DS2201 Multi-I/O Board

Features

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dSPACE

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Contents

About This Document

About this document

This document provides feature-oriented access to the information you need to implement the functions of the DS2201.

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>`

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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.

Introduction to the Features of the DS2201

Where to go from here

Information in this section

Information in other sections

DS2201 Data Sheet (PHS Bus System Hardware Reference 🕮)

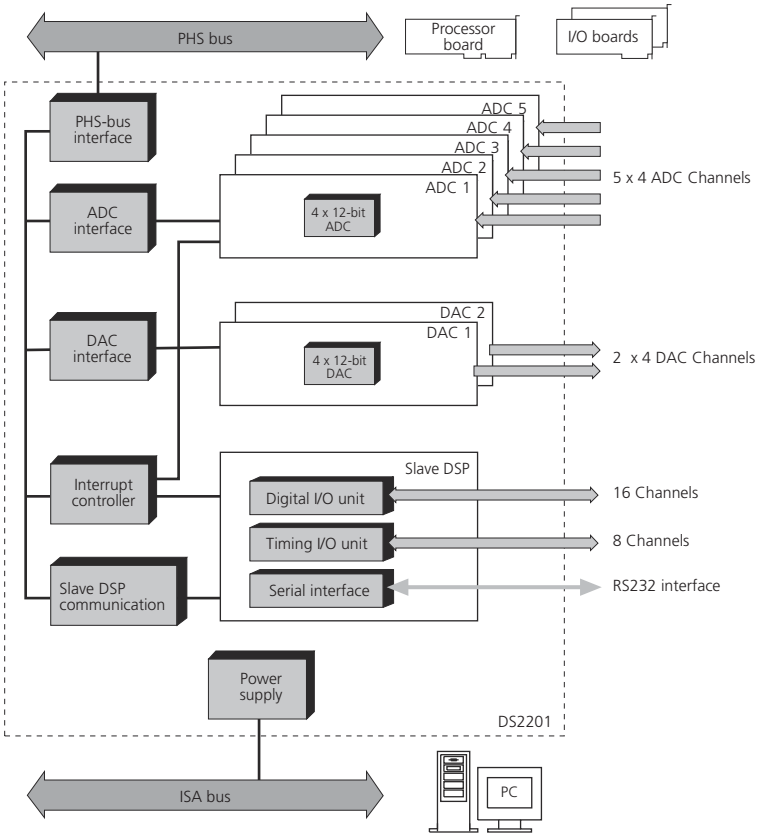
CP2201 Data Sheet (PHS Bus System Hardware Reference 🕮)

LP2201 Data Sheet (PHS Bus System Hardware Reference 🕮)

DS2201 Architecture

Introduction

The following illustration gives an overview of the functional units and architecture of the DS2201:



Related topics

Basics

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Feature Overview 8

Feature Overview

Introduction

The DS2201 has several units which provides the different features.

Overview

Many applications, especially in the automotive field, require a lot of different I/O types. The DS2201 provides numerous I/O types on one board.

The DS2201 Multi-I/O Board provides 20 channels for A/D conversion, 8 parallel channels for D/A conversion and 16 digital I/O lines.

It also provides up to 6 channels for signal generation and up to 4 channels for signal measurement.

Functions for PWM signal generation as well as square-wave signal generation and measurement are included.

ADC unit

The ADC unit provides access to 20 analog input channels, see ADC Unit on page 11.

DAC unit

The DAC unit provides access to 8 analog output channels, see DAC Unit on page 15.

Slave DSP

The features below are based on the slave DSP of the DS2201:

- The digital I/O unit provides access to 16 digital I/O lines. Refer to Digital I/O Unit on page 23.
- The timing I/O unit provides access to up to 6 channels for signal generation and up to 4 channels for signal measurement. Refer to Timing I/O Unit on page 25.
- Serial interface providing a universal asynchronous receiver/transmitter serial interface. Refer to Serial Interface on page 35.

Interrupt control

The DS2201 provides 8 interrupts. Refer to Interrupts Provided by the DS2201 on page 39.

Limitations

There are some limitations when you work with the DS2201. Refer to Limitations on page 43.

Related topics

Basics

DS2201 Interfaces

Introduction

The DS2201 has interfaces for connection to a PHS-bus-based system and external devices.

Integration into a PHS-bus-based system

To be used, the DS2201 must be integrated into a PHS-bus-based system. While the DS2201 performs the required I/O tasks, the processor board takes over the calculation of the real-time model. That is, applications using DS2201 I/O features are implemented on the processor board.

Communication between processor board and I/O board is performed via the peripheral high-speed bus: That is the PHS bus for a connection to a dSPACE processor board.

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 🕮).

Connection to external devices

There are different ways to connect external devices to the DS2201. To access the I/O units of the DS2201, connect external devices

- to the 44-pin analog I/O connector P5 of the DS2201
- to the 26-pin digital I/O connector P4 of the DS2201
- to the serial interface connector P2 of the DS2201
- to the optional connector panel CP2201 or the optional LED panel LP2201, which provides an array of LEDs indicating the states of the digital signals

Related topics

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References

Board Overview (PHS Bus System Hardware Reference 🕮)

Analog/Digital Conversion

ADC Unit

Introduction

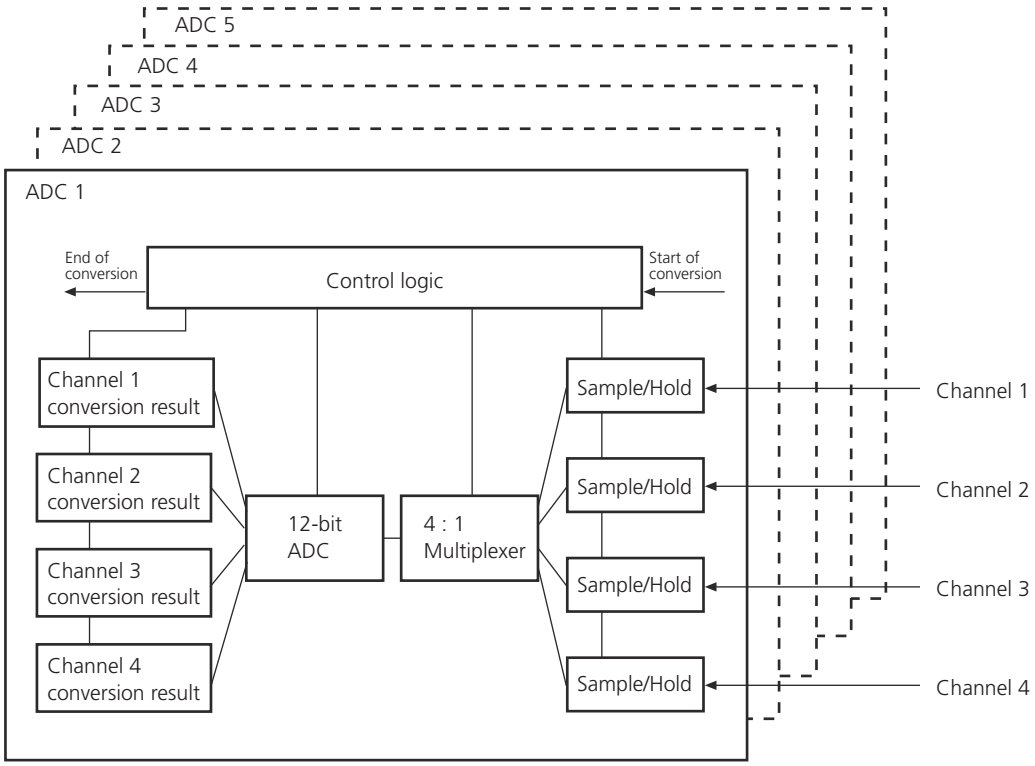
A/D conversion is an element of most applications in rapid control prototyping and hardware-in-the-loop simulation. In control prototyping, sensors for pressure, temperature, or other signals provide analog voltages. In hardware-in-the-loop simulation, an electronic control unit (ECU) provides analog voltages that control the simulated actuators.

Features

The DS2201 provides an ADC unit featuring 5 A/D converters (ADC1 … ADC5) multiplexed to 4 channels each. The A/D converters have the following characteristics:

- 12-bit resolution
- Simultaneous sample & hold for each channel
- ±10 V input voltage range

The following illustration gives an overview of the architecture of the ADC unit:



Synchronous start of A/D conversion

A/D conversion is started synchronously on all the channels you use in your application. This is possible for any number of converters on the same DS2201 separately or in parallel.

To start A/D conversion, use the `ds2201_adc_start` function.

With RTI, the function is used automatically.

Note

Each converter always processes all the 4 channels when started.

Interrupt on end of A/D conversion

The converters ADC1 … ADC5 provide an interrupt at the end of an A/D conversion. For information on interrupt handling, refer to Interrupts Provided by the DS2201 on page 39.

RTI/RTLib support

You can access the ADC unit via DS2201 blockset and RTLib. Refer to

- RTI: ADC Unit (DS2201 RTI Reference 🕮)
- RTLib: ADC Unit (DS2201 RTLib Reference 🕮)

Execution times

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Connecting external devices

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

I/O mapping

The following table shows the mapping between the RTI block and RTLib functions and the corresponding pins used by the ADC unit:

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Conn. Pin	Pin on CP	Signal
DS2201ADC_Bx	Ch 1 (ADC 1)	Refer to ADC Unit (DS2201 RTLib Reference 🕮)	Ch 1 (Conv 1)	P5 1	P1	VIN1
	Ch 2 (ADC 1)		Ch 2 (Conv 1)	P5 17	P2	VIN2
	Ch 3 (ADC 1)		Ch 3 (Conv 1)	P5 2	P3	VIN3
	Ch 4 (ADC 1)		Ch 4 (Conv 1)	P5 18	P4	VIN4
	Ch 5 (ADC 2)		Ch 5 (Conv 2)	P5 3	P5	VIN5
	Ch 6 (ADC 2)		Ch 6 (Conv 2)	P5 19	P6	VIN6
	Ch 7 (ADC 2)		Ch 7 (Conv 2)	P5 4	P7	VIN7
	Ch 8 (ADC 2)		Ch 8 (Conv 2)	P5 20	P8	VIN8
	Ch 9 (ADC 3)		Ch 9 (Conv 3)	P5 5	P9	VIN9
	Ch 10 (ADC 3)		Ch 10 (Conv 3)	P5 21	P10	VIN10
	Ch 11 (ADC 3)		Ch 11 (Conv 3)	P5 6	P11	VIN11
	Ch 12 (ADC 3)		Ch 12 (Conv 3)	P5 22	P12	VIN12
	Ch 13 (ADC 4)		Ch 13 (Conv 4)	P5 7	P13	VIN13
	Ch 14 (ADC 4)		Ch 14 (Conv 4)	P5 23	P14	VIN14
	Ch 15 (ADC 4)		Ch 15 (Conv 4)	P5 8	P15	VIN15
	Ch 16 (ADC 4)		Ch 16 (Conv 4)	P5 24	P16	VIN16
	Ch 17 (ADC 5)		Ch 17 (Conv 5)	P5 9	P17	VIN17
	Ch 18 (ADC 5)		Ch 18 (Conv 5)	P5 25	P18	VIN18
	Ch 19 (ADC 5)		Ch 19 (Conv 5)	P5 10	P19	VIN19
	Ch 20 (ADC 5)		Ch 20 (Conv 5)	P5 26	P20	VIN20

Related topics

References

ADC Unit (DS2201 RTI Reference 🕮)
ADC Unit (DS2201 RTLib Reference 🕮)
ds2201_adc_start (DS2201 RTLib Reference 🕮)
DS2201ADC_Bx (DS2201 RTI Reference 🕮)

Digital/Analog Conversion

DAC Unit

Introduction

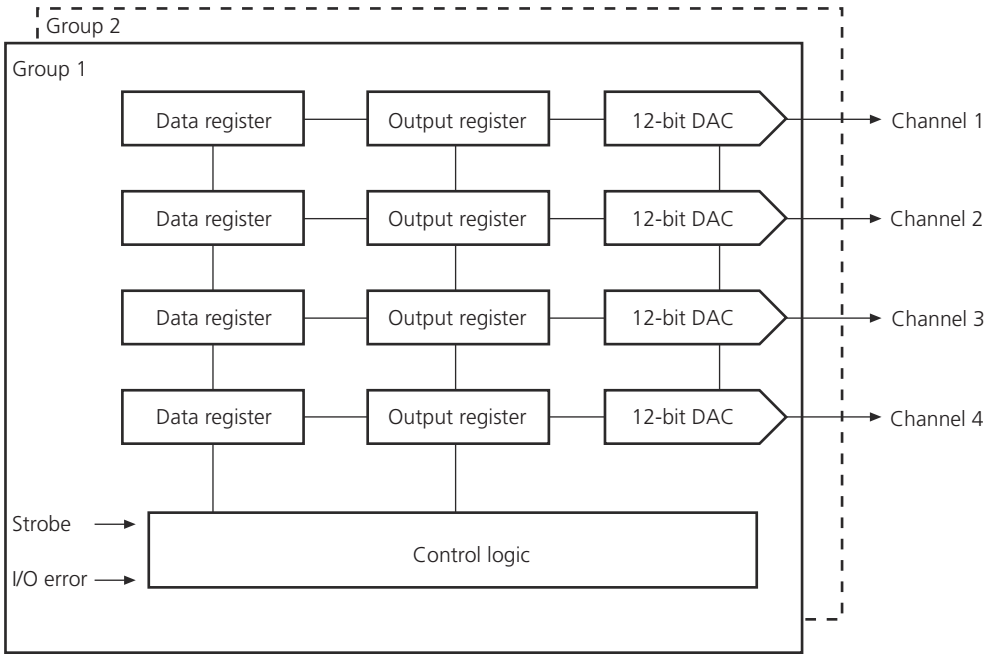
D/A conversion is required by many control applications to provide the control signal for actuators. In hardware-in-the-loop applications, sensors that provide analog signals have to be simulated.

Features

The DS2201 controls a DAC unit featuring 2 parallel D/A converter groups, each providing 4 outputs. They have the following characteristics:

- 12-bit resolution
- ±10 V output voltage range
- Transparent and latched modes

The following illustration gives an overview of the architecture of the DAC unit:



Transparent and latched modes

The DAC unit consists of 2 groups, each containing 4 D/A channels. For each group the output mode can be programmed separately. Each group can be driven in two operating modes:

- In the *transparent mode*, the converted value is output immediately.
- In the *latched mode*, the converted value is output after a strobe command. This allows you to write output values to more than one channel, and output the values simultaneously. To operate the outputs in *latched mode*, the `ds2201_dac_strobe` function must be used.

  The *latched mode* is not supported by RTI.

Power-up state

On power-up of the DS2201, each output channel of the DAC unit is set to 0 V.

Reacting to I/O errors

If another board activates the I/O error signal of the PHS bus, the DS2201 provides two different modes:

- If the *I/O error mode* is enabled, the output is reset to zero and remains zero until a new output value is written to the channel.
- If the *I/O error mode* is disabled, an I/O error has no influence on the output value.

You can set the *I/O error mode* individually for each of the 2 D/A converter groups with RTI and RTLib.

RTI/RTLib support

You can access the DAC unit via DS2201 blockset and RTLib. Refer to

- RTI: DAC Unit (DS2201 RTI Reference 🕮)
- RTLib: DAC Unit (DS2201 RTLib Reference 🕮)

Execution times

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Connecting external devices

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

I/O mapping

The following table shows the mapping between the RTI block and RTLib functions and the corresponding pins used by the DAC unit:

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Conn. Pin	Pin on CP	Signal
DS2201DAC_Bx	Ch 1	See DAC Unit (DS2201 RTLib Reference 🕮)	Ch 1 (group 1)	P5 11	CP21	VOUT1
	Ch 2		Ch 2 (group 1)	P5 27	CP22	VOUT2
	Ch 3		Ch 3 (group 1)	P5 12	CP23	VOUT3
	Ch 4		Ch 4 (group 1)	P5 28	CP24	VOUT4
	Ch 5		Ch 5 (group 2)	P5 13	CP25	VOUT5
	Ch 6		Ch 6 (group 2)	P5 29	CP26	VOUT6
	Ch 7		Ch 7 (group 2)	P5 14	CP27	VOUT7
	Ch 8		Ch 8 (group 2)	P5 30	CP28	VOUT8

Related topics

References

ds2201_dac_strobe (DS2201 RTLib Reference 🕮)

Features of the Slave DSP

Introduction

Several features of the DS2201 are provided by the slave DSP. They are implemented by the firmware and five ready-to-use slave-DSP applications.

Where to go from here

Information in this section

Basics of the Slave DSP

Where to go from here

Information in this section

Slave DSP Microcontroller

MicroController

The slave-DSP subsystem of the DS2201 consists of a Texas Instruments TMS320E14 DSP microcontroller, which provides a digital I/O unit, a timing I/O unit and a serial interface. It is a 16-bit fixed-point digital signal processor (DSP) with 4 timers.

For more information on the TMS320E14, refer to http://www.ti.com.

Related topics

References

Block Description (DS2201_HWINT_Bx_Iy) (DS2201 RTI Reference 🕮)
Digital I/O Unit (DS2201 RTLib Reference 🕮)

Firmware and Slave-DSP Applications

Introduction

The firmware and 5 ready-to-use slave-DSP applications are provided, adding different features to a subset of the standard firmware features.

Overview of the features

The firmware supports a certain set of features. These are digital I/O, PWM signal generation on 6 channels and the serial interface. In addition to the firmware, 5 ready-to-use slave-DSP applications are provided, adding different features to a subset of the standard firmware features.

Note

Either the firmware or one slave-DSP application can be executed on the slave DSP at a time. The slave-DSP application currently downloaded cannot be changed during run time. This means that you can use only the features that are provided by the firmware or the slave-DSP application, respectively.

The following table shows the firmware and the slave-DSP applications with the features they provide:

Application	Digital I/O Unit	PWM Signal Generation	Square-Wave Signal Generation (D2F)	Square-Wave Signal Measurement (F2D)	Serial Interface
Firmware	✓	6 channels	–	–	✓
1FD slave application	✓	–	–	1 channel	✓
2FD6PWM slave application	✓	6 channels	–	2 channels	✓
2FD2DF slave application	✓	–	2 channels	2 channels	✓
4DF slave application	–	–	4 channels	–	✓
4FD4PWM slave application	✓	4 channels	–	4 channels	✓

Firmware

The firmware does not need to be loaded to the slave DSP. It resides in the slave DSP's EPROM. It is executed by default after power-up or after a slave-DSP reset. The firmware supports digital I/O, PWM generation on 6 channels and the serial interface. Other features are not available.

Slave-DSP applications

If you want to use other features, you have to download the appropriate slave-DSP application. It is executed instead of the firmware. You can use only the features that are provided by the slave-DSP application currently downloaded. Other features are not available.

Note

- For square-wave signal generation (D2F), the channels (I/O pins) used depend on the slave-DSP application used. Square-wave signal generation on 2 channels (2FD2DF slave-DSP application) uses other channels than square-wave signal generation on 4 channels (4DF slave-DSP application).
- Square-wave signal generation on 4 channels (D2F) is not supported by RTI.

Related topics

Basics

Downloading Slave-DSP Applications

Introduction

To use a slave-DSP application, it must be downloaded to the slave-DSP.

Loading slave-DSP applications using RTI

If you use RTI, you do not need to download a slave-DSP application. After you specify an RTI block of the DS2201 blockset, the respective slave-DSP application is downloaded automatically. The only exception is the following: If you use S-functions in your model, the respective slave-DSP application must be downloaded to the slave DSP.

Note

If you specify more than one RTI block a conflict can occur, because the RTI blocks may use different slave-DSP applications. Only certain combinations of RTI blocks are allowed. If you choose a combination that is not allowed an error message is output. For more information, refer to the DS2201 RTI Reference 🕮.

Loading slave-DSP application using RTLib

With RTLib, if you have to use a slave-DSP application, the slave-DSP application must be downloaded to the slave DSP. For more information on downloading slave-DSP applications, refer to Slave-DSP Applications (DS2201 RTLib Reference 🕮).

Digital I/O Unit

Digital I/O Unit

Introduction

The slave DSP on the DS2201 provides a digital I/O unit. It has the following characteristics:

- 16 bit-selectable digital I/O lines
- TTL voltage range

For basic information on the slave DSP, refer to Basics of the Slave DSP on page 20.

Applications supporting digital I/O

The following table shows the applications that support digital I/O:

Application	Digital I/O
Firmware	✓
Slave-DSP applications	
1FD	✓
2FD6PWM	✓
2FD2DF	✓
4DF	–
4FD4PWM	✓

Power-up state

On power-up of the DS2201, the slave DSP executes the firmware.

The digital I/O lines are set to *input mode*. They are set to the logical high level by the built-in pull-up resistors.

RTI/RTLib support

You can access the digital I/O unit via DS2201 blockset and RTLib. Refer to

- RTI: Digital I/O Unit (DS2201 RTI Reference 🕮)
- RTLib: Digital I/O Unit (DS2201 RTLib Reference 🕮)

Execution times

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Connecting external devices

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 digital

I/O unit, refer to Signal Connection to External Devices (PHS Bus System Hardware Reference 🕮).

I/O mapping

The following table shows the mapping between the RTI blocks and RTLib functions and the corresponding pins used by the digital I/O unit.

The I/O features of the DS2201 conflict with each other. Refer to Limitations on page 43.

Related RTI Blocks	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Conn. Pin	Pin on CP	Signal
DS2201IN_Bx; DS2201IN_Bx_Cy; DS2201OUT_Bx; DS2201OUT_Bx_Cy	Bit 1	See Digital I/O Unit (DS2201 RTLib Reference 🕮)	Bit 1	P4 13	CP29 20	IOP0
	Bit 2		Bit 2	P4 4	CP29 2	IOP1
	Bit 3		Bit 3	P4 22	CP29 21	IOP2
	Bit 4		Bit 4	P4 14	CP29 3	IOP3
	Bit 5		Bit 5	P4 5	CP29 23	IOP4
	Bit 6		Bit 6	P4 23	CP29 5	IOP5
	Bit 7		Bit 7	P4 15	CP29 24	IOP6
	Bit 8		Bit 8	P4 6	CP29 6	IOP7
	Bit 9		Bit 9	P4 24	CP29 26	IOP8
	Bit 10		Bit 10	P4 16	CP29 8	IOP9
	Bit 11		Bit 11	P4 7	CP29 27	IOP10
	Bit 12		Bit 12	P4 25	CP29 9	IOP11
	Bit 13		Bit 13	P14 17	CP29 29	IOP12
	Bit 14		Bit 14	P4 8	CP29 11	IOP13
	Bit 15		Bit 15	P4 26	CP29 30	IOP14
	Bit 16		Bit 16	P4 18	CP29 12	IOP15

Related topics

References

Digital I/O Unit (DS2201 RTI Reference 🕮)
Digital I/O Unit (DS2201 RTLib Reference 🕮)

Timing I/O Unit

Introduction

The slave-DSP subsystem on the DS2201 provides a timing I/O unit that you can use to generate and measure signals.

Where to go from here

Information in this section

Information in other sections

PWM Signal Generation

Introduction

PWM signal generation is crucial to many motor and motion control applications. PWM signals are pulse trains with fixed frequency and magnitude and variable pulse width. There is one pulse of fixed magnitude in every PWM period.

However, the width of the pulses changes from period to period according to a modulating signal. When a PWM signal is applied to the gate of a power transistor, it causes the turn-on/turn-off intervals of the transistor to change from one PWM period to another, according to the same modulating signal. The frequency of a PWM signal is usually much higher than that of the modulating signal, or the fundamental frequency, so that the energy delivered to the motor and its load depends mainly on the modulating signal.

Applications supporting PWM signal generation

PWM signal generation is supported by the firmware and two slave-DSP applications. The number of channels that can be used for PWM signal generation depends on the application used. The following table shows the applications that support PWM signal generation:

Application	PWM Signal Generation
Firmware	6 channels
Slave-DSP applications	
1FD	–
2FD6PWM	6 channels
2FD2DF	–
4DF	–
4FD4PWM	4 channels

Loading slave-DSP applications

When using one of the slave-DSP applications for PWM signal generation, the respective slave-DSP application has to be loaded to the slave DSP. It is executed instead of the firmware.

Downloading the slave-DSP application to the slave DSP is performed by the master processor application. It is done automatically if you use RTI, or by invoking a special loader function, when using RTLib. See also Basics of the Slave DSP on page 20.

PWM period, duty cycle and resolution

You can specify the PWM period T_p (= T_{high} + T_{low}) in the following range:

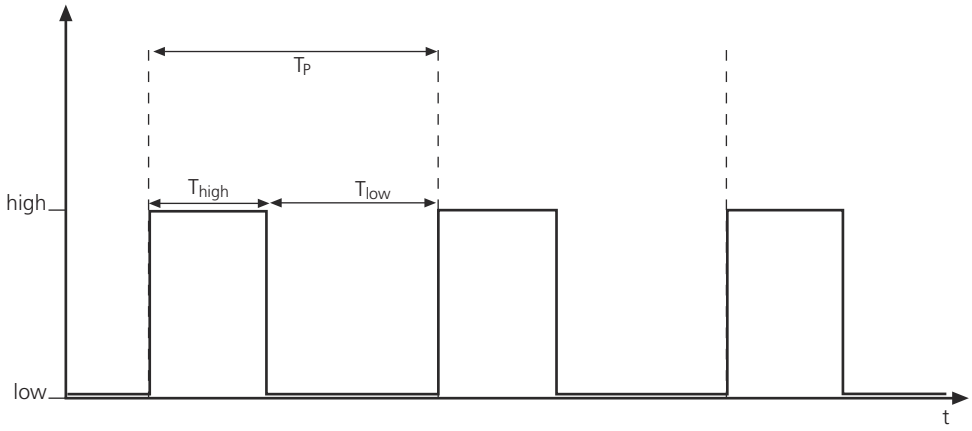
- The minimum PWM period T_{p_min} is 160 ns.
- The maximum PWM period T_{p_max} is 171.8 s.

The minimum PWM period yields a maximum PWM frequency of 6.25 MHz.

The PWM resolution is 40 ns for PWM periods below approximately 2.6 ms. Otherwise it is 160 ns.

The PWM period cannot be changed during run time.

You can specify the duty cycle during run time. The following illustration shows how the duty cycle d (= T_{high}/T_p) is defined. The available duty cycle range is 0 … 1 (0 … 100%).



When the duty cycle d is changed during run time, new values become effective with the next PWM period, beginning with the rising edge of the PWM signal.

All PWM signals on the different channels depend on the same timer and are therefore synchronous. The PWM periods begin at the same time with the rising edge of the PWM signal.

Note

- Due to quantization effects, you will encounter considerable deviations between the desired PWM period T_p and the generated PWM period, especially for high PWM frequencies. Refer to Quantization Effects on page 47.
- For PWM periods of more than approximately 42 ms, square-wave signal measurement cannot be used at the same time. Refer to Limitation for PWM Signal Generation on page 48.

RTI/RTLib support

You can perform PWM signal generation via DS2201 Blockset and RTLib. Refer to

- RTI: DS2201PWM_Bx (DS2201 RTI Reference 🕮)
- RTLib: PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)

Execution times

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Connecting external devices

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 timing I/O unit, refer to Signal Connection to External Devices (PHS Bus System Hardware Reference 🕮).

I/O mapping

The following table shows the mapping between the RTI block and the RTLib functions and the corresponding pins used to provide PWM signals.

The I/O features of the DS2201 conflict with each other. Refer to Limitations on page 43.

Related RTI Blocks	Ch/Bit (RTI)	Related RTLib functions	Ch/Bit (RTLib)	Conn. Pin	Pin on CP	Signal
Firmware						
DS2201PWM_Bx	Ch 1 Ch 2 Ch 3 Ch 4 Ch 5 Ch 6	See PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)	Ch 1 Ch 2 Ch 3 Ch 4 Ch 5 Ch 6	P4 20 P4 12 P4 3 P4 21 P4 11 P4 2	CP30 5 CP30 6 CP30 7 CP30 8 CP30 3 CP30 4	CMP0 CMP1 CMP2 CMP3 CAP2 CAP3
4FD4PWM application						
DS2201PWM_Bx	Ch 1 Ch 2 Ch 3 Ch 4	See PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)	Ch 1 Ch 2 Ch 3 Ch 4	P4 20 P4 12 P4 3 P4 21	CP30 5 CP30 6 CP30 7 CP30 8	CMP0 CMP1 CMP2 CMP3
2FD6PWM application						
DS2201PWM_Bx	Ch 1 Ch 2 Ch 3 Ch 4 Ch 5 Ch 6	See PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)	Ch 1 Ch 2 Ch 3 Ch 4 Ch 5 Ch 6	P4 20 P4 12 P4 3 P4 21 P4 11 P4 2	CP30 5 CP30 6 CP30 7 CP30 8 CP30 3 CP30 4	CMP0 CMP1 CMP2 CMP3 CAP2 CAP3

Related topics

Basics

Digital I/O Unit.....23

References

PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)

Square-Wave Signal Generation (D2F)

Introduction

Using the timing I/O unit of the DS2201 to generate square-wave signals with variable frequencies, you can choose between square-wave signal generation on 2 channels and square-wave signal generation on 4 channels.

Applications supporting square-wave signal generation

Square-wave signal generation is supported by two slave-DSP applications. The number of channels that can be used for square-wave signal generation depends on the application used. The following table shows the applications that support square-wave signal generation:

Application	Square-Wave Signal Generation (D2F)
Firmware	–
Slave-DSP applications	
1FD	–
2FD6PWM	–
2FD2DF	2 channels
4DF	4 channels
4FD4PWM	–

Loading slave-DSP applications

When using square-wave signal generation, the respective slave-DSP application has to be loaded to the slave DSP. It is executed instead of the firmware.

Downloading the slave-DSP application to the slave DSP is performed by the master processor application. It is done automatically if you use RTI, or by invoking a special loader function, when using RTLib. See also Basics of the Slave DSP on page 20.

Square-wave signal generation on 2 channels

For square-wave signal generation (D2F) on the DS2201, you can specify the frequency f_{D2F}. If you choose square-wave signal generation on 2 channels, the frequency must be within the range 0.01 Hz … 10 kHz.

The resolution is 160 ns.

For square-wave signal generation on 2 channels, the 2FD2DF application is needed.

Note

If you use square-wave signal generation on 2 channels, the frequency value is output on pins CMP0 and CMP1.

Square-wave signal generation on 4 channels

If you choose square-wave signal generation on 4 channels, the frequency must be within the range 0.01 Hz … 4 kHz.

The resolution is 15 µs.

For square-wave signal generation on 4 channels the 4DF application is needed.

Square-wave signal generation on 4 channels is not supported by RTI.

Note

If you use square-wave signal generation on 4 channels, the frequency value is output on pins IOP0 … IOP3.

RTI/RTLib support

You can perform square-wave signal generation via DS2201 Blockset and RTLib. Refer to

- RTI: DS2201D2F_Bx_Cy (DS2201 RTI Reference 🕮)
- RTLib: Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)

Execution times

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Connecting external devices

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 timing I/O unit, refer to Signal Connection to External Devices (PHS Bus System Hardware Reference 🕮).

I/O mapping

The following table shows the mapping between the RTI blocks and RTLib functions and the corresponding pins used to provide square-wave signal generation.

The I/O features of the DS2201 conflict with each other. Refer to Limitations on page 43.

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Conn. Pin	Pin on CP	Signal
Square-Wave Signal Generation (D2F) on 2 channels (*2FD2DF application*)						
DS2201D2F_Bx_Cy	Ch 1 Ch 2	See ds2201_dtof (DS2201 RTLib Reference 🕮)	Ch 1 Ch 2	P4 20 P4 12	CP30 5 CP30 6	CMP0 CMP1

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Conn. Pin	Pin on CP	Signal
Square-Wave Signal Generation (D2F) on 4 channels (*4DF application*)						
-	-	See ds2201_dtof_4 (DS2201 RTLib Reference 🕮)	Ch 1 Ch 2 Ch 3 Ch 4	P4 13 P4 4 P4 22 P4 14	CP29 20 CP29 2 CP29 21 CP29 3	IOP0 IOP1 IOP2 IOP3

Related topics

Basics

Digital I/O Unit.....23

References

Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)

Square-Wave Signal Measurement (F2D)

Introduction

The timing I/O unit of the DS2201 provides inputs to measure the frequency of square-wave signals on 1, 2 or 4 channels.

Applications supporting square-wave signal measurement

Square-wave signal measurement is supported by various slave-DSP applications. The number of channels that can be used for square-wave signal measurement depends on the application used. The following table shows the applications that support square-wave signal measurement:

Application	Square-Wave Signal Measurement (F2D)
Firmware	–
Slave-DSP applications	
1FD	1 channel
2FD6PWM	2 channels
2FD2DF	2 channels
4DF	–
4FD4PWM	4 channels

Loading slave-DSP applications

When using square-wave signal measurement, the respective slave-DSP application has to be loaded to the slave DSP. It is executed instead of the firmware.

Downloading the slave-DSP application is performed by the master processor application. It is done automatically if you use RTI or by invoking a special loader function, when using RTLib.

See also Basics of the Slave DSP on page 20.

Principle of frequency measurement

For each falling edge, the slave DSP stores a time stamp in a FIFO buffer. These time stamps are used for frequency measurement. The frequency is measured by calculating the difference between the last two time stamps. The accuracy is 160 ns.

Frequency range

You can measure frequencies within the range 0.01 Hz to 60 kHz.

The maximum frequency value that can be measured depends on the number of channels used:

Number of Channels	Frequency in kHz
1	60
2	20
4	10

Overflow flag

The FIFO error flag indicates that time stamps of falling edges have been lost. This occurs if the input signal's frequency is too high. The measured frequency value is not valid.

Update flag

During square-wave signal measurement, the update flag is set by the slave DSP. It indicates that a new frequency value has been measured by the slave-DSP application since the last execution of the DS2201F2D_Bx_Cy block or the last call of the `ds2201_ftd` function.

Detecting zero frequency

You can use the update flag to detect zero frequency or the absence of an input signal. If no new frequency value has been measured within a certain interval (in other words, the update flag has not been set when calling the respective function or the RTI block), the frequency value can be supposed to be 0 Hz, or there is no input signal, for example, when the input channel is turned off or disconnected during measurement.

The time-out interval that is used must be specified for each application individually. It can be measured by using the time base of the processor board. Refer to Time Interval Measurement (DS1006 RTLib Reference 🕮), or Time Interval Measurement (DS1007 RTLib Reference 🕮).

Frequency and execution times

The execution times for square-wave signal measurement depend on the frequency values. Refer to Limitation for Square-Wave Signal Measurement (F2D) on page 49.

RTI/RTLib support

You can perform square-wave signal measurement (F2D) via DS2201 Blockset and RTLib. Refer to

- RTI: DS2201F2D_Bx_Cy (DS2201 RTI Reference 🕮)
- RTLib: Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)

Execution times

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Connecting external devices

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 timing I/O unit, refer to Signal Connection to External Devices (PHS Bus System Hardware Reference 🕮).

I/O mapping

The following table shows the mapping between the RTI block and RTLib functions and the corresponding pins used for square-wave signal measurement.

The I/O features of the DS2201 conflict with each other. Refer to Limitations on page 43.

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Conn. Pin	Pin on CP	Signal
1FD application						
DS2201F2D_Bx_Cy	Ch 1	See Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)	Ch 1	P4 1	CP30 1	CAP0
2FD6PWM application						
DS2201F2D_Bx_Cy	Ch 1 Ch 2	See Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)	Ch 1 Ch 2	P4 1 P4 19	CP30 1 CP30 2	CAP0 CAP1
2FD2DF application						
DS2201F2D_Bx_Cy	Ch 1 Ch 2	See Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)	Ch 1 Ch 2	P4 1 P4 19	CP30 1 CP30 2	CAP0 CAP1
4FD4PWM application						
DS2201F2D_Bx_Cy	Ch 1	See Square-Wave Signal Measurement (F2D)	Ch 1	P4 1	CP30 1	CAP0

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	Conn. Pin	Pin on CP	Signal
	Ch 2 Ch 3 Ch 4	(DS2201 RTLib Reference 🕮)	Ch 2 Ch 3 Ch 4	P4 19 P4 11 P4 2	CP30 2 CP30 3 CP30 4	CAP1 CAP2 CAP3

Related topics

Basics

Digital I/O Unit.....23

References

DS2201F2D_Bx_Cy (DS2201 RTI Reference 🕮)
Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)

Serial Interface

Introduction

The DS2201 contains a universal asynchronous receiver/transmitter (UART) to perform serial asynchronous communication with external devices. The UART is provided by the slave DSP system and configured as an RS232 transceiver.

Where to go from here

Information in this section

Basics of the Serial Interface

Introduction

The DS2201 contains a universal asynchronous receiver/transmitter (UART) to perform serial asynchronous communication with external devices. The UART is provided by the slave DSP system and configured as an RS232 transceiver with the following characteristics:

- Full duplex data transmission
- Selectable number of data bits and parity bit
- Maximum baud rate of up to 250 kBd

  For details on the baud rates, refer to Specifying Baud Rates on page 36.

Applications supporting the serial interface

The serial interface is supported by the firmware and all slave-DSP applications.

Note

The serial interface is not supported by RTI.

Serial data transfer

Data transfer is initiated by a start bit. Starting with the least significant bit (LSB), a selectable number of data bits (6 ... 9) is transferred, followed by an optional parity bit. You can select between different parity modes (no, even, odd parity).

RS232 transceiver mode

The only mode that is supported by the serial interface of the DS2201 is the RS232 mode. One transmitter and one receiver are supported at each data

transmission line (point-to-point connection). The RS232 mode is a single-ended data transfer mode: Signals are represented by voltage levels with respect to ground. There is one wire for each signal.

Data signals and control signals

The TXD signal provides the data to be transmitted. The RXD signal provides the received data.

The serial interface of the DS2201 does not support handshake lines (DCD, DTR, DSR, RTS, and CTS lines), which are usually used in RS232 mode.

RTLib support

You can access the serial interface via RTLib2201. For details, see Serial Interface (DS2201 RTLib Reference 🕮).

Execution times

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Connecting external devices

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

I/O mapping

The following table shows the mapping between the RTLib functions and the corresponding pins used by the serial interface.

Related RTLib Functions	Conn. Pin	Pin on CP	Signal
See Serial Interface (DS2201 RTLib Reference 🕮)	P2 3	–	RXD
	P2 5	–	TXD

Related topics

References

Serial Interface (DS2201 RTLib Reference 🕮)

Specifying Baud Rates

Introduction

You can specify the baud rate for serial communication with the DS2201.

Baud rate range

The serial interface of the DS2201 is driven by an oscillator with a frequency f_{osc} = 6.25 MHz. You can specify the baud rate for serial communication with the DS2201 in the range 5 … 390,625 Baud.

Available baud rates

Using RTLib, you can specify any baud rate from the range above. However, according to the oscillator frequency f_{OSC}, only specific baud rates are available with the DS2201. The available baud rates can be calculated to

$$f = \frac{f_{OSC}}{(16 \cdot n)}$$

Here, n is a positive integer called the divisor. The maximum divisor for the DS2201 is 65,535.

When you specify a baud rate within RTLib, the closest available baud rate is actually used for serial communication. For example, if you specify 70,000 Baud, the baud rate actually used is 65,104 Baud.

Note

For a successful data transfer between transmitter and receiver, you have to make sure that the baud rates of the transmitter and the receiver differ only negligibly. The difference should be as small as possible. The maximal difference that is allowed can be calculated to
±(1/2) / number of bits transferred · 100%.

Baud rates for serial communication

For serial communication between the DS2201 and the UART 16550 Asynchronous Communication Element (for example, used in a PC) the following baud rates should be used:

DS2201	UART 16550
1213	1200
2426	2400
9765	9600
19,531	19,200
39,062	38,400

Related topics

References

ds2201_serial_port_init (DS2201 RTLib Reference 🕮)

Interrupts Provided by the DS2201

Where to go from here

Information in this section

Information in other sections

Overview of DS2201 Interrupts

Interrupts

The DS2201 provides access to various hardware interrupts – originating either from on-board devices, or from external devices connected to the DS2201. The following interrupts are available:

Interrupt Type	Description
ADC1 … ADC5 end of conversion	Interrupt on end of A/D conversion (multiplexed converters ADC1 … ADC5)
Slave-DSP-ready interrupt	Interrupt is set after the slave DSP has finished command execution
User interrupt	Interrupt from external device

Note

There is a limitation for performing A/D conversion and using hardware interrupts of the DS2201 in the same application. Refer to Limitations for A/D Conversion and Interrupt Usage on page 44.

Interrupt processing

Via the interrupt lines of the PHS bus, interrupts from the DS2201 are sent to the interrupt controller of the connected processor board. Using RTI, the interrupts of the DS2201 can therefore be used to implement interrupt-driven tasks. For details, see Tasks Driven by Interrupt Blocks (RTI and RTI-MP Implementation Guide 🕮).

Related topics

Basics

Influence of the Processor Board on the Execution Times (DS2201 RTLib Reference 🕮)

ADC-End-of-Conversion Interrupt

Introduction

The DS2201 indicates the conversion status of each channel. When one of the A/D converters ADC1 … ADC5 has completed a conversion, the end-of-conversion interrupt is generated for that converter.

RTI/RTLib support

For information on how to access the end-of-conversion interrupt, refer to:

- RTI blockset: DS2201_HWINT_Bx_Iy (DS2201 RTI Reference 🕮)
- RTLib: ADC Unit (DS2201 RTLib Reference 🕮)

Related topics

References

ADC Unit (DS2201 RTLib Reference 🕮)
DS2201_HWINT_Bx_Iy (DS2201 RTI Reference 🕮)

Slave-DSP-Ready Interrupt

Introduction

The processor board sends commands to the DS2201's slave DSP, and the slave DSP executes them. A new command cannot be executed before the execution of the preceding command has finished. For basic information on the slave DSP, refer to Basics of the Slave DSP on page 20.

Therefore the slave DSP provides the slave-DSP-ready flag and in connection with the flag the slave-DSP-ready interrupt: When the slave DSP has executed a command, it indicates its command execution status by setting the slave-DSP-ready flag and issueing the slave-DSP-ready interrupt. The flag is polled by the processor board before sending a new command.

Note

The standard software does not use the slave-DSP-ready interrupt.

RTI/RTLib support

For information on how to access the DSP-ready interrupt, refer to:

- RTI blockset: DS2201_HWINT_Bx_Iy (DS2201 RTI Reference 🕮)
- RTLib: Slave-DSP Applications (DS2201 RTLib Reference 🕮)

Related topics

Basics

Influence of the Processor Board on the Execution Times (DS2201 RTLib Reference 🕮)

References

DS2201_HWINT_Bx_Iy (DS2201 RTI Reference 🕮)
Slave-DSP Applications (DS2201 RTLib Reference 🕮)

User Interrupt

Introduction

The DS2201 provides an interrupt that can be triggered by an external device.

RTI/RTLib support

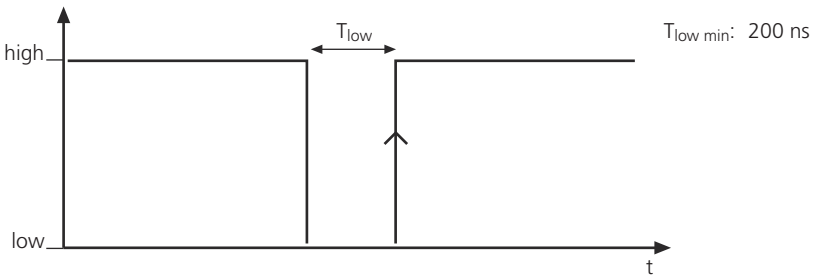
For information on how to access the user interrupt, refer to DS2201_HWINT_Bx_Iy (DS2201 RTI Reference 🕮).

Timing requirements

User interrupts are triggered at the rising edge of the corresponding external signal.

The interrupt signal should be high all the time, and it should be set to low for approximately 200 ns before the interrupt, so that the interrupt is triggered by the rising edge of the signal.

The following illustration shows the timing of the interrupt.



I/O mapping

The following table shows the mapping between the RTI block and the RTLib functions and the corresponding pins used by the interrupt control unit:

Related RTI Block	Ch/Bit (RTI)	Related RTLib Functions	Ch/Bit (RTLib)	Conn. Pin	Pin on CP	Signal
DS2201_HWINT_Bx_Iy	User int	See ds4001_set_int_input (DS4001 RTLib Reference 🕮) and PHS-Bus Interrupt Handling (DS1006 RTLib Reference 🕮) or PHS-Bus Interrupt Handling (DS1007 RTLib Reference 🕮)	-	P4 10	CP29 36	USRINT

Related topics

References

DS2201_HWINT_Bx_Iy (DS2201 RTI Reference 🕮)

Limitations

Introduction

There are some limitations you have to take into account when working with the DS2201.

Where to go from here

Information in this section

Information in other sections

Introduction to the Features of the DS2201 7
Providing a diagram of the board's architecture, and an overview of the board's hardware and software features.

Limitations for A/D Conversion and Interrupt Usage

Introduction

To read converted values from an ADC input channel of the DS2201, you can use RTLib's `ds2201_adc_in` or `ds2201_adc_read` function. With RTI, you can work with the DS2201ADC_Bx block, which internally uses the `ds2201_adc_in` function.

Polling the EOC flag

The board's interrupt control unit holds an end-of-conversion (EOC) flag that indicates whether or not A/D conversion has finished.

RTLib's `ds2201_adc_in` function and RTI's DS2201ADC_Bx block poll the EOC flag, and do not read the converted value until the flag is set. To use the `ds2201_adc_in` function and the DS2201ADC_Bx block, the interrupt control unit must therefore be initialized to polling mode. With RTLib's `ds2201_adc_in` function, you have to initialize the interrupt control unit using macros of the dSPACE processor board RTLib, refer to init() (DS1006 RTLib Reference 🕮) or init() (DS1007 RTLib Reference 🕮).

With RTI's DS2201ADC_Bx block, this is done automatically.

Limitations

The DS2201 provides several hardware interrupts. To implement them in an application, you have to insert a DS2201_HWINT_Bx_Iy block if you use RTI, or program an interrupt service routine if you use RTLib.

However, if you implement one of the DS2201 hardware interrupts in your application, the interrupt control unit is initialized to interrupt mode and cannot be used in polling mode at the same time.

As a result, the following limitations apply:

- With RTI, you cannot use the DS2201ADC_Bx block and the DS2201_HWINT_Bx_Iy block in the same model.
- With RTLib, you cannot use the `ds2201_adc_in` function and implement an interrupt service routine in the same program.

Workaround

To implement one or more DS2201 hardware interrupts and read converted values in the same application, use RTLib's `ds2201_adc_read` function instead of the `ds2201_adc_in` function. The `ds2201_adc_read` function does not poll the EOC flag.

Using RTI, you have to program this with RTLib, and incorporate your C code in a Simulink S-function. Refer to Implementing S-Functions (RTI and RTI-MP Implementation Guide 🕮).

Related topics

References

ADC Unit (DS2201 RTLib Reference 🕮)
DS2201_HWINT_Bx_Iy (DS2201 RTI Reference 🕮)
DS2201ADC_Bx (DS2201 RTI Reference 🕮)

Limitations of the Slave DSP

Introduction

When using the slave DSP's access functions, there are some limitations regarding the execution times.

Communication between processor board and slave DSP

The dSPACE processor board sends commands to the slave DSP. There are two different types of commands:

- Commands that transfer data to the slave DSP
- Commands that request data from the slave DSP

The slave DSP provides a slave-DSP-ready flag that is set when the slave DSP has finished command execution and is waiting for a new command.

Command execution when using firmware

The slave DSP executes one command after another in its command interpreter loop. The command interpreter loop is not interrupted if the slave DSP executes the firmware.

Command execution when using slave-DSP applications

If a slave-DSP application is executed, internal interrupts are requested on the slave DSP in addition to the commands, for example, when performing frequency measurement. The slave DSP has to execute interrupt service routines as well as commands. These routines interrupt the slave DSP's command interpreter loop. Therefore the slave DSP needs increasing execution times to execute the commands in the command interpreter loop.

Interrupt service routines are needed for square-wave signal generation and measurement.

The increasing execution times are particularly noticeable for square-wave signal measurement. With increasing frequency the number of detected edges, and thus also the number of requested interrupts, rises.

The worst-case execution time for executing a command can be in a range of milliseconds.

Execution times of slave-DSP applications

The execution times for the slave DSP to execute a command from the processor board vary. They depend on the communication between the processor board and the slave DSP.

Regarding the execution time the slave DSP needs to execute a command from the processor board, three different aspects have to be taken into account:

- Is the slave DSP already executing a command at the time a new command needs to be sent?
- Does the command that is sent to the slave DSP by the processor board transfer data to the slave DSP, or does it request data from the slave DSP?
- The slave DSP can execute one command at a time. During command execution, the slave DSP possibly has to execute other tasks as well, for example, measuring frequencies. So, the third aspect that has to be taken into account is: Is the slave DSP executing square-wave signal measurement or square-wave signal generation (by executing a slave-DSP application)?

The execution time depends on these three aspects.

The lowest execution time is possible if the slave DSP is ready to execute a new command and the function executed on the processor board only sends data to the slave DSP without having to wait for data that is returned by the slave DSP.

The execution times required by the RTLib functions have been measured. For details on the results and the corresponding measurement setup, refer to Function Execution Times (DS2201 RTLib Reference 🕮).

Limitations for Slave-DSP Applications

Introduction

There are some limitations you have to take into account when using slave-DSP applications:

- To use the `ds2201_dtof` function, the slave DSP must execute the 2fd2df application for square-wave signal generation on 2 channels.
- To use the `ds2201_dtof_enable` function, the slave DSP must execute the 2fd2df application for square-wave signal generation on 2 channels.
- To use the `ds2201_dtof_4` function, the slave DSP must execute the 4df application for square-wave signal generation on 4 channels.

- To use the `ds2201_ftd` function, the slave DSP must execute one of the frequency measurement applications:
  - 1fd for frequency measurement on 1 channel
  - 2fd2df or 2fd6pwm for frequency measurement on 2 channels
  - 4fd4pwm for frequency measurement on 4 channels

Related topics

References

ds2201_dtof (DS2201 RTLib Reference 🕮)
Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)

Limitation for the Digital I/O Unit

Limitation

You can configure the channels of the DS2201 digital I/O unit freely for input or output. However, a digital channel can be used either for input or for output.

Related topics

References

Digital I/O Unit (DS2201 RTLib Reference 🕮)

Quantization Effects

Introduction

Signal generation and measurement are feasible only within the limits of the slave DSP's time base, which causes quantization errors that increase with higher frequencies.

When performing square-wave signal generation, for example, you will encounter considerable deviations between the desired frequency $f_{desired}$ and the generated frequency $f_{generated}$, especially for higher frequencies. The (quantized) generated signal frequencies can be calculated according to the following equation:

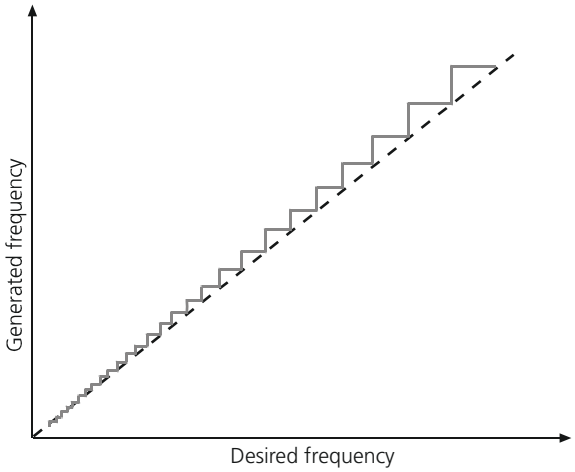
$f_{generated} = 1/(n \cdot R)$

where R is the time base (in s), and n is the integer part of $(1/f_{desired} \cdot R)$.

Example

Suppose you want to generate a square-wave signal with $f_{desired}$ = 9900 Hz. Calculating the integer part of (1/(9900 Hz · 160 ns)) yields n = 631. According to $f_{generated}$ = 1/(n · R), the generated frequency is 9904.91 Hz.

The following illustration shows the increasing quantization effect for increasing desired frequencies:



Related topics

References

PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)

Limitation for PWM Signal Generation

Introduction

For PWM periods of more than approximately 42 ms, an additional internal timer is used as a prescaler. Therefore, square-wave signal measurement, which also uses this timer, cannot be used at the same time.

You have to take this restriction into account when using a slave-DSP application that supports PWM signal generation and square-wave signal measurement.

These slave-DSP applications are:

- 2FD6PWM application
- 4FD4PWM application

Related topics

References

PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)

Limitation for Square-Wave Signal Measurement (F2D)

Introduction

For square-wave signal measurement, you have to take into account the following restriction.

Frequency and execution times

The execution times for square-wave signal measurement depend on the frequency values. With higher frequencies, the execution times also increase. The following table shows some frequencies and the respective execution times for 1-channel square-wave signal measurement using the `1FD application` and the `ds2201_ftd function`:

Frequency in kHz	Maximum Execution Time in µs
1	82.75
5	82.75
10	97.0
20	132.35
30	168.0
40	249.45
50	578.85
60	1848.0

The execution times also depend on the slave application used.

For more information, see Limitations of the Slave DSP on page 45.

Related topics

References

PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)
Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)

Conflicting I/O Features

Introduction

There are some I/O features of the DS2201 that conflict with other I/O features of the board.

Types of I/O conflicts

There are I/O features that share the same board resources.

Conflicts concerning single I/O channels There are conflicts that concern single channels of an I/O feature. The dSPACE board provides only a limited number of I/O pins. The same pins can be shared by different I/O features. However, a pin can serve as the I/O channel for only one feature at a time.

Conflicts concerning an I/O feature as a whole There are conflicts that concern the use of an I/O feature as a whole. Suppose two I/O features of the dSPACE board use the same on-board timer device. In this case, only one of the two I/O features can be used at a time. The other feature is completely blocked.

Conflicts for the DS2201

The following tables list the I/O features of the DS2201 that conflict with other I/O features, and the related RTI blocks/ RTLib functions:

- Conflicts for the Digital I/O Unit on page 50
- Conflicts for PWM Signal Generation (4 or 6 Channels) on page 51
- Conflicts for Square-Wave Signal Generation (D2F) on 2 Channels on page 51
- Conflicts for Square-Wave Signal Generation (D2F) on 4 Channels on page 52
- Conflicts for Square-Wave Signal Measurement (F2D) on page 52

Conflicts for the Digital I/O Unit

The following I/O features of the DS2201 conflict with the digital I/O unit:

Digital I/O Unit *)		**Signal**	**Conflicting I/O Feature **)**		
Bit (RTI)	**Bit (RTLib)**			**Ch (RTI)**	**Ch (RTLib)**
Conflicts Concerning Digital I/O as a Whole ▪ If you perform square-wave signal generation on 4 channels, digital I/O is not supported.					
*) Related RTI blocks and RTLib functions: ▪ DS2201IN_Bx/ DS2201IN_Bx_Cy/ DS2201OUT_Bx/ DS2201OUT_Bx_Cy ▪ See Digital I/O Unit (DS2201 RTLib Reference 🕮)			**) Related RTLib functions: ▪ See Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)		

Conflicts for PWM Signal Generation (4 or 6 Channels)

The following I/O features of the DS2201 conflict with PWM signal generation (4 or 6 channels):

PWM Signal Generation (4 or 6 channels) *)		Signal	Conflicting I/O Feature **)		
Ch (RTI)	**Ch (RTLib)**			**Ch (RTI)**	**Ch (RTLib)**
Conflicts Concerning PWM Signal Generation as a Whole ▪ If you perform D2F, you cannot generate PWM signals at the same time. ▪ If you perform square-wave signal measurement (F2D) on 4 channels, you can use only pins CMP0 … CMP3 to generate PWM signals (PWM signal generation on 4 channels) at the same time.					
*) Related RTI blocks and RTLib functions: ▪ DS2201PWM_Bx ▪ See PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)			**) Related RTI blocks and RTLib functions: ▪ D2F: ▪ DS2201D2F_Bx_Cy ▪ See Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮) ▪ F2D: ▪ DS2201F2D_Bx_Cy ▪ See Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)		

Conflicts for Square-Wave Signal Generation (D2F) on 2 Channels

The following I/O features of the DS2201 conflict with square-wave signal generation (D2F) on 2 channels:

Square-Wave Signal Generation (2 channels) *)		Signal	Conflicting I/O Feature **)		
Ch (RTI)	**Ch (RTLib)**			**Ch (RTI)**	**Ch (RTLib)**
Conflicts Concerning Square-Wave Signal Generation as a Whole ▪ If you generate PWM signals, you cannot perform square-wave signal generation (D2F) at the same time. ▪ If you perform square-wave signal measurement (F2D) on 4 channels, you cannot perform square-wave signal generation (D2F) at the same time.					
*) Related RTI blocks and RTLib functions: ▪ DS2201D2F_Bx_Cy ▪ See Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)			**) Related RTI blocks and RTLib functions: ▪ DS2201PWM_Bx ▪ See PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)		

Conflicts for Square-Wave Signal Generation (D2F) on 4 Channels

The following I/O features of the DS2201 conflict with square-wave signal generation (D2F) on 4 channels:

Square-Wave Signal Generation (D2F) on 4 Channels *)		Signal	Conflicting I/O Feature **)		
Ch (RTI)	**Ch (RTLib)**			**Bit (RTI)**	**Bit (RTLib)**
Conflicts Concerning Square-Wave Signal Generation as a Whole ▪ If you perform digital I/O, you cannot perform square-wave signal generation on 4 channels at the same time.					
*) Related RTI blocks and RTLib functions: ▪ See Square-Wave Signal Generation (D2F) (DS2201 RTLib Reference 🕮)			**) Related RTLib functions: ▪ DS2201IN_Bx/ DS2201IN_Bx_Cy/ DS2201OUT_Bx/ DS2201OUT_Bx_Cy ▪ See Digital I/O Unit (DS2201 RTLib Reference 🕮)		

Conflicts for Square-Wave Signal Measurement (F2D)

The following I/O features of the DS2201 conflict with square-wave signal measurement:

Square-Wave Signal Measurement *)		Signal	Conflicting I/O Feature **)		
Ch (RTI)	**Ch (RTLib)**			**Ch (RTI)**	**Ch (RTLib)**
Conflicts Concerning Square-Wave Signal Measurement as a Whole ▪ If you perform PWM signal generation, you can use only pins CAP0 and CAP1 to perform square-wave signal measurement (F2D) at the same time. ▪ If you perform square-wave signal generation (D2F) on 2 channels, you can use only pins CAP0 and CAP1 to perform square-wave signal measurement (F2D) at the same time.					
*) Related RTI blocks and RTLib functions: ▪ DS2201F2D_Bx_Cy ▪ See Square-Wave Signal Measurement (F2D) (DS2201 RTLib Reference 🕮)			**) Related RTI blocks and RTLib functions: ▪ DS2201PWM_Bx ▪ See PWM Signal Generation (PWM) (DS2201 RTLib Reference 🕮)		