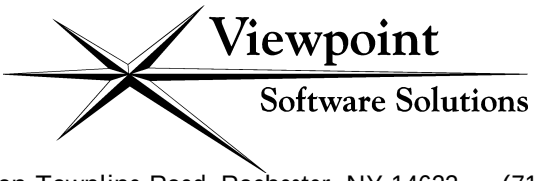
DIO-128 User Manual

State Change Monitoring System



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DIO-128 User Manual Table of Contents

1. Introduction

The DIO-128 state change monitoring system combines an intelligent plug-in data acquisition (DAQ) card with customized driver and application software. The DIO-128 card provides 128 TTL-compatible digital lines for a wide variety of high speed and high channel count digital applications. The supplied software includes a LabVIEW® user interface and digital signal processing (DSP) code specialized for time-interval measurements and state change monitoring.

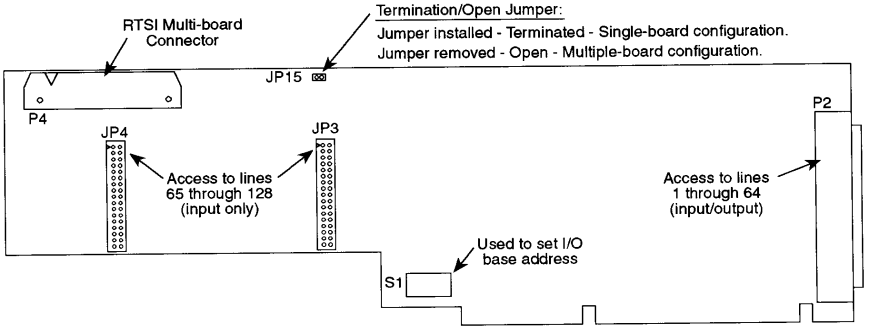
DIO-128 features include:

- High speed: The DIO-128 is designed to measure time intervals as short as 500 nanoseconds.
- High channel count: The DIO-128 gives you the ability to group boards together for large system timing analysis problems. The high channel density per slot allows for easy PC system configuration. The maximum number of boards in the system is only restricted by the number of free slots available in the PC.
- Intelligence: The onboard Analog Devices 2181 16 MHz DSP with 16 kword data and 16 kword program memory is capable of 32 MIPS. The large data memory space allows for a FIFO of approximately 16,000 words, alleviating many Windows™ programming problems.
- RTSI® interface: This hardware bus allows for accurate triggering and timing between combinations of DIO-128s and other RTSI compatible data acquisition cards.
- Compatibility: The DIO-128 can be used with all signal conditioning options available for National Instruments' AT-DIO-32F™ as well as Viewpoint Software's OPTO-2300 digital isolation module.
- Driver software included: All the software you need to use the board with LabVIEW to create high-level applications is included (DSP control program, Windows interface DLL, LabVIEW VIs).
- Examples: A large list of LabVIEW example VIs provide a great starting place for a variety of applications.

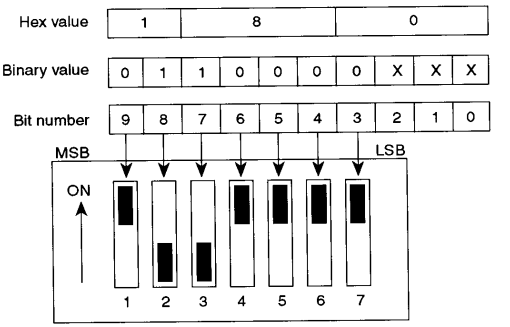
2. Getting Started

Hardware Configuration

The DIO-128 is based on Dataq Instrument's DI-660 digital I/O board. The DI-660 is an I/O mapped device requiring eight bytes of I/O address space in the range from 100 (hex) to 3F0 (hex). A 100-pin connector on the back of the board and two 34-pin connectors (JP3 and JP4) on the board provide the signal interface.



The I/O base address for the DI-660 is set with the switches of the S1 switch block. These switches represent bits 3 throug of the base address (bits 0 through 2 do not matter) and are used to turn an address line either on or off. Valid I/O base addresses are from 100 (hex) in increments of 8. A switch in the ON position selects a 0 for the bit it represents. A switch the OFF position selects a 1 for the bit it represents. The value of an address line exists only when the switch is OFF. The following example illustrates a base address setting of 180 (hex).



Refer to the I/O Connector Pinouts section on page 22 for pin descriptions.

The board setting of 180 (hex) is the default board address. Before installing the board in your computer, make sure that the selected I/O space is free. If the space is not free, error -7 will occur when you run the DIO128 Load.vi.

Recommended cabling for this board includes a National Instruments NB5 cable to interface from the P2 connector on the back of the DIO-128 board to a pair of CB-50s. Connect a 34-pin straight-through cable to JP3 and JP4 to interface the high channels of the DIO-128 to 34-pin termination blocks. All of these cables and termination blocks are available through Viewpoint Software.

Installing the Software

The DIO-128 software requires 1.5 megabytes of free hard disk space. The software is installed with a Windows setup program as follows:

1. Place the DIO-128 diskette in a 3.5" floppy drive.
2. Start Windows.
3. For Windows 3.1 and Windows for Workgroups 3.11, open the Program Manager and select File\Run from the menu bar. For Windows 95, select the Start button and choose Run.
4. Use the following table to determine which setup program to run:

	LabVIEW Version	
Windows Version	16-bit LabVIEW 4.0 or LabVIEW 3.xx	32-bit LabVIEW 4.0
Windows 3.1 and Windows for Workgroups 3.11	A:\DIO128\SETUP	N/A
Windows 95	A:\DIO128\SETUP	A:\DIO12832\SETUP

A destination path for the files will be requested. The default path is C:\DIO128.

Installed Files

The following files are copied to your system when the setup program is executed.

DIO128.DLL, DIO12832.DLL
Depending on the installation program that is run, one of these DLLs is copied to the System directory under the current version of Windows. This DLL is needed for the software to communicate with the DIO-128 board.

STATECHG.BNM
This file contains DSP code that is downloaded to the DIO-128 with the DIO128 Load.vi. This file is also copied to the System directory under the current version of Windows.

DIO128.LLB, DIO12832.LLB
Depending on the installation program that is run, one of these LLBs is installed on your system. This file is a LabVIEW VI library that contains the driver VIs described in the Driver VIs section on page 13.

README.TXT
Please review this file for last minute additions and changes.

The following files are found in the EXAMPLES directory:

DIOEXMPL.LLB
This file is a LabVIEW library that contains the example VIs described in the Examples section on page 18.

DIOTOOLS.LLB
This file is a LabVIEW library that contains tools for use with the DIO-128 board. The VIs in the library are described in the Utility VIs section on page 19.

System Setup Verification

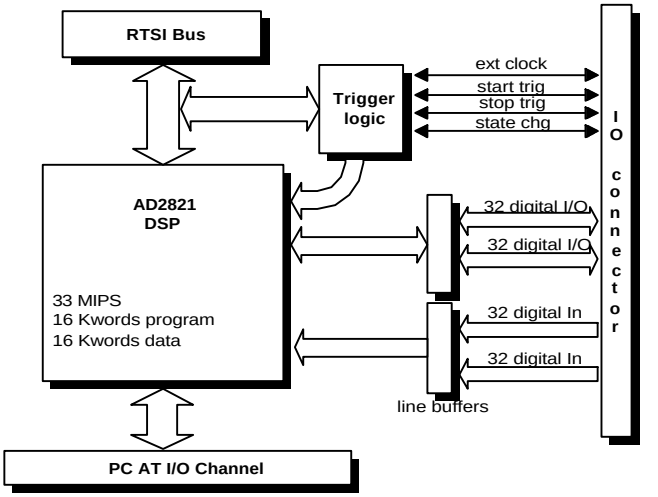
When the installation is completed, you can test your setup. Perform the steps below to verify that your system is properly installed.

1. Start LabVIEW
2. Open and run the file Simple One Channel.vi which is located in \DIO128\EXAMPLES\DIOEXMPL.LLB.
3. Toggle the digital input lines either by using a function generator or by temporarily grounding one of the digital I/O lines by connecting it to pin 17. If the graph is set to show the bit being toggled, the graph should display the state change and old state. For instance, if a bit is triggered from high to low, the right side of the graph will show a state change from high to low. Previous to this state change, a high signal will be displayed.

If you experience any problems, refer to the Troubleshooting section starting on page 26.

3. Theory of Operation

DIO-128 Block Diagram



Overview

The board used by the DIO-128 state change monitoring system is a high channel count, intelligent board capable of solving many types of digital acquisition tasks. The onboard DSP allows the board to handle tasks that would be difficult or impossible to accomplish by relying only on the main PC CPU. The DIO-128 hardware was designed to be used in conjunction with other data acquisition hardware with extensive clocking/triggering options via RTSI and external connections. In order to acquire state change data from more than 128 channels of digital data, the DIO-128 has been designed to allow multiple boards to work together to handle larger state change problems.

DSP

The Analog Devices ADSP-2181 DSP is the heart of the DIO-128 system. It controls every aspect of the digital acquisition process. The DSP internally doubles its 16 MHz clock to provide 32 MIPS sustained performance and it allows for single cycle interrupt latency. The ADSP-2181 has 16k words of on-chip instruction RAM and 16k words of on-chip data RAM. The DIO-128 communicates between the ADSP-2181 and the host PC through the DSP's DMA port and the PC's I/O bus.

The DSP control program is not hard coded into the system. It is loaded through a simple loader before starting any application. After loading, the control program is started and a verification step is performed to ensure that the host and DIO-128 are communicating properly.

The control program defines the operation of the DIO-128 system. This particular system is designed for digital state change monitoring. There are a large number of other digital acquisition problems that could be solved with the DIO-128 and the correct control program. Viewpoint Software can provide other custom solutions. Please feel free to contact us with your unique digital acquisition problems.

Board I/O

Digital Channels

The digital channels are organized into eight 16 channel ports (A through H).

Port	A	B	C	D	E	F	G	H
Connector	P2	P2	P2	P2	JP4	JP4	JP3	JP3

Connector P2 is the 100-pin rear connector, connector JP4 is the 34-pin connector under the RTSI connector, and connector JP3 is the 34-pin connector closest to the rear connector (P2).

The DIO-128's 128 digital channels are interfaced through transceivers that latch the current state of all inputs with the digital scan clock, ensuring that a scan will not show any timing skew. These transceivers expect TTL level inputs and are pulled high through 4.7 kΩ resistors.

External Clocking/Triggering

The DIO-128 provides for external connections to the digital scan clock and the start and stop triggers. These connections are pulled high through 4.7 kΩ resistors.

RTSI

The DIO-128 includes a RTSI connector to provide multiple board synchronization and triggering. The DIO-128 can source or sink its digital scan clock and start and stop triggers over the RTSI connection. RTSI trigger 1 is a special open collector connection for use with multiple DIO-128 boards. This line is pulled high through a pull-up resistor on the master DIO-128. Any board that wishes can pull the line low and all boards will see the change.

RTSI Trigger #	Use
0	digital scan clock
1	DIO-128 voting line, open collector
2	start trigger
3	stop trigger
4	general purpose

The RTSI connector mirrors any activity on the clocking/triggering connections of the DIO-128. For instance, if the board has been configured for internal clocking, the digital scan clock is presented on RTSI trigger 0. If the board has been configured for an external start trigger, that trigger is presented on RTSI trigger 2.

Please note that the DIO-128 cannot disconnect fully from the RTSI connections. The system should not be configured so that multiple

boards are attempting to drive the same RTSI trigger line. When the DIO-128 is stopped, all RTSI connections are forced to be inputs.

State Change Control Program

Basic Operation

The state change DSP control program (STATECHG.BNM) that is included with this system performs high speed digital sampling and logs data only when certain channels (per channel mask) have changed. Whenever one or more digital channels have changed, data from all channels and a timestamp are queued in a FIFO. The host can monitor the status of the acquisition and pull data out of the FIFO without disturbing the digital acquisition.

With the state change control program provided, the DSP on the DIO-128 handles two concurrent tasks. The highest priority task is the digital acquisition task which monitors the digital channels and trigger lines. This task is driven by an onboard timer or externally through the external clock or RTSI trigger 0. The other task handles communication with the host PC application.

Modes of Operation

An acquisition run can consist of one or more of the following options, depending on the mode of operation:

	Mode	
Options	Simple	Master/Slave
Basic	X	X
DAQ Clock Modulo	X	X
Start Trigger		X
Stop Trigger		X

From the table above, choose one of the modes listed below:

- Simple: The simple mode allows for single DIO-128 board operation only. This mode does not monitor for timestamp overflow.

- Master/Slave: The master/slave mode allows for single or multiple DIO-128 board synchronized operation. This mode offers more functionality at a slight performance cost. This mode always checks RTSI trigger 1 for state changes. This mode monitors for timestamp overflow and introduces extra scans if necessary. The master DIO-128 board is determined by convention to be the DIO-128 board that is providing the digital scan clock. The slave DIO-128 boards typically use RTSI trigger 0 for the scan clock.

From the table above, choose one or more of the options listed:

- Basic: Basic state change monitoring only
- DAQ Clock Modulo: Drives the RTSI Trigger 4 line with a modulo of the DIO-128 scan clock
- Start Trigger: Waits for a start trigger before starting
- Stop Trigger: Acquires data until a stop trigger is received

The simple acquisition mode removes any overhead involved with monitoring the DIO-128 multi-board state changed RTSI line (RTSI trigger 1) allowing for increased sampling rates.

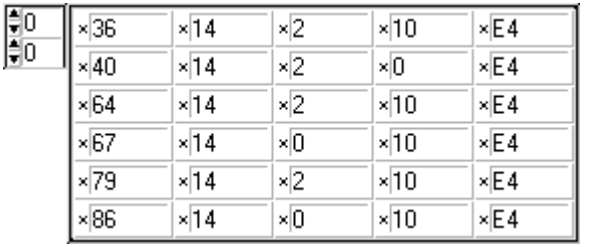
Data Format

The data is read back from the DIO-128 as an array of scans of U16 integer words. The first two words of the array are the timestamp for that scan, least significant word first. The remaining words are the actual data on the digital inputs at the time the scan was acquired.

In order to ensure that the initial state of all digital channels is known, the state change control program will always acquire a scan of the digital input channels when acquisition begins.

Note that timestamps are the number of digital scan clock ticks that have occurred from the start trigger. When in the master/slave mode, the control program also will force a scan at timestamp wrap, which is at 0x7FFFFFFF. This guarantees that the host acquisition application will see at least one scan in every timestamp period.

For instance, the following data are from a 3-port DIO-128 state change acquisition run, with a scan rate of 200 kHz:



0	×36	×14	×2	×10	×E4
0	×40	×14	×2	×0	×E4
	×64	×14	×2	×10	×E4
	×67	×14	×0	×10	×E4
	×79	×14	×2	×10	×E4
	×86	×14	×0	×10	×E4

Here are 6 scans with 5 words of information. The first two columns in the array are the timestamps. The remaining columns correspond to the data on the ports used for this acquisition run. You can see that:

At timestamp	with this data	this happened	at time (secs)
0x00140036	0x00E400100002		6.553870
0x00140040	0x00E400000002	bit 20 (B8) off	6.553920
0x00140064	0x00E400100002	bit 20 (B8) on	6.554100
0x00140067	0x00E400100000	bit 2 (A2) off	6.554115
0x00140079	0x00E400100002	bit 2 (A2) on	6.554205
0x00140086	0x00E400100000	bit 2 (A2) off	6.554270

*** Note: (decimal_timestamp) / (scan rate in Hz) = time in seconds

For a VI that converts data from the DIO-128 to timestamps and boolean or word data, refer to the Separate Data.vi utility in the EXAMPLES\DIOTOOLS.LLB file.

Multiple DIO-128 Boards

In order to acquire state change data from more than 128 channels of digital data the DIO-128 has been designed to allow multiple boards to work together to handle larger state change problems. When using multiple DIO-128 boards, you must select the master/slave mode. The master DIO-128 is designated as the board which supplies the timing signals to the other boards (slaves). RTSI trigger 1 serves as a “voting” line which each DIO-128 asserts if it has detected a state change. At the end of the sampling period, all boards check this line and save the current sample if any board has asserted the RTSI trigger 1 line.

For proper operation, the host PC application must use some care with the sequence in which it programs the various boards in the system. The typical scenario is as follows:

1. Make sure all boards are stopped.
2. Program the start options on any slaves.
3. Program the start options on the master DIO-128.
4. Start data collection.
5. Check the status on the master; see if the FIFO contains any data.
6. Read the FIFO on the master.
7. For each slave, check the status and use the status and the master's number of scans for the read.
8. Repeat steps 4 through 7 until finished collecting state changes.
9. Stop the master.
10. Stop all the slaves.

Refer to the Simple Two Board.vi for an example of this operation.

Using RTSI with DIO-128 Boards

The RTSI interface opens up opportunities for mixing DIO-128 boards with other acquisition hardware. There are a large number of acquisition boards available with RTSI connections. It is possible to combine digital and analog acquisition to provide a hybrid data monitoring system. In these scenarios, the DIO-128 might provide the analog scan clock via RTSI trigger 4. The state change control program can clock RTSI trigger 4 as a divided down digital scan clock. Another possibility would be to have the RTSI capable analog acquisition card provide the digital scan clock and/or start and stop triggers.

Refer to the DIO128 with Analog RTSI.vi for an example of this operation.

4. Software Reference

Driver VIs

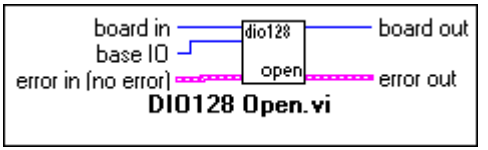
These VIs are arranged in the order in which you will typically execute them. For examples on how to use these VIs, open any of the examples provided with this package.

The following four parameters are found in each VI that is described in this section. There are two board number parameters and two error parameters associated with each VI.

- board in is a user defined value between 0 and 7 that is used as a handle to the particular digital board. The board number is assigned in the DIO128 Open.vi and all subsequent VIs reference the physical board via this board number.
- board out is a flow-through parameter which is the same as board in.
- error in (no error) is a standard error cluster input. This cluster includes a status boolean that indicates whether or not an error has occurred previous to this VI, a 32-bit error code that lists the error number that occurred before this VI was called, and a source string which shows which previous VI caused the error.
- error out is a standard error cluster output. This cluster includes a status boolean that indicates whether or not an error occurred, a 32-bit error code that lists the error number that occurred, and a source string which shows the VI that caused the error.

DIO128 Open.vi

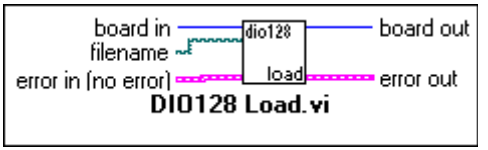
This VI initializes the selected DIO-128 board.



U16 base IO is the base I/O address of the DIO-128 board. The default base I/O address is 180 hex.

DIO128 Load.vi

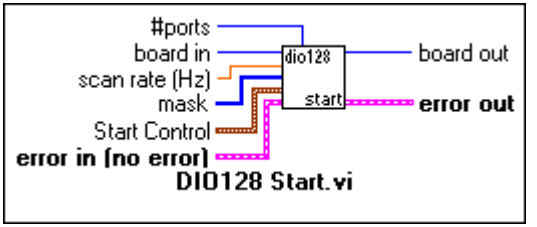
This VI loads the desired DSP code onto the DIO-128 board.



filename is the filename of the DSP code image. The default filename is STATECHG.BNM. If the file is not found where specified in this control, the system searches for this file in the \WINDOWS and \WINDOWS\SYSTEM directories.

DIO128 Start.vi

This VI starts the acquisition on the digital I/O board. If you have multiple DIO-128 boards connected via the RTSI connector, start the master board last. See the State Change Control Program section on page 9 for a definition of master board.



U8 #ports is the number of 16-bit ports that will be processed during the monitoring of the scans. A value of 1 indicates port A is processed, a value of 2 indicates ports A and B are processed, etc. Valid values are between 1 and 8.

DBL scan rate is the scan rate of the digital board in Hz. The minimum scan rate possible is 256 Hz.

mask is an array of U16 numbers representing the mask of bits to be sampled. A '1' in a bit position indicates that the bit should be sampled. Each element of the array represents a 16 bit port on the digital card. Element 0 corresponds to port A, element 1 corresponds to port B, etc.

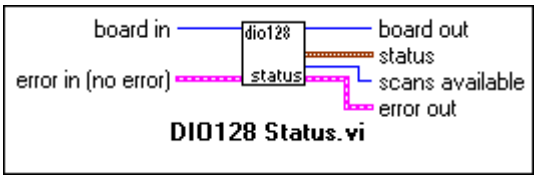
Start Control is a cluster specifying advanced clocking and triggering options. See the Advanced Control section on page 23 for information about these advanced features.

- flags
  Enum Values:
  - simple (0) - single board with no external connections
  - master/slave (1) - RTSI or external connections
- clock control
  Enum Values:
  - internal (0) - internal clock base
  - external (1) - clocked via pin 20 of P2 (rear) connector
  - RTSI 0 (2) - clocked via RTSI Trigger0 line
- start trigger
  Enum Values:
  - none (0) - starts immediately
  - internal (1) - Future expansion: do not use this option
  - external (2) - triggered with low level signal applied to pin 24 of P2 (rear) connector
  - RTSI 2 in (3) - triggered via RTSI Trigger2
- stop trigger
  Enum Values:
  - none (0) - stops immediately upon DIO128 Stop.vi execution
  - internal (1) - Future expansion: do not use this option
  - external (2) - triggered with low level signal applied to pin 25 of P2 (rear) connector
  - RTSI 3 in (3) - triggered via RTSI Trigger3
- DAQ clock modulo - divisor of the DIO-128 scan clock applied to RTSI Trigger4. A modulo of 0

indicates that no clock is applied to the RTSI Trigger4 connector.

DIO128 Status.vi

This VI checks the status of the selected digital I/O board.



status is a cluster containing information about the current status of the digital card. This cluster needs to be passed to the DIO128 Read.vi. The parameters of interest are as follows:

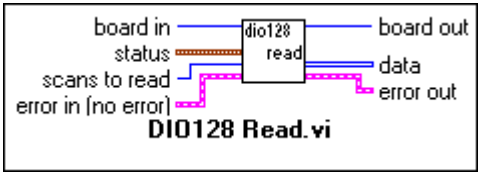
- Time0 is the low byte of the time elapsed. This is the first element of the cluster.
- Time1 is the high byte of the time elapsed. This is the second element of the cluster.
- portCount is the number of ports currently being scanned. This is the third element of the cluster.

All other variables in this cluster are for internal use only.

scans available is the number of scans stored in the buffer since the last read. A scan occurs whenever a monitored bit transitions from low-to-high or high-to-low.

DIO128 Read.vi

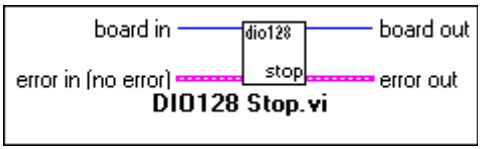
This VI reads transition data from the selected digital I/O board as 16-bit words.



- status is a cluster of status information. This data should be input from a previous status read. See DIO128 Status.vi for a description of the status parameters.
- scans to read is the number of scans to read from the digital I/O board. This field should be passed in from a previous DIO128 Status.vi.
- data is the actual data read from the digital I/O board. The data is passed back as a two-dimensional array of U16 numbers. See the Data Format section on page 10, for a description of the structure of the data.

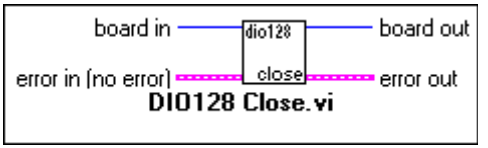
DIO128 Stop.vi

This VI stops acquisition on the selected digital I/O board. When this VI is executed, all RTSI lines in the DIO-128 System are reset to an input state, clearing all devices from driving any of the RTSI lines.



DIO128 Close.vi

This VI closes the connection to the selected digital I/O board.



Examples

These example VIs are found in \DIO128\EXAMPLES\DIOEXMPL.LLB.

Simple One Channel.vi

This VI demonstrates a common method to configure and read from the DIO-128. All monitored ports are collected and a single channel is displayed. Parameters in the section above the graph must be set before the VI is started.

Cont DIO128 to Disk.vi

This VI demonstrates how to continuously monitor and write data to a binary file. A bit mask is used and the number of state changes are monitored. All parameters, except Output Data File, must be set before running the VI.

Read DIO128 Data from Disk.vi

This VI is a reader for data collected with Cont DIO128 to Disk.vi. The file data is read and displayed in a bit pattern and a single channel is displayed graphically. The speed of playback is adjustable and the scan number and corresponding time are shown. The port and bit to view on the graph must be set before running the VI.

DIO128 with Analog RTSI.vi

This VI demonstrates simultaneous digital and analog input acquisition with synchronization through the RTSI bus. The analog acquisition is clocked at a modulo of the digital acquisition. All parameters in the sections above the graph must be set before the VI is started.

Simple Two Board.vi

This VI is an example of using multiple DIO-128 boards. Timing is synchronized through the RTSI bus. Parameters in the sections above the graph must be set before the VI is started.

Utility VIs

The following VIs are located in the file \DIO128\EXAMPLES\DIOTOOLS.LLB.

Bit Mask to Word Mask.vi

This VI converts a bit mask pattern to a word mask pattern. It is useful to select the bits to sample on a bit-by-bit basis yet the DIO-128 is configured with 16-bit words. This VI provides the necessary conversion.

DIO Bit to SCXI Mod,Chan.vi

The arrangement of bits on the DIO-128 is different than that of National Instruments AT-DIO-32F. This is not significant unless you are using a channel labeled device such as the SCXI-1162/1326. In this case, you can use this VI along with the SCXI Mod,Chan to DIO Bit.vi to map the DIO-128 to the AT-DIO-32F.

DIO128 Calculate Clock Divider.vi

If you are clocking a National Instruments DAQ card through RTSI Trigger4, you can use this VI to calculate the clock divider needed. This VI will also report the actual clock frequency used for the DAQ card. See the Multiple Boards section on page 25 for a description of the clock divider.

Extract Bit.vi

Given a two-dimensional array of digital data as well as a desired bit, this VI will return a one-dimensional array of data collected on that bit.

SCXI Mod,Chan to DIO Bit.vi

This VI will map an SCXI channel to a DIO-128 channel. See also DIO Bit to SCXI Mod,Chan.vi.

Separate Data.vi

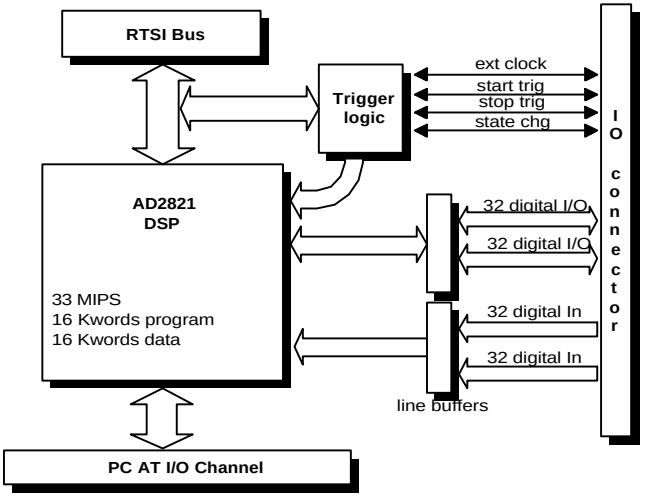
This VI separates the data returned from a DIO-128 read into an array of timestamps and a two-dimensional array of either 16-bit words or boolean bit values.

Word, Mask to Bit Values.vi

The purpose of this VI is to format the data collected with a DIO-128 to an easily readable format. The data collected will be ANDed with the selected channel mask and returned as a boolean array.

6. Hardware Reference

DIO-128 Block Diagram



JP15 Multiboard Jumper

The JP15 jumper needs to be installed on exactly one DIO-128 board. If you are using multiple boards, connect this jumper on only one board, preferably the master board (refer to the State Change Control Program section on page 9 to determine which board is the master). This jumper connects a pull-up resistor to the sample negotiation pin (RTSI Trigger1). If you have more than one resistor connected you could damage your DIO-128 boards.

I/O Connector Pinouts

Below are the pin connectors for the DIO-128 board. The bits are grouped by ports. For example, pin A0 is the connection for port A, bit

P2

A0	1	51	C0
A1	2	52	C1
A2	3	53	C2
A3	4	54	C3
A4	5	55	C4
A5	6	56	C5
A6	7	57	C6
A7	8	58	C7
A8	9	59	C8
A9	10	60	C9
A10	11	61	C10
A11	12	62	C11
A12	13	63	C12
A13	14	64	C13
A14	15	65	C14
A15	16	66	C15
GND	17	67	GND
GND	18	68	GND
SCLK	19	69	GND
ExtClk	20	70	GND
DIO Enabled	21	71	GND
Data Changed	22	72	GND
GND	23	73	GND
Start Trig	24	74	GND
Stop Trig	25	75	GND
GND	26	76	GND
GND	27	77	GND
GND	28	78	GND
GND	29	79	GND
GND	30	80	GND
GND	31	81	GND
GND	32	82	GND
GND	33	83	GND
GND	34	84	GND
B0	35	85	D0
B1	36	86	D1
B2	37	87	D2
B3	38	88	D3
B4	39	89	D4
B5	40	90	D5
B6	41	91	D6
B7	42	92	D7
B8	43	93	D8
B9	44	94	D9
B10	45	95	D10
B11	46	96	D11
B12	47	97	D12
B13	48	98	D13
B14	49	99	D14
B15	50	100	D15

JP4

E0	1	2	E1
E2	3	4	E3
E4	5	6	E5
E6	7	8	E7
E8	9	10	E9
E10	11	12	E11
E12	13	14	E13
E14	15	16	E15
GND	17	18	GND
F0	19	20	F1
F2	21	22	F3
F4	23	24	F5
F6	25	26	F7
F8	27	28	F9
F10	29	30	F11
F12	31	32	F13
F14	33	34	F15

JP3

G0	1	2	G1
G2	3	4	G3
G4	5	6	G5
G6	7	8	G7
G8	9	10	G9
G10	11	12	G11
G12	13	14	G13
G14	15	16	G15
GND	17	18	GND
H0	19	20	H1
H2	21	22	H3
H4	23	24	H5
H6	25	26	H7
H8	27	28	H9
H10	29	30	H11
H12	31	32	H13
H14	33	34	H15

7. Advanced Control: External Clocking/Triggering

The DIO-128 has the ability to synchronize external signals and other data acquisition cards. Physically, these connections are made through the P2 (rear) connector and the RTSI connector. The software is configured via the Start Control cluster in the DIO128 Start.vi.

Clocking

Clocking refers to sampling of the digital input lines which can be accomplished internally, via an external signal, or via the RTSI bus.

For the simplest acquisition, set the clock control to internal (0). In this mode, the acquisition starts when the DIO128 Start.vi is executed and stops when the DIO128 Stop.vi is executed and samples at the clock rate specified with the scan rate (Hz) control.

Clocking via an External Signal

With External Clocking, you can control the sampling of the digital input lines with an external clock source.

To externally clock the DIO-128:

1. connect the external clock to pin 20 of P2 (rear connector)
2. set clock control in the start control cluster to external (1)
3. set flags in the start control cluster to master/slave (1)

The DIO-128 input lines are sampled whenever a high-to-low transition occurs on the external clock pin.

Clocking via the RTSI Bus

Alternately, you can clock the DIO-128 from the RTSI bus which is useful if you have multiple DIO-128 cards or if you want to drive the DIO-128 from a National Instruments DAQ card.

To clock via the RTSI bus:

1. set clock control in the in the start control cluster to RTSI 0 (2)
2. set flags in the start control cluster to master/slave (1)

Note: The timestamp returned with acquired data is in terms of clock tics. To convert these tics to seconds, you must know the scan rate.

Triggering

Triggering consists of starting and stopping the acquisition, which can be accomplished automatically, via an external signal, or through the RTSI bus.

For the simplest acquisition, set the start and stop trigger to none (0). In this mode, the acquisition starts when the DIO128 Start.vi is executed and stops when the DIO128 Stop.vi is executed.

Triggering via an External Signal

External triggering is accomplished by connecting the trigger source to pin 24 (start) or pin 25 (stop) of the P2 (rear) connector. The acquisition will start/stop when a low level signal is applied to the appropriate pin. As with the other I/O pins, the trigger lines are pulled high with a 4.7K ohm resistor.

To start the acquisition with an external trigger:

1. connect the start trigger signal to the Start Trig pin 24 of P2
2. set start trigger in the start control cluster to external (2)
3. set flags in the start control cluster to master/slave (1)

To stop acquisition with an external trigger:

1. connect the stop trigger signal to the Stop Trig pin 25 of P2
2. set stop trigger in the start control cluster to external (2)
3. set flags in the start control cluster to master/slave (1)

Triggering via the RTSI Bus

To start the acquisition via the RTSI bus:

1. set start trigger in the start control cluster to RTSI 2 in (3)
2. set flags in the start control cluster to master/slave (1)

To stop the acquisition via the RTSI bus:

1. set stop trigger in the start control cluster to RTSI 3 in (3)
2. set flags in the start control cluster to master/slave (1)

Multiple Boards

One of the key features of the DIO-128 is the ability to synchronize multiple DIO-128 boards and/or to synchronize with National Instruments DAQ cards. This synchronization is accomplished through the RTSI connector. It is important when connecting multiple boards to make sure that there is only one board driving the clock or trigger. All other boards should have the clock or trigger flags set to the RTSI connector. Also, the flags control for all boards should be set to master/slave.

If you are driving a National Instruments DAQ card, you can clock that card at a different rate than the DIO-128 by setting the DAQ clock modulo. The modulo is the divisor of the DIO-128 scan clock. For example, if you have the DIO-128 internally clocked at 100 kHz and want to acquire analog data at 1 kHz, set the DAQ clock modulo to 100. When connected in this fashion, the divided clock signal is presented on RTSI Trigger4.

Note: The DIO-128 takes control of the Trigger0 and Trigger1 lines. Do not use these lines for any other functions. Also, if you are using multiple DIO-128 boards, make sure that the JP15 jumper is installed on only one of the boards. If your setup includes a National Instruments board connected through RTSI, you still need to have one DIO-128 with a jumper installed on JP-15.

8. Troubleshooting

Error Codes

Error #	Location	Explanation
-11	All VIs	Bad handshake between DIO-128 and host computer.
-10	DIO Status	Bad status block, DSP code corrupted, running too fast for the current mode
-9	All VIs except DIO128 Open.vi	Requested Board # has not been opened
-8	All VIs	Illegal Board # - Board # must be between 0 and 7
-7	DIO Load	DSP code doesn't handshake, error during load, bad .BNM file, board not at IO location
-6	DIO Load	.BNM incorrectly formed
-5	DIO Load	.BNM incorrectly formed
-4	DIO Load	.BNM incorrectly formed
-3	DIO Load	.BNM incorrectly formed
-2	DIO Load	.BNM incorrectly formed
-1	DIO Load	.BNM file not found

Diagnostics

Problem: Whenever I open a DIO-128 VI, I am prompted to find the file DIO128.DLL.

Solution: The DLL was not installed in your WINDOWS\SYSTEM directory. There is a copy of the DLL in the \DIO128 directory. Copy this file to your WINDOWS\SYSTEM directory.

Problem: I get one of the errors listed that reports that the .BNM is incorrectly formed (errors -2 to -6).

Solution: The BNM file has become corrupt. Please reinstall the software from floppy. If there is still a problem, please contact Viewpoint Software (See Reaching Us on page 31).

Problem: When running one of the example VIs that graphically displays data, I set the digital Port to View and Bit to View but I still see no change of state on the graph.

Solution: The bit mask that appears above the graph must have this bit active (red) to see state changes in the graph. This bit mask must be set before running the VI. Also, Ports to Analyze must be set high enough to include the Port to View.

Problem: I get an error that I am trying to load a VI that was created with a later version of LabVIEW.

Solution: You are using either the 16-bit version of LabVIEW 4.0 or LabVIEW 3.1.1 or earlier and are trying to load a 32-bit version of a DIO-128 VI. Reinstall the DIO-128 software using the setup program C:\DIO128\SETUP and either overwrite all the current DIO-128 files on the hard drive or install the files to a different directory.

Problem: Upon loading a VI with DIO-128 sub VIs, I get prompted to select a library but it looks like the system is searching for

DIO128.DLL. If I point the system to DIO128.DLL, it just prompts me again. What is wrong?

Solution: You are using the 32-bit version of LabVIEW 4.0 and are trying to load a 16-bit version of a DIO-128 VI. Reinstall the DIO-128 software using the setup program C:\DIO12832\SETUP and either overwrite all the current DIO-128 files on the hard drive or install the files to a different directory.

Problem: When running the DIO-128 with Analog RTSI.vi, nothing happens when signals are applied to the analog and digital inputs and the time scale does not change.

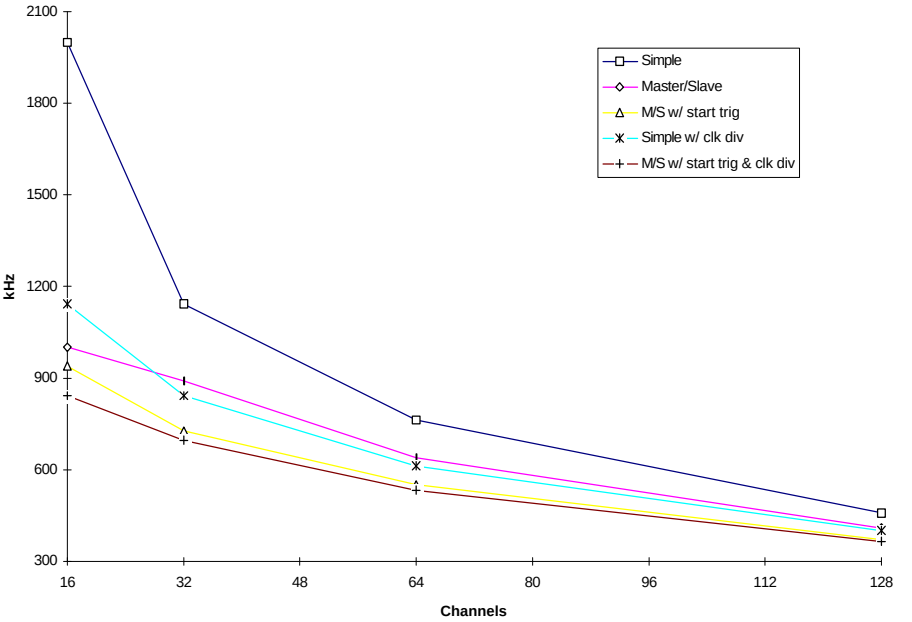
Solution: Verify that the RTSI connector is attached to the DIO-128 and the analog input board being used. Ensure that the connector is plugged in all the way.

Problem: When running the Simple Two Board.vi, nothing happens when signals are applied to the digital inputs and the time scale does not change.

Solution: Verify that the RTSI connector is attached to the DIO-128 boards being used. Ensure that the connector is plugged in all the way.

9. Technical Specifications

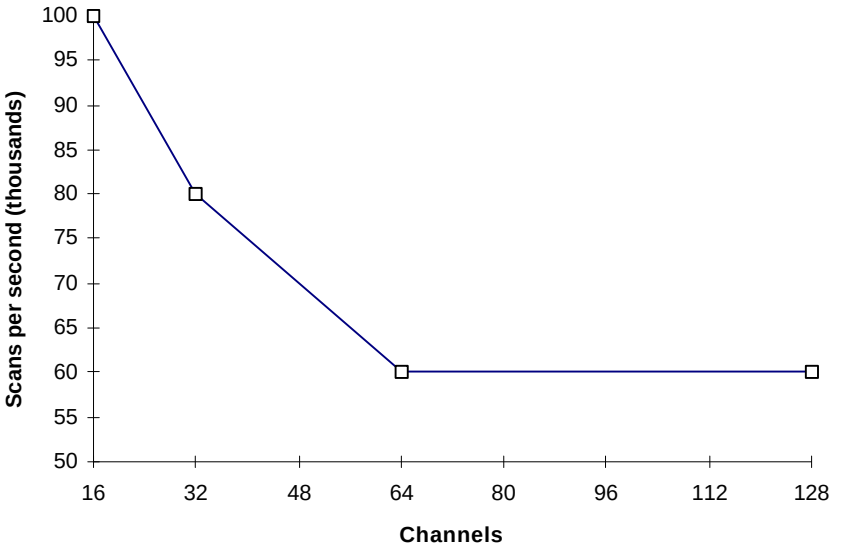
Board Sampling Rates



The chart above shows the sampling rates possible for different hardware setups using one DIO-128 board. The chart shows the rates to sample scans. Time to transfer the scans are shown below in Data Transfer Rates.

The trace designations in the legend are in reference to the options set in the Start Control cluster in the DIO128 Start.vi. Simple refers to a flags setting of simple (0) while Master/Slave (M/S) refers to a flags setting of master/slave (1). Start trig indicates that a start trigger setting of external (2) was used. Clk div indicates that a DAQ clock modulo was used to set a clock divisor on the RTSI Trigger4 line.

Data Transfer Rates



The chart above shows the number of scans per second that were transferred from the FIFO on the DIO-128 board to LabVIEW. These transfer rates were observed while running on a 166 MHz pentium machine with 32 Meg of RAM under Windows 95.

Board Specifications

Power Requirements: +5V
Operating Temperature Range: 0 to 60 degrees C
Storage Temperature Range: -40 to 100 degrees C
Humidity: 0 to 90%, non-condensing
Power Consumption: 2A @ +5V
Max I/O Line Current: Source: -15mA
Sink: 24mA

10. Reaching Us

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Technical support is available any business day from 9:00 am to 5:00 p.m. Eastern time. Of course, you may fax or e-mail questions at any time.