
Keithley KPCI-1800 Series

Using DriverLINX with Your Hardware

KEITHLEY

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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 KPCI-1800 Series 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 KPCI-1800 Series

Shows how to configure the KPCI-1800 Series using the *Configure DriverLINX Device* dialog box.

Using the KPCI-1800 Series with DriverLINX

Shows how to set up DriverLINX with the *Edit Service Request* dialog box to use KPCI-1800 Series hardware features.

Uninstalling DriverLINX

Describes how to remove DriverLINX hardware drivers and other files.

Troubleshooting

Gives troubleshooting tips for installing, configuring, and loading DriverLINX drivers.

Conventions Used in This Manual

The following notational conventions are used in this manual:

- A round bullet (●) identifies itemized lists.
- Numbered lists indicate a step-by-step procedure.
- 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 bound tables of information.

Tables

Concept

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

Configuring the KPCI-1800 Series

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 KPCI-1800 Series boards.

Installing and configuring DriverLINX for a Keithley KPCI-1800 Series board 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.** This creates a Logical Device, which stores configuration information for your board. See "Configure DriverLINX Device Dialog" on page 11 for configuration options specific to a Keithley KPCI-1800 Series model.
3. **Install your KPCI-1800 hardware,** read and follow the instructions in your hardware manual.


After configuring DriverLINX, installing your board and restarting Windows, reopen the *DriverLINX Configuration Panel* to make sure that DriverLINX loaded the Logical Device for your board. If the Logical Device is not loaded, the Event Log may have a message from the driver that explains why. You can check the Event Log using the *DriverLINX Event Viewer* on the Windows Start Menu.

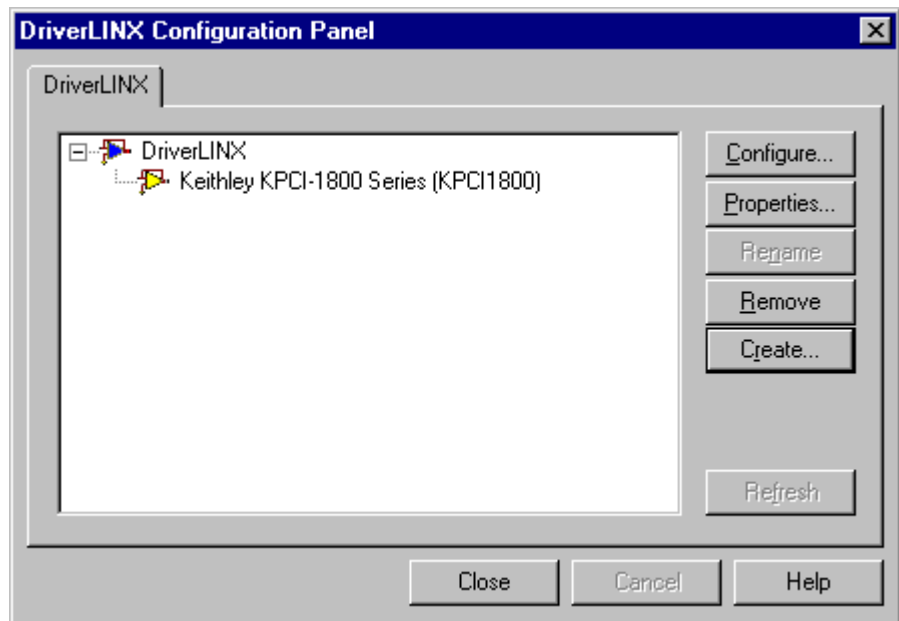
Windows NT

Under Windows NT 4.0, a Logical Device may not load because the operating system does not always configure Plug-and-Play PCI devices properly. To work around this, set your computer's BIOS to configure Plug-and-Play devices before it starts the operating system. On various computers the BIOS setting is called "Plug-and-Play Aware OS – Disabled" or "Plug & Play OS – No".

Configure DriverLINX Device Dialog

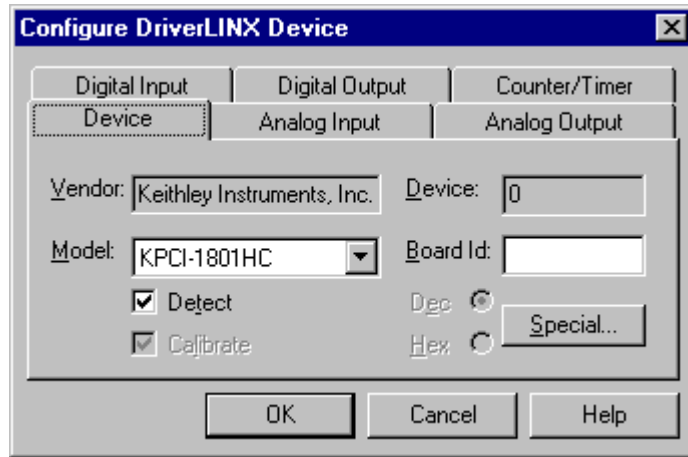
DriverLINX uses a standardized configuration protocol for all data-acquisition hardware. Configuration assigns an identifying device number to a specific KPCI-1800 Series board in your computer and allows you to enable or disable bus mastering.

The installation program automatically starts the *DriverLINX Configuration Panel*. To start it now, 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 the Keithley KPCI-1800 Series. 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 of your KPCI-1800 Series 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:

- KPCI-1801HC
- KPCI-1802HC

Windows 95/98

Windows 95 automatically determines the model of your board so DriverLINX disables Model selection.

Board Id

The Board Id property associates this Logical Device with a specific board. DriverLINX automatically enters the KPCI-1800’s serial number in this field. DriverLINX uses the board’s serial number to uniquely recognize boards if you have installed multiple boards of the same model into your computer.

Windows NT

Under Windows NT, Board Id is initially blank. DriverLINX will use the Model setting to match this Logical Device to the first available board and then enter that board’s serial number.

Windows 95/98 automatically determines which board to associate with this Logical Device. DriverLINX enters the serial number of the board when it starts the configuration.

Detect

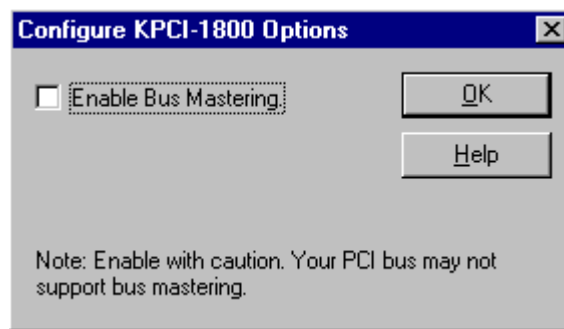
The *Detect* property enables and disables DriverLINX's hardware detection and testing algorithms. For maximum system reliability, always leave this check-box marked.

Calibrate

The *Calibrate* property enables and disables hardware auto-calibration. This option is grayed-out for the KPCI-1800 Series because it does not support automatic calibration.

Special...

The *Special...* button displays the following dialog box of KPCI-1800 Series-specific configuration options:



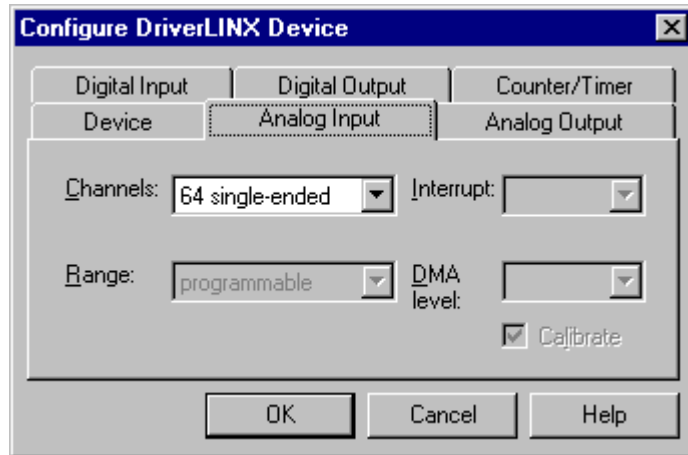
Bus Mastering

Bus Mastering is a mode that PCI devices use to perform DMA data transfers. The KPCI-1800 Series can use bus mastering on motherboards that support it. With bus mastering disabled, the board will operate in interrupt mode when the Service Request asks for DMA mode. For maximum throughput, enable bus mastering if your motherboard supports it.

Motherboards compliant with revision 2.1 of the PCI specification support bus mastering. Almost all newer motherboards support bus mastering but some require BIOS settings to enable it for a particular PCI slot. Older motherboards may not support bus mastering at all and may cause the system to hang, *risking loss of unwritten disk data* and requiring you to reboot. Consult your computer manufacturer's documentation to determine if your motherboard supports bus mastering.

To test bus-mastering, check the *Enable Bus Mastering* box, click OK as necessary to exit the DriverLINX Configuration Panel and restart Windows. Close all other applications, wait until all disk activity stops, then run the DriverLINX AIO Panel. If the AIO Panel can display an input signal then your motherboard is compatible with your KPCI-1800 board. As long as your BIOS has enabled bus-mastering for the PCI slot your board is in, DriverLINX can use DMA mode.

Analog Input Subsystem Page



Use the Analog Input subsystem page to choose between 64 single-ended or 32 differential analog input channels as a default configuration.

Channels

On the KPCI-1800 Series, each Analog Input channel can use single-ended or differential connections. When configuring the Analog Input Subsystem, you choose a default configuration for all channels. Applications can use the default configuration or specify the connection type for each channel it uses. This scheme supports applications that use KPCI-1800-specific features as well as those that use only generic features. For programming information, see “Analog Input Channels” on page 45.

Range

The analog input ranges for the KPCI-1800 Series are fully software programmable. DriverLINX grays out this property in the configuration dialog.

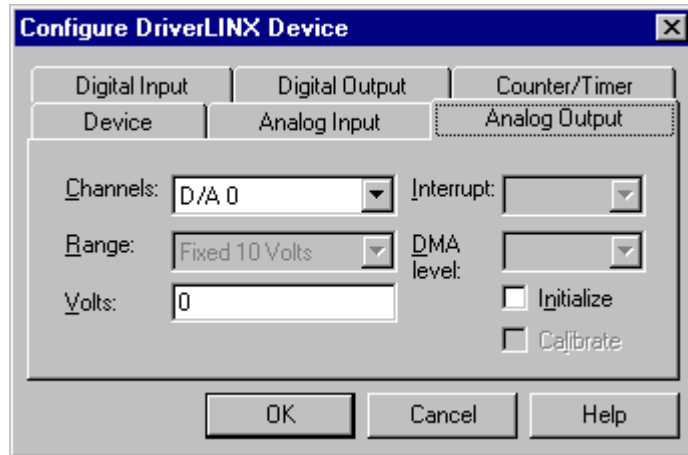
Interrupt

Windows automatically determines the interrupt level for the KPCI-1800 board. DriverLINX disables this property.

DMA

The KPCI-1800 Series does not use DMA channels for direct memory transfers. PCI devices use bus mastering for DMA. DriverLINX initially disables bus mastering for your KPCI-1800 board. See “Special...” on page 14 for more information.

Analog Output Subsystem Page



Use the Analog Output subsystem page to set or view the initial output voltages.

Channels

Lists the analog output channels on the board and selects a channel for the Volts and Initialize properties.

Range

The analog output ranges for the KPCI-1800 Series are fully software programmable. DriverLINX grays out this property in the configuration dialog.

Volts

The *Initialization Value* property specifies the analog output value DriverLINX will write to the selected Logical Channel upon hardware initialization. DriverLINX only writes this value if you enable the *Initialize* check box.

Interrupt

Windows automatically determines the interrupt level for the KPIC-1800 board. DriverLINX disables this property.

DMA

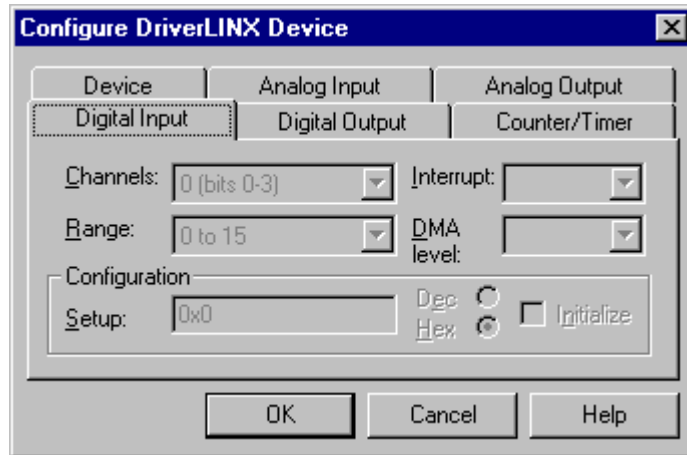
The KPCI-1800 Series does not use DMA channels for direct memory transfers. DriverLINX disables this property.

Initialize

Checking the *Initialize* check box instructs DriverLINX to use the *Volts* property for analog output initialization.

Digital Input Subsystem Page

For the KPCI-1800 Series, there are no configurable options on the Digital Input subsystem page.



Channels

The Channels property allows you to select a Logical Channel for configuration or viewing the channel's range. The KPCI-1800 Series digital channels have fixed configurations.

DriverLINX defines the following Logical Channels for the KPCI-1800 Series digital inputs:

| Logical Channel | DriverLINX Function | KPCI-1800 Series External Connector |
|-----------------|------------------------|-------------------------------------|
| 0 | Standard Digital Input | DI 0 ... DI 3 |
| 1 | External Clock | XPCLK |
| 2 | External Trigger | TGIN |

Range

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

Interrupt

The KPCI-1800 Series does not use interrupts for the digital input subsystem. DriverLINX disables this property and displays it as blank.

DMA

The KPCI-1800 Series does not use DMA channels for direct memory transfers. DriverLINX disables this property.

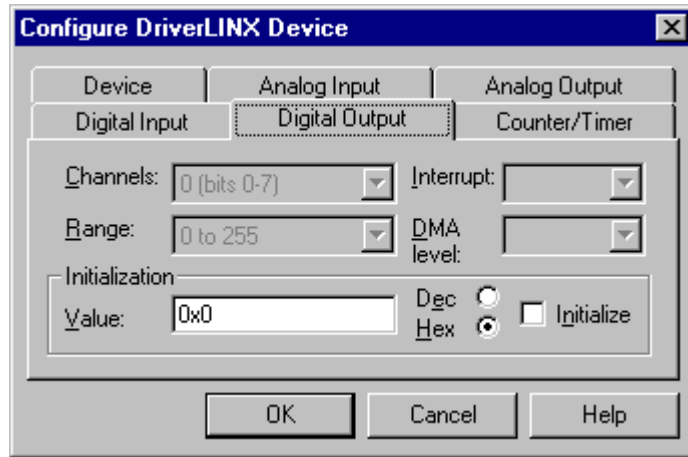
Configuration Setup

The Configuration Setup property specifies the hardware configuration of the digital I/O ports. The KPCI-1800 Series has a fixed digital I/O configuration. Therefore, DriverLINX disables this field.

Initialize

Checking the *Initialize* check box instructs DriverLINX to use the *Configuration Setup* property to configure the digital I/O ports. The KPCI-1800 Series has a fixed digital I/O configuration. Therefore, DriverLINX disables this field.

Digital Output Subsystem Page



Use the Digital Output subsystem page to change the default digital output port initialization values.

Channels

The *Channels* property allows you to select a Logical Channel for initialization or viewing the channel's range. DriverLINX defines the following Logical Channels for the KPCI-1800 Series digital outputs:

| Logical Channel | DriverLINX Function | KPCI-1800 Series External Connector |
|-----------------|-------------------------|-------------------------------------|
| 0 | Standard Digital Output | DO 0 ... DO 7 |

Range

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

Interrupt

The KPCI-1800 Series does not use interrupts for the digital output subsystem. DriverLINX disables this property and displays it as blank.

DMA

The KPCI-1800 Series does not use DMA channels for direct memory transfers. DriverLINX disables this property.

Initialization Value

The *Initialization Value* property specifies the digital output value DriverLINX will write to the selected Logical Channel upon hardware initialization. DriverLINX only writes this value if you enable the *Initialize* check box.

Initialize

Checking the *Initialize* check box instructs DriverLINX to use the *Initialization Value* property for digital output port initialization.

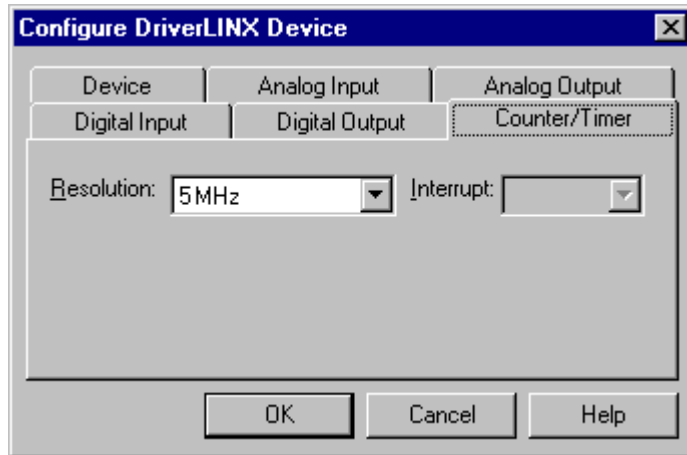
Dec

This check box converts the *Initialization Value* property to decimal.

Hex

This check box converts the *Initialization Value* property to hexadecimal.

Counter/Timer Subsystem Page



Resolution

The *Resolution* property specifies the default clock frequency of the master oscillator. All models have a programmable 10 MHz, 5 MHz, 1 MHz or 100 kHz clock source for pacing input/output tasks. This setting selects the default frequency. Applications can use the default or specify a frequency for each task.

Interrupt

Windows automatically determines the interrupt level for the KPCI-1800 board. DriverLINX disables this property.

Using the KPCI-1800 Series with DriverLINX

Introduction

See the Analog I/O Programming Guide for an overview of DriverLINX programming.

This chapter shows you how to set up and use KPCI-1800 Series hardware features with DriverLINX.

The descriptions here use the *Edit Service Request* dialog 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 subdirectories of your DriverLINX installation directory or on the original distribution media.

DriverLINX Hardware Model for KPCI-1800 Series

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 KPCI-1800 Series hardware capabilities.

The following sections describe how DriverLINX implements KPCI-1800 Series hardware features as Subsystems, Modes, Operations, Events, Logical Channels, Buffers, and Messages.

DriverLINX Subsystems

The KPCI-1800 Series supports the following DriverLINX subsystems:

1. **Device**—refers to a KPCI-1800 board as a whole.
2. **Analog Input**—refers to the analog input channels, clocks, and control signals.
3. **Analog Output**—refers to the analog output channels, clocks, and control signals.
4. **Digital Input**—refers to the digital input port as well as 1-bit digital input (TTL) control signals, such as TGIN.

5. **Digital Output**—refers to the digital output port.
6. **Counter/Timer**—refers to the input/output subsystem-specific internal clock channels for pacing analog input/output.

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 four modes with the KPCI-1800 Series 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.
- **DMA Mode**—This is a background or asynchronous operation. DriverLINX programs the data-acquisition board to transfer data between the computer's memory and the board.
- **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 KPCI-1800 Series.

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

KPCI-1800 Series 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 KPCI-1800 Series. 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 Input 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 | | | | |
| Polled | Start | null | null, cmd | null, TC |
| Interrupt | Start, Stop, Status | dig, rate | cmd, dig | cmd, TC, dig |
| DMA | Start, Stop, Status | dig, rate | cmd, dig | cmd, TC, dig |
| Other | Initialize | | | |
| Analog Output | | | | |
| Polled | Start | null | null, cmd | null, TC |
| Interrupt | Start, Stop, Status | rate | cmd, dig | cmd, TC |
| DMA | Start, Stop, Status | rate | cmd, dig | cmd, TC |
| Other | Initialize | | | |
| Digital Input | | | | |
| Polled | Start | null | null, cmd | null, TC |
| Interrupt | Start, Stop, Status | rate | cmd | cmd, TC |
| Other | Initialize | | | |
| Digital Output | | | | |
| Polled | Start | null | null, cmd | null, TC |
| Interrupt | Start, Stop, Status | rate | cmd | cmd, TC |
| Other | Initialize | | | |
| Counter/Timer | | | | |
| Other | Initialize | | | |
| Device | | | | |
| Other | Initialize, Configure, Capabilities | | | |

Allowed Operations and Events for KPCI-1800 Series 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 KPCI-1800 Series

The Keithley hardware manual describes the data and control signals for the KPCI-1800 Series and the connector pinouts for these signals. This section summarizes how DriverLINX numbers the I/O data signals and how DriverLINX uses the control connections for external clock, trigger, and gating inputs.

Analog Input Subsystem Signals

The Analog Input subsystem has 64 analog inputs and an analog ground. You set the default subsystem configuration as 32 differential or 64 single-ended channels. Applications can then use the default configuration or request a specific configuration for each channel. See “Analog Input Channels” on page 45 for programming information.

DriverLINX maps these connections to Logical Channels as shown in the following table:

| Physical Channels | Connector Name | Logical Channels |
|---------------------|-------------------------|------------------|
| 0 – 31 Differential | CH00LO, HI – CH31LO, HI | 0 – 31 |
| 0 – 63 Single-ended | CH00LO – CH63LO, AGND | 0 – 63 |

How DriverLINX maps analog input hardware channels to Logical Channels.

Analog Input Pacing, Triggering and Gating Signals

Analog input tasks can use the input-pacing counter, which DriverLINX designates as Counter/Timer Logical Channel 0. For this counter the clock source can be internal or external.

The Analog Input subsystem uses two control signals that DriverLINX defines as an external clock and a trigger/gate as shown in the following table:

| Connector Name | DriverLINX Usage |
|----------------|-----------------------|
| TGIN | External trigger/gate |
| XPCLK | External pacer clock |

How DriverLINX uses analog input control signals.

Analog Output Subsystem Signals

The Analog Output subsystem has 2 analog differential output connections.

DriverLINX maps these connections to Logical Channels as shown in the following table:

| Physical Channel | Connector Name | Logical Channel |
|------------------|-----------------|-----------------|
| 0 | DAC0IN,DAC0OUT | 0 |
| 1 | DAC1IN, DAC1OUT | 1 |

How DriverLINX maps analog output hardware channels to Logical Channels.

Digital Input Subsystem Signals

The Digital Input subsystem has one 4-bit digital input port and two control inputs 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 Channel |
|------------------------|----------------|-----------------|
| 4-bit digital input | DI 0 ... DI 3 | 0 |
| External clock alias | XPCLK | 1 |
| External trigger alias | TGIN | 2 |

How DriverLINX maps digital input hardware channels to Logical Channels.

Digital Output Subsystem Signals

The Digital Output subsystem has an 8-bit digital output port. DriverLINX maps these signals to Logical Channels as shown in the following tables:

| Port | Connector Name | Logical Channel |
|----------------------|----------------|-----------------|
| 8-bit digital output | DO 0 ... DO 7 | 0 |

How DriverLINX maps digital output hardware channels to Logical Channels.

Counter/Timer Subsystem Signals

The Counter/Timer subsystem has an external clock source and a gate input that the board can use with any Logical Channel. DriverLINX maps these signals as shown in the following table:

| 8254 Chip Counter | Connector Name | Logical Channel |
|--------------------------|-----------------------|------------------------|
| Counters 1 & 2 | XPCLK, TGIN | 0 |
| Counter 0 | XPCLK, TGIN | 1 |
| Counter 1 | XPCLK, TGIN | 2 |
| Counter 2 | XPCLK, TGIN | 3 |

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

Device Subsystem

The following sections describe how DriverLINX implements Device Subsystem features for the KPCI-1800 Series.

Device Modes

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

Device Operations

The KPCI-1800 Series 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 another application's data-acquisition tasks.

- **Initialize**—DriverLINX aborts all data-acquisition tasks for every subsystem controlled by the current application. DriverLINX then initializes each 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 Input Subsystem

The following sections describe how DriverLINX implements Analog Input Subsystem features for the KPCI-1800 Series.

Analog Input Modes

The Analog Input Subsystem supports the following modes:

- **Polled**—For single-value or scan analog-input samples.
- **Interrupt**—For buffered transfers using programmed I/O.
- **DMA**—For buffered transfers using direct memory access.
- **Other**—For subsystem initialization and data conversion.

Analog Input Operations

The KPCI-1800 Series Analog Input Subsystem supports the following DriverLINX operations:

- **Initialize**—aborts all active analog input 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 input data-acquisition task.
- **Message**—DriverLINX displays a pop-up dialog box for the user containing the text for the current DriverLINX error message.

Analog Input Timing Events

Timing Events specify how the hardware paces or clocks the acquisition of analog input samples. DriverLINX uses the Timing Event to program when the KPCI-1800 Series acquires the next analog input sample.

The KPCI-1800 Series supports the following Timing Events:



- **None**—Sampling requires no pacing as DriverLINX is acquiring only a single value or scan.
- **Rate**—The KPCI-1800 Series supports fixed rate and burst mode sampling using internal and external clocks.
- **Digital**—DriverLINX uses an external digital input signal to pace the acquisition of the next sample.

None or Null Event

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

Rate Event

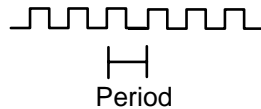
The KPCI-1800 Series supports two types of Rate Events for analog input:

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

- **Burst Generator**—Generates a dual frequency clock with a fixed number of tics at a high frequency separated by a time interval at a lower frequency.


KPCI-1800 boards have a programmable 10 MHz, 5 MHz, 1 MHz or 100 kHz master clock frequency. The sample period can range from 3 μ s to $2^{32} - 1$ tics at 100 kHz. This means the sample rate can range from 0.0000233 Hz to 333kHz. However, using multiple channels or non-unity gains may reduce the maximum sample rate. Consult your hardware manual for details.

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 acquire all analog input samples at equally spaced time intervals.

How to set up the KPCI-1800 Series for fixed rate sampling using an internal clock.

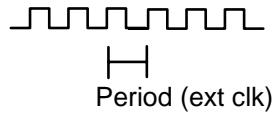
For hardware independence, specify the clock channel using the symbolic constant, DEFAULTTIMER, which always maps to the default Logical Channel for analog input timing.

- Specify internal clocking using a **Rate Generator** on any available **Channel** with any internal **Clock** source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources.
- The *Period* property specifies the time interval between samples in tics, where a tic period depends on the clock source. The minimum period is 3 μ s. The maximum period is 4294967295 tics ($2^{32} - 1$) for *Channel 0* or 65535 tics ($2^{16} - 1$) for the other channels. See “Counter/Timer Subsystem” on page 82 for details.
- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

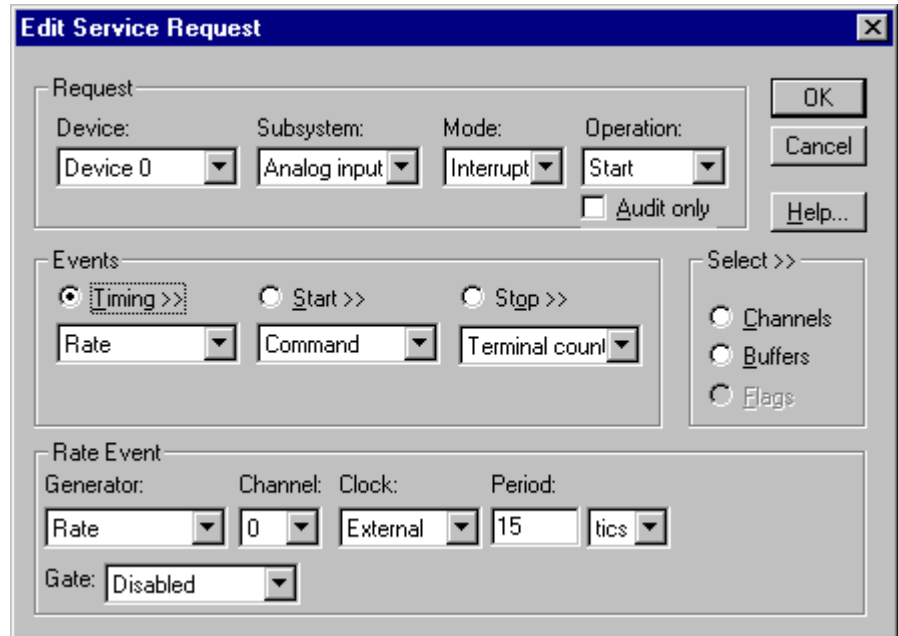
Note: You cannot use a gated clock with a digital start or stop trigger.

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 input samples with a recurrent external signal. In this mode you will need a separate external clock tic for each analog sample you want to acquire.



How to set up the KPCI-1800 Series 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!

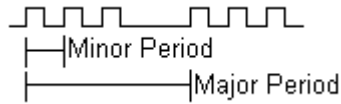
- Specify external clocking using a **Rate Generator** on any available **Channel** with an **External**, **External+**, or **External-** Clock source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources. For hardware-independence, you can specify the hardware external clock channel by the symbolic constant, *DI_EXTCLK*.
- Users should connect the external clock signal to the XPCLK line.
- The *Period* may be any value $\geq 3 \mu\text{s}$. 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. *Period* is in tics, where a tic period depends on the clock source. See “Counter/Timer Subsystem” on page 82 for details.
- The frequency of the external clock must not exceed 333 kHz.
- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate*

setting.

Note: You cannot use a gated clock with a digital start or stop trigger.

Burst Generator: Internal Clocking

An internally clocked Burst Generator produces a dual frequency clock with a fixed number of tics at a high frequency repeated at a lower frequency.



Use an internally clocked rate generator when you want to acquire analog input samples from a several channels at closely spaced time intervals and then repeat at longer intervals.

The screenshot shows the 'Edit Service Request' dialog box. The 'Request' section has Device: Device 0, Subsystem: Analog input, Mode: Interrupt, and Operation: Start. The 'Events' section has 'Timing >>' selected, with Rate, Command, and Terminal count dropdowns. The 'Rate Event' section has Generator: Burst, Channel: 0, Clock: Internal 1, Period: 150 tics, On time: 20 tics, Gate: Disabled, and Pulses: 2.

How to set up the KPCI-1800 Series for burst mode 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 input timing.

- Specify internal clocking using a **Burst Generator** on any available **Channel** with any internal **Clock** source. For hardware independence, specify the clock channel using the symbolic constant, DEFAULTTIMER, which always maps to the default Logical Channel for analog input timing. See “Counter/Timer Subsystem” on page 82 for a description of clock sources.
- The *Period* property specifies the time interval between the start of each burst in tics, where a tic period depends on the clock source. The minimum period is 3 μ s. The maximum period is 4294967295 tics ($2^{32} - 1$) for *Channel 0* or 65535 tics ($2^{16} - 1$) for the other channels. See “Counter/Timer Subsystem” on page 82 for details.
- The *On time* property specifies the time interval between samples. It must be within the range of 4 μ s to 64 μ s. Also $Pulses \times (On\ time + 1\mu s)$ must be **less than** *Period*.

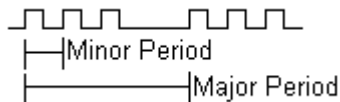
- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

Note: You cannot use a gated clock with a digital start or stop trigger.

- The *Pulses* property specifies how many channels the board samples in each *Period*. *Pulses* must equal the number of channels in the channel list.

Burst Generator: External Clocking

An externally clocked Rate Generator produces a dual frequency clock with a fixed number of tics at a high, internal frequency repeated at a lower, externally controlled frequency.



Use an externally clocked burst generator when you want to synchronize a burst of analog input samples with a recurrent external signal. In this mode you will need a separate external clock tic for each burst of analog samples you want to acquire.

How to set up the KPCI-1800 Series for burst mode 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 **Burst Generator** on any available *Channel* with an **External**, **External+**, or **External-** *Clock* source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources. For hardware-independence, you can specify the hardware external clock channel by the symbolic constant, *DI_EXTCLK*.
- Users should connect the external clock signal to the XPCLK line.
- The *Period* may be any value $\geq 3 \mu\text{s}$. 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. *Period* is in tics, where a tic period depends on the clock source. See “Counter/Timer Subsystem” on page 82 for details.
- The *On time* property specifies the time interval between samples. It must be within the range of $4\mu\text{s}$ to $64\mu\text{s}$. Also $Pulses \times (On\ time + 1\mu\text{s})$ must be **less than** *Period*.
- The frequency of the external clock must not exceed 333 kHz.
- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

Note: You cannot use a gated clock with a digital start or stop trigger.

- The *Pulses* property specifies how many channels the board samples in each *Period*. *Pulses* must be between 2 and the number of channels in the channel list.

Digital Event

DriverLINX supports Digital Events as aliases for externally clocked Rate Generators. Use this technique for compatibility with data-acquisition products that only support external clock sources.

The screenshot shows the 'Edit Service Request' dialog box with the following settings:

- Request:** Device: Device 0, Subsystem: Analog input, Mode: Interrupt, Operation: Start. Audit only.
- Events:** Timing >>, Start >>, Stop >>. Digital, Command, Terminal count.
- Digital Event:** Channel: 1, Mask: Bit 0, Equals, Not equals, Pattern: 0.

How to set up the KPCI-1800 Series for external rate sampling using a digital event.

- 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 XPCLK 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 ($\neq 0$) or **1** for a falling, or negative, edge clock ($\neq 1$).

Analog Input Start Events

Start Events specify when the KPCI-1800 hardware starts acquiring analog input data.

The KPCI-1800 Series supports the following Start Events:

- **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 KPCI-1800 hardware for the task.
- **Digital**—The KPCI-1800 starts acquiring analog input samples when the hardware detects the digital Logical Channel 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 KPCI-1800 can acquire analog input 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 with the following settings:

- Request:** Device: Device 0, Subsystem: Analog input, Mode: Interrupt, Operation: Start. Audit only.
- Events:** Timing >>, Start >>, Stop >>. Rate: [dropdown], Digital: [dropdown], Terminal count: [dropdown]. Delay: 0.
- Digital Event:** Channel: 2, Mask: AND Bit 0, Equals, Not equals, Pattern: 0.

Buttons: OK, Cancel, Help...

How to set up the KPCI-1800 Series for post-triggered analog input.

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 **2**. For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTRG*.
- Users should connect the external trigger signal to the TGIN 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 trigger ($\neq 0$) or **1** for a falling, or negative, edge trigger ($\neq 1$).
- Specify the *Delay* property as 0. The KPCI-1800 does not support a delay in sampling after the start trigger.
- You cannot use a digital start trigger with a gated clock.
- If both the start trigger and stop trigger are digital events, they must have identical *Pattern* settings.

Analog Input Stop Events

Stop Events specify when the hardware stops acquiring analog input data.

The KPCI-1800 Series supports the following Stop Events:

- **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 filled all the data buffers once.
- **Digital**—The KPCI-1800 stops acquiring analog input samples when the hardware detects the digital Logical Channel input satisfies the condition specified in the Stop Event.

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 filling them with analog input data from the data-acquisition hardware.

Terminal Count Event

The Terminal Count Event stops data acquisition after DriverLINX has filled all the data buffers *once* with analog input data. Use Terminal Count when you want to acquire a single scan or fixed amount of data.

Digital Event or Pre-Triggering

The KPCI-1800 can acquire analog input samples *until* the hardware detects a digital trigger condition. Use pre-triggering when you want to synchronize the end of data acquisition with an external signal.

The screenshot shows the 'Edit Service Request' dialog box with the following settings:

- Request:** Device: Device 0, Subsystem: Analog input, Mode: Interrupt, Operation: Start, Audit only:
- Events:** Timing >>, Start >>, Stop >>. Rate: Digital, Command: Command, Delay: 0. Select >>: Channels, Buffers, Flags.
- Digital Event:** Channel: 2, Mask: AND Bit 0, Equals, Not equals, Pattern: 0.

How to set up the KPCI-1800 Series for pre-triggered analog input.

Digital Stop 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 **2**. For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTTRG*.
- Users should connect the external trigger signal to the TGIN 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 trigger ($\neq 0$) or **1** for a falling, or negative, edge trigger ($\neq 1$).
- Specify the *Delay* property as an integer from 0 to $2^{32} - 1$. The KPCI-1800 continues sampling until it obtains this number of samples after the trigger. The number must be a multiple of the number of channels in the channel list.

- You cannot use a digital stop trigger with a gated clock.
- If both the start trigger and stop trigger are digital events, they must have identical *Pattern* settings.

Analog Input Channels

The KPCI-1800 Series models support a variety of channel gains with differential or single-ended connections. The Logical Device configuration sets the default connection type for analog input channels. An application can request a particular connection type for each channel it uses. The channel gains are also application selectable.

The KPCI-1800 Series allows applications to specify the analog channels using three techniques:

- **Start Channel**—Acquire data from a single channel.
- **Start/Stop Channel Range**—Acquire data from a consecutive range of channels.
- **Channel List**—Acquire data from a list of channels.

You should be aware that using multiple channels or non-unity gains may reduce the maximum sample rate. Consult your hardware manual for details.

Analog Input Channel Gains

Each channel in a channel scan list has a gain code property to select the pre-amplifier gain when sampling that channel. The following tables show the correspondence between the gain multiplier, the maximum input signal range, and the gain code for each input range. Note: DriverLINX uses a negative (-) gain multiplier to signify a bipolar (\pm) range.

KPCI-1801HC

| Gain Multiplier | Range | Gain Code |
|-----------------|--------------|-----------|
| -1 | ± 5 V | 0 |
| -5 | ± 1 V | 1 |
| -50 | ± 100 mV | 2 |
| -250 | ± 20 mV | 3 |
| 1 | 0 ... 5 V | 4 |
| 5 | 0 ... 1 V | 5 |
| 50 | 0 ... 100 mV | 6 |
| 250 | 0 ... 20 mV | 7 |

Gain Multipliers, Ranges, and Gain Codes for KPCI-1801HC.

KPCI-1802HC

| Gain Multiplier | Range | Gain Code |
|-----------------|--------------|-----------|
| -1 | ± 10 V | 0 |
| -2 | ± 5 | 1 |
| -4 | ± 2.5 V | 2 |
| -8 | ± 1.25 V | 3 |
| 1 | 0 ... 10 | 4 |
| 2 | 0 ... 5 | 5 |
| 4 | 0 ... 2.5 V | 6 |
| 8 | 0 ... 1.25 V | 7 |

Gain Multipliers, Ranges, and Gain Codes for KPCI-1802HC.

Use the DriverLINX **Gain2Code** method to easily convert between the gains in the above tables and Gain Codes. Using this method makes applications portable to different hardware models.

Analog Input Channel Connection Types

On the KPCI-1800 Series, each Analog Input channel can use single-ended or differential connections. When configuring the Analog Input Subsystem, you choose a default configuration for all channels. Applications can use the default configuration or specify the connection type for each channel it uses. This scheme supports applications that use KPCI-1800-specific features as well as those that use only generic features.

Each channel in a channel list has a gain code property. To specify a connection type for a channel, an application includes a connection-type flag in its gain code. The following table shows the flag value for each connection type:

| Connection Type | Flag Value |
|-----------------------|--------------------------------------|
| Default Configuration | CHAN_SEDIFF_DEFAULT = 0 |
| Single-Ended | CHAN_SEDIFF_SE = 2×2^{13} |
| Differential | CHAN_SEDIFF_DIFF = 3×2^{13} |

Note: The user chooses the default configuration on the Analog Input page of the DriverLINX Configuration Panel. See “Analog Input Subsystem Page” on page 15.

For example, an application that requires or knows a channel’s connection type obtains the gain code for a single-ended channel with a bipolar gain of 5, with:

```
Gain2Code (-5) + CHAN_SEDIFF_SE
```

```
// This code will work with only drivers that allow applications to specify a connection type.
```

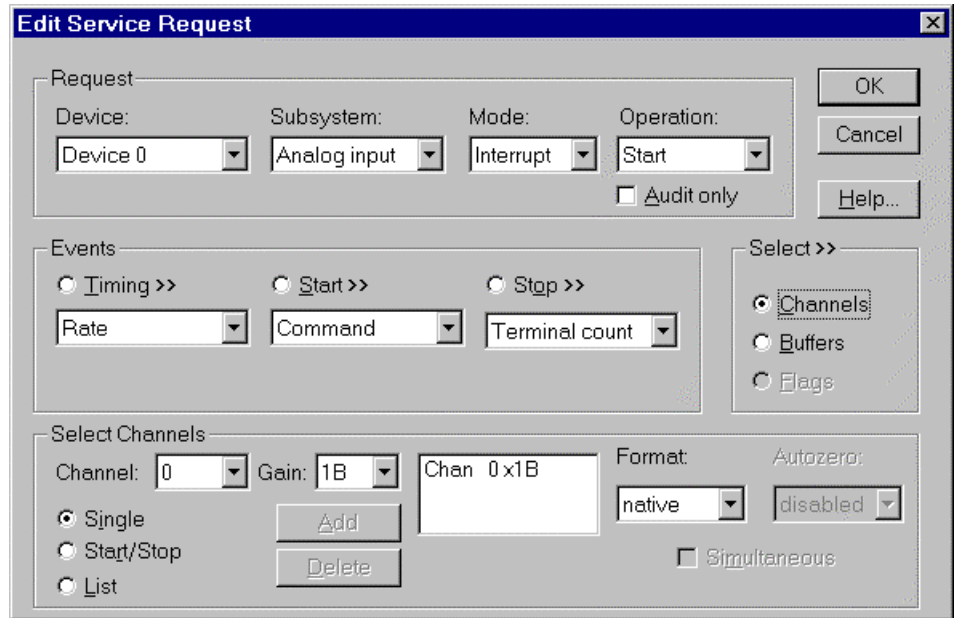
An application that does not require or know a channel's connection type obtains the gain code for a channel with a bipolar gain of 5, with:

```
Gain2Code (-5)
```

```
// This code will work with any board that supports bipolar ranges.
```

Single Channel Analog Input

In single channel mode, the KPCI-1800 Series acquires all data from one channel at the specified gain.

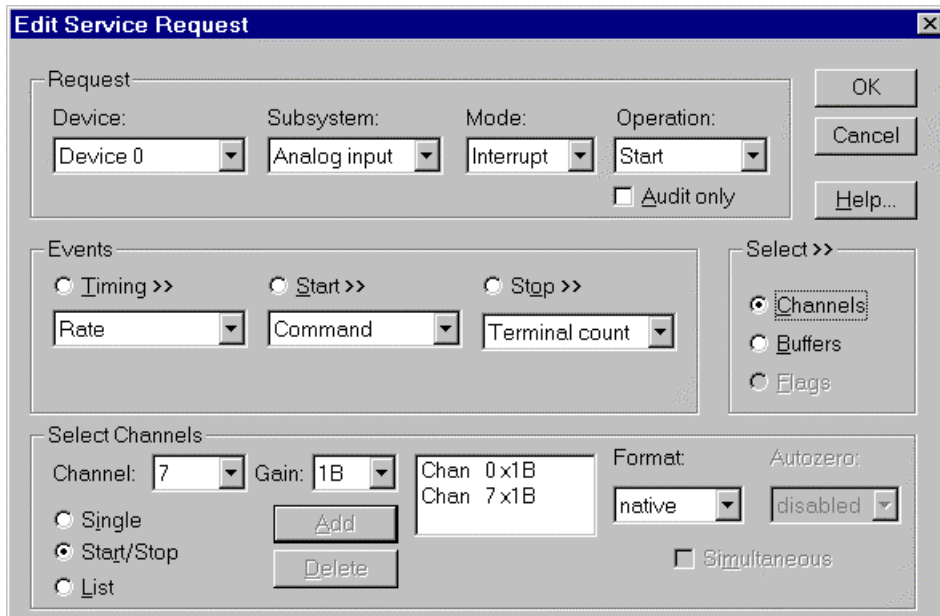


How to set up the KPCI-1800 Series for sampling on a single channel.

Multi-channel Analog Input Range

In multi-channel range mode, the KPCI-1800 Series acquires data from a consecutive range of analog channels.

- The Start Channel's gain only applies to the first channel.
- DriverLINX uses the Stop Channel's gain for all the other analog channels in the range.
- The gains may vary but they must all be either unipolar or bipolar.
- 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 default configuration (31 or 63).

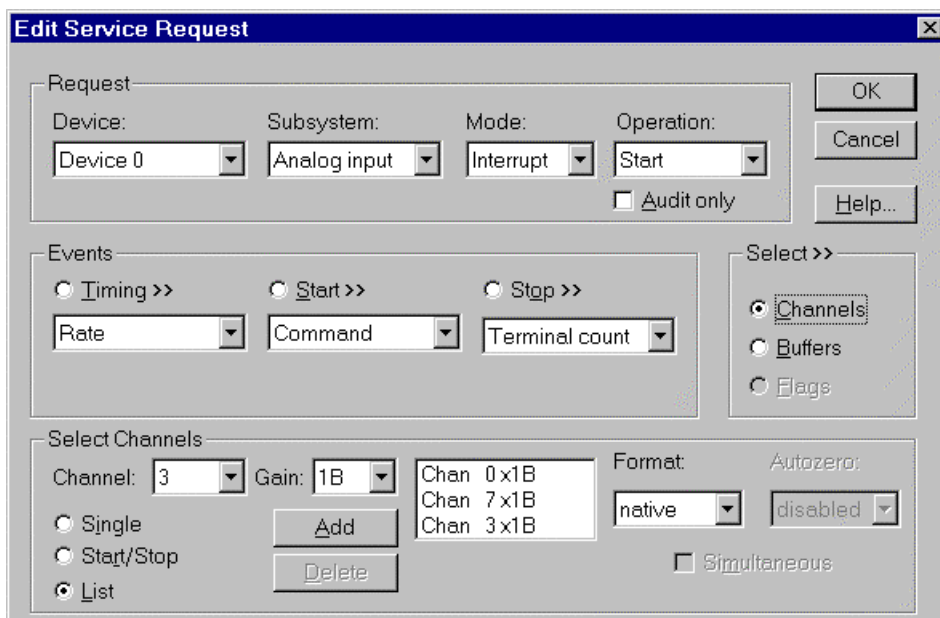


How to set up the KPCI-1800 Series for sampling on a consecutive range of channels.

Multi-channel Analog Input List

In multi-channel list mode, the KPCI-1800 Series acquires data from an arbitrary list of analog channels.

- The channel-gain list may contain up to 64 channels in any order. The list may repeat the same channel with the same or different gains and connection types.
- The gains may vary but they must all be either unipolar or bipolar.



How to set up the KPCI-1800 Series to sample on an arbitrary list of channels.

Analog Input Buffers

DriverLINX supports single-value, single-scan and buffered analog input.

- **For single-value input**, specify the *Number* of buffers as **0**. The buffer for a single value is the *ioValue* property.
- **For single-scan input**, specify the *Number* of buffers as **1** and the number of *Samples* as **1**.
- **For buffered input**, specify the *Number* of buffers from **1** to **256** and the number of *Samples* as desired.

The screenshot shows the 'Edit Service Request' dialog box. It is divided into three main sections: 'Request', 'Events', and 'Select Buffers'.
- **Request:** Contains four dropdown menus: 'Device:' (Device 0), 'Subsystem:' (Analog input), 'Mode:' (Interrupt), and 'Operation:' (Start). There is also an 'Audit only' checkbox and buttons for 'OK', 'Cancel', and 'Help...'.
- **Events:** Contains three radio buttons: 'Timing >>', 'Start >>', and 'Stop >>'. Below each radio button is a dropdown menu: 'Rate', 'Command', and 'Terminal count'. To the right is a 'Select >>' section with three radio buttons: 'Channels', 'Buffers' (which is selected), and 'Flags'.
- **Select Buffers:** Contains a 'Samples:' text box with the value '500', a 'Number:' dropdown menu with the value '2', and two checkboxes: 'Notify' and 'Auto-allocate'.

How to set up the KPCI-1800 Series to store samples in 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 input channels you're acquiring). This restriction enforces the requirement that all acquired channels have the same number of samples.

Special Requirements for DMA Mode Buffering

The KPCI-1800 Series performs direct memory access (DMA) using the PCI bus mastering mode. To maintain the high efficiency that bus mastering provides, the hardware transfers samples in pairs (four bytes at a time) to memory on 4-byte boundaries. This feature has the following consequences:

- Each buffer must have an even number of samples (a multiple of four bytes). If an application requests a DMA-mode task with an odd number of samples per buffer, DriverLINX returns an "Invalid # of conversions" error.
- A sample taken on an odd-numbered clock pulse is not available until the next even-numbered clock pulse. At high sample rates with continuous internal or external clocking, this effect is imperceptible. At very low sample rates, you may observe applications taking twice as long as expected to acquire a sample. With an external clock that

produces an odd number of pulses and then stops, the application will not receive the last sample.

Applications that require an odd number of samples per buffer or use an external clock with an odd, finite number of clock pulses should use interrupt mode instead of DMA mode. For existing applications that use DMA mode but do not meet these requirements, the user can cause DriverLINX to substitute interrupt mode for DMA mode by disabling bus mastering in the KPCI-1800's *Configure DriverLINX Device* dialog.

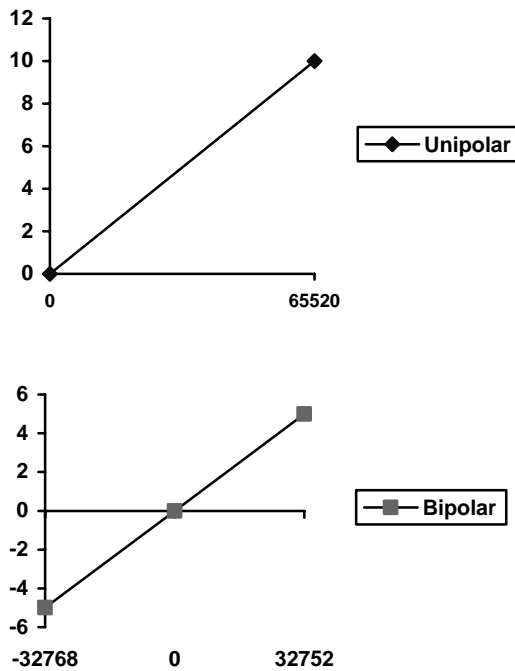
Analog Input Data Coding

KPCI-1800 Series models return Analog Input 12-bit hardware codes in left-shifted binary for unipolar ranges and left-justified two's complement binary for bipolar ranges. DriverLINX refers to these coding schemes as the “native” format.

For any programmable gain, the KPCI-1800 models return hardware codes with the ranges in the following table:

| Polarity | Analog Input Resolution | Analog Input Hardware Code |
|----------|-------------------------|------------------------------------|
| Unipolar | 12 bits | 0 to 65520 in multiples of 16 |
| Bipolar | 12 bits | -32768 to 32752 in multiples of 16 |

Native Analog Input hardware codes for each KPCI-1800 Series polarity.



KPCI-1800 Series native Analog Input Codes versus Voltage Range.

DriverLINX refers to the default hardware analog-coding scheme as the “native” format. For computer arithmetic in a higher level language, the 16-bit two's complement integer format is generally easier to use. Applications can use DriverLINX's data conversion operations to transform an entire data buffer from many common integer and floating-point formats to native format.

Analog Input Messages

For analog input 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 filled an analog input buffer. |
| Start Event | DriverLINX has processed the interrupt for a hardware start event. |
| Data Lost | DriverLINX has detected an analog input data overrun condition. |
| Critical Error | DriverLINX has encountered an unexpected hardware or software condition. |

DriverLINX Event messages for analog input.

Data Lost

The KPCI-1800 provides hardware monitoring of analog input data overruns. DriverLINX notifies applications that an overrun has occurred by posting an event message, DL_DATALOST. DriverLINX posts this message only the first time the board detects an overrun during an acquisition task. The KPCI-1800 hardware will stop acquisition when an overrun has occurred.

Analog Output Subsystem

The following sections describe how DriverLINX implements Analog Output Subsystem features for the KPCI-1800 Series.

Analog Output Modes

The Analog Output Subsystem supports the following modes:

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

Analog Output Operations

The KPCI-1800 Series 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 Timing Events

Timing Events specify how the hardware paces or clocks the writing of analog output samples. DriverLINX uses the Timing Event to program when the KPCI-1800 Series writes the next analog output sample.

The KPCI-1800 Series supports the following Timing Events:

- **None**—Task requires no pacing as DriverLINX is writing only a single value or scan.
- **Rate**—The KPCI-1800 Series supports fixed rate sampling using internal and external clocks.

You can also synchronize an Analog Output task with an Analog Input task using a Rate Event. See “Rate Generator: Internal Clocking” on page .

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

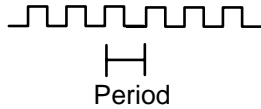
The KPCI-1800 Series supports only the Rate Generator mode for Rate Events for analog output:

- **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.

How to set up the KPCI-1800 Series for fixed rate writing 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 input timing

- Specify internal clocking using a **Rate Generator** on any available Channel with any internal Clock source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources.
- The *Period* property specifies the time interval between samples in tics, where a tic period depends on the clock source. The minimum period is 1 tic. The maximum period is 4294967295 tics ($2^{32} - 1$) for Channel 0 or 65535 tics ($2^{16} - 1$) for the other channels. See “Counter/Timer Subsystem” on page 82 for details.

- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

Note: You cannot use a gated clock with a digital start trigger.

To synchronize Analog Output with Analog Input, use the same settings for the Timing Event except set the *Period* to zero. Submit the Analog Output service request with a *Start* operation before submitting the Analog Input service request. The output task begins when the input task begins.

Analog Output Start Events

Start Events specify when the KPCI-1800 hardware starts acquiring analog output data.

The KPCI-1800 Series supports the following Start Events:

- **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 KPCI-1800 hardware for the task.
- **Digital**—The KPCI-1800 starts the task when the hardware detects the digital Logical Channel 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 KPCI-1800 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 with the following settings:

- Request:** Device: Device 0, Subsystem: Analog output, Mode: Interrupt, Operation: Start. Audit only.
- Events:** Timing >>, Start >>, Stop >>. Rate: [dropdown], Digital: [dropdown], Terminal count: [dropdown]. Delay: 0.
- Digital Event:** Channel: 2, Mask: AND Bit 0. Equals, Not equals. Pattern: 0.

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 **2**. For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTTRG*.
- Users should connect the external trigger signal to the TGIN 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 trigger ($\neq 0$) or **1** for a falling, or negative, edge trigger ($\neq 1$).
- Specify the *Delay* property as 0. The KPCI-1800 does not support a delay in sampling after the start trigger.
- You cannot use a digital start trigger with a gated clock.

Analog Output Stop Events

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

The KPCI-1800 Series supports the following Stop Events:

- **None**—Use this event when the DriverLINX operation doesn't require a Stop Event.
- **Terminal count**—DriverLINX stops the task after the data-acquisition hardware has filled 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.

Terminal Count Event

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

Analog Output Channels

The KPCI-1800 Series allows applications to specify the analog channels using three techniques:

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

The KPCI-1800 Series models support one channel gain for analog output channels. The following table shows the correspondence between DriverLINX gains, the maximum output signal range, and the hardware gain code for each output range. Note: DriverLINX uses a negative (-) gain value to signify a bipolar (\pm) range.

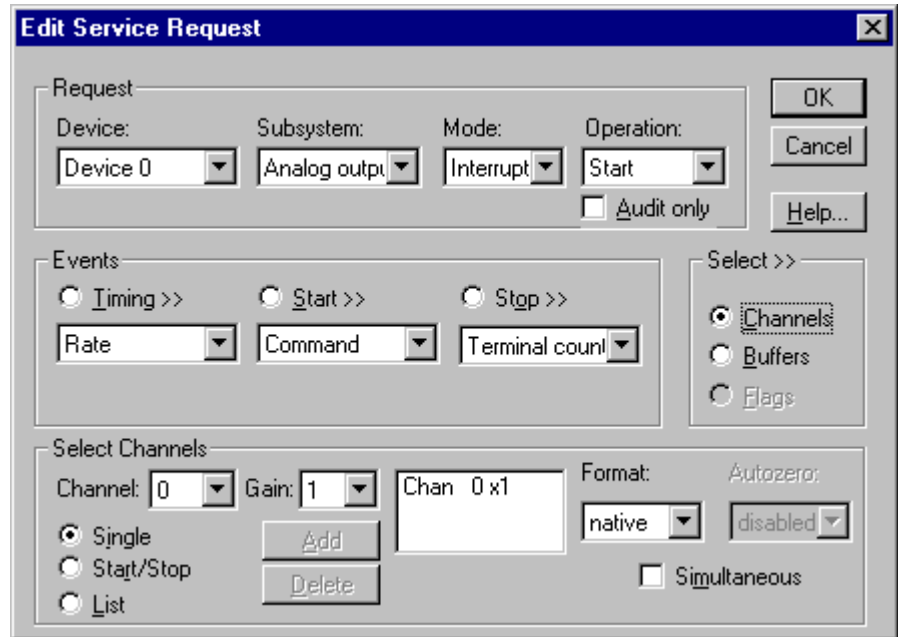
| Gain Multiplier | Range | Gain Code |
|-----------------|------------|-----------|
| -1 | ± 10 V | 0 |

Gain Multipliers, Ranges, and Gain Codes.

Use the DriverLINX **Gain2Code** method to easily convert between the gains in the above tables and hardware Gain Codes.

Single Channel Analog Output

In single channel mode, the KPCI-1800 Series writes all data to one channel at the specified gain.

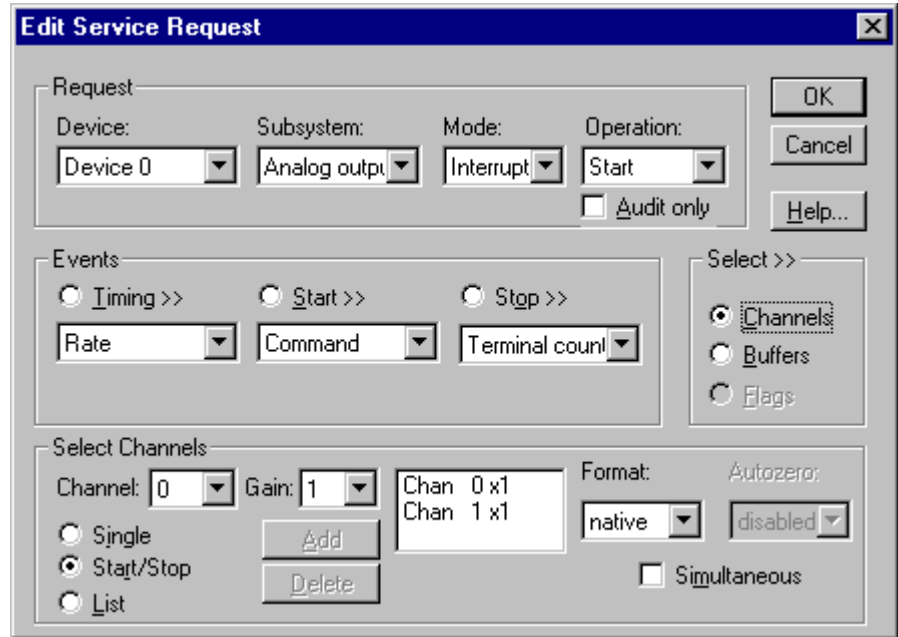


How to set up the KPCI-1800 Series for writing to a single channel.

Multi-channel Analog Output Range

In multi-channel range mode, the KPCI-1800 Series writes data to a consecutive range of analog channels.

- The range can specify both channels in either order.

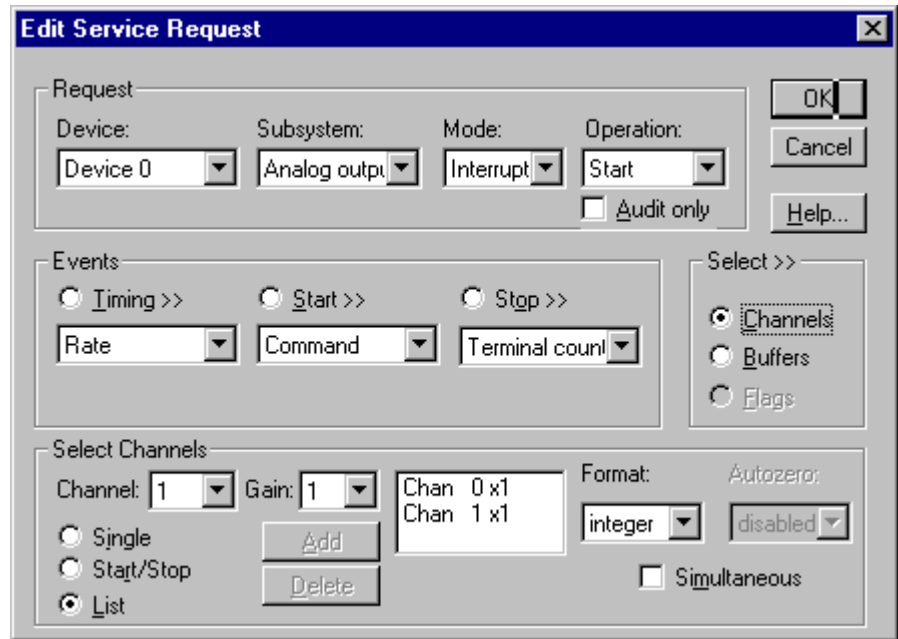


How to set up the KPCI-1800 Series for writing to a consecutive range of channels.

Multi-channel Analog Output List

In multi-channel list mode, the KPCI-1800 Series writes data to an arbitrary list of analog channels.

- For the KPCI-1800 Series, a channel cannot appear more than once in the list.



How to set up the KPCI-1800 Series to write to an arbitrary list of channels.

Analog Output Buffers

DriverLINX supports single-value, single-scan and buffered analog output.

- **For single-value output**, specify the *Number* of buffers as **0**. The buffer for a single value is the *ioValue* property.
- **For a single-scan output**, specify the *Number* of buffers as **1** and the number of *Samples* equal to the number of channels.
- **For buffered output**, specify the *Number* of buffers from **1** to **256** and the number of *Samples* as desired.

How to set up the KPCI-1800 Series to store samples in buffers.

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

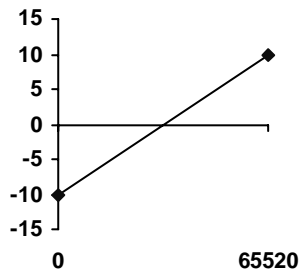
An individual DriverLINX buffer may have any size as long as the buffer length holds an integral number of channel scans (i.e., a multiple of the number of analog output channels you’re writing). This restriction enforces the requirement that all channels have the same number of samples.

Analog Output Data Coding

KPCI-1800 Series uses the left-shifted, offset binary format to encode analog output data, as shown in the following table. DriverLINX refers to this coding scheme as the “native” format.

| Format | Analog Output Resolution | Analog Output Hardware Code |
|---------------|--------------------------|-------------------------------|
| Offset binary | 12 bits | 0 to 65520 in multiples of 16 |

Native Analog Output hardware codes for the KPCI-1800 Series.



KPCI-1800 Series native Analog Output Codes versus Voltage Range at unity gain.

DriverLINX refers to the default hardware analog-coding scheme as the “native” format. For computer arithmetic in a higher level language, the 16-bit two’s complement integer format is generally easier to use. Applications can use DriverLINX’s data conversion operations to transform an entire data buffer from many common integer and floating-point formats to native format.

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 filled an analog output buffer. |
| Start Event | DriverLINX has processed the interrupt for a hardware start event. |
| Data Lost | DriverLINX has detected an analog output data overrun condition. |
| Critical Error | DriverLINX has encountered an unexpected hardware or software condition. |

DriverLINX Event messages for analog output.

Data Lost

The KPCI-1800 provides hardware monitoring of analog output data overruns. DriverLINX notifies applications that an overrun has occurred by posting an event message, DL_DATALOST. DriverLINX posts this message only the first time the board detects an overrun during an acquisition task. The KPCI-1800 hardware will stop acquisition when an overrun has occurred.

Digital Input Subsystem

The following sections describe how DriverLINX implements Digital Input Subsystem features for the KPCI-1800 Series.

Digital Input Modes

The Digital Input Subsystem supports the following modes:

- **Polled**—For single-value or scan digital input samples.
- **Interrupt**—For buffered transfers using programmed I/O.
- **Other**—For subsystem initialization.

Digital Input Operations

The KPCI-1800 Series Digital Input Subsystem supports the following DriverLINX operations:

- **Initialize**—aborts any active interrupt data-acquisition tasks and stops the clock. 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 a digital input data-acquisition task.
- **Message**—DriverLINX displays a pop-up dialog box for the user containing the text for the current DriverLINX error message.

Digital Port Configuration

The KPCI-1800 Series has separate, dedicated digital input and output ports and doesn't require the application to configure its digital I/O ports.

Digital Input Timing Events

Timing Events specify how the hardware paces or clocks the reading of Digital Input samples. DriverLINX uses the Timing Event to program when the KPCI-1800 Series reads the next digital input sample from the port.

The KPCI-1800 Series supports the following Timing Events:

- **None**—Input requires no pacing as DriverLINX is reading only a single value.
- **Rate**—The KPCI-1800 Series supports fixed rate sampling using internal and external clocks.

None or Null Event

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

Rate Event

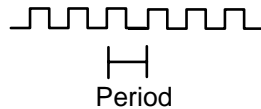
The KPCI-1800 Series supports only the Rate Generator mode for Rate Events for digital input:

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

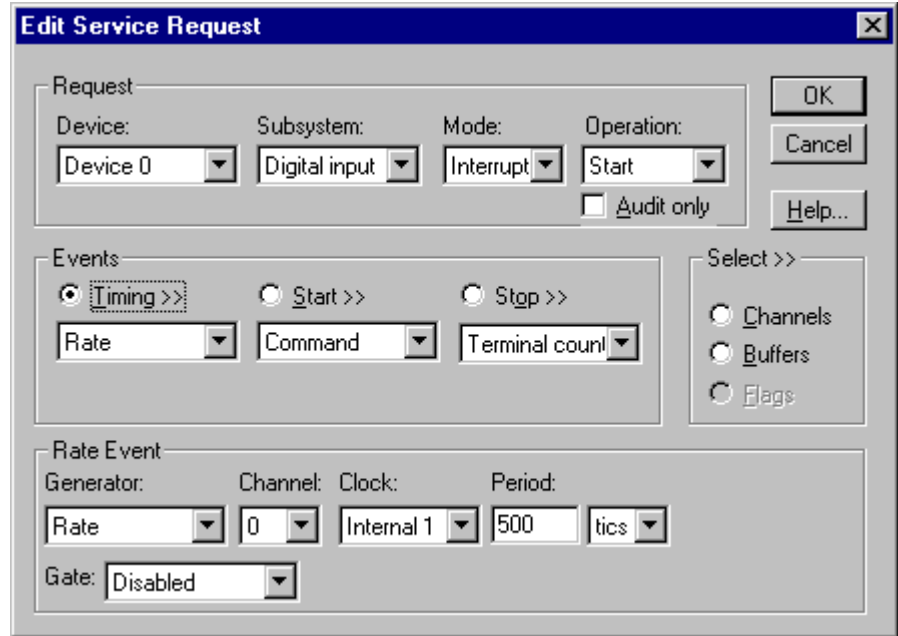


Rate Generator: Internal Clocking

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 acquire all digital input samples at equally spaced time intervals.



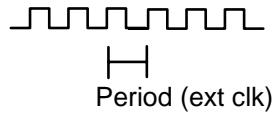
How to set up the KPCI-1800 Series for fixed rate sampling using an internal clock.

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

- Specify internal clocking using a **Rate Generator** on any available *Channel* with any internal *Clock* source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources.
- The *Period* property specifies the time interval between samples in tics, where a tic period depends on the clock source. The minimum period is 1 tic. The maximum period is 4294967295 tics ($2^{32} - 1$) for *Channel 0* or 65535 tics ($2^{16} - 1$) for the other channels. See “Counter/Timer Subsystem” on page 82 for details.
- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

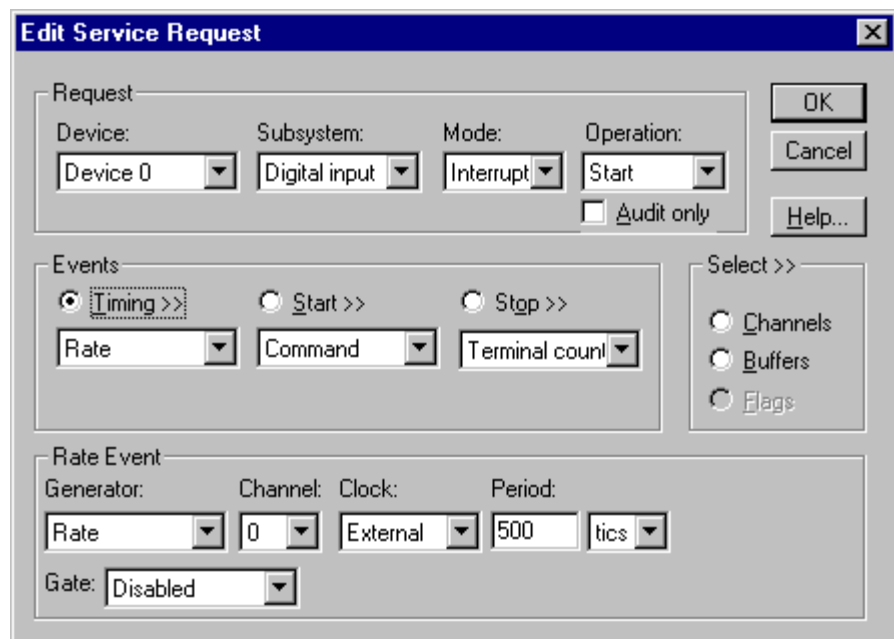
Rate Generator: External Clocking

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 digital input samples with a recurrent external signal. In this mode you will need a separate external clock tic for each analog sample you want to acquire.

The KPCI-1800 produces an interrupt upon receipt of the clock signal but does not latch the digital input value. The input signal must maintain its value until the software can process the interrupt.



How to set up the KPCI-1800 Series 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 available **Channel** with an **External**, **External+**, or **External-** Clock source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources. For hardware-independence, you can specify the hardware external clock channel by the symbolic constant, *DI_EXTCLK*.
- Users should connect the external clock signal to the XPCLK line.
- 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. *Period* is in tics, where a tic period depends on the clock source. See “Counter/Timer Subsystem” on page 82 for details.

- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

Digital Input Start Events

Start Events specify when the KPCI-1800 Series hardware starts reading digital input data.

The KPCI-1800 Series supports the following Start Events for digital input:

- **None**—Use this event when the DriverLINX operation doesn't require a Start Event.
- **Command**—DriverLINX starts the task on software command, i.e., as soon as DriverLINX finishes programming the KPCI-1800 hardware for the task.

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 KPCI-1800 Series hardware with the task parameters.

Digital Input Stop Events

Stop Events specify when the KPCI-1800 Series hardware stops reading digital input data.

The KPCI-1800 Series supports the following Stop Events for digital input:

- **None**—Use this event when the DriverLINX operation doesn't require a Stop Event.
- **Terminal count**—DriverLINX stops the task after the KPCI-1800 Series hardware has filled 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, reading from the digital port on the KPCI-1800 Series.

Terminal Count Event

The Terminal Count Event stops data acquisition after DriverLINX has read the digital input data into all the data buffers *once*. Use terminal count when you want to read a fixed amount of data.

Digital Input Channels

The KPCI-1800 Series allows applications to specify the digital channels using three techniques:

- **Start Channel**—Acquire data from a single channel.
- **Start/Stop Channel Range**—Acquire data from a consecutive range of channels.
- **Channel List**—Acquire data from a list of channels.

Digital Input Logical Channels

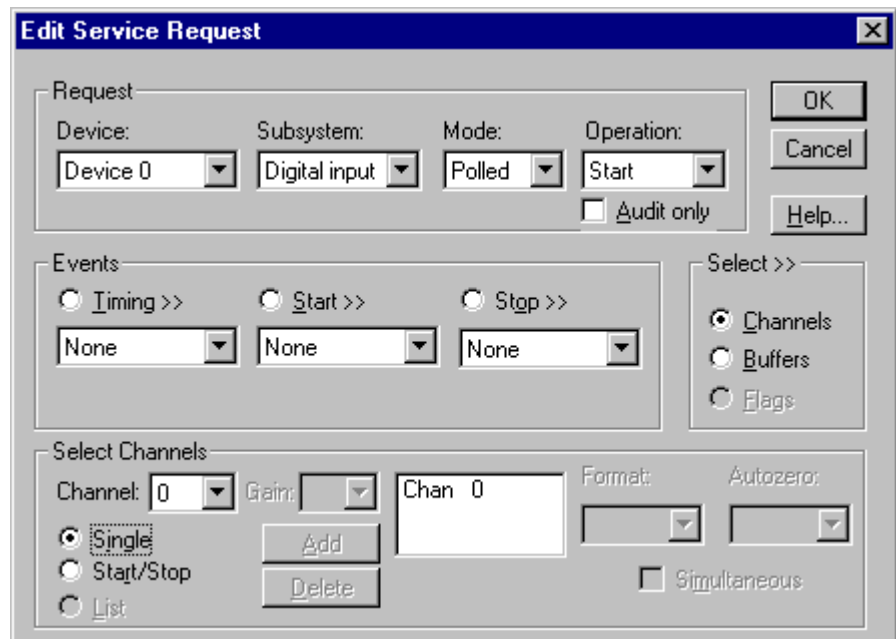
The KPCI-1800 Series has a single digital input port that DriverLINX designates as Logical Channel 0. DriverLINX defines two additional Logical Channels for the external clock and trigger signals but applications cannot directly read their values.

DriverLINX defines the following Logical Channels for the KPCI-1800 Series digital inputs:

| Logical Channel | DriverLINX Function | KPCI-1800 Series External Connector |
|-----------------|------------------------|-------------------------------------|
| 0 | Standard Digital Input | DI 0 ... DI 3 |
| 1 | External Clock | XPCLK |
| 2 | External Trigger | TGIN |

Single Channel Digital Input

In single channel mode, the KPCI-1800 Series acquires all data from one channel.



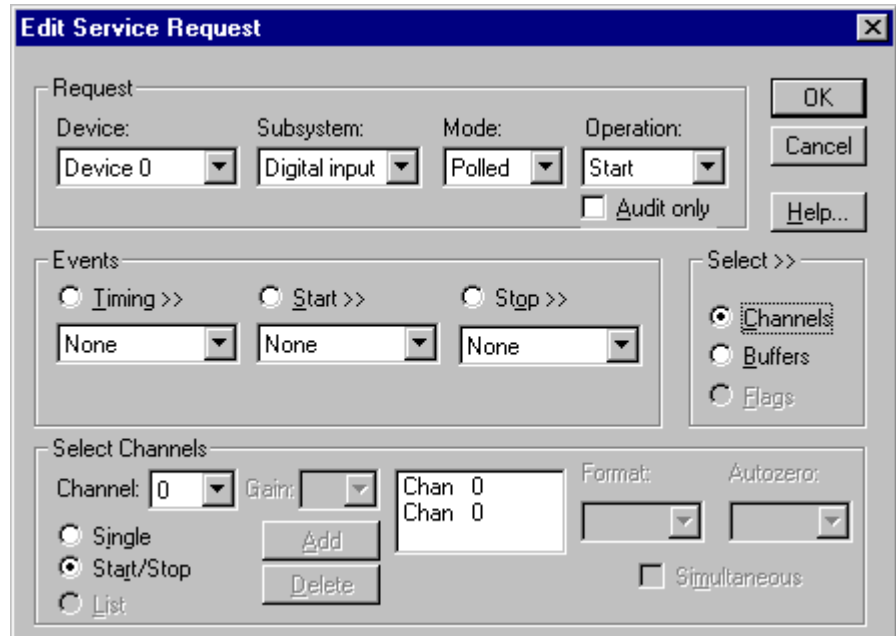
How to set up the KPCI-1800 Series for sampling on a single channel.

Even though the KPCI-1800 Series has only one digital input channel, DriverLINX supports specifying a channel range for compatibility with applications that use this method.

Multi-channel Digital Input Range

In multi-channel range mode, the KPCI-1800 Series acquires all data from a consecutive range of digital channels.

- The Start and Stop Channel must specify channel 0.



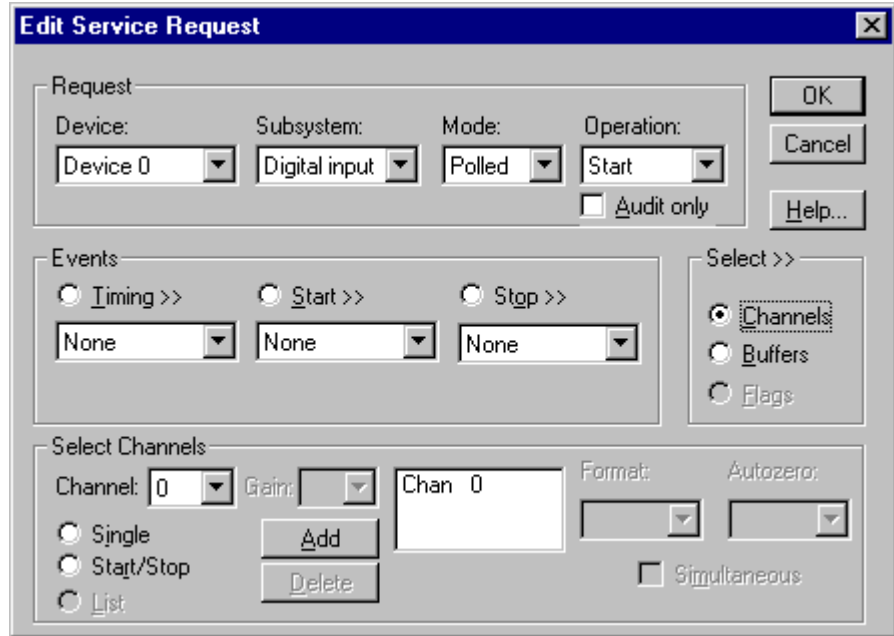
How to set up the KPCI-1800 Series for sampling on a consecutive range of channels.

Multi-channel Digital Input List

In multi-channel list mode, the KPCI-1800 Series acquires all data from an arbitrary list of digital channels.

- The channel list may contain only channel 0.

Even though the KPCI-1800 Series has only one digital input channel, DriverLINX supports specifying a channel range for compatibility with applications that use this method.

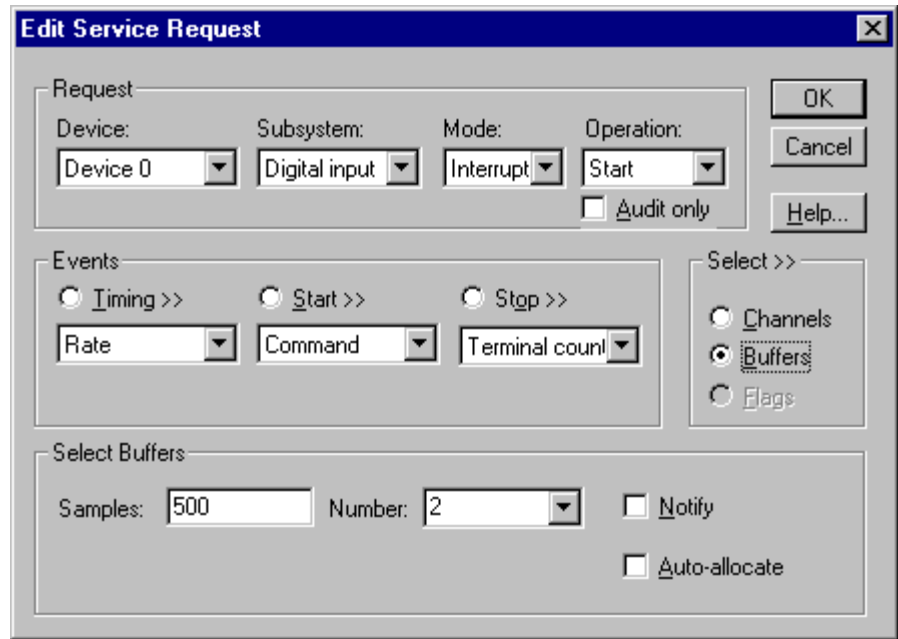


How to set up the KPCI-1800 Series to read from an arbitrary list of channels.

Digital Input Buffers

DriverLINX supports single-value, single-scan and buffered digital input.

- **For single-value input**, specify the *Number* of buffers as **0**. The buffer for a single value is the *ioValue* property.
- **For single-scan input**, specify the *Number* of buffers as **1** and the number of *Samples* as **1**.
- **For buffered input**, specify the *Number* of buffers from **1** to **256** and the number of *Samples* as desired.



How to set up the KPCI-1800 Series to read digital samples using data buffers.

Digital Input Messages

For digital input 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. |
| Critical Error | DriverLINX has encountered an unexpected hardware or software condition. |

DriverLINX Event message for digital input

Digital Output Subsystem

The following sections describe how DriverLINX implements Digital Output Subsystem features for the KPCI-1800 Series.

Digital Output Modes

The Digital Output Subsystem supports the following modes:

- **Polled**—For single-value or scan digital-output samples.
- **Interrupt**—For buffered transfers using programmed I/O.
- **Other**—For subsystem initialization.

Digital Output Operations

The KPCI-1800 Series Digital Output Subsystem supports the following DriverLINX operations:

- **Initialize**—aborts any active interrupt data-acquisition tasks and stops the clock. 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 read from a buffer.
- **Stop**—terminates a digital output data-acquisition task.
- **Message**—DriverLINX displays a pop-up dialog box for the user containing the text for the current DriverLINX error message.

Digital Output Initialization

By default, the Digital Output subsystem writes zero into the digital output port. You can specify a different initial output value using the *Configure DriverLINX Device* dialog. See “Digital Output Subsystem Page” on page 19.

Digital Output Timing Events

Timing Events specify how the hardware paces or clocks writing Digital Output samples. DriverLINX uses the Timing Event to program when the KPCI-1800 Series writes the next digital output sample from the port.

The KPCI-1800 Series supports the following Timing Events:

- **None**—Output requires no pacing as DriverLINX is writing only a single value.
- **Rate**—The KPCI-1800 Series supports fixed rate writing using internal and external clocks.

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

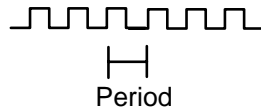
The KPCI-1800 Series supports only the Rate Generator mode for Rate Events for digital output:

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

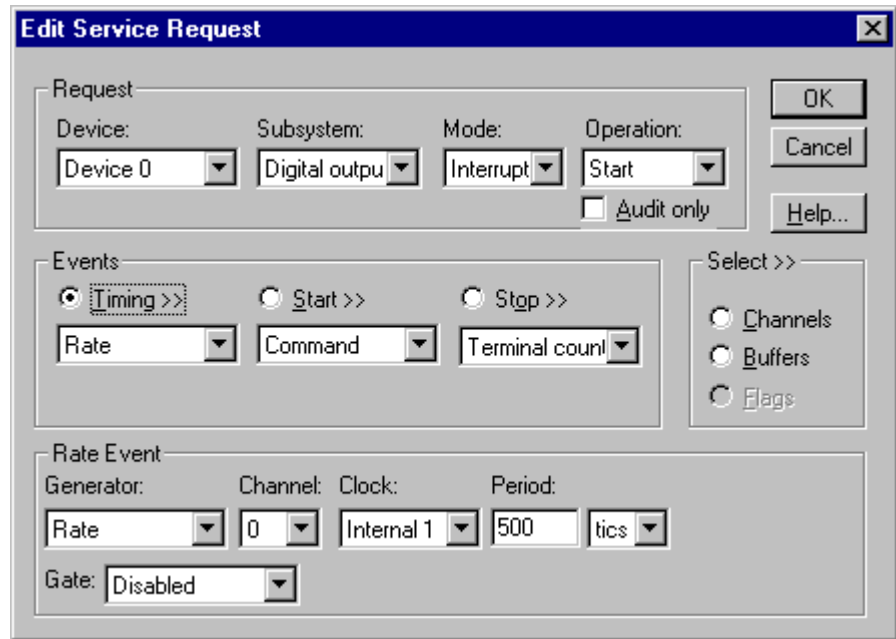


Rate Generator: Internal Clocking

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 all digital output samples at equally spaced time intervals.



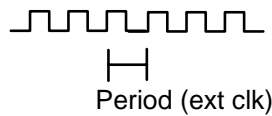
How to set up the KPCI-1800 Series for fixed rate sampling using an internal clock.

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

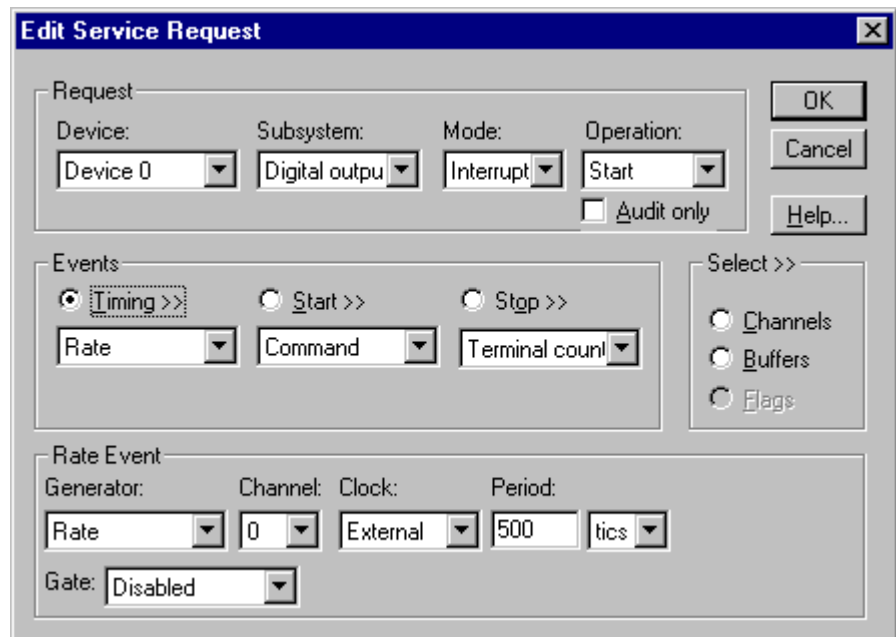
- Specify internal clocking using a **Rate Generator** on any available *Channel* with any internal *Clock* source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources.
- The *Period* property specifies the time interval between samples in tics, where a tic period depends on the clock source. The minimum period is 1 tic. The maximum period is 4294967295 tics ($2^{32} - 1$) for *Channel 0* or 65535 tics ($2^{16} - 1$) for the other channels. See “Counter/Timer Subsystem” on page 82 for details.
- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

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 digital input samples with a recurrent external signal. In this mode you will need a separate external clock tic for each analog sample you want to acquire.



How to set up the KPCI-1800 Series for fixed rate writing 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 available *Channel* with an **External**, **External+**, or **External-** *Clock* source. See “Counter/Timer Subsystem” on page 82 for a description of clock sources. For hardware-independence, you can specify the hardware external clock channel by the symbolic constant, *DI_EXTCLK*.
- Users should connect the external clock signal to the XPCLK line.
- 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. *Period* is in tics, where a tic period depends on the clock source. See “Counter/Timer Subsystem” on page 82 for details.
- The *Gate* property specifies how the TGIN signal affects the operation of the internal clock. Valid settings are Enabled, Disabled, and Hi Level, Low Level, Low Edge and High Edge Enabled. See “Counter/Timer Subsystem” on page 82 for a description of each *Gate* setting.

Digital Output Start Events

Start Events specify when the KPCI-1800 Series hardware starts writing digital output data.

The KPCI-1800 Series supports the following Start Events for digital output:

- **None**—Use this event when the DriverLINX operation doesn’t require a Start Event.
- **Command**—DriverLINX starts the task on software command, i.e., as soon as DriverLINX finishes programming the KPCI-1800 hardware for the task.

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 KPCI-1800 hardware with the task parameters.

Digital Output Stop Events

Stop Events specify when the KPCI-1800 Series hardware stops writing digital output data.

The KPCI-1800 Series supports the following Stop Events for digital output:

- **None**—Use this event when the DriverLINX operation doesn’t require a Stop Event.
- **Terminal count**—DriverLINX stops the task after the KPCI-1800 Series 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.

Terminal Count Event

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

Digital Output Channels

The KPCI-1800 Series allows applications to specify the digital channels using three techniques:

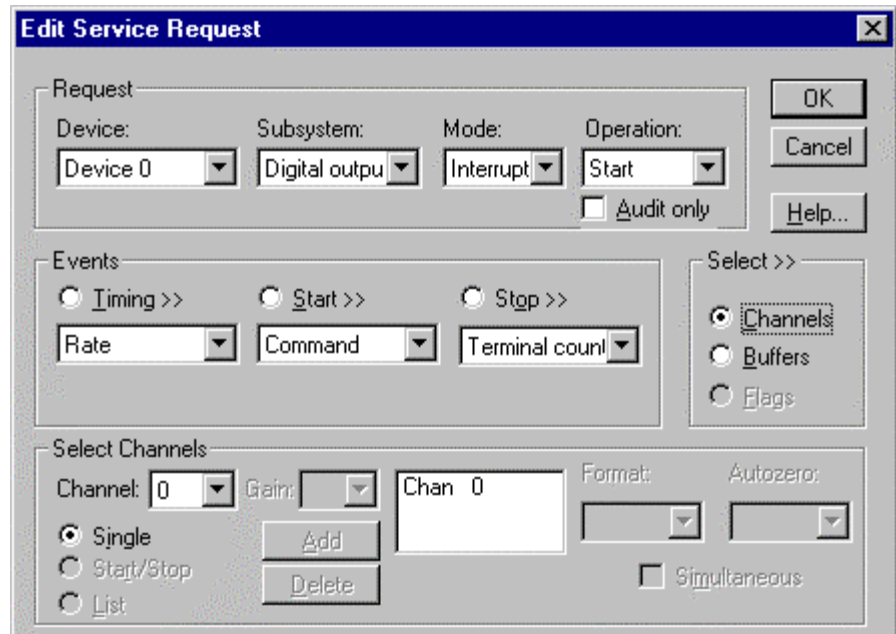
- **Start Channel**—Acquire data from a single channel.
- **Start/Stop Channel Range**—Acquire data from a consecutive range of channels.
- **Channel List**—Acquire data from a list of channels.

Digital Output Logical Channels

The KPCI-1800 Series has a single digital output port that DriverLINX designates as channel 0.

Single Channel Digital Output

In single channel mode, the KPCI-1800 Series writes all data from one channel.



How to set up the KPCI-1800 Series for writing to a single channel.

Multi-channel Digital Output Range

In multi-channel range mode, the KPCI-1800 Series acquires all data from a consecutive range of digital channels.

- The Start and Stop Channel must specify channel 0.

The screenshot shows the 'Edit Service Request' dialog box with the following settings:

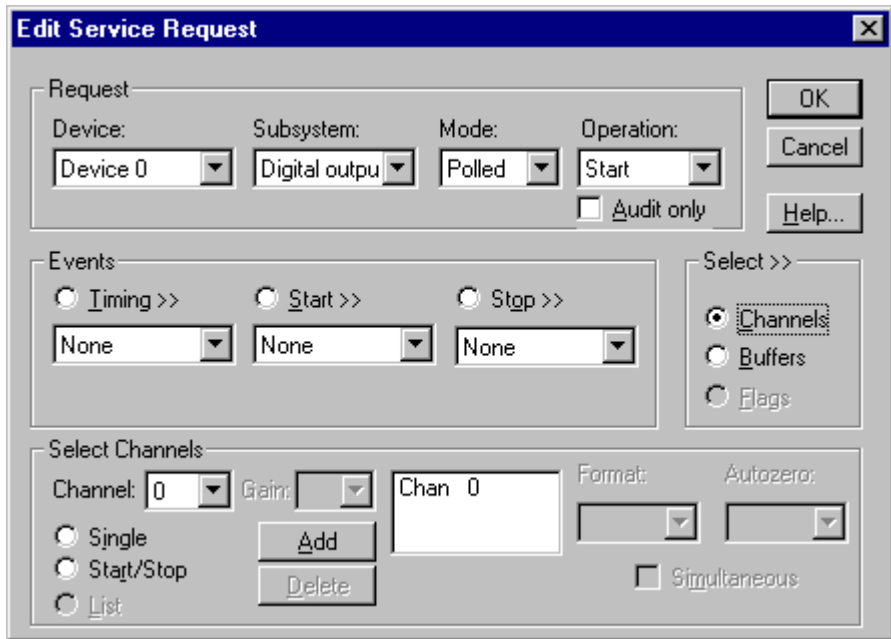
- Request:** Device: Device 0, Subsystem: Digital output, Mode: Polled, Operation: Start. Audit only.
- Events:** Timing >>, Start >>, Stop >>. Dropdowns: None, None, None.
- Select Channels:** Channel: 0, Gain: (empty). List: Chan 0, Chan 0. Format: (empty), Autozero: (empty). Simultaneous. Radio buttons: Single, Start/Stop, List. Buttons: Add, Delete.

How to set up the KPCI-1800 Series for writing to a consecutive range of channels.

Multi-channel Digital Output List

In multi-channel list mode, the KPCI-1800 Series acquires all data from an arbitrary list of digital channels.

- The channel list may contain only channel 0.

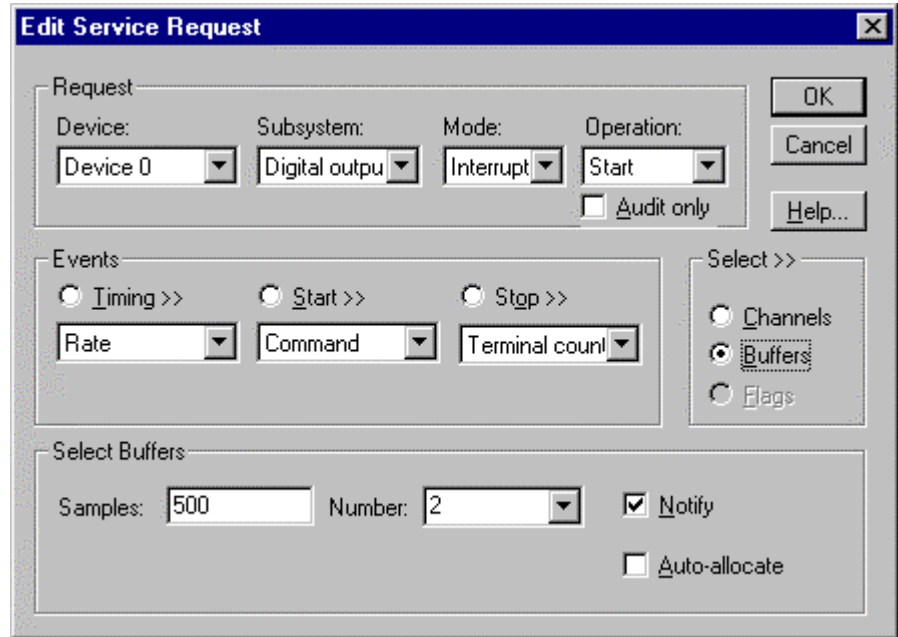


How to set up the KPCI-1800 Series to write to an arbitrary list of channels.

Digital Output Buffers

DriverLINX supports single-value, single-scan and buffered digital output.

- **For single-value output**, specify the *Number* of buffers as **0**. The buffer for a single value is the *ioValue* property.
- **For single-scan output**, specify the *Number* of buffers as **1** and the number of *Samples* as **1**.
- **For buffered output**, specify the *Number* of buffers from **1** to **256** and the number of *Samples* as desired.



How to set up the KPCI-1800 Series to write digital output using data buffers.

Digital Output Messages

For digital 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 written all data in the buffer. |
| Data Lost | DriverLINX has detected a digital output data overrun condition. |
| Critical Error | DriverLINX has encountered an unexpected hardware or software condition. |

DriverLINX Event messages for digital output.

Counter/Timer Subsystem

The KPCI-1800 Series provides counter/timers for analog and digital input/output pacing only. You cannot use the Counter/Timer Subsystem for independent counting or timing tasks.

Each board has an Intel 8254 Programmable Interval Timer that consists of three 16-bit counters, Counter 0, Counter 1, and Counter 2. For flexibility and compatibility with the DAS-1800 Series, DriverLINX operates Counters 1 and 2 in a 32-bit cascaded configuration. Counter 0 is then available to pace a separate, concurrent task. For pacing three concurrent tasks, DriverLINX maps Counters 1 and 2 in non-cascaded mode as Logical Channels 2 and 3. Using Logical Channel 0 makes Logical Channels 2 and 3 unavailable, and vice versa.

The KPCI-1800 Series has one gate and one external clock connection. You can use the signal to control any of the four Logical Channels. See “Counter/Timer Subsystem Signals” on page 30 for connection details.

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—8254 Chip Counters 1 & 2 Default channel for Analog Input pacing | Internal 1 | 1 / config freq | Rate Gen | Enabled |
| | Internal 2 | 0.1 μ s | Burst Gen | Disabled |
| | Internal 3 | 0.2 μ s | | No Connect |
| | Internal 4 | 1 μ s | | Low Level |
| | Internal 5 | 10 μ s | | Low Edge |
| | External | 1 / config freq | | High Level |
| | External+ | | | High Edge |
| 1—8254 Chip Counter 0 Default channel for Analog Output pacing | Internal 1 | 1 / config freq | Rate Gen | Enabled |
| | Internal 2 | 0.1 μ s | Burst Gen | Disabled |
| | Internal 3 | 0.2 μ s | | No Connect |
| | Internal 4 | 1 μ s | | Low Level |
| | Internal 5 | 10 μ s | | Low Edge |
| | External | 1 / config freq | | High Level |
| | External+ | | | High Edge |
| 2—8254 Chip Counter 1 Default channel for Digital Input pacing | Internal 1 | 1 / config freq | Rate Gen | Enabled |
| | Internal 2 | 0.1 μ s | Burst Gen | Disabled |
| | Internal 3 | 0.2 μ s | | No Connect |
| | Internal 4 | 1 μ s | | Low Level |
| | Internal 5 | 10 μ s | | Low Edge |
| | External | 1 / config freq | | High Level |
| | External+ | | | High Edge |
| 3—8254 Chip Counter 2 Default channel for Digital Output pacing | Internal 1 | 1 / config freq | Rate Gen | Enabled |
| | Internal 2 | 0.1 μ s | Burst Gen | Disabled |
| | Internal 3 | 0.2 μ s | | No Connect |
| | Internal 4 | 1 μ s | | Low Level |
| | Internal 5 | 10 μ s | | Low Edge |
| | External | 1 / config freq | | High Level |
| | External+ | | | High Edge |

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

For the **Internal 1** and **External** clock sources, the tic period is the inverse of the frequency of the default master clock source. The user sets default master clock source on the Counter/Timer Subsystem Page of the *DriverLINX Configuration Panel*. Applications can use the **Sec2Tics** function to determine the tic period of **Internal 1** or override the default clock source by selecting from **Internal 2** to **Internal 5** as the clock source for a task.

Gate Settings

The *Gate* setting specifies how the TGIN signal affects the operation of the internal or external clock. Valid settings are Enabled, Disabled, No Connect, and Hi Level, Low Level, Low Edge and High Edge Enabled.

- **Enabled** selects the gate's default enabled mode. On the KPCI-1800 Series this is Hi Level.

- **Disabled** allows the clock to pace samples independently of the gate signal.
- **No Connect** specifies that the application does not need to enable or disable the gate, so it can run on boards that do not have a gate or enabled and disabled modes.
- **Hi and Low Level** allow the clock to pace samples only while the gate signal is high or low, respectively.
- **Low and Hi Edge** are aliases for a digital start trigger. They enable the clock after the first falling or rising edge, respectively.

Uninstalling DriverLINX

How do I uninstall DriverLINX?

DriverLINX consists of three separate component installations:

- DriverLINX for Keithley KPCI-1800 Series
- DriverLINX Programming Interfaces
- DriverLINX Documentation

You can uninstall the last two installations at any time without interfering with compiled applications that require DriverLINX drivers. To uninstall the latter components, run the “Add/Remove Programs” tool in the Windows Control Panel.

To uninstall DriverLINX drivers for the Keithley KPCI-1800 Series, you must

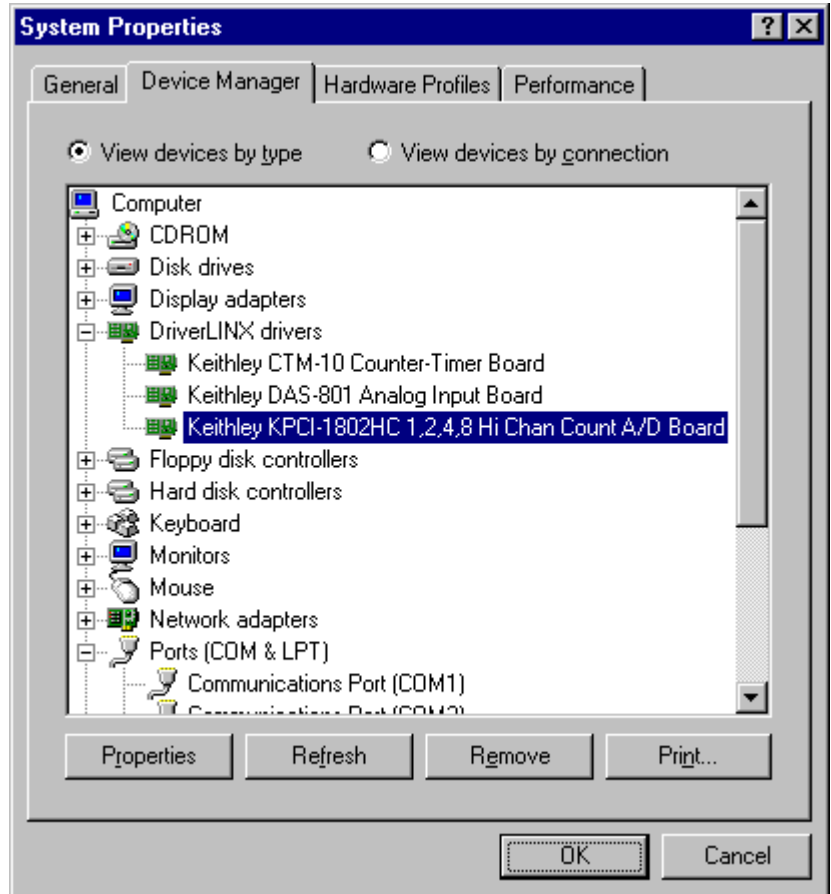
- Disable the DriverLINX driver.
- Shut down your computer to remove the hardware.
- Reboot your computer to unload the driver.
- Run the DriverLINX uninstall program.

How to Disable a DriverLINX Driver in Windows NT

1. From the Windows Start menu, select “Settings”, then “Control Panel”. Left click on the DriverLINX Configuration icon in the Control Panel.
2. Select the KPCI-1800 devices you want to disable.
3. Right click on each device and select “Disabled” on the popup menu.
4. Repeat steps 2-3 for each KPCI-1800 card that you are uninstalling.
5. Close the DriverLINX Configuration Panel.
6. When finished, shut down your computer and physically remove any installed KPCI-1800 hardware.
7. Reboot Windows.
8. To finish uninstalling, see “How to Remove DriverLINX for Keithley KPCI-1800 Series” on page 86.

How to Disable a DriverLINX Driver in Windows 95/98

1. From the Windows Start menu, select “Settings”, then “Control Panel”. Left click on the System icon in the Control Panel. Select the “Device Manager” tab in the System Properties dialog.
2. Left click the “+” icon next to “DriverLINX drivers” to display the installed Keithley KPCI-1800 devices.



3. Select the KPCI-1800 device you want to disable.
4. Click the “Remove” button.
5. In the “Confirm Device Removal” dialog, select “OK”.
6. Repeat steps 3-5 for each KPCI-1800 card or driver that you are uninstalling.
7. When finished, click “Close”, shut down your computer, and physically remove any installed KPCI-1800 hardware.
8. Reboot Windows.
9. To finish uninstalling, see “How to Remove DriverLINX for Keithley KPCI-1800 Series” on page 86.

How to Remove DriverLINX for Keithley KPCI-1800 Series

1. From the Windows Start menu, select “Settings”, then “Control Panel”. Left click on the Add/Remove Programs icon in the Control Panel.

2. Select “DriverLINX for Keithley KPCI-1800 Series” in the Add/Remove Programs Properties dialog.
3. Click the “Add/Remove...” button.
4. Answer “Yes” to “Are you sure you want to remove ‘DriverLINX for Keithley KPCI-1800 Series’ and all of its components?” in the Confirm File Deletion dialog.
5. The DriverLINX uninstall program will proceed.

The uninstall program will not remove the folder, “\DrvLINX4\System”. This folder contains copies of any \Windows\System or \Windows\System32 files that the original DriverLINX installation updated.

Troubleshooting

Solving Problems

Correct operation of your KPCI-1800 hardware requires successful completion of three steps.

1. Windows recognizes KPCI-1800 hardware and installs drivers.
2. You configure the KPCI-1800 drivers using the DriverLINX Configuration Panel.
3. Windows loads the KPCI-1800 drivers into memory.

If you are having a problem installing or configuring your KPCI-1800 product, review the following notes. If these notes do not solve your problem, or your problem is not described, then contact technical support and fully describe your problem.

Solving Problems Recognizing and Installing Drivers

Windows must recognize the KPCI-1800 hardware and then install KPCI-1800 drivers for the hardware.

- For Windows to automatically recognize the KPCI-1800 hardware, you must install a KPCI-1800 product into your machine and restart the computer.
- For Windows to install KPCI-1800 drivers, you must install the KPCI-1800 driver software on the DriverLINX CD.

If you installed the KPCI-1800 hardware before you installed the DriverLINX software, Windows 95/98 may install the KPCI-1800 hardware without drivers. To fix this, you must instruct Windows to reinstall the Plug-and-Play driver. Follow the notes below for instructions.

Fixing Problems Installing Hardware Before Software on Windows 95/98

If you installed the KPCI-1800 hardware before installing the DriverLINX software, Windows 95/98 may install the hardware incorrectly.

1. Start Windows Device Manager.

2. Search for “DriverLINX drivers”. If you do not see it, go to step 4.
3. Click on the “+” icon next to “DriverLINX drivers” and search for “PCI Card”. If you find “PCI Card”, go to step 6, otherwise go to the next step.
4. Search for “Other devices”. If you do not see it, go to “Editing the Windows 95/98 Registry” on page 90.
5. Click on the “+” icon next to “Other devices” and search for “PCI Card”. If you do not find it, go to “Editing the Windows 95/98 Registry” on page 90.
6. Select “PCI Card”.
7. Click “Remove” in the Device Manager.
8. Highlight “Computer” in the Device Manager and click “Refresh”.
9. Windows should re-install your hardware under “DriverLINX drivers”. If this fails, see “Editing the Windows 95/98 Registry” on page 90.
10. Answer “Yes” to “Do you want to restart your computer now?”.
11. After rebooting your computer, you must configure DriverLINX. See “Configuring the KPCI-1800 Series” on page 11.

Editing the Windows 95/98 Registry

Before trying to edit the Windows Registry, follow the instructions for “Fixing Problems Installing Hardware Before Software on Windows 95/98” on page 89.

Caution: Incorrect or unintended changes to Registry can prevent Windows from booting. A complete reinstall of Windows may be the only recovery option. For safety, first make a backup copy of the Registry using the “Registry | Export Registry File...” menu option in the Registry Editor. Then follow these instructions carefully.

1. From the Windows “Start” menu, select “Run”, type “regedit” into the Run dialog and click OK
2. Under “My Computer”, first click the “+” next to “HKEY_LOCAL_MACHINE”.
3. Next click the “+” next to “Enum” and then “PCI”.
4. If you have a KPCI-1801HC, search for “VEN_11F3&DEV_1801” on Win 95 or “VEN_11F3&DEV_1801&SUBSYS_00000000&REV_00” on Win 98. If you have a KPCI-1802HC, search for “VEN_11F3&DEV_1802” on Win 95 or “VEN_11F3&DEV_1802&SUBSYS_00000000&REV_00” on Win 98.
5. If you find neither entry, no Registry edits are needed. Exit the Registry Editor and quit these instructions.
6. If you find either entry, select it and then delete the key by selecting “Edit | Delete” from the Registry Editor menu. Answer “Yes” to “Are you sure you want to delete this key?”
7. Install the DriverLINX software, if you have not previously done so, and then reboot your machine.

Solving Problems Configuring the Drivers

Windows automatically assigns hardware resources for the KPCI-1800 Series, but you must still configure the KPCI-1800 drivers before using them. The DriverLINX configuration only requires that you assign each KPCI-1800 product a unique Logical Device number. And, on Windows NT, you must manually select the hardware model of your KPCI-1800 board. See “Configuring the KPCI-1800 Series” on page 11 for more information.

Solving Problems Loading Drivers

Before the KPCI-1800 drivers can load, you must

1. Install the DriverLINX software.
2. Install the KPCI-1800 hardware into your computer.
3. Configure DriverLINX.
4. Reboot your computer.

If you have not completed the above steps, please do so before proceeding.

On both Windows NT and Windows 95/98, the operating system will automatically assign hardware resources to the KPCI-1800 cards. Automatic resource assignment can fail sometimes on

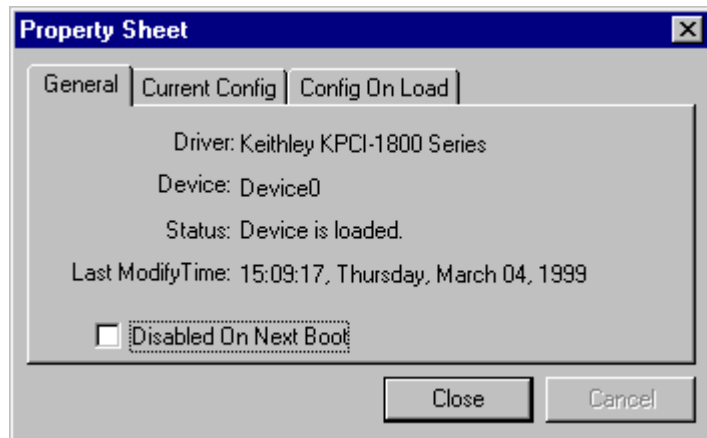
- Older PCI computers.
- Computers with ISA cards installed.
- Computers with no free hardware resources.
- Computers running Windows NT 4.0 with a BIOS setting designating the operating system as Plug-and-Play Aware.

Sorting through all possibilities can be a challenge due to the sheer number of combinations of PCI hardware designs, PC plug-in boards, and versions of Windows. The following sections will help you gather information about why a driver may have failed to load. This information is essential for you or technical support to solve your problem.

Did the DriverLINX Driver Load?

1. Run “DriverLINX Configuration” from Windows Control Panel.
2. Select the “DriverLINX” tab.
3. Click the “+” icon next to DriverLINX to expand the list of drivers, if necessary.
4. Select “Keithley KPCI-1800 Series”. Click “+”, if necessary, to expand the list.
5. Select the line with the number of the Logical Device you configured. If the number does not exist on Windows NT or, on Windows 95/98, you see only a hardware description, you did not configure the driver. See “Configuring the KPCI-1800 Series” on page 11.
6. Click the “Properties...” button and then select the “General” tab.
7. Do you see “Status: Device Loaded”? If not, did you reboot the computer after configuring? If not, reboot now and repeat the above

steps.



8. If you rebooted the computer after configuring and Windows did not load your device, see “Checking for Device Errors” on page 92.

Checking for Device Errors

When a DriverLINX kernel driver cannot load, it usually writes an explanation into the system event log. You can view this log under Windows 95/98 or Windows NT using the DriverLINX Event Viewer.

Windows 95/98 maintains additional driver information in the Device Manager. Also see “Getting More Driver Information on Windows 95/98” on page 92.

1. Run “DriverLINX Event Viewer” from the DriverLINX folder.
2. Click on the “+” icon next to “DriverLINX” in the left panel.
3. Select the abbreviation for your driver.
4. Does the first line in the right panel show a current error?
5. Double click on the error line to see more detail and an explanatory message.
6. If you cannot resolve the problem yourself, please provide this error information when contacting technical support.

Getting More Driver Information on Windows 95/98

Windows 95/98 reports additional information about device status using the Device Manager. To access this utility,

1. Right click on “My Computer” and then select “Properties”.
2. Select “Device Manager” and “View devices by type
3. Does “DriverLINX drivers” appear in the list? If not, see “Solving Problems Recognizing and Installing Drivers” on page 89.
4. Click the “+” next to “DriverLINX drivers”.
5. Does your KPCI-1800 product appear in the list? If not, see “Solving Problems Recognizing and Installing Drivers” on page 89.
6. Does the icon next to your KPCI-1800 product display an exclamation point (!)? If no, Windows has loaded your KPCI-1800 driver.

7. Select the line with the “!” and then click “Properties”.
8. The General tab will show the reason why the driver did not load.
9. The Resources tab will show if Windows detected an unresolvable hardware conflict.

Getting More Driver Information on Windows NT

On Windows NT, the only reasons that a driver does not load are

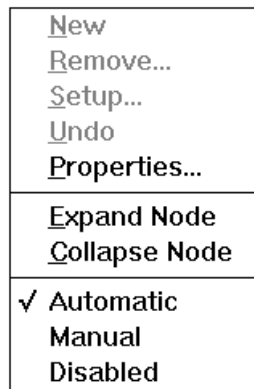
- You did not install the driver software.
- You did not correctly configure the driver.
- You changed the driver startup parameters.
- Your BIOS setting designates the operating system as Plug-and-Play aware. (Applies only to Window NT 4.0).

An incorrectly configured driver will report the reasons that it failed to load into the Windows Event Log. See “Checking for Device Errors” on page 92 for more information.

Under Windows NT 4.0, a Logical Device may not load because the operating system does not always configure Plug-and-Play PCI devices properly. This may result in unexpected or no Event Log entries. To work around this, set your computer’s BIOS to configure Plug-and-Play devices before it starts the operating system. On various computers the BIOS setting is called “Plug-and-Play Aware OS – Disabled” or “Plug & Play OS – No”.

On Windows NT, DriverLINX drivers load automatically during system boot. An administrator can change the startup command for any NT driver to either “manual” or “disabled”.

1. Run “DriverLINX Configuration” from Windows Control Panel.
2. Select the “DriverLINX” tab.
3. Click the “+” icon next to DriverLINX to expand the list of drivers, if necessary.
4. Select “Keithley KPCI-1800 Series”. Click “+”, if necessary, to expand the list.
5. Select the line with the number of the Logical Device that did not load.
6. Right click the mouse to see a popup menu.



7. Select “Automatic” to instruct Windows to load the driver the next time you reboot.


Generating a DriverLINX Configuration Report

Your DriverLINX installation includes a troubleshooting tool that generates a report of your DriverLINX configuration. If you call Technical Support, after reading “Solving Problems” on page 89, they may ask you to generate and e-mail this report to help you solve installation and configuration problems.

What is in the Report?

The troubleshooting tool analyzes your computer to obtain information about DriverLINX and operating system software that would assist Technical Support in troubleshooting a problem you are having. It includes information on DriverLINX files, environment variables, registry entries, hardware and the operating system.

How do I Generate the Report?

You can easily generate the report by clicking this shortcut . Once the troubleshooting tool generates the report, you will have the opportunity to review it and make deletions, if desired, before e-mailing it to Technical Support. If you do not have direct access to e-mail, you can save the report to a disk file and send a copy later. A Technical Support engineer will guide you through these steps when you are asked to send a report.

Glossary of Terms

Bus mastering

Bus mastering is a mode that PCI devices use to perform DMA data transfers. Bus mastering requires a compatible PCI device and motherboard. The KPCI-1800 Series and most motherboards support bus mastering.

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 process.

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.