KEITHLEY

Application Note Series

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Migration to PCI-Based KPCI-PIO32IOA and KPCI-PDISO8A from ISA Equivalents

Introduction

New computer designs incorporate fast processors at speeds greater than 1GHz and new bus designs (PCI and AGP) that can use these fast processor speeds. Early design specifications of the nearly 25-year-old ISA bus are more and more difficult to support in cooperation with the new designs found in computers from mainstream vendors. As a consequence, computers with ISA slots are difficult to find. While industrial PC manufacturers still provide computer systems or motherboards with ISA slots, a premium is paid for these configurations. This is often the motivating factor for migration to PCI boards.

This document is for customers who currently use one of Keithley's ISA-based digital switching boards, such as the PDISO-8, PIO-32 Series, REL-16 Series, and PIO-HV. This document focuses primarily on two boards, the PDISO-8 and the PIO-32I/O.

Background Information

An ISA board (Industrial Standard Architecture) operates on a 16-bit, 3 to 8MHz bus, while a PCI board (Peripheral Component Interconnect) operates on a 32-bit, 33MHz bus. This allows a PCI device to take advantage of the Pentium's faster processor speeds to transfer data at a faster rate.

At the same time, the newer bus has implemented changes in configuring and installing boards. Configuring a board on the ISA bus involves configuring DIP switches and/or jumpers to match the board's features and parameters to the PC resources. Configuring a board on the PCI bus is done automatically by the PC via its "plug and play" capabilities. Because the PC allocates resources, there are no DIP switches or jumpers to set.

When migrating from an ISA board to a PCI board, selecting hardware is only part of the challenge. Depending on the current circumstance (i.e., operating system, existing and future needs, and programming language interface) migration can either lead to many long frustrating days or just a few hours of updates and programming changes. The reason for this is the way the PC communicates with these boards across their respective buses. ISA boards are "I/O mapped" and are mostly used in a DOS environment, and PCI boards are "memory mapped" and are mostly used in a Windows® environment.

Because the migration from an ISA board to a PCI board is not a trivial task to complete, Keithley offers a wide range of digital I/O PCI boards to address a wide variety of applications. The next few pages concentrate on two of these digital I/O boards, examine some digital I/O applications using these PCI boards, and help make the transition from a PIO-32IO to a KPCI-PIO32IOA or from a PDISO-8 to a KPCI-PDISO8A.

An Overview of Keithley's Digital I/O Offering

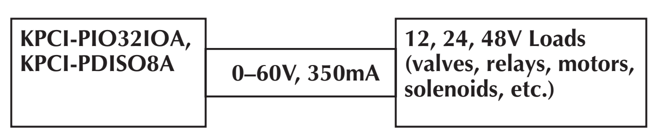
The PCI bus-based KPCI-PIO32IOA offers 32 lines of optically isolated digital I/O (16 inputs/16 outputs). The KPCI-PDISO8A offers 16 lines of optically isolated digital I/O (8 inputs/8 outputs). These boards can directly switch and sense up to 60V, 350mA, which makes them ideal for controlling industry standard 12V, 24V, and 48V loads. These new boards expand Keithley's offering of PCI digital I/O boards by filling the gap between the TTL solution (5V, 64mA) and the external signal conditioning relay solution (220V, 3A). The external interrupt and latching capability of the KPCI-PIO32IOA and KPCI-PDISO8A is ideal for synchronizing digital inputs with other signals in the system. These boards also serve as a replacement for the PIO-32I/O and PDISO-8 ISA boards.

The following describes three applications that use plug-in digital I/O boards as well as the boards' unique benefits:

Application 1:

This application requires isolated digital I/O that will perform the following:

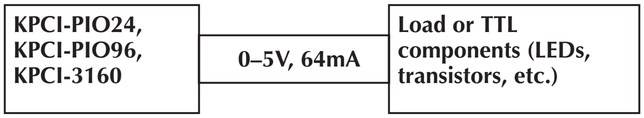
1. Provide optical isolation for noise immunity, safety, and computer protection.
2. Directly switch and sense up to 60VDC, 350mA.
3. Connect directly to a load without costly external relays and the additional space required to mount them.



Keithley's Solution: KPCI-PIO32IOA or KPCI-PDISO8A

Application 2:

The application must interface TTL/NMOS/CMOS digital I/O with a 0–5V range to LEDs and relays.

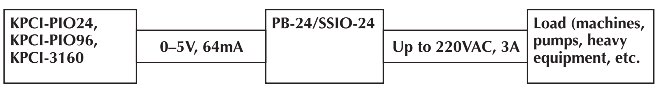


Keithley's Solution: KPCI-PIO24, KPCI-PIO96, or KPCI-3160

Application 3:

This application needs to interface industry standard external solid-state relays with:

1. Optical isolation for the solid-state relays.
2. High voltage, high current control and sense.
3. Line switching up to 220VAC, 3A.
4. Channel count up to 96 channels.



Keithley's Solution: KPCI-PIO24, KPCI-PIO96, or KPCI-3160 with PB-24 or SSIO-24

Comparison of the KPCI-PIO32IOA to the PIO-32I/O

The KPCI-PIO32IOA board offers several advantages over its ISA counterpart, the PIO-32I/O. The PCI board has solid-state relays instead of mechanical relays, which require routine maintenance. The PCI board offers shielded interface cables with 18 twisted pairs that provide enhanced noise immunity and improved data transfer over the ISA board's ribbon cable. The PCI board has optically isolated, non-polarized inputs and outputs, while the ISA board has optically isolated, polarized inputs and electromechanical outputs. The chart below lists more features and comparisons.

FEATURE	PIO-32I/O	KPCI-PIO32IOA
Outputs	16 electromechanical	16 solid-state, optically isolated, non-polarized
Ratings	10W max at 0.5A or 30Vrms, 42VACp-p	350mA load current, 60VDC, 42VACp-p
Type	16 SPST Form A, N.O.	16 SPST N.O. Form A
Contact Life Rating	1,000,000,000 mechanical operations	> 1,000,000,000 operations
On/Off Time	2.0ms	3.0ms
Inputs	16 solid-state, optically isolated, polarized	16 solid-state, optically isolated, non-polarized
Input Range	3.5–28VDC	0–60VDC or 10–42VAC p-p (50 and 60Hz)
AC Sensing	No	Yes
External Interrupt/ Latching Capability	No	Yes

Comparison of the KPCI-PDISO8A to the PDISO-8

The KPCI-PDISO8A board offers several advantages over its ISA counterpart, the PDISO-8. The PCI board has solid-state relays instead of mechanical relays, which require routine maintenance. The PCI board offers shielded interface cables with 18 twisted pairs that provide enhanced noise immunity and improved data transfer over the ISA board's ribbon cable. The PCI board has optically isolated, non-polarized inputs and outputs, while the ISA board has optically isolated, polarized inputs and electromechanical outputs. The chart below lists more features and comparisons.

FEATURE	PDISO-8	KPCI-PDISO8A
Outputs	8 electromechanical	8 solid-state, optically isolated, non-polarized
Ratings	3A @ 125VACrms	350mA load current, 60VDC, 42VACp-p
Type	5 SPDT Form C, 3 SPST Form A, N.O.	8 SPST, Form A, N.O.
Contact Life Rating	Min 10,000,000 mechanical operations	> 1,000,000,000 operations
On/Off time	20ms	3.0ms
Inputs	8 solid-state, optically isolated, non-polarized	8 solid-state, optically isolated, non-polarized
Input range	5-24VDC or VAC (50-1,000Hz)	0-60VDC or 10-42VAC p-p (50 and 60Hz)
AC Sensing	No	Yes
External Interrupt/ Latching Capability	No	Yes

Comparison Summary

1. Solid-state relays have a much longer life when compared to mechanical relays because there are no moving mechanical parts to wear out. The life of a solid-state relay is also extended because the contacts do not arc. Mechanical relays "arc," shortening their lives. This innate product enhancement decreases maintenance cost by virtually eliminating the need to replace worn out mechanical relays.
2. Solid-state relays are never completely open-circuit because of the off-state leakage current. While this leakage current is extremely low (<1µA), this could be enough current to cause some equipment to be energized when the solid-state relays are in an off state.
3. The new KPCI-PDISO8A and KPCI-PIO32IOA have an external interrupt that is capable of latching digital inputs or of notifying an application that a change of state has occurred at the IRQ line. This enables these boards to be synchronized with other processes and signals in the control system. This feature is not available for either the PIO-32I/O or the PDISO-8.
4. The mating connectors for the PCI boards use a 36-pin IEEE-1284CC mini-Centronics connector that provides a

more convenient and robust snap-on connection, has a high level of noise ejection, is shielded, and improves the transfer of data.

5. The wiring connections must be changed when changing from a PIO-32I/O to a KPCI-PIO32IOA or from a PDISO8A to a KPCI-PIO32IOA. It will be necessary to rewire the fixture with a STP-36 instead of the STP-37/FC and order a mating cable, CAB-1284CC-0.5 (0.5 meter cable) or CAB-1284CC-2 (2 meter cable).
6. The PIO-32I/O inputs are 28V while the KPCI-PIO32IOA can handle up to 60V, which is ideal for all 12V, 24V, and 48V loads.

Comparison of Other Digital I/O ISA Boards to the KPCI-PIO32IOA/ PDISO8A

If the application is currently using a REL-16 Series board and needs to move to a PCI digital I/O board, consider using a KPCI-PIO32IOA. The REL-16 has 16 electromechanical Form A (SPST-NO) relay outputs. The KPCI-PIO32IOA offers the advantage of optically isolated solid-state relays, which require less maintenance and replacement than electromechanical relays, robust connectors, and cables with shielded twisted pairs for better noise immunity and better data transfer rates. The KPCI-PIO32IOA can also synchronize the input data with other processes and signals in the control system.

I/O Register Maps

Because both boards have a base address, the existing program can remain intact, but the base address needs to be changed to match the current PCI board base address. Before doing this, be aware of the following: the address mapping between the ISA board and the PCI board are identical for the PIO-32I/O but slightly different for the PDISO-8. See the charts below:

BASE Address +	PIO-32I/O	KPCI-PIO32IOA
0	Port A Isolated Outputs (Read Only)	Port A Isolated Inputs (Read Only)
1	Port B Isolated Outputs (Read Only)	Port B Isolated Inputs (Read Only)
2	N/A	N/A
3	N/A	Latching Control (Read/Write)
4	Port A´ Relay Inputs (Read/Write)	Port A´ Relay Outputs (Read/Write)
5	Port B´ Relay Inputs (Read/Write)	Port B´ Relay Outputs (Read/Write)
6	N/A	N/A
7	N/A	N/A

BASE Address +	PDISO-8	KPCI-PDISO8A
0	Relay Outputs (Read/Write)	Isolated Inputs (Read Only)
1	Isolated Inputs (Read Only)	N/A
2	N/A	N/A
3	N/A	Latching Control (Read/Write)
4	N/A	Relay Outputs (Read/Write)
5	N/A	N/A
6	N/A	N/A
7	N/A	N/A

The ISA board has a DIP switch selectable base address, while the PCI board has its base address assigned by computer resources via the Windows plug-n-play operating system. A “PCI sniffer” program should be used to interrogate the PCI bus to identify the board and its base address or the Device Manager under System in the Control Panel can be used. Once the base address of the PCI board is identified, insert this address into the existing program and modify the register locations to match the new address mapping. Each time a new device is added to a computer system, this can affect the base address of the board, so the base address will need to be found again. Using a technique that dynamically detects the base address of a board is recommended over the concept of trusting that the base address will always remain at the last assigned location.

Programming Options

When upgrading ISA boards to their PCI equivalents, there are four programming options to consider:

OPTION 1: The application is currently using DriverLINX® in a Windows environment.

If the application is already using Keithley’s DriverLINX device drivers in a Windows environment, all that needs to be done is to load the DriverLINX drivers for the new board, configure the board, change the driver name from “KMBPIO” to ”KPCIISO,” and assign the correct device number to the new board in the DriverLINX Configuration Panel. The new driver resolves any differences in the register locations that the board may have. The application will still read and/or write to the same digital channel. This is an example of how DriverLINX protects users’ software investment with its hardware independent API (application programming interface). This same code could be used with a totally different series of board, provided that the board supports the digital I/O subsystem.

OPTION 2: The application is in a Windows environment, but doing register control with the ISA board.

There is no need to load the DriverLINX device drivers to continue port calls in Windows. To account for the register differences between the PDISO-8 and the KPCI-PDISO8A, locate the base address by using a PCI sniffer tool. The Device Manager could also be used to find the base address of the board. If another piece of hardware is added, it is possible for the base address to move, so verify the base address after installing new hardware by using a PCI sniffer tool or the Device Manager. See the section titled "I/O Register Maps" for more information.

OPTION 3: Upgrading from a DOS environment to a Windows environment.

Use Keithley's 32-bit DriverLINX device drivers for Visual Basic, C/C++, and Delphi, which include ActiveX and DLL interfaces. If starting from a clean slate, see our website, www.keithley.com, or the DriverLINX CD that is provided with the board for sample programs using these ActiveX and DLL interfaces.

OPTION 4: Using DOS with INP and OUTP commands (DriverLINX is not needed).

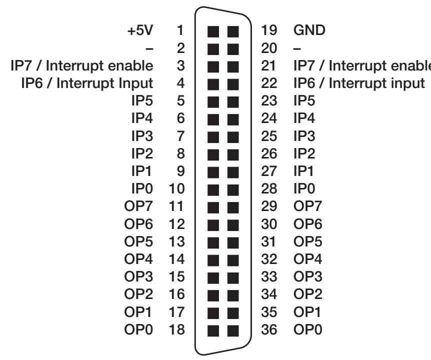
Here's a simple DOS example program, written in QBASIC 4.5 for the PIO-32I/O ISA board and KPCI-PIO32IOA PCI board, that reads from the input channels and writes to the output channels. See the "I/O Register Maps" section for more information about the register maps.

```
CLS
Print
B = &H300
PA = INP(B)           'INPUT BITS P0 TO P7
PB = INP(B + 1)       'INPUT BITS P8 TO P15
PC = B + 4            'OUTPUT BITS P16 TO P23
PD = B + 5            'OUTPUT BITS P24 TO P31
'READS PORT A
Print "PORTA has an input value of "; Hex$(PA)
Print
'READS PORT B
Print "PORTB has an input value of "; Hex$(PB)
Print
OUT PC, 0
Print "BITS 0 to 7 are OFF"
SLEEP (2)
OUT PC, 255
Print "BITS 0 to 7 are ON"
SLEEP (2)
OUT PD, 0
Print "BITS 8 to 15 are OFF"
SLEEP (2)
OUT PD, 255
Print "BITS 8 to 15 are ON"
SLEEP (2)
OUT PC, 0
Print "BITS 0 to 7 are OFF"
SLEEP (2)
OUT PD, 0
Print "BITS 8 to 15 are OFF"
SLEEP (2)
```

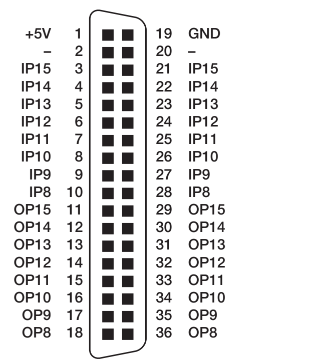
Pin Assignments and Connector Information for the KPCI-PDISO8A and KPCI-PIO32IOA

Note the following if using the KPCI-PIO32IOA:

Each connector only contains 8 digital inputs and 8 digital outputs. To use 16 digital inputs or 16 digital outputs, two mating cables (CAB-1284CC-0.5 or CAB-1284CC-2) and two STP-36 screw terminals are required.



Top Connector



Bottom Connector (KPCI-PIO32IOA only)

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