

32-Bit Counter/Timers

NI 660x

- Up to eight 32-bit counter/timers
- Up to 80 MHz maximum source frequency (125 MHz with prescalers)
- Debouncing and glitch removal
- High-stability timebase (PXI-6608 only)
- GPS-based synchronization (PXI-6608 only)
- NI DAQ driver simplifies configuration and measurements

Models

NI 6601

- NI PCI-6601

NI 6602

- NI PCI-6602
- NI PXI-6602

NI 6608

- NI PXI-6608

Operating Systems

- Windows 2000/NT/XP/Me/9x
- Mac OS 9*
- Real-time performance with LabVIEW (p. 56)

Recommended Software

- LabVIEW
- LabWindows/CVI
- Measurement Studio for Visual Basic

Other Compatible Software

- Visual Basic
- Visual C/C++

Driver Software (included)

- NI-DAQ

Calibration Certificate Included

*See Ordering Information



Overview and Applications

The NI 660x devices are timing and digital I/O modules for PCI and PXI. They offer up to eight 32-bit counter/timers and up to 32 lines of 5 V TTL/CMOS-compatible digital I/O. You can perform a wide variety of buffered measurements or other counter/timer tasks with the NI 660x devices, including position or quadrature encoder measurement, event counting, period measurement, pulse-width measurement, frequency measurement, pulse generation, and pulse-train generation.

Features Counter/Timers

The NI 660x devices are equipped with the NI-TIO ASIC, a National Instruments counter and digital I/O ASIC for advanced timing and counting applications. Each NI 6602 and NI 6608 device features two NI-TIO ASICs to provide a total of eight counter/timers. The NI 6601 devices feature one NI-TIO ASIC for a total of four counter/timers. The counters are software-compatible with those found on E Series multifunction DAQ devices, but NI 660x devices offer additional capabilities.

Each counter has a gate, up/down, and source input, which can be controlled by external or internal signals. Each counter has one output that can be routed externally or to other counters on the board. 20 MHz and 100 kHz timebases are available on each device for use with each counter/timer. In addition, an 80 MHz timebase is available on the NI 6602 and NI 6608 devices. A hardware trigger can be used to start multiple counters simultaneously. See Table 1 for more information.

INFO CODES

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

pci6601
pci6602
pxi6602
pxi6608

BUY ONLINE!

Family	Bus	Counter/Timers	Size	Max Source Frequency	Compatibility	Digital I/O	Pulse Generation	Buffered Operations	Debouncing/ Glitch Removal	Oscillator Stability	GPS Synchr.	Buffered Operations ²	
												DMA	Interrupt
NI 6601	PCI	4	32 bits	20 MHz ¹	5 V TTL/CMOS	Up to 32	✓	✓	✓	50 ppm	–	1	3
NI 6602	PCI PXI	8	32 bits	80 MHz ¹	5 V TTL/CMOS	Up to 32	✓	✓	✓	50 ppm	–	3	5
NI 6608	PXI	8	32 bits	80 MHz ¹	5 V TTL/CMOS	Up to 32	✓	✓	✓	75 ppb	✓	3	5

¹Max Source Frequency with prescalers is 60 MHz for the NI 6601 and 125 MHz for the NI 6602 and NI 6608. These frequencies are dependent on drive strength of input signal and cable length. Consider these speeds to be the maximum. ²DMA transfers have higher throughput than interrupt transfers. .

Table 1. NI 660x Products Specifications Summary (see page 399 for detailed specifications)

32-Bit Counter/Timers

High-Stability, Oven-Controlled Oscillator

The NI PXI-6608 module includes a high-stability 10 MHz oven-controlled crystal oscillator (OCXO) for high-precision applications. When the PXI-6608 is installed in the star trigger slot of a PXI chassis (slot 2), you can drive the OCXO signal to the PXI backplane for high-stability timing of your entire measurement system. The PXI-6602 and PXI-6608 feature phase-lock loop (PLL) circuitry so that the devices can synchronize their reference clocks to the backplane.

Debouncing and Glitch Removal

Each input on the NI 660x devices can be passed through a digital debouncing filter to eliminate glitches on the input signal. You can use predefined filter settings to remove noise/glitches narrower than 2.5 μ s, 500 ns, 250 ns, and 50 ns from your input signal, or you can use the counter outputs to create custom filter settings.

Buffered Measurements

NI 660x devices use the National Instruments MITE bus interface controller to implement bus-master DMA transfers. As a result, you can perform high-speed, continuous operations such as buffered position encoder measurement and buffered period measurement. You can perform one high-speed DMA-based transfer on the NI 6601 devices and up to three simultaneous DMA transfers on the NI 6602 and NI 6608 devices. You can use interrupts for additional simultaneous buffered transfers. See page 399 for more information.

Digital I/O

The NI-TIO ASIC also provides up to 32 digital I/O lines on the NI 660x devices. Eight lines are dedicated to digital I/O, while the others can be used for digital I/O when not used by the counter/timers. Digital I/O lines are individually software configurable for input or output.

RTSI and PXI Trigger Bus

NI 660x devices are equipped with the RTSI bus or PXI trigger bus for multiboard synchronization. Timing signals on an NI 660x device can be routed to or from other devices in your system to perform advanced timing and synchronization.

PF131/SOURCE2	34	68	GND
GND	33	67	PF130/GATE2
PF128/OUT2	32	66	PF129/UP_DOWN2
PF127/SOURCE3	31	65	GND
GND	30	64	PF126/GATE3
PF124/OUT3	29	63	PF125/UP_DOWN3
PF123/SOURCE4	28	62	GND
GND	27	61	PF122/GATE4
PF120/OUT4	26	60	PF121/UP_DOWN4
PF119/SOURCE5	25	59	GND
GND	24	58	PF118/GATE5
PF116/OUT5	23	57	PF117/UP_DOWN5
PF115/SOURCE6	22	56	Reserved
PF114/GATE6	21	55	GND
GND	20	54	PF113/UP_DOWN6
Reserved	19	53	PF112/OUT6
GND	18	52	PF111/SOURCE7
PF19/UP_DOWN7	17	51	PF110/GATE7
PF18/OUT7	16	50	GND
PF17/DIO7	15	49	GND
GND	14	48	PF16/DIO6
PF14/DIO4	13	47	PF15/DIO5
PF13/DIO3	12	46	GND
GND	11	45	PF12/DIO2
PF10/DIO0	10	44	PF11/DIO1
PF132/OUT1	9	43	Reserved
PF134/GATE1	8	42	GND
PF135/SOURCE1	7	41	GND
PF133/UP_DOWN1	6	40	PF137/UP_DOWN0
PF136/OUT0	5	39	GND
Reserved	4	38	Reserved
PF138/GATE0	3	37	Reserved
PF139/SOURCE0	2	36	GND
+5V	1	35	Reserved

Figure 1. NI 660x I/O Connector

Synchronizing Networked Measurements with GPS

You can correlate measurements performed in a wide area using the Global Positioning System (GPS). With the PXI-6608, you can correlate data from several PXI chassis, determine the time when a hardware event occurs, or generate a pulse at a user-specified time.

I/O Connector

The NI 660x devices each have a 68-pin shielded, latching connector, with a SOURCE, GATE, UP/DOWN, and OUT signal for each of the counter/timers. PFI<8..31> can be used as general-purpose digital I/O lines when not used as counter/timer I/O signals. The DION lines are the eight dedicated digital I/O lines. The PCI-6601 devices have the same I/O interface, except that only Counters 0-3 are present.

Driver Software

With NI-DAQ driver software, you can configure your devices interactively, write custom programs, and perform counter/timer I/O easily. NI-DAQ provides the counter/timer functions natively, so you can programmatically select whether you want to measure position with a quadrature encoder, measure a frequency, output a pulse train, or perform one of the other provided counter/timer functions. NI-DAQ also includes numerous example programs for LabVIEW and other ADEs to get you started with your application quickly.

Ordering Information

NI PCI-6601	777918-01
NI PCI-6602	777531-01
NI PXI-6602	777557-01
NI PXI-6608*	777937-01

Includes NI-DAQ driver software.

*Windows only.

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

Recommended Configurations

Family	DAQ Device	Accessory	Cable
NI 6601	PCI-6601	CB-68LP (777145-01)	SH68-68-D1 (183432-01)
NI 6602	PCI-6602	BNC-2121 (778289-01)	SH68-68-D1 (183432-01)
		PXI-6602	TB-2715 (778242-01)
NI 6608	PXI-6608	TB-2715 (778242-01)	None required

See page 396 for accessory and cable information.

Counter/Timer Accessories and Cables



Figure 1. BNC-2121 Connector Block



Figure 2. CA-1000 Configurable Signal Conditioning Solution

Accessory and Cable Selection Process

Step 1. Select your counter/timer device from Table 1.

Step 2. Using Table 1 as a guide, determine which accessories are appropriate for that device. Select an accessory using Table 2 as reference.

Step 3. Using Table 1, determine the appropriate cable solution for your selected counter/timer device and accessory.

Accessories		
	BNC-2121, CA-1000, SCB-68, TBX-68, CB-68LP, and CB-68LPR	TB-2715
Device	Cables	
PCI-6601, PCI-6602	R6868 or SH68-68-D1	N/A
PXI-6602, PXI-6608	R6868 or SH68-68-D1	Connects directly to the device

Table 1. Accessories and Cables for Counter/Timers

Accessory	Description	Page
BNC-2121	BNC connector block with built-in test features	see below
CA-1000	Configurable connector accessory	352
SCB-68	Shielded screw connector block	397
TB-2715	Front-mount terminal block for PXI-660x	397
TBX-68	DIN-rail connector block	397
CB-68LP	Low-cost screw connector block	397
CB-68LPR	Low-cost screw connector block	397

Table 2. Overview of Accessories

Accessories

BNC-2121 (see Figure 1)

Connector block with BNC and spring terminal connections for easy connection of I/O signals to counter/timer devices. The BNC-2121 offers spring terminals, as well as eight dedicated and six user-defined BNC connectors, which allow access to all I/O signals. This connector block is also a full-featured test accessory that provides pulse-train, trigger, and quadrature encoder signals. For the connections, refer to the BNC-2121 user guide at ni.com/manuals

BNC-2121778289-01
 Dimensions – 26.7 by 11.2 by 5.5 cm (8.0 by 4.4 by 2.2 in.)

CA-1000 (see Figure 2)

Configurable signal connectivity solution for connecting counter/timers to different types of standard I/O connectors. You can also incorporate switches and LED indicators. You can place the CA-1000 under a laptop PC, on a benchtop, or in a 19 in. rack. For detailed information about this accessory, see page 352.

CA-1000See page 352
 Dimensions – 30.7 by 25.4 by 4.3 cm (12.1 by 10 by 1.7 in.)

Counter/Timer Accessories and Cables

SCB-68 Shielded I/O Connector Block (See Figure 3)

Shielded I/O connector block for easy connection of I/O signals to the counter/timer devices. The screw terminals are housed in a metal enclosure for protection from noise corruption. Combined with a shielded cable, the SCB-68 provides rugged, very low-noise signal termination. The SCB-68 also includes two general-purpose breadboard areas.

SCB-68776844-01
Dimensions – 19.5 by 15.2 by 4.5 cm (7.7 by 6.0 by 1.8 in)



Figure 3. SCB-68 Shielded I/O Connector Block

TB-2715 Terminal Block (See Figure 4)

With the TB-2715 terminal block for PXI counter/timer devices, you can connect signals directly without additional cables. Screw terminals provide easy connection of I/O signals. The TB-2715 latches to the front of your PXI module with locking screws and provides strain relief.

TB-2715778242-01
Dimensions – 8.43 by 10.41 by 2.03 cm (3.32 by 4.1 by 0.8 in.)



Figure 4. TB-2715 I/O Connector Block

TBX-68 I/O Connector Block with DIN-Rail Mounting (See Figure 5)

Termination accessory with 68 screw terminals for easy connection of field I/O signals to the counter/timer devices. The TBX-68 is mounted in a protective plastic base with hardware for mounting on a standard DIN rail.

TBX-68777141-01
Dimensions – 12.50 by 10.74 cm (4.92 by 4.23 in.)



Figure 5. TBX-68 I/O Connector Block

CB-68LP and CB-68LPR I/O Connector Blocks (See Figure 6)

Low-cost termination accessories with 68 screw terminals for easy connection of field I/O signals to the counter/timer devices. The connector blocks include standoffs for use on a desktop or mounting in a custom panel. The CB-68LP has a vertically mounted 68-pin connector. The CB-68LPR has a right-angle mounted connector for use with with the CA-1000.

CB-68LP777145-01
Dimensions – 14.35 by 10.74 cm (5.65 by 4.23 in.)

CB-68LPR.....777145-02
Dimensions – 7.62 by 16.19 cm (3.00 by 6.36 in.)



Figure 6. CB-68LP and CB-68LPR I/O Connector Blocks

Counter/Timer Accessories and Cables



Figure 7. RTSI Bus Cable



Figure 8. Extended RTSI Bus Cable



Figure 9. SH68-68-D1 Shielded Cable



Figure 10. R6868 Ribbon Cable



Figure 11. 68-Pin Custom Cable Kit

Cables

RTSI Bus Cables (see Figures 7 and 8)

Use RTSI cables to connect timing and synchronization signals among measurement, vision, motion, and CAN boards for PCI, and ISA, and some external devices, such as the DAQPad-6070E for FireWire. For systems using long and short boards, order the extended RTSI cable.

2 boards	776249-02
3 boards	776249-03
4 boards	776249-04
5 boards	776249-05
Extended, 5 boards	777562-05
3 external devices	186464-01

SH68-68-D1 Shielded Cable (see Figure 9)

Shielded 68-conductor cable terminated with two 68-pin female 0.050 series D-type connectors. This cable connects counter/timer devices to accessories.

1 m	183432-01
2 m	183432-02

R6868 Ribbon I/O Cable (see Figure 10)

68-conductor flat ribbon cable terminated with two 68-pin connectors. Use this cable to connect the NI PCI-6601 to an accessory. For signal integrity with high-frequency signals, use the SH68-68-D1 with the NI 6602 and NI 6608.

1 m	182482-01
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Custom Connectivity Components

68-Pin Custom Cable Connector/Backshell Kit (see Figure 11)

68-pin female mating connector and backshell kit for use in making custom 68-conductor cables. Solder-cup contacts are available for soldering of cable wires to the connector.

68-pin connector/backshell kit	776832-01
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PCB Mounting Connectors

Printed circuit board (PCB) connectors for use in building custom accessories that connect to 68-conductor shielded and ribbon cables. Two connectors are available, one for right-angle and one for vertical mounting onto a PCB.

68-pin, male, right-angle mounting	777600-01
68-pin, male, vertical mounting	777601-01

Counter/Timer Specifications

Specifications – NI 660x

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

Timing I/O

General-Purpose Up/Down Counter/Timers

Number of channels	
NI 6601	4 up/down counters
NI 6602/6608	8 up/down counters
Counter size/number of bits	32 bits
Prescalers (per counter)	3 bits (divided by 8) 1 bit (divided by 2) Disabled (by default)
Power-on state	Input (high-Z), pulled low Pull down current: 10 µA (min) to 200 µA (max)
Hysteresis	300 mV Schmitt triggers
Compatibility	5 V TTL/CMOS
Digital logic levels	

Level	Minimum	Maximum
Input low voltage	-0.3 V	0.8 V
Input high voltage	2.0 V	5.25 V
Output low voltage (I _{out} = 4 mA)	–	0.4 V
Output high voltage (I _{out} = 4 mA)	2.4 V	–

Base clocks available	
NI 6601	100 kHz and 20 MHz
NI 6602/6608	100 kHz, 20 MHz, and 80 MHz
Base clock accuracy (NI 6601 and NI 6602)	±0.005% (50 ppm) ¹
Base Clock (OCXO) accuracy (NI 6608)	±0.000075% (75 ppb)
Maximum source frequency	

Board	Without Prescaling	With Prescaling
NI 6601	20 MHz	60 MHz
NI 6602		
NI 6608	80 MHz	125 MHz

External source selections	I/O connector, RTSI/PXI Trigger lines, software selectable
External gate selections	I/O connector, RTSI/PXI Trigger lines, software selectable
Minimum source pulse duration	
with prescalers	3.5 ns; edge-detect mode
without prescalers	5 ns; edge-detect mode
Minimum gate pulse duration	5 ns; edge-detect mode
Frequency ranges to measure or generate	

	Min/Max Frequency to Measure	Min/Max Frequency to Generate
NI 6601	µHz to 20 MHz	µHz to 10 MHz
NI 6602	µHz to 80 MHz	µHz to 40 MHz
NI 6608	µHz to 80 MHz	µHz to 40 MHz

For More Information, please visit ni.com/info and enter exaltz

Data Transfers

Transfer modes	DMA, interrupts, programmed I/O
Transfer rates	

DMA		Interrupt	
Finite Operation		Finite Operation	
Buffer Size (samples)	Rate (kSamples/sec)	Buffer Size (samples)	Rate (kSamples/sec)
100	5000	100	55
1,000	42000	1,000	49
10,000	2000	10,000	49
100,000	1800	100,000	48

Continuous Operation		Continuous Operation	
Buffer Size (samples)	Rate (kSamples/sec)	Buffer Size (samples)	Rate (kSamples/sec)
50,000,000	28	50,000	15

¹Values may vary depending on your computer hardware, operating system and system activity. Benchmark data was determined on a Pentium II 400 MHz computer with 64 MB RAM running Windows 98 and LabVIEW using one counter of a PCI-6602. The number of simultaneous DMA transfers you can perform is equivalent to the DMA channels available on your device. The rate is based on one counter using the interrupts. If multiple counters share interrupts, the transfer rate per counter is lower.

DMA channels	
NI 6601	1
NI 6602/6608	3
DMA modes	Scatter-gather (single-transfer, demand transfer)
Onboard memory	16x32-bit FIFO per DMA channel

Oven-Controlled Crystal Oscillator (OCXO) (NI 6608 only)

Frequency	10 MHz
OCXO accuracy	±0.000075% (75 ppb)
Warm-up time (to within 0.02 ppm of operating frequency)	5 minutes
Frequency stability versus supply voltage change (±5%)	≤ 0.005 ppm
Temperature stability (0 to 50 °C)	≤ 0.005 ppm
Drift in frequency	≤ 0.00045 ppm/day ≤ 0.045 ppm/year
Allowed frequency adjustment	0.5 ppm, typical

Note: You can use the OCXO to replace the PXI 10 MHz backplane clock when the PXI-6608 is installed in the PXI star trigger slot (slot 2). You can also use it as the counter source or gate in any slot.

Digital I/O

Number of channels	Up to 32 input/output
Compatibility	5 V TTL/CMOS
Power-on state	Input (high-Z), pulled low
Pulldown current	10 µA (min) to 200 µA (max)
Hysteresis	300 mV Schmitt triggers
Data transfers	Unstrobed I/O
Digital logic levels	

Level	Minimum	Maximum
Input low voltage	-0.3 V	0.8 V
Input high voltage	2.0 V	5.25 V
Output low voltage (I _{out} = 4 mA)	–	0.4 V
Output high voltage (I _{out} = 4 mA)	2.4 V	–

RTSI Bus (PCI only)

Trigger lines	7
Minimum pulse width for trigger and clock	25 ns

PXI Trigger Bus (PXI only)

Trigger lines	6
Star trigger	1

Bus Interface

PCI, PXI	Master, slave
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Power Requirements

Device	+5 VDC (±5%)*	Power Available at I/O Connector
NI 6601	0.4 to 0.75 A	+4.65 to +5.25 VDC, 1 A
NI 6602	0.5 to 1.5 A	
NI 6608	1 to 2.5 A	

*Excludes power consumed through I/O connector

Physical

Dimensions (not including connectors)	
PCI	17.5 by 9.9 cm (6.9 by 3.9 in.)
PXI	16.0 by 10.0 cm (6.3 by 3.9 in.)
I/O connector	68-pin male SCSI-II type

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**

¹ If a PXI-6608 is installed in slot 2 of a PXI chassis, then the PXI-6608 and any PXI-6602 installed in that chassis inherit a base clock accuracy of ±0.000075%(75 ppb).