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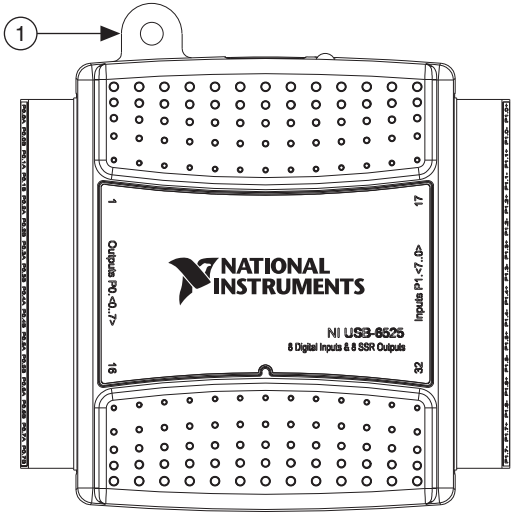
USER GUIDE AND SPECIFICATIONS

NI USB-6525

This user guide describes how to use the National Instruments USB-6525 data acquisition (DAQ) device.

Introduction

The NI USB-6525 is a full-speed USB 2.0 device that provides eight ±60 VDC channel-to-channel isolated digital inputs (DI), eight 60 VDC/30 V_{rms} channel-to-channel isolated solid-state relay (SSR) outputs, and a 32-bit counter.



1	USB Cable Strain Relief

Figure 1. USB-6525 Top View

NATIONAL INSTRUMENTS

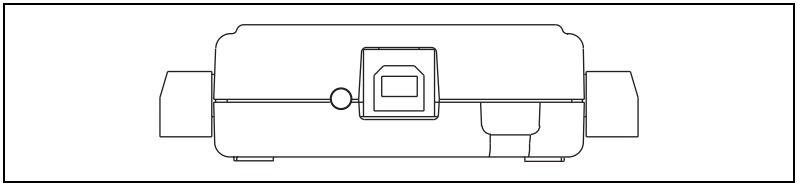


Figure 2. USB-6525 Back View

Installing Software

Software support for the USB-6525 for Windows 2000/XP is provided by NI-DAQmx.

The NI-DAQmx CD contains example programs that you can use to get started programming with the USB-6525. Refer to the *NI-DAQmx for USB Devices Getting Started Guide*, that shipped with your device and is also accessible from **Start»All Programs»National Instruments»NI-DAQ** for more information.

Note For information about non-Windows operating system support, refer to `ni.com/info` and enter `rddqld`.

Hardware

The block diagram in Figure 3 shows key functional components of the USB-6525.

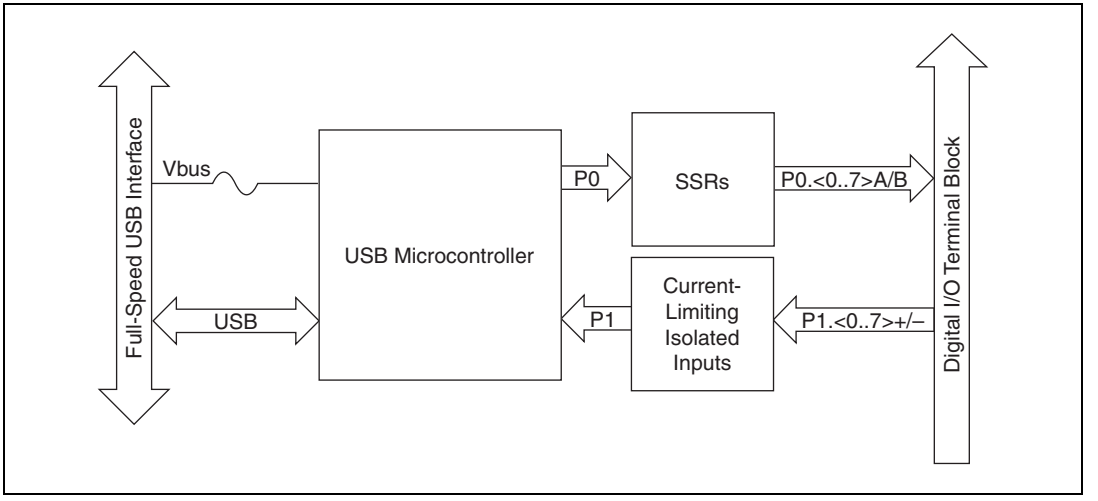


Figure 3. USB-6525 Block Diagram

Refer to the *Safety Guidelines* section of this document for important safety information.

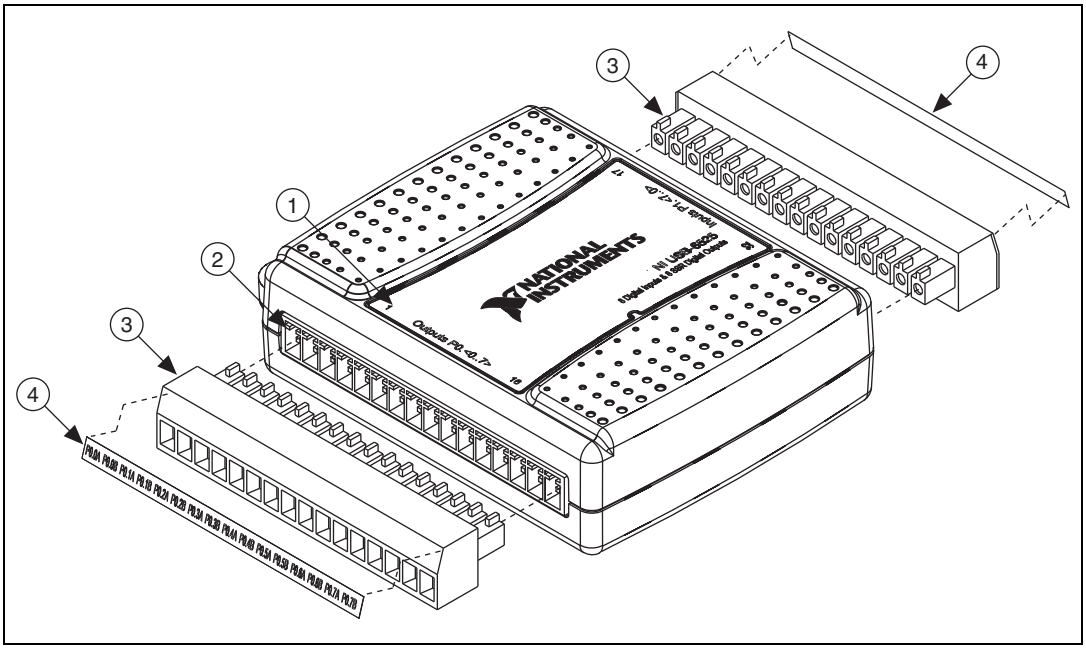
Setting Up Hardware

Complete the following steps to set up the hardware:

1. Install combicon screw terminal blocks by inserting them into the combicon jacks.

Note The USB-6525 kit ships with signal labels. You can apply the signal labels on the screw terminal blocks for easy signal identification.

2. Refer to Table 1 and Figure 4 for label orientation and affix provided signal labels to the screw terminal blocks. Insert the screw terminal blocks into their respective matching combicon jacks. Refer to Figure 4 for more information about signal label orientation.



1	Overlay Label with Pin Orientation Guides	3	Screw Terminal Blocks
2	Combicon Jack	4	Signal Labels

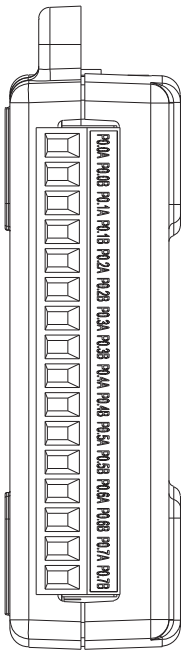
Figure 4. Signal Label Application Diagram

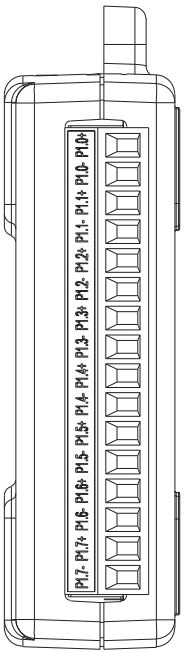
3. Connect the wiring to the appropriate screw terminals.

I/O Connector

The USB-6525 device ships with two detachable terminal blocks for digital signals. Each individual terminal accepts a wire gauge between 16 AWG–28 AWG.

Table 1. Digital Terminal Assignments

Module	Terminal	Signal
	1	P0.0A
	2	P0.0B
	3	P0.1A
	4	P0.1B
	5	P0.2A
	6	P0.2B
	7	P0.3A
	8	P0.3B
	9	P0.4A
	10	P0.4B
	11	P0.5A
	12	P0.5B
	13	P0.6A
	14	P0.6B
	15	P0.7A
	16	P0.7B

Module	Terminal	Signal
	17	P1.0+
	18	P1.0–
	19	P1.1+
	20	P1.1–
	21	P1.2+
	22	P1.2–
	23	P1.3+
	24	P1.3–
	25	P1.4+
	26	P1.4–
	27	P1.5+
	28	P1.5–
	29	P1.6+
	30	P1.6–
	31	P1.7+/PFI 0+
	32	P1.7–/PFI 0–

Signal Descriptions

Table 2 describes the signals available on the I/O connectors.

Table 2. Signal Descriptions

Signal Name	Direction	Description
P0.<0..7>A/B	Output	Solid-state relay 60 VDC/30 V_{rms} (42.4 V_{pk}) output
P1.<0..6>+/–	Input	±60 VDC digital input. P1.<0..6>+ corresponds to the positive input terminal. P1.<0..6>– corresponds to the negative input terminal.
P1.7+/– or PFI 0+/–	Input	This channel is configurable as either a digital input or an event counter. **Digital Input Signal**—±60 VDC digital input. P1.7+ corresponds to the positive input terminal. P1.7– corresponds to the negative input terminal. **CTR**—As a counter, this signal can be used as an event counter input source. PFI 0+ corresponds to the positive counter terminal. PFI 0– corresponds to the negative counter terminal.

Features

The NI 6525 features digital filtering, change detection, programmable power-up output states, and a watchdog timer.

Digital Filtering

Use the digital filter option available on the NI 6525 input lines to eliminate glitches on input data. When used with change detection, filtering can also reduce the number of changes to examine and process.

You can configure the digital input channels to pass through a digital filter, and you can program the filter interval the filter uses. The filter blocks pulses that are shorter than half of the specified filter interval and passes pulses that are longer than the specified interval. Intermediate-length pulses—pulses longer than half of the interval but less than the interval—may or may not pass the filter.

The filter operates on the inputs from the optocouplers. The optocouplers turn on faster than they turn off, passing rising edges faster than falling

edges. The optocouplers can therefore subtract up to 150 µs from a low pulse.

Table 3 lists the pulse widths guaranteed to be passed and blocked.

Table 3. NI 6525 Digital Filtering

Filter Interval	Pulse Width Passed		Pulse Width Blocked	
	Low Pulse	**High Pulse**	**Low Pulse**	**High Pulse**
$t_{interval}$	$t_{interval}$ + 150 µs	$t_{interval}$	$t_{interval}/2$	$(t_{interval}/2)$ – 150 µs

You can enable filtering on as many input lines as is necessary for your application. All filtered lines share the same timing interval, which ranges from 120 µs to 2600 ms.

Internally, the filter uses two clocks: the sample clock and the filter clock. The sample clock has a 40 µs period[1]. The filter clock is generated by a counter and has a period equal to one half of the specified timing interval. The input signal is sampled on each rising edge of the sample clock, which is every 40 µs[1]. A change in the input signal is recognized only if it maintains its new state for at least two consecutive rising edges of the filter clock.

The filter clock is programmable and allows you to control how long a pulse must last to be recognized. The sample clock provides a fast sample rate to ensure that input pulses remain constant between filter clocks.

[1] The accuracy of the sample clock is ±1.5%.

Digital Filtering Example

Figure 5 shows a filter configuration with a $t_{interval}$ filter interval ($t_{interval}$/2 filter clock).

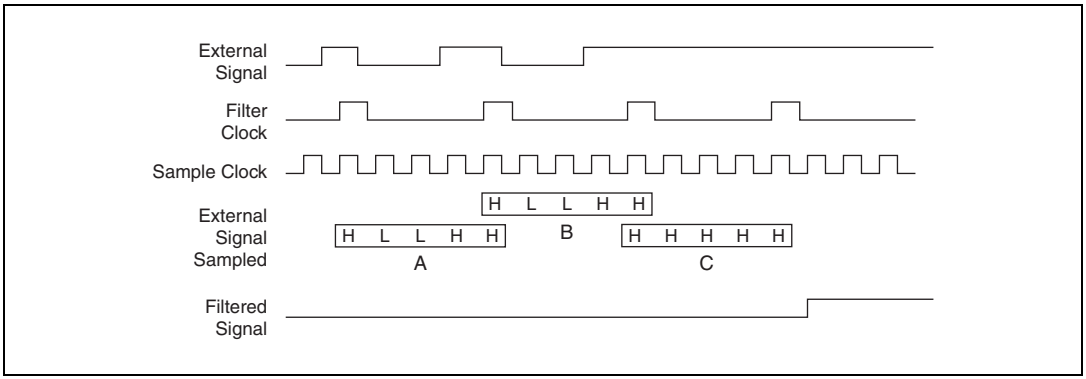


Figure 5. Digital Filtering Example

In periods A and B, the filter blocks the glitches because the external signal does not remain steadily high from one rising edge of the filter clock to the next. In period C, the filter passes the transition because the external signal remains steadily high. Depending on when the transition occurs, the filter may require up to two filter clocks—one full filter interval—to pass a transition. The figure shows a rising (0 to 1) transition. The same filtering applies to falling (1 to 0) transitions.

Change Detection

You can program the NI 6525 to send an interrupt when a change occurs on any input line.

The NI 6525 can monitor changes on selected input lines or on all input lines. It can monitor for rising edges (0 to 1), falling edges (1 to 0), or both. When an input change occurs, the NI 6525 generates an interrupt, and the NI-DAQ driver then notifies the software.

Note Excessive change detections can affect system performance. Use digital filtering to minimize the effects of noisy input lines.

The NI 6525 sends a change detection when any one of the changes occurs, but it does not report which line changed or if the line was rising or falling. After a change, you can read the input lines to determine the current line states. The maximum rate of change detection is determined by the software response time, which varies from system to system.

An overflow bit indicates that an additional rising or falling edge has been detected before the software could process the previous change.

Refer to the software documentation for information about how to set up and implement the change detection.

Change Detection Example

Table 4 shows a change detection example for six bits of one port.

Table 4. Change Detection Example

	Bit							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Changes to detect	↕	↕	↕	↕	—	—	↑	↓
Enable rising-edge detection	yes	yes	yes	yes	no	no	yes	no
Enable falling-edge detection	yes	yes	yes	yes	no	no	no	yes

This example assumes the following line connections:

- Bits 7, 6, 5, and 4 are connected to data lines from a four-bit TTL output device. The NI 6525 detects any change in the input data so you can read the new data value.
- Bit 1 is connected to a limit sensor. The NI 6525 detects rising edges on the sensor, which correspond to over-limit conditions.
- Bit 0 is connected to a switch. The software can react to any switch closure, which is represented by a falling edge. If the switch closure is noisy, enable digital filtering for this line.

In this example, the NI 6525 reports rising edges only on bit 1, falling edges only on bit 0, and rising and falling edges on bits 7, 6, 5, and 4. The NI 6525 reports no changes for bits 3 and 2. After receiving notification of a change, you can read the port to determine the current values of all eight lines. You cannot read the state of any lines that are configured for change detection until the change detection interrupt occurs.

Programmable Power-Up Output States

The default power-up state of the digital output lines is logic low, which opens the solid-state relays. The lines on output ports are user-configurable for logic high (closed relay) or logic low (open relay). User-configurable power-up states are useful for ensuring that the NI 6525 powers up in a known state.

To use MAX (recommended) to program the power-up states, select the device and click the **Properties** button. Refer to the software documentation for information about how to program the power-up states using NI-DAQ with LabVIEW or other National Instruments application development environments (ADEs).

Watchdog Timer

The watchdog timer is a software configurable feature used to set critical outputs to safe states in the event of a software failure, a system crash, or any other loss of communication between the application and the NI 6525.

When the watchdog timer is enabled, if the NI 6525 does not receive a **watchdog reset** software command within the time specified for the watchdog timer, the outputs go to a user-defined safe state and remain in that state until the watchdog timer is disarmed by the application and new values are written, the NI 6525 is reset, or the computer is restarted. The expiration signal that indicates an expired watchdog will continue to assert until the watchdog is disarmed. After the watchdog timer expires, the NI 6525 ignores any writes until the watchdog timer is disarmed.

You can set the watchdog timer timeout period to specify the amount of time that must elapse before the watchdog timer expires. The counter on the watchdog timer is configurable up to $(2^{32} - 1) \times 40\ \mu s$[1] before it expires.

Digital I/O

USB-6525 has eight channel-to-channel optically isolated inputs, P1.<0..7>, and eight channel-to-channel optically isolated solid-state relay outputs, P0.<0..7>. P1.7/PFI 0 can also function as a 32-bit counter. Refer to the *Event Counter* section for more information about the counter.

Optically Isolated Inputs

The USB-6525 provides eight channels of isolated digital inputs. These inputs consist of an optocoupler, a depletion-mode MOSFET-based current-limiting circuit, and Schottky diode.

[1] The accuracy of the sample clock is ±1.5%.

Each channel has its own positive and negative terminals. The input range on the channels is –60 VDC to +60 VDC.

Sensing DC Voltages

The USB-6525 detects a wide range of DC signals, from TTL-like logic levels to DC power supply levels up to 60 V.

Applying a DC voltage of at least 3.2 V across two input terminals registers logic high. Applying no voltage or a voltage difference of 1 V or less registers logic low. DC voltages between 1 V and 3.2 V may not register a consistent or usable value.

Signal Connection Example

Figure 6 shows signal connections for a power supply and load connected to an isolated input.

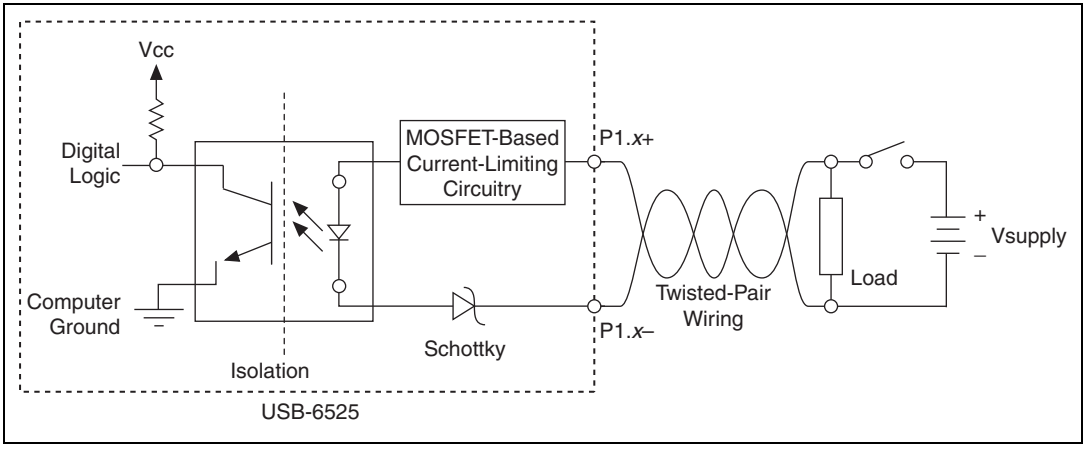


Figure 6. Connecting a Power Supply and Load to the Isolated Input

Caution Use twisted-pair field wiring to reduce EMC noise.

In Figure 6, the USB-6525 is sensing a powered load that is connected to the power supply through a switch.

Note Power supplies must be within the USB-6525 device range. Refer to the *Specifications* section for information about these ranges.

When the switch is open, no current flows through the load and no voltage is applied to the load or to the USB-6525 input. The digital logic of the USB-6525 then registers a logic low for the channel. When the switch is

closed, current flows through both the load and the USB-6525 optocoupler, and the USB-6525 registers a logic high for the channel.

Solid-State Relay (SSR) Outputs

You can connect loads to the USB-6525. Connect the load to one of the leads of the power source. Connect either the P0.*x*A or the P0.*x*B terminal to the load and the other terminal to the other lead of the AC or DC power source. Figure 7 shows a possible configuration where the load is connected to the P0.*x*B terminal and the DC or AC power source.

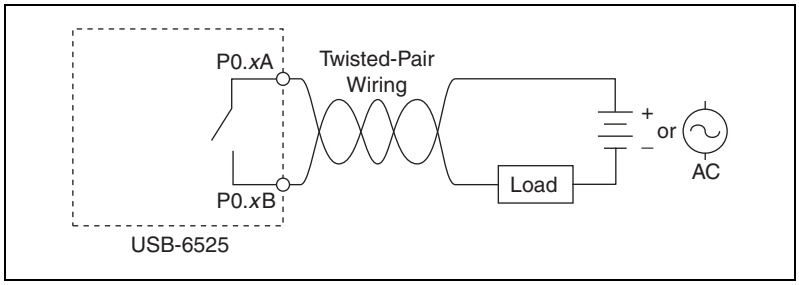


Figure 7. Connecting a Load to the USB-6525

Caution Use twisted-pair field wiring to reduce EMC noise.

Power-On and Power-Off Conditions

The default power-on state of the solid-state relays is open. By default, the solid-state relays remain open when the chassis and the USB-6525 device are powered off.

Protecting Inductive Loads

When inductive loads are connected to the USB-6525 SSR outputs, a large counter-electromotive force may occur at switching time because of the energy stored in the inductive load. These flyback voltages can damage the SSR outputs and/or the external power supply.

Limit flyback voltages at your inductive load by installing one of the following:

- For DC loads—Install a flyback diode within 18 in. of the load.
- For AC loads—Install a metal oxide varistor (MOV) rated for 30 V_{rms} or slightly higher.

Figures 8 and 9 show examples of using an external flyback diode to protect DC inductive loads and an MOV to protect AC inductive loads, respectively.

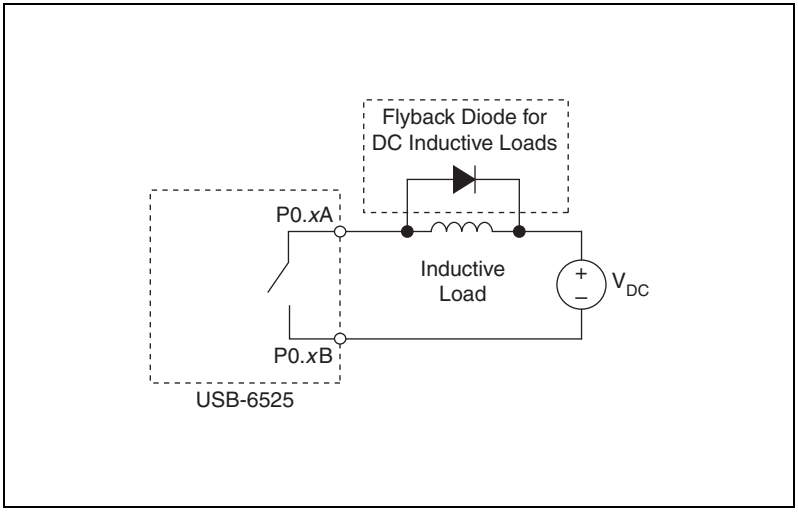


Figure 8. Contact Protection for DC Inductive Loads

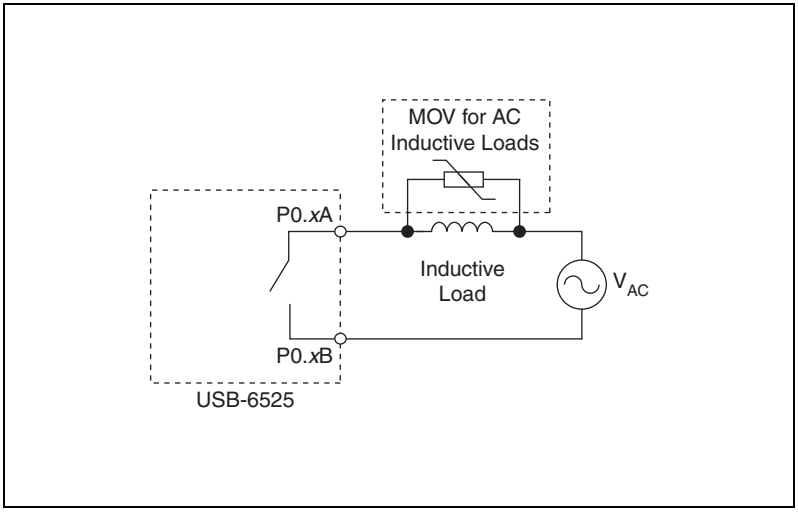


Figure 9. Contact Protection for AC Inductive Loads

Using the USB-6525 as a TTL Output Device

Figure 10 shows a signal connection example for a TTL-level application with an external supply voltage of +5 V.

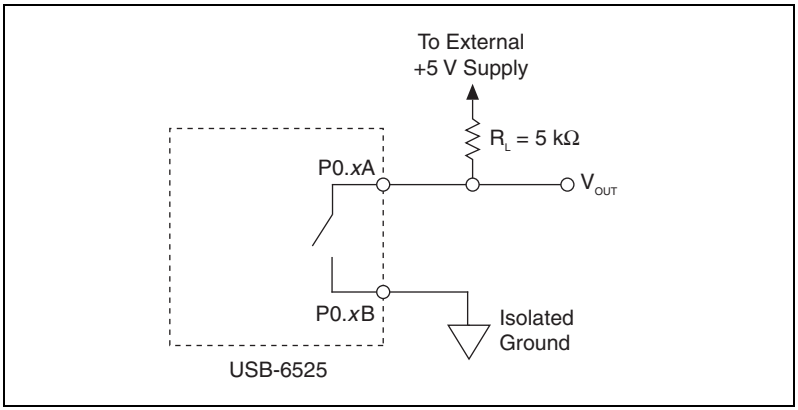


Figure 10. TTL Device Signal Connection Example

When the SSR is open, a small amount of current flows through R_L and the output voltage is close to 5 V, a logic high. When the SSR is closed, current flows through R_L and the output voltage is close to 0 V, a logic low.

Choose an R_L value small enough to provide the necessary source current but large enough to reduce sink current and to avoid consuming unnecessary power. Many TTL-level applications use an R_L value of 5 kΩ.

Event Counter

You can configure PFI 0 (an alias to P1.7) as the source for a 32-bit counter. In this mode, the device counts low to high transitions on P1.7. The counter can be armed and disarmed and the count can be read or reset through software. For more information about event timing requirements, refer to the *Specifications* section. Refer to your software documentation for more information about counter programming techniques.

Specifications

The following specifications are typical at 25 °C, unless otherwise noted.

Isolated Inputs

Number of input channels.....8, ch-ch isolated

Input voltage range .....–60 VDC to 60 VDC

Level	Min	Max
Input low voltage	–60 VDC	1 VDC
Input high voltage	3.2 VDC	60 VDC

Input current .....3.0 mA/channel max

Minimum pulse-width
for change detection.....200 µs

Propagation delay .....65 µs, typical

Solid-State Relay Outputs

Number of output channels.....8, ch-ch isolated

Relay type .....Normally open solid-state relay (SSR)

Switching voltage .....60 VDC/30 V_{rms} max

Switching current (per channel).....500 mA max, full operation temperature range

Switching rate (90% duty cycle) .....5 operations per second

Relay open time .....60 µs typ

Relay close time.....1.2 ms typ

On resistance.....550 mΩ max

Off state leakage .....0.6 µA typ

Counter

Number of counters .....1 (P1.7 can be configured as a counter)

Resolution ..... 32 bits

Counter measurements ..... Rising edge counting

Maximum input frequency ..... 5 KHz

Minimum high pulse width ..... 20 µs

Minimum low pulse width ..... 180 µs

Bus Interface

USB specification ..... USB 2.0 full-speed (12 Mb/s)

Power Requirements

USB

Input voltage ..... 4.5 to 5.25 VDC in configured state

Active current ..... 150 mA max

Suspend current ..... 350 µA typ

Physical Characteristics

Dimensions

Without connectors ..... 6.35 cm × 8.51 cm × 2.31 cm (2.50 in. × 3.35 in. × 0.91 in.)

With connectors ..... 8.18 cm × 8.51 cm × 2.31 cm (3.22 in. × 3.35 in. × 0.91 in.)

I/O connectors ..... USB series B receptacle, (2) 16 position (screw terminal) plug headers

Screw-terminal wiring ..... 16 to 28 AWG copper conductor wire with 10 mm (0.39 in.) of insulation stripped from the end

Torque for screw terminals ..... 0.22 – 0.25 N · m (2.0 – 2.2 lb · in.)

Weight

With connectors ..... Approx. 87 g (3.1 oz)

Without connectors ..... Approx. 64 g (2.3 oz)

Safety

Standards

This product meets the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note For UL and other safety certifications, refer to the product label or the *Online Product Certification* section.

Isolation

Channel-to-channel.....60 VDC continuous

Channel-to-earth ground.....60 VDC continuous

Withstand.....60 VDC continuous

Caution Do not use this module for connection to signals or for measurements within Measurement Categories II, III, or IV.

Hazardous Locations

The USB-6525 is not certified for use in hazardous locations.

Environmental

The USB-6525 device is intended for indoor use only.

Operating temperature
(IEC 60068-2-1 and IEC 60068-2-2).....0 to 55 °C

Operating humidity
(IEC 60068-2-56) .....10 to 90% RH, noncondensing

Maximum altitude.....2,000 m (at 25 °C ambient temperature)

Storage temperature
(IEC 60068-2-1 and IEC 60068-2-2).....–40 to 85 °C

Storage humidity
(IEC 60068-2-56) .....5 to 90% RH, noncondensing

Pollution Degree (IEC 60664).....2

Electromagnetic Compatibility

This product meets the requirements of the following EMC standards for electrical equipment for measurement, control, and laboratory use:

- EN 61326 (IEC 61326): Class A emissions; Basic immunity
- EN 55011 (CISPR 11): Group 1, Class A emissions
- AS/NZS CISPR 11: Group 1, Class A emissions
- FCC 47 CFR Part 15B: Class A emissions
- ICES-001: Class A emissions

Note For the standards applied to assess the EMC of this product, refer to the *Online Product Certification* section.

Note For EMC compliance, operate this product according to the documentation.

CE Compliance CE

This product meets the essential requirements of applicable European Directives as follows:

- 2006/95/EC; Low-Voltage Directive (safety)
- 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

Online Product Certification

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

Environmental Management

NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the *NI and the Environment* Web page at `ni.com/environment`. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers At the end of their life cycle, all products *must* be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit `ni.com/environment/weee.htm`.

电子信息产品污染控制管理办法 （中国 RoHS）

中国客户 National Instruments 符合中国电子信息产品中限制使用某些有害物质指令 (RoHS)。
关于 National Instruments 中国 RoHS 合规性信息，请登录 `ni.com/environment/rohs_china`。
(For information about China RoHS compliance, go to `ni.com/environment/rohs_china`.)

Safety Guidelines

Caution Operate the hardware only as described in these operating instructions.

The following section contains important safety information that you must follow when installing and using the USB-6525.

Do not operate the USB-6525 in a manner not specified in this document. Misuse of the device can result in a hazard. You can compromise the safety protection built into the device if the device is damaged in any way. If the device is damaged, contact National Instruments for repair.

Do not substitute parts or modify the device except as described in this document. Use the device only with the chassis, modules, accessories, and cables specified in the installation instructions. You must have all covers and filler panels installed during operation of the device.

Do not operate the device in an explosive atmosphere or where there may be flammable gases or fumes. If you must operate the device in such an environment, it must be in a suitably rated enclosure.

If you need to clean the device, use a dry cloth. Make sure that the device is completely dry and free from contaminants before returning it to service.

Operate the device only at or below Pollution Degree 2. Pollution is foreign matter in a solid, liquid, or gaseous state that can reduce dielectric strength or surface resistivity. The following is a description of pollution degrees:

- Pollution Degree 1 means no pollution or only dry, nonconductive pollution occurs. The pollution has no influence.
- Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.

- Pollution Degree 3 means that conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation.

You must insulate signal connections for the maximum voltage for which the device is rated. Do not exceed the maximum ratings for the device. Do not install wiring while the device is live with electrical signals. Do not remove or add connector blocks when power is connected to the system. Avoid contact between your body and the connector block signal when hot swapping modules. Remove power from signal lines before connecting them to or disconnecting them from the device.

Operate the device at or below the Measurement Category I[1]. Measurement circuits are subjected to working voltages[2] and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Measurement categories establish standard impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of measurement categories:

- Measurement Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS[3] voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.
- Measurement Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (for example, 115 V for U.S. or 230 V for Europe). Examples of Measurement Category II are measurements performed on household appliances, portable tools, and similar USB devices.
- Measurement Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.
- Measurement Category IV is for measurements performed at the primary electrical supply installation (<1,000 V). Examples include

[1] Measurement Category as defined in electrical safety standard IEC 61010-1. Measurement Category is also referred to as Installation Category.

[2] Working Voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

[3] MAINS is defined as a hazardous live electrical supply system that powers equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

electricity meters and measurements on primary overcurrent protection devices and on ripple control units.

Where to Go for Support

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371818B-01 Apr09

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