

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

NI 6533, NI 6534

## NI 6533, NI 6534

**NI 6534** (Available Q1 2001)  
PCI-6534  
PXI-6534

### NI 6533

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

### Real-Time Option

Refer to 7030/6533 family, page 184.

### Digital I/O

32 (5 V/TTL) digital input/output lines  
Rates up to 80 Mbytes/s  
Two independent data paths  
8, 16, or 32-bit transfers  
Start and stop triggering  
Pattern and change detection

### Driver Software

NI-DAQ  
Windows 2000/NT/Me/9x  
Mac OS\*  
\*Not for all hardware.

### Application Software

LabVIEW  
Measurement Studio  
Lookout  
VirtualBench

### Solutions

Automated test equipment (ATE)  
Pattern recognition/generation  
Electronic and logic testing  
Board and chip verification  
Parallel digital communication  
Interface to electromechanical and solid-state relays



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	80 Mbytes/s	✓	5 V/TTL	–	✓	✓	✓	✓
NI 6533	PCI, PXI/CPCI, ISA,	32	Up to 13 Mbytes/s <sup>1</sup> (pattern I/O)	–	5 V/TTL	–	✓	✓	✓	✓
	PCMCIA		Up to 76 Mbytes/s <sup>1</sup> (handshaking)							

<sup>1</sup>Rates may depend on application, computer, and software. See detailed specifications on page 414.

**Table 1. NI 653x Specifications Overview** (see page 414 for detailed specifications)

## 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 80 Mbytes/s (NI 6534). The NI 6534 Family delivers digital I/O coupled with large on-board memories, 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-compatible. When configured for standard output, each data line can sink or source 24 mA when set logic low or high, respectively. When configured as inputs, the 653x data lines are diode-terminated to dampen line reflections.

When not using handshaking or group operations, 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 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 at a consistent rate. With handshaking I/O, you can interface your NI 653x to a peripheral device. Data is transferred when both the NI 653x and the peripheral are ready. See page 400 in the Digital I/O Overview and Tutorial for more details.

### Change Detection

You can program the 653x devices for change detection. See page 400 in the Digital I/O Overview and Tutorial for details.



For information or to buy products online, visit [ni.com/catalog](http://ni.com/catalog) and enter:

pci6534  
pxi6534  
pcidio32hs  
pxi6533  
daqcard6533  
atdio32hs

**BUY ONLINE!**

Measurements

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

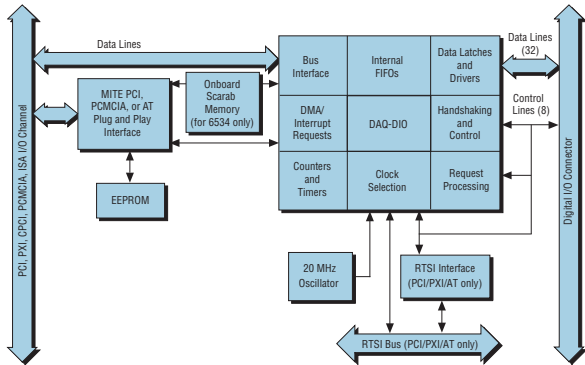


Figure 1. NI 653x Hardware Block Diagram.

## Messaging

You can create event-driven application programs with the NI 653x devices, by programming the devices 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 large onboard memories, so you can perform pattern I/O at deterministic high rates as long as patterns can fit in these memories. These devices, which are appropriate for digital board and chip testing, can easily be integrated into measurement systems with other measurements components, such as digitizers, sources, counter/timers, and image acquisition devices. To improve system performance for repetitive pattern output applications, you can load your pattern into the onboard memory and output it repeatedly, without reloading it.

## 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 DAQCards use the PXI Trigger Bus or RTSI Bus to send and receive clock and trigger signals to and from other boards in your system. Using these buses, you can create synchronized systems with large number of digital I/O lines, and systems in which digital I/O is synchronized with other types

of measurements, including high-speed analog input, analog output, counting/timing, and image acquisition. See page 266 for more information on multidevice synchronization.

## 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 Description
DIOAx, DIOBx, DIOCx, DIODx	Digital input/output lines
REQ1, REQ2, ACK1, ACK2	Handshaking lines
STOPTRIG1, STOPTRIG2	Trigger lines
PCKL1, PCKL2	Clock lines
CPULL, DPULL	Lines determine start-up states

Table 2. I/O Signal Connection Description



See page 414 for detailed product specifications.

## Ordering Information

NI 6534 (Available Q1 2001)

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 for Windows 2000/NT/Me/9x and Mac OS unless otherwise noted.

\*Windows only

Extended warranty and value added services .....page 880

## 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)	Accessory plugs directly into the board
NI 6533	PCI-DIO-32HS	SCB-68 (776844-01)	SH68-68-D1 (183432-01)
	PXI-6533	TB-2715	Accessory plugs directly into the board
	DAQCard-6533	SCB-68 (776844-01)	PSHR68-68-D1 (777420-01)
	AT-DIO-32HS	TBX-68 (777141-01)	SH68-68-D1 (183432-01)

See page 408 for accessory and cable information.

DIO07	34	68	GND
GND	33	67	DIO06
DIO04	32	66	DIO05
DIO03	31	65	GND
GND	30	64	DIO02
DIO00	29	63	DIO01
DIO07	28	62	GND
GND	27	61	DIO06
DIO04	26	60	DIO05
DIO03	25	59	GND
GND	24	58	DIO02
DIO00	23	57	DIO01
DIO07	22	56	RGND
DIO06	21	55	GND
GND	20	54	DIO05
RGND	19	53	DIO04
GND	18	52	DIO03
DIO01	17	51	DIO02
DIO00	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
PCKL2	6	40	CPULL
PCKL1	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

# Digital I/O 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
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 programs and with the following computer systems:

- PCI-6534 – Dell Dimension V400, Pentium II, Windows 98
- PXI-6534 – PXI-8170, Pentium III, Windows 98
- PCI-DIO-32HS – Gateway Pentium III, Win 98SE
- 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

In case of the NI 6534 Family, numbers shown here for all single-shot and continuous output benchmarks were performed using the on-board memory, so those numbers are independent of the computer system used. In all other cases, performance depends on the computer hardware, the operating system, and other programs running on the computer.

**Single-Shot Pattern I/O** – The benchmark for single shot pattern I/O repeatedly transfers a finite amount of data a given number of times. If the selected transfer rate is too high, an expected error will occur. The rate of transfer programmatically decreases and the transfer is repeated. The benchmark stops once the percentage of successful transfer is greater than 95%.

Device	Input Rates (Mbyte/s)			Output Rates (Mbyte/s)		
	8-bit	16-bit	32-bit	8-bit	16-bit	32-bit
PCI-6534	20.0	40.0	80.0	20.0	40.0	80.0
PXI-6534	20.0	40.0	80.0	20.0	40.0	80.0
PCI-DIO-32HS	10.0	10.0	20.0	4.00	4.40	8.00
PXI-6533	10.0	13.3	20.0	5.00	5.00	10.0
DAQCard-6533	0.12	0.22	0.38	0.12	0.24	0.40
AT-DIO-32HS	1.67	1.74	3.33	1.47	1.48	1.50

**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 the selected transfer rate does not result in any error messages.

Device	Input Rates (Mbyte/s) <sup>1</sup>			Output Rates (Mbyte/s)		
	8-bit	16-bit	32-bit	8-bit	16-bit	32-bit
PCI-6534	call <sup>1</sup>	call <sup>1</sup>	call <sup>1</sup>	20.0	40.0	80.0
PXI-6534	call <sup>1</sup>	call <sup>1</sup>	call <sup>1</sup>	20.0	40.0	80.0
PCI-DIO-32HS	10.0	10.0	13.3	4.00	3.62	7.24
PXI-6533	10.0	10.0	13.3	4.00	5.00	8.88
DAQCard-6533	0.12	0.22	0.38	0.12	0.24	0.40
AT-DIO-32HS	1.67	1.6	1.25	1.43	1.33	1.56

<sup>1</sup>Some performance benchmark data unavailable as of press date. Visit ni.com/catalog and enter express codes pci6534 or pxi6534 to access most current specifications for these new products.

**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 as for continuous I/O.

Device	Input Rates (Mbyte/s)			Output Rates (Mbyte/s)		
	8-bit	16-bit	32-bit	8-bit	16-bit	32-bit
PCI-6534	call <sup>1</sup>	call <sup>1</sup>	call <sup>1</sup>	20.0	40.0	80.0
PXI-6534	call <sup>1</sup>	call <sup>1</sup>	call <sup>1</sup>	20.0	40.0	80.0
PCI-DIO-32HS	19.9	39.2	76.2	19.9	39.1	74.1
PXI-6533	19.9	39.2	77.8	19.7	36.1	36.6
DAQCard-6533	0.23	0.47	0.74	0.23	0.47	0.74
AT-DIO-32HS	1.67	1.74	1.73	1.51	1.51	1.49

<sup>1</sup>Some performance benchmark data unavailable as of press date. Visit ni.com/catalog and enter express codes pci6534 or pxi6534 to access most current specifications for these new products.

### Memory

6533, DIO-32HS .....	N/A
6534 .....	64 Mbytes, 32 Mbytes per I/O group

### Start and Stop Triggers

Compatibility.....	5 V/TTL
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
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### PXI Trigger Bus (PXI only)

Trigger lines .....	7
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### 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
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/CPXI .....	10 by 16 cm (3.9 by 6.3 in.)
DAQCard .....	Type II PC Card

I/O Connector

PCI, PXI/CPXI, AT.....	68-pin male SCSI-II type
DAQCard .....	68-pin female PCMCIA

# Digital I/O Specifications

## High-Speed Digital I/O – 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**

## Optically Isolated Digital I/O – 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 <sub>RMS</sub> (42 V peak)
DC.....	60 VDC
Maximum switching capacity, 25 °C.....	120 mA
Common-mode isolation.....	60 VDC or 30 V <sub>RMS</sub> (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
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**

## Low-Cost, Static Digital I/O – NI 650x

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

### Digital I/O

Number of channels	
6503/DIO-24.....	24
6507/8/DIO-96.....	96
Compatibility.....	5 V/TTL
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 (I <sub>out</sub> = 2.5 mA)	–	0.4 V
Output high voltage (I <sub>out</sub> = 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
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### 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	
6503, except DAQCard.....	50-pin male
DAQCard-DIO-24.....	25-pin female PCMCIA
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.

### Certifications and Compliances

CE Mark Compliance **CE**