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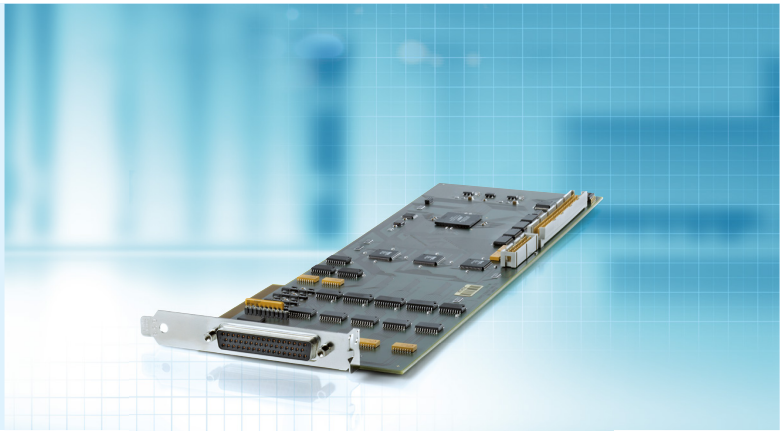
Find the *dSPACE DS4002-05* at our website: *Click HERE*

DS4002 Timing and Digital I/O Board

Generating and capturing digital signals

Highlights

- Captures digital signals for parameter measurement
- Generates flexible pulse patterns
- Comprehensive set of standard applications included



Key Benefits

The DS4002 Timing and Digital I/O Board combines a variety of digital I/O tasks on one board. It provides the functionality you expect from an ordinary digital I/O board plus additional features that help you perform specific control tasks easily. Eight channels can be programmed for either capturing digital signals or generating flexible pulse patterns. 32 additional I/O lines can be used for further digital I/O tasks, for example, to control single input lines (switches, sensors) or output lines (relays, displays).

Application Areas

The DS4002 Timing and Digital I/O Board is ideally suited to all kinds of hardware-in-the-loop simulations and rapid control prototyping. It captures digital signals for the measurement of parameters such as frequency or phase, and generates digital signals such as PWM pulses to control actuators or simulate sensors. It also performs many digital I/O tasks, for example, controlling switches or displays.
A brief overview of applications:

- Frequency measurement (F/D)
- PWM duty cycle measurement
- Phase shift measurement
- 1- and 3-phase PWM pulse pattern generation
- Square-wave signal generation (D/F)
- Monoflop signal generation

Further Features

The DS4002 Timing and Digital I/O Board can be used together with the DS2211 HIL I/O Board to capture engine signals angle-synchronously. The DS4002 can also be the time base (angle master) in such a setup (DS2211, p. 410).
In many situations, the DS4002 board can be used as an alternative to our DS5001 Digital Waveform Capture and DS5101 Digital Waveform Output Boards (p. 452, p. 456).

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Technical Details

Parameter		Specification
General		■ 8 channels (timing I/O) with 200 ns resolution ■ Each channel individually programmable as input or output ■ Common 30 bit/200 ns time base ■ Fast dual-port RAM for data storage ■ 32 additional digital I/O lines (TTL) ■ 2 external trigger input lines ■ Time-base connector
Interrupt controller		■ 1 read event interrupt ■ 2 signal generation interrupts
Timing I/O	Signal capture mode	■ Time and polarity stored for each edge (time stamps) ■ Stores up to 512 30-bit time stamps per channel ■ Rising and/or falling edge detection programmable ■ Latchup protection ■ Interrupt to master processor after predefined number of edges ■ Minimum pulse widths: see table on p. 430
	Signal generation mode	■ Signals described as a series of rising and falling edges ■ Stores up to 256 commands and 29-bit delay constants ■ Minimum pulse width: see table on p. 430 ■ All channels triggerable from channels 1 and 2 ■ Interrupts programmable from channels 1 and 2 ■ Loop counter ■ Update of time constants, output level, jump address, and loop counter during program execution (swinging buffer mechanism) ■ 2 external trigger input lines
	Voltage range	■ TTL input/output levels
	Output current	■ Max. ±75 mA
	Input/output frequency	■ Max. 833 kHz (1 channel active)

Digital I/O	Lines	■ 32 lines with ESD (electrostatic discharge) protection:
		  ■ 24 lines input/output (programmable in 8-bit groups, as direct input, strobed input or output)
		  ■ 4 lines fixed input mode
		  ■ 4 lines fixed output mode
		■ 1 strobe input
		■ 2 handshake lines for acknowledge and output ready
		■ Direct and/or latched input mode
		■ Used to control single input or output lines

	Voltage range	■ TTL input/output level
	Output current	■ Max. -64 mA/+16 mA
External trigger input		■ 2 lines with TTL input level
Physical connections		■ 50-pin female Sub-D connector
Host interface		■ One 8- or 16-bit ISA slot (power supply only)
Physical characteristics	Physical size	■ 338 x 114 x 20 mm (13.3 x 4.5 x 0.8 in)
	Ambient temperature	■ 0 … 70 °C (32 … 158 °F)
	Power supply	■ +5 V ±5%, 3 A

Order Information

Product	Order Number
DS4002 Timing and Digital I/O Board	■ DS4002

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Relevant Software and Hardware

Software		Order Number
Included	■ C functions for accessing/controlling the DS4002	–
Required	■ Real-Time Interface (RTI), (p. 56)	■ RTI

Hardware		Order Number
Optional	■ Connector Panel for DS4002 (p. 504)	■ CP4002
	■ Connector/LED Combi Panel for DS4002 (p. 504)	■ CLP4002

Minimum Pulse Widths[1)]

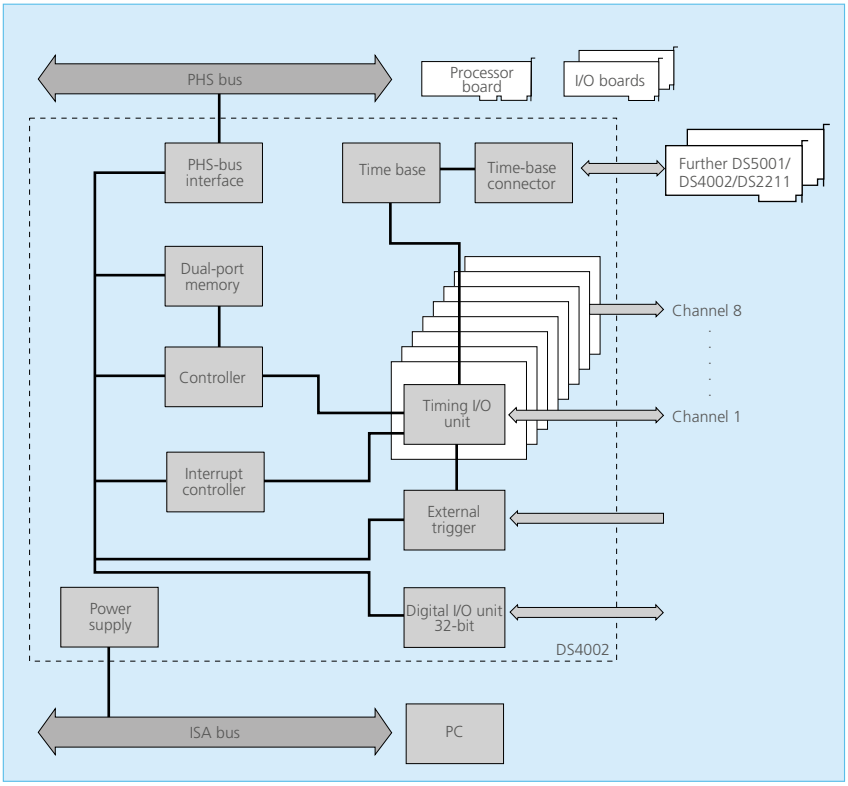
The table below shows the minimum pulse widths for different numbers of channels in use, which are the same for Capture and Generation mode.

Channels in Use	Pulse Width (Capture Mode)	Pulse Width (Generation Mode)
1	0.6 µs	0.6 µs
2	1.0 µs	1.0 µs
3	1.4 µs	1.4 µs
4	1.8 µs	1.8 µs
5	2.2 µs	2.2 µs
6	2.6 µs	2.6 µs
7	3.0 µs	3.0 µs
8	3.4 µs	3.4 µs

1) *Speed and timing specifications describe the capabilities of the hardware components and circuits of our products. Depending on the software complexity, the attainable overall performance figures can deviate significantly from the hardware specifications.*

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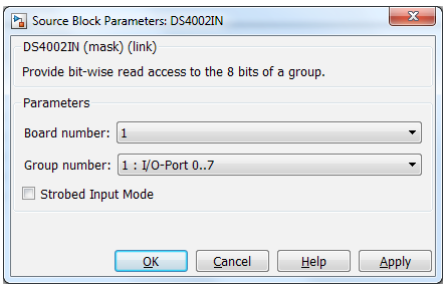
Block Diagram

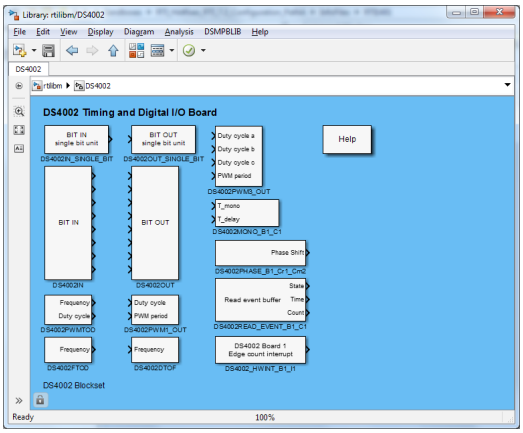


Graphical Programming

Using Real-Time Interface

The DS4002 Simulink® blocks provided by Real-Time Interface allow convenient control of all timing and I/O lines: bit in, bit out, PWM, F/D, D/F, signal capture mode, and hardware interrupt.





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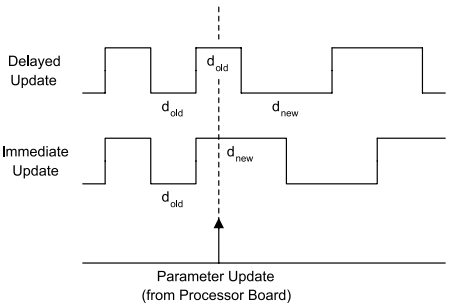
Application Examples

Creating Pulse Patterns in Generation Mode

You can create complex pulse patterns flexibly in Generation mode. Functions for the most common applications, such as PWM pulse pattern generation and square-wave signal generation, are included. Alternatively, you can program your own pulse patterns directly in C code.
Channels 1 and 2 can trigger other channels and send interrupts to the master processor. In addition, all channels can be controlled by two external trigger input lines. During program execution, the delay constants, output level, jump address, and loop counter can be updated synchronously or individually per channel.

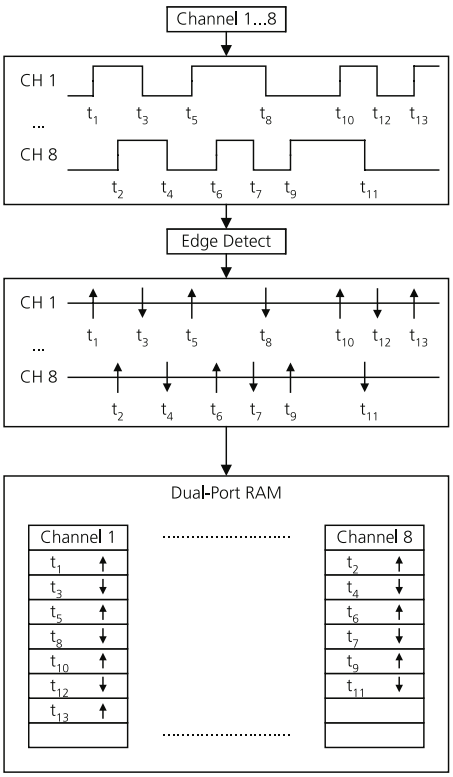
Changing Frequencies During Run Time

Square-wave signals, such as those for transmission speed simulation, can be changed at any time simply by updating the delay parameter. You have two options for doing this. With delayed update, the new value d_{new} becomes active after the old value d_{old} has expired. With immediate update, d_{new} replaces the current d_{old} without any delays.



Recording Signals in Capture Mode

Using a channel in Capture mode, you can record any digital signal you want. This is especially useful for evaluating signal parameters such as frequency, phase, or jitter.
Functions for standard applications, such as PWM pulse evaluation or frequency measurement, are included.
The captured signals are described as a series of rising and falling edges. The time and polarity are recorded for each edge (rising and/or falling programmable) (time stamps). The on-board dual-port RAM stores up to 512 time stamps of 30 bits per channel. This data is used for further data processing by a dSPACE processor board. Recording a predefined number of edges can trigger an interrupt to the master processor.



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