DS2004 High-Speed A/D Board

RTI Reference

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dSPACE

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About This Reference

Content

This RTI Reference provides a full description of the Real-Time Interface (RTI) software support for the DS2004 High-Speed A/D Board, which can be controlled by the DS1006 Processor Board and the DS1007 PPC Processor 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 DS2004 Blockset

Objective

Here you get basic information on the RTI blockset of the DS2004.

Where to go from here

Information in this section

Overview of the DS2004 Blockset

Objective

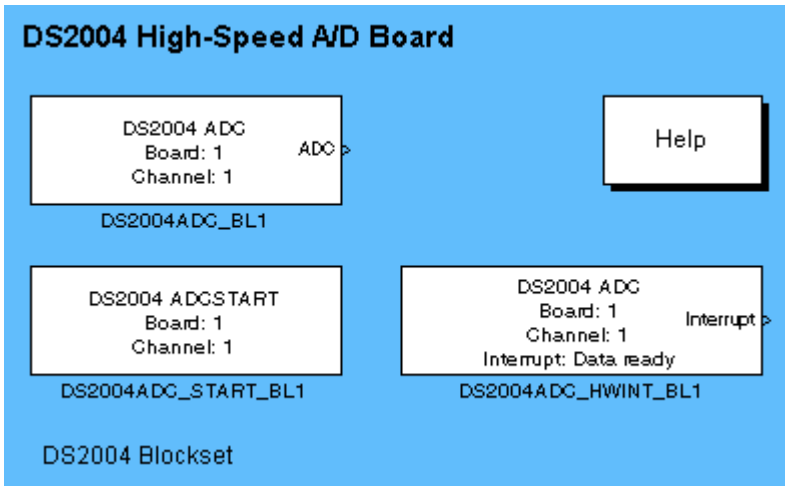
The DS2004 RTI blockset is part of the modular RTI library (rtilibm) based on DS1006 and DS1007.

DS2004 blockset

The Real-Time Interface (RTI) board library for the DS2004 High-Speed A/D Board provides the RTI blocks that implement the functionality and A/D conversion capabilities of the DS2004 board in Simulink models.

Library access

After you double-click the DS2004 board library icon in the rtilibm library, the Library rti2004lib opens:



Blockset overview

The following I/O units and corresponding blocks can be accessed by the RTI blockset for the DS2004:

- A/D Conversion on page 13
  - DS2004ADC_BLx on page 14
  - DS2004ADC_START_BLx on page 22
- Interrupts on page 25
  - DS2004ADC_HWINT_BLx on page 26

Demo models

For Simulink models that show how to use the RTI blocks of the DS2004 board, refer to the RTI demo library of your processor board. You can also find the model files at `<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI`.

Features of the DS2004 Blockset

Objective

The DS2004 RTI blockset provides the configurable RTI blocks for implementing A/D conversion for various use cases.

Main features

The main features are:

- The blockset provides an RTI block for implementing a sequence of A/D conversions (burst mode) with configurable sample modes and trigger sources.

This block provides also a single mode option, which allows you to use the converters for standard A/D conversion without utilizing their burst capabilities.

- The blockset provides a separate RTI block for implementing starting the A/D conversion. Using this block, A/D conversions and reading the conversion results can be executed in different tasks.
- The blockset provides an RTI block for making the hardware interrupts available.

For basic information on the required settings, for example, for trigger sources and conversion modes, refer to A/D Conversion (DS2004 Features 🕮).

A/D Conversion

Objective

The RTI blockset for the DS2004 provides configurable RTI blocks for starting and performing A/D conversion.

Demo model

For demo models using the ADC unit, refer to `<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI\DemomDS2004AdcSingle.slx` and `<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI\DemomDS2004AdcBurst.slx`. These are the DS2004_1 and DS2004_2 models, which you can find in the processor board's RTI demo library.

Where to go from here

Information in this section

DS2004ADC_BLx

Purpose

To configure and perform A/D conversion.

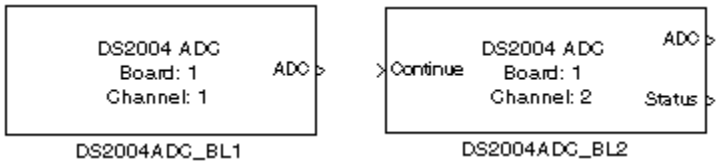
Where to go from here

Information in this section

Block Description (DS2004ADC_BLx)

Block

To give information about the appearance and purpose of the block.



Purpose

To provide read access to one of the DS2004 A/D converters.

Description

One DS2004ADC_BLx block controls one A/D converter. The DS2004 High-Speed A/D Board provides 16 independent A/D conversion channels with a separate converter each.

I/O mapping

For information on the I/O mapping, refer to I/O Mapping of the DS2004 (DS2004 Features 🕮).

I/O characteristics

Input Voltage Range	Simulink Output
–10 V ... +10 V	–1 ... +1
–5 V ... +5 V	–1 ... +1

The following table describes the ports of the block:

Port	Description
Input	
Continue	Controls A/D conversion. Available only if the sample mode of the burst conversion mode is set to continuous. Data type: Boolean 1: Successive A/D conversion bursts are activated. 0: Successive A/D conversion bursts are stopped immediately. The conversion results of the aborted burst are not available. The conversion results of the preceding burst are read again instead.
Output	
ADC	Outputs the current results of the A/D conversions on the current channel. If the conversion settings are set to burst conversion mode, the output comprises the A/D conversion results of the last burst of A/D conversions on the selected channel. This is a vector of 1 ... 16384 results depending on the buffer settings. The earliest value is stored in the first element of the vector. If the conversion settings are set to single conversion mode, the output is the (one) result of the last A/D conversion on the current channel. Data type: Double Range: –1 ... +1
Status	Represents the current status of the output. Available only if the enable status outport checkbox is selected. Data type: UInt8 1: A buffer with new conversion results was read. 0: A buffer was read repeatedly. New conversion results are not yet available.

Related RTLib functions

This RTI block is implemented using the following RTLib functions. The *DS2004 RTLib Reference* contains descriptions of these functions.

- ds2004_init
- ds2004_channel_control
- ds2004_sw_trigger
- ds2004_burst_init
- ds2004_burst_in
- ds2004_burst_read
- ds2004_single_init
- ds2004_single_in
- ds2004_single_read

Unit Page (DS2004ADC_BLx)

Purpose

To provide access to an A/D converter by referencing the related DS2004 board and channel.

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.

Channel number Lets you select a channel number in the range 1 … 16.

Related topics

References

Parameters Page (DS2004ADC_BLx)

Purpose

To specify the A/D conversion settings.

Dialog settings

Single conversion mode Lets you choose the single conversion mode to use a conversion channel of a DS2004 without its burst capabilities. Only one conversion mode, single or burst, can be set on an A/D conversion channel at the same time.

Trigger source (Single conversion settings) Lets you select the trigger source for the single A/D conversions:

Trigger Source	Meaning
Sample base rate	The start of an A/D conversion is triggered by the model step size. You additionally can set the sample time. For details, refer to Sample Time (refer to Advanced Page (DS2004ADC_BLx) on page 20).
External trigger input 1 External trigger input 2 External trigger input 3 External trigger input 4	The start of an A/D conversion is triggered by the trigger signal on the selected external trigger input. You additionally can set the edge polarity.

Edge polarity (Single conversion settings) Lets you select the edge of the trigger signal to be used as the trigger source. This setting can be made only if an external trigger input is set as the trigger source in the single conversion settings:

Edge Polarity	Meaning
Rising edge	The rising edge of the trigger signal is used as the trigger.
Falling edge	The falling edge of the trigger signal is used as the trigger.

Note

If sample base rate is selected as A/D conversion trigger source, the block uses the polling functions for reading the conversion results. If an external trigger input is selected as A/D conversion trigger source, the current read buffer is read immediately without using the polling functions. You can evaluate the read buffer state for reading the conversion results by enabling the status outport of the DS2004ADC_BLx block. Alternatively you can evaluate the data ready interrupt for reading the conversion. For details on the reading methods, refer to Methods of Reading Conversion Results (DS2004 Features 🕮).

Burst conversion mode Lets you choose burst conversion mode to use the burst capabilities of a conversion channel of the DS2004. Only one conversion mode, single or burst, can be set on an A/D conversion channel at the same time.

Sample mode Lets you select the sample mode, if burst conversion mode is selected:

Sample Mode	Meaning
Triggered	The start of an A/D conversion burst is triggered by the burst trigger source which you additionally have to set. The trigger source for the A/D conversion within a burst must be also set. See Trigger source (Burst trigger settings).
Continuous	The starts of successive A/D conversion bursts are triggered internally. An additional burst trigger source cannot be set. The A/D conversions within the bursts must be set with the selected conversion trigger source. See Trigger source (Conversion trigger settings).

Trigger source (Conversion trigger settings) Lets you select the trigger source for the A/D conversions within a burst:

Trigger Source	Meaning
Sample base rate	The start of an A/D conversion is triggered by the model step size. You additionally can set the sample time. For details, refer to Sample Time (refer to Advanced Page (DS2004ADC_BLx) on page 20).
Timer	The start of an A/D conversion is triggered by the channel timer. You additionally have to specify the trigger interval.
External trigger input 1 External trigger input 2 External trigger input 3 External trigger input 4	The start of an A/D conversion is triggered by the trigger signal on the selected external trigger input. You additionally can set the edge polarity.

Edge polarity (Conversion trigger settings) Lets you select the edge of the trigger signal which is used as the trigger source. This setting can be made only if an external trigger input is set as the trigger source in the conversion trigger settings:

Edge Polarity	Meaning
Rising edge	The rising edge of the trigger signal is used as the trigger.
Falling edge	The falling edge of the trigger signal is used as the trigger.

Trigger interval [0.8 µs ... 1 s] Lets you specify the time interval between two conversions in the range 0.8 µs ... 1 s with a resolution of 10 ns. Variables of your Simulink model can be used. This setting can be made only if the channel timer is set as the trigger source in the conversion trigger settings.

Trigger source (Burst trigger settings) Lets you select the trigger source for the A/D conversion bursts, if sample mode is set to *Triggered*:

Trigger Source	Meaning
Sample base rate	The start of an A/D conversion burst is triggered by the model step size. You additionally have to set the sample time. For details, refer to Sample Time (refer to Advanced Page (DS2004ADC_BLx) on page 20).

Trigger Source	Meaning
External trigger input 1 External trigger input 2 External trigger input 3 External trigger input 4	The start of an A/D conversion burst is triggered by the trigger signal on the selected external trigger input. You additionally can set the edge polarity.

Edge polarity (Burst trigger settings) Lets you select the edge of the trigger signal which is used as the trigger source. This setting can be made only if an external trigger input is set as the trigger source in the burst trigger settings:

Edge Polarity	Meaning
Rising edge	The rising edge of the trigger signal is used as the trigger.
Falling edge	The falling edge of the trigger signal is used as the trigger.

Note

- If sample base rate is selected as burst trigger source and timer is specified as A/D conversion trigger source, the block uses the polling functions for reading the conversion results. In all other cases in burst mode, the current read buffer is read immediately without using the polling functions. You can evaluate the read buffer state for reading the conversion results by enabling the status outport of the DS2004ADC_BLx block. Alternatively you can evaluate the data ready interrupt for reading the conversion. For details on the reading methods, refer to Methods of Reading Conversion Results (DS2004 Features 🕮).
- The burst and conversion trigger sources must not be identical on a channel at the same time.

Burst size Lets you specify the number of A/D conversions within a burst in the range 1 ... 16384. The number specifies the capacity of each of 3 swinging buffers, which are used for writing and reading conversion results interchangeably. Variables of your Simulink model can be used. For details on swinging buffers, refer to Swinging Buffer (DS2004 Features 🕮).

Offset Lets you specify a read position in the read buffer, where the read-out is to be started, within the range 0 ... <Burst size>-1. Variables of your Simulink model can be used. You additionally have to specify the length.

Length Lets you specify the number of conversion results which are read from the read buffer. Length can be specified within the range 1 ... <Burst size>-<Offset>. Variables of your Simulink model can be used. You additionally have to specify the offset in the buffer, where the read-out of the conversion results starts.

Offset and length allow you to read a burst of conversion results in fractions of the burst size.

Note

- You can specify the buffer settings only in burst conversion mode.
- You can specify the buffer offset and buffer length only in triggered sample mode, when the specified burst size is greater than 1.

Related topics

References

Advanced Page (DS2004ADC_BLx)

Purpose

To specify additional options, like input voltage range or use of the DS2004ADC_START_BLx block.

Dialog settings

Use separate DS2004ADC_START block Lets you specify if A/D conversion is to be started from a separate task. This setting can be made only if sample base rate is set as the trigger source for the conversion trigger or the burst trigger.

This setting must be made if the sample base rate is set as one of the three trigger sources and the read-out of the conversion results is performed in a triggered subsystem using the data ready or burst start interrupt. For more information on Simulink models which require a DS2004ADC_START_BLx block, refer to Using a Separate Start Block in Simulink Models (DS2004 Features 🕮).

Input voltage range Lets you select the voltage range for the analog differential inputs:

Input Voltage Range	Meaning
+/–10 V	The difference between the 2 analog input pins of the differential input can be a maximum of 10 V. The input voltage working range for the differential input is –12 V ... +12 V.

Input Voltage Range	Meaning
+/–5 V	The difference between the 2 analog input pins of the differential input can be a maximum of 5 V. The input voltage working range for the differential input is –12 V ... +12 V.

Sample time Lets you select or specify the sample time. This setting can be made only if sample base rate is set as the trigger source:

Sample Time	Meaning
–1	The sample time is inherited from the blocks the block is connected to. If the block is in a triggered subsystem, you must select this setting.
0	The block uses the discrete sample time of the Simulink model.
>0	The block uses the sample time you specify.

You can make the setting for the sample time in the DS2004ADC_BLx block independently of the sample time setting in a corresponding DS2004ADC_START_BLx block, if used.

Note

If the DS2004ADC_BLx block is executed in a timer task, it works with the sample time of the fastest block in the task it is part of. To avoid this behavior the sample time has to be set to the sample time of the model.

Enable status outport Lets you enable the status outport, which indicates whether a read buffer with new conversion results was read, or if the read buffer was already read before. For more information on the reading methods, refer to Methods of Reading Conversion Results (DS2004 Features 🕮).

Related topics

References

DS2004ADC_START_BLx

Purpose

To start the A/D conversion by software in a separate task.

Where to go from here

Information in this section

Block Description (DS2004ADC_START_BLx)

Block

Purpose

To start A/D conversion or A/D burst conversion by software in a separate task with the specified sample time.

Description

The DS2004ADC_START_BLx block allows you to start A/D conversion or A/D burst conversion by software on the specified A/D conversion channel.

You can use a separate DS2004ADC_START_BLx block in your Simulink model, if the conversion trigger source or the burst trigger source is set to the sample base rate and the read-out of the conversion results is to be performed in a different task, for example, in a subsystem driven by the data ready interrupt. In all other cases it is recommended to start A/D conversion in the DS2004ADC_BLx block. For basic information on the DS2004ADC_START_BLx block, refer to Using a Separate Start Block in Simulink Models (DS2004 Features 🕮).

Note

The DS2004_ADC_START block is unsuitable for the use in an *Enabled Subsystem*. The A/D converter will be always started independently of the state of the Enable port.
If you want to start the block only under specific conditions, you must place it in a *Triggered Subsystem* or a *Function-Call Subsystem*.

Other RTI blocks

The DS2004ADC_BLx block must reside in the model, too – with the same board and channel number. Additionally, *Use separate DS2004ADC_START block* must be selected in the DS2004ADC_BLx block settings. For details on the DS2004ADC_BLx block, refer to DS2004ADC_BLx on page 14.

I/O mapping

For information on the I/O mapping, refer to I/O Mapping of the DS2004 (DS2004 Features 🕮).

Dialog pages

The dialog settings can be specified on the Unit page (refer to Unit Page (DS2004ADC_START_BLx) on page 23).

Related RTLib functions

This RTI block is implemented using the following RTLib functions. The *DS2004 RTLib Reference* contains descriptions of these functions.

- ds2004_sw_trigger

Related topics

Basics

Using a Separate Start Block in Simulink Models (DS2004 Features 🕮)

Unit Page (DS2004ADC_START_BLx)

Purpose

To reference the related DS2004 board and channel and to start A/D conversion by software.

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.

Channel number Lets you select a channel number in the range 1 … 16.

Sample time Lets you select or specify the sample time:

Sample Time	Meaning
–1	The sample time is inherited from the blocks the block is connected to. If the block is in a triggered subsystem, you must select this setting.
0	The block uses the discrete sample time of the Simulink model.
>0	The block uses the sample time you specify.

You can make the setting for the sample time in the DS2004ADC_START_BLx block independently of the sample time setting in a corresponding DS2004ADC_BLx block.

Note

If the DS2004ADC_BLx block is executed in a timer task, it works with the sample time of the fastest block in the task it is part of. To avoid this behavior the sample time has to be set to the sample time of the model.

Interrupts

Objective

The DS2004 generates hardware interrupts which you can use in your Simulink model.

DS2004ADC_HWINT_BLx

Purpose

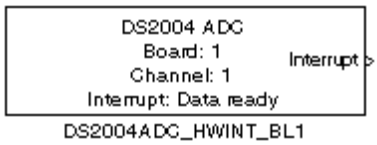
To make the hardware interrupts available to your Simulink model.

Where to go from here

Information in this section

Block Description (DS2004ADC_HWINT_BLx)

Block



Purpose

To make the interrupts of the DS2004 High-Speed A/D Board available as the trigger sources for subsystems in a Simulink model.

Description

The DS2004ADC_HWINT_BLx block allows you to make one of the DS2004 hardware interrupts available on one A/D conversion channel.

For more information on the DS2004 interrupts, refer to Interrupts Provided by the DS2004 (DS2004 Features 🕮).

Other RTI blocks

The DS2004ADC_BLx block must reside in the model, too – with the same board and channel number. For details on the DS2004ADC_BLx block, refer to DS2004ADC_BLx on page 14.

I/O mapping

For information on the I/O mapping, refer to I/O Mapping of the DS2004 (DS2004 Features 🕮).

I/O characteristics

The following table describes the port of the block:

Port	Description
Output	
Interrupt	Trigger output. Data type: Function call

Dialog pages

The dialog settings can be specified on the Unit page (refer to Unit Page (DS2004ADC_HWINT_BLx) on page 27).

Related RTLib functions

None

Related topics

Basics

Interrupts Provided by the DS2004 (DS2004 Features 🕮)

Unit Page (DS2004ADC_HWINT_BLx)

Purpose

To reference the related DS2004 hardware and channel and to choose an interrupt as the trigger source.

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.

Channel number Lets you select a channel number in the range 1 … 16.

Type Lets you select the interrupt type:

Interrupt Type	Meaning
Burst start	The interrupt is generated on the start of an A/D conversion burst. In single conversion mode the interrupt is generated on the start of an A/D conversion.
Data ready	The interrupt is generated on the completion of an A/D conversion burst. In single conversion mode the interrupt is generated on the completion of an A/D conversion. The interrupt indicates that a buffer with new conversion results is ready to be read.
Conversion trigger overflow	The interrupt is generated if an A/D conversion trigger is received before the current A/D conversion has completed.

Interrupt Type	Meaning
Data lost	The interrupt is generated if a buffer with conversion results, which still has not been read by the application, is overwritten with new conversion results.

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