Digital Pattern I/O and Handshaking

NI 653x

- 20 MHz (80 Mbytes/s) maximum transfer rate
- 32 digital (5 V TTL/CMOS) input/output lines
- 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 I/O operations

Models

- NI PCI-6534
- NI PXI-6534
- NI PCI-6533 (PCI-DIO-32HS)
- NI PXI-6533
- NI DAQCard-6533

Operating Systems

- Windows 2000/NT/XP
- Real-time performance with LabVIEW (page 134)
- Others such as Linux and Mac OS X (page 187)

Recommended Software

- LabVIEW
- LabWindows/CVI
- Measurement Studio

Other Compatible Software

- Visual Basic
- C/C++

Driver Software (included)

- NI-DAQ

Product	Bus	Channels	Maximum Rate (MHz)	Voltage Levels	Memory
NI 6534	PCI, PXI	32	20	5 V TTL/CMOS	64 MB
NI 6533	PCI, PXI, PCMCIA, ISA	32	Up to 2 (pattern I/O)	5 V TTL/CMOS	–

Table 1. NI 653x Specifications Overview (See page 434 for detailed specifications)

Overview and Applications

NI 653x devices are parallel digital pattern I/O and handshaking interfaces for PCI, PXI, and PCMCIA. They incorporate the National Instruments DAQ-DIO ASIC, specifically designed to deliver high performance on plug-in DIO devices. The NI 653x devices perform pattern I/O, handshaking, and unstrobed 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 pattern I/O at deterministic rates.

Features

I/O Lines

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 group can perform either input or output using the same clock source and clock rate. 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 NI 653x data lines are diode-terminated to dampen the input signals at TTL levels. When performing static or unstrobed I/O, you can individually configure each of the 32 I/O lines as input or output.

Pattern I/O and Handshaking I/O

With pattern I/O, you can input or output patterns under timing control of a clock signal. When using handshaking I/O to interface your NI 653x to a peripheral device, data is transferred when both the NI 653x and the peripheral are ready. See page 779 in the Digital I/O tutorial for more information.

Change Detection

You can program the NI 653x devices to acquire data when one or more user-specified digital input lines changes state, saving valuable processing time. You can also use an NI 660x counter/timer device to timestamp when the lines change state. See page 779 in the Digital I/O tutorial for more information.

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

NI 6534 devices provide two banks of 32 MB of onboard memory, each corresponding to a 8 Mb/pin for a 32-bit group, 16 Mb/pin for each 16-bit group, or 32 Mb/pin for each 8-bit group. 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.

Digital Pattern I/O and Handshaking

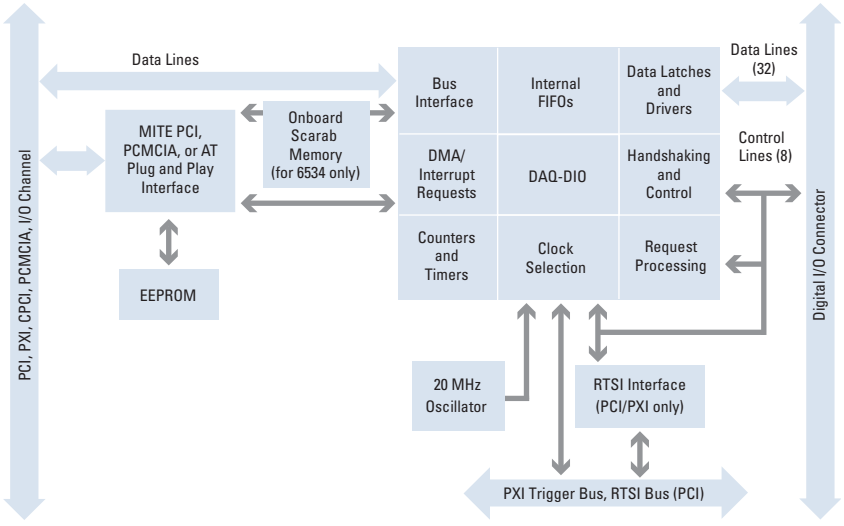

Figure 1. NI 653x Hardware Block Diagram

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

DMA Control Circuitry

NI 653x devices for PCI and PXI 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. The PXI-6534 module features phase-lock loop (PLL) circuitry to tightly synchronize with other PLL devices.

Front Panel Connector and Power-Up States

All digital I/O transmission 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.

Driver Software

With NI-DAQ driver software, you can configure your devices interactively, write custom programs, and perform digital I/O transfers easily. With NI-DAQ, the NI 6533 and NI 6534 devices are software-compatible, providing a seamless upgrade path. Sharing clocks and triggers between NI 653x and other measurement devices is also greatly simplified. To get you started with your application quickly, NI-DAQ includes numerous example programs for LabVIEW and other ADEs.

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

Table 2. Signal Names and Descriptions

Ordering Information

NI PCI-6534 778287-01
NI PXI-6534 778288-01
NI PCI-6533 (PCI-DIO-32HS) 777314-01
NI PXI-6533 777429-01
NI DAQCard-6533. 777315-01

Includes NI-DAQ driver software.

For information on extended warranty and value added services, see page 20.

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)	–
NI 6533	PCI-DIO-32HS	SCB-68 (776844-01)	SH68-68-D1 (183432-01)
	PXI-6533	TB-2715 (778242-01)	–
	DAQCard-6533	SCB-68 (776844-01)	PSHR68-68-D1 (777420-01)

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

See page 474 for accessory and cable information.

Related Products

Digital waveform generator/analyzers .....see page 435
High-speed digitizers .....see page 438
Arbitrary waveform and function generators .....see page 454
Multifunction data acquisition .....see page 189

BUY ONLINE!

Visit ni.com/products and enter pci6534, pxi6534, pci6533, pxi6533, or daqcard6533.

Digital Pattern I/O and Handshaking

Specifications

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[1] (I_{out} = 24 mA)	2.4 V	–

[1]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 ..... 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-6533 (PCI-DIO-32HS) – Gateway Pentium III, Win 98 SE
PXI-6533 – PXI-8170, Pentium III, Windows 98
For pattern I/O, the benchmarks shown are the clock rates. For handshaking 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 x 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 the transfer of finite amount of data (32 MB) for 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-6533	10.5	5.0	5.0	5.00	2.5	2.5
PXI-6533	10	5.0	5.0	5.00	2.857	2.857

Continuous Pattern I/O – This benchmark uses the internal clock to control the transfer rate of the transfer. If the selected transfer rate is too high, an expected error will occur, and the internal clock rate is decreased. The benchmark executes until 1 GB of data is acquired. If an error occurs before 1 GB of data is acquired, the internal clock rate is decreased and the test starts over.

	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	5	20.0	10.0	5
PXI-6534	20.0	10.0	10	20.0	10.0	6.67
PCI-6533	2.5	1.43	1.43	4.00	2.0	2.0
PXI-6533	2.5	1.43	1.43	5.00	2.50	2.5

Continuous Handshaking I/O – This benchmark configures the NI 653x device for burst mode handshaking protocol. The continuous burst mode I/O test calculates the average transfer rate over 1 GB of data transfer. The average transfer rate is calculated as the total data transferred divide by total length of time used for transfer. Single-shot burst mode handshaking 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	20.0	20.0	19	19.9	19.8	13.0
PXI-6534	19.9	19.9	17.3	19.9	18.0	9.17
PCI-6533	19.9	19.7	17.3	19.9	18.0	13.0
PXI-6533	19.9	19.6	13.2	19.7	17.8	9.06

Memory

NI 6533 ..... 16-sample FIFO
NI 6534 ..... 64 MB, 32 MB 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 Bus (PCI only)

Trigger lines 7

PXI Trigger Bus (PXI only)

Trigger lines 7

Bus Interfaces

PCI, PXI ..... Master, slave
DAQCard ..... PCMCIA slave

Power Requirements

Device	+5 VDC (±5 %)[2]
PCI-6533, PXI-6533	1.3 A
PCI-6534, PXI-6534	2 A
DAQCard-6533	500 mA

[2]Excludes power consumed through I/O connector

Physical

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

Environment

Operating temperature ..... 0 to 55 °C
Storage temperature ..... -20 to 70 °C
Relative humidity ..... 10 to 90% noncondensing

Certifications and Compliances

CE Mark Compliance CE