NI 625x Specifications

Specifications listed below are typical at 25 °C unless otherwise noted.

**Analog Input**

Number of channels

NI 6250/NI 6251.............. 8 differential or 16 single ended
NI 6254/NI 6259.............. 16 differential or 32 single ended

ADC resolution .............. 16 bits

DNL..................................... No missing codes guaranteed

INL ...................................... Refer to the *AI Absolute Accuracy Table*

**Sampling rate**

Maximum....................... 1.25 MS/s
  single channel,
  1.00 MS/s
  multi-channel

Minimum ....................... 0 S/s

Timing accuracy .............. 50 ppm of sample rate

Timing resolution.............. 50 ns

Input coupling ............... DC

Input range..................... ±10 V, ±5 V, ±2 V,
  ±1 V, ±0.5 V, ±0.2 V, ±0.1 V

Maximum working voltage for analog inputs (signal + common mode).... ±11 V of AI GND

CMRR (DC to 60 Hz) ........... 100 dB

Input impedance
  AI+ to AI GND ................. >10 GΩ in parallel
  with 100 pF
  AI– to AI GND ................. >10 GΩ in parallel
  with 100 pF

Input bias current ................ ±100 pA

Crosstalk (at 100 kHz)
  Adjacent channels .......... –75 dB
  Non-adjacent channels .... –95 dB

Small signal bandwidth
  (–3 dB)............................ 1.7 MHz

Input FIFO size.................. 4,095 samples

Scan list memory .............. 4,095 entries

Data transfers.................. DMA
  (scatter-gather), interrupts,
  programmed I/O

Overvoltage protection
  (AI <0..31>, AI SENSE, AI SENSE 2)
  Device on ...................... ±25 V for up to four AI pins
  Device off .................... ±15 V for up to four AI pins

Input current during overvoltage condition .... ±20 mA max/AI pin
Settling Time for Multichannel Measurements

<table>
<thead>
<tr>
<th>Range</th>
<th>±60 ppm of Step (±4 LSB for Full Scale Step)</th>
<th>±15 ppm of Step (±1 LSB for Full Scale Step)</th>
</tr>
</thead>
<tbody>
<tr>
<td>±10 V, ±5 V, ±2 V, ±1 V</td>
<td>1 µs</td>
<td>1.5 µs</td>
</tr>
<tr>
<td>±0.5 V</td>
<td>1.5 µs</td>
<td>2 µs</td>
</tr>
<tr>
<td>±0.2 V, ±0.1 V</td>
<td>2 µs</td>
<td>8 µs</td>
</tr>
</tbody>
</table>

Typical Performance Graphs

- Settling Error versus Time for Different Source Impedances
- AI <0..31> CMRR
- AI <0..31> Small Signal Bandwidth
### Analog Triggers

**Number of triggers** .............. 1

**Source**
- NI 6250/NI 6251 .............. AI <0..15>, APFI 0
- NI 6254/NI 6259 .............. AI <0..31>, APFI <0..1>

**Functions** ...
- Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Convert Clock, Sample Clock

**Timebase Source level**
- (AI <0..31>) ..................... ±full scale
- (APFI <0..1>) .................. ±10 V

**Resolution** .................... 10 bits, 1 in 1,024

**Modes** ......................... Level triggering, level triggering with hysteresis, window triggering

**Bandwidth (–3 dB)**
- AI <0..31> ..................... 3.4 MHz
- APFI <0..1> ..................... 3.9 MHz

**Accuracy** ........................ ±1%

**APFI <0..1> characteristics**
- Input impedance .............. 10 kΩ
- Coupling ......................... DC
- Protection
  - Power on ....................... ±30 V
  - Power off ....................... ±15 V

### Analog Output

**Number of channels**
- NI 6250 ............................ 0
- NI 6251 ............................ 2
- NI 6254 ............................ 0
- NI 6259 ............................ 4

**DAC resolution** .................. 16 bits

**DNL** ............................... ±1 LSB

**Monotonicity** ................. 16 bit guaranteed

**Accuracy** ........................ Refer to the AO Absolute Accuracy Table

**Maximum update rate**
- 1 channel ........................ 2.86 MS/s
- 2 channels ......................... 2.00 MS/s
- 3 channels ......................... 1.54 MS/s
- 4 channels ......................... 1.25 MS/s

**Timing accuracy** ............... 50 ppm of sample rate

**Timing resolution** ............ 50 ns

**Output range** .................. ±10 V, ±5 V, ±external reference on APFI <0..1>

**Output coupling** .............. DC

**Output impedance** ............ 0.2 Ω

**Output current drive** .......... ±5 mA

**Overdrive protection** ........ ±25 V

**Overdrive current** ............ 20 mA

**Power-on state** ............... ±5 mV

**Power-on glitch** .............. 1.2 V peak for 12 ms

**Output FIFO size** ............. 8,191 samples shared among channels used
Data transfers .......................DMA
(Scatter-gather),
interrupts,
programmed I/O

AO waveform modes:
• Non-periodic waveform
• Periodic waveform regeneration mode from onboard FIFO
• Period waveform regeneration from host buffer including dynamic update

Settling time, full scale step
15 ppm (1 LSB) ......................2 µs

Slew rate ..............................20 V/µs

Glitch energy at midscale transition, ±10 V range
  Magnitude ..............................10 mV
  Duration ..............................1 µs

External Reference
APFI <0..1> characteristics
  Input impedance ...............10 kΩ
  Coupling .........................DC
  Protection
    Power on ...............±30 V
    Power off ...............±15 V

Range ..............................±11 V
Slew rate ..............................20 V/µs

Calibration (AI and AO)
Recommended warm-up time ...............15 minutes
Calibration interval .......... 2 years

Diagram: AO <0..3> Analog Output External Reference Bandwidth

Table: DAC Output CODE (HEX)

<table>
<thead>
<tr>
<th>Value</th>
<th>Normalized AO Amplitude</th>
<th>Attenuation (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>800F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>803F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80FF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>83FF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8FFF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FFFF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Diagram: Normalized AO Amplitude vs. Frequency (Hz)
## AI Absolute Accuracy Table

<table>
<thead>
<tr>
<th>Nominal Range</th>
<th>Positive Full Scale</th>
<th>Negative Full Scale</th>
<th>Residual Gain Error (ppm of Reading)</th>
<th>Gain Tempco (ppm/°C)</th>
<th>Reference Tempco</th>
<th>Residual Offset Error (ppm of Range)</th>
<th>Offset Tempco (ppm of Range/°C)</th>
<th>INL Error (ppm of Range)</th>
<th>Random Noise, σ (µV rms)</th>
<th>Absolute Accuracy at Full Scale (µV)</th>
<th>Sensitivity (µV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>-10</td>
<td>60</td>
<td>13</td>
<td>1</td>
<td>20</td>
<td>21</td>
<td>60</td>
<td>280</td>
<td>1,920</td>
<td>112.0</td>
<td>56.0</td>
</tr>
<tr>
<td>5</td>
<td>-5</td>
<td>70</td>
<td>13</td>
<td>1</td>
<td>20</td>
<td>21</td>
<td>60</td>
<td>140</td>
<td>1,010</td>
<td>56.0</td>
<td>12.8</td>
</tr>
<tr>
<td>2</td>
<td>-2</td>
<td>70</td>
<td>13</td>
<td>1</td>
<td>20</td>
<td>24</td>
<td>60</td>
<td>57</td>
<td>410</td>
<td>22.8</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>-1</td>
<td>80</td>
<td>13</td>
<td>1</td>
<td>20</td>
<td>27</td>
<td>60</td>
<td>32</td>
<td>220</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>0.5</td>
<td>-0.5</td>
<td>90</td>
<td>13</td>
<td>1</td>
<td>40</td>
<td>34</td>
<td>60</td>
<td>21</td>
<td>130</td>
<td>12.8</td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>-0.2</td>
<td>130</td>
<td>13</td>
<td>1</td>
<td>80</td>
<td>55</td>
<td>60</td>
<td>16</td>
<td>74</td>
<td>6.4</td>
<td></td>
</tr>
<tr>
<td>0.1</td>
<td>-0.1</td>
<td>150</td>
<td>13</td>
<td>1</td>
<td>150</td>
<td>90</td>
<td>60</td>
<td>15</td>
<td>52</td>
<td>6.0</td>
<td></td>
</tr>
</tbody>
</table>

1 Absolute accuracy at full scale on the analog input channels is determined using the following assumptions:
- `TempChangeFromLastExternalCal` = 10 °C
- `TempChangeFromLastInternalCal` = 1 °C
- `number_of_readings` = 100
- `CoverageFactor` = 3

2 Sensitivity is the smallest voltage change that can be detected. It is a function of noise.

Absolute Accuracy = Reading · (GainError) + Range · (OffsetError) + NoiseUncertainty

Gain Error = Residual AI Gain Error + Gain Tempco · (TempChangeFromLastInternalCal) + Reference Tempco · (TempChangeFromLastExternalCal)

Offset Error = Residual AI Offset Error + Offset Tempco · (TempChangeFromLastInternalCal) + INL Error

Noise Uncertainty = \[\frac{\text{RandomNoise} \cdot 3}{\sqrt{100}}\]

For a coverage factor of 3 σ and averaging 100 points.

For example, on the 10 V range, the absolute accuracy at full scale is as follows:

Gain Error = 60 ppm + 13 ppm · 1 + 1 ppm · 10
Gain Error = 83 ppm

Offset Error = 20 ppm + 21 ppm · 1 + 60 ppm
Offset Error = 101 ppm

Noise Uncertainty = \[\frac{275 \, \mu V \cdot 3}{\sqrt{100}}\]

Noise Uncertainty = 83 µV

Absolute Accuracy = 10 V · (GainError) + 10 V · (OffsetError) + Noise Uncertainty
Absolute Accuracy = 1920 µV
### AO Absolute Accuracy Table

<table>
<thead>
<tr>
<th>Nominal Range</th>
<th>Residual Gain Error (ppm of Reading)</th>
<th>Gain Tempco (ppm/°C)</th>
<th>Reference Tempco</th>
<th>Residual Offset Error (ppm of Range)</th>
<th>Offset Tempco (ppm of Range/°C)</th>
<th>INL Error (ppm of Range)</th>
<th>Absolute Accuracy at Full Scale¹ (µV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Full Scale</td>
<td>Negative Full Scale</td>
<td>10</td>
<td>-10</td>
<td>75</td>
<td>17</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>-5</td>
<td>85</td>
<td>8</td>
<td>1</td>
<td>40</td>
<td>2</td>
<td>64</td>
</tr>
</tbody>
</table>

¹ Absolute Accuracy at full scale numbers is valid immediately following internal calibration and assumes the device is operating within 10 °C of the last external calibration.

\[
\text{Absolute Accuracy} = \text{Output Value} \cdot (\text{Gain Error}) + \text{Range} \cdot (\text{Offset Error})
\]

\[
\text{Gain Error} = \text{Residual Gain Error} + \text{Gain Tempco} \cdot (\text{Temp Change From Last Internal Cal}) + \text{Reference Tempco} \cdot (\text{Temp Change From Last External Cal})
\]

\[
\text{Offset Error} = \text{Residual Offset Error} + \text{AO Offset Tempco} \cdot (\text{Temp Change From Last Internal Cal}) + \text{INL Error}
\]
Digital I/O/PFI

Static Characteristics

Number of channels

NI 6250/NI 6251 .............. 24 total,
8 (P0.<0..7>),
16 (PFI <0..15>/
P1/P2)

NI 6254/NI 6259 .............. 48 total,
32 (P0.<0..31>),
16 (PFI <0..15>/
P1/P2)

Ground reference ................. D GND

Direction control ................. Each terminal
individually
programmable as
input or output

Pull-down resistor ............... 50 kΩ to 75 kΩ

Input voltage protection1 .... ±20 V on up to
two pins

Waveform Characteristics
(Port 0 Only)

Terminals used

NI 6250/NI 6251 .............. Port 0 (P0.<0..7>)
NI 6254/NI 6259 .............. Port 0 (P0.<0..31>)

Port/sample size

NI 6250/NI 6251 .............. Up to 8 bits
NI 6254/NI 6259 .............. Up to 32 bits

Waveform generation
(DO) FIFO ........................... 2,047 samples

Waveform acquisition
(DI) FIFO ........................... 2,047 samples

DO or DI Sample
Clock source ...................... Any PFI, RTSI,
AI Sample or
Convert Clock,
AO Sample Clock,
DI change event, 
Ctr n Internal
Output, and many
other signals

PFI/Port 1/Port 2 Functionality

Functionality ...................... Static digital input,
Static digital output,
timing input,
timing output

Timing output sources .......... Many AI, AO,
counter, DI,
DO timing signals

Debounce filter settings ...... 125 ns, 6.425 µs,
2.54 ms, disable;
high and low
transitions;
selectable per input

---

1 Stresses beyond those listed under Input voltage protection may cause permanent damage to the device.
## Recommended Operation Conditions

<table>
<thead>
<tr>
<th>Level</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input high voltage ($V_{IH}$)</td>
<td>2.2 V</td>
<td>5.25 V</td>
</tr>
<tr>
<td>Input low voltage ($V_{IL}$)</td>
<td>0 V</td>
<td>0.8 V</td>
</tr>
<tr>
<td>Output high current ($I_{OH}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P0.&lt;0..31&gt;</td>
<td>—</td>
<td>—24 mA</td>
</tr>
<tr>
<td>PFI &lt;0..15&gt;/ P1/P2</td>
<td>—</td>
<td>—16 mA</td>
</tr>
<tr>
<td>Output low current ($I_{OL}$)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P0.&lt;0..31&gt;</td>
<td>—</td>
<td>24 mA</td>
</tr>
<tr>
<td>PFI &lt;0..15&gt;/P1/P2</td>
<td>—</td>
<td>16 mA</td>
</tr>
</tbody>
</table>

## Electrical Characteristics

<table>
<thead>
<tr>
<th>Level</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive-going threshold ($V_{T+}$)</td>
<td>—</td>
<td>2.2 V</td>
</tr>
<tr>
<td>Negative-going threshold ($V_{T–}$)</td>
<td>0.8 V</td>
<td>—</td>
</tr>
<tr>
<td>Delta VT hysteresis ($V_{T+} – V_{T–}$)</td>
<td>0.2 V</td>
<td>—</td>
</tr>
<tr>
<td>$I_{IL}$ input low current ($V_{in} = 0$ V)</td>
<td>—</td>
<td>—10 μA</td>
</tr>
<tr>
<td>$I_{IH}$ input high current ($V_{in} = 5$ V)</td>
<td>—</td>
<td>250 μA</td>
</tr>
</tbody>
</table>
Digital I/O Characteristics

Digital I/O (P0.<0..31>): $I_{oh}$ versus $V_{oh}$

Digital I/O (PFI<0..15>/P1/P2): $I_{oh}$ versus $V_{oh}$

Digital I/O (P0.<0..31>): $I_{ol}$ versus $V_{ol}$

Digital I/O (PFI<0..15>/P1/P2): $I_{ol}$ versus $V_{ol}$
General-Purpose Counter/Timers

Number of counter/timers ....2
Resolution .......................32 bits
Counter measurements .......Edge counting, pulse, semi-period, period, two-edge separation
Position measurements ........X1, X2, X4 quadrature encoding with Channel Z reloading; two-pulse encoding
Output applications ..........Pulse, pulse train with dynamic updates, frequency division, equivalent time sampling
Internal base clocks ..........80 MHz, 20 MHz, 0.1 MHz

External base clock frequency ........0 MHz to 20 MHz
Base clock accuracy ..........50 ppm
Inputs .............................Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down
Routing options for inputs ....Any PFI, RTSI, PXI_TRIG, PXI_STAR, analog trigger, many internal signals
FIFO ..............................2 samples
Data transfers ..................Dedicated scatter-gather DMA controller for each counter/timer; interrupts; programmed I/O

Frequency Generator

Number of channels ........... 1
Base clocks ...................... 10 MHz, 100 kHz
Divisors ..........................1 to 16
Base clock accuracy ..........50 ppm
Output can be available on any PFI or RTSI terminal.

Phase-Locked Loop (PLL)

Number of PLLs ............... 1
Reference signal ............... PXI_STAR, PXI_CLK10, RTSI <0..7>
Output of PLL ...................80 MHz Timebase; other signals derived from 80 MHz Timebase including 20 MHz and 100 kHz Timebases

External Digital Triggers

Source ............................ Any PFI, RTSI, PXI_TRIG, PXI_STAR
Polarity ........................... Software-selectable for most signals
Analog input function ....... Start Trigger, Reference Trigger, Pause Trigger, Sample Clock, Convert Clock, Sample Clock Timebase
Analog output function ...... Start Trigger, Pause Trigger, Sample Clock, Sample Clock Timebase
Counter/timer functions........ Gate, Source, HW_Arm, Aux, A, B, Z, Up_Down

Digital waveform generation (DO) function................... Sample Clock

Digital waveform acquisition (DI) function................... Sample Clock

**Device-To-Device Trigger Bus**

PCI devices.......................... RTSI <0..7> 1

PXI devices ....................... PXI_TRIG <0..7>, PXI_STAR

Output selections ................. 10 MHz Clock; frequency generator output; many internal signals

Debounce filter settings...... 125 ns, 6.425 µs, 2.54 ms, disable; high and low transitions; selectable per input

**Power Requirements**

Current draw from bus during no-load condition
+5 V .................................. 0.03 A
+3.3 V ................................ 0.725 A
+12 V ................................ 0.35 A

Current draw from bus during AI and AO overvoltage condition
+5 V .................................. 0.03 A
+3.3 V ................................ 1.2 A
+12 V ................................ 0.38 A

Power available from
+5 V terminal..................... 1 A max, each connector, with self-resetting fuse

Other power limit for PXI devices............. Current drawn from +5 V terminals and all P0/PFI/P1/P2 terminals should not exceed 2 A

**Bus Interface**

PCI or PXI................. 3.3 V or 5 V signal environment

DMA channels................. 6, analog input, analog output, digital input, digital output, counter/timer 0, counter/timer 1

**Physical Requirements**

Printed circuit board dimensions
NI PCI 6250/6251/6254/6259 ............ 9.7 cm × 15.5 cm (3.8 in. × 6.1 in.)

NI PXI 6250/6251/6254/6259 ............. Standard 3U PXI

I/O connector
NI 6250/NI 6251.............. 1 68-pin VHDCI
NI 6254/NI 6259.............. 2 68-pin VHDCI

---

1 In other sections of this document, RTSI refers to RTSI <0..7> for PCI devices or PXI_TRIG <0..7> for PXI devices.
Maximum Working Voltage

NI 6250/NI 6251/NI 6254/NI 6259

Channel to earth ...............11 V, Installation Category I
Channel to channel ...........11 V, Installation Category I

Environmental

Operating temperature ..........0 to 55 °C
Storage temperature ..........–20 to 70 °C
Humidity ..................................10 to 90% RH, noncondensing
Maximum altitude ............2,000 m
Pollution Degree (indoor use only) ..........2

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1
- CAN/CSA C22.2 No. 61010-1

Note For UL and other safety certifications, refer to the product label, or visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

Emissions ...................... EN 55011 Class A at 10 m FCC Part 15A above 1 GHz
Immunity ....................... EN 61326:1997 + A2:2001, Table 1
CE, C-Tick, and FCC Part 15 (Class A) Compliant

Note For EMC compliance, operate this device with shielded cabling.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

Low-Voltage Directive (safety) ................. 73/23/EEC
Electromagnetic Compatibility Directive (EMC) ............... 89/336/EEC

Note Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit ni.com/certification, search by model number or product line, and click the appropriate link in the Certification column.

1 Maximum working voltage refers to the signal voltage plus the common-mode voltage.

© 2004 National Instruments Corp. All rights reserved.