLINX should only compare a 1-bit digital input value against the *Pattern* property.
- Specify the *Match* property as **Not equals**.
- Specify the *Pattern* property as **0** for a rising, or positive, edge clock ($\neq 1$), or **1** for a falling, or negative, edge clock ($\neq 0$).

Analog Output Start Events

Start Events specify when the DDA-08/16 hardware starts writing analog output data.

The DDA-08/16 supports the following Start Events for analog output:

- **None**—Use this event when the DriverLINX operation does not require a Start Event.
- **Command**—DriverLINX starts the task on software command, i.e., as soon as DriverLINX finishes programming the DDA-08/16 hardware for the task.
- **Digital**—The DDA-08/16 starts writing analog output samples when the hardware detects that the digital input satisfies the condition specified in the Start Event.

None or Null Event

The Null Event specifies that the task does not need a Start Event to begin the task.

Command Event

The Command Event starts data acquisition as soon as DriverLINX has completed programming the data-acquisition hardware with the task parameters.

Digital Event or Post-Triggering

The DDA-08/16 can write analog output samples *after* the hardware detects a digital trigger condition. Use post-triggering when you want to synchronize the start of data acquisition with an external signal.

The screenshot shows the 'Edit Service Request' dialog box. It is divided into three main sections: 'Request', 'Events', and 'Digital Event'.
1. **Request**: Contains four dropdown menus: 'Device' (set to 'Device 0'), 'Subsystem' (set to 'Analog output'), 'Mode' (set to 'Interrupt'), and 'Operation' (set to 'Start'). There is also an 'Audit only' checkbox which is unchecked. Buttons for 'OK', 'Cancel', and 'Help...' are on the right.
2. **Events**: Contains three radio buttons: 'Timing >>', 'Start >>' (which is selected), and 'Stop >>'. Below these are three dropdown menus: 'Rate' (set to 0), 'Digital' (set to Digital), and 'Terminal count'. A 'Delay' field is set to 0. On the right, there is a 'Select >>' section with three radio buttons: 'Channels', 'Buffers', and 'Flags'.
3. **Digital Event**: Contains a 'Channel' dropdown set to 0, followed by 'AND' and a 'Mask' dropdown set to 1. There are two radio buttons: 'Equals' (unchecked) and 'Not equals' (checked). A 'Pattern' field contains the value 1.

How to set up the DDA-08/16 for post-triggered analog output.

Digital Start Events contain *mask*, *pattern*, and *match* fields. The mask is logically ANDed with the digital input data on the Logical Channel and then compared with the *pattern* for a match/mismatch.

- Specify the *Channel* as **0**. For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTTRG*.
- Specify the *Mask* and *Pattern* properties to **1** to specify the bit position of the 1-bit trigger input.
- Specify the *Match* property as **Not equals** to trigger on the edge of the trigger input.
- Specify the *Delay* property as any number of samples from 0 to $2^{32} - 1$.
- Connect the signal to the TRIGGER IN line.

Analog Output Stop Events

Stop Events specify when the hardware stops writing analog output data.

The DDA-08/16 supports the following Stop Events for analog output:

- **None**—Use this event when the DriverLINX operation doesn't require a Stop Event.
- **Command**—DriverLINX stops the task on software command, i.e., when the application issues a Service Request with a *Stop* operation.
- **Terminal count**—DriverLINX stops the task after the data-acquisition hardware has written all the data buffers once.

None or Null Event

The Null Event specifies that the task does not need a Stop Event to end the task.

Command Event

The Command Event stops data acquisition when the user application changes the *Operation* property in the Service Request to *Stop* and resubmits the Service Request to DriverLINX.

In Stop-on-Command mode, DriverLINX continuously cycles through all the data buffers, writing them to the DACs on the DDA-08/16.

Terminal Count Event

The Terminal Count Event stops data acquisition after DriverLINX has written the analog output data in all the data buffers *once*. Use Terminal Count when you want to write a fixed amount of data.

Analog Output Channels

The DDA-08/16 allows applications to specify the analog channels using three techniques:

- **Start Channel**—Write analog data to a single channel.
- **Start/Stop Channel Range**—Write analog data to a consecutive range of channels.
- **Channel List**—Write analog data to a list of channels.

The DDA-08/16 boards have individual gain switches for each channel. DriverLINX uses a gain code of zero for all switch settings. Consequently, the **Gain2Code** function always returns zero.

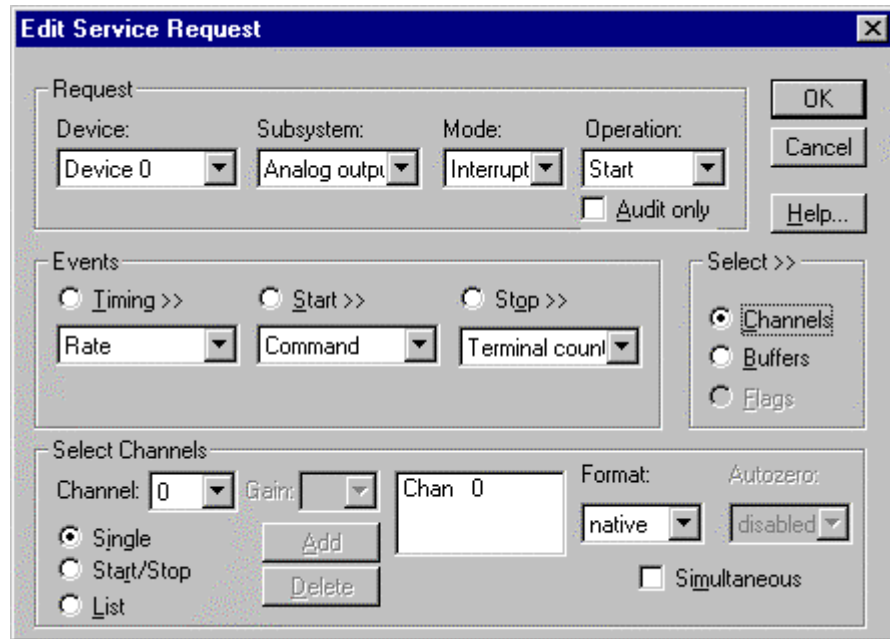
Analog Output Logical Channels

The DDA-08/16 has eight or sixteen 12-bit digital-to-analog converter channels. DriverLINX maps these physical channels to Logical Channels as follows:

| Number of D/A Channels | Connector Name | Logical Channels |
|------------------------|----------------------------------|------------------|
| 8 | D/A 0 OUT, GND – D/A 7 OUT, GND | 0 - 7 |
| 16 | D/A 0 OUT, GND – D/A 15 OUT, GND | 0 - 15 |

Single Channel Analog Output

In single channel mode, the DDA-08/16 writes all data to one channel.



How to set up the DDA-08/16 to write to a single DAC Channel.

Multi-channel Analog Output Range

In multi-channel range mode, the DDA-08/16 writes all data to a consecutive range of analog channels.

- If the Start Channel is greater than the Stop Channel, the channel sequence is [Start Channel, ..., Last Channel, 0, ..., Stop Channel], where Last Channel is the highest numbered channel for the DDA-08/16 model the application is using.
- The DDA-08/16 can optionally output to all DACs in the range simultaneously, or write to one DAC in the range at each timing event.

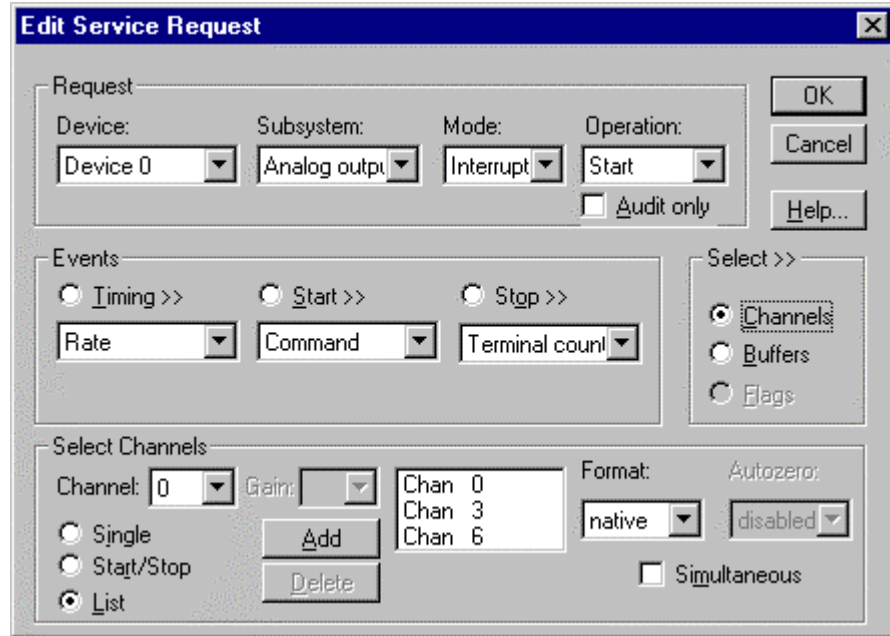
The screenshot shows the 'Edit Service Request' dialog box. It is divided into three main sections: 'Request', 'Events', and 'Select Channels'.
1. 'Request' section: Contains dropdown menus for 'Device' (set to 'Device 0'), 'Subsystem' (set to 'Analog output'), 'Mode' (set to 'Interrupt'), and 'Operation' (set to 'Start'). There is also an 'Audit only' checkbox which is unchecked. Buttons for 'OK', 'Cancel', and 'Help...' are on the right.
2. 'Events' section: Contains three radio buttons: 'Timing >>', 'Start >>', and 'Stop >>'. Below them are dropdown menus for 'Rate', 'Command', and 'Terminal count'. To the right is a 'Select >>' section with radio buttons for 'Channels' (selected), 'Buffers', and 'Flags'.
3. 'Select Channels' section: Contains a 'Channel:' dropdown set to '0', a 'Gain:' dropdown, and a list box containing 'Chan 0' and 'Chan 2'. There are 'Add' and 'Delete' buttons. To the right are 'Format:' (set to 'native') and 'Autozero:' (set to 'disabled') dropdowns. At the bottom right is a 'Simultaneous' checkbox which is unchecked. Radio buttons for 'Single', 'Start/Stop' (selected), and 'List' are on the left.

How to set up the DDA-08/16 using a start/stop range to write to multiple DACs.

Multi-channel Analog Output List

In multi-channel list mode, the DDA-08/16 acquires all data to a random list of analog channels.

- The channel-gain list may contain channels in any order but only with unity gain. In simultaneous mode, the list may *not* repeat the same channel.
- The DDA-08/16 can optionally output to all DACs in the list simultaneously, or write to one DAC in the list at each timing event.

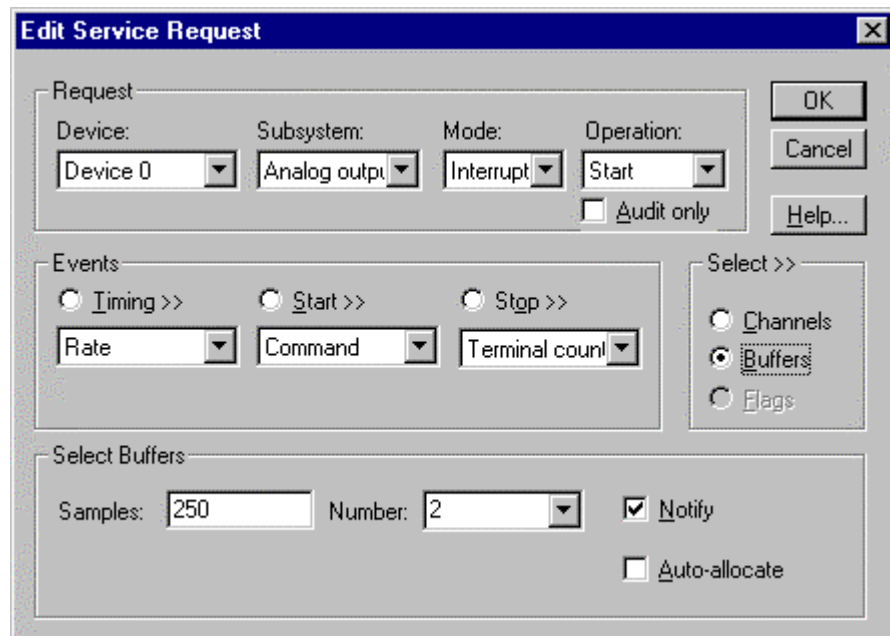


How to set up the DDA-08/16 using a channel list to write to multiple DACs.

Analog Output Buffers

DriverLINX supports both single-value analog output and buffered analog output.

- **For single-value output**, specify the Number of buffers as **0** and the number of *Samples* as **1**. Use Polled mode and store the data in the *ioValue* Service Request property.
- **For buffered output**, specify the Number of buffers from **1** to **256** and the number of *Samples* as desired.



How to set up the DDA-08/16 for analog output using buffers.

For example, 500 samples/2 channels = 250 is ok, but 500 samples/3 channels = 166.67 is incorrect.

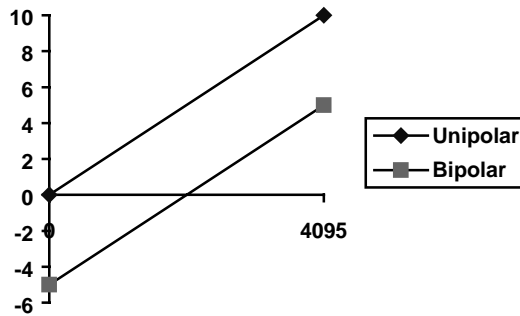
An individual DriverLINX buffer may have any size as long as the buffer length holds an integral number of channel scans (i.e., a multiple of the number of analog output channels you are using). This restriction enforces the requirement that all channels have the same number of samples.

Analog Output Data Coding

The DDA-08/16 offers both a bipolar and unipolar analog output ranges. Bipolar ranges encode D/A output values using a 12-bit binary offset integer. Unipolar ranges encode D/A output values using a 12-bit true binary (unsigned) integer. DriverLINX refers to these coding schemes as the “native” format for the channel data.

| D/A Resolution | Range | A/D Hardware Code |
|----------------|----------|-------------------|
| 12 bits | ±2.5 V | 0 - 4095 |
| 12 bits | ±5 V | 0 - 4095 |
| 12 bits | ±10 V | 0 - 4095 |
| 12 bits | 4 -20 mA | 0 - 4095 |
| 12 bits | 0 -5 V | 0 - 4095 |
| 12 bits | 0 - 10 V | 0 - 4095 |

Native hardware codes for the DDA-08/16 DACs.



DDA-08/16 native D/A Codes versus Voltage for the 0-10V and ±5V Ranges.

DriverLINX refers to the default hardware analog coding scheme as the “native” format. For computer arithmetic in a higher level language, the integer, or two’s complement, format is generally easier to use. For unipolar data, native and integer formats are identical.

For bipolar data, DriverLINX automatically converts A/D codes to integer format, if you specify **integer** for the *Format* property. Or, applications can use DriverLINX’s data conversion operations to transform an entire data buffer from native format to many common integer and floating-point formats.

Because the DDA-08/16 boards have gain switches for each channel, applications should use buffer conversions instead of the single-value functions, **Volts2Code** and **Code2Volts**.

Analog Output Messages

For analog output operations, DriverLINX can report the following messages to the application:

| DriverLINX Message | Explanation |
|---------------------------|--|
| Service Start | DriverLINX has started the acquisition task. |
| Service Done | DriverLINX has completed the acquisition task. |
| Buffer Filled | DriverLINX has finished writing from the data buffer. |
| Start Event | DriverLINX has processed the interrupt for a hardware start event |
| Stop Event | DriverLINX has processed the interrupt for a hardware stop event |
| Data Lost | DriverLINX has detected an analog output data underrun condition. |
| Critical Error | DriverLINX has encountered an unexpected hardware or software condition. |

DriverLINX Event messages for analog output.

Digital Input Subsystem

The following sections describe how DriverLINX implements Digital Input Subsystem features for the DDA-08/16.

Digital Input Modes

The Digital Input Subsystem supports the following mode:

- **Other**—For subsystem initialization.

Digital Input Operations

The DDA-08/16 Digital Input Subsystem supports the following DriverLINX operations:

- **Initialize**—aborts any active interrupt data-acquisition tasks and stops the clock. However, DriverLINX prevents one application from interfering with another application's data-acquisition tasks.
- **Message**—DriverLINX displays a pop-up dialog box for the user containing the text for the current DriverLINX error message.

Digital Port Configuration

The DDA-08/16 has only two fixed-configuration input signals. Therefore, DriverLINX does not allow the application to configure the DDA-08/16's Digital Input Subsystem channels.

Digital Input Timing Events

Timing Events specify how the hardware paces or clocks the reading of Digital Input samples. Because the DDA-08/16 does not have any digital input data channels, DriverLINX does not allow application to create any independent tasks with the Digital Input Subsystem.

Digital Input Channels

The DDA-08/16 has only two input signals that DriverLINX assigns to the Digital Input Subsystem: TRIGGER IN and CLOCK IN. Application can use these external clock and trigger signals to control analog output or counter/timer tasks but applications cannot directly read their values.

| Logical Channel | DriverLINX Function | DDA-08/16 External Connector |
|-----------------|---------------------|------------------------------|
| 0 | External Trigger | TRIGGER IN |
| 1 | External Clock | CLOCK IN |

Counter/Timer Subsystem

The DDA-08/16 has a simple counter/timer subsystem. It allows analog output pacing at rates from 0.004 Hz to 50 kHz. In addition, it can perform independent counter/timer tasks while the analog output subsystem is idle, such as frequency division and strobe generation.

The following table lists the Counter/Timer Subsystem's Logical Channels and shows their allowable clock sources, modes and gates.

| Logical Channels | Clocks | | Modes | Gates |
|------------------|------------|----------------------|--------------------------|--|
| | Source | Tic Period | | |
| 0 — Pacer Clock | Internal 1 | 1 μ s (1 MHz) | Rate Gen Freq Divider | Enabled Disabled No Connect Low Level High Level |
| | Internal 2 | 10 μ s (100 kHz) | | |
| | Internal 3 | 100 μ s (10 kHz) | | |
| | Internal 4 | 1 ms (1 kHz) | | |
| | Internal 5 | 10 ms (100 Hz) | | |
| | Source 1 | 100 ms (10 Hz) | | |
| | Source 2 | 1 s (1 Hz) | | |
| | External | | | |
| | External+ | | | |
| | External | | | |
| 1 — Output Clock | Internal 1 | 1 μ s (1 MHz) | Retrig One-Shot | Enabled No Connect |
| | Internal 2 | 10 μ s (100 kHz) | | |
| | Internal 3 | 100 μ s (10 kHz) | | |
| | Internal 4 | 1 ms (1 kHz) | | |
| | Internal 5 | 10 ms (100 Hz) | | |
| | Source 1 | 100 ms (10 Hz) | | |
| | Source 2 | 1 s (1 Hz) | | |
| | External | | | |
| | External+ | | | |
| | External | | | |

Counter/Timer Subsystem Logical Channels and Allowed Clocks, Modes and Gates.

Pacer Clock

The Pacer Clock (Logical Channel 0) is an 8-bit counter combined with a 7-range prescaler that supports both internal and external clock sources.

Internal Clocking

The DDA-08/16 has a master oscillator with seven prescaler outputs to pace input/output tasks. DriverLINX defines the following internal clock sources for the Pacer Clock:

- **Internal 1**—specifies a clock source that allows the full range of output frequencies, from 0.004 Hz to 1 MHz. With this clock source each tic is 1 μ s.
- **Internal 2**—specifies the 100 kHz clock source, which allows output frequencies from 393 Hz to 100 kHz. With this clock source each tic is 10 μ s.
- **Internal 3**—specifies the 10 kHz clock source, which allows output frequencies from 40 Hz to 10 kHz. With this clock source each tic is 100 μ s.
- **Internal 4**—specifies the 1 kHz clock source, which allows output frequencies from 4 Hz to 1 kHz. With this clock source each tic is 1 ms.

- **Internal 5**—specifies the 100 Hz clock source, which allows output frequencies from 0.4 Hz to 100 Hz. With this clock source each tic is 10 ms.
- **Source 1**—specifies the 10 Hz clock source, which allows output frequencies from 0.04 Hz to 10 Hz. With this clock source each tic is 100 ms.
- **Source 2**—specifies the 1 Hz clock source, which allows output frequencies from 0.004 Hz to 1 Hz. With this clock source each tic is 1 s.

Applications that wish to control the prescaler selection should choose a clock source from **Internal 1** through **Source 2** to specify a specific prescaler and use a tic count from 1 to 256.

External Clocking

The DDA-08/16 allows an external clock source to pace input/output tasks. DriverLINX defines the following external clock sources for the Pacer Clock:

- **External, External+** —specify sampling on the rising, or positive, edge of the external clock signal.
- **External-** —specifies sampling on the falling, or negative, edge of the external clock signal.

Clocking Modes

The Pacer Clock can operate in either of two modes. DriverLINX defines the following clock modes for this Logical Channel:

- **Rate Generator**—specifies sampling of one channel (or all channels simultaneously) in the scan list at each tic of an internal or external clock source.
- **Frequency Divider**—provides a waveform output at the input frequency divided by a specified value. The Pacer Clock must have an internal clock source in this mode.

Gating

The Pacer Clock has a level-active gate input, GATE IN, that enables and disables its operation. The gate control has the following modes:

- **Enabled**—specifies that the application needs the gate enabled. A signal at the gate connection enables or disables the counter/timer with a default active state. For the DDA-08/16, DriverLINX uses High Level for the active state.
- **Disabled**—specifies that the application needs the gate disabled. Any signal present at the connection does not affect the counter/timer.
- **No Connect**—specifies that the application does not need a gate input. For the DDA-08/16, DriverLINX disables the gate for this mode.
- **High Level**—specifies that the application needs the gate enabled with a High Level active state. A signal at the gate connection enables the counter/timer when it is high and disables the counter/timer when it is low.
- **Low Level**—specifies that the application needs the gate enabled with a Low Level active state. A signal at the gate connection enables the

counter/timer when it is low and disables the counter/timer when it is high.

Output Clock

The Output Clock (Logical Channel 1) is an 8-bit counter combined with a 7-range prescaler that supports both internal and external clock sources.

Internal Clocking

The DDA-08/16 has a master oscillator with seven prescaler outputs to pace input/output tasks. DriverLINX defines the following internal clock sources for the Output Clock:

- **Internal 1**—specifies a clock source that allows the full range of output frequencies, from 0.004 Hz to 1 MHz. With this clock source each tic is 1 μ s.
- **Internal 2**—specifies the 100 kHz clock source, which allows output frequencies from 393 Hz to 100 kHz. With this clock source each tic is 10 μ s.
- **Internal 3**—specifies the 10 kHz clock source, which allows output frequencies from 40 Hz to 10 kHz. With this clock source each tic is 100 μ s.
- **Internal 4**—specifies the 1 kHz clock source, which allows output frequencies from 4 Hz to 1 kHz. With this clock source each tic is 1 ms.
- **Internal 5**—specifies the 100 Hz clock source, which allows output frequencies from 0.4 Hz to 100 Hz. With this clock source each tic is 10 ms.
- **Source 1**—specifies the 10 Hz clock source, which allows output frequencies from 0.04 Hz to 10 Hz. With this clock source each tic is 100 ms.
- **Source 2**—specifies the 1 Hz clock source, which allows output frequencies from 0.004 Hz to 1 Hz. With this clock source each tic is 1 s.

Applications that wish to control the prescaler selection should choose a clock source from **Internal 1** through **Source 2** to specify a specific prescaler and use a tic count from 1 to 256.

External Clocking

The DDA-08/16 allows an external clock source for Output Clock tasks. DriverLINX defines the following external clock sources for the Output Clock:

- **External, External+** —specify counting on the rising, or positive, edge of the external clock signal.
- **External-** —specifies counting on the falling, or negative, edge of the external clock signal.

Clocking Modes

The Output Clock can operate in only one mode. DriverLINX defines the following clock mode for this Logical Channel:

- **Retriggerable One-Shot**—specifies a single pulse after detecting a gate signal. The pulse starts after a delay period. A subsequent gate signal triggers another pulse. For the DDA-08/16 the length of the pulse is one-half the prescaler output period.

Gating

The Output Clock has an edge active gate input that triggers its operation. The gate source is output of the Pacer Clock. It triggers the Output Clock at same time it causes a DAC update. The DDA-08/16 does not allow any software control over the gate. However, for compatibility with other boards, DriverLINX defines the following gate control modes:

- **Enabled**—specifies that the application needs the gate enabled. A signal at the gate connection enables or disables the counter/timer with a default active state. The DDA-08/16 always uses Low Edge for the active state.
- **No Connect**—specifies that the application does not need a gate input. The DDA-08/16 always uses Low Edge for the active state.
- **Low Edge**—specifies that the application needs the gate enabled with a Low Level active state. A signal at the gate connection enables the counter/timer when it is low and disables the counter/timer when it is high. The DDA-08/16 always uses Low Edge for the active state.

Glossary of Terms

A/D

Abbreviation for Analog-to-Digital, a process that converts a continuous analog signal into a discrete digital approximation of the analog signal.

ADC

Abbreviation for Analog-to-Digital Converter, the hardware that performs the A/D conversion.

API

Abbreviation for Application Programming Interface. An API defines the syntax of the data structures and functions of software services.

Buffer

A block of memory used to receive data from a data-acquisition device or to write data to a data-acquisition device.

Clocking

A periodic pulse or signal that data-acquisition hardware uses to read or write the next sample or block of samples. Also referred to as “pacing”.

D/A

Abbreviation for digital-to-analog, a process that converts a discrete digital value into a continuous analog voltage representing that value.

DAC

Abbreviation for digital-to-analog converter, the hardware that performs the D/A conversion.

DMA

Abbreviation for Direct Memory Access, a technique where the system board can transfer data between a device and memory without using the CPU. In the PC, a standard chip on the system board controls the transfer.

Event

For DriverLINX, an event is the occurrence of a signal that clocks, starts, or stops a data-acquisition task.

Gating

A signal that enables and disables another signal or data-acquisition task depending on the value of the gate signal.

IRQ

Abbreviation for interrupt request. Peripheral hardware signals the CPU that it is ready to transfer data.

ISA

Abbreviation for Industry Standard Architecture. A standard for the original IBM AT bus specification that defines the bus structure, CPU and support chip architecture, and the clock frequency of the ISA bus.

ISR

Abbreviation for interrupt service routine, the software function inside a device driver that handles interrupt requests.

Logical Device

DriverLINX's designation for a specific data-acquisition board inside your computer.

Messages

In Windows and DriverLINX, a message notifies the application about the state of a process.

Modes

DriverLINX data-acquisition techniques.

Operations

Allowed DriverLINX data-acquisition commands.

Pacing

A periodic pulse or signal that data-acquisition hardware uses to read or write the next sample or block of samples. Also referred to as “clocking”.

Process

Refers to the collection of data and code segments and hardware resources that the operating system assigns to one application.

Service Request

A DriverLINX object or data structure that completely defines a data-acquisition task.

Subsystem

DriverLINX subdivides a general-purpose data-acquisition device into six subsystems—Device, Analog Input, Analog Output, Digital Input, Digital Output, and Counter/Timer.

Triggering

The technique of using a pulse or signal to start or stop a data-acquisition task.

TTL

Abbreviation for transistor-transistor logic, a family of digital logic elements.