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Find the *National Instruments AT-DIO-32HS* at our website: *Click HERE*

High-Speed 32-bit Digital Pattern I/O and Handshaking

NI 653x

- 32 (5 V TTL/CMOS) digital input/output lines
- 20 MHz (80 Mbytes/s) maximum transfer rate
- 8, 16, or 32-bit transfers
- Start and stop triggering, pattern and change detection
- 32 MB onboard memory per data path (group) (NI 6534 only)
- NI-DAQ driver simplifies configuration and measurements

Models

- NI 6534
  - PCI-6534
  - PXI-6534
- NI 6533
  - PCI-DIO-32HS
  - PXI-6533
  - DAQCard-6533
  - AT-DIO-32HS

Real-Time

See page 142

NI Application Software

- LabVIEW
- Measurement Studio

Operating Systems

- Windows 2000/NT/Me/9x*
- Mac OS**

Applications

- Automated test equipment (ATE)
- Pattern recognition/generation
- Electronic and logic testing
- Board and chip verification
- Parallel digital communication

Accessories

See page 338

* Visit *ni.com/info* and enter winxp for the latest operating system information

**Not for all hardware



Family	Bus	Digital I/O Lines	Maximum Rate	Onboard Memory	Logic Level	Isolation	Handshaking I/O	Pattern I/O	Messaging	Triggering
NI 6534	PCI, PXI/CPCI	32	20 MHz (80 Mbytes/s for 32-bit transfers)	64 MB[2]	5 V TTL/CMOS	–	✓	✓	✓	✓
NI 6533	PCI, PXI/CPCI, ISA, PCMCIA	32	Up to 6.7 MHz[1] (pattern I/O) Up to 19.6 MHz[1] (handshaking)	–	5 V TTL/CMOS	–	✓	✓	✓	✓

[1]Rates may depend on application, computer, and software. See detailed specifications on page 344. [2]Configured as 32 MB/group.

Table 1. NI 653x Specifications Overview (see page 344 for detailed specifications)

INFO CODES

For more information or to order products online, visit *ni.com/info* and enter:

pci6534
pxi6534
pcidio32hs
pxi6533
daqcard6533
atdio32hs

BUY ONLINE!

Overview

The NI 653x devices are high-speed, 32-bit, parallel, digital I/O interfaces for PCI, PXI/CompactPCI, PCMCIA, and ISA computers. They incorporate the National Instruments DAQ-DIO ASIC, specifically designed to deliver high performance on plug-in DIO devices. The NI 653x devices perform unstrobed I/O, pattern I/O, and handshaked I/O at speeds up to 20 MHz, or 80 Mbytes/s for 32-bit transfers (NI 6534). The NI 6534 family delivers digital I/O coupled with large onboard memory for high-speed pattern I/O at deterministic rates.

Hardware

Data Latches and Drivers

The 32 digital I/O lines are divided into four 8-bit ports. For pattern I/O or handshaking, the ports can be grouped into two 8-bit or 16-bit groups, or a single 32-bit group. Each I/O line is 5 V TTL/CMOS compatible. When configured for output, each data line can sink or source up to 24 mA when set logic low or high, respectively. When configured as inputs, the 653x data lines are diode-terminated to damp line reflections.

When performing static or unstrobed I/O, you can individually configure each of the 32 I/O lines as input or output. You can also choose standard or wired-OR outputs. Wired-OR outputs sink up to 24 mA when logic low, but do not source current when logic high. Unlike standard outputs, two or more wired-OR outputs can drive a single line.

Pattern I/O and Handshaking I/O

With pattern I/O, you can input or output patterns under timing control of a clock signal. With handshaking I/O, you can interface your NI 653x to a peripheral device, and data is transferred when both the NI 653x and the peripheral are ready. See page 330 in the Digital I/O overview and page 732 in the Digital I/O tutorial for more information.

Change Detection

You can program the 653x devices to acquire data when one or more user-specified digital input lines changes state. See page 330 in the Digital I/O overview and page 732 in the Digital I/O tutorial for more information.

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High-Speed 32-bit Digital Pattern I/O and Handshaking

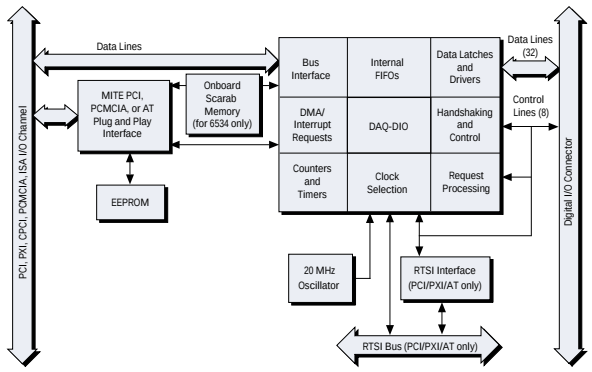


Figure 1. NI 653x Hardware Block Diagram

Messaging

You can develop event-driven application programs with NI 653x devices by programming them to generate a message when conditions you specify are met. The messages can be generated when a specified number of bytes have been transferred, when a specified input pattern is matched, or when a measurement operation completes.

Onboard Memory

The NI 6534 devices provide two groups of 32 MB of onboard memory, so you can perform pattern I/O at deterministic high rates as long as the patterns can fit in one of these memory locations. To improve system performance for repetitive pattern output applications, you can load your patterns into the onboard memory once and then output them repeatedly, without reloading them across the computer bus.

DMA Control Circuitry

The NI 653x devices for PCI and PXI/CompactPCI use the National Instruments MITE PCI interface. The MITE provides bus-master operation, PCI burst transfers, and high-performance DMA controllers for fast, continuous, scatter-gather DMA.

Multidevice Synchronization

All NI 653x devices except the DAQCard-6533 use the PXI Trigger Bus or RTSI Bus to send and receive clock and trigger signals to and from other devices in your system. Using these buses, you can create synchronized systems with large numbers of digital I/O lines, and systems in which digital I/O is synchronized with other types of measurements, including high-speed analog input, digitizers, sources, analog output, counter/timers, image acquisition, motion control, and CAN interfaces. See page 203 for more information on multidevice synchronization.

DIOD7	34	68	GND
GND	33	67	DIOD6
DIOD4	32	66	DIOD5
DIOD3	31	65	GND
GND	30	64	DIOD2
DIOD0	29	63	DIOD1
DIOC7	28	62	GND
GND	27	61	DIOC6
DIOC4	26	60	DIOC5
DIOC3	25	59	GND
GND	24	58	DIOC2
DIOC0	23	57	DIOC1
DIOB7	22	56	RGND
DIOB6	21	55	GND
GND	20	54	DIOB5
RGND	19	53	DIOB4
GND	18	52	DIOB3
DIOB1	17	51	DIOB2
DIOB0	16	50	GND
DIOA7	15	49	GND
GND	14	48	DIOA6
DIOA4	13	47	DIOA5
DIOA3	12	46	GND
GND	11	45	DIOA2
DIOA0	10	44	DIOA1
REQ2	9	43	RGND
ACK2	8	42	GND
STOPTRIG2	7	41	GND
PCLK2	6	40	CPULL
PCLK1	5	39	GND
STOPTRIG1	4	38	DPULL
ACK1	3	37	GND
REQ1	2	36	GND
+5 V	1	35	RGND

Figure 2. NI 653x I/O Connector

I/O Connector and Start-Up States

All digital I/O is through a 68-pin cable connector. See pin assignments and descriptions in Figure 2 and Table 2. You can independently select the power-on state for the control and data lines through the use of CPULL and DPULL, respectively.

Signal Names	Signal Types	Signal Descriptions
DIOAx, DIOBx, DIOCx, DIODx	data	Digital input/output lines
REQ1, REQ2, ACK1, ACK2	control	Handshaking and trigger lines
STOPTRIG1, STOPTRIG2	control	Trigger lines
PCLK1, PCLK2	control	Clock lines
CPULL, DPULL	power-up	Lines determine power-up states

Table 2. I/O Signal Connection Description

Ordering Information

NI 6534

PCI-6534* 778287-01

PXI-6534* 778288-01

NI 6533

PCI-DIO-32HS 777314-01

PXI-6533 777429-01

DAQCard-6533. 777315-01

AT-DIO-32HS* 777313-01

Includes NI-DAQ driver software.

*Windows only

For information on extended warranty and value added services, see page 22.

Recommended Configurations

Family	DAQ Device	Accessory	Cable
NI 6534	PCI-6534	SCB-68 (776844-01)	SH68-68-D1 (183432-01)
	PXI-6534	TB-2715 (778242-01)	N/A*
NI 6533	PCI-DIO-32HS	SCB-68 (776844-01)	SH68-68-D1 (183432-01)
	PXI-6533	TB-2715 (778242-01)	N/A*
	DAQCard-6533	SCB-68 (776844-01)	PSHR68-68-D1 (777420-01)
	AT-DIO-32HS	SCB-68 (776844-01)	SH68-68-D1 (183432-01)

*TB-2715 plugs directly into device; no cable required.

See page 338 for accessory and cable information.

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Digital I/O Specifications

Specifications

High-Speed Digital I/O – NI 653x

These specifications are typical for 25 °C unless otherwise noted.

Digital I/O

Number of channels ..... 32 input/output
4 dedicated output and control
4 dedicated input and status
Compatibility ..... 5 V TTL/CMOS
Hysteresis ..... 500 mV
Digital logic levels

Level	Minimum	Maximum
Input low voltage	0 V	0.8 V
Input high voltage	2 V	5 V
Output low voltage (I_{out} = 24 mA)	–	0.4 V
Output high voltage* (I_{out} = 24 mA)	2.4 V	–

*When configured as standard outputs. Drivers configured as wired-OR outputs are tri-stated (high-impedance) when logic is high.

Power-on state for outputs ..... High-impedance, pulled up or down (selectable)

Data transfers
PCI, PXI, AT ..... DMA, interrupts, programmed I/O
DAQCard ..... Interrupts, programmed I/O

Pattern I/O

Direction ..... Input or output
Modes ..... Internally or externally timed, change detection

Handshaking I/O

Direction ..... Input or output
Modes ..... 6 (burst, level-ACK, leading-edge pulse, trailing-edge pulse, long pulse, and 8255 emulation)

Performance Benchmarks

The performance benchmarks were conducted using LabVIEW or LabWindows/CVI programs and with the following computer systems:
PCI-6534 – Dell Dimension XPS T700r, Pentium II, Windows 98 SE
PXI-6534 – PXI-8170, Pentium III, Windows 98
PCI-DIO-32HS – Gateway Pentium III, Win 98 SE
PXI-6533 – PXI-8170, Pentium III, Windows 98
DAQCard-6533 – Quantex, Pentium III, Windows 98
AT-DIO-32HS – Dell Dimension XPS, Pentium III, Windows 98 SE

For pattern I/O, the benchmarks shown are the clock rates. For handshaked I/O, the time interval between transfers is not constant since both the NI 653x and the external device can pause the transfer; the benchmarks shown here present the average transfer rate rather than the sustained transfer rate. To find throughput in Mbytes/s from MHz, use the following formula:

Mbytes/s = transfer rate in MHz * number of bits / 8

The number of bits must be 8, 16, or 32. For NI 6534 devices, if the data is less than 32 MB, then the transfer rate will be 20 MHz for single-shot pattern I/O or pattern regeneration (looping) from onboard memory. In all other cases, performance depends on the computer hardware, operating system, and other programs running on the computer. Visit *ni.com/products* to access the most current benchmarks.

Single-Shot Pattern I/O – This benchmark uses the internal clock to control a transfer of finite amount of data (<32 MB) a given number of times. If the selected transfer rate is too high, an expected error will occur, and the internal clock rate is decreased until all tests pass without error.

	Input Rates (MHz)			Output Rates (MHz)		
Device	8-bit	16-bit	32-bit	8-bit	16-bit	32-bit
PCI-6534	20.0	20.0	20.0	20.0	20.0	20.0
PXI-6534	20.0	20.0	20.0	20.0	20.0	20.0
PCI-DIO-32HS	10.0	5.0	5.0	4.00	2.20	2.0
PXI-6533	10.0	6.65	5.0	5.00	2.50	2.50
DAQCard-6533	0.12	0.11	0.10	0.12	0.12	0.10
AT-DIO-32HS	1.67	0.87	0.83	1.47	0.74	0.38

Continuous Pattern I/O – The continuous pattern I/O benchmark configures the NI 653x device for continuously updated double-buffered transfer at a selected transfer rate. If the selected transfer rate is too high, an expected error will occur. The rate of transfer programmatically decreases and transfer starts again. The benchmark stops once 100 MB are transferred without error. For NI 6534 devices, the transfer rate is limited by the computer hardware and system, not the digital I/O device.

	Input Rates (MHz)			Output Rates (MHz)		
Device	8-bit	16-bit	32-bit	8-bit	16-bit	32-bit
PCI-6534	20.0	10.0	6.67	20.0	10.0	6.67
PXI-6534	20.0	10.0	6.67	20.0	10.0	6.67
PCI-DIO-32HS	10.0	5.0	3.33	4.00	1.81	1.81
PXI-6533	10.0	5.0	3.33	4.00	2.50	2.22
DAQCard-6533	0.12	0.11	0.10	0.12	0.12	0.10
AT-DIO-32HS	1.67	0.80	0.31	1.43	0.67	0.39

Continuous Handshaked I/O – The continuous burst mode handshaking benchmark configures the 653x device for burst mode protocol of the handshaking mode. The 653x device repeatedly transfers the same buffer of data in the case of output, or continuously input data into the pre-allocated buffer for a given amount of time. The average transfer rate is calculated as the total of the buffered transferred divided by the length of time. For single-shot handshaked I/O, performance is as good or better than continuous I/O.

	Input Rates (MHz)			Output Rates (MHz)		
Device	8-bit	16-bit	32-bit	8-bit	16-bit	32-bit
PCI-6534	Visit *ni.com/products* to access latest benchmarks					
PXI-6534	Visit *ni.com/products* to access latest benchmarks					
PCI-DIO-32HS	19.9	19.6	19.1	19.9	19.6	18.5
PXI-6533	19.9	19.6	19.5	19.7	18.1	9.15
DAQCard-6533	0.23	0.24	0.19	0.23	0.24	0.19
AT-DIO-32HS	1.67	0.87	0.43	1.51	0.76	0.37

Memory

6533, DIO-32HS ..... 16-sample FIFO
6534 ..... 64 Mbytes, 32 Mbytes per I/O group

Start and Stop Triggers

Compatibility ..... 5 V TTL/CMOS
Trigger types ..... Rising or falling edge, digital pattern
Pulse width for edge triggers ..... 10 ns, minimum
Pattern triggers detection capabilities ..... Detect pattern match or mismatch on user-selected bits

RTSI Triggers (PCI and AT only)

Trigger lines 7

PXI Trigger Bus (PXI only)

Trigger lines 7

Bus Interfaces

PCI, PXI ..... Master, slave
DAQCard ..... PCMCIA slave
AT ..... AT slave with dual DMA

Power Requirements

Device	+5 VDC (±5%)*	Power Available at I/O Connector
PCI-DIO-32HS, PXI-6533, AT-DIO-32HS	500 mA	+4.65 to +5.25 VDC, 1A
PCI-6534, PXI-6534	1 A	+4.65 to +5.25 VDC, 1A max
DAQCard-6533	500 mA	+4.65 to +5.25 VDC, 250 mA

*Excludes power consumed through I/O connector

Physical

Dimensions, not including connectors
PCI, AT ..... 17.5 by 10.7 cm (6.9 by 4.2 in.)
PXI/CPCI ..... 10 by 16 cm (3.9 by 6.3 in.)
DAQCard ..... Type II PC Card
I/O Connector
PCI, PXI/CPCI, AT ..... 68-pin male SCSI-II type
DAQCard ..... 68-pin female PCMCIA

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Digital I/O Specifications

Specifications

NI 653x (Continued)

Environment

Operating temperature ..... 0 to 55 °C, DAQCard should not exceed 55 °C while in PCMCIA slot
Storage temperature..... -20 to 70 °C
Relative humidity ..... 10% to 90% noncondensing

Certifications and Compliances

CE Mark Compliance CE

NI 6527

These specifications are typical for 25 °C unless otherwise noted.

Digital Input

Optically isolated input channels ..... 24, each with its own isolated ground reference
Maximum input voltage..... 28 VDC
Digital Logic Levels

Level	Minimum	Maximum
Input low voltage	0 VDC	1 V
Input high voltage	2 VDC	28 VDC

Input current
  5 V input ..... 1.5 mA/channel max
  24 V input ..... 8 mA/channel max
Isolation ..... 60 VDC channel-to-channel, and from computer

Digital Switch Output

Solid-state relay output channels..... 24, each with two terminals isolated from other channels
Relay type ..... Normally open form A solid-state relays
Maximum switching voltage
  AC..... 30 V_{rms} (42 V peak)
  DC..... 60 VDC
Maximum switching capacity, 25 °C ..... 120 mA
Common-mode isolation..... 60 VDC or 30 V_{rms} (42 V peak) channel-to-channel and channel-to-computer
On resistance..... 35 Ω maximum
Off leakage current (maximum)..... 200 nA
Relay set time (maximum)..... 3.0 ms
Relay reset time (maximum) ..... 3.0 ms
Power-on state..... Relays open by default, can be user-defined through software utility
Overcurrent protection on outputs ..... 260 mA, typical

Power Requirement

+5 VDC (±5%) ..... 500 mA, maximum
Power available at I/O connector..... +4.5 to +5.25 VDC, fused at 1 A

Physical

Dimensions (not including connectors)
  PCI-6527 ..... 17.5 by 10.7 cm (6.9 by 4.2 in.)
  PXI-6527 ..... 16 by 10 cm (6.3 by 3.9 in.)
I/O connector ..... 100-pin keyed female

Environment

Operating temperature ..... 0 to 50 °C
Storage temperature..... -20 to 70 °C
Relative humidity ..... 10% to 90%, noncondensing

Certifications and Compliances

CE Mark Compliance CE

NI 650x

These specifications are typical for 25 °C unless otherwise noted.

Digital I/O

Number of channels
  NI 6503..... 24
  NI 6507, NI 6508 96
Compatibility ..... 5 V TTL/CMOS
Power-on state..... Input
Digital logic levels

Level	Minimum	Maximum
Input low voltage	-0.3 V	0.8 V
Input high voltage	2.2 V	5.3 V
Output low voltage (Iout = 2.5 mA)	–	0.4 V
Output high voltage (Iout = 2.5 mA)	3.7 V	–

Transfer rate

Bus	Maximum with NI-DAQ Software	Typical Sustainable Rate
PCI, PXI, DAQCard, ISA	50 kbytes/s	1-10 kbytes/s
DAQPad	250 bytes/s	175 bytes/s

Note: Transfer rate depends on the computer and software. The rates may vary due to programming language and code efficiency, CPU utilization, transfer methods, and so on. Please consult the user manual for specifics. The DAQPad-650x transfer rate is dependent upon available USB bandwidth.

Handshaking 2-wire
Data transfers ..... Interrupts, programmed I/O

Bus interface

PCI, PXI, DAQCard, DAQPad, AT ..... Slave

Power Requirements

Device	+5 VDC (±5%)	Power Available at I/O Connector
6507/8 and PCI-6503	400 mA	+4.65 to +5.25 VDC, 1 A fused
DAQCard-DIO-24	15 mA	+4.65 to +5.25 VDC, 500 mA
PC-DIO-24	160 mA	+4.65 to +5.25 VDC, 1 A fused

Device	+9 to + 30 VDC	Power Available at I/O Connector
DAQPad-6507/8	150 mA at 12 VDC typical; 1 A max	+4.65 to +5.25 VDC, 1 A fused

Physical

Dimensions
  PCI-6503 ..... 12.2 by 9.5 cm (4.8 by 3.7 in.)
  DAQCard-DIO-24 ..... Type II PC Card
  PC-DIO-24..... 11.7 by 10.6 cm (4.6 by 4.2 in.)
  PCI-DIO-96..... 13.7 by 10.7 cm (5.4 by 4.2 in.)
  PXI-6508 ..... 10 by 16 cm (3.9 by 6.3 in.)
  PC-DIO-96..... 16.5 by 9.9 cm (6.3 by 3.9 in.)
  DAQPad-6507/8..... 14.6 by 21.3 by 3.8 cm (5.8 by 8.4 by 1.5 in.)
I/O Connector
  NI 6503, except DAQCard..... 50-pin male
  DAQCard-DIO-24 ..... 25-pin female PCMCIA
  NI 6508, except PC-DIO-96..... 100-pin female 0.050 series D-type
  PC-DIO-96..... 100-pin male ribbon cable

Environment

Operating temperature ..... 0 to 55 °C, DAQCard should not exceed 55 °C while in PCMCIA slot
Storage temperature..... -20 to 70 °C
Relative humidity ..... 10% to 90% noncondensing

For information on static digital I/O in the VXI form factor, refer to the VXI Solutions Product Guide.

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