100 MHz Digital Adapter Module for NI FlexRIO

**Overview**

The NI 6581 is a 100 MHz digital adapter module for NI FlexRIO field-programmable gate array (FPGA) modules. This adapter module features 54 single-ended digital I/O lines with software-selectable voltages of 1.8, 2.5, and 3.3 V (5 V tolerant). You can combine it with an NI FlexRIO FPGA module to create an NI FlexRIO digital instrument (NI PXI-6581R) for a wide variety of applications from high-speed communication with a device under test to custom protocol emulation. You can also use this adapter module with an NI FlexRIO FPGA module for the following:

- Customized semiconductor testing
- Electronics testing
- Implementation and testing of standard protocols such as SPI and I2C, both as a master or slave

In addition, you can configure the digital I/O lines as custom counter/timers, pulse-width modulation (PWM) channels, or communication buses for user-defined protocols or applications requiring serial triggering. You can even customize the communications with the onboard DRAM for optimized streaming operations.

**Features**

At sampling rates of 100 MHz, you can program the banks of I/O lines independently to implement read or write operations or synchronize multiple banks. You can configure the NI 6581 module for 1.8, 2.5, 3.3, or 5 V (TTL) logic. You also can use an external source (such as a PXI programmable power supply) as a voltage reference (1.8 to 5.5 V), for each connector independently, to create custom voltage references.

**Programmable Onboard FPGA**

NI FlexRIO FPGA modules for PXI include user-programmable FPGAs for onboard processing and flexible I/O operation. You can implement customizable features such as hardware compare, waveform linking/looping, and other hardware-based algorithms inside the onboard FPGA through the LabVIEW FPGA programming environment or through VHDL.

The NI 6581 adapter module with the NI FlexRIO FPGA modules can perform truly parallel data processing on the FPGA, which would otherwise be too processor- and time-intensive in software. This instrument is programmable with the NI-RIO driver and LabVIEW FPGA Module for not only high-speed digital acquisition and generation but also hardware-implemented signal processing and control.

The new Virtex-5 FPGA architecture is optimized to execute faster and more efficiently using single-cycle timed loops in LabVIEW FPGA. This means you can optimize more LabVIEW FPGA code to fit within Virtex-5 FPGAs and execute more operations per clock cycle.

**NI 6581** NEW!

- 100 MHz maximum clock rate
- 54 single-ended digital I/O channels
- Selectable voltages of 1.8, 2.5, 3.3, and 5.0 V or external reference voltage (1.8 to 5.5 V)
- Mates with an NI FlexRIO FPGA module for reliable and deterministic control of digital communication and tests

**Operating Systems**

- Windows Vista/XP/2000
- LabVIEW Real-Time

**Required Software**

- LabVIEW
- LabVIEW FPGA Module

**Recommended Software**

- LabVIEW Real-Time Module

**Driver Software (included)**

- NI-RIO

**Applications**

- Digital Interfacing
- Aerospace/Defense
- Communications
- Consumer Electronics

**Operating Systems**

- Windows Vista/XP/2000
- LabVIEW Real-Time

**Required Software**

- LabVIEW
- LabVIEW FPGA Module

**Recommended Software**

- LabVIEW Real-Time Module

**Driver Software (included)**

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In addition, you can configure the digital I/O lines as custom counter/timers, pulse-width modulation (PWM) channels, or communication buses for user-defined protocols or applications requiring serial triggering. You can even customize the communications with the onboard DRAM for optimized streaming operations.
Graphical Programming with LabVIEW FPGA
The LabVIEW FPGA Module uses LabVIEW embedded technology to extend LabVIEW graphical development and target FPGAs on NI reconfigurable I/O (RIO) hardware. LabVIEW is distinctly suited for FPGA programming because it clearly represents parallelism and data flow. With the LabVIEW FPGA Module, you can create custom measurement and control hardware without low-level hardware description languages or board-level design. You can use this custom hardware for unique timing and triggering routines, ultrahigh-speed control, interfacing to digital protocols, digital signal processing (DSP), and many other applications requiring high-speed hardware reliability and tight determinism.

Connectivity Options
The NI 6581 adapter module has two VHDCI connectors. Each connector has 24 general-purpose digital I/O lines, three PFI lines, one clock-out line, and one clock-in line. You can connect the NI 6581 using an NI SHC68-C68-D4 shielded single-ended cable to a terminal block such as the NI SMB-2163 for SMB connectivity or the NI CB-2162 for direct termination. The pinout of the NI 6581 is the same as the pinout of NI high-speed digital instruments such as NI 654x devices.

Required Software
NI FlexRIO products require Version 8.6 or later of LabVIEW and the LabVIEW FPGA Module as well as NI-RIO Version 3.1 or later driver software.

Ordering Information
NI 6581 ..................................................................................780565-01
NI FlexRIO FPGA Modules
NI PXI-7951R .................................................................780560-01
NI PXI-7952R .................................................................780561-01
NI PXI-7953R .................................................................780562-01
NI PXI-7954R .................................................................780563-01
Cables
NI SHC68-C68-D4 (shielded single-ended cable) ..............196275-01
NI C68-C68-D4 (unshielded 1 m cable) ..........................195949-01
NI SHC68-H1X38 (flying lead 1.5 m cable) .......................192681-1R5
Terminal Blocks
NI CB-2162 (terminal block with pin headers) .................778592-01
NI SMB-2163 (SMB breakout box) ..................................778747-01
Header jumper kit ..........................................................199101-01
Connectors
Dual-stacked VHDCI connector, 68-pin, right-angle ...........780390-01
VHDCI connector, 68-pin, vertical ....................................780389-01
VHDCI connector, 68-pin, right-angle .............................778914-01

For complete product specifications, pricing, and accessory information, call 800 813 3693 (U.S.) or go to ni.com/flexrio.
Specifications

This document lists the specifications of the NI 6581 adapter module for NI FlexRIO. Pair these specifications with your NI FlexRIO FPGA module specifications. Refer to the Getting Results with the NI PXI-6581R document for instructions on how to install and configure the NI PXI-6581R. These specifications are typical at 25 °C unless otherwise noted. For detailed specifications, see NI 6581 Specifications at ni.com/manuals.

Channel Specifications per Connector

Number of DDC connectors ............... 2, DDCA and DDCB
Number of digital I/O channels .......... 54 total (48 data, 6 PFI)
27 per DDC connector

Direction control of data channels
P0.<0..7> ......................................... Per 8-bit port
P1.<0..7> ......................................... Per 8-bit port
P2.<0..7> ......................................... Per 8-bit port

Direction control of PFI channels
CLOCK OUT/PFI 0 .......................... Output only
PFI <1..3> ........................................ All input or output, per port per connector

Note: Digital I/O signals, P0.<0..7>, P1.<0..7>, P2.<0..7>, and PFI <0..3>, appear on both connectors, DDCA and DDCB.

Generation voltage levels (P0.<0..7>, P1.<0..7>, P2.<0..7>, and PFI 0)

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Low-Voltage Levels Guaranteed</th>
<th>Typical</th>
<th>High-Voltage Levels Guaranteed</th>
<th>Typical</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 V</td>
<td>0.55 V</td>
<td>0 V</td>
<td>3.8 V</td>
<td>5 V</td>
</tr>
<tr>
<td>3.3 V</td>
<td>0.55 V</td>
<td>0 V</td>
<td>2.4 V</td>
<td>3.3 V</td>
</tr>
<tr>
<td>2.5 V</td>
<td>0.30 V</td>
<td>0 V</td>
<td>1.9 V</td>
<td>2.5 V</td>
</tr>
<tr>
<td>1.8 V</td>
<td>0.45 V</td>
<td>0 V</td>
<td>1.2 V</td>
<td>1.8 V</td>
</tr>
</tbody>
</table>

1 Voltage levels guaranteed by design through the digital buffer specification.
2 5 V only available through an external power supply.

Note: Each connector can be referenced to external or internal power supply.

Acquisition voltage levels (P0.<0..7>, P1.<0..7>, P2.<0..7>, and PFI 0)

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Guaranteed Low-Voltage Levels</th>
<th>Guaranteed High-Voltage Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 V</td>
<td>1.5 V</td>
<td>3.5 V</td>
</tr>
<tr>
<td>3.3 V</td>
<td>0.8 V</td>
<td>2.0 V</td>
</tr>
<tr>
<td>2.5 V</td>
<td>0.7 V</td>
<td>1.7 V</td>
</tr>
<tr>
<td>1.8 V</td>
<td>0.6 V</td>
<td>1.2 V</td>
</tr>
</tbody>
</table>

1 Voltage levels guaranteed by design through the digital buffer specification.
2 5 V only available through an external power supply.

Note: Each connector can be referenced to external or internal power supply.

Note: The I/O buffer performance on the NI 6581 is similar to the buffer performance specifications for the TI SN74LVCH124 transceiver. The performance is correlated to supply voltage. I/O timing performance degrades as supply voltage decreases.

P0.<0..7>, P1.<0..7>, P2.<0..7>, and PFI 1..3

- Output impedance (nominal) ........... 50 Ω series
- Maximum input leakage .................. ±6 μA
- Characteristic impedance ............... 50 Ω traces
- Power-on state .......................... Drivers disabled
- Absolute maximum input range ........ -0.5 to 6.5 V

CLOCK OUT/PFI 0

- Output impedance (nominal) ........... 50 Ω
- Maximum output voltage range ........ 1.8 to 5.5 V, output only
- Maximum toggle rate ..................... 100 MHz at ≥3.3 V

GLOBAL CLOCK <0..1>

- Direction .................................. Input into device

Note: Clock is connected to NI FlexRIO FPGA module global clock inputs.

- Maximum input leakage .................. ±4 μA
- Characteristic impedance ............... 50 Ω traces
- Power-on state .......................... Drivers disabled
- Absolute maximum input range ........ -0.5 to 6.5 V
- Maximum toggle rate ..................... 100 MHz at ≥3.3 V

BUY ONLINE at ni.com or CALL 800 813 3693 (U.S.)
Pinout and Signal Information

**Note:** Digital I/O signals, P0.<0..7>, P1.<0..7>, P2.<0..7>, and PFI <0..3>, appear on both connectors, DDCA and DDCB.
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### NI 6581 DDC Connector Pins

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>Pin(s)</th>
<th>Signal Type</th>
<th>Signal Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLOBAL CLOCK 0</td>
<td>67 on DDCA</td>
<td>Control</td>
<td>Input terminal for the external sample clock source, which can be used for dynamic acquisition.</td>
</tr>
<tr>
<td>PB &lt;1..3&gt;</td>
<td>25, 27, 29, 31, 59, 61, 63, 65</td>
<td>Data/Control</td>
<td>Bidirectional Port 0 digital I/O data channels 0 through 7.</td>
</tr>
<tr>
<td>P1 &lt;1..7&gt;</td>
<td>17, 19, 21, 23, 51, 53, 55, 57</td>
<td>Data/Control</td>
<td>Bidirectional Port 1 digital I/O data channels 0 through 7.</td>
</tr>
<tr>
<td>P2 &lt;1..7&gt;</td>
<td>9, 11, 13, 15, 43, 45, 47, 49</td>
<td>Data/Control</td>
<td>Bidirectional Port 2 digital I/O data channels 0 through 7.</td>
</tr>
<tr>
<td>CLOCK OUT/PFI 0</td>
<td>33</td>
<td>Control</td>
<td>Output terminal for the exported sample clock.</td>
</tr>
<tr>
<td>PFI &lt;1..3&gt;</td>
<td>26, 30, 64</td>
<td>Data/Control</td>
<td>Bidirectional digital I/O channels 1 through 3.</td>
</tr>
<tr>
<td>GND</td>
<td>2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58, 60, 62, 64</td>
<td>Ground</td>
<td>Ground reference for signals.</td>
</tr>
<tr>
<td>RESERVED</td>
<td>1, 3, 5, 7, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49</td>
<td>N/A</td>
<td>These terminals are reserved for future use. Do not connect to these pins.</td>
</tr>
<tr>
<td>No Connect</td>
<td>60</td>
<td>N/A</td>
<td>Do not connect to this pin.</td>
</tr>
</tbody>
</table>

Table 1. Pin Location and Signal Information for the NI 6581

### NI 6581 Power Connector Terminals

<table>
<thead>
<tr>
<th>External Power Terminal Name</th>
<th>Terminal Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>Ground reference for external power</td>
</tr>
<tr>
<td>+VA</td>
<td>External power terminal for DDCA connector</td>
</tr>
<tr>
<td>+VB</td>
<td>External power terminal for DDDB connector</td>
</tr>
</tbody>
</table>

Table 2. External Power Connector Terminal Information for the NI 6581

### Power

- **Internal power source**
  - Power requirements from the NI FlexRIO FPGA module:
    - +3.3 V ......................................... 200 mA, maximum
    - +12 V.......................................... 250 mA, maximum
  - **External power source**
    - **Voltage range** ............................. 1.8 to 5.5 V
    - **Current** ................................... 0.7 A at 3.3 V driving a 1 k load, all channels toggling with a PRBS pattern at full rate
  - **Power dissipation**
    - VA power + VB power .......................... <5 W, maximum
    - Capacitance on +VA and +VB .......... 50 µF per rail
  - **Note:** With higher voltages, it is possible to exceed the power dissipation limit.
  - **Maximum DC drive strength**
    - 5 V........................................... 32 mA
    - 3.3 V......................................... 24 mA
    - 2.5 V......................................... 8 mA
    - 1.8 V.......................................... 4 mA
  - **Note:** You must wait at least 10 ms after changing the power supply to allow the rails to settle to their new voltage before acquiring or generating data.

### Physical

- **Dimensions**................................. 12.9 by 2.0 by 12.1 cm
  (5.1 by 0.8 by 4.7 in.)
- **Weight**.................................. 284 g (10 oz)
- **Front panel connectors** ........... Two 68-pin VHDCI connectors
- **Spring-terminal wiring** ............... 18 to 28 AWG copper conductor wire with 7 mm (0.28 in.) of insulation stripped from the end

### Environmental

- **The NI 6581 is intended for indoor use only.**
- **Operating environment** ............. 0 to 55 °C (tested in accordance with IEC-60068-2-1 and IEC-60068-2-2)
- **Relative humidity range** ............. 10 to 90%, noncondensing (tested in accordance with IEC-60068-2-56)
- **Storage environment** ................. Ambient temperature range .... -20 to 70 °C (tested in accordance with IEC-60068-2-1 and IEC-60068-2-2)
- **Relative humidity range** ............. 5 to 95%, noncondensing (tested in accordance with IEC-60068-2-56)

- **Note:** Clean the device with a soft, nonmetallic brush. Make sure that the device is completely dry and free from contaminants before returning it to service.
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, CSA 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
This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:
• EN 61326 (IEC 61326): Class A emissions; Basic immunity
• EN 55011 (CISPR 11): Group 1, Class A emissions
• AS/NZS CISPR 11: Group 1, Class A emissions
• FCC 47 CFR Part 15B: Class A emissions
• ICES-001: Class A emissions

Note: For EMC compliance, operate this product according to the documentation.

CE Compliance
This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:
• 2006/95/EC; Low-Voltage Directive (safety)
• 2004/108/EC; Electromagnetic Compatibility Directive (EMC)

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.

Environmental Management
NI is committed to designing and manufacturing products in an environmentally responsible manner. NI recognizes that eliminating certain hazardous substances from our products is beneficial to the environment and to NI customers.

For additional environmental information, refer to the NI and the Environment Web page at ni.com/environment. This page contains the environmental regulations and directives with which NI complies, as well as other environmental information not included in this document.

Waste Electrical and Electronic Equipment (WEEE)
EU Customers: At the end of their life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit ni.com/environment/weee.htm.
NI Services and Support

NI has the services and support to meet your needs around the globe and through the application life cycle – from planning and development through deployment and ongoing maintenance. We offer services and service levels to meet customer requirements in research, design, validation, and manufacturing. Visit ni.com/services.

Training and Certification

NI training is the fastest, most certain route to productivity with our products. NI training can shorten your learning curve, save development time, and reduce maintenance costs over the application life cycle. We schedule instructor-led courses in cities worldwide, or we can hold a course at your facility. We also offer a professional certification program that identifies individuals who have high levels of skill and knowledge on using NI products. Visit ni.com/training.

Professional Services

Our NI Professional Services team is composed of NI applications and systems engineers and a worldwide National Instruments Alliance Partner program of more than 600 independent consultants and integrators. Services range from start-up assistance to system assurance programs and turnkey system integration. Visit ni.com/alliance.

OEM Support

We offer design-in consulting and product integration assistance if you want to use our products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Local Sales and Technical Support

In offices worldwide, our staff is local to the country, giving you access to engineers who speak your language. NI delivers industry-leading technical support through online knowledge bases, our applications engineers, and access to 14,000 measurement and automation professionals within NI Developer Exchange forums. Find immediate answers to your questions at ni.com/support.

We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit ni.com/ssp.

Hardware Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration Services

NI recognizes the need to maintain properly calibrated devices for high-accuracy measurements. We provide manual calibration procedures, services to recalibrate your products, and automated calibration software specifically designed for use by metrology laboratories. Visit ni.com/calibration.

Repair and Extended Warranty

NI provides complete repair services for our products. Express repair and advance replacement services are also available. We offer extended warranties to help you meet project life-cycle requirements. Visit ni.com/services.

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