DS2004 High-Speed A/D Board

Features

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dSPACE

How to Contact dSPACE

Mail:	dSPACE GmbH Rathenaustraße 26 33102 Paderborn Germany
Tel.:	+49 5251 1638-0
Fax:	+49 5251 16198-0
E-mail:	info@dspace.de
Web:	http://www.dspace.com

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  Tel.: +49 5251 1638-941 or e-mail: support@dspace.de

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Important Notice

Contents

About This Document

Content

This document provides feature-oriented access to the information you need to use the functions of the DS2004.

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.

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 Implementation Features of the DS2004

Objective

For a better understanding of the capabilities of the DS2004 board, it is useful to know some general information on its features.

Where to go from here

Information in this section

Introduction to the Features of the DS2004

Objective

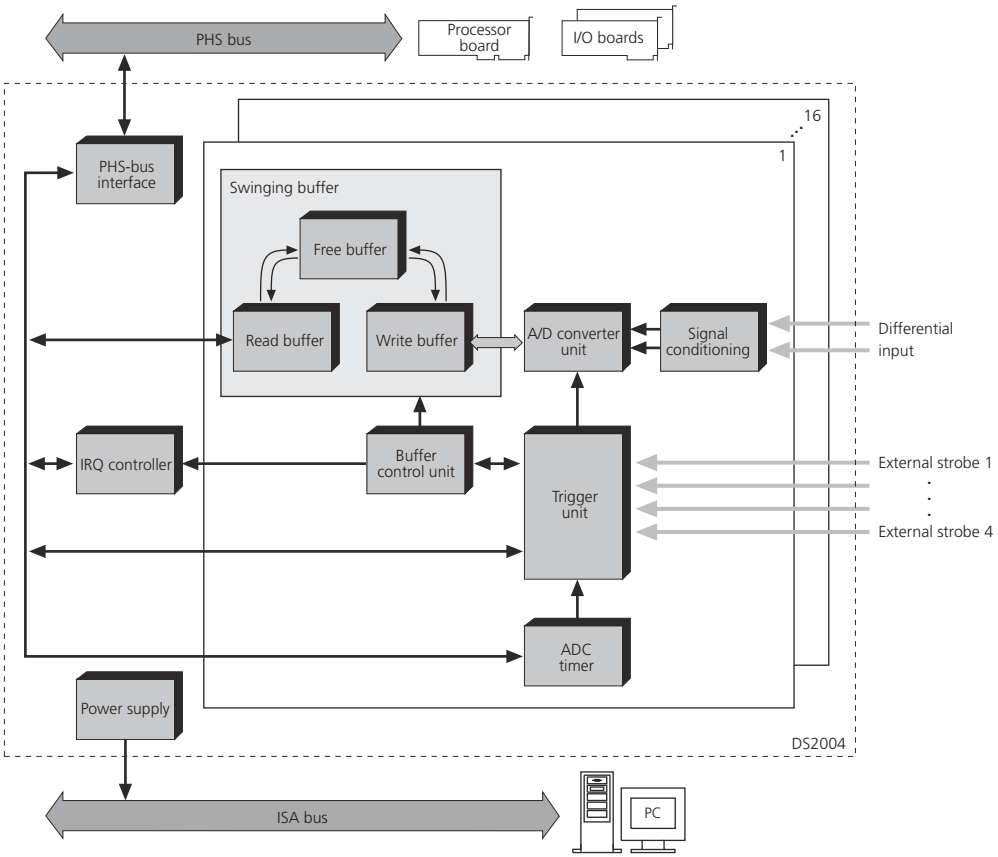
The following introduction gives you an overview of the features, the architecture and the main components of the DS2004.

DS2004 features

The DS2004 High-Speed A/D Board is used in PHS-bus-based systems for digitizing analog input signals. The A/D converters of the DS2004 are equipped with differential inputs and particularly meet the requirements for digitizing analog input signals at high sampling rates, for example, for measuring internal cylinder pressures.

DS2004 architecture

The following illustration gives an overview of the functional units of the DS2004:



Main components of a DS2004 conversion channel

Signal conditioning This unit adapts the analog input signals to the requirements of the A/D converter unit.

A/D converter unit This unit comprises a sample&hold unit and a converter for digitizing the analog input signal.

Trigger unit This unit evaluates the trigger configuration set by the user, controls the buffer control unit by reacting to burst trigger signals, and controls the A/D conversion unit by reacting to conversion trigger signals. For more information on burst and conversion trigger signals, refer to Trigger Signals on page 13.

Swinging buffer This unit comprises a write buffer, a read buffer, and a free buffer. The write buffer can be written and the read buffer can be read simultaneously. The free buffer is used as intermediate buffer. For more information, refer to Swinging Buffer on page 11.

Buffer control unit This unit controls the swinging buffer, exchanges the write buffer with the free buffer, and sets a flag indicating that new conversion results are ready to be read.

ADC timer This unit has a high-resolution timer that can be used as trigger source for the A/D conversions.

Integration into a PHS-bus-based system

The applications which use and process the A/D conversion results from the DS2004 are executed on the dSPACE processor board. The DS2004 performs the required input and A/D conversion tasks. Communication between processor board and DS2004 is performed via the enhanced peripheral high speed bus (PHS++ bus).

Partitioning the PHS bus with the DS802 With the DS802 PHS Link Board you can spatially partition the PHS bus by arranging the I/O boards in several expansion boxes.

The DS802 can be used in combination with many types of available dSPACE I/O boards. However, some I/O boards and some functionalities of specific I/O boards are not supported.

The I/O board support depends on the dSPACE software release which you use. For a list of supported I/O boards, refer to DS802 Data Sheet (PHS Bus System Hardware Reference 🕮).

Related topics

Basics

Basics of the ADC Unit

Objective

A/D conversion is an element of most applications in rapid control prototyping, because sensors, for example, for pressure or temperature, provide analog signals which have to be processed as digital signals.

The DS2004 High-Speed A/D Board enables your applications to use numerous options for conversion trigger sources and conversion modes.

Basic features of the DS2004 ADC unit

Each of the 16 A/D conversion channels provides:

- A differential input with a sample&hold unit and an A/D converter
- Successive-approximation conversion technique with 16-bit resolution and a maximum conversion time of 800 ns
- Selectable input voltage range (±5 V or ±10 V)
- Burst mode for digitizing a data set of up to 16384 analog values per burst:
  - Triggered sample mode with selectable trigger source for starting the bursts. See Burst Triggered Sample Mode on page 14.
  - Continuous sample mode with automatically started successive bursts. See Burst Continuous Sample Mode on page 15.
- Single A/D conversion mode to use the channel as a standard A/D converter without utilizing its burst capability. See Single Conversion Mode on page 16.
- Selectable sources for triggering A/D conversions, for example, external trigger inputs, channel timer, and software trigger. See Trigger Signals on page 13.
- Swinging buffers for decoupling the conversion process from the read process. See Swinging Buffer on page 11.
- Four independent hardware interrupts associated to the A/D conversion state. For information on interrupt handling, see Interrupts Provided by the DS2004 on page 27.

RTI/RTLib support

You can access the ADC units via RTI Blockset and RTLib. For details, see

- A/D Conversion in the *DS2004 RTI Reference*
- A/D Conversion in the *DS2004 RTLib Reference*

Execution times

For details on the execution times and the corresponding measurement setup, refer to Function Execution Times (DS2004 RTLib Reference 🕮).

Connection to external devices

To access the ADC unit of the DS2004, you can connect external devices

- To the 50-pin ADC connector P1 of the DS2004.
- To the optional connector panel CP2004. It makes the P1 signals available via separate BNC connectors.

For an excerpt from the circuit diagram that shows the I/O circuit and for information on the electrical characteristics and signal conditioning of the ADC

units, refer to Signal Connection to External Devices (PHS Bus System Hardware Reference 🕮).

Data sheet

For the data sheet of the DS2004 and the connector panel CP2004, see Data Sheets (PHS Bus System Hardware Reference 🕮).

Related topics

Basics

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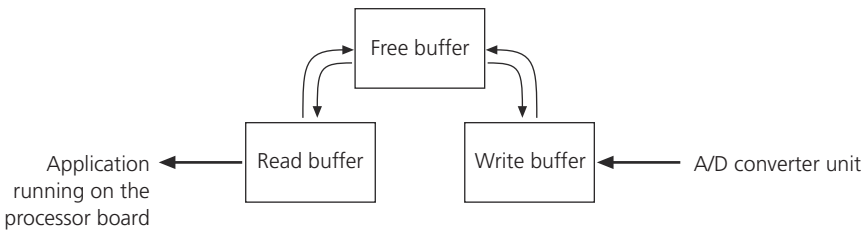
References

A/D Conversion (DS2004 RTI Reference 🕮)
A/D Conversion (DS2004 RTLib Reference 🕮)
Data Sheets (PHS Bus System Hardware Reference 🕮)
Function Execution Times (DS2004 RTLib Reference 🕮)
Signal Connection to External Devices (PHS Bus System Hardware Reference 🕮)

Swinging Buffer

Objective

Each A/D conversion channel features a swinging buffer for decoupling the write buffer and the read buffer.



Swinging buffer principle

The swinging buffer, comprising a write, a free, and a read buffer, passes all conversion results from the A/D converter unit to the application running on the processor board. The buffers can change place, as indicated by the arrows between them in the illustration above. This is implemented by pointer management, so that no buffer needs to be copied from one position to another. The events which trigger the buffer exchange are described below. The number of temporarily stored conversion results, the burst size, can be uniformly specified in the range 1 ... 16384.

Write buffer

The A/D converter unit writes the conversion results to the write buffer until it is filled to the specified burst size. When this event occurs, the write buffer changes places with the free buffer which is then filled with new conversion results.

Read buffer

The application running on the processor board reads the conversion results from the read buffer via the PHS bus. Before the conversion results are transferred, the read function used in the application requests a read buffer.

Depending on the read method used by the application,

- the current conversion results in the read buffer are transferred immediately, even if they were already read before.
- or the application waits until the buffer control unit exchanges the read buffer with the free buffer containing new conversion results.

For more information on the read methods, refer to Methods of Reading Conversion Results on page 22.

If the application does not read the conversion results fast enough, it can happen that the free buffer, containing new results, is overwritten by the write buffer before it could become the read buffer. In this case a data lost interrupt is generated on the corresponding channel.

Free buffer

The free buffer decouples the write and read buffers and can prevent data overflow if the data rate of the writing process is temporarily higher than the data rate of the reading process.

Related topics

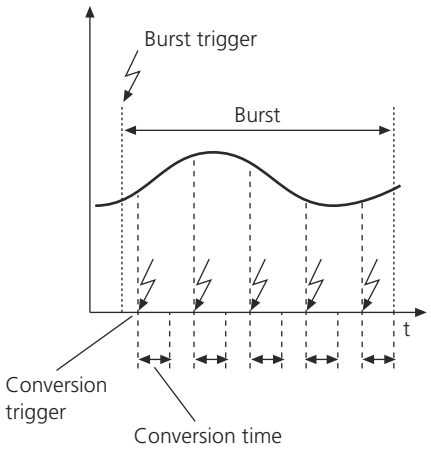
Basics

Methods of Reading Conversion Results.....22

Trigger Signals

Objective

Configuring an A/D converter channel of the DS2004 requires the selection of two kinds of triggers.



Burst trigger

A burst trigger initiates a sequence of A/D conversions, called a conversion burst. You select the burst trigger by assigning a burst trigger source to a converter channel, for example, an external trigger input.

Conversion trigger

The conversion trigger starts every A/D conversion with one conversion result per trigger. You select the conversion trigger by assigning a conversion trigger source to a converter channel, for example, the channel timer.

Starting a conversion burst

You need a burst trigger and a conversion trigger for every burst. One burst trigger has to initiate the burst. Then the conversion triggers have to start the A/D conversions. The burst ends, controlled by the buffer control unit, when the number of A/D conversion results in the write buffer has reached the specified burst size.

Trigger control

While a burst is running, additional burst triggers are ignored. If no burst is running, conversion triggers are ignored.

If a conversion is in progress and has not completed before another conversion trigger occurs, this trigger is ignored, and a conversion trigger overflow interrupt is generated. For more information, refer to Conversion Trigger Overflow Interrupt on page 31.

Trigger sources

A DS2004 A/D conversion channel can react to the following trigger sources:

- 4 external trigger inputs
- Individual channel timer for each channel
- Software trigger (DS2004 RTLib) and sample base rate (DS2004 RTI Blockset).

For detailed information on the trigger sources which can be assigned as the burst trigger and as the conversion trigger, refer to

- Using A/D Conversion in Burst Mode on page 19
- Using A/D Conversion in Single Mode on page 21

External trigger

The external trigger inputs can be used with a maximum frequency of 1.25 MHz according to the conversion time of 800 ns. For detailed information on the electrical characteristics, refer to External Trigger Inputs (PHS Bus System Hardware Reference 🕮).

Related topics

Basics

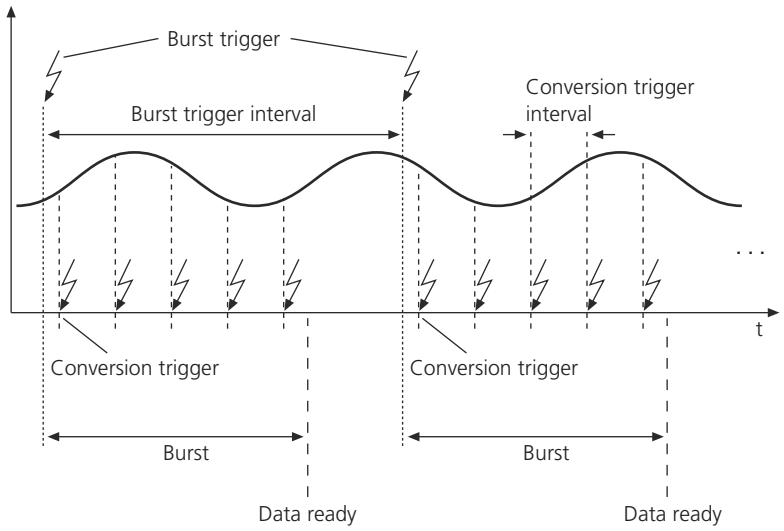
Burst Triggered Sample Mode

Objective

The burst conversion mode provides two methods how to start a burst. One of these methods is the triggered sample mode.

Characteristic

Each burst is started by the trigger event according to the selected burst trigger source. The burst is finished if the specified number of A/D conversions was executed. Then, the conversion channel is waiting for the next burst trigger before starting a new burst conversion.



The conversion results can be read after the last A/D conversion in a burst has been finished. There are three methods of reading the conversion results. For details, refer to Methods of Reading Conversion Results on page 22.

Note

The minimum delay between the burst trigger and the first conversion trigger is 75 ns. Otherwise the first conversion will not be started.

Related topics

Basics

Methods of Reading Conversion Results....22

Burst Continuous Sample Mode

Objective

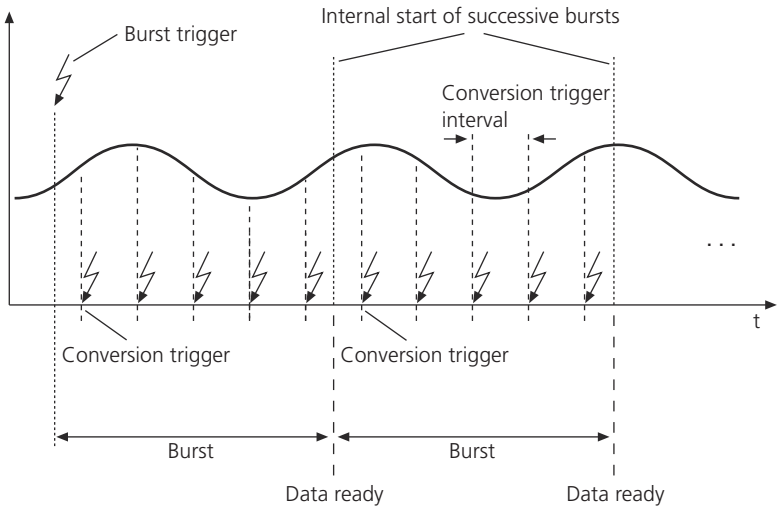
The burst conversion mode provides two methods how to start a burst. One of these is the continuous sample mode.

Characteristic

Only the first burst must be started by a trigger event according to the selected burst trigger source. Successive bursts are started automatically. After a burst is finished, the next burst is started immediately after the last A/D conversion of the previous burst. There are no further burst triggers required.

Using the RTI Blockset, the initial burst trigger is performed internally when the continuous sample mode is set.

The A/D conversions within the bursts are performed according to the selected conversion trigger source.



The conversion results can be read after the last A/D conversion in a burst has been finished. There are three methods of reading the conversion results. For details, refer to Methods of Reading Conversion Results on page 22.

Note

The minimum delay between the burst trigger and the first conversion trigger is 75 ns. Otherwise the first conversion will not be started.

Related topics

Basics

Methods of Reading Conversion Results.....22

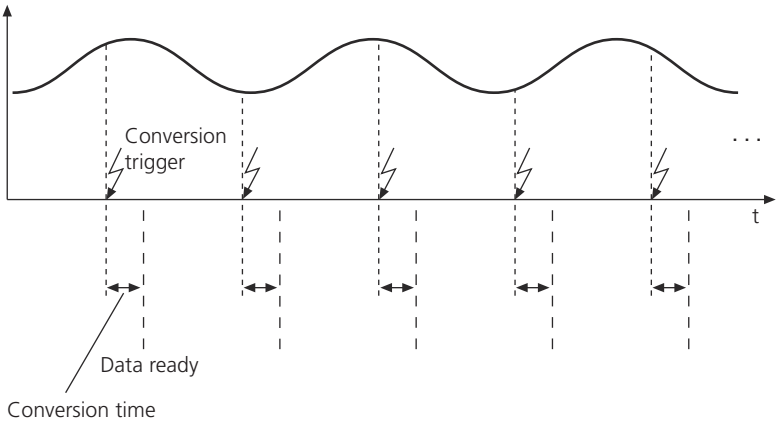
Single Conversion Mode

Objective

You can use the DS2004 channels as standard A/D converters without using the capability of burst conversions.

Characteristic

In single conversion mode, the burst capabilities of a DS2004 conversion channel are not used. The conversion channels work as standard A/D converters for converting a single value after receiving a conversion trigger. Each trigger event produces one conversion result which can be read immediately after its conversion time.


Conversion
trigger
t
Data ready
Conversion time

A/D Conversion

Objective

The DS2004 High-Speed A/D Board provides 16 parallel A/D converter channels that you can use for digitizing analog signals.

Where to go from here

Information in this section

Using A/D Conversion in Burst Mode

Objective

Before you can use the burst mode, an A/D conversion channel has to be configured for it.

General settings

The general settings have to be made regardless of the conversion mode, burst conversion mode or single conversion mode:

- Board and channel number
- Input voltage range

Burst mode settings

The settings for using A/D conversion in burst mode are:

A/D conversion mode Using RTI, you have to select the burst conversion mode in the DS2004ADC_BLx block dialog. Using RTLib, you have to initialize the burst mode, and use the `ds2004_burst_xxx` functions.

Sample mode Lets you choose between triggered sample mode and continuous sample mode. This setting affects only the burst trigger.

Conversion trigger Lets you select a conversion trigger source. The conversion trigger sources for burst conversion mode are:

- External trigger inputs
- Channel timer
- Sample base rate (RTI) / software (RTLib)

When choosing an external trigger input you can additionally select the edge polarity for triggering the conversion. For details, refer to External Trigger Inputs (PHS Bus System Hardware Reference 🕮).

Burst trigger Lets you select a burst trigger source.

When the RTI Blockset is used, the burst trigger source can be selected only in triggered sample mode.

The burst trigger sources for triggered sample mode are:

- External trigger inputs
- Sample base rate (RTI) / software (RTLib)

When choosing an external trigger input you can additionally select the edge polarity for triggering the burst. For details, refer to External Trigger Inputs (PHS Bus System Hardware Reference 🕮).

Buffer settings Lets you specify a buffer size. The value is valid for the write, free, and read buffers. Additionally, you can specify if the read buffer is read in fractions of the buffer size.

The buffer settings are:

- Burst size
- Offset

  If you use the RTI Blockset, you can specify it only in triggered sample mode.
- Length

  If you use the RTI Blockset, you can specify it only in triggered sample mode.

For details on burst mode settings, refer to:

- Parameters Page (DS2004ADC_BLx) (DS2004 RTI Reference 🕮) or
- A/D Conversion (DS2004 RTLib Reference 🕮)

Reading method

You have to decide which method of reading the A/D conversion results is used in your model or application. For further information, refer to Methods of Reading Conversion Results on page 22.

Related topics

Basics

Methods of Reading Conversion Results 22

References

A/D Conversion (DS2004 RTLib Reference 🕮)
External Trigger Inputs (PHS Bus System Hardware Reference 🕮)
Parameters Page (DS2004ADC_BLx) (DS2004 RTI Reference 🕮)

Using A/D Conversion in Single Mode

Objective

Before you can use the single mode, an A/D conversion channel has to be configured for it.

General settings

The general settings have to be made regardless of the conversion mode, burst conversion mode or single conversion mode:

- Board and channel number
- Input voltage range

Single mode settings

The settings for using A/D conversion in single mode are:

A/D conversion mode Using RTI, you have to select the single conversion mode in the DS2004ADC_BLx block dialog. Using RTLib, you have to initialize the single conversion mode, and use the `ds2004_single_xxx` functions.

Conversion trigger Lets you select the conversion trigger source. The conversion trigger sources for single conversion mode are:

- External trigger inputs
- Sample base rate (RTI) / software (RTLib)
- Channel timer (RTLib only)

When choosing an external trigger input you can additionally select the edge polarity for triggering the conversion. For details, refer to External Trigger Inputs (PHS Bus System Hardware Reference 🕮).

For details on single mode settings, refer to:

- Parameters Page (DS2004ADC_BLx) (DS2004 RTI Reference 🕮) or
- A/D Conversion (DS2004 RTLib Reference 🕮)

Reading method

You have to decide which method of reading the A/D conversion results is used in your model or application. For more information, refer to Methods of Reading Conversion Results on page 22.

Related topics

Basics

Methods of Reading Conversion Results.....22

References

A/D Conversion (DS2004 RTLib Reference 🕮)
External Trigger Inputs (PHS Bus System Hardware Reference 🕮)
Parameters Page (DS2004ADC_BLx) (DS2004 RTI Reference 🕮)

Methods of Reading Conversion Results

Objective

The RTI Blockset and the DS2004 RTLib functions offer different methods of reading the A/D conversion results.

Overview

The first method to read new conversion results is to use the read functions which causes the application to wait until new conversion results are available. This is the polling method.

The second method of reading new conversion results is to use the data ready interrupt indicating that the conversion has been finished.

The third method is to read conversion results immediately without waiting for a finished conversion. With this non-polling method you can also read old conversion results.

Using the polling method

This reading method uses the read functions which internally poll for the availability of a read buffer with new conversion results.

RTI Blockset The RTI Blockset uses this method in the configurations shown in the table below.

DS2004 RTLib The DS2004 RTLib offers the following polling functions:

- ds2004_burst_in
- ds2004_single_in

Note

As this read-out method polls for a new buffer with A/D conversion results, it is important that the required number of A/D conversions is triggered by the selected conversion trigger source. Otherwise the application remains in the internal polling loop and hangs up.

Using the data ready interrupt

Using the data ready interrupt is the most efficient way to read new conversion results. This method is recommended for use in applications with fast reaction requirements.

The data ready interrupt indicates that a burst of A/D conversions has finished and the new conversion results can be read using a non-polling read method. The interrupt must be made available by adding a DS2004ADC_HWINT_BLx to your Simulink model. The ds2004_data_ready_int_enable function enables the interrupt in your handcoded C application.

The RTI block which reads the conversion results and other functions you want to react to the interrupt must be embedded in a subsystem driven by the data ready interrupt. In handcoded C applications the reading functions and other functions are generally placed in the interrupt service routine. For details on the DS2004 interrupts, refer to Interrupts Provided by the DS2004 on page 27.

Using the non-polling method

This reading method uses the read functions which internally do not poll for the availability of a read buffer with new conversion results. The current read buffer is read instead. The required information on whether a buffer was read repeatedly or a buffer with new conversion results was read, is indicated by an RTI block output or a flag as a parameter of the RTLib function.

RTI Blockset The DS2004 RTI Blockset uses these functions in the configurations shown in the table below.

DS2004 RTLib The DS2004 RTLib offers the following functions which read the current buffer and provide the buffer state:

- ds2004_burst_read
- ds2004_single_read

To avoid reading the current conversion results repeatedly until a new read buffer is available, the DS2004 RTLib alternatively offers the ds2004_data_ready function, which only queries if a new buffer is available but does not read the conversion results.

Read methods used with RTI

With RTLib, you can implement the desired read method by using the corresponding RTLib functions. With RTI, the specified block settings are

responsible for the read method used. Because there is no visible hint in the block's dialog, the following table shows you which settings result in a specific read method.

Conversion Mode	Burst Trigger	Conversion Trigger	Read Method
Single conversion	(Continuous)	Sample base rate (ADC)	Polling
		Sample base rate (ADCSTART)	Non-polling
		External trigger	Non-polling
Burst conversion	Sample base rate (ADC)	Timer	Polling
		External Trigger	Non-polling
	Sample base rate (ADCSTART)	Timer	Non-polling
		External Trigger	Non-polling
	External trigger	Sample base rate (ADC)	Non-polling
		Sample base rate (ADCSTART)	Non-polling
		Timer	Non-polling
		External trigger	Non-polling
	Continuous	Sample base rate (ADC)	Non-polling
		Sample base rate (ADCSTART)	Non-polling
		Timer	Non-polling
		External trigger	Non-polling

- Sample base rate (ADC) means, that the DS2004ADC_BLx block triggers the conversion start and burst start respectively.
- Sample base rate (ADCSTART) means, that the DS2004ADC_START_BLx block triggers the conversion start and burst start respectively.

Related topics

Basics

Interrupts Provided by the DS2004 27

References

ds2004_burst_in (DS2004 RTLib Reference 🕮)
ds2004_burst_read (DS2004 RTLib Reference 🕮)
ds2004_data_ready (DS2004 RTLib Reference 🕮)
ds2004_data_ready_int_enable (DS2004 RTLib Reference 🕮)
ds2004_single_in (DS2004 RTLib Reference 🕮)
ds2004_single_read (DS2004 RTLib Reference 🕮)

Using a Separate Start Block in Simulink Models

Objective

You can trigger A/D conversion bursts and A/D conversions using a separate DS2004ADC_START_BLx block in your Simulink model.

Application range

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 sample base rate and the read-out of the conversion results is to be performed in a different task. For example, you can use the DS2004ADC_START_BLx block, if the read-out of the conversion results is embedded in an interrupt-driven subsystem. In this case, a DS2004ADC_START_BLx block can be implemented in a task superior to the subsystem containing the DS2004ADC_BLx block. For more information, refer to DS2004ADC_START_BLx (DS2004 RTI Reference 🕮).

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*.

Related topics

References

DS2004ADC_START_BLx (DS2004 RTI Reference 🕮)

I/O Mapping of the DS2004

I/O mapping

The following table shows the mapping between the RTI blocks, the RTLib functions, the corresponding pins used by the external connector of the DS2004, and the BNC connectors on the front of the CP2004 connector panel. For further information on the connectors, refer to the connector pinouts.

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Connector Pin[1)]	Pin on CP2004	Signal
DS2004ADC_BLx DS2004ADC_START_BLx	Ch 1	ds2004_init ds2004_channel_control	Ch 1	P1 18	CP1	VIN1
				P1 2		$\overline{\text{VIN1}}$
	Ch 2	ds2004_sw_trigger ds2004_single_init ds2004_single_in	Ch 2	P1 35	CP2	VIN2
				P1 19		$\overline{\text{VIN2}}$
	Ch 3	ds2004_single_read ds2004_burst_init ds2004_burst_in	Ch 3	P1 36	CP3	VIN3
				P1 20		$\overline{\text{VIN3}}$
	Ch 4		Ch 4	P1 4	CP4	VIN4

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Connector Pin[1)]	Pin on CP2004	Signal
		ds2004_burst_read		P1 37		$\overline{\text{VIN4}}$
	Ch 5		Ch 5	P1 5	CP5	VIN5
				P1 38		$\overline{\text{VIN5}}$
	Ch 6		Ch 6	P1 22	CP6	VIN6
				P1 6		$\overline{\text{VIN6}}$
	Ch 7		Ch 7	P1 23	CP7	VIN7
				P1 7		$\overline{\text{VIN7}}$
	Ch 8		Ch 8	P1 40	CP8	VIN8
				P1 24		$\overline{\text{VIN8}}$
	Ch 9		Ch 9	P1 41	CP9	VIN9
				P1 25		$\overline{\text{VIN9}}$
	Ch 10		Ch 10	P1 9	CP10	VIN10
				P1 42		$\overline{\text{VIN10}}$
	Ch 11		Ch 11	P1 10	CP11	VIN11
				P1 43		$\overline{\text{VIN11}}$
	Ch 12		Ch 12	P1 27	CP12	VIN12
				P1 11		$\overline{\text{VIN12}}$
	Ch 13		Ch 13	P1 28	CP13	VIN13
				P1 12		$\overline{\text{VIN13}}$
	Ch 14		Ch 14	P1 45	CP14	VIN14
				P1 29		$\overline{\text{VIN14}}$
	Ch 15		Ch 15	P1 46	CP15	VIN15
				P1 30		$\overline{\text{VIN15}}$
	Ch 16		Ch 16	P1 14	CP16	VIN16
				P1 47		$\overline{\text{VIN16}}$
	–		–	P1 16	CP17	EXT. TRIGGER 1
	–		–	P1 49	CP18	EXT. TRIGGER 2
	–		–	P1 33	CP19	EXT. TRIGGER 3
	–		–	P1 17	CP20	EXT. TRIGGER 4

[1)] "P1" means "board's plug no. 1"

Related topics

References

ADC Connector (P1) (PHS Bus System Hardware Reference 🕮)
BNC Connectors CP1 ... CP20 (PHS Bus System Hardware Reference 🕮)

Interrupts Provided by the DS2004

Objective

The DS2004 provides several interrupts indicating conversion states your application can react to.

Where to go from here

Information in this section

Basics of Interrupt Processing

Objective

The hardware interrupts from the DS2004 are used to trigger interrupt-driven tasks which are executed on the dSPACE processor board.

Interrupt processing

The interrupts are forwarded via the interrupt lines of the PHS bus which connect the I/O boards in a PHS-bus-based system to the processor board. Its interrupt controller evaluates the interrupts.

To be used, an interrupt must be enabled. The functions you want to trigger by interrupt must be embedded in an interrupt-driven subsystem. For instructions on doing this, refer to Tasks Driven by Interrupt Blocks (RTI and RTI-MP Implementation Guide 🕮).

Required RTI blocks

The interrupt which is to trigger the subsystem must be made available using the DS2004ADC_HWINT_BLx block. The appropriate channel number and the respective interrupt specification in the block's dialog have to be selected. The model must contain a DS2004ADC_BLx block using the specified channel. For details, see A/D Conversion (DS2004 RTI Reference 🕮).

Note

You need a separate DS2004ADC_HWINT_BLx block for each interrupt on each single conversion channel. For example, you need 8 blocks for 4 interrupts on each of 2 channels.

RTLib support

See Interrupts (DS2004 RTLib Reference 🕮).

Related topics

Basics

Tasks Driven by Interrupt Blocks (RTI and RTI-MP Implementation Guide 🕮)

References

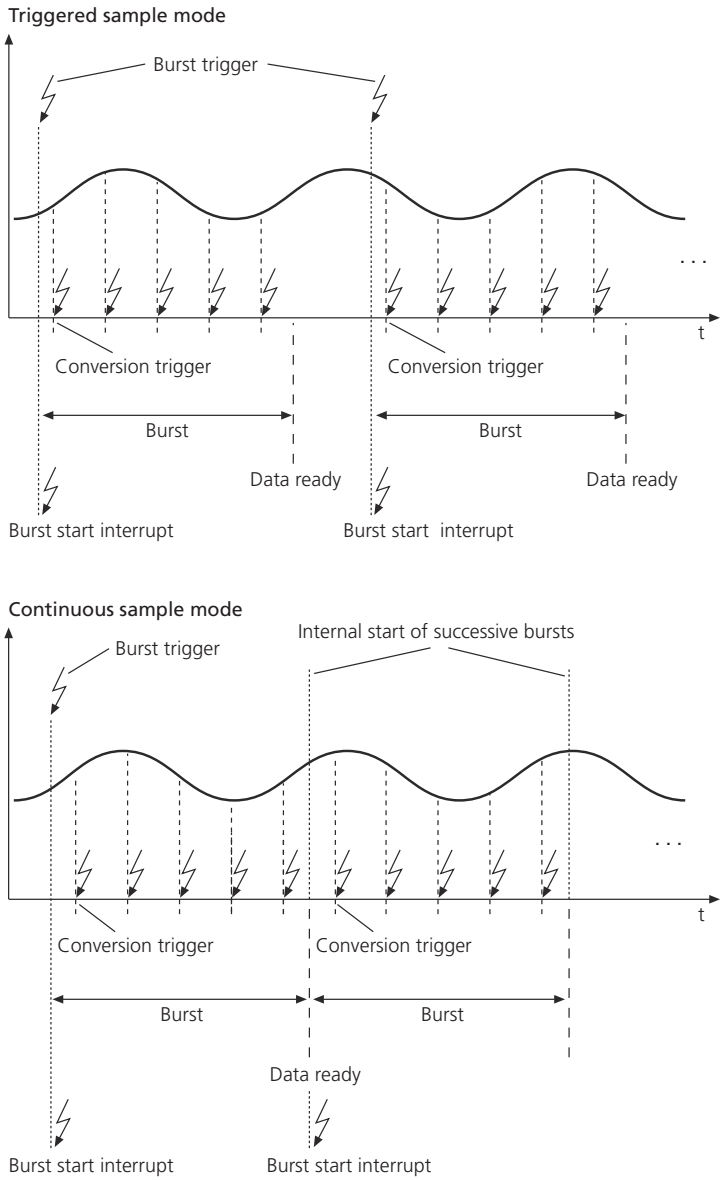
A/D Conversion (DS2004 RTI Reference 🕮)
Interrupts (DS2004 RTLib Reference 🕮)

Burst Start Interrupt

Interrupt source

The burst start interrupt is provided by the A/D conversion units, one per channel.

For burst conversion mode, the interrupt shows that a conversion burst has started.



For single conversion mode, the interrupt can be made available, but it is of no relevance for possible use cases.

Required RTI blocks and settings

A DS2004ADC_HWINT_BLx block has to be added to the model. The appropriate board and channel number and the burst start interrupt have to be selected in the block's dialog.

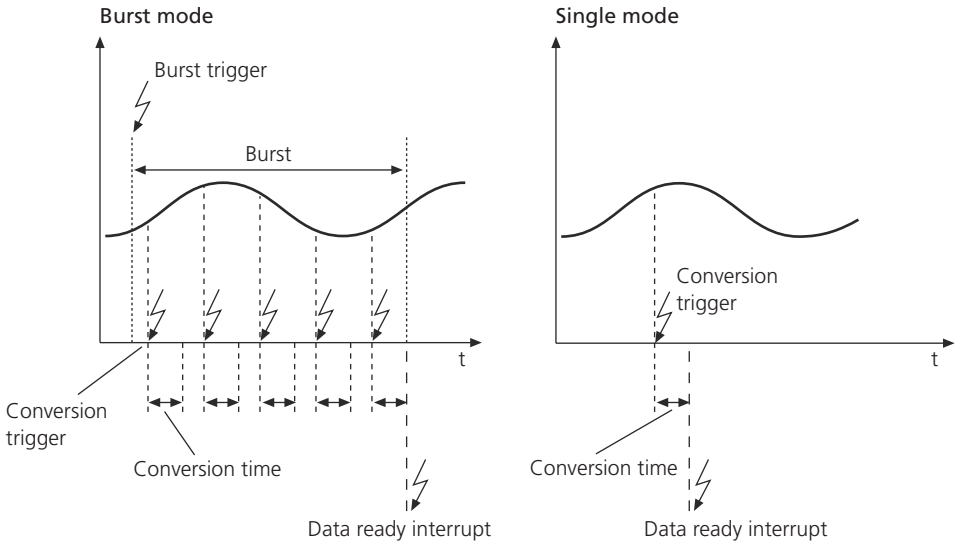
Data Ready Interrupt

Interrupt source

The data ready interrupt is provided by the A/D conversion units, one per channel.

For burst conversion mode, the interrupt shows that a conversion burst has finished and the new conversion results are available. If a burst is terminated before it has reached the number of specified conversions, the interrupt is generated when the current conversion has been finished and the incomplete conversion results are available.

For single conversion mode, the interrupt shows that a conversion has finished and the new conversion result is available.



Required RTI blocks and settings

A DS2004ADC_HWINT_BLx block has to be added to the model. The appropriate board and channel number and the data ready interrupt have to be selected in the block's dialog.

Data Lost Interrupt

Interrupt source

The data lost interrupt is provided by the A/D conversion units, one per channel.

The interrupt shows that a filled free buffer in the swinging buffer was overwritten by new conversion results before the old conversion results could be read. This condition occurs if conversion bursts are started more frequently than the buffers are read. For more information on the swinging buffer, refer to Swinging Buffer on page 11.

Required RTI blocks and settings

A DS2004ADC_HWINT_BLx block has to be added to the model. The appropriate board and channel number and the data lost interrupt have to be selected in the block's dialog.

Related topics

Basics

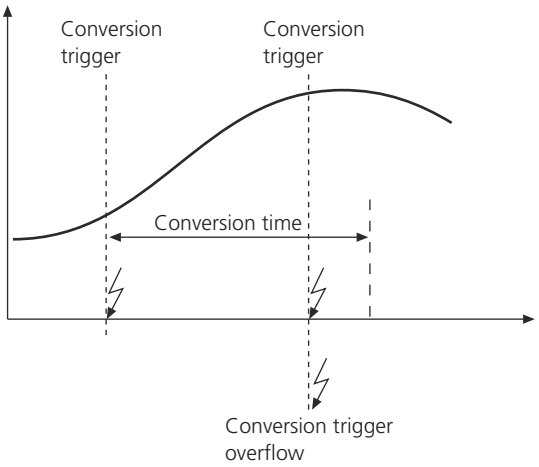
Swinging Buffer 11

Conversion Trigger Overflow Interrupt

Interrupt source

The conversion trigger overflow interrupt is provided by the A/D conversion units, one per channel.

The interrupt shows that a conversion trigger was received before the preceding conversion finished. The conversion trigger is ignored.



Note

A conversion trigger overflow can occur if:

- The signal of the specified external trigger source is noisy.
- The conversion trigger signal period is lower than the conversion time.

Required RTI blocks and settings

A DS2004ADC_HWINT_BLx block has to be added to the model. The appropriate board and channel number and the conversion trigger overflow interrupt have to be selected in the block's dialog.

Application Examples

Objective

The following application examples cover typical DS2004 use cases and are intended to help you to implement the different A/D conversion modes with RTI.

Where to go from here

Information in this section

How to Use Single A/D Conversion

Objective

You can configure an A/D conversion channel to be used in the single conversion mode.

Single conversion mode

In single conversion mode, the burst capabilities of a DS2004 conversion channel are not used. For basic information on using the single conversion mode, refer to Using A/D Conversion in Single Mode on page 21.

Method

To use single A/D conversion

1. Open a new Simulink model.
2. Drag a *DS2004ADC_BLx* block into the model.
3. Open the block and specify the settings.
   - On the Unit page, specify the board and channel number.
   - On the Parameters page, select Single Conversion Mode.
4. Specify the single conversion settings.
   - If you want to trigger by sample base rate, select Sample base rate from the Trigger source list.

     Tip

     You can use a separate DS2004ADC_START_BLx block in your Simulink model, if the conversion trigger source is set to sample base rate and the read out of the conversion results is to be performed in a different task. Therefore, select Use separate DS2004ADC_START Block on the Advanced page.

   - If you want to trigger by external trigger input, select an external trigger input from the Trigger source list.
   - If the trigger source is set to an external trigger input, you can select the evaluated edge polarity of the trigger signal.
5. Click OK to close the dialog.
6. If required, drag a *DS2004ADC_START_BLx* block to your model and specify the settings.

Result

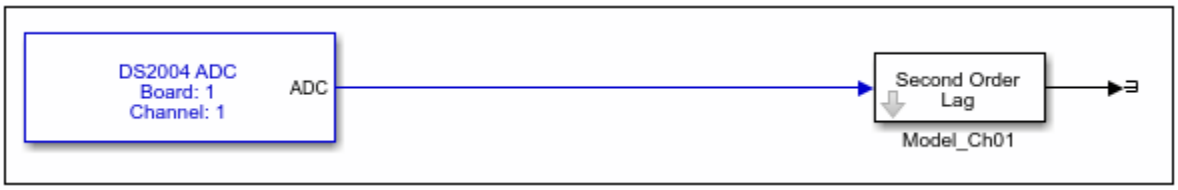
The model is now prepared for executing a single A/D conversion with the specified settings.

Demo models

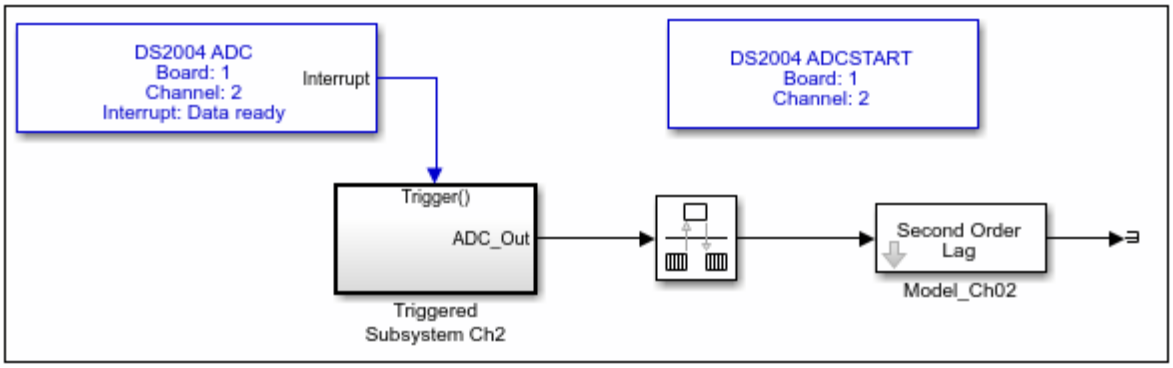
The RTI Blockset contains several demo models which show the use of the ADC RTI blocks. You can access the demo models via the Demos button in the blockset.

DS2004_1 (DemomDS2004AdcSingle) The demo model shows how to use A/D conversion in single mode:

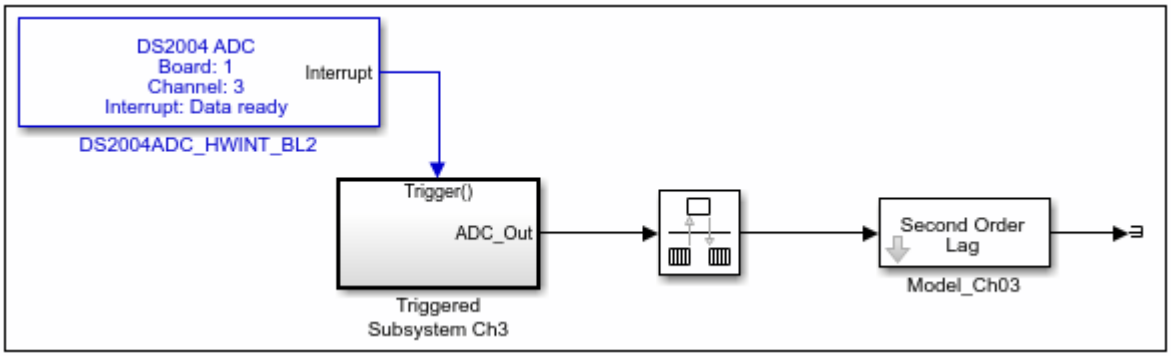
- Channel 1: triggered by software



- Channel 2: triggered by a DS2004ADC_START_BLx block

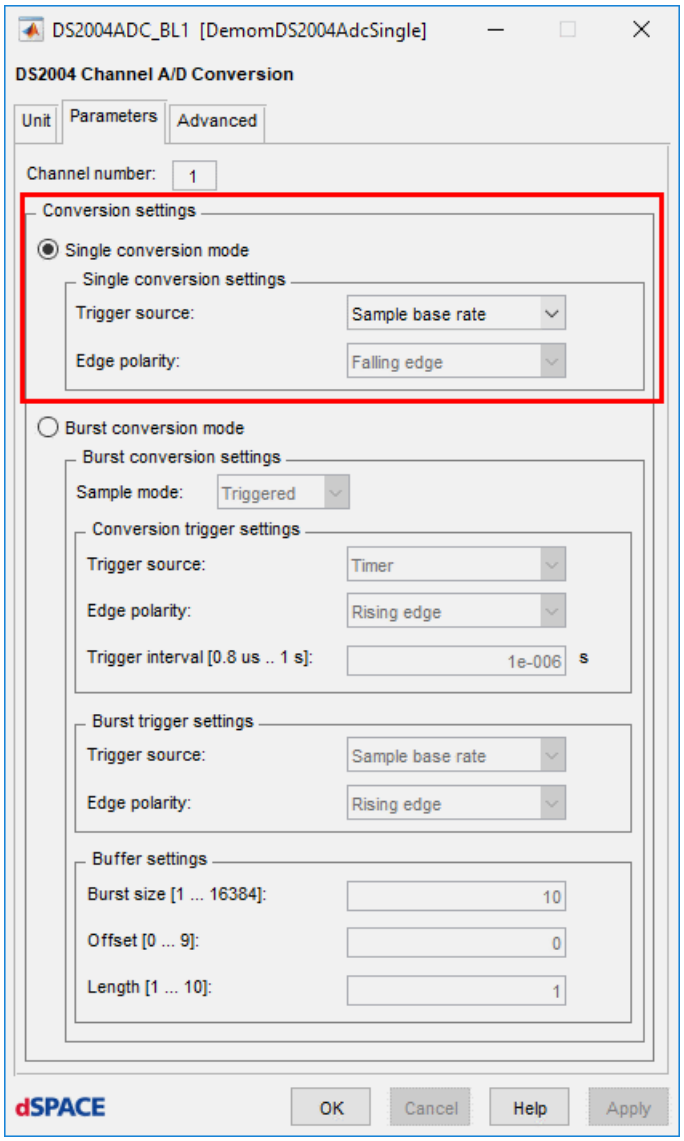


- Channel 3: triggered by an external hardware signal



Example

The following settings of the DS2004ADC_BLx block perform a single A/D conversion triggered by software.



Related topics

Basics

Using A/D Conversion in Single Mode.....21

How to Use Burst A/D Conversion in Triggered Sample Mode

Objective

You can use the burst capabilities of the DS2004 in triggered sample mode and start each burst by a trigger event.

Burst A/D conversion in triggered sample mode

In triggered sample mode, each burst is started by the trigger event according to the selected burst trigger source. In addition, you need a conversion trigger to start the individual conversions. After a burst is finished the following burst is started when the next burst trigger occurs. For basic information on using the burst conversion mode, refer to Using A/D Conversion in Burst Mode on page 19. For information on the available trigger sources, refer to Trigger Signals on page 13.

Reading the conversion results

The RTI Blockset offers different methods of reading the A/D conversion results. For detailed information on the methods, refer to Methods of Reading Conversion Results on page 22. The most efficient method of reading conversion results is to use the data ready interrupt. The data ready interrupt indicates that a burst of A/D conversions has finished and the new conversion results can be read. The interrupt must be made available by adding a DS2004ADC_HWINT_BLx block to your Simulink model.

Method

To use burst A/D conversion in triggered sample mode

1. Open a new Simulink model.
2. Drag a function-call triggered subsystem into the model.
3. Drag a *DS2004ADC_BLx* block into the subsystem.
4. Open the block and specify the settings.
   - On the **Unit** page, specify the board and channel number.
   - On the **Parameters** page, select **Burst Conversion Mode**.
5. Specify the burst conversion settings.
   - From the **Sample mode** list, select **Triggered**.
6. Specify the conversion trigger settings.
   - If you want to trigger by the channel timer, select **Timer** from the **Conversion trigger settings** list.

     You can specify the trigger interval in the **Trigger interval** edit field.
   - If you want to trigger by an external hardware signal, select an external trigger input from the **Conversion trigger settings** list.

If the trigger source is set to an external trigger input, you can select the evaluated edge polarity of the trigger signal.

- If you want to trigger by software or sample base rate, select **Sample base rate** from the **Conversion trigger settings** list.

Tip

You can use a separate DS2004ADC_START_BLx block in your Simulink model, if the conversion trigger source is set to sample base rate and the read out of the conversion results is to be performed in a different task. Therefore, select **Use separate DS2004ADC_START Block** on the **Advanced** page.

7 Specify the burst trigger settings.

- If you want to trigger by an external hardware signal, select an external trigger input from the **Burst trigger settings** list.

  If the trigger source is set to an external trigger input, you can select the evaluated edge polarity of the trigger signal.
- If you want to trigger by sample base rate, select **Sample base rate** from the **Burst trigger settings** list.

Tip

You can use a separate DS2004ADC_START_BLx block in your Simulink model, if the burst trigger source is set to sample base rate and the read out of the conversion results is to be performed in a different task. Therefore, select **Use separate DS2004ADC_START Block** on the **Advanced** page.

8 Specify the buffer settings.

9 Click **OK** to close the dialog.

10 Drag a *DS2004ADC_HWINT_BLx* block to your model and connect it to the trigger port of the subsystem.

11 Open the block and specify the settings.

12 If required, drag a *DS2004ADC_START_Blx* block to your model and specify the settings.

Result

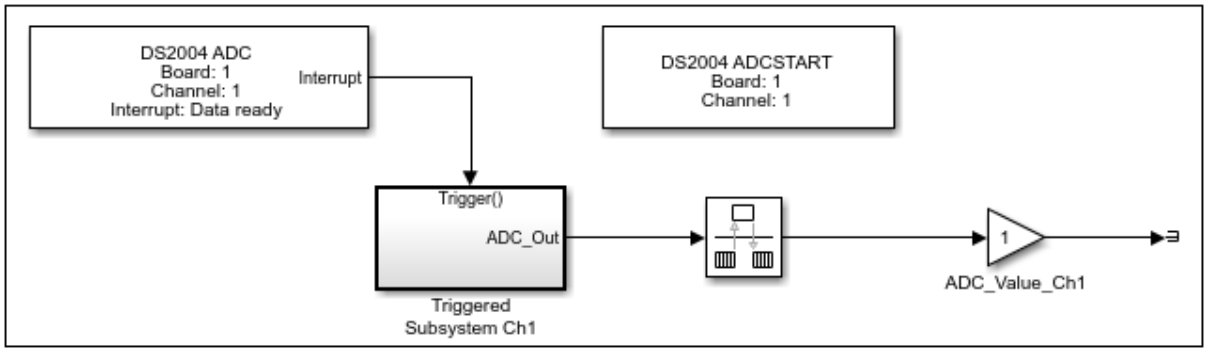
You can use burst A/D conversion in triggered sample mode with the specified settings.

Demo models

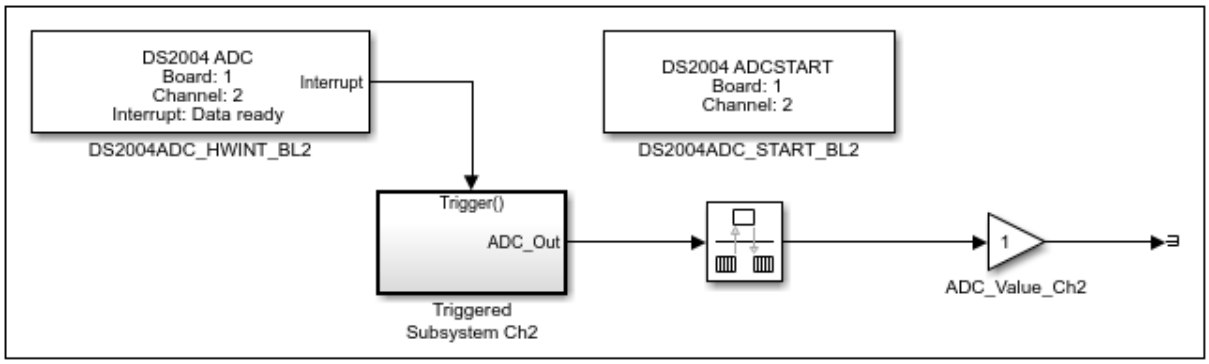
The RTI Blockset contains several demo models which show the use of the ADC RTI blocks. You can access the demo models via the **Demos** button in the blockset.

Demo_2 (DemomDS2004AdcBurst) The demo model shows how to use burst A/D conversion in triggered sample mode:

- Channel 1: Burst triggered by an DS2004ADC_START_BLx block and A/D conversion triggered by an internal timer

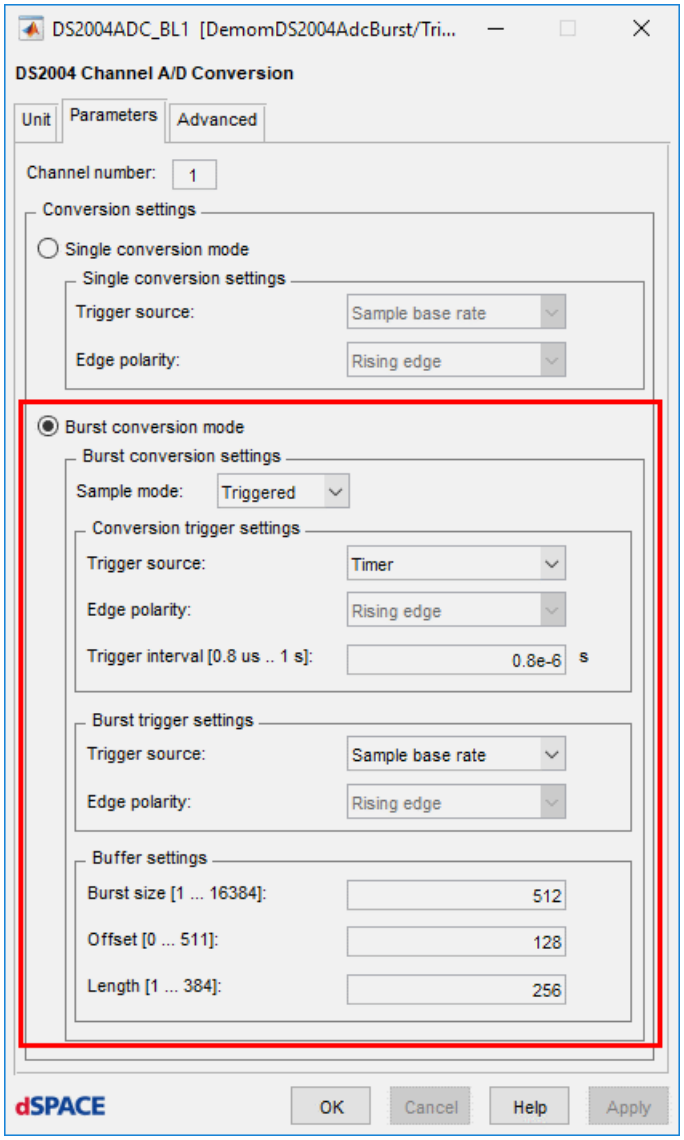


- Channel 2: Burst triggered by an DS2004ADC_START_BLx block and A/D conversion triggered by an external hardware signal

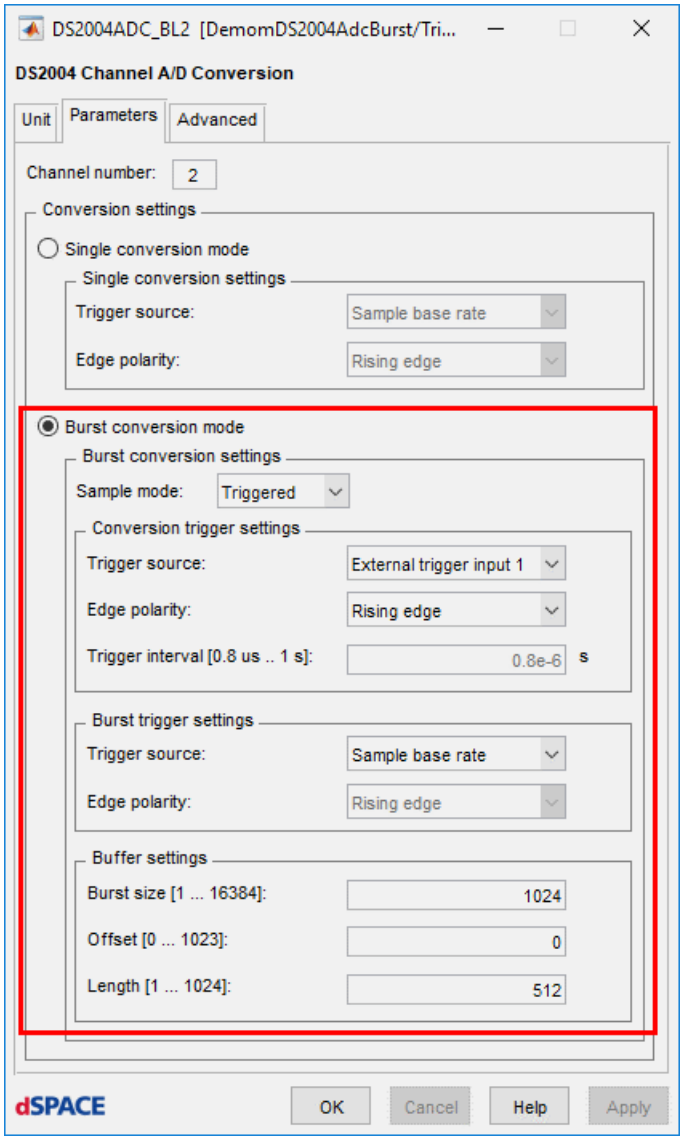


Examples

The following settings of the DS2004ADC_BLx block perform a burst conversion with bursts triggered by the sample base rate and conversions triggered by the channel timer. The burst size is specified to 512 conversions. The conversion result contains 256 values starting with the value of the 129th conversion.



The following settings of the DS2004ADC_BLx block perform a burst conversion with bursts triggered by the sample base rate and conversions triggered by an external trigger input with a rising edge. The burst size is specified to 1024 conversions. The conversion result contains 512 values starting with the value of the first conversion.



Related topics

Basics

Methods of Reading Conversion Results....22
Trigger Signals....13
Using A/D Conversion in Burst Mode....19

How to Use Burst A/D Conversion in Continuous Sample Mode

Objective

You can use the burst capabilities of the DS2004 in continuous sample mode and start the successive bursts automatically.

Burst A/D conversion in continuous sample mode

In the continuous sample mode, the bursts are started automatically. After a burst and its last conversion are finished, the next burst is started automatically. For basic information on using the burst conversion mode, refer to Using A/D Conversion in Burst Mode on page 19. For detailed information on the continuous sample mode, refer to Burst Continuous Sample Mode on page 15.

Method

To use burst A/D conversion in continuous sample mode

1. Open a new Simulink model.
2. Drag a function-call triggered or enabled subsystem into the model.
3. Drag a *DS2004ADC_BLx* block into the subsystem.
4. Open the block and specify the settings.
   - On the **Unit** page, specify the board and channel number.
   - On the **Parameters** page, select **Burst Conversion Mode**.
5. Specify the burst conversion settings.
   - From the **Sample mode** list, select **Continuous**.
6. Specify the conversion trigger settings.
   - If you want to trigger by the channel timer, select **Timer** from the **Conversion trigger settings** list.

     You can specify the trigger interval in the **Trigger interval** edit field.
   - If you want to trigger by an external hardware signal, select an external trigger input from the **Conversion trigger settings** list.

     If the trigger source is set to an external trigger input, you can select the evaluated edge polarity of the trigger signal.
   - If you want to trigger by sample base rate, select **Sample base rate** from the **Conversion trigger settings** list.
7. Specify the buffer settings. In the continuous sample mode you can only specify the burst size. The settings for buffer offset and buffer length are disabled.
8. Click **OK** to close the dialog.

Result

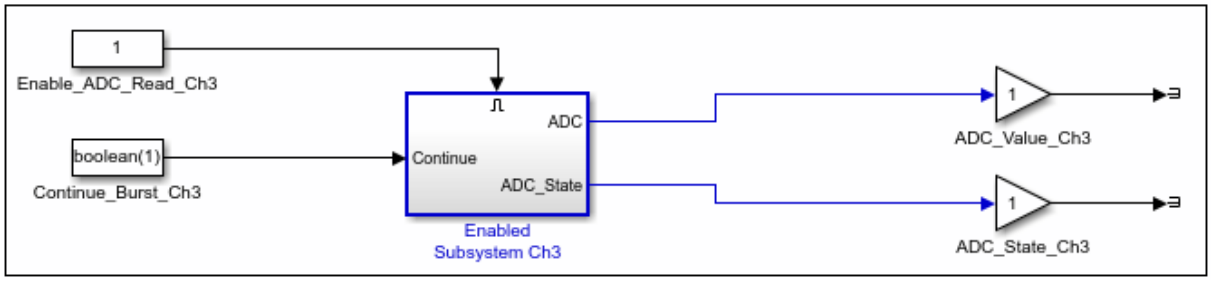
You can use burst A/D conversion in continuous sample mode with the specified settings.

Demo models

The RTI Blockset contains several demo models which show the use of the ADC RTI blocks. You can access the demo models via the Demos button in the blockset.

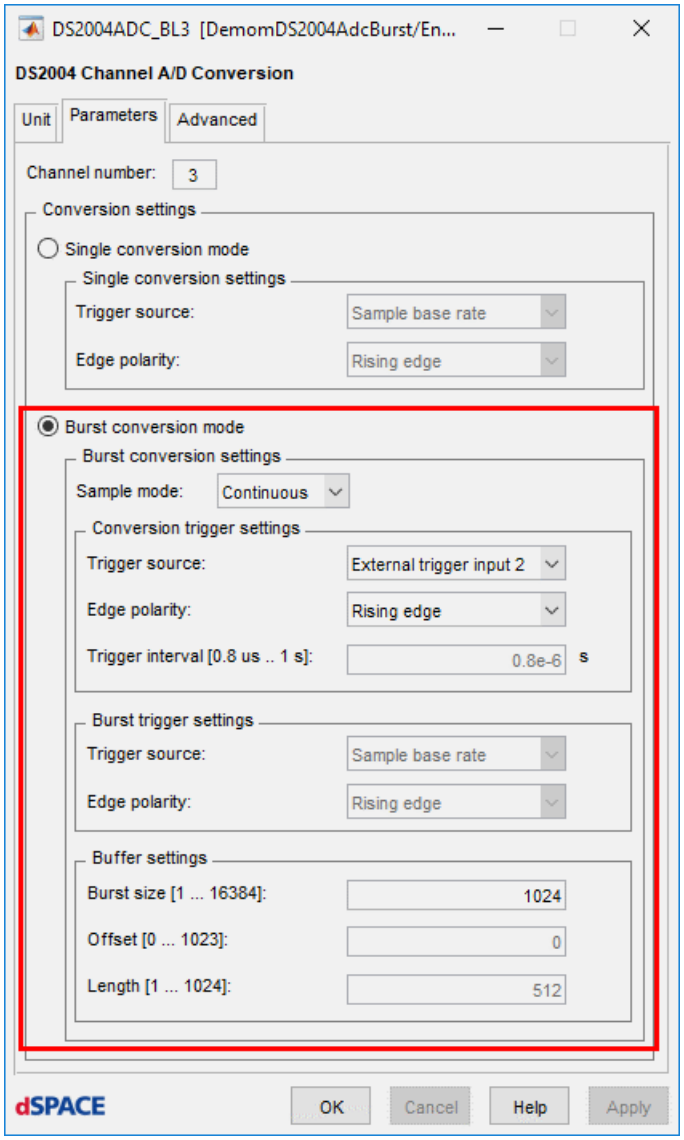
Demo_2 (DemomDS2004AdcBurst) The demo model shows how to use burst A/D conversion in triggered sample mode:

- Channel 3: Continuous burst and A/D conversion triggered by external hardware signal



Example

The following settings of the DS2004ADC_BLx block perform a burst conversion in continuous sample mode with conversions triggered by an external trigger input with a rising edge. The burst size is specified to 1024 conversions. Because the other buffer settings are disabled, the buffer length is also 1024.



Related topics

Basics

Burst Continuous Sample Mode..... 15
Using A/D Conversion in Burst Mode..... 19