

DS2302 Direct Digital Synthesis Board

RTI Reference

Release 2021-A – May 2021

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:

- Local dSPACE companies and distributors: <http://www.dspace.com/go/locations>
- 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

This publication contains proprietary information that is protected by copyright. All rights are reserved. The publication may be printed for personal or internal use provided all the proprietary markings are retained on all printed copies. In all other cases, the publication must not be copied, photocopied, reproduced, translated, or reduced to any electronic medium or machine-readable form, in whole or in part, without the prior written consent of dSPACE GmbH.

© 1999 - 2021 by:
dSPACE GmbH
Rathenaustraße 26
33102 Paderborn
Germany

This publication and the contents hereof are subject to change without notice.

AUTERA, ConfigurationDesk, ControlDesk, MicroAutoBox, MicroLabBox, SCALEXIO, SIMPHERA, SYNECT, SystemDesk, TargetLink and VEOS are registered trademarks of dSPACE GmbH in the United States or other countries, or both. Other brand names or product names are trademarks or registered trademarks of their respective companies or organizations.

Contents

About This Reference	5
General Information on the DS2302 Blockset	9
Overview of the DS2302 Blockset.....	9
Loading Slave Applications	11
DS2302_DSP_SETUP_Bx.....	12
Block Description (DS2302_DSP_SETUP_Bx).....	12
Unit Page (DS2302_DSP_SETUP_Bx).....	13
Channel Configuration Page (DS2302_DSP_SETUP_Bx).....	13
Access to the DPMEM Areas of the DDS Board	15
DS2302READ_Bx.....	16
Block Description (DS2302_READ_Bx).....	16
Unit Page (DS2302READ_Bx).....	18
DPMEM Page (DS2302READ_Bx).....	18
DS2302WRITE_Bx.....	19
Block Description (DS2302_WRITE_Bx).....	19
Unit Page (DS2302WRITE_Bx).....	21
DPMEM Page (DS2302WRITE_Bx).....	21
Interrupts	23
DS2302_HWINT_Bx_Iy.....	24
Block Description (DS2302_HWINT_Bx_Iy).....	24
Unit Page (DS2302_HWINT_Bx_Iy).....	25
Index	27









About This Reference

Introduction

This reference provides a full description of the Real-Time Interface (RTI) software support for the DS2302 Direct Digital Synthesis Board.

Symbols

dSPACE user documentation uses the following symbols:

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

Naming conventions

dSPACE user documentation uses the following naming conventions:

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

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

Examples:

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

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

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

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

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

Special folders

Some software products use the following special folders:

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

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

or

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

Documents folder A standard folder for user-specific documents.

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

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

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

Accessing dSPACE Help and PDF Files


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

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

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

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

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

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

General Information on the DS2302 Blockset

Introduction

Here you get basic information on the DS2302 blockset.

Overview of the DS2302 Blockset

Introduction

The Real-Time Interface (RTI) board library for the DS2302 Direct Digital Synthesis Board provides the RTI blocks that implement the functionality and I/O capabilities of the DS2302 board in Simulink models.

About this board

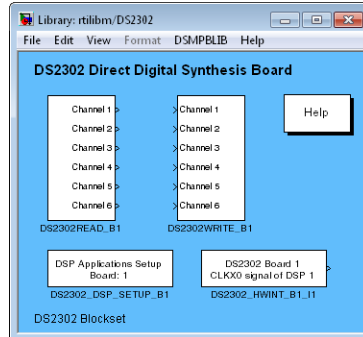
The DS2302 Direct Digital Synthesis (DDS) Board is equipped with 6 DSPs and is designed for fast and flexible waveform generation. It computes each signal sample just-in-time and outputs it immediately. The blocks of the Real-Time Interface (RTI) board library for the DS2302 Direct Digital Synthesis Board allow you to exchange data between your Simulink application and an application running on one of the 6 DSPs (slave application). The communication is established via the dual-port memories of the DDS board.

Note

With RTI you cannot build slave applications for the DSPs on the DS2302 based on Simulink block diagrams.

Library access

After you double-click the corresponding board library icon in the library rtilibm the Library: rtilibm/DS2302 opens:



Library components

The following I/O units can be accessed by the RTI blockset for the DS2302:

- [Loading Slave Applications](#) on page 11
- [Access to the DPMEM Areas of the DDS Board](#) on page 15
- [Interrupts](#) on page 23

Partitioning the 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 \(PHS Bus System Hardware Reference\)](#).

Demo model

For Simulink models, that shows how to use the RTI blocks of the DS2302 board, refer to the RTI demo library of your processor board. You can find the model files also at <RCP_HIL_InstallationPath>\Demos\DS100<x>\RTI.

Loading Slave Applications

Introduction

To load slave applications to the DS2302.

DS2302_DSP_SETUP_Bx

Purpose To load slave applications to the DS2302.

Where to go from here

Information in this section

Block Description (DS2302_DSP_SETUP_Bx)	12
To describe the purpose and function of the block.	
Unit Page (DS2302_DSP_SETUP_Bx)	13
To specify the board number.	
Channel Configuration Page (DS2302_DSP_SETUP_Bx)	13
To enable the channels and select the slave applications.	

Block Description (DS2302_DSP_SETUP_Bx)


Illustration



Purpose To load slave applications to the DS2302 board.

Description

This block loads slave applications to the DSPs of a DS2302.

Slave applications are written in the C programming language. To load them to the DS2302, they must be converted to an intermediate format (SLC format). Then they are included in the real-time application for the processor board and loaded to the DS2302 during application start. For details on programming and downloading slave applications, refer to [DS2302 DSP Programming](#) .

Dialog pages

The dialog settings can be specified on the following pages:

- Unit Page (refer to [Unit Page \(DS2302_DSP_SETUP_Bx\)](#) on page 13)
- Channel Configuration Page (refer to [Channel Configuration Page \(DS2302_DSP_SETUP_Bx\)](#) on page 13)

Related RTLib functions

`ds2302_load_board`

Unit Page (DS2302_DSP_SETUP_Bx)

Purpose To specify the board number.

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

Channel Configuration Page (DS2302_DSP_SETUP_Bx)

Purpose To enable the channels and select the slave applications.

Description In the dialog settings, you can enable each channel individually.

Dialog settings

Enable DSP application Lets you enable the channel. You can select which slave application will be loaded and select an interrupt source only if a channel is enabled.

Browse Lets you select the slave application to be loaded to the DSP. A slave application is written in the C programming language. To load it to the DSP, you must convert the corresponding object file into the SLC format. Refer to [How to Load Slave Applications via RTI \(DS2302 DSP Programming !\[\]\(830769b31eeeaca920791081939ff8ba_img.jpg\)](#)).

Interrupt source Lets you select an interrupt source. You must select a source if a slave application must be interrupted by a slave application running on another slave DSP (the `int_xf0()` or if the `int_xf1()` function is used in the slave application). Otherwise, the parameter is irrelevant. For details on working with interrupts, refer to [Interrupts \(DS2302 DSP Programming !\[\]\(198f559926258ddfad814817bda0ffbc_img.jpg\)](#)).

Access to the DPMEM Areas of the DDS Board

Introduction The RTI block library provides read and write access to the dual-port memory areas of the DDS board.

Where to go from here **Information in this section**

DS2302READ_Bx.....	16
To provide read access to the 6 dual-port memory (DPMEM) areas of the DDS board.	
DS2302WRITE_Bx.....	19
To provide write access to the 6 dual-port memory (DPMEM) areas of the DDS board.	

DS2302READ_Bx

Purpose To provide read access to the 6 dual-port memory (DPMEM) areas of the DDS board.

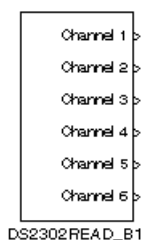
Where to go from here

Information in this section

Block Description (DS2302_READ_Bx).....	16
To describe the purpose and function of the block.	
Unit Page (DS2302READ_Bx).....	18
To specify the board number.	
DPMEM Page (DS2302READ_Bx).....	18
To specify the read memory areas of the 6 channels.	

Block Description (DS2302_READ_Bx)

Illustration



Purpose To provide read access to the 6 dual-port memory (DPMEM) areas of the DDS board.

Description

Note

Read operations will be included in the generated code for all 6 outputs. To avoid this for outputs you do not read data from, connect a Terminator block to them.

The read operation includes:

- Conversion between IEEE and TI float format
- Block transfer over the PHS bus

To prevent data corruption while the data is transferring, the generated RTI code includes instructions to disallow interrupts. A data transfer that is performed by a hand-written S-function have to contain a similar interrupt blocking mechanism. For further information, refer to *RTLIB_INT_SAVE_AND_DISABLE*, *RTLIB_INT_RESTORE* and *RTLIB_FORCE_IN_ORDER* in the RTLib reference of your processor board.

Note

The data transfer blocks all interrupts. Depending on the transfer time, also a high-priority task can take a significant delay.

I/O mapping

For details on the I/O mapping, refer to [Mapping of I/O Signals \(PHS Bus System Hardware Reference !\[\]\(d66ff64371a51729ac8c1cdaa685ba6f_img.jpg\)](#)).

I/O characteristics

- The block output labeled Channel 1 refers to the first DSP on the DDS board, Channel 2 refers to the second DSP, and so on.
- The contents of the DPMEM are read out as float values.
- Each output vector width matches the number of elements selected from the Number of elements entry on the DPMEM page.

Note

If you try to read from and to write to the same DPMEM address, the error message **Overlapping DPMEM areas detected** is displayed. This avoids situations in which the sequence of the read/write accesses is undefined. In undefined situations only the structure of the block diagram would determine if the overlapping memory is first read or written.

Dialog pages

The dialog settings can be specified on the following pages:

- Unit Page (refer to [Unit Page \(DS2302READ_Bx\)](#) on page 18)
- DPMEM Page (refer to [DPMEM Page \(DS2302READ_Bx\)](#) on page 18)

Related RTLib functions

ds2302_init, ds2302_read_block_float

Unit Page (DS2302READ_Bx)

Purpose To specify the board number.

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

Related topics

References

DPMEM Page (DS2302READ_Bx)..... 18

DPMEM Page (DS2302READ_Bx)

Purpose To specify the read memory areas of the 6 channels.

Dialog settings **Start address** Lets you specify the index of the first memory cell to be read from the DPMEM. Valid addresses must remain within the range 1 ... 16384. It is selectable for all channels.

Number of elements Lets you specify the number of memory elements to be consecutively read. The sum of entries under **Start address** and **Number of elements** must not exceed 16385. It is selectable for all channels.

To assign one value for the **Start address** and one value for the **Number of elements** to all the 6 channels, specify the desired values in the lowest row before pushing the Set all button.

Related topics

References

Unit Page (DS2302READ_Bx)..... 18

DS2302WRITE_Bx

Purpose To provide write access to the 6 dual-port memory (DPMEM) areas of the DDS board.

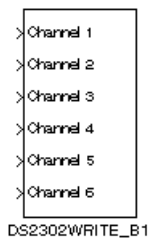
Where to go from here

Information in this section

Block Description (DS2302_WRITE_Bx).....	19
To describe the purpose and function of the block.	
Unit Page (DS2302WRITE_Bx).....	21
To specify the board number.	
DPMEM Page (DS2302WRITE_Bx).....	21
To specify the DPMEM areas for write access and to synchronize the execution of the slave application and the Simulink model.	

Block Description (DS2302_WRITE_Bx)

Illustration



Purpose To provide write access to the 6 dual-port memory (DPMEM) areas of the DDS board.

Description

Note

Write operations will be included in the generated code for all 6 inputs. To avoid this for inputs you do not write data to, connect a Ground block to them.

The write operation includes:

- Conversion between IEEE and TI float format
- Block transfer over the PHS bus

To prevent data corruption while the data is transferring, the generated RTI code includes instructions to disallow interrupts. A data transfer that is performed by a hand-written S-function have to contain a similar interrupt blocking mechanism. For further information, refer to *RTLIB_INT_SAVE_AND_DISABLE*, *RTLIB_INT_RESTORE* and *RTLIB_FORCE_IN_ORDER* in the RTLib reference of your processor board.

Note

The data transfer blocks all interrupts. Depending on the transfer time, also a high-priority task can take a significant delay.

I/O mapping

For details on the I/O mapping, refer to [Mapping of I/O Signals \(PHS Bus System Hardware Reference !\[\]\(23d9fc146e83b5c3013cfa32c784f8d5_img.jpg\)](#)).

I/O characteristics

- The block input labeled Channel 1 refers to DSP 1 on the DDS board, Channel 2 refers to DSP 2, and so on.
- The number of memory elements written to the DPMEM is automatically inherited from the input vector's width.
- The DPMEM contents are written as float values.

Note

If you try to read from and write to the same DPMEM address, the error message **Overlapping DPMEM areas detected** is generated. This avoids situations in which the sequence of the read/write accesses is undefined. In undefined situations only the structure of the block diagram would determine if the overlapping memory is first read or written.

Dialog pages

The dialog settings can be specified on the following pages:

- Unit Page (refer to [Unit Page \(DS2302WRITE_Bx\)](#) on page 21)
- DPMEM Page (refer to [DPMEM Page \(DS2302WRITE_Bx\)](#) on page 21)

Related RTLib functions

`ds2302_init`, `ds2302_write`, `ds2302_write_block_float`

Unit Page (DS2302WRITE_Bx)

Purpose To specify the board number.

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

Related topics

References

[DPMEM Page \(DS2302WRITE_Bx\).....21](#)

DPMEM Page (DS2302WRITE_Bx)

Purpose To specify the DPMEM areas for write access and to synchronize the execution of the slave application and the Simulink model.

Dialog settings

Start address Lets you specify the index of the first memory cell of the DPMEM that will be written. Valid addresses must remain within the range 1 ... 16384. It is selectable for all channels. To assign one value for the **Start address** to all the 6 channels, specify the desired value in the lowest row before pushing the **Set all** button.

Write simState Lets you select whether the simulation control variable **simState** is written to the DPMEM. This variable can be used to synchronize the slave application and the Simulink model. It is selectable for all channels.

To write the control variable **simState** to all the 6 channels of the DS2302, select the checkbox in the lowest row, specify the desired value and push the **Set all** button.

Tip

Writing the **simState** variable to the DPMEM is useful if the Simulink model and the slave application are to be started, paused or stopped synchronously. Then the slave application code can refer to the Simulink simulation state available from the DPMEM.

Note

In contrast to the variables of the Simulink model written to the DPMEM, the simState variable is of type integer.

Related topics

References

Unit Page (DS2302WRITE_Bx).....	21
---	--------------------

Interrupts

Introduction

The DS2302 interrupts provide an interrupt-driven synchronization mechanism between a slave application and the real-time application.

DS2302_HWINT_Bx_Iy

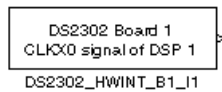
Purpose To make the hardware interrupts of the DS2302 board available as trigger sources.

Where to go from here Information in this section

Block Description (DS2302_HWINT_Bx_Iy)	24
To describe the purpose and function of the block.	
Unit Page (DS2302 HWINT_Bx_Iy)	25
To select one DSP as interrupt source.	

Block Description (DS2302_HWINT_Bx_Iy)

Illustration



Purpose To make the hardware interrupts of the DS2302 board available as trigger sources.

Description This block initializes the Interrupt Control unit to edge-trigger mode. To generate an interrupt, you have to use the `phs_bus_interrupt_request` function in your slave application. It sets the CLKX0 signal of the specified DDS board DSP's serial port for at least 100 ns to zero. For further information on interrupt generation, refer to [Interrupts \(DS2302 DSP Programming !\[\]\(f95dab70c751fda7d824b8b03650f7aa_img.jpg\)](#)).

Dialog pages The dialog settings can be specified on the Unit Page (refer to [Unit Page \(DS2302 HWINT_Bx_Iy\)](#) on page 25).

Unit Page (DS2302 HWINT_Bx_Iy)

Purpose

To select one DSP as interrupt source.

Dialog settings

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

Type Lets you select the DSP in the range 1 ... 6 as interrupt source.

Interrupt No.	Interrupt Type
1	CLKX0 signal of DSP 1
2	CLKX0 signal of DSP 2
3	CLKX0 signal of DSP 3
4	CLKX0 signal of DSP 4
5	CLKX0 signal of DSP 5
6	CLKX0 signal of DSP 6

C

Common Program Data folder 6

D

Documents folder 6

DS2302_HWINT_Bx_ly 24

DS2302READ_Bx 16

DS2302WRITE_Bx 19

DS802

partitioning PHS bus 10

dual-port memory of DS2302

reading 16

writing 19

L

Local Program Data folder 6

P

partitioning PHS bus with DS802 10

R

reading

dual-port memory of DS2302 16

W

writing

dual-port memory of DS2302 19

