DS4201-S Serial Interface 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

How to Contact dSPACE Support

If you encounter a problem when using dSPACE products, contact your local dSPACE representative:

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- For countries not listed, contact dSPACE GmbH in Paderborn, Germany.
  Tel.: +49 5251 1638-941 or e-mail: support@dspace.de

You can also use the support request form: http://www.dspace.com/go/supportrequest. If you are logged on to mydSPACE, you are automatically identified and do not need to add your contact details manually.

If possible, always provide the relevant dSPACE License ID or the serial number of the CmContainer in your support request.

Software Updates and Patches

dSPACE strongly recommends that you download and install the most recent patches for your current dSPACE installation. Visit http://www.dspace.com/go/patches for software updates and patches.

Important Notice

Contents

About This Document

Content

This document provides feature-oriented access to the information you need to work with the DS4201-S board.

Symbols

dSPACE user documentation uses the following symbols:

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

Naming conventions

dSPACE user documentation uses the following naming conventions:

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

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

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.

Introduction to the Features of the DS4201-S

Objective

You can use the DS4201-S Serial Interface Board to set up communication connections between the PHS-bus-based system and any external device that provides a RS232, RS422, or RS485 interface. You can connect external devices such as sensors, measuring instruments, or displays.

Where to go from here

Information in this section

Information in other sections

Data Sheets (PHS Bus System Hardware Reference 🕮)
Summarizes the technical specifications of the hardware components.

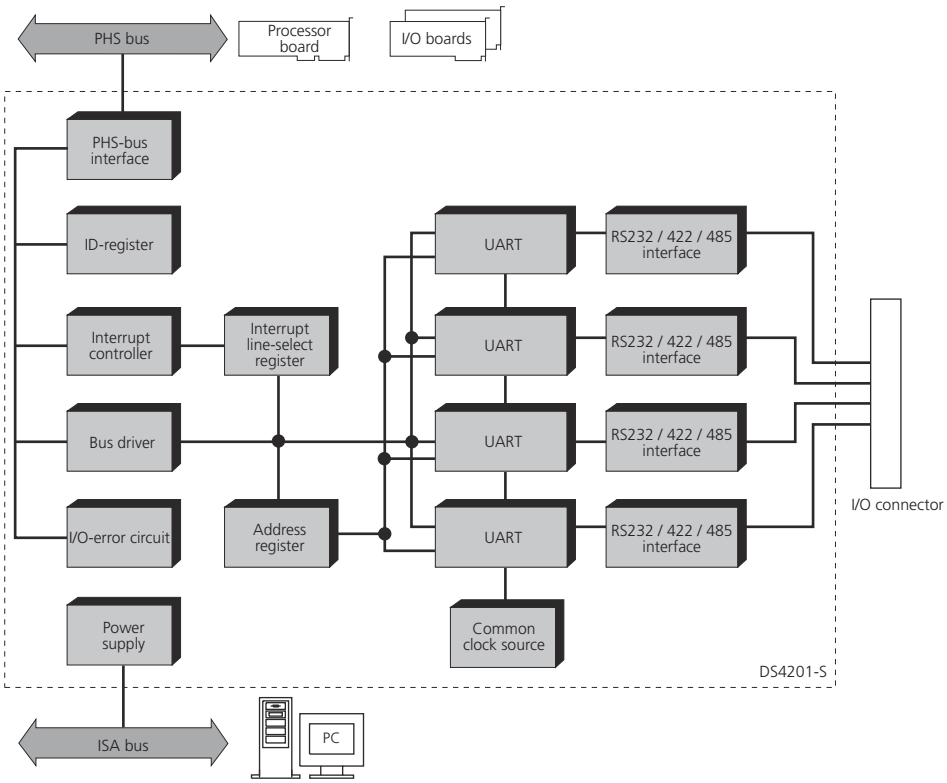
Board Architecture

Objective

The DS4201-S Serial Interface Board has been designed to provide serial communication between a PHS-bus-based system and external devices. It supports RS232, RS422 and RS485 asynchronous communication on four separate channels.

System overview

The illustration shows the architecture and the functional units of the DS4201-S.



Connection within the dSPACE system Every dSPACE board provides a *PHS bus* connector for system internal communication. The DS4201-S is connected to the processor board and other I/O boards in this way.

Interrupt handling The DS4201-S provides a slave *interrupt controller* and an *interrupt line-select register* which expand the master interrupt line of the PHS-bus to every board channel.

Power supply via ISA bus The *ISA bus* connection only supplies the board with power.

Four channels for serial communication There are two interface blocks for each channel:

- The *UART* interface (universal asynchronous receiver transmitter)
- and the *RS232/422/485 interface* to adapt the channel to your interface standard

Connection of external devices via I/O connector All signals of the four serial communication channels are available on the board's *I/O connector*. There is an optional adapter cable available from dSPACE to separate the four channels

to four different 9-pin, male Sub-D flying plugs. For further information, refer to Adapter Cable (PHS Bus System Hardware Reference 🕮).

Changing the clock source A quartz oscillator is the *common clock source* for all channels. You can change this quartz oscillator to adapt the baud rates of the board to your needs. For information on changing it, refer to DS4201-S: How to Change the Quartz Oscillator.

Related topics

HowTos

DS4201-S: How to Change the Quartz Oscillator (DS1006 Hardware Installation and Configuration Guide 🕮)
DS4201-S: How to Change the Quartz Oscillator (DS1007 Hardware Installation and Configuration Guide 🕮)

Feature Overview

Main features

- Four independent serial communications channels, each with a standard 16550-type-universal asynchronous receiver transmitter (UART)
- Supported transceiver modes: RS232, RS422, RS485
- Programmable interrupt controller with independent serial communication interrupts for each channel
- Serial interface characteristics:
  - Different oscillator frequencies possible (by changing the oscillator on the board): 1.8432 MHz (default) ... 24 MHz

    (see DS4201-S: How to Change the Quartz Oscillator (DS1006 Hardware Installation and Configuration Guide 🕮) or DS4201-S: How to Change the Quartz Oscillator (DS1007 Hardware Installation and Configuration Guide 🕮))
  - Baud rate specification with RTLib or RTI (depends on the oscillator)
  - Parity bits: Even-, odd-, or no-parity
  - Stop bits: 1, 1.5, or 2 stop bits
  - Wordlength: 5, 6, 7, or 8 bits
  - FIFO
    - 16-byte input
    - 16-byte output
  - Support of a software FIFO buffer (see Software FIFO Buffer on page 14)

More features

For a complete list of the board's features, refer to Data Sheets (PHS Bus System Hardware Reference 🕮).

Related topics

References

DS4201-S RTI Reference
DS4201-S RTLib Reference

DS4201-S Interfaces

Introduction

The DS4201-S has interfaces for connection to a PHS-bus-based system and for cascading boards.

Integration into a PHS-bus-based system

Every dSPACE board provides a peripheral high-speed (PHS) bus connector for internal communication in a PHS-bus-based system. The DS4201-S is connected to the processor board and other I/O boards in this way.

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 🕮).

Serial Interfaces

Objective

The DS4201-S provides four independent universal asynchronous receiver transmitters (UART) for performing serial asynchronous communication with external devices.

RTI/RTLib support

You can access the serial interface via RTI and RTLib. For details, see

- RTI: Serial Interface (DS4201-S RTI Reference 🕮)
- RTLib: Serial Interface Communication (DS4201-S RTLib Reference 🕮)

Where to go from here

Information in this section

Comparing Transceiver Modes

Objective

The DS4201-S allows you to choose the RS232, RS422, or RS485 transceiver mode independently for each channel.

RS232 transceiver mode

In RS232 transceiver mode, one transmitter and one receiver are supported at each data transmission line (point-to-point connection). The RS232 transceiver

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 In RS232 transceiver mode, the TXD signal provides the data to be transmitted. The RXD signal provides the received data. The RS232 transceiver mode provides optional control signals – DCD, DTR, DSR, RTS, and CTS – for handshaking. You can use the control signals to avoid overflows.

Cable length and baud rate Due to the single-ended mode, noise signals strongly affect data transfer in an RS232 network. The maximum distance and baud rate between transmitter and receiver are therefore limited. The cable length also limits the maximum baud rate (meets EIA-232-E and V.28 specifications).

RS422 and RS485 transceiver mode

The RS422 and RS485 transceiver modes are balanced differential data transfer modes: Each signal is transmitted together with the corresponding inverted signal. For example, the data transmission signals TXD and $\overline{\text{TXD}}$ represent a pair of balanced differential inputs.

Data signals and control signals In RS422 transceiver mode, the TXD and $\overline{\text{TXD}}$ signals provide the data to be transmitted. The RXD and $\overline{\text{RXD}}$ signals provide the received data.

In RS485 transceiver mode, RX is connected together with TX and $\overline{\text{RX}}$ is connected to $\overline{\text{TX}}$ to provide a bidirectional data bus.

The RS422 and RS485 transceiver modes provide optional control signals – RTS, CTS, and the inverted signals $\overline{\text{RTS}}$ and $\overline{\text{CTS}}$ – for hardware handshaking. You can use the control signals to avoid overflows.

Cable length and baud rate Since the RS422 and RS485 transceiver modes use differential signals, the effects of induced noise signals that appear as common mode voltages on a network are reduced. Compared to the RS232 transceiver mode, higher baud rates between transmitters and receivers are therefore possible. However, the cable length limits the maximum baud rate: As a rule of thumb, the baud rate (in baud) multiplied by the cable length (in meters) should not exceed 10^8.

RS422 networks In RS422 networks, data is sent by one transmitter and received by up to 10 receivers. Two twisted pair cables – each providing two transmission lines – are usually used (unidirectional connections) for transmission and reception of data: one twisted pair cable for the transmitted data (TXD and $\overline{\text{TXD}}$), the other for the received data (RXD and $\overline{\text{RXD}}$).

RS485 networks Up to 32 nodes can participate in RS485 networks. However, only one node is allowed to control the lines at a time. The twisted pair cable is used for transmitting and receiving data (bidirectional connections) – one for the signals TXD and RXD, the other for the inverted signals $\overline{\text{TXD}}$ and $\overline{\text{RXD}}$. The control signals RTS and CTS can also be used to select the transmitting node.

Line termination for RS422 and RS485 The network you connect to the serial interface has to contain a line termination that is suitable for the respective receiver.

For details, see:

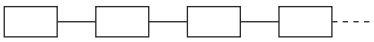
- Connecting RS422 Devices (PHS Bus System Hardware Reference 🕮)
- Connecting RS485 Devices (PHS Bus System Hardware Reference 🕮)

Avoiding undefined conditions (RS485) If no transmitter is currently active in an RS485 network, undefined conditions may occur. An open-line fail-safe termination is mandatory to avoid these conditions. You must provide a pull-up and a pull-down resistor – 1 kΩ each. The pull-up resistor has to be connected between +5 V and the TXD signal line. The pull-down resistor has to be connected between GND and the $\overline{TXD}$ signal line.

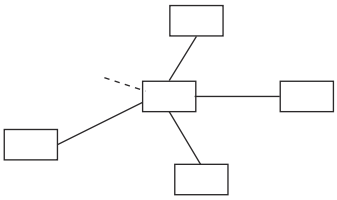
Topologies of RS422 and RS485 networks In RS422 and RS485 networks, you can implement different topologies such as

- Simple point-to-point connections

- Daisy-chain connections



- Backbone connections



Signal types

Signal	Description
RXD	Receive data
TXD	Transmit data
RTS	Ready to send
CTS	Clear to send

Specifying the Baud Rate of the Serial Interface

Oscillator frequency

The serial interface of the DS4201-S can be driven by an oscillator with a frequency f_{osc} = 1.8432 MHz or by an oscillator with each other frequency up to f_{osc} = 24 MHz.

Baud rates physically available

The baud rates that are physically available with the DS4201-S depend on the oscillator frequency f_{osc}:

baudrate = f_{osc} / (16 · n),

where n is a positive integer in the range 1 … 65535. The range physically available therefore is:

Baud Rate Range (f_{osc} = 1.8432 MHz)	Baud Rate Range (f_{osc} = 24 MHz)
1.76 … 115,200 baud	22.89 … 1,500,000 baud

Baud rate specification with RTLib or RTI

You can specify any baud rate for serial communication with the DS4201-S in the range listed below using RTI and RTLib. It depends on the oscillator frequency f_{osc} and on the selected transceiver mode:

Mode	Baud Rate Range with RTLib/RTI (f_{osc} = 1.8432 MHz)	Baud Rate Range with RTLib/RTI (f_{osc} = 24 MHz)
RS232	5 … 115,200 baud	5 … 115,200 baud
RS422	5 … 115,200 baud	5 … 1,500,000 baud
RS485	5 … 115,200 baud	5 … 1,500,000 baud

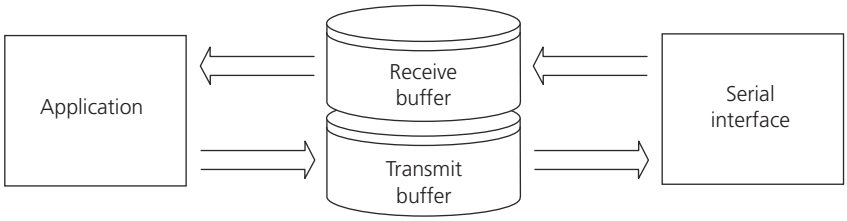
Note

When you specify a baud rate within RTI or RTLib, the closest physically available baud rate is actually used for serial communication. For example, if you specify 70,000 baud as the baud rate, the baud rate actually used is 57,600 baud (f_{osc} = 1.8432 MHz) or 71,429 baud (f_{osc} = 24 MHz).

Software FIFO Buffer

Objective

The software FIFO buffer is a memory section that provides the UART with additional space for data storage and ensures that the generic functions, which are provided by the RTLib module dsser.h, are hardware independent.



The software FIFO buffer stores data that will be written to (transmit buffer) or has been read by (receive buffer) the UART.

Transmit buffer

Data to be transmitted is usually sent immediately. Data that cannot be transmitted immediately is buffered in the transmit buffer TX SW FIFO. The

buffer cannot be overwritten: If an overflow of TX SW FIFO occurs, you can specify either to discard all new data, or to write as much data as possible to the buffer.

Receive buffer

Data that is received via the serial interface is first copied to the UART FIFO buffer. When your specified number of bytes is received, the UART generates an interrupt and the bytes are moved to the receive buffer (RX SW FIFO).

The software interrupt that is generated in the model depends on the level of filling of the RX SW FIFO.

If an overflow of the RX SW FIFO occurs, either old data can be overwritten, or new data discarded.

Demo Models

Objective

The RTI Blockset contains four demo models which show the use of the DS4201-S RTI blocks. You can access the demo models via the Demos button in the blockset.

The related files are located in `<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI\`. They are named `demom_ds4201_serial_<x>.slx` (x = 1 ... 4).

Demo DS4201-S_1

The demo model shows how to send and receive one byte during each sample period in polled mode with the UART interface. For further information, refer to the model description `<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI\demo1xxx_serial_1.html`.

Demo DS4201-S_2

The demo model shows how several bytes can be sent and received during each sample period in polled mode with the UART interface. The number of bytes to be sent/received is tunable and is switched between 5 and 10 every 0.5 s during run time. The Serial Transmit/Receive block gets the number of bytes to be sent/received by its block input port "NumBytes". For further information, refer to the model description `<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI\demo1xxx_serial_2.html`.

Demo DS4201-S_3

The demo model shows how several bytes can be sent periodically and can be received in interrupt mode. The UART line status is also read out in interrupt mode. To run the experiment, pins RXD and TXD of channel 1 have to be connected externally. For further information, refer to the model description

	`<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI\demo1xxx_serial_3.html`.
Demo DS4201-S_4	The demo model shows how a fixed number of bytes can be sent periodically and how a variable number of bytes can be received in interrupt mode. The level of the receive interrupt (Receive SW FIFO Threshold) is also changed during run time. For further information, refer to the model description `<RCP_HIL_InstallationPath>\Demos\<ProcessorBoard>\RTI\demo1xxx_serial_4.html`.