DS2401 Resistive Sensor Simulation Board

Features

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dSPACE

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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

Contents

This document provides feature-oriented access to the information you need to implement the functions of the DS2401.

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 DS2401

Introduction

The DS2401 Resistive Sensor Simulation Board provides 4 simulated resistors of identical build. They can be used to simulate sensors that have a resistance output, for example, thermistors or resistance temperature detectors (RTDs) for temperature measurement.

Where to go from here

Information in this section

DS2401 Architecture 8
Provides an overview of the functional units and architecture of the DS2401.

Feature Overview 8
To get an overview on the features of the DS2401.

DS2401 Interfaces 9
To get an overview on the interfaces of the DS2401.

Information in other sections

Basics of the Resistive Sensor Simulation 11
To get basic on simulating resistances.

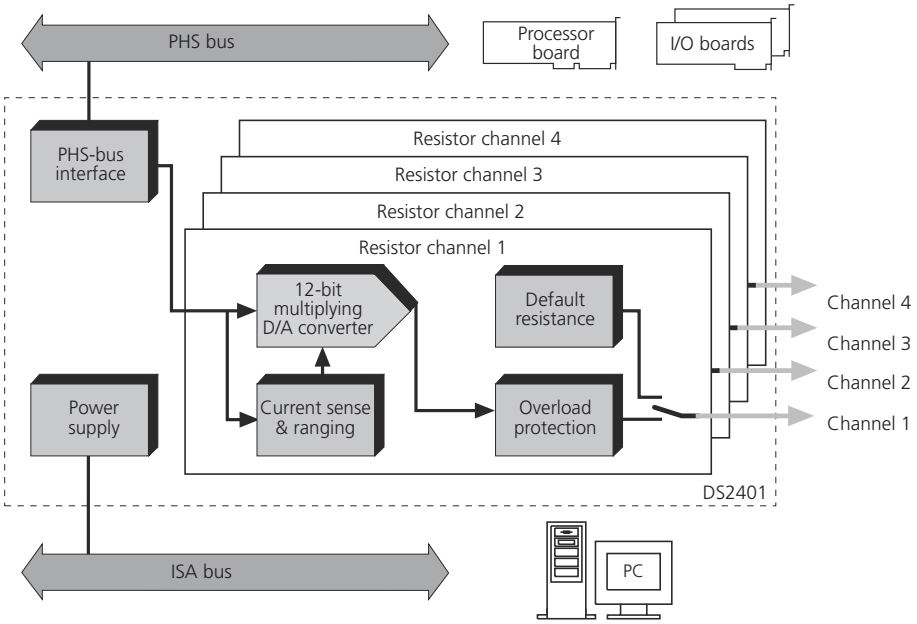
Details of the Resistive Sensor Simulation Unit 12
To get details on the Resistive Sensor Simulation Unit.

DS2401 Data Sheet (PHS Bus System Hardware Reference 🕮)

DS2401 Architecture

Introduction

The following illustration gives an overview of the functional units and architecture of the DS2401:



Related topics

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Feature Overview

Introduction

To get an overview on the features of the DS2401.

Resistive sensor simulation unit

Provides access to 4 simulated resistors, refer to Resistive Sensor Simulation Unit on page 11.

Related topics

References

DS2401 Interfaces

Introduction

The DS2401 has interfaces for connection to a PHS-bus-based system and external devices.

Integration into a PHS-bus-based system

To be used, the DS2401 must be integrated into a PHS-bus-based system. While the DS2401 performs the required output tasks, the processor board takes over the calculation of the real-time model. That is, applications using DS2401 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

To access the I/O unit of the DS2401, connect external devices to the 25-pin output connector P1 of the DS2401.

Related topics

References

Resistive Sensor Simulation Unit

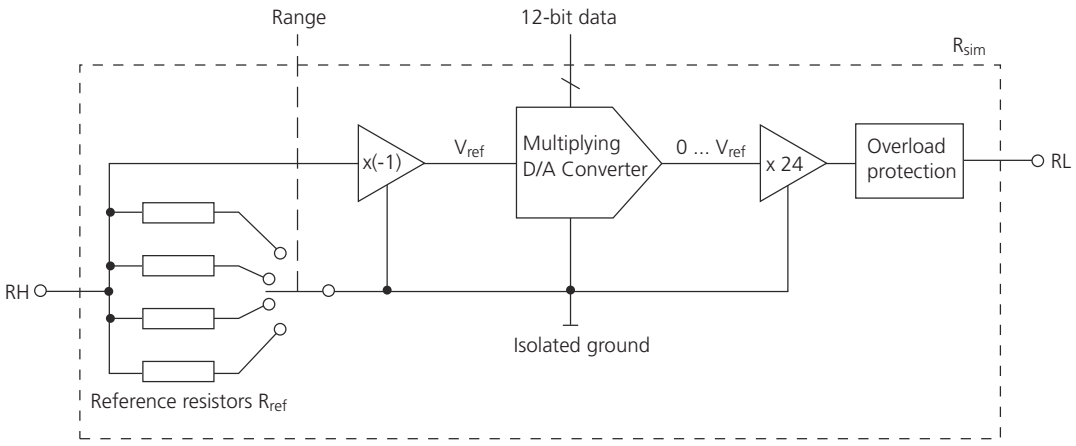
Where to go from here

Information in this section

Basics of the Resistive Sensor Simulation

Introduction

A DS2401 resistor channel works according to Ohm's law. The following illustration shows a simplified block diagram of a single resistor channel:



The voltage across the reference resistor is measured. The reference resistor is connected to isolated ground.

Reference resistor

There is one reference resistor for each range. For details on the resistance ranges, see Resistance range and resolution on page 13.

Multiplying D/A converter

After the voltage V_{ref} across the reference resistor R_{ref} is measured, it is fed into the reference voltage input of a multiplying D/A converter. The multiplying D/A converter and the 24-fold amplifier form a voltage source in reference to the reference resistor. Therefore the circuit provides a serial connection of the voltage across the reference resistor and the voltage generated by the multiplying D/A converter together with the 24-fold amplifier:

$V_{total} = V_{ref} + 24 \cdot U_{MDAC} \cdot x$

Factor x is specified by a digital input. It is the second input to the multiplying D/A converter. The value of x must be within the range of 0 … 1.

Because of Ohm's law ($V = R \cdot I$) the equation resolves to:

$R_{sim} \cdot I = R_{ref} \cdot I + 24 \cdot R_{ref} \cdot I \cdot x$

Because the current is the same throughout the circuit, this resolves to:

$R_{sim} = R_{ref} + 24 \cdot R_{ref} \cdot x = R_{ref} \cdot (1 + 24 \cdot x)$

The simulated resistor R_{sim} is determined by the reference resistor R_{ref} , which depends on the resistance range, and by factor x (= 0 … 1), which is specified as a 12-bit digital input signal.

Related topics

Basics

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Details of the Resistive Sensor Simulation Unit

Characteristics

The DS2401 provides a resistive sensor simulation unit with the following characteristics:

- 4 parallel simulated resistors
- Resistor value adjustable with 12-bit resolution
- All channels are isolated from system ground individually
- Operating range ±20 V, ±20 mA, AC or DC

- Overload protection featuring disconnection of outputs in case of overload and automatic restart, withstanding up to 100 V
- Immediate and latched mode

Principle of operation

For information on how the DS2401 works, refer to Basics of the Resistive Sensor Simulation on page 11.

Resistance range and resolution

The DS2401 provides a total resistance range of 10 Ω … 500 kΩ. It consists of four resistance ranges:

Range Number	Resistance Range	Resolution
1	10 Ω … 250 Ω	0.06 Ω
2	200 Ω … 5 kΩ	1.17 Ω
3	2 kΩ … 50 kΩ	11.7 Ω
4	20 kΩ … 500 kΩ	117 Ω

The range is selected automatically. If a resistance value is contained in two overlapping ranges, the lower range is chosen since it provides the better resolution.

Calculating the sensor simulation precision

For an ideal resistor, the voltage across the resistor is $V = R \cdot I$. However, the DS2401 has an electronic circuit to simulate resistors. This circuit has a gain error, which is a percentage of the desired resistance, and there is an offset voltage error of a few mV.

The equation to calculate the sensor simulation precision therefore resolves to:

$V = (R \cdot (1 + \text{gain\_error\%}) \cdot I) + V\_offset$

V_offset is not a constant. It depends on the selected range and resistance, and board temperature.

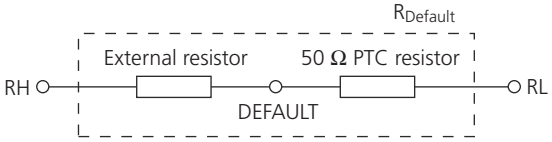
Immediate and latched mode

The DS2401 can be driven in two modes:

- In the *immediate mode* the simulated resistance is updated immediately. The output resistance of an individual channel is set to the new output value.
- In the *latched mode* a new resistor value can be written to the DS2401 without affecting the current resistance value. The simulated resistances of any combination of channels can then be updated simultaneously with a strobe command. The strobe command can be programmed with the `ds2401_strobe` function. The *latched mode* is not supported by RTI.

Default resistor and behavior on power-up

On power-up of the DS2401, the simulated resistors are disconnected from the output connector and the default resistors are enabled instead. The default resistance is also provided when no power is applied to the board or the board has not been initialized.



The board's default resistors each consist of an external resistor with a 50 Ω PTC resistor that is available on the DS2401. You can select the resistance of the external resistor to be connected between the DEFAULTx and RHx pins of the corresponding channel according to your specific requirements.

If you do not connect an external resistor, the resistance between the RH and RL pins of the corresponding channel is infinite.

The /DEF_EN signal indicates that all default resistors for all the output channels are enabled. For more information on signal groups, refer to Signal Description (PHS Bus System Hardware Reference 🕮).

Overload protection

An overload of the DS2401 occurs if either the current limits or the voltage limits are exceeded, whichever occurs first. The voltage limits are ±20 V. The current limits are ±20 mA.

Overload protection withstands up to 100 V.

If a channel is overloaded, the DS2401 disconnects the overloaded channel, so that the board enters the power-up condition and automatically tries to restart the overloaded channel every two seconds.

The channel resumes normal operation once the overload condition no longer applies.

For each resisitive sensor simulation channel, the signal OVERLOADx indicates that the corresponding channel is turned off. This signal is provided for each channel separately.

The resistor channels of the DS2401 can be checked for overload. The check can be performed for any set of channels by the `ds2401_ch_ovld` function.

The check for overload is not supported by RTI.

RTI/RTLib support

You can access the resistive sensor simulation unit via DS2401 Blockset and RTLib. For details, see

- Blockset: Resistive Sensor Simulation Unit (DS2401 RTI Reference 🕮)
- RTLib: Resistive Sensor Simulation Unit (DS2401 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 resistive sensor simulation unit, refer to Signal Connection to External Devices (PHS Bus System Hardware 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 (DS2401 RTLib Reference 🕮).

I/O mapping

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

Related RTI Block	Ch (RTI)	Related RTLib Functions	Ch (RTLib)	I/O Pin on DS2401	Signal
DS2401_Bx	Ch 1	Resistive Sensor Simulation Unit	Ch 1	P1 15	RH1
				P1 14	RL1
				P1 2	DEFAULT1
				P1 11	OVERLOAD1
	Ch 2		Ch 2	P1 5	RH2
				P1 4	RL2
				P1 17	DEFAULT2
				P1 24	OVERLOAD2
	Ch 3		Ch 3	P1 20	RH3
				P1 19	RL3
				P1 7	DEFAULT3
				P1 12	OVERLOAD3
	Ch 4		Ch 4	P1 10	RH4
				P1 9	RL4
				P1 22	DEFAULT4
				P1 25	OVERLOAD4
	All		All	P1 13	/DEF_EN

Related topics

Basics

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References

ds2401_ch_ovld (DS2401 RTLib Reference 🕮)
ds2401_strobe (DS2401 RTLib Reference 🕮)

Symbols

A

C

D

I

L

O

P

R