KUSB-3160

User's Manual

KUSB3160-900-01 Rev. A / January 2005

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WARRANTY

Keithley Instruments, Inc. warrants this product to be free from defects in material and workmanship for a period of 3 years from date of shipment.

Keithley Instruments, Inc. warrants the following items for 90 days from the date of shipment: probes, cables, rechargeable batteries, diskettes, and documentation.

During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

To exercise this warranty, write or call your local Keithley representative, or contact Keithley headquarters in Cleveland, Ohio. You will be given prompt assistance and return instructions. Send the product, transportation prepaid, to the indicated service facility. Repairs will be made and the product returned, transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

LIMITATION OF WARRANTY

This warranty does not apply to defects resulting from product modification without Keithley's express written consent, or misuse of any product or part. This warranty also does not apply to fuses, software, non-rechargeable batteries, damage from battery leakage, or problems arising from normal wear or failure to follow instructions.

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

Revision A (Document Number KUSB3160-900-01A)..... January 2005

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Measurement Category I and Measurement Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Measurement Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Measurement Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The  symbol indicates a connection terminal to the equipment frame.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Table of Contents

About this Manual

This manual describes the features of the KUSB-3160 module, the capabilities of the device driver, and how to program the KUSB-3160 module using DT-Open Layers™ software. Troubleshooting information is also provided.

Intended Audience

This document is intended for engineers, scientists, technicians, or others responsible for using and/or programming the KUSB-3160 module for data acquisition operations in the Microsoft® Windows 2000 or Windows XP operating systems. It is assumed that you have some familiarity with data acquisition principles and that you understand your application.

What You Should Learn from this Manual

This manual provides detailed information about the features of the KUSB-3160 module and the capabilities of the device driver. It is organized as follows:

- Chapter 1, "Overview," describes the major features of the modules, as well as the supported software and accessories for the modules.
- Chapter 2, "Principles of Operation," describes all of the features of the modules and how to use them in your application.
- Chapter 3, "Supported Device Driver Capabilities," lists the data acquisition subsystems and the associated features accessible using the device driver.
- Chapter 4, "Programming Flowcharts," describes the processes you must follow to program the subsystems on the KUSB-3160 module using DT-Open Layers-compliant software.

- Chapter 5, "Troubleshooting," provides information that you can use to resolve problems with the modules and the device driver, should they occur.
- Appendix A, "Specifications," lists the specifications of the module.
- Appendix B, "Connector Pin Assignments," shows the pin assignments for the connectors and the screw terminal assignments for the module.
- An index completes this manual.

Conventions Used in this Manual

The following conventions are used in this manual:

- Notes provide useful information or information that requires special emphasis, cautions provide information to help you avoid losing data or damaging your equipment, and warnings provide information to help you avoid catastrophic damage to yourself or your equipment.
- Items that you select or type are shown in **bold**.

Related Information

Refer to the following documents for more information on using the KUSB-3160 module:

- *KUSB-3160 Getting Started Manual*. This manual describes the how to install the KUSB-3160 module and related software.
- *DataAcq SDK User's Manual*. For programmers who are developing their own application programs using the Microsoft C compiler, this manual describes how to use the DT-Open Layers™ DataAcq SDK™ in Windows 2000 or Windows XP to access the capabilities of your module.

- *DTx-EZ Getting Started Manual*. This manual describes how to use the ActiveX controls provided in DTx-EZ™ to access the capabilities of your module in Microsoft Visual Basic® or Visual C++®.
- *DT-LV Link Getting Started Manual.* This manual describes how to use DT-LV Link™ with the LabVIEW® graphical programming language to access the capabilities of your module.
- Microsoft Windows 2000 or Windows XP documentation.
- USB web site (http://www.usb.org).

Where To Get Help

Should you run into problems installing or using your KUSB-3160 module, please call the Keithley Technical Support Department.

Overview

Key Features

The KUSB-3160 is a low-cost, high-power, digital I/O module for the Universal Serial Bus (USB). The KUSB-3160 module provides the following major features:

- USB compatibility;
- 64 configurable digital I/O lines (configurable in banks of eight) and 32 dedicated digital input lines for nonclocked monitoring or control.
- Interrupt-on-change on 16 dedicated digital input lines.
- External solid-state relay module support. Digital outputs can drive sink 12 mA, source 100 kΩ pullup.
- Isolated output common from the USB bus to 500 V peak.

Supported Software

The following software is available for use with the KUSB-3160 module:

- **Device Driver** –This software is provided on the CD shipped with the module. The device driver allows you to use a KUSB-3160 module with any of the supported software packages or utilities. Refer to the *KUSB-3160 Getting Started Manual* for more information on loading and configuring the device driver.
- **Quick Data Acq application** –This application provides a quick way to get a KUSB-3160 module up and running. Using the Quick Data Acq application, you can verify the features of the module, display data on the screen, and save data to disk.
- **DataAcq SDK** –This DT-Open Layers Software Develop Kit (SDK) allows programmers to develop application programs for the KUSB-3160 using the Microsoft C compiler in Windows 2000 or Windows XP.
- **DTx-EZ** –This software package contains ActiveX controls that allow Microsoft Visual Basic® or Visual C++® programmers to access the capabilities of the KUSB-3160 module.
- **DT-LV Link** –This software package allows LabVIEW® programmers to access the capabilities of the KUSB-3160 module.

Accessories

The following accessories are provided for the KUSB-3160 module:

- **KUSB-STP100** –a 100 mm x 160 mm screw terminal panel that connects to the KUSB-3160 module using the KUSB-CABDIO cable. This screw terminal panel allows you to connect all of the input and output connections that are supported by a KUSB-3160 module. LEDs on up to 64 of the outputs light when the outputs are low. Note that the LEDs are not provided for the dedicated digital input lines.
- **KUSB-CABDIO** –a 1-meter, 100-conductor cable that connects the KUSB-STP100 screw terminal panel to the KUSB-3160 module.

Principles of Operation

Figure 1 shows a block diagram of the KUSB-3160 module. Note that bold entries indicate signals you can access.

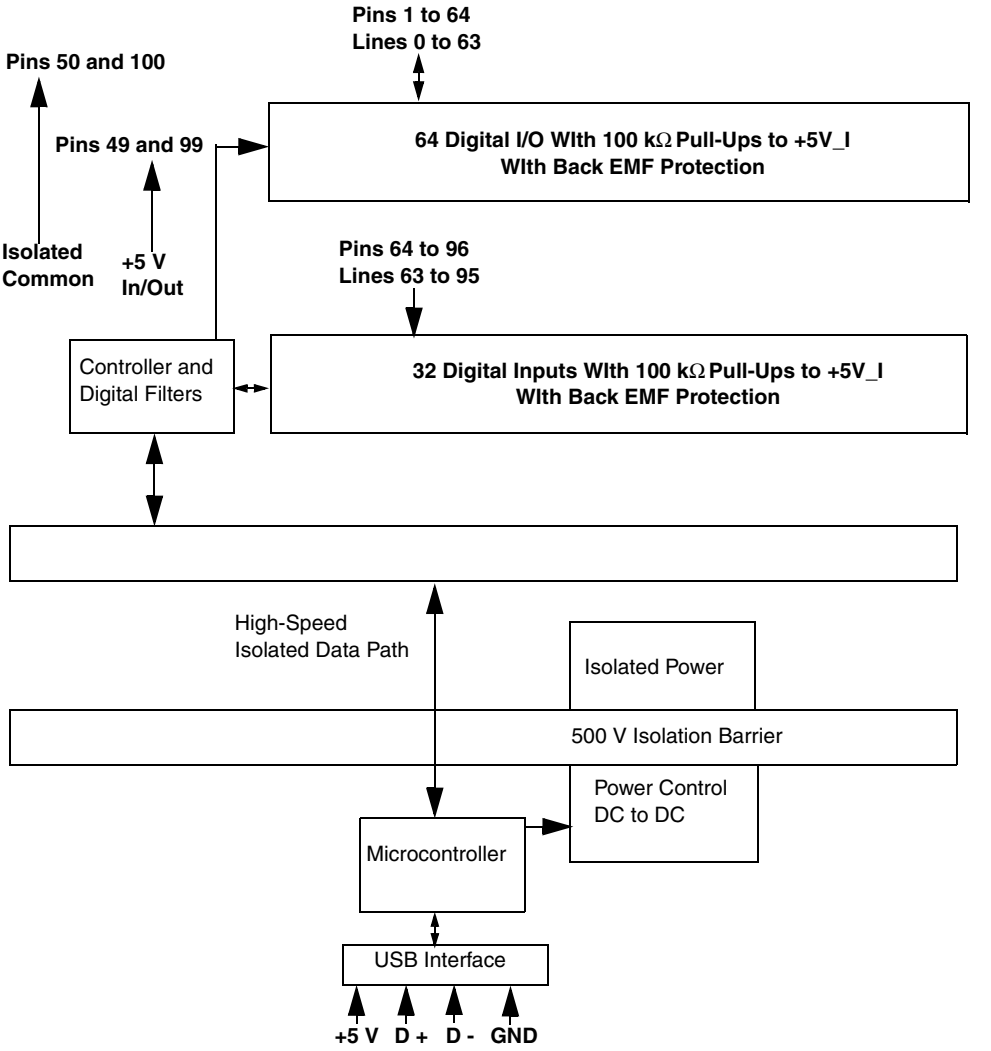

Figure 1: Block Diagram of the KUSB-3160 Module

This chapter describes the following features of the digital I/O subsystem:

- Digital I/O lines, described on page 8;
- Resolution, described on page 10;
- Interrupts, described on page 13, and
- Operation modes, described on page 14.

Digital I/O Lines

The KUSB-3160 module supports 64 shared digital I/O lines. These lines are organized as eight digital banks (banks 0 to 7)), each containing eight digital I/O lines (lines 0 to 7).

The KUSB-3160 module also supports 32 dedicated digital input lines. These lines are organized as four banks (banks 8 to 11), each containing eight digital input lines (lines 0 to 7).

You access the digital inputs through the digital input (DIN) subsystem and the digital outputs through the digital output (DOUT) subsystem.

The inputs are pulled up to +5 V through a 100 kΩ resistor. You can choose to debounce the inputs using the Open Layers Control Panel. When debounce is selected, a debounce delay of 5 ms occurs before a change is passed through the digital filter on the module. When debounce is not selected (the default configuration), a delay of less than 1 ms occurs. Refer to the *KUSB-3160 Getting Started Manual* for more information.

Outputs are open collectors with a 100 kΩ resistor connected to the internal isolated +5 V. All outputs are diode-protected for back EMF voltages typically seen when driving relays. The output stage latches are normally powered by the module. However, you can externally power the +5 V output so that the digital outputs retain their current values when the module is powered down.

Note: +5 V output is available only when one of the subsystems is activated, which, in turn, activates power to the module.

The KUSB-3160 provides enough current to drive only one LED per output line on the KUSB-STP100 screw terminal panel at a time. An LED turns on when the output is low.

You can specify the digital input lines to read in a single-value digital I/O or continuous operation. You can specify the digital output lines to write to in a single-value digital I/O operation. Refer to page 14 for more information on digital I/O operation modes.

Note: Continuous digital input operations are supported by digital input banks 10 and 11 only. Therefore, in continuous mode, the resolution is always 16 bits.

The number of digital I/O lines that are read or written to depend on the resolution that is specified, as described in the next section.

Resolution

Using software, specify the number of digital I/O lines to read or write at once by specifying the resolution as 8, 16, 24, or 32. Table 1 shows the effect of resolution on the number of DIN and DOUT subsystems available for a bank.

Note: If you are using digital input banks 10 and 11 in continuous mode, the resolution is always 16 bits.

Table 1: Resolution, Digital I/O Lines, and Number of Subsystems

Resolution	Digital I/O Lines	DIN or DOUT Subsystem
8	Bank 0, lines 0 to 7	Element 0
	Bank 1, lines 0 to 7	Element 1
	Bank 2, lines 0 to 7	Element 2
	Bank 3, lines 0 to 7	Element 3
	Bank 4, lines 0 to 7	Element 4
	Bank 5, lines 0 to 7	Element 5
	Bank 6, lines 0 to 7	Element 6
	Bank 7, lines 0 to 7	Element 7
	Bank 8, lines 0 to 7[a]	Element 8
	Bank 9, lines 0 to 7[a]	Element 9
	Bank 10, lines 0 to 7[a]	Element 10
	Bank 11, lines 0 to 7[a]	Element 11

Table 1: Resolution, Digital I/O Lines, and Number of Subsystems (cont.)

Resolution	Digital I/O Lines	DIN or DOUT Subsystem
16	Banks 0 and 1, lines 0 and 15 combined	Element 0
	Banks 2 and 3, lines 0 and 15 combined	Element 2
	Banks 4 and 5, lines 0 and 15 combined	Element 4
	Banks 6 and 7, lines 0 and 15 combined	Element 6
	Banks 8 and 9, lines 0 and 15 combined[a]	Element 8
	Banks 10 and 11, lines 0 and 15 combined[a]	Element 10
24	Banks 0, 1, and 2, lines 0 to 23 combined	Element 0
	Banks 3, 4, and 5, lines 0 to 23 combined	Element 3
	Banks 6, 7, and 8, lines 0 to 23 combined[a]	Element 6
	Banks 9, 10, and 11, lines 0 to 23 combined[a]	Element 9
32	Banks 0, 1, 2, and 3, lines 0 to 31	Element 0
	Banks 4, 5, 6, and 7, lines 0 to 31	Element 4
	Banks 8, 9, 10, and 11, lines 0 to 31[a]	Element 8

a. Banks 8 to 11 are dedicated digital input lines. All other banks can be used as digital input or digital output lines.

For example, if you specify a resolution of 8, you can read or write to each digital bank separately by specifying element number 0 to 11. If you specify a resolution of 16, you can read or write to two banks at once by specifying element 0, 2, 4, 6, 8, or 10. If you specify a resolution of 24, you can read or write to three banks at once by specifying element 0, 3, 6, or 9. Lastly, if you specify a resolution of 32, you can read or write to four banks at once by specifying element 0, 4, or 8.

The data is encoded in binary format.

Interrupts

The KUSB-3160 module can generate a PCI-bus interrupt when any of the digital input lines corresponding to banks 10 and 11 changes state. This feature is useful when you want to monitor critical signals or when you want to signal the host computer to transfer data to or from the module. You enable the interrupts on a bit-by-bit basis using the Open Layers Control Panel. Refer to the *KUSB-3160 Getting Started Manual* for more information.

Use software to determine which digital input line changed state.

Operation Modes

KUSB-3160 modules support the following digital I/O operation modes:

- **Single-value operations** are the simplest to use but do not allow you to check the interrupt status. Use software to specify the DIN or DOUT subsystem, the resolution, and a gain of 1 (the gain is ignored). Data is then read from or written to the appropriate digital I/O lines.

  Single-value operations stop automatically when finished; you cannot stop a single-value operation.

- **Continuous digital input** allows you to read digital input values as well as check the interrupt status of the digital input lines corresponding to banks 10 and 11. Use software to specify the DIN subsystem element, continuous mode, the resolution, the trigger source as software, and the window or procedure to handle the messages. Once the operation is configured and started, an event done message is generated when the interrupt occurs. You can then read the value and determine which digital I/O line changed state to cause the interrupt.

Programming Flowcharts

The following flowcharts show the steps required to perform data acquisition operations using DT-Open Layers. For illustration purposes, the DataAcq SDK functions are shown; however, the concepts apply to all DT-Open Layers software.

Note that many steps represent several substeps; if you are unfamiliar with the detailed operations involved with any one step, refer to the indicated page for detailed information. Optional steps appear in shaded boxes.

Single-Value Operations

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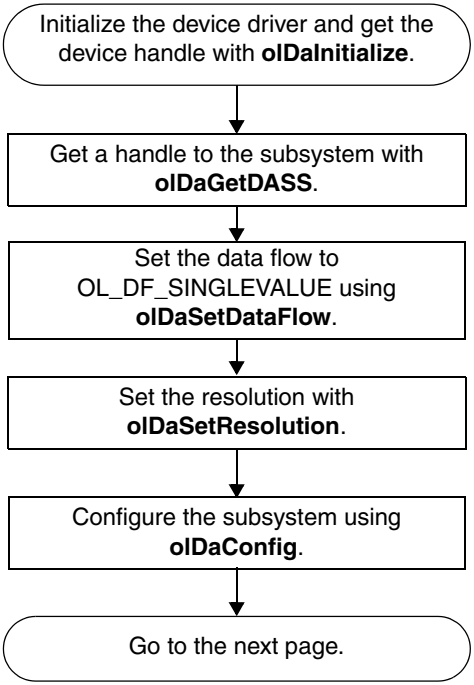
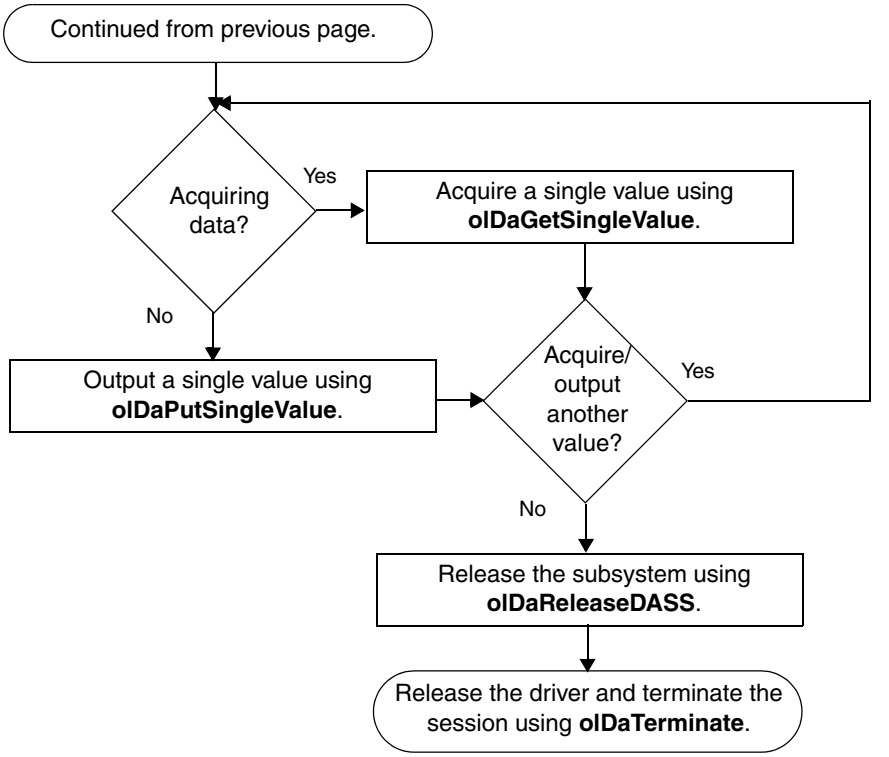
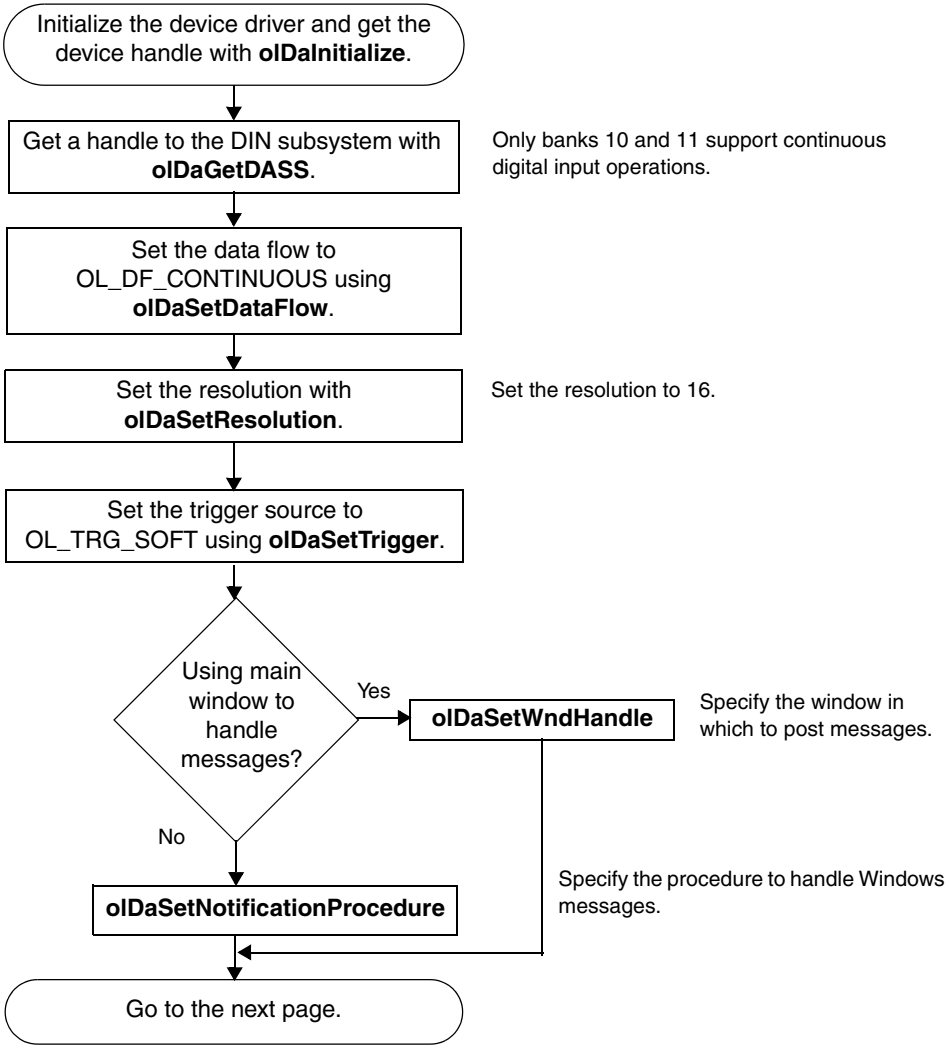
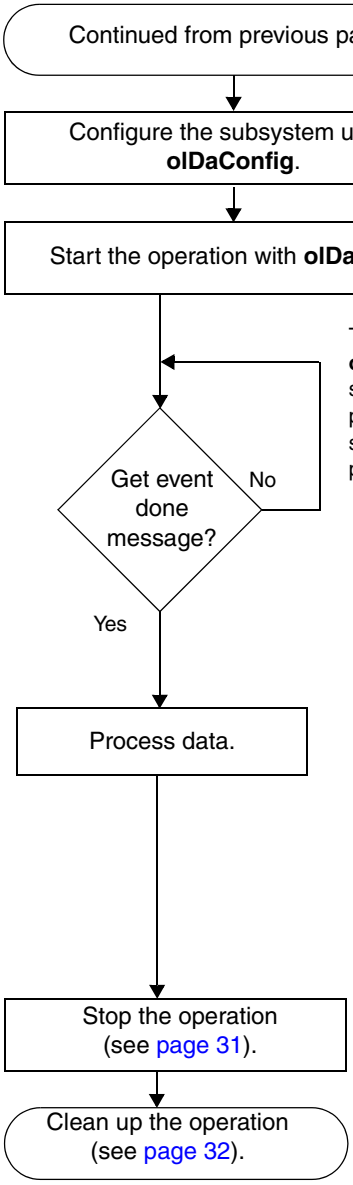



Continued from previous page.
Acquiring data?
Yes
Acquire a single value using **olDaGetSingleValue**.
No
Output a single value using **olDaPutSingleValue**.
Acquire/ output another value?
Yes
No
Release the subsystem using **olDaReleaseDASS**.
Release the driver and terminate the session using **olDaTerminate**.

Continuous Digital Input Operations



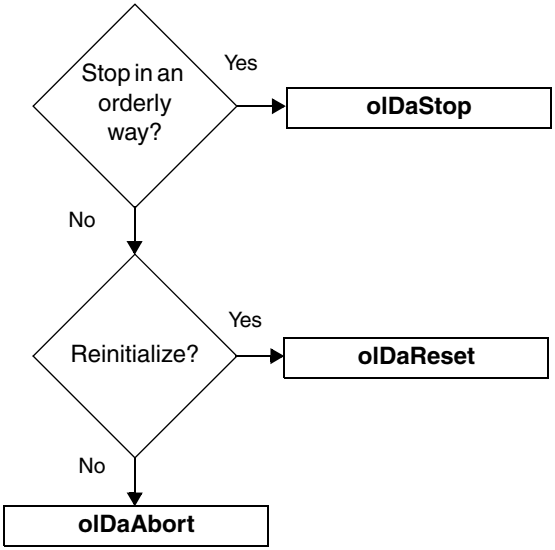


The event done message is OLDA_WM_EVENT_DONE. In **olDaSetWndHandle** or **olDaSetNotificationProcedure**, the subsystem handle, HDASS, is returned in the *wParam* parameter; this allows one window to handle messages from both subsystems. The subsystem status is returned in the *lParam* parameter.

Table 3: Subsystem Status in lParam

Bits	Definition
High Word	State of the subsystem. The resolution reflects the number of significant bits and represents actual line states read from the board.
Low Word	DIO lines (bits) which caused the event. Bit 0 corresponds to subsystem's bit 0. Bit 1 corresponds to subsystem's bit 1, and so on. Resolution reflects the # of significant bits.

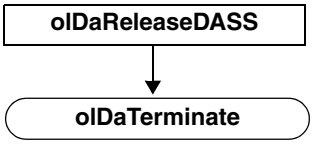
Stop the Operation



olDaStop stops the operation on the subsystem in an orderly way.

olDaAbort and **olDaReset** stop the operation on the subsystem immediately. **olDaReset** also reinitializes the subsystem to a known state.

Clean up the Operation



Release each subsystem.

Release the device driver and terminate the session.

Supported Device Driver Capabilities

The KUSB-3160 Device Driver provides support for DIN and DOUT subsystems. For information on how to configure the device driver, refer to the *KUSB-3160 Getting Started Manual.*

Table 2 summarizes the features available for use with the DataAcq SDK and the KUSB-3160 modules. The DataAcq SDK provides functions that return support information for specified subsystem capabilities at run-time.

The first row in the table lists the subsystem types. The first column in the table lists all possible subsystem capabilities. A description of each capability is followed by the parameter used to describe that capability in the DataAcq SDK.

Note: Blank fields represent unsupported options.

The DataAcq SDK uses the functions **olDaGetSSCaps** (for those queries starting with OLSSC) and **olDaGetSSCapsEx** (for those queries starting with OLSSCE) to return the supported subsystem capabilities for a device.

For more information, refer to the description of these functions in the DataAcq SDK online help. See the *DataAcq Getting Started Manual* for information on launching this help file.

Table 2: KUSB-3160 Supported Options

	KUSB-3160	A/D	D/A	DIN	DOUT	SRL	C/T
	Total Subsystems on Board	**0**	**0**	**12[a]**	**8[a]**	**0**	**0**
Data Flow Mode	Single-Value Operation Support OLSSC_SUP_SINGLEVALUE			Yes	Yes		
	Continuous Operation Support OLSSC_SUP_CONTINUOUS			Yes[b]			
	Continuous Operation until Trigger Event Support OLSSC_SUP_CONTINUOUS_PRETRIG						
	Continuous Operation before and after Trigger Event OLSSC_SUP_CONTINUOUS_ ABOUTTRIG						
	DT-Connect Support OLSSC_SUP_DTCONNECT						
	Continuous DT-Connect Support OLSSC_SUP_DTCONNECT_ CONTINUOUS						
	Burst DT-Connect Support OLSSC_SUP_DTCONNECT_BURST						
Sim. Oper.	Simultaneous Start List Support OLSSC_SUP_SIMULTANEOUS_START						
Pause Oper.	Pause Operation Support OLSSC_SUP_PAUSE						
Wind. Mess.	Asynchronous Operation Support OLSSC_SUP_POSTMESSAGE			Yes			
Buffering	Buffer Support OLSSC_SUP_BUFFERING						
	Single Buffer Wrap Mode Support OLSSC_SUP_WRPSINGLE						
	Multiple Buffer Wrap Mode Support OLSSC_SUP_WRPMULTIPLE						
	Inprocess Buffer Flush Support OLSSC_SUP_INPROCESSFLUSH						

Table 2: KUSB-3160 Supported Options (cont.)

	KUSB-3160	A/D	D/A	DIN	DOUT	SRL	C/T
	Total Subsystems on Board	**0**	**0**	**12[a]**	**8[a]**	**0**	**0**
DMA	Number of DMA Channels OLSSC_NUMDMACHANS			0	0		
	Supports Gap Free Data with No DMA OLSSC_SUP_GAPFREE_NODMA						
	Supports Gap Free Data with Single DMA OLSSC_SUP_GAPFREE_SINGLEDMA						
	Supports Gap Free Data with Dual DMA OLSSC_SUP_GAPFREE_DUALDMA						
Triggered Scan Mode	Triggered Scan Support OLSSC_SUP_TRIGSCAN						
	Maximum Number of CGL Scans per Trigger OLSSC_MAXMULTISCAN			0	0		
	Supports Scan per Trigger Event Triggered Scan OLSSC_SUP_RETRIGGER_SCAN_PER_TRIGGER						
	Supports Internal Retriggered Triggered Scan OLSSC_SUP_RETRIGGER_INTERNAL						
	Extra Retrigger Support OLSSC_SUP_RETRIGGER_EXTRA						
	Maximum Retrigger Frequency OLSSCE_MAXRETRIGGER			0	0		
	Minimum Retrigger Frequency OLSSCE_MINRETRIGGER			0	0		
Channel-Gain List	Maximum Channel Gain-List Depth OLSSC_CGL_DEPTH			0	0		
	Sequential Channel Gain-List Support OLSSC_SUP_SEQUENTIAL_CGL						
	Zero Start Sequential Channel-Gain List Support OLSSC_SUP_ZEROSEQUENTIAL_CGL						

Table 2: KUSB-3160 Supported Options (cont.)

	KUSB-3160	A/D	D/A	DIN	DOUT	SRL	C/T
	Total Subsystems on Board	**0**	**0**	**12[a]**	**8[a]**	**0**	**0**
Channel-Gain List (cont.)	Simultaneous Sample and Hold Support OLSSC_SUP_SIMULTANEOUS_SH Random Channel-Gain List Support OLSSC_SUP_RANDOM_CGL Channel List Inhibit Support OLSSC_SUP_CHANNELLIST_INHIBIT						
Gain	Programmable Gain Support OLSSC_SUP_PROGRAMGAIN Number of Gains OLSSC_NUMGAINS AutoRanging Support OLSSC_SINGLEVALUE_AUTORANGE			1	1		
Synchronous Digital I/O	Synchronous Digital I/O Support OLSSC_SUP_SYNCHRONOUS_DIGITALIO Maximum Synchronous Digital I/O Value OLSSC_MAX_DIGITALIOLIST_VALUE			0	0		
I/O Channels	Number of Channels OLSSC_NUMCHANNELS			1	1		
Channel Type	SE Support OLSSC_SUP_SINGLEENDED SE Channels OLSSC_MAXSECHANS DI Support OLSSC_SUP_DIFFERENTIAL DI Channels OLSSC_MAXDICHANS			0 Yes 1	0 Yes 1		

Table 2: KUSB-3160 Supported Options (cont.)

	KUSB-3160	A/D	D/A	DIN	DOUT	SRL	C/T
	Total Subsystems on Board	**0**	**0**	**12[a]**	**8[a]**	**0**	**0**
Filters	Filter/Channel Support OLSSC_SUP_FILTERPERCHAN						
	Number of Filters OLSSC_NUMFILTERS			1	1		
Ranges	Number of Voltage Ranges OLSSC_NUMRANGES			0	0		
	Range per Channel Support OLSSC_SUP_RANGEPERCHANNEL						
Resolution	Software Programmable Resolution OLSSC_SUP_SWRESOLUTION			Yes	Yes		
	Number of Resolutions OLSSC_NUMRESOLUTIONS			4[c]	4[c]		
Data Encoding	Binary Encoding Support OLSSC_SUP_BINARY			Yes	Yes		
	Twos Complement Support OLSSC_SUP_2SCOMP						
Triggers	Software Trigger Support OLSSC_SUP_SOFTTRIG			Yes			
	External Trigger Support OLSSC_SUP_EXTERNTRIG						
	Positive Threshold Trigger Support OLSSC_SUP_THRESHTRIGPOS						
	Negative Threshold Trigger Support OLSSC_SUP_THRESHTRIGNEG						
	Analog Event Trigger Support OLSSC_SUP_ANALOGEVENTTRIG						
	Digital Event Trigger Support OLSSC_SUP_DIGITALEVENTTRIG						
	Timer Event Trigger Support OLSSC_SUP_TIMEREVENTTRIG						
	Number of Extra Triggers OLSSC_NUMEXTRATRIGGERS			0	0		

Table 2: KUSB-3160 Supported Options (cont.)

	KUSB-3160	A/D	D/A	DIN	DOUT	SRL	C/T
	Total Subsystems on Board	**0**	**0**	**12[a]**	**8[a]**	**0**	**0**
Clocks (cont.)	Internal Clock Support OLSSC_SUP_INTCLOCK						
	External Clock Support OLSSC_SUP_EXTCLOCK						
	Number of Extra Clocks OLSSC_NUMEXTRACLOCKS			0	0		
	Base Clock Frequency OLSSCE_BASECLOCK			0	0		
	Maximum External Clock Divider OLSSCE_MAXCLOCKDIVIDER			1	1		
	Minimum External Clock Divider OLSSCE_MINCLOCKDIVIDER			1	1		
	Maximum Throughput OLSSCE_MAX_THROUGHPUT			0	0		
	Minimum Throughput OLSSCE_MIN_THROUGHPUT			0	0		
Counter/Timers	Cascading Support OLSSC_SUP_CASCADING						
	Event Count Mode Support OLSSC_SUP_CTMODE_COUNT						
	Generate Rate Mode Support OLSSC_SUP_CTMODE_RATE						
	One-Shot Mode Support OLSSC_SUP_CTMODE_ONESHOT						
	Repeatable One-Shot Mode Support OLSSC_SUP_CTMODE_ONESHOT_RPT						
	Up/Down Counting Mode Support OLSSC_SUP_CTMODE_UP_DOWN						
	Edge-to-Edge Measurement Mode Support OLSSC_SUP_CTMODE_MEASURE						

Table 2: KUSB-3160 Supported Options (cont.)

	KUSB-3160	A/D	D/A	DIN	DOUT	SRL	C/T
	Total Subsystems on Board	**0**	**0**	**12[a]**	**8[a]**	**0**	**0**
Counter/Timers (cont.)	High to Low Output Pulse Support OLSSC_SUP_PLS_HIGH2LOW						
	Low to High Output Pulse Support OLSSC_SUP_PLS_LOW2HIGH						
	None (internal) Gate Type Support OLSSC_SUP_GATE_NONE						
	High Level Gate Type Support OLSSC_SUP_GATE_HIGH_LEVEL						
	Low Level Gate Type Support OLSSC_SUP_GATE_LOW_LEVEL						
	High Edge Gate Type Support OLSSC_SUP_GATE_HIGH_EDGE						
	Low Edge Gate Type Support OLSSC_SUP_GATE_LOW_EDGE						
	Level Change Gate Type Support OLSSC_SUP_GATE_LEVEL						
	High Level Gate Type with Input Debounce Support OLSSC_SUP_GATE_HIGH_LEVEL_DEBOUNCE						
	Low Level Gate Type with Input Debounce Support OLSSC_SUP_GATE_LOW_LEVEL_DEBOUNCE						
	High Edge Gate Type with Input Debounce Support OLSSC_SUP_GATE_HIGH_EDGE_DEBOUNCE						
	Low Edge Gate Type with Input Debounce Support OLSSC_SUP_GATE_LOW_EDGE_DEBOUNCE						

Table 2: KUSB-3160 Supported Options (cont.)

	KUSB-3160	A/D	D/A	DIN	DOUT	SRL	C/T
	Total Subsystems on Board	**0**	**0**	**12[a]**	**8[a]**	**0**	**0**
Counter/ Timers (cont.)	Level Change Gate Type with Input Debounce Support OLSSC_SUP_GATE_LEVEL_ DEBOUNCE						
Interrupt	Interrupt Support OLSSC_SUP_INTERRUPT			Yes[d]			
FIFOs	FIFO in Data Path Support OLSSC_SUP_FIFO						
	Output FIFO Size OLSSC_FIFO_SIZE_IN_K						
Processor	Data Processing Capability OLSSC_SUP_PROCESSOR						
Software Calibration	Software Calibration Support OLSSC_SUP_SWCAL						

a. A total of eight banks of eight digital I/O lines and four banks of eight dedicated digital input lines exist on the board. You can configure the nondedicated banks for either digital input or digital output when you configure the device driver. Refer to the *KUSB-3160 Getting Started Manual* for more information on configuring the device driver.

b. Continuous digital input operations are supported by digital input banks 10 and 11 only.

c. The number of subsystem elements depends on the bank size or resolution established in the driver configuration dialog. Values for resolution are 8, 16, 24, or 32. If you are using digital input banks 10 and 11 in continuous mode, the resolution is always 16 bits. Refer to page 10 for more information on resolution.

d. Digital banks 10 and 11 can generate an interrupt on a bit-by-bit basis. You configure the digital lines to interrupt using the Open Layers Control Panel. Refer to the *KUSB-3160 Getting Started Manual* for more information.

Troubleshooting

General Checklist

Should you experience problems using the KUSB-3160 module, please follow these steps:

1. Read all the documentation provided for your product. Make sure that you have added any "Read This First" information to your manual and that you have used this information.
2. Check the Keithley CD for any README files and ensure that you have used the latest installation and configuration information available.
3. Check that your system meets the requirements stated in the *KUSB-3160 Getting Started Manual*.
4. Check that you have installed your hardware properly using the instructions in the *KUSB-3160 Getting Started Manual*.
5. Check that you have installed and configured the device driver properly using the instructions in the *KUSB-3160Getting Started Manual*.

If you still experience problems, try using the information in Table 4 to isolate and solve the problem. If you cannot identify the problem, refer to page 37.

Table 4: Troubleshooting Problems

Symptom	Possible Cause	Possible Solution
Module does not respond.	The module configuration is incorrect.	Check the configuration of your device driver; see the instructions in the *KUSB-3160 Getting Started Manual*.
	The module is damaged.	Contact Keithley for technical support; refer to page 37.
Intermittent operation.	Loose connections or vibrations exist.	Check your wiring and tighten any loose connections or cushion vibration sources; see the instructions in the *KUSB-3160 Getting Started Manual*.
	The module is overheating.	Check environmental and ambient temperature; consult the module's specifications on page 41 of this manual and the documentation provided by your computer manufacturer for more information.
	Electrical noise exists.	Check your wiring and either provide better shielding or reroute unshielded wiring; see the instructions in the *KUSB-3160 Getting Started Manual*.
Device failure error reported.	The KUSB-3160 module cannot communicate with the Microsoft bus driver or a problem with the bus driver exists.	Check your cabling and wiring and tighten any loose connections; see the instructions in the *KUSB-3160 Getting Started Manual*.
	The KUSB-3160 module was removed while an operation was being performed.	Ensure that your KUSB-3160 module is properly connected; see the instructions in the *KUSB-3160 Getting Started Manual*.

Table 4: Troubleshooting Problems (cont.)

Symptom	Possible Cause	Possible Solution
Data appears to be invalid.	An open connection exists.	Check your wiring and fix any open connections; see the instructions in the *KUSB-3160 Getting Started Manual*.
	A signal source is not connected to the channel being read.	Check the transducer connections; see the instructions in the *KUSB-3160 Getting Started Manual*.
Computer does not boot.	The power supply of the computer is too small to handle all the system resources.	Check the power requirements of your system resources and, if needed, get a larger power supply; consult the module's specifications on page 41 of this manual.

Service and Support

For the latest tips, software fixes, and other product information, you can always access our World-Wide Web site at the following address: http://www.keithley.com

If you have difficulty using a KUSB-3160 module, the Keithley Technical Support Department is available to provide technical assistance.

For the most efficient service, complete the form on page 38 and be at your computer when you call for technical support. This information helps to identify specific system and configuration-related problems and to replicate the problem in house, if necessary.

Information Required for Technical Support

Name:_____Phone_____
Contract Number: _____
Address: _____
_____

Hardware product(s): _____
serial number: _____
configuration: _____
Device driver: _____ _____
_____ version: _____
Software: _____ _____
serial number: _____ version:_____
PC make/model: _____
operating system: _____ version:_____
Windows version: _____
processor: _____ speed:_____
RAM: _____ hard disk space:_____
network/number of users: _____ disk cache:_____
graphics adapter: _____ data bus:_____

I have the following modules and applications installed in my system:_____
_____
_____
I am encountering the following problem(s): _____
_____
_____
_____
and have received the following error messages/codes: _____
_____
_____
I have run the module diagnostics with the following results: _____
_____
You can reproduce the problem by performing these steps:
1. _____
_____
2. _____
_____
3. _____
_____

Specifications

Table 5 lists the specifications for the digital input subsystem.

Table 5: DIN Subsystem Specifications

Feature	Specifications
Number of lines	64 shared digital I/O lines and 32 dedicated digital input lines[a]
Termination	100 kΩ Pullup to +5V_I[b]
Inputs Input type: Input load: High-level input voltage: Low-level input voltage: High-level input current: Low-level input current:	 Level sensitive 1 (HCT) 2.0 V minimum 0.8 V maximum 100 kΩ Pullup to +5V_I[b] –100 µA
Back EMF diodes	Yes

a. The KUSB-3160 module can generate a PCI-bus interrupt when any of the digital input lines corresponding to banks 10 and 11 changes state.

b. You can drive the +5V_I isolated output pin from an external power supply. This will allow the last digital output value to be latched to the input stage; therefore, if the power is reduced by the host, the digital output values will not change. Current requirements are 50 mA plus load.

Table 6 lists the specifications for the digital output subsystem.

Table 6: DOUT Subsystem Specifications

Feature	Specifications
Number of lines	64 shared digital I/O lines
Termination	22 Ω series resistor
Output driver	Open collector (5 V)

Table 6: DOUT Subsystem Specifications (cont.)

Feature	Specifications
Output driver high voltage	100 kΩ Pullup to +5V_I[a]
Output driver low voltage	0.6 V maximum (IOL = 12 mA)
Back EMF diodes	Yes

a. You can drive the +5V_I isolated output pin from an external power supply. This will allow the last digital output value to be latched to the input stage; therefore, if the power is reduced by the host, the digital output values will not change. Current requirements are 50 mA plus load.

Table 7 lists the power, physical, and environmental specifications for the KUSB-3160 module.

Table 7: Power, Physical, and Environmental Specifications

Feature	Specifications
Power	
+5 V Standby:	500 µA maximum
+5 V Enumeration:	100 mA maximum
+5 V Power ON:	500 mA maximum[a]
+5 V Isolated Power Out:	2.5 mA maximum
Physical	
Dimensions:	6.6 inches x 4.5 inches x 1.4 inches 160 mm x 100 mm mounting
Weight:	16 ounces (448 grams)
Environmental	
Operating temperature range:	0° C to 55° C
Storage temperature range:	-25° C to 85° C
Relative humidity:	To 95%, noncondensing

a. Typical power supply current is 200 mA on startup.

Table 8 lists the cable and connector specifications for the KUSB-3160 module.

Table 8: KUSB-3160 Cable and Connector Specifications

Feature	Specifications
USB cable	2-meter, Type A-B, USB cable AMP part# 974327-1
J1 Connector	100-pin D, Robinson Nugent [a] part# P50E-100P1-SR1-TG
J1 Mating Connector	100-pin D, Robinson Nugent part# P50E-100S-TG

a. Because of different vendor number pinning schemes, the Robinson Nugent connector has a mirror pinout from that described in Appendix B. The KUSB-STP100 and KUSB-CABDIO cable already account for the mirroring; however, if you are building your own cable or screw terminal panel, you must take this into account.

B

Connector Pin Assignments

Table 9 lists the pin assignments of connector J1 on the KUSB-3160 module and on the KUSB-STP100 screw terminal panel.

Note: Because of different vendor number pinning schemes, the Robinson Nugent connector specified on page 42 has a mirror pinout from that described in this appendix. The KUSB-STP100 and KUSB-CABDIO cable already account for the mirroring; however, if you are building your own cable or screw terminal panel, you must take this into account.

Table 9: Pin Assignments for Connector J1

Pin Number	Signal Description	Pin Number	Signal Description
1	Bank 0, Bit 0	2	Bank 0, Bit 1
3	Bank 0, Bit 2	4	Bank 0, Bit 3
5	Bank 0, Bit 4	6	Bank 0, Bit 5
7	Bank 0, Bit 6	8	Bank 0, Bit 7
9	Bank 1, Bit 0	10	Bank 1, Bit 1
11	Bank 1, Bit 2	12	Bank 1, Bit 3
13	Bank 1, Bit 4	14	Bank 1, Bit 5
15	Bank 1, Bit 6	16	Bank 1, Bit 7
17	Bank 2, Bit 0	18	Bank 2, Bit 1
19	Bank 2, Bit 2	20	Bank 2, Bit 3
21	Bank 2, Bit 4	22	Bank 2, Bit 5
23	Bank 2, Bit 6	24	Bank 2, Bit 7
25	Bank 3, Bit 0	26	Bank 3, Bit 1

Table 9: Pin Assignments for Connector J1 (cont.)

Pin Number	Signal Description	Pin Number	Signal Description
27	Bank 3, Bit 2	28	Bank 3, Bit 3
29	Bank 3, Bit 4	30	Bank 3, Bit 5
31	Bank 3, Bit 6	32	Bank 3, Bit 7
33	Bank 4, Bit 0	34	Bank 4, Bit 1
35	Bank 4, Bit 2	36	Bank 4, Bit 3
37	Bank 4, Bit 4	38	Bank 4, Bit 5
39	Bank 4, Bit 6	40	Bank 4, Bit 7
41	Bank 5, Bit 0	42	Bank 5, Bit 1
43	Bank 5, Bit 2	44	Bank 5, Bit 3
45	Bank 5, Bit 4	46	Bank 5, Bit 5
47	Bank 5, Bit 6	48	Bank 5, Bit 7
49	Isolated +5 V	50	Isolated Ground
51	Bank 6, Bit 0	52	Bank 6, Bit 1
53	Bank 6, Bit 2	54	Bank 6, Bit 3
55	Bank 6, Bit 4	56	Bank 6, Bit 5
57	Bank 6, Bit 6	58	Bank 6, Bit 7
59	Bank 7, Bit 0	60	Bank 7, Bit 1
61	Bank 7, Bit 2	62	Bank 7, Bit 3
63	Bank 7, Bit 4	64	Bank 7, Bit 5
65	Bank 7, Bit 6	66	Bank 7, Bit 7
67	Bank 8, Bit 0[a]	68	Bank 8, Bit 1[a]
69	Bank 8, Bit 2[a]	70	Bank 8, Bit 3[a]

Table 9: Pin Assignments for Connector J1 (cont.)

Pin Number	Signal Description	Pin Number	Signal Description
71	Bank 8, Bit 4[a]	72	Bank 8, Bit 5[a]
73	Bank 8, Bit 6[a]	74	Bank 8, Bit 7[a]
75	Bank 9, Bit 0[a]	76	Bank 9, Bit 1[a]
77	Bank 9, Bit 2[a]	78	Bank 9, Bit 3[a]
79	Bank 9, Bit 4[a]	80	Bank 9, Bit 5[a]
81	Bank 9, Bit 6[a]	82	Bank 9, Bit 7[a]
83	Bank 10, Bit 0[a]	84	Bank 10, Bit 1[a]
85	Bank 10, Bit 2[a]	86	Bank 10, Bit 3[a]
87	Bank 10, Bit 4[a]	88	Bank 10, Bit 5[a]
89	Bank 10, Bit 6[a]	90	Bank 10, Bit 7[a]
91	Bank 11, Bit 0[a]	92	Bank 11, Bit 1[a]
93	Bank 11, Bit 2[a]	94	Bank 11, Bit 3[a]
95	Bank 11, Bit 4[a]	96	Bank 11, Bit 5[a]
97	Bank 11, Bit 6[a]	98	Bank 11, Bit 7[a]
99	Isolated +5 V	100	Isolated Ground

a. Dedicated digital input line. The KUSB-3160 module can generate a PCI-bus interrupt when any of the digital input lines (bits) corresponding to banks 10 and 11 changes state.

Table 10 lists the screw terminal assignments of the KUSB-STP100 screw terminal panel.

Table 10: Screw Terminal Assignments of the KUSB-STP100 Screw Terminal Panel

Screw Terminal Block	Terminal Number	Signal Description
TB1	1	Bank 0, Bit 0
	2	Bank 0, Bit 1
	3	Bank 0, Bit 2
	4	Bank 0, Bit 3
	5	Bank 0, Bit 4
	6	Bank 0, Bit 5
	7	Bank 0, Bit 6
	8	Bank 0, Bit 7
	9	Bank 1, Bit 0
	10	Bank 1, Bit 1
TB2	51	Bank 6, Bit 0
	52	Bank 6, Bit 1
	53	Bank 6, Bit 2
	54	Bank 6, Bit 3
	55	Bank 6, Bit 4
	56	Bank 6, Bit 5
	57	Bank 6, Bit 6
	58	Bank 6, Bit 7
	59	Bank 7, Bit 0

Table 10: Screw Terminal Assignments of the KUSB-STP100 Screw Terminal Panel (cont.)

Screw Terminal Block	Terminal Number	Signal Description
TB2 (cont.)	60	Bank 7, Bit 1
TB3	11	Bank 1, Bit 2
	12	Bank 1, Bit 3
	13	Bank 1, Bit 4
	14	Bank 1, Bit 5
	15	Bank 1, Bit 6
	16	Bank 1, Bit 7
	17	Bank 2, Bit 0
	18	Bank 2, Bit 1
	19	Bank 2, Bit 2
	20	Bank 2, Bit 3
TB4	61	Bank 7, Bit 2
	62	Bank 7, Bit 3
	63	Bank 7, Bit 4
	64	Bank 7, Bit 5
	65	Bank 7, Bit 6
	66	Bank 7, Bit 7
	67	Bank 8, Bit 0[a]
	68	Bank 8, Bit 1[a]
	69	Bank 8, Bit 2[a]
	70	Bank 8, Bit 3[a]

Table 10: Screw Terminal Assignments of the KUSB-STP100 Screw Terminal Panel (cont.)

Screw Terminal Block	Terminal Number	Signal Description
TB5	21	Bank 2, Bit 4
	22	Bank 2, Bit 5
	23	Bank 2, Bit 6
	24	Bank 2, Bit 7
	25	Bank 3, Bit 0
	26	Bank 3, Bit 1
	27	Bank 3, Bit 2
	28	Bank 3, Bit 3
	29	Bank 3, Bit 4
	30	Bank 3, Bit 5
TB6	71	Bank 8, Bit 4[a]
	72	Bank 8, Bit 5[a]
	73	Bank 8, Bit 6[a]
	74	Bank 8, Bit 7[a]
	75	Bank 9, Bit 0[a]
	76	Bank 9, Bit 1[a]
	77	Bank 9, Bit 2[a]
	78	Bank 9, Bit 3[a]
	79	Bank 9, Bit 4[a]
	80	Bank 9, Bit 5[a]

Table 10: Screw Terminal Assignments of the KUSB-STP100 Screw Terminal Panel (cont.)

Screw Terminal Block	Terminal Number	Signal Description
TB7	31	Bank 3, Bit 6
	32	Bank 3, Bit 7
	33	Bank 4, Bit 0
	34	Bank 4, Bit 1
	35	Bank 4, Bit 2
	36	Bank 4, Bit 3
	37	Bank 4, Bit 4
	38	Bank 4, Bit 5
	39	Bank 4, Bit 6
	40	Bank 4, Bit 7
TB8	81	Bank 9, Bit 6[a]
	82	Bank 9, Bit 7[a]
	83	Bank 10, Bit 0[a]
	84	Bank 10, Bit 1[a]
	85	Bank 10, Bit 2[a]
	86	Bank 10, Bit 3[a]
	87	Bank 10, Bit 4[a]
	88	Bank 10, Bit 5[a]
	89	Bank 10, Bit 6[a]
	90	Bank 10, Bit 7[a]

Table 10: Screw Terminal Assignments of the KUSB-STP100 Screw Terminal Panel (cont.)

Screw Terminal Block	Terminal Number	Signal Description
TB9	41	Bank 5, Bit 0
	42	Bank 5, Bit 1
	43	Bank 5, Bit 2
	44	Bank 5, Bit 3
	45	Bank 5, Bit 4
	46	Bank 5, Bit 5
	47	Bank 5, Bit 6
	48	Bank 5, Bit 7
	49	Isolated +5 V
	50	Isolated Ground
TB10	91	Bank 11, Bit 0[a]
	92	Bank 11, Bit 1[a]
	93	Bank 11, Bit 2[a]
	94	Bank 11, Bit 3[a]
	95	Bank 11, Bit 4[a]
	96	Bank 11, Bit 5[a]
	97	Bank 11, Bit 6[a]
	98	Bank 11, Bit 7[a]
	99	Isolated +5 V
	100	Isolated Ground

a. Dedicated digital input line.

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