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

<table>
<thead>
<tr>
<th>Family</th>
<th>Bus</th>
<th>Digital I/O Lines</th>
<th>Maximum Rate</th>
<th>Onboard Memory</th>
<th>Logic Level</th>
<th>Isolation</th>
<th>Handshaking I/O</th>
<th>Pattern I/O</th>
<th>Messaging</th>
<th>Triggering</th>
</tr>
</thead>
<tbody>
<tr>
<td>NI 6534</td>
<td>PCI, PXI/PCI</td>
<td>32</td>
<td>20 MHz (80 Mbytes/s for 32-bit transfers)</td>
<td>64 MBs</td>
<td>5 V TTL/CMOS</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>NI 6533</td>
<td>PCI, PXI/PCI, ISA, PCMCIA</td>
<td>32</td>
<td>Up to 6.7 MHz (pattern I/O) Up to 19.6 MHz (handshaking)</td>
<td>-</td>
<td>5 V TTL/CMOS</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

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

Table 1. NI 653x Specifications Overview (see page 344 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 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.
High-Speed 32-bit Digital Pattern I/O and Handshaking

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.

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.

<table>
<thead>
<tr>
<th>Signal Names</th>
<th>Signal Types</th>
<th>Signal Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIOAx, DIOBx, DIOCx, DIOdx</td>
<td>data</td>
<td>Digital input/output lines</td>
</tr>
<tr>
<td>REQ1, REQ2, ACK1, ACK2</td>
<td>control</td>
<td>Handshaking and trigger lines</td>
</tr>
<tr>
<td>STOPTRIG1, STOPTRIG2</td>
<td>control</td>
<td>Trigger lines</td>
</tr>
<tr>
<td>PCLK1, PCLK2</td>
<td>control</td>
<td>Clock lines</td>
</tr>
<tr>
<td>CPULL, DPULL</td>
<td>power-up</td>
<td>Lines determine power-up states</td>
</tr>
</tbody>
</table>

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

See page 338 for accessory and cable information.
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

<table>
<thead>
<tr>
<th>Level</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input low voltage</td>
<td>0 V</td>
<td>0.8 V</td>
</tr>
<tr>
<td>Input high voltage</td>
<td>5 V</td>
<td>5 V</td>
</tr>
<tr>
<td>Output low voltage (Iout = 24 mA)</td>
<td>-</td>
<td>0.4 V</td>
</tr>
<tr>
<td>Output high voltage* (Iout = 24 mA)</td>
<td>2.4 V</td>
<td>-</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Device</th>
<th>Input Rates (MHz)</th>
<th>Output Rates (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8-bit</td>
<td>16-bit</td>
</tr>
<tr>
<td>PCI-6534</td>
<td>40.0</td>
<td>20.0</td>
</tr>
<tr>
<td>PCI-6533</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>DaQCard-6533</td>
<td>0.12</td>
<td>0.06</td>
</tr>
<tr>
<td>AT-DIO-32HS</td>
<td>1.67</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Patterns

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

Performance Benchmarks
The performance benchmarks were conducted using LabVIEW or LabWindows/CVI programs and with the following computer systems:

<table>
<thead>
<tr>
<th>Device</th>
<th>Input Rates (MHz)</th>
<th>Output Rates (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8-bit</td>
<td>16-bit</td>
</tr>
<tr>
<td>PCI-6534</td>
<td>20.0</td>
<td>10.0</td>
</tr>
<tr>
<td>PCI-6533</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>DaQCard-6533</td>
<td>0.12</td>
<td>0.06</td>
</tr>
<tr>
<td>AT-DIO-32HS</td>
<td>1.67</td>
<td>0.87</td>
</tr>
</tbody>
</table>

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.

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.

Memory

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

Start and Stop Triggers

<table>
<thead>
<tr>
<th>Device</th>
<th>Input Rates (MHz)</th>
<th>Output Rates (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8-bit</td>
<td>16-bit</td>
</tr>
<tr>
<td>PCI-6534</td>
<td>50.0</td>
<td>25.0</td>
</tr>
<tr>
<td>PCI-6533</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>DaQCard-6533</td>
<td>0.12</td>
<td>0.06</td>
</tr>
<tr>
<td>AT-DIO-32HS</td>
<td>1.67</td>
<td>0.87</td>
</tr>
</tbody>
</table>

Bus Interfaces

<table>
<thead>
<tr>
<th>Device</th>
<th>Input Rates (MHz)</th>
<th>Output Rates (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8-bit</td>
<td>16-bit</td>
</tr>
<tr>
<td>PCI-6534</td>
<td>50.0</td>
<td>25.0</td>
</tr>
<tr>
<td>PCI-6533</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>DaQCard-6533</td>
<td>0.12</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Power Requirements

<table>
<thead>
<tr>
<th>Device</th>
<th>Input Rates (MHz)</th>
<th>Output Rates (MHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8-bit</td>
<td>16-bit</td>
</tr>
<tr>
<td>PCI-6534</td>
<td>50.0</td>
<td>25.0</td>
</tr>
<tr>
<td>PCI-6533</td>
<td>10.0</td>
<td>5.0</td>
</tr>
<tr>
<td>DaQCard-6533</td>
<td>0.12</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Physical

Dimensions, not including connectors
PCI, AT: 17.5 by 10.7 cm (6.9 by 4.2 in.)
PCI/PCI-C: 10 by 16 cm (3.9 by 6.3 in.)
DaQCard: Type II PC Card

I/O Connector
PCI, PXI/PCI-C, AT: 68-pin male SCSI-II type
DaQCard: 68-pin female PCMCIA
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

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

<table>
<thead>
<tr>
<th>Level</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input low voltage</td>
<td>0 VDC</td>
<td>3 V</td>
</tr>
<tr>
<td>Input high voltage</td>
<td>2 VDC</td>
<td>28 VDC</td>
</tr>
</tbody>
</table>

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 Vrms (42 V peak)
DC....................................................... 60 VDC
Maximum switching capacity, 25 °C ......... 120 mA
Common-mode isolation............................ 60 VDC or 30 Vrms (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 ............................................. 14.6 by 21.3 by 3.8 cm (5.8 by 8.4 by 1.5 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

Digital I/O Specifications
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

<table>
<thead>
<tr>
<th>Level</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input low voltage</td>
<td>-0.3 V</td>
<td>0.8 V</td>
</tr>
<tr>
<td>Input high voltage</td>
<td>2.2 V</td>
<td>5.3 V</td>
</tr>
<tr>
<td>Output low voltage (Iout = 2.5 mA)</td>
<td>-0.4 V</td>
<td>-</td>
</tr>
<tr>
<td>Output high voltage (Iout = 2.5 mA)</td>
<td>3.3 V</td>
<td>-</td>
</tr>
</tbody>
</table>

Transfer rate

<table>
<thead>
<tr>
<th>Device</th>
<th>Maximum with NI-DAQ Software</th>
<th>Typical Sustainable Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI, PXI</td>
<td>PCIe, 10/100/1000Base-T, 1000Base-X</td>
<td>100 bytes/s, 100 Mbytes/s</td>
</tr>
<tr>
<td>DAQCard</td>
<td>10/100Base-T, 1000Base-X</td>
<td>100 bytes/s, 100 Mbytes/s</td>
</tr>
<tr>
<td>DAQPad</td>
<td>10/100Base-T, 1000Base-X</td>
<td>100 bytes/s, 100 Mbytes/s</td>
</tr>
</tbody>
</table>

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

Power Requirements

<table>
<thead>
<tr>
<th>Device</th>
<th>Maximum with NI-DAQ Software</th>
<th>Power Available at I/O Connector</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCI-6503</td>
<td>12.2 by 9.5 cm (4.8 by 3.7 in.)</td>
<td>+4.65 to +5.25 VDC, 1 A fused</td>
</tr>
<tr>
<td>PC-DIO-96</td>
<td>11.7 by 10.6 cm (4.6 by 4.2 in.)</td>
<td>+4.65 to +5.25 VDC, 1 A fused</td>
</tr>
<tr>
<td>DAQCard-DIO-24</td>
<td>13.7 by 10.7 cm (5.4 by 4.2 in.)</td>
<td>+4.65 to +5.25 VDC, 1 A fused</td>
</tr>
<tr>
<td>DAQPad-6507/8</td>
<td>14.6 by 21.3 by 3.8 cm (5.8 by 8.4 by 1.5 in.)</td>
<td>+4.65 to +5.25 VDC, 1 A fused</td>
</tr>
</tbody>
</table>

Physical
Dimensions
PCI-6503 .............................................. 12.2 by 9.5 cm (4.8 by 3.7 in.)
PC-DIO-96 ........................................... 11.7 by 10.6 cm (4.6 by 4.2 in.)
DAQCard-DIO-24 .................................... 13.7 by 10.7 cm (5.4 by 4.2 in.)
XI-6508 .............................................. 10 by 16 cm (3.9 by 6.3 in.)
PC-DIO-96 ........................................... 14.5 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
PCI-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

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