IOB_x Digital I/O Module

Summary

This core reference describes how to place and use the Digital I/O Module in an FPGA design.

Core Reference
CR0102 (v2.1) August 11, 2008

The IOB_x family of devices provide a range of 8- or 16-bit digital I/O instruments for use in an FPGA design. Each device features separated inputs and outputs, allowing you to monitor and display signal levels, as well as define control signals for use elsewhere in the design.

📖 For information on the configurable digital IO module – DIGITAL_IO – refer to the document *CR0179 DIGITAL_IO Configurable Digital IO Module*. Unlike its legacy counterparts (IOB_x family of devices), with the DIGITAL_IO device you are not constrained to limited signals of 8- or 16-bits. Instead, any number of signals may be added, and any number of bits can be assigned to a single signal. You may also have different numbers of input and output signals. The DIGITAL_IO device also brings more variety in the way the inputs and outputs are displayed.

Features

- 1-, 2- or 4-channel devices
    - 8-bit data
    - 16-bit data
- Separated inputs and outputs
- Two-level display of inputs
    - Hexadecimal value
    - Bit-level display
- Two-level control of outputs
    - Hexadecimal entry of entire value
    - Bit-level control.

Available devices

The following Digital I/O instruments are available:

IOB_1X8   -   1-channel by 8-bit digital I/O

IOB_2X8   -   2-channel by 8-bit digital I/O

IOB_4X8   -   4-channel by 8-bit digital I/O

IOB_1X16   -   1-channel by 16-bit digital I/O

IOB_2X16   -   2-channel by 16-bit digital I/O

IOB_4X16   -   4-channel by 16-bit digital I/O.

All of the devices in the IOB_x family can be found in the FPGA Instruments integrated library (`FPGA Instruments.IntLib`), located in the `\Library\Fpga` folder of the installation.

IOB_x Digital I/O Module

Functional description

Symbol
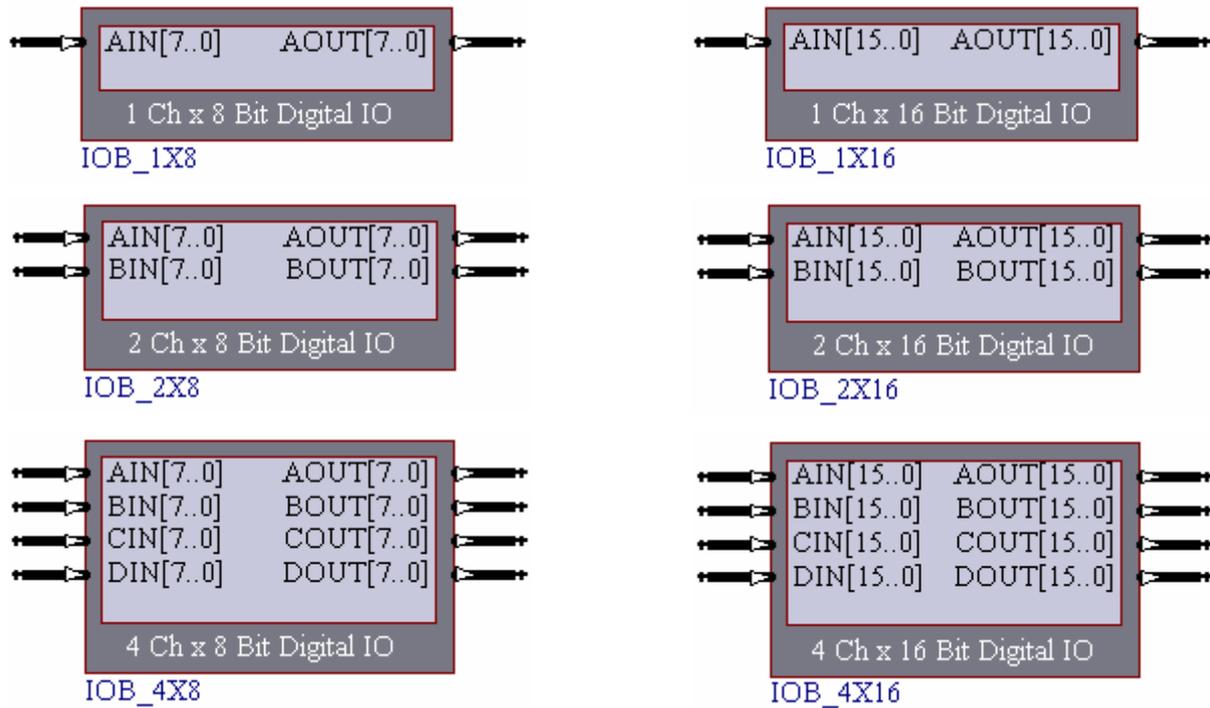
Figure 1. IOB_x Symbols

Pin description

Table 1. IOB_x Pin description

Name	Type	Polarity/ Bus size	Description
Digital I/O Module Input Signals			
AIN	I	8/16	Channel A input
BIN	I	8/16	Channel B input
CIN	I	8/16	Channel C input
DIN	I	8/16	Channel D input
Digital I/O Module Output Signals			
AOUT	O	8/16	Channel A output
BOUT	O	8/16	Channel B output
COUT	O	8/16	Channel C output
DOUT	O	8/16	Channel D output

Operation

Placing an IOB_x device in a design

The IOB_x family of devices provide a simple method of monitoring/generating 8- or 16-bit digital signals in a design. Figure 2 shows an example of how a Digital I/O device is wired into a design.
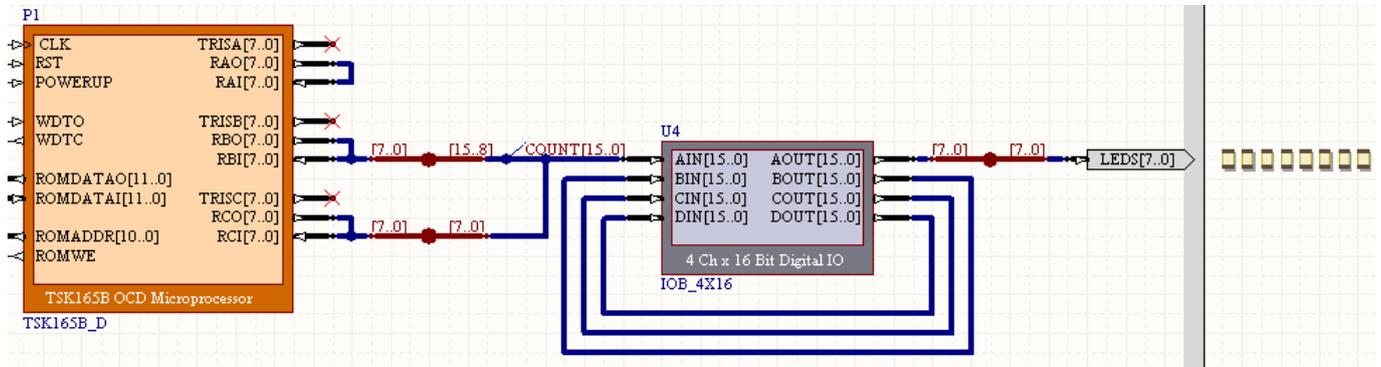
Figure 2. Using an IOB_x device to monitor/generate digital I/O in a design.

In the example circuit above, the Digital I/O device used is the IOB_4X16. Channel A input is used to monitor the 16-bit digital output formed by the concatenated outputs of Ports B and C from a TSK165B_D microcontroller (in this case the 16-bit output of an embedded counting process).

Channel A output is connected to the LEDs on the NanoBoard which, in turn, can be used to display a separately defined 8-bit output value.

The other three output channels (B, C and D) are connected to their corresponding input channels. Whatever is set on the output side of the device will be fed back and displayed on the input side.

Note: In order to communicate with soft devices in a design (processors and/or virtual instruments) you must enable the soft devices JTAG chain within the design. This is done by placing a JTAG Port (NEXUS_JTAG_CONNECTOR) and corresponding Soft Nexus-Chain Connector (NEXUS_JTAG_PORT) on the top schematic sheet of the design, as shown in Figure 3.
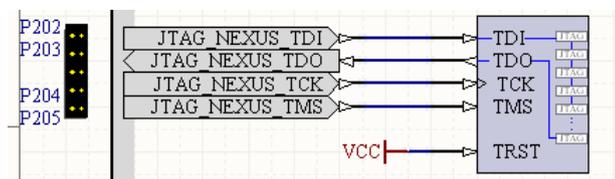
Figure 3. Implementing the soft devices chain within the design

These devices can be found in the FPGA NB2DSK01 Port-Plugin (FPGA NB2DSK01 Port-Plugin.IntLib) and FPGA Generic (FPGA Generic.IntLib) integrated libraries respectively, both of which are located in the \Library\Fpga folder of the installation.

Accessing the Digital I/O Module Controls

The host computer is connected to the target Digital I/O instrument using the IEEE 1149.1 (JTAG) standard interface. This is the physical interface, providing connection to physical pins of the FPGA device in which the instrument has been embedded.

The Nexus 5001 standard is used as the protocol for communications between the host and all devices that are debug-enabled with respect to this protocol. This includes the digital I/O modules, as well as other Nexus-compliant devices such as OCD-version microcontrollers, frequency generators, logic analyzers and counters.

All such devices are connected in a chain – the Soft Devices chain – which is determined when the design has been implemented within the target FPGA device and presents in the **Devices** view (Figure 4). It is not a physical chain, in the sense that you can see no external wiring – the connections required between the Nexus-enabled devices are made internal to the FPGA itself.

IOB_x Digital I/O Module
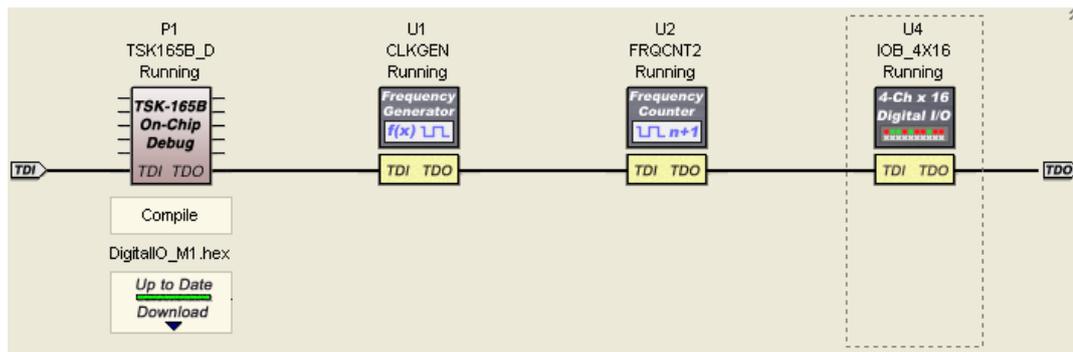
Figure 4. Nexus-enabled devices appearing in the Soft Devices chain

For instruments such as the IOB_x, the Nexus protocol enables you to access the registers used for controlling the device. These registers are not exposed as such, rather input to them is provided through an instrument panel, which allows you to:

- View digital inputs
- Set digital outputs

The controls for a Digital I/O Module used in a design can be accessed from the **Devices** view. Simply double click on the icon representing the Digital I/O Module whose controls you wish to access, in the **Soft Devices** region of the View. The Instrument Rack – Soft Devices panel will appear, with the chosen instrument added to the rack (Figure 5)[1].
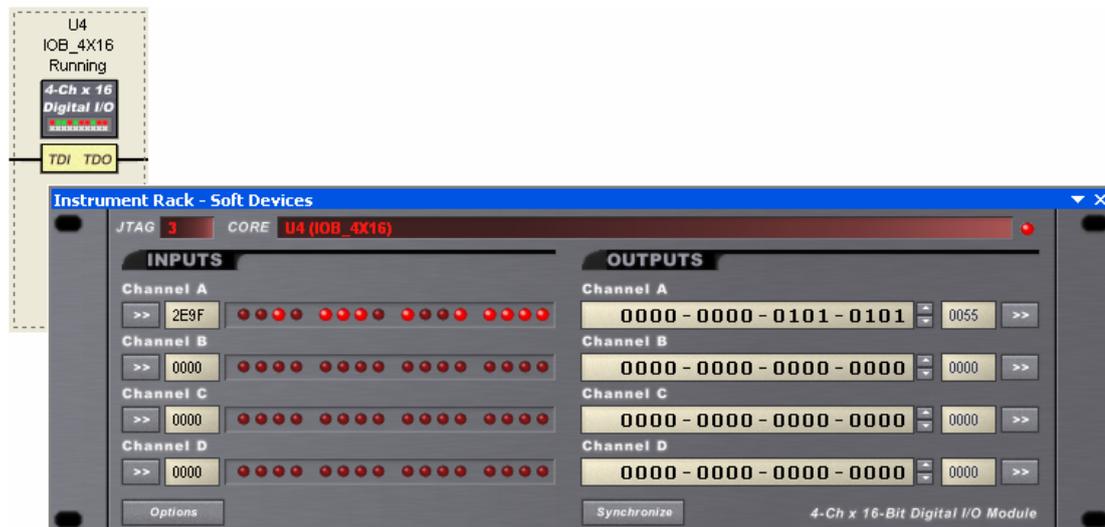
Figure 5. Accessing the Digital I/O Module Instrument Panel

Note: Each Digital I/O Module that you have included in the design will appear, when double-clicked, as an Instrument in the rack (along with any other Nexus-enabled devices).

Operating the Digital I/O Module – Controls

The instrument panel for a Digital I/O device contains various controls and options that allow you to effectively use the instrument in your design. The following sections discuss each of the available controls in greater detail.

Monitoring digital signals - Inputs

The **INPUTS** region of the Instrument Panel allows you to monitor the digital signals that have been wired to the input channels of the device.

For each input channel, the value of the 8- or 16-bit signal is presented in hexadecimal format and also at the bit-level, using a graphical display of LEDs.

Any changes to input signals will be reflected on the panel in real-time, in accordance with defined polling (see *Polling*).

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[1] The Instrument Panel shown in Figure 5 is for a 4-channel, 16-bit Digital I/O Module. The Instrument Panels for the other devices in the IOB_x family will differ in the number of channels displayed and the number of bits per channel.

Generating digital signals - Outputs

The **OUTPUTS** region of the Instrument Panel allows you to generate digital signals for output to other areas of the design.

For each output channel, the value for the 8- or 16-bit digital signal to be generated can be specified either at the bit level, or by entering a complete hexadecimal value.

When specifying the signal – either at the bit level or with a direct hex value – any change made will be output in real-time, in accordance with defined polling (see *Polling*). So, for example, if you have an IOB_4X8 device, with channel A output hooked up to the LEDs on the NanoBoard, changing bit zero from a '0' to a '1' will instantly light the corresponding LED (LED0).

To extend this example a little further, you could also feed the output from channel A back to its corresponding input, as shown in Figure 6.
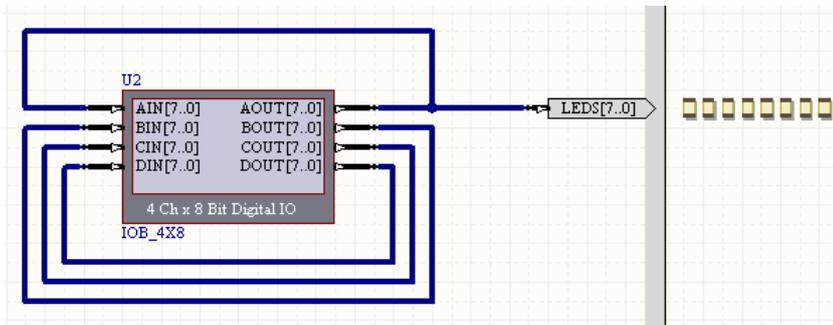
Figure 6. Generating and monitoring the same digital signal.

In this case, changing the output signal will reflect not only in the LEDs on the NanoBoard, but also in the display for the channel A input on the device's Instrument Panel. In Figure 7, setting bits 0, 2 and 5 of the channel A output signal sets (in this case changes to green) the corresponding bits 0, 2 and 5 in the bit-level display for the channel A input signal. On the NanoBoard, LED0, LED2 and LED5 would be lit also.
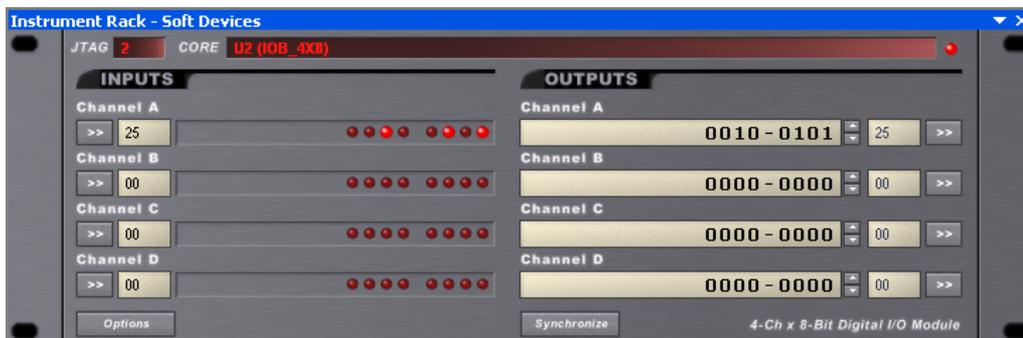
Figure 7. Direct feedback from output to input for channel A.

Polling

Click on the [Options] button, at the bottom left of the panel, to access the *Digital I/O Module – Options* dialog (Figure 8). Input values to, and output values from, the Digital I/O Module, are automatically refreshed (updated) in accordance with the value specified in the **Update Display From Core Every** field of this dialog. In other words, this is the defined polling interval for the instrument. By default, the values will be refreshed every 250ms.

You can, if desired, manually refresh the IO values to/from the instrument – manual polling if you will. Such polling can be engaged at the global level, affecting all input and outputs simultaneously, or at the individual input/output level:

Figure 8. Accessing instrument options.

- *Global IO update* – simply click the [Synchronize] button, at the bottom-center of the panel.

- *Individual input/output update* - click on the [>>] button associated with the input/output signal you wish to update.

Note: Use of the [Synchronize] or [>>] buttons is only logical if the Update value in the *Digital I/O Module – Options* dialog is set to either 0ms, or some longer time interval (e.g. 2000ms or more). If the IO values are left to be automatically refreshed at the default 250ms interval, this will be too quick to make use of these manual polling-related buttons!

IOB_x Digital I/O Module

Revision History

Date	Version No.	Revision
19-Dec-2003	1.0	New product release
27-May-2005	1.1	Updated for Altium Designer SP4
12-Dec-2005	1.2	Path references updated for Altium Designer 6
17-Mar-2008	2.0	Updated for Altium Designer Summer 08
11-Aug-2008	2.1	Updated in line with current functionality of the instrument: Information on use of Options and Synchronize buttons updated and moved into the new section – Polling. Information on Color Mode removed.