DS4003 Digital I/O Board

RTI Reference

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dSPACE

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About This Reference

Objective

This RTI Reference provides a full description of the Real-Time Interface (RTI) software support for the DS4003 Digital I/O Board.

Symbols

dSPACE user documentation uses the following symbols:

Symbol	Description
DANGER	Indicates a hazardous situation that, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation that, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a hazard that, if not avoided, could result in property damage.
Note	Indicates important information that you should take into account to avoid malfunctions.
Tip	Indicates tips that can make your work easier.
	Indicates a link that refers to a definition in the glossary, which you can find at the end of the document unless stated otherwise.
	Precedes the document title in a link that refers to another document.

Naming conventions

dSPACE user documentation uses the following naming conventions:

%name% Names enclosed in percent signs refer to environment variables for file and path names.

< > Angle brackets contain wildcard characters or placeholders for variable file and path names, etc.

Examples:

- Where you find terms such as `rti<XXXX>` replace them by the RTI platform support you are using, for example, `rti1007`.
- Where you find terms such as `<model>` or `<submodel>` in this document, replace them by the actual name of your model or submodel. For example, if the name of your Simulink model is `smd_1007_sl.slx` and you are asked to edit the `<model>_usr.c` file, you actually have to edit the `smd_1007_sl_usr.c` file.

RTI block name conventions All I/O blocks have default names based on dSPACE's board naming conventions:

- Most RTI block names start with the board name.
- A short description of functionality is added.
- Most RTI block names also have a suffix.

Suffix	Meaning
B	Board number (for PHS-bus-based systems)
M	Module number (for MicroAutoBox II)
C	Channel number
G	Group number
CON	Converter number
BL	Block number
P	Port number
I	Interrupt number

A suffix is followed by the appropriate number. For example, DS2201IN_B2_C14 represents a digital input block located on a DS2201 board. The suffix indicates board number 2 and channel number 14 of the block. For more general block naming, the numbers are replaced by variables (for example, DS2201IN_Bx_Cy).

Special folders

Some software products use the following special folders:

Common Program Data folder A standard folder for application-specific configuration data that is used by all users.

```
%PROGRAMDATA%\dSPACE\<InstallationGUID>\<ProductName>
```

or

```
%PROGRAMDATA%\dSPACE\<ProductName>\<VersionNumber>
```

Documents folder A standard folder for user-specific documents.

```
%USERPROFILE%\Documents\dSPACE\<ProductName>\
<VersionNumber>
```

Local Program Data folder A standard folder for application-specific configuration data that is used by the current, non-roaming user.

```
%USERPROFILE%\AppData\Local\dSPACE\<InstallationGUID>\
<ProductName>
```

Accessing dSPACE Help and PDF Files

After you install and decrypt dSPACE software, the documentation for the installed products is available in dSPACE Help and as PDF files.

dSPACE Help (local) You can open your local installation of dSPACE Help:

- On its home page via Windows Start Menu
- On specific content using context-sensitive help via **F1**

dSPACE Help (Web) You can access the Web version of dSPACE Help at www.dspace.com.

To access the Web version, you must have a *mydSPACE* account.

PDF files You can access PDF files via the icon in dSPACE Help. The PDF opens on the first page.

General Information on the DS4003 Blockset

Introduction

Here you get basic information on the DS4003 blockset.

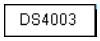
Overview of the DS4003 Blockset

About the board

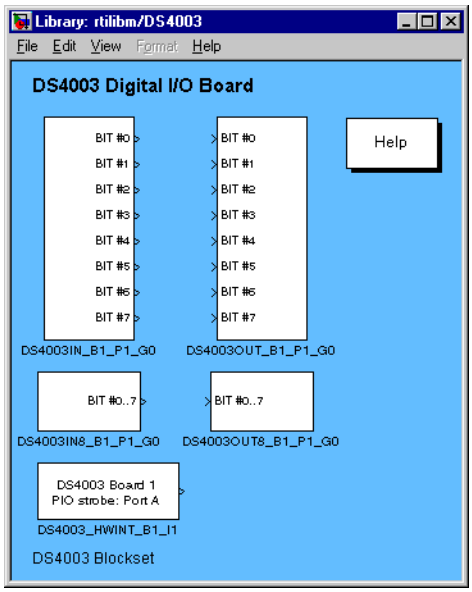
The DS4003 Timing and Digital I/O Board provides 96 bidirectional TTL digital I/O lines, divided into three 32-bit ports.

Access

The Real-Time Interface (RTI) board library for the DS4003 Timing and Digital I/O Board provides the RTI blocks that implement the functionality and I/O capabilities of the DS4003 board in Simulink models.



After you double-click the corresponding board library icon in the library **rtilibm** the **Library: rtilibm/DS4003** opens:



Library components

The following I/O units can be accessed by the RTI blockset for the DS4003:

- Digital I/O Unit on page 11
- Interrupts on page 23

Digital I/O Unit

Introduction

The Library: rtilibm/DS4003 provides access to the digital I/O unit of the DS4003.

Note

You can configure each 8-bit group of the DS4003 board freely for input or output. However, all digital channels of one group can be used either for input or for output only.

Where to go from here

Information in this section

DS4003IN_Bx_Py_Gz..... 12
To provide bit-wise read access to the 8 bits of a group.

DS4003IN8_Bx_Py_Gz..... 14
To provide byte-wise read access to 8 bits of a group.

DS4003OUT_Bx_Py_Gz..... 16
To provide bit-wise write access to the 8 bits of a group.

DS4003OUT8_Bx_Py_Gz..... 20
To provide byte-wise write access to 8 bits of a group.

DS4003IN_Bx_Py_Gz

Purpose

To provide bit-wise read access to the 8 bits of a group.

Where to go from here

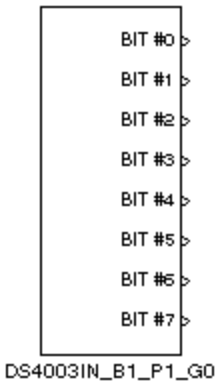
Information in this section

Block Description (DS4003IN_Bx_Py_Gz)..... 12
To describe the purpose and function of the block.

Unit Page (DS4003IN_Bx_Gy_Pz)..... 13
To specify the board number and the bits for digital input.

Block Description (DS4003IN_Bx_Py_Gz)

Illustration



Purpose

To provide bit-wise read access to the 8 bits of a group.

Note

After changing the group number, the block output labels are updated to show the new bit range of the group.

I/O mapping

For details on the I/O mapping, refer to Digital I/O Unit (DS4003 Features 🕮).

I/O characteristics

- RTI supports data typing for this block. If the block's output is of boolean type, the block can be used with all logical operators without using data type conversion blocks.
- Relationship between the digital input and the output of the block:

Digital Input (TTL)	Simulink Output	
	Without Data Typing	**With Data Typing**
High	1 (double)	1 (boolean)
Low	0 (double)	0 (boolean)

Dialog pages

The dialog settings can be specified on the Unit Page.

Related RTLib functions

`ds4003_init`, `ds4003_pio_init`, `ds4003_bit_in`

Unit Page (DS4003IN_Bx_Gy_Pz)

Purpose

To specify the board number and the bits for digital input.

Dialog settings

Board number Lets you select the board number in the range 1 … 16. If your system contains several boards of the same type, RTI uses the board number to distinguish between them.

Port number Lets you select an I/O port. Each port supports 32 bits. Valid port numbers are 1, 2, and 3.

Group number Lets you select a group of 8 bits. Valid group numbers are:

- 0 (bits 0 … 7)
- 1 (bits 8 … 15)
- 2 (bits 16 … 23)
- 3 (bits 24 … 31)

DS4003IN8_Bx_Py_Gz

Purpose

To provide byte-wise read access to 8 bits of a group.

Where to go from here

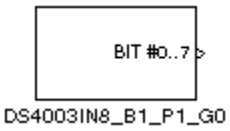
Information in this section

Block Description (DS4003IN8_Bx_Py_Gz)..... 14
To describe the purpose and function of the block.

Unit Page (DS4003IN8_Bx_Py_Gz)..... 15
To specify the board number and the bits for digital input.

Block Description (DS4003IN8_Bx_Py_Gz)

Illustration



Purpose

To provide byte-wise read access to 8 bits of a group.

Note

After changing the group number, the block output label is updated to show the new bit range of the group.

I/O mapping

For details on the I/O mapping, refer to Digital I/O Unit (DS4003 Features 🕮).

I/O characteristics

- The 8 bits of a group are combined to one byte and its decimal equivalent is the Simulink block output in the range 0 … 255.
- The most significant bit (msb) is the one with the highest bit number in the group.

The following table gives an example of a digital input (TTL) and the corresponding Simulink output:

Digital Input (TTL)	Simulink Output
1100 0001 (1 = high, 0 = low)	193.0

- RTI supports data typing for this block. If data typing is enabled, the block's output will be of uint8 type, otherwise it will be of double type.
- Datatype of the Simulink output without and with Data Typing:

Datatype of Simulink Output	
Without Data Typing	**With Data Typing**
double	uint8

Dialog pages

The dialog settings can be specified on the Unit Page.

Related RTLib functions

`ds4003_init`, `ds4003_pio_init`, `ds4003_bit_in`

Unit Page (DS4003IN8_Bx_Py_Gz)

Purpose

To specify the board number and the bits for digital input.

Dialog settings

Board number Lets you select the board number in the range 1 … 16. If your system contains several boards of the same type, RTI uses the board number to distinguish between them.

Port number Lets you select an I/O port. Each port supports 32 bits. Valid port numbers are 1, 2, and 3.

Group number Lets you select a group of 8 bits (1 byte). Valid group numbers are:

- 0 (bits 0 … 7)
- 1 (bits 8 … 15)
- 2 (bits 16 … 23)
- 3 (bits 24 … 31)

DS4003OUT_Bx_Py_Gz

Purpose

To provide bit-wise write access to the 8 bits of a group.

Where to go from here

Information in this section

Block Description (DS4003OUT_Bx_Py_Gz)..... 16
To describe the purpose and function of the block.

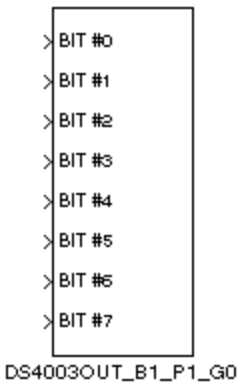
Unit Page (DS4003OUT_Bx_Py_Gz)..... 17
To specify the board number and the bits for digitat output.

Initialization Page (DS4003OUT_Bx_Py_Gz)..... 18
To specify the initial state of the selected output bits.

Termination Page (DS4003OUT_Bx_Py_Gz)..... 19
To specify the digital output at termination.

Block Description (DS4003OUT_Bx_Py_Gz)

Illustration



Purpose

To provide bit-wise write access to the 8 bits of a group.

Note

After changing the group number, the block output labels are updated to show the new bit range of the group.

PRDY and PACK handshake lines

This block is not suitable for handshaking with an external device via the PRDY and PACK handshake lines. You can use the handshaking feature by programming an S-function using the RTLib function. Refer to ds4003_bit_out (DS4003 RTLib Reference 🕮).

I/O mapping

For details on the I/O mapping, refer to Digital I/O Unit (DS4003 Features 🕮).

I/O characteristics

- RTI supports data typing for this block. The block's input has to be of boolean type, and the block can be used with all logical operators without using data type conversion blocks.
- Relation between the digital output and the input of the block:

Digital Output (TTL)	Simulink Input	
	Without Data Typing	With Data Typing
High	> 0 (double)	1 (boolean)
Low	≤ 0 (double)	0 (boolean)

Dialog pages

The dialog settings can be specified on the following pages:

- Unit Page (refer to Unit Page (DS4003OUT_Bx_Py_Gz) on page 17)
- Initialization Page (refer to Initialization Page (DS4003OUT_Bx_Py_Gz) on page 18)
- Termination Page (refer to Termination Page (DS4003OUT_Bx_Py_Gz) on page 19)

Related RTLib functions

`ds4003_init`, `ds4003_pio_init`, `ds4003_bit_out`

Unit Page (DS4003OUT_Bx_Py_Gz)

Purpose

To specify the board number and the bits for digitat output.

Dialog settings

Board number Lets you select the board number in the range 1 … 16. If your system contains several boards of the same type, RTI uses the board number to distinguish between them.

Port number Lets you select an I/O port. Each port supports 32 bits. Valid port numbers are 1, 2, and 3.

Group number Lets you select a group of 8 bits. Valid group numbers are:

- 0 (bits 0 … 7)
- 1 (bits 8 … 15)
- 2 (bits 16 … 23)
- 3 (bits 24 … 31)

Related topics

References

Initialization Page (DS4003OUT_Bx_Py_Gz)..... 18
Termination Page (DS4003OUT_Bx_Py_Gz)..... 19

Initialization Page (DS4003OUT_Bx_Py_Gz)

Purpose

To specify the initial state of the selected output bits.

Description

During the model initialization phase, an initial digital output value is written to each channel. This is especially useful if a channel is written from within a triggered or enabled subsystem which is not executed right from the start of the simulation. With the initialization value all channels have defined outputs during this simulation phase.

Dialog settings

Initialization state The initial output at the start of the simulation. Selectable for each channel. To assign one value to all of the 8 bits, specify the desired value in the lowest row before pushing the **Set all** button.

Related topics

References

Termination Page (DS4003OUT_Bx_Py_Gz)..... 19
Unit Page (DS4003OUT_Bx_Py_Gz)..... 17

Termination Page (DS4003OUT_Bx_Py_Gz)

Purpose

To specify the digital output at termination.

Description

When the simulation terminates, all channels hold their last digital output values by default. You can set user-defined output values on termination to drive your external hardware into a safe final condition.

Dialog settings

Termination state Either keep the current digital output when the simulation terminates or select the checkbox to specify the desired value of the digital output. Selectable for each channel. To assign one termination state to all of the bits, select the checkbox in the lowest row and specify the desired value before pushing the **Set all** button.

The specified termination values of I/O channels are set when the simulation executes its termination function by setting the `simState` variable to STOP. If you stop the real-time application by using ControlDesk's **Stop RTP** command, the processor resets immediately without executing termination functions. The current values of the I/O channels are kept and the specified termination values are not set.

Related topics

References

Initialization Page (DS4003OUT_Bx_Py_Gz)..... 18
simState (RTI and RTI-MP Implementation Reference 🕮)
Stop RTP (ControlDesk Platform Management 🕮)
Unit Page (DS4003OUT_Bx_Py_Gz)..... 17

DS4003OUT8_Bx_Py_Gz

Purpose

To provide byte-wise write access to 8 bits of a group.

Where to go from here

Information in this section

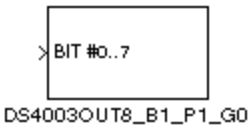
Block Description (DS4003OUT8_Bx_Py_Gz)..... 20
To describe the purpose and function of the block.

Unit Page (DS4003OUT8_Bx_Py_Gz)..... 21
To specify the board number and the bits for digital output.

Parameters Page (DS4003OUT8_Bx_Py_Gz)..... 22
To specify the digital output at initialization and termination.

Block Description (DS4003OUT8_Bx_Py_Gz)

Illustration



Purpose

To provide byte-wise write access to 8 bits of a group.

Note

After changing the group number, the block output label is updated to show the new bit range of the group.

PRDY and PACK handshake lines

This block is not suitable for handshaking with an external device via the PRDY and PACK handshake lines. You can use the handshaking feature by programming an S-function using the RTLib function. Refer to ds4003_bit_out (DS4003 RTLib Reference 🕮).

I/O mapping

For details on the I/O mapping, refer to Digital I/O Unit (DS4003 Features 🕮).

I/O characteristics

- The block input has to be a decimal value in the range of 0 … 255.
- The Simulink block input has to be the decimal equivalent of a single byte within the range 0 ... 255 whose bit pattern is then written to 8 bits of the selected DS4003 group.
- The most significant bit (msb) is the one with the highest bit number in the group.

  The following table gives an example of a digital output (TTL) and the corresponding Simulink input:

Digital Output (TTL)	Simulink Input
1100 0001 (1 = high, 0 = low)	193.0

- RTI supports data typing for this block. If data typing is enabled, the block's input has to be of uint8 type, otherwise it must be of double type.
- Datatype of the Simulink input without and with data typing:

Datatype of Simulink Input	
Without Data Typing	**With Data Typing**
double	uint8

Dialog pages

The dialog settings can be specified on the following pages:

- Unit Page (refer to Unit Page (DS4003OUT8_Bx_Py_Gz) on page 21)
- Parameters Page (refer to Parameters Page (DS4003OUT8_Bx_Py_Gz) on page 22)

Related RTLib functions

`ds4003_init`, `ds4003_pio_init`, `ds4003_bit_out`

Unit Page (DS4003OUT8_Bx_Py_Gz)

Purpose

To specify the board number and the bits for digital output.

Dialog settings

Board number Lets you select the board number in the range 1 … 16. If your system contains several boards of the same type, RTI uses the board number to distinguish between them.

Port number Lets you select an I/O port. Each port supports 32 bits. Valid port numbers are 1, 2, and 3.

Group number Lets you select a group of 8 bits (1 byte). Valid group numbers are 0 (bits 0 … 7), 1 (bits 8 … 15), 2 (bits 16 … 23), and 3 (bits 24 … 31).

Related topics

References

Parameters Page (DS4003OUT8_Bx_Py_Gz)..... 22

Parameters Page (DS4003OUT8_Bx_Py_Gz)

Purpose

To specify the digital output at initialization and termination.

Description

During the model initialization phase, an initial digital output value is written to each channel. This is especially useful if a channel is written from within a triggered or enabled subsystem which is not executed right from the start of the simulation. With the initialization value all channels have defined outputs during this simulation phase.

When the simulation terminates, all channels hold their last digital output values by default. You can set user-defined output values on termination to drive your external hardware into a safe final condition.

The specified termination values of I/O channels are set when the simulation executes its termination function by setting the `simState` variable to STOP. If you stop the real-time application by using ControlDesk's Stop RTP command, the processor resets immediately without executing termination functions. The current values of the I/O channels are kept and the specified termination values are not set.

Dialog settings

Initial output The initial digital output at the start of the simulation. Because a complete byte is written at a time, the value must remain within the range 0 … 255.

Termination output Either keep the current digital output when the simulation terminates or select the checkbox to specify the digital output to the desired value. Because a complete byte is written at a time, the value must remain within the range 0 … 255.

Related topics

References

simState (RTI and RTI-MP Implementation Reference 🕮)
Stop RTP (ControlDesk Platform Management 🕮)
Unit Page (DS4003OUT8_Bx_Py_Gz)..... 21

Interrupts

Introduction

The Library: rtilibm/DS4003 provides access to the hardware interrupts of the DS4003.

DS4003_HWINT_Bx_Iy

Purpose

To make the hardware interrupts of the DS4003 board available as trigger sources in a block diagram.

Where to go from here

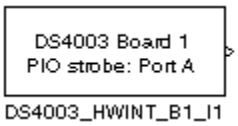
Information in this section

Block Description (DS4003_HWINT_Bx_Iy)..... 24
To describe the purpose and function of the block.

Unit Page (DS4003_HWINT_Bx_Iy)..... 25
To specify the board number and the interrupt type.

Block Description (DS4003_HWINT_Bx_Iy)

Illustration



Purpose

To make the hardware interrupts of the DS4003 board available as trigger sources in a block diagram.

I/O mapping

For details on the I/O mapping, refer to Interrupts Provided by the DS4003 (DS4003 Features 🕮).

Dialog pages

The dialog settings can be specified on the Unit Page.

Unit Page (DS4003_HWINT_Bx_Iy)

Purpose

To specify the board number and the interrupt type.

Dialog settings

Board number Lets you select the board number in the range 1 … 16. If your system contains several boards of the same type, RTI uses the board number to distinguish between them.

Interrupt Lets you select the type of the interrupt source:

Interrupt No.	Interrupt Type
1	PIO strobe: Port A (Connected to the PSTB input of port A)
2	PIO strobe: Port B (Connected to the PSTB input of port B)
3	PIO strobe: Port C (Connected to the PSTB input of port C)
4	User interrupt: Port A
5	User interrupt: Port B
6	User interrupt: Port C
7	I/O error (low active)

- The DS4003 board offers the following interrupts: 3 interrupts for strobed signal output, 3 user interrupts and 1 I/O error interrupt.
- Because all DS4003 I/O blocks are configured for non-strobed operation, the PSTB input can be used as an additional external interrupt source.
- The user interrupts are triggered by an external signal and can be used freely.
- An I/O error request does not only generate an interrupt on the processor board. It can also influence peripheral boards via the I/O error line, which may result in zeroed outputs of D/A conversion boards.

C

Common Program Data folder 6

D

Documents folder 6
DS4003 digital I/O board
  DS4003IN8_Bx_Py_Gz 15
DS4003_HWINT_Bx_Iy 24
DS4003IN_Bx_Py_Gz 12
DS4003IN8_Bx_Py_Gz 14
DS4003OUT_Bx_Py_Gz 16
DS4003OUT8_Bx_Py_Gz 20

L

Local Program Data folder 6