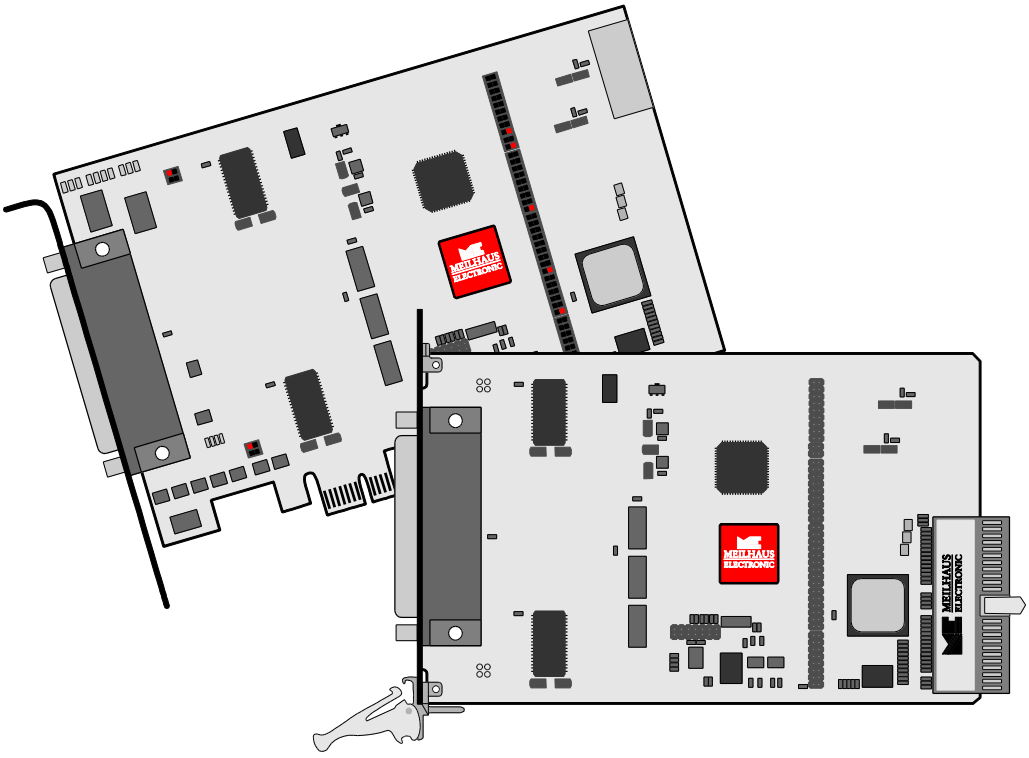
Meilhaus Electronic Manual

ME-5100 Series 3.0E



32-Channel High-Speed Digital-I/O Board

(alternatively: Frequency Measurement and Pulse Generator)

Imprint

Manual ME-5100 Series

Revision 3.0E

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Content

1 Introduction

Valued customer,

Thank you for purchasing this device from Meilhaus Electronic. You have chosen an innovative high-technology product that left our premises in a fully functional and new condition.

Please take the time to carefully examine the contents of the package for any loss or damage that may have occurred during shipping. If there are any items missing or if an item is damaged, please contact us immediately.

Before installing the board in your computer, we recommend you read this manual carefully, especially the chapter describing board installation.

The descriptions in this manual concern PCI-Express- and CompactPCI-versions of the ME-5100 series if not otherwise noted.

1.1 Important Notes

1.1.1 Use in Accordance with the Requirements

The PC boards of the ME-5000 series are designed for acquisition and output of digital signals with a PC. Depending on type install the models of the ME-5000 series into:

a free PCI-Express slot (PCIe) or

a free CompactPCI-slot (cPCI)

For information on how to install a plug-in board or connect a USB device, please read the manual of your PC.

Please note the instructions and specifications as presented in this manual (Appendix A, Specifications):

- Please ensure sufficient heat dissipation for the board within the PC housing.
- All unused inputs should be connected to the ground reference of the appropriate functional section. This avoids cross talk between the input lines.
- The opto-isolated inputs and outputs achieve an electrical isolation of the application relative to PC ground.

- Note that the computer must be powered up prior to connecting signals by the external wiring of the board.
- As a basic principle, all connections to the board should only be made or removed in a powered-down state of all components.
- Ensure that no static discharge occurs while handling the board or while connecting/disconnecting the external cable.
- Ensure that the connection cable is properly connected. It must be seated firmly on the D-Sub connector and must be tightened with both screws, otherwise proper operation of the board cannot be guaranteed.

1.1.2 Improper Application

PC plug-in boards for the PCI-, PCI-Express- or CompactPCI-bus may not be taken into operation outside of the PC. Never connect the devices with voltage-carrying parts, especially not with mains voltage. As power supply for the USB models only an authorized power adaptor may be used.

Make sure that no contact with voltage-carrying parts can happen by the external wiring of the device. As a basic principle, all connections should only be made or removed in a powered-down state.

1.1.3 Unforeseeable Misapplications

The device is not suitable to be used as a children's toy, in the household or under unfavourable environmental conditions (e.g. in the open). Appropriate precautions to avoid any unforeseeable misapplication must be taken by the user.

1.2 Package Contents

We take great care to ensure your delivery is complete. Nonetheless, please check the list enclosed to verify the contents of your delivery. You should find included:

- Digital-I/O board in one of the versions:
  - ME-5100 PCIe or cPCI.
  - ME-5100A with additional add-on board ME-5001.
  - ME-5100B with additional add-on board ME-5004.
- Manual in PDF format on CD/DVD.
- Driver software on CD/DVD.
- 78-pin D-Sub mating male connector, ME-5100A additional 25-pin mating male connector, ME-5100B additional 37-pin mating male connector.

1.3 Features

There are different versions of ME-5100:

Model		TTL I/Os/Counters
ME-5100 PCIe/cPCI	ME-5100	32 I/O, TTL
ME-5100A PCIe/cPCI	ME-5100 + ME-5001	32 I/O, TTL
ME-5100B PCIe/cPCI	ME-5100 + ME-5004	32 I/O, 16 inputs, 16 outputs, opto-isolated, 3 counters, 16 bit, opto-isolated

The ME-5100 is a fast digital-I/O board for the PCI-Express- and CompactPCI-systems. The base board can optionally be extended with plug-on boards (see Table 2 on page 10).

Overview:

Model	DIO	FIO*	3.3 V/5 V	Termination
ME-5100 (subdevice 0)	16 bit DIO	4 FI channels	✓	✓
(subdevice 1)	16 bit DIO	4 FO channels	✓	✓

Table 1: Overview ME—5100

*Alternative configuration can be activated via ME-iDC.

- **High-speed digital-I/O ports:** The ME-5100 has two 16-bit digital-I/O ports and a number of control lines. When operating in single mode, the two ports can be configured, independently of one another, as input or output. The direction of the ports is defined in software. Immediately after powering up, all the ports are configured as inputs. When operating in streaming mode, the direction of the ports is specified by hardware: port A is the input port, while port B is the output port.
- **Frequency counter:** The concept of the "configurable subdevices" allows subdevice 0 to be employed as a frequency counter. Four independent channels are available for measuring the frequency and duty cycle of rectangular signals (max. 5.5 MHz).
- **Pulse generator:** The concept of the "configurable subdevices" allows subdevice 1 to be employed as a rectangular wave generator. Four independent channels are available for the output of a periodic, rectangular signal at up to 5.5 MHz with a variable duty cycle.
- **Signal level 3.3/5 V:** the signal level of all the digital inputs/outputs and of the control lines can be switched together between 3.3 V and 5 V, depending on the external circuitry.
- For optimum signal matching, you are able to activate, via software, an active **110 Ω termination** at the digital inputs/outputs of each port.
- The DATA_VALID and L_CLK signals are available for **synchronization** with the external circuitry. The DATA_VALID pin indicates the validity of the data during output in streaming mode operation, while the 66 MHz system clock can be accessed at the L-CLK pin.
- **Bit-pattern detection:** The bit-pattern at the digital inputs can be monitored if required. Depending on the configuration, an interrupt can be triggered in response to a change in the bit-pattern. In streaming mode operation, the bit-pattern detection can also be used to control the input/output operation, depending on the selected operation mode (not using interrupts).

Thanks to the DMA architecture, the data can be transferred very quickly between the PC's working memory and the board. In streaming mode, an input/output rate of up to 30 MS/s, in which all the ports must participate, is possible. (See also Table 3 on page 22). The actual transmission rate will depend on the operating mode and the configuration of your computer.

Depending on requirements, you can select from the following **operating modes:**

- **Single**: In this operating mode, a single value can be read or written under software control (see chapter 4.1.1 on page 24).
- **Streaming**: Data is read in/output in this operating mode via a FIFO. It is possible to choose between a timer and/or external trigger signals for timing control. A large number of **trigger options**, with which you can define start and stop conditions, are available. Port A is specified as a 16-bit input port, and Port B as a 16-bit output port (see chapter 4.2 on page 27).
- **Interrupt**: For interrupt handling in the "bit-pattern change" and "bit-pattern comparison" modes (see chapter 4.3 on page 30).

Customer-specific versions of the firmware are available on request.

Model	ME-5100	ME-5001	ME-5004
PC interface	cPCI/PCIe	-	-
Board type	base board	plug-on board	plug-on board
DIO channels	2 x 16 bit DIO	4 x 8 bit DIO	1 x 16 bit DI 1 x 16 bit DO
Streaming channels	1 x 16 bit DI 1 x 16 bit DO	-	-
DI/DO/ I/O rate	30 MS/s / 30 MS/s	-	-
FI/FO frequency	5.5 MHz/ 5.5 MHz	5.5 MHz/ 5.5 MHz	300 kHz/ 3 kHz
External trigger for streaming	✓	-	-
Software Start/Stop for streaming mode operation	✓	-	-
Frequency measurement	4 channels	8 channels	8 channels
Pulse generator	4 channels	8 channels	8 channels
Bit-pattern change	✓	✓	✓
Bit-pattern compare	-	-	✓
DI/FI level	3.3 V/5 V (TTL)	3.3 V/5 V (4 x 8 bit**)	3...60 V
DO/FO level	3.3 V/5 V (TTL)	3.3 V/5 V (4 x 8 bit**)	15...30 V
Active termination	✓	4 x 8 bit**	-

Opto-isolation	-	-	✓
Sink/source selection	-	-	✓
Temperature monitoring	-	-	✓
External wiring	78-pin D-Sub socket	25-pin D-Sub socket	37-pin D-Sub socket
Configurable firmware	✓	✓	✓
Configurable subdevices	✓	✓	✓

Table 2: ME-5100 and plug-on boards in overview

*opt. via ME-AK-D25F/S (cPCI) **only for subdevices 0..3

1.4 System Requirements

The ME-5000 series may be installed into any PC with PCI-Express- resp. CompactPCI-slot (32 bit, 33 MHz, 5 V). The board is supported by the Meilhaus Electronic Intelligent Driver System (ME-iDS).

1.5 Software Support

The ME-5000 series is supported by the Meilhaus Electronic Intelligent Driver System (ME-iDS). The ME-iDS is a unique driver system covering different devices and operating systems. It supports Windows 2000, XP, Vista, 7, 8.1, 10 and contains a universal function library (API) for all common programming languages.

A detailed description of the functions can be found in the ME-iDS manual on the CD/DVD enclosed.

Please also note the corresponding README-files.

2 Starting up

Please read your computer's instruction manual on how to install new hardware components **before installing the board**.

2.1 Software Installation

- Installation under Windows

The following basic procedure should be used:

If you have received the driver software as an archive file please unpack the software before installing the board. First choose a directory on your computer (e.g. C:\Temp\Meilhaus\ME-iDS).

Use the Meilhaus Electronic Intelligent Driver System (ME-iDS) for programming your new data acquisition hardware. For installation and operation of the driver system please follow the documentation in electronic form included with the software package.

2.2 Test Program

ME-PowerLab^3: Run the program from the Windows Start menu. This will allow you to test all the important functions of the hardware.

For simple testing of the board use the corresponding test program provided with the ME-iDS.

2.3 Fitting the Plug-on Boards

The boards should be handled with care in order to make sure that the device is not damaged by electrostatic discharge (ESD), mechanical stress or unsuitable current surges. Precautions should also be taken to avoid an electric shock. Ensure that standard ESD safety precautions are taken. At least one hand should be grounded in order to dissipate any static charge.

Observe the following procedure:

1. If the base board is installed, you must first remove it in order to be able to insert the plug-on board. Here you should observe the procedure as described in the manual for your PC system.
2. Make sure that electrostatic discharges cannot take place through the plug-on board or the base board as you plug it in. Follow the standard ESD safety precautions.
3. Push the plug-on board carefully, and with only a little force, on to the male connector provided for it (see Diagram 1, items 1, 2 and 3). Check that the board is fully plugged in.
4. Choose two adjacent slots for the installation. If necessary, remove an additional mounting bracket for the slot of the plug-on board.
5. Carefully plug the combination of the base and plug-on board into the computer.
6. Screw the two slot brackets down firmly.
7. Close the PC system again.

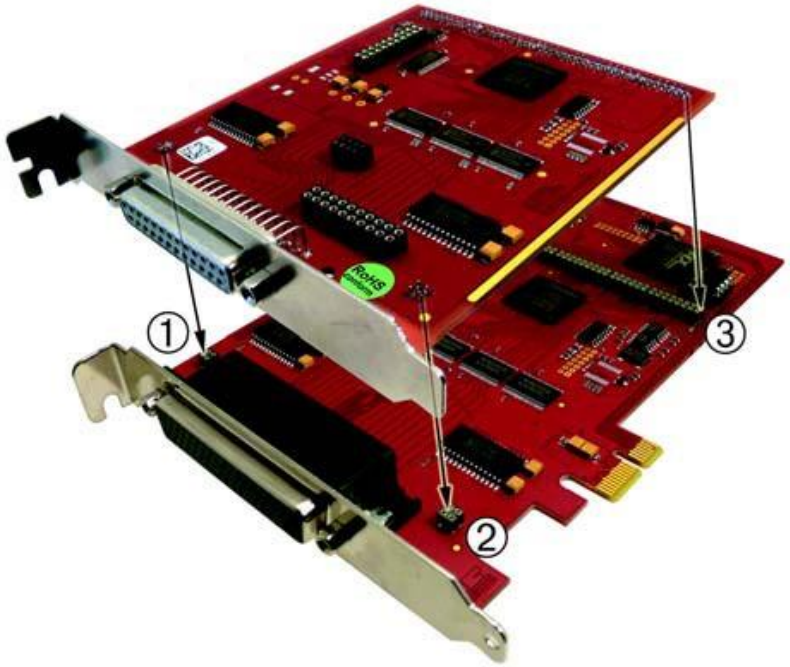

Diagram 1: Fitting the plug-on boards

2.4 Power Supply for PCI-Express Models

Because of the PCI-Express slot drive's insufficient current for operating the board, an additional supply is required via the PC power supply. For that purpose connect a free "MOLEX" connector of the PC (as used for power supply of drives) with the appropriate terminal of the board (see the following diagram). **Otherwise the board may be irreversibly damaged!**

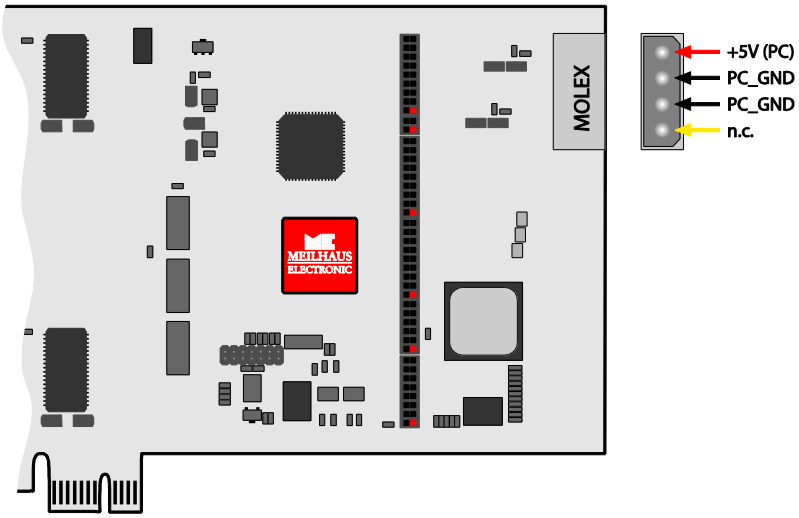

Diagram 2: Additional power to the PCIExpress models

3 Hardware

3.1 Block Diagram

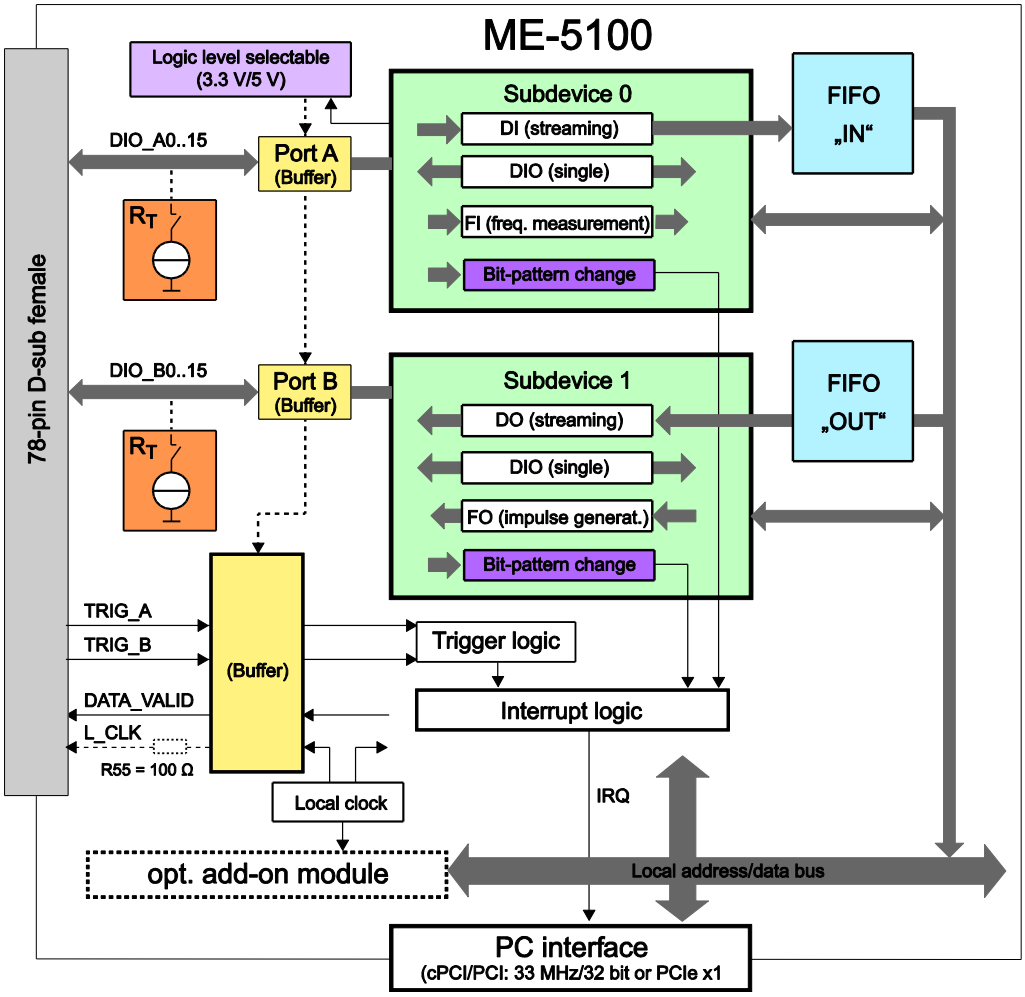

Diagram 3: Block diagram of ME-5100

- **Subdevice 0 (port A) Single mode operation:** bidirectional, specified as an input port for operation in streaming mode.
- **Subdevice 1 (port B) Single mode operation:** bidirectional, specified as an output port for operation in streaming mode.

*SPI:"Serial Programming Interface"
The pin assignment for the 78-pin D-Sub socket can be found in the appendix (see "Pinout" on page 36).
You will find a description of the circuitry of the individual function groups in the following sections. Please read the chapter 4 from page 22 for operating modes and programming.

3.2 ME-5100 cPCI

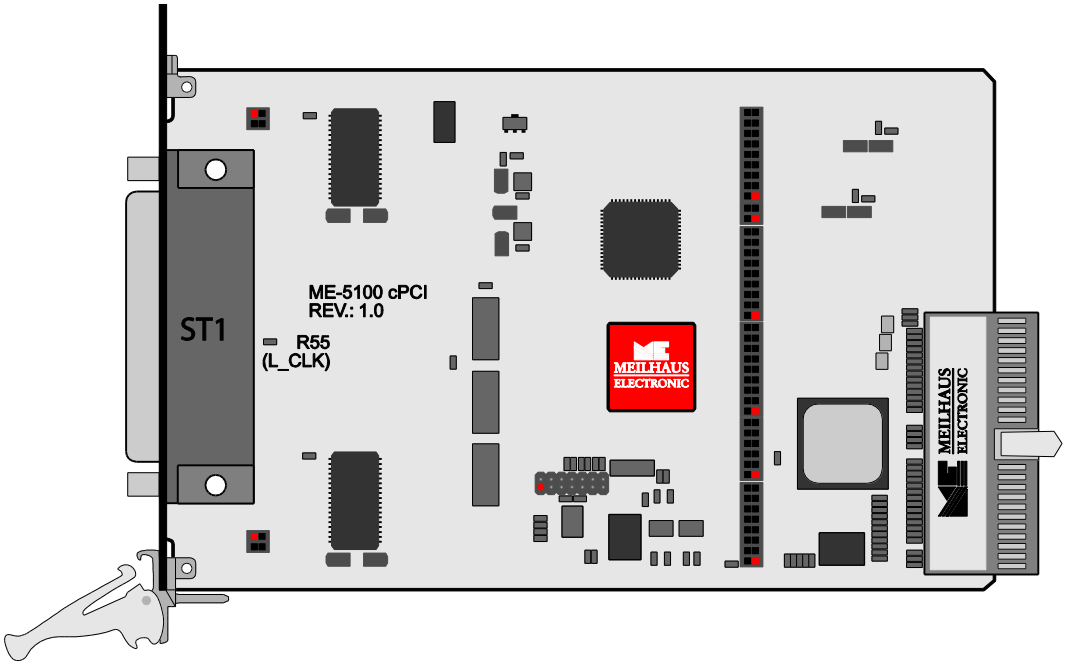

Diagram 4: ME-5100 cPCI

3.3 ME-5100 PCIe

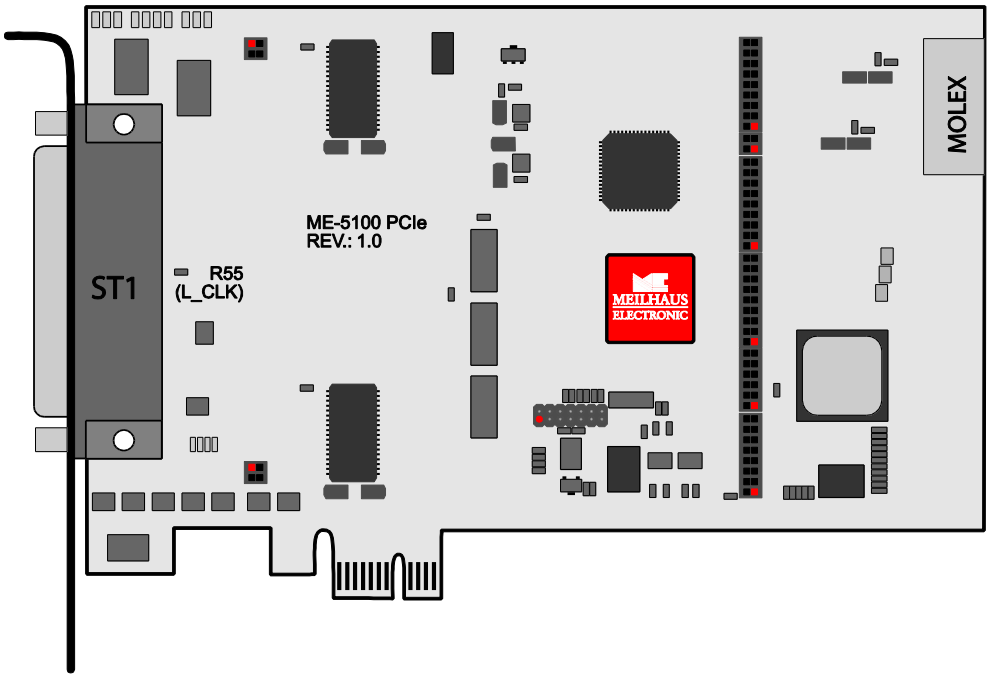

Diagram 5: ME-5100 PCIe

3.4 Digital Input/Output

The ME-5100 has two 16-bit digital-I/O ports and a number of control lines. When operating in single mode, the two ports can be configured, independently of one another, as input or output. The direction of the ports is defined in software. When operating in streaming mode, the direction of the ports is specified by hardware: port A is the input port, while port B is the output port.

In streaming mode, ports A and B must share the bandwidth for the data transfer between the board and the PC. This depends on the configuration of your computer - a total data throughput of up to 30 MS/s is realistic (see also Table 4 on page 23).

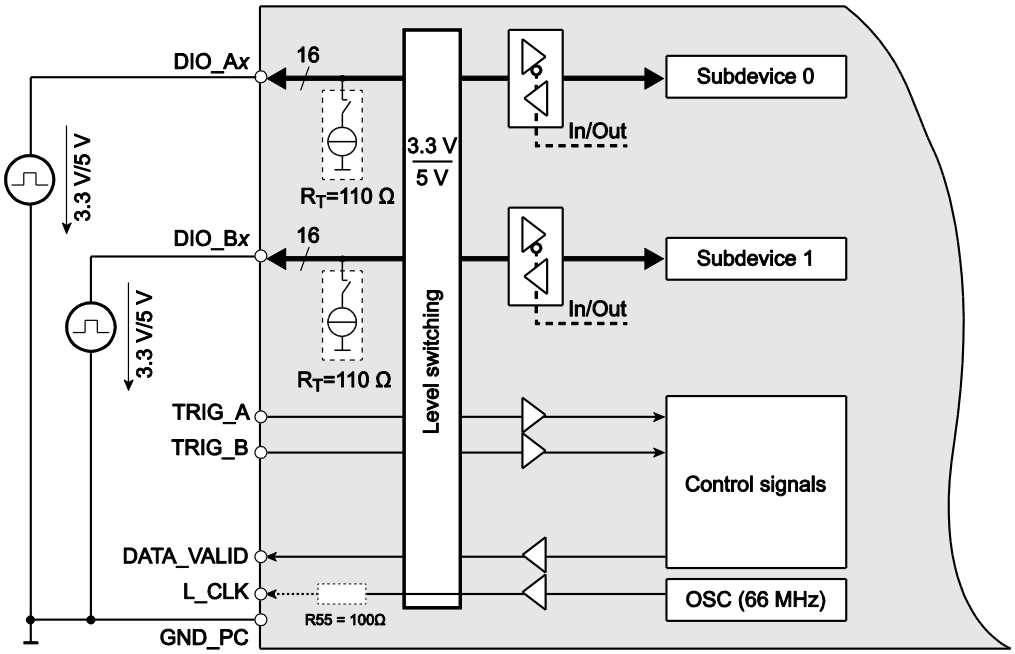

Diagram 6: Wiring of digital inputs/outputs

Please read chapter 4.1.1 from page 24 for programming the different operating modes.

3.4.1 Digital Inputs

When wiring the inputs, note that the voltage level must be observed (see the specifications on page 32) and that a reference to the PC ground (GND_PC) must be established (see Diagram 6).

3.4.2 Digital Outputs

When wiring the outputs, note that the voltage level must be observed (see the specifications on page 35) and that a reference to the PC ground (GND_PC) must be established (see Diagram 6).
$I_{Out} = I_{OL} = I_{OH} = 24$ mA per pin.

3.4.3 External Trigger

3.4.3.1 External Trigger Inputs

In addition to the trigger inputs TRIG_A and TRIG_B, any of the digital inputs can also be used as a trigger input. You can therefore configure the trigger conditions for starting and stopping a timer-controlled input/output (streaming mode operation) very flexibly. See also Diagram 7 on page 18, and the trigger matrix, Diagram 12 on page 29.

The specifications for the digital inputs apply to the wiring of the trigger inputs TRIG_A and TRIG_B.

Note: The input/output cannot be externally triggered in single mode operation. Compare here chapter 3.6 “External Interrupt” on page 20.

3.4.3.2 Edge Detection

You can specify, both for the trigger inputs TRIG_A and TRIG_B and for all the usable digital inputs, whether the operation is to be started by a rising edge, falling edge, or by any edge (i.e. equally by rising or falling edges).

Diagram 7: Trigger edges

3.5 Frequency Input/Output

The concept of the „configurable subdevices“ of the ME-5000 series gives you the option of using individual subdevices with an alternative functionality. The associated configuration is carried out with the ME-iDC configuration tool before your application is called.

The following channels are available:

- **Frequency counter** (FI = “Frequency Input”):
  4 independent inputs for measuring the frequency and duty cycle of rectangular signals (max. 5.5 MHz).
- **Pulse generator** (FO = “Frequency Output”):
  4 independent outputs for the output of a periodic rectangular signal at up to 5.5 MHz with a variable duty cycle.

The associated pins are identified as FI_A0..3 and FO_B0..3 in the terminal assignment on page 37. In this configuration, the remaining inputs/outputs of the digital ports cannot be used.

Please note: In the “pulse generator” (FO) configuration, the unused pins DIO_B4..15 are connected to ground!

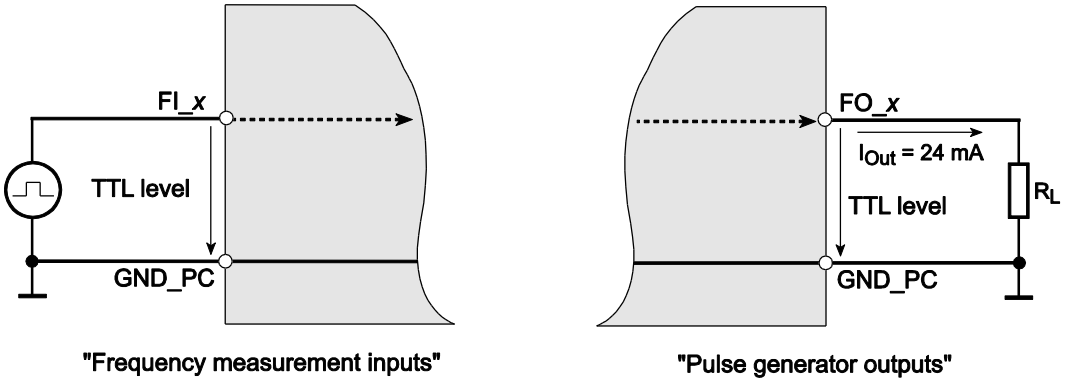

Diagram 8: Wiring the frequency inputs/outputs

The specifications for the digital-I/O ports apply to the wiring of the inputs and outputs. A reference to the PC ground (PC_GND) must always be established. The maximum output current is $I_{OUT} = I_{OL} = I_{OH} = 24$ mA.

The frequency counters and pulse generators are configured by software. Please read chapter 4.1.2 on page 25 for programming the frequency input/output.

3.6 External Interrupt

If required, you can also monitor the bit-pattern of a digital input port. The “bit-pattern change” mode is available on the ME-5100. As soon as the specified event occurs, an interrupt is issued and passed directly to the PC.

The digital inputs/outputs are programmed in the single operating mode. The interrupt handling is carried out with the *meIOIrq...*functions; see also chapter 4.3 on page 30.

3.7. Additional Functions

You can make the following settings for adapting to your application regardless of the operating mode.

3.7.1 System Clock Output

If required, you can output the 66 MHz clock (L_CLK) at pin 29 of the 78-pin D-Sub connector. A 100 Ω resistor must be fitted at R55 for this purpose. You can find the position of R55 with the aid of Figs. 4 and 5 (page 16).

Note: Remember that crosstalk between the clock and the signal lines can easily happen in the external wiring. We recommend use of the optional ME AB-D78/IDC adapter board, where a ground line is included between each signal line. Used together with a suitable ribbon cable, you can minimize the crosstalk in this way.

3.7.2 Termination

For optimum signal matching, you can enable via software, an active 110 Ω termination at the digital inputs/outputs of each port.

The termination circuits are effectively protected against overload by the combination of current limiting and thermal shutdown (with automatic return to service).

3.7.3 Logic Level Matching

The signal level of all the digital inputs/outputs and of the control lines can be switched together between 3.3 V and 5 V, depending on the external circuitry. The changeover is made for all the ports of the base board at once using software.

3.7.4 "DATA_VALID" Pin

A high level at the DATA_VALID output indicates the validity of the data at output port B in streaming mode operation.

4 Programming

For programming the device please use the Meilhaus Electronic Intelligent Driver System (ME-iDS) included in your package. The ME-iDS is a unique driver system covering different devices and operating systems. It supports Windows 2000 and higher and contains a universal function library (API) for all common programming languages (the extent of the current software support can be found in the README-files of the ME-iDS).

A detailed description of the functions can be found in the ME-iDS manual (see CD/DVD enclosed or online:
www.meilhaus.de/download/ME-iDS.

Further details regarding the assignment of the subdevices and device specific arguments can be found in the help file (help file format under Windows, *.chm) which can be accessed via the „ME-iDS Control Center“ in the info area of the task bar (as a rule in the lower right corner of the screen) or via the Windows start menu.

The ME-5100 base board is a device with two "subdevices", beginning with the index "0". When a plug-on board (e.g. the ME-5001) is used, further subdevices (starting with the index "0") are added. The functionality of the subdevices can be specified by the user through selecting a pre-defined configuration. The desired configuration is loaded into the board by the ME-iDC configuration tool before your application starts. Using the standard configuration, (ID 0), the board is ready to operate immediately. You will find an overview of the currently available configurations in the following table:

Subdevice of Type	...Subtype	I/Os	ID of the Configuration
Subdevice 0 (DIO, DI, FO)			
Digital input (DI)	streaming	16-bit port	0*
Digital input/output (DIO)	single	16-bit port	1
Frequency input (FI)	single	4 channels	2

Table 3: Subdevice configurations of the ME-5100

Subdevice of Type	...Subtype	I/Os	ID of the Configuration
Subdevice 0 (DIO, DI, FO)			
Digital output (DO)	streaming	16-bit port	0*
Digital input/output (DIO)	single	16-bit port	1
Frequency output (FO)	single	4 channels	2

Table 4: Subdevice configurations of the ME-5100

*Standard configuration at shipment. The most recently selected configuration in the ME-iDC is stored in a non-volatile memory on the board, and is automatically loaded after a restart.

Depending on requirements, you can select from the following operation modes:

- Single: Individual values can be read or written in this operating mode.
- Streaming: Data is read in/output in this operating mode via a FIFO. It is possible to choose between a timer and/or external trigger signals for timing control. A large number of trigger options, with which you can define start and stop conditions, are available. See chapter 4.2 starting on page 27.
- Interrupt: For the interrupt handling in the bit-pattern change mode (see chapter 4.3.1 starting on page 31).

Operation Mode	Speed	Trigger
Single	single value	input/output via software
Stream-Timer ...with „wraparound“ option	up to 30 MS/s (depending on the computer)	start/stop by software of by external trigger
Stream-Trigger-Sample	up to 30 MS/s (depending on the computer)	start/stop by software of by external trigger
Interrupt (Bit-pattern detection)	$f_{IRQmax.}$ = 10 kHz	ext. trigger signal at a digital input/output port

Table 5: Operation modes summary

Comprehensive timing diagrams will be found in the ME-iDS manual.

**see chapter 4.2 starting on page 27.

4.1 Single Operation Mode

Individual values can be read or written in this operating mode.

Notes:

- In the single operating mode, the ports of the ME-5100 can be used bi-directionally.
- Immediately after powering up, the bidirectional ports are configured as inputs.
- In streaming mode, port A is specified as input and port B as output.
- A port that is configured as an output can also be read back!

4.1.1 Digital Input/Output

ME-5100	ME-5001	ME-5004
✓	✓	✓

The input/output of individual digital values is carried out in the single operating mode. Each digital port is addressed as a function group of type ME-TYPE_DIO subtype ME_SUBTYPE_SINGLE. Ports A and B can optionally be configured as 16-bit input or output ports.

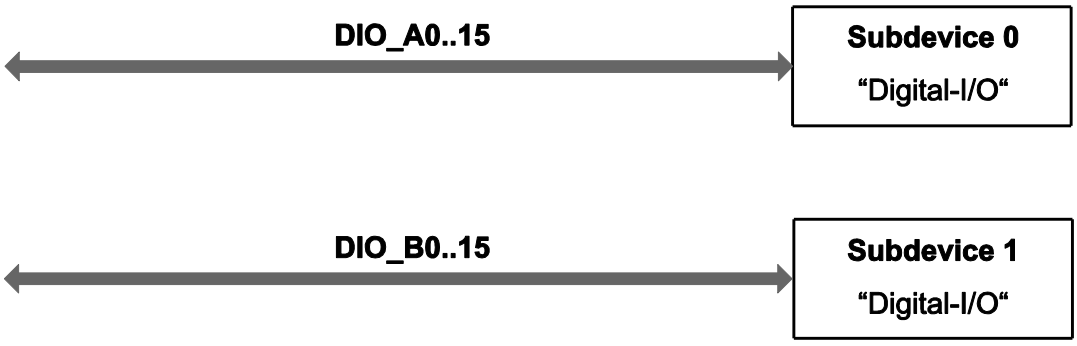

Diagram 9: Digital input/output in single operating mode

Please observe the ME-iDS manual and the ME-iDS help file (*.chm) for the procedure. You can open both these documents through the “ME-iDS Control Center” or through the Windows Start menu.

Please read chapter 3.4 on page 17 for wiring of the digital ports.

4.1.2 Frequency Input/Output

ME-5100	ME-5001	ME-5004
✓	✓	✓

Before you can use the "Frequency measurement" or "Pulse generator" modes, it is necessary, before opening your application, to run the ME-iDC configuration tool in order to specify the configuration for the corresponding subdevice (see also Table 3 on page 22).

The programming of the frequency measurement and the pulse generator is always done in the single operating mode. The subtype of the subdevices is always ME-SUBTYPE_SINGLE.

Diagram 10: Frequency input/output in single operating mode

Please read the ME-iDS manual and the ME-iDS help file (*.chm) carefully prior to programming. You can open both of these documents through the "ME-iDS Control Center" or through the Windows Start menu.

Two variables are introduced to describe the rectangular signal, and apply equally to input and output. One value indicates the period T, while the other value provides the duration of the pulse of the first phase of the period t_{1p}. For frequency measurement, the measurement starts with the first rising edge, and finishes with the next rising edge. The falling edge that lies between them defines the end of the first phase. In pulse generator mode, output normally starts with a high level, changing to the low level when the first phase has elapsed.

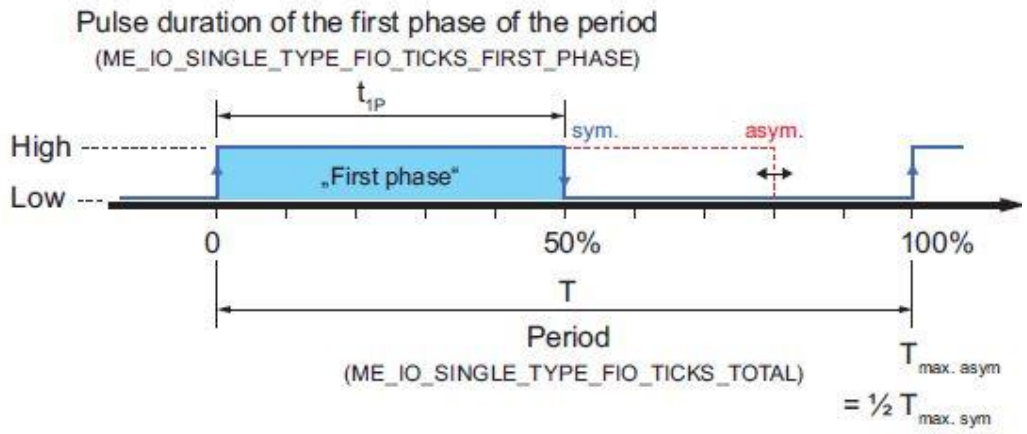

Diagram 11: Signal definition

The time reference is provided by a 66 MHz counter. It is configured using the *melOSingleConfig()* function. A period of 15.$\overline{15}$ ns follows from this, and is defined as the smallest unit of time. It is referred to below as "1 tick". The resolution for T and t_{1P} is therefore 1 tick (see also the specifications on page 32).

Note that the value of the maximum period $T_{max.}$ depends on the duty cycle. A distinction is drawn between rectangular signals with an asymmetrical duty cycle $T_{max.\ asym.}$ and a symmetrical duty cycle $T_{max.\ sym.}$ The figures for the ME-5100 are:

$T_{max.\ asym.}$ = 32.5 s (0.03 Hz); $T_{max.\ sym.}$ = 65 s (0.015 Hz)

The wiring of the frequency inputs/outputs can be found in chapter 3.5 on page 19.

4.1.2.1 Frequency Measurement

With the frequency measurement operating mode (FI="Frequency Input") you can determine the period or frequency, and the duty cycle of rectangular signals up to about 5.5 MHz. The resolution is 1 tick = 15.$\overline{15}$ ns. The measurement always starts at a rising edge. On the ME-5100, all 4 frequency measuring channels (FI_AO...3) are addressed as subdevices of type ME_TYPE_FI, subtype ME_SUBTYPE_SINGLE. Each channel can be programmed independently.

Note: If the frequency and duty cycle are the magnitudes you want, these can easily be calculated from the values returned for `<pdTime>`. The formula is:

Frequency [Hz] = 1/period [s]

Duty cycle [%] = („duration of the first phase of the period“ [s]/period [s] x 100.

4.1.2.2 Pulse Generator

In the pulse generator operating mode (FO = “Frequency Output”) you can output rectangular signals with a variable duty cycle at frequencies of up to 5.5 MHz and with a resolution of 1 tick. On the ME-5100, all 4 pulse generator channels (FO_B0...3) are addressed as a subdevices of type ME_TYPE_FO, sub-type ME_SUBTYPE_SINGLE. Each channel can be programmed independently.

The first phase of the rectangular signal is “high” by default. By setting the ME_IO_SINGLE_TYPE_FO_START_LOW flag it is also possible to start the output with a “low” level.

Note: An output channel can also be read back!

4.2 Streaming Operation Mode

4.2.1 Digital Input/Output

ME-5100	ME-5001	ME-5004
✓	-	-

The programming of the timer-controlled input/output via FIFO is carried out in the streaming operating modes. The 16 pins of subdevice 0 are specified as inputs (subdevice of type ME_TYPE_DI), while the 16 pins of subdevice 1 are specified outputs (subdevice of type ME_TYPE_DO), all of these having the sub-type ME_SUBTYPE_STREAMING.

Please observe the ME-iDS manual and the ME-iDS help file (*.chm) for the procedure. You can open both of these documents through the “ME-iDS Control Center” or through the Windows Start menu.

4.2.1.1 Stream Timer

In this operating mode the values are acquired or output under the control of a timer. A continuous transfer bandwidth between the PC and the ME-5100 of up to 30 MHz is available. This must be divided between all the subdevices (measured with a dual core computer running under Windows 7 – it will depend on your computer configuration).

4.2.1.2 Stream Trigger Sample

In this operating mode individual values can be acquired or output under the control of one or more external trigger signals. A continuous transfer bandwidth between the PC and the ME-5100 of up to 30 MHz is available. This must be divided between all the subdevices (measured with a dual core computer running under Windows 7 – it will depend on your computer configuration).

4.2.1.3 Burst Mode

In what is known as the "burst mode" you can read a maximum of 8192 data words from subdevice 0, or output them on subdevice 1, at a guaranteed rate of 33 MS/s. The transfer to and from the PC is carried out at a maximum of 30 MHz.

4.2.1.4 Wraparound Mode

This option is used for the repeated output of one and the same data buffer on subdevice 1.

Note: When no more than 8192 values are to be output for an indefinitely long period at an output rate of at most 7.4 MS/s (at least 9 ticks), this is done on firmware level of the ME-5100 without loading the host computer.

4.2.1.5 External Trigger

The trigger conditions for starting and stopping the streaming operating mode can be selected very flexibly. It is thus possible to enable one or more trigger inputs individually, with specification of the desired trigger edge (rising, falling, or any). All the enabled trigger inputs are logically ORed together. This means that the first edge to arrive that meets the trigger condition starts or stops the input/output operation, according to the selected operation mode (stream timer or stream trigger sample). In other words, any change of the bit-pattern can be used as a trigger event for the subdevice concerned.

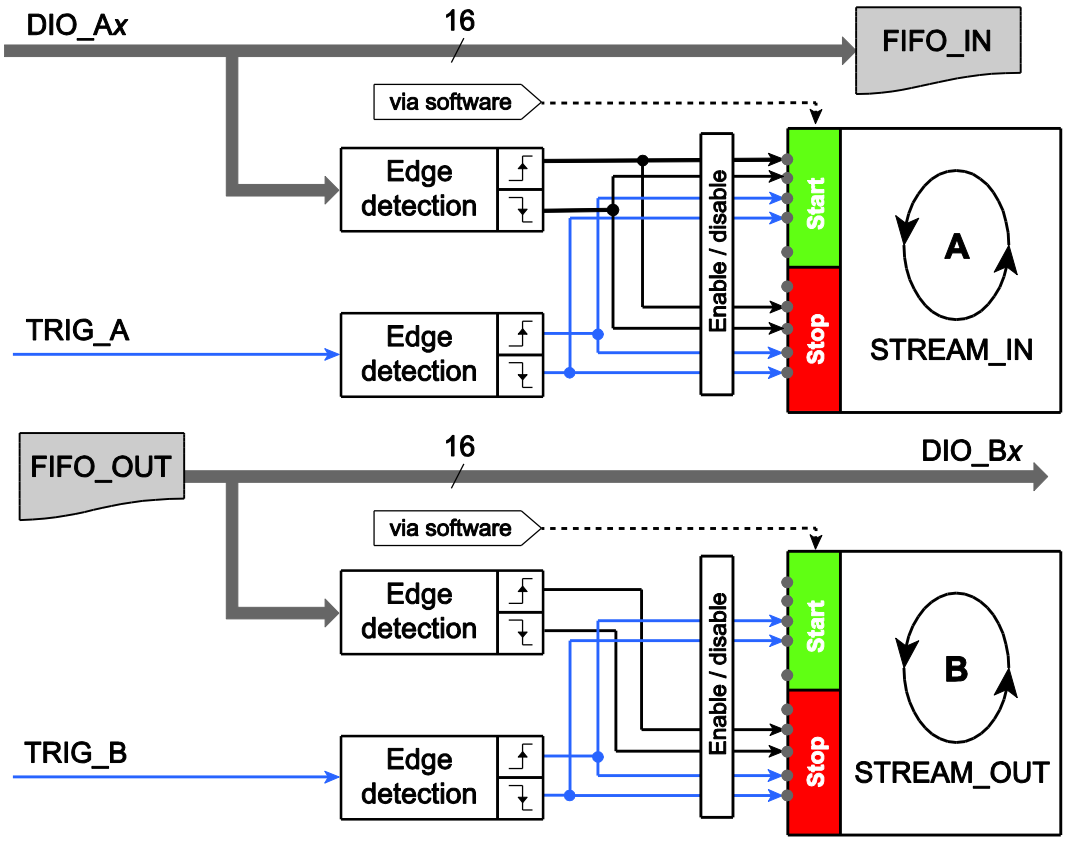

Diagram 12: Trigger in streaming mode

Trigger signals from TRIG_A or the inputs DIO_A0...15 can be used for subdevice 0, while for subdevice 1 the trigger signals from TRIG_B and any of the inputs DIO_B0..15 can be used (see Diagram 12 on page 29).

4.3 Interrupt Operation

ME-5100	ME-5001	ME-5004
✓	-	✓

On the ME-5100 you can monitor the bit-pattern of a digital-I/O port configured as an input for changes in one or more masked bits. As soon as the first edge that meets the trigger condition arrives, an interrupt is generated and passed directly to the PC. A digital port used for bit-pattern detection must be of type ME_TYPE_DIO or ME_TYPE_DI.

The programming is carried out in the single operating mode.

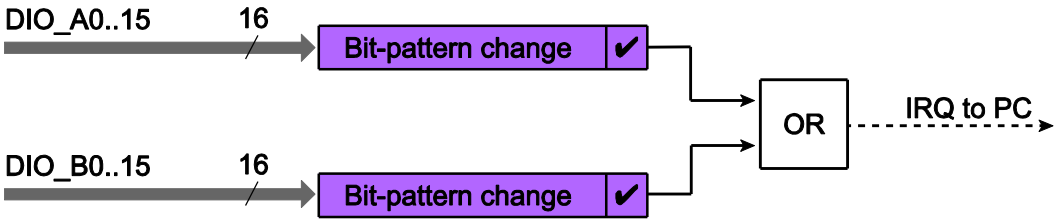

Diagram 13: Interrupt option

Note: TRIG_A and TRIG_B can also be used as interrupt inputs with the aid of the property functions (see the ME-iDS help file).

Please observe the ME-iDS manual and the ME-iDS help file (*.chm) for the **procedure**. You can open both of these documents through the "ME-iDS Control Center" or through the Windows Start menu.

4.3.1 Bit-pattern Change

In the bit-pattern change mode, one or more bits that are to be monitored for a change of state can be defined (masked). A 32-bit-wide argument per subdevice contains the mask. For each input pin both one bit for rising edge and one bit for falling edge is available. If the state of at least one bit masked with a "1" changes (0 ⟶ 1 or 1 ⟶ 0), an interrupt is issued (see diagram 14 on page 31).

In what is known as the "extended format" of interrupt handling (see the ME-iDS manual), two bits are available for the interrupt status of each pin. One is for the rising edge, and one for the falling edge. The bits for the falling edges are assigned to the bit b15…0, while the bits for the rising edges are assigned to the bits b31…16.

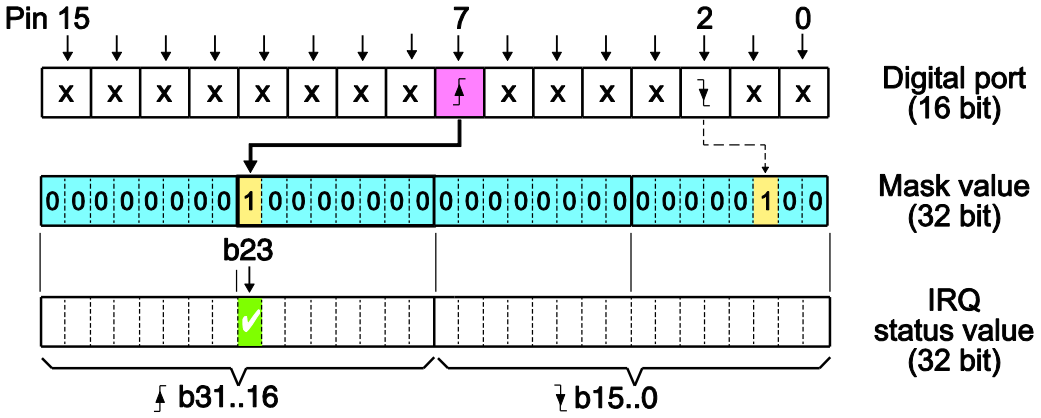

Diagram 14: Bit-pattern change

Example (see diagram 14):

By writing the value 00800004 Hex as a mask value (see parameter `<iIrqArg>` of the function *melOlrqStart(),* bit 2 is monitored for a falling edge, and bit 7 for a rising edge. A rising edge now is to arrive at bit 7, so that an interrupt is issued and in the interrupt status value bit b23 returns "1". Any edges that might arrive at pins labelled with an "X" are ignored. Only the change in state of a pin whose edge is set to "1" in the parameter `<iIrqArg>` can issue an interrupt.

The interrupt event is evaluated with the function *melOlrqWait().* We recommend using what is known as the "extended format" to obtain detailed information about the triggering edge.

5 Appendix

A Specification

PC Interface

PCI-Express bus	32 bit, 33 MHz, 3.3 V, PCI-Express x 1 specification version 2.0
CompactPCI bus	32 bit, 33 MHz, 5 V, PICMG 2.0 R3.0
Plug&Play	is fully supported

Digital Input/Output

Measured Quantity/criterion	**Condition/ Explanation**	**Value**
Ports	subdevice 0 single mode operation	16-bit-bidirectional
	subdevice 0 streaming mode operation	16-bit input port
	subdevice 1 mode operation	16-bit bidirectional
	subdevice 1 streaming mode operation	16-bit output port
Operating modes	single	software-triggered reading/writing
	stream timer	timer-controlled reading/writing of the values via FIFO
	stream trigger sample	trigger-controlled reading/writing of the values via FIFO
	interrupt	monitoring the digital ports for a change in the bit-pattern
FIFO size	FIFO_IN	8192 values (16-bit-wide)
	FIFO_OUT	8192 values (16-bit-wide)
Transfer rate in streaming mode	between the ME-5100 and PC	max. 25 MHz (cPCI) resp. 30 MHz (PCIe) (system-dependent)

Input/output rate in streaming mode	continuous (total for both ports)	max. 25 MS/s (cPCI) resp. 30 MS/s (PCIe) (system-dependent)
	„burst"-option (input/output of up to 8192 values)	max. 33 MS/s per channel, transfer: see transfer rate
	„wraparound"-option (total for both ports)... if $f_{max.}$ <7.4 MS/s and the number of values ≤ 8192 and the number of repetitions is „infinite"	max. 25 MS/s (cPCI) resp. 30 MS/s (PCIe) (system-dependent)
		max. 7.4 MS/s (without loading the host PC)
Timer (CHAN time)*	programmable in steps 15. $\overline{15}$ ns (1 tick)	30.$\overline{30}$ ns ...65 s (2..FFFFFFF Hex ticks)
External trigger inputs		TRIG_A, TRIG_B, DIO_Ax, DIO_Bx
External trigger edges		rising, falling, any
Output level: U_{OL}	at I_{OUT} = 24 mA	max. 0.5 V
$U_{OH\ 3.3V}$	at I_{OUT} = -24 mA	min. 2.4 V
$U_{OH\ 5V}$	at I_{OUT} = -24 mA	min. 2.4 V
Input level: U_{IL}	at Vcc =3.3 V or 5 V	max. 0.8 V
$U_{IH\ 3,3V}$	at Vcc = 3.3 V	min. 2 V
$U_{IH\ 5V}$	at Vcc = 5 V	min. 2 V
Input current:	I_{IN}	±1 µA
Output current: I_{OUT}	per pin	max. 24 mA
Reference ground		PC ground (GND_PC)

*Due to the nature of the system, boards that are not fitted into the ME Synapse do not reach the full sampling rate. The sampling rate that can actually be achieved depends heavily on the capacity of your computer and on the number of USB devices connected.

Frequency Input/Output

Availability	alternative subdevice configuration via ME-iDC
Signal form	rectangular

Frequency Measuring Channels

Measured Quantity/Criterion	**Condition/ Explanation**	**Value**
Reference ground		PC ground (GND_PC)
Number of channels	(FI_A0...3)	4 inputs (TTL)
Input level		see digital I/O
Input current		see digital I/O
Period (T)	$T_{min.} = T_{min.asym.} = T_{min.sym.}$ $T_{max.asym}$ $T_{max.sym}$	181. $\overline{81}$ ns (5.5 MHz) 32.5 s (0.03 Hz) 65 s (0.015 Hz)
Duty cycle	variable, depending on T	measurable in steps of 1 tick
Resolution	1 tick	15.$\overline{15}$ ns
Accuracy		$\pm$15.$\overline{15}$ ns
Operating modes		Single

Pulse Generator Channels

Measured Quantity/Criterion	**Condition/ Explanation**	**Value**
Reference ground		PC ground (GND_PC)
Number of channels	(FI_B0...3)	4 outputs (TTL)
Output level		see digital I/O
Period (T)	$T_{min.} = T_{min.asym.} = T_{min.sym.}$ $T_{max.asym}$ $T_{max.sym}$	181.$\overline{81}$ ns (5.5 MHz) 32.5 s (0.03 Hz) 65 s (0.015 Hz)
Duty cycle	variable, depending on T	adjustable in steps 1 tick
Resolution	1 tick	15.$\overline{15}$ ns
Accuracy		$\pm$15.$\overline{15}$ ns
Operating modes		single

Interrupt

Measured Quantity/Criterion	Condition/Explanation	Value
Interrupt sources	passed directly to the PC	bit-pattern change

General Data

Measured Quantity/Criterion	Condition/Explanation	Value
Power supply	CompactPCI	+5 V (via PCI bus)
	PCI-Express	+3.3 V (via PCIe bus) +5 V (via Molex plug from PC power supply unit)
Current consumption	CompactPCI	0.8...1.2 A (full load)
	PCI-Express	0.8...1.2 A (full load)
Board dimensions (without mounting bracket and connector)	PCI-Express	162 mm x 98 mm
	CompactPCI	3 HE CompactPCI board
Connections	ST1	78-pin D-Sub female socket
		IDC connectors for plug-on board
Operating temperature		0...70 °C
Storage temperature		-40...100 °C
Air humidity		20...55 % (non-condensing)
Certification	CE	

B Pinout

Legend for pinouts:

Pin-name	Function
DI_A0..15	digital input/output (subdevice 0)
DO_B0..15	digital input/output (subdevice 1)
TRIG_A	digital trigger input for subdevice 0
TRIG_B	digital trigger input for subdevice 1
DATA_VALID	output indicating the validity of the data at outputs DIO_B0...15 in streaming mode
L_CLK	local clock output (66 MHz). Not connected by default – if necessary, can be brought to the connector (ST1) by fitting R55 (see page 16 for position of R55).
FI_A0...3	frequency measuring inputs (alternative configuration)
FO_B0...3	pulse generator outputs (alternative configuration)
GND_PC	common ground (=PC ground)
„Reserved“	pin reserved for extensions
	These pins must not be connected. Otherwise the board may be irreversibly damaged!

B1 78-pin D-Sub (ST1) – ME-5100

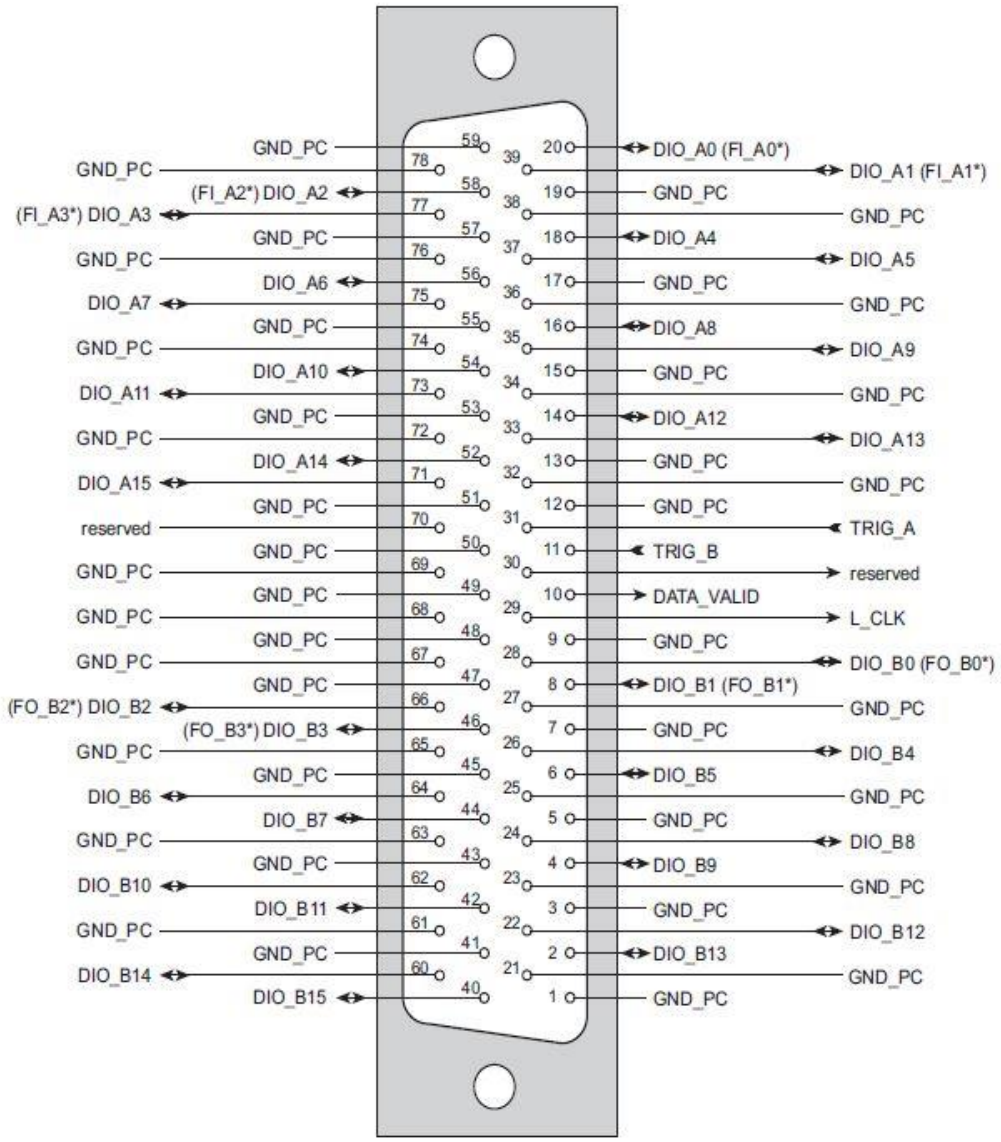

Diagram 15: 78-pin D-Sub socket ME-5100 (ST1)

*Use as a frequency measuring input or pulse generator. Output is only possible after appropriate configuration using ME-iDC. The other pins of the relevant digital port (DIO_A4…15 or DIO_B4…15) can then no longer be used for digital input/output.

Note that the unused pins DIO_B4…15 are connected to ground for frequency output (FO)!

B2 Adapter Board – ME AB-D78/IDC

The optional ME AB-D78/IDC adapter board (78-pin D-Sub connector to male connector) carries a ground line between every signal line. Used together with ribbon cables, you can thus minimize the crosstalk.

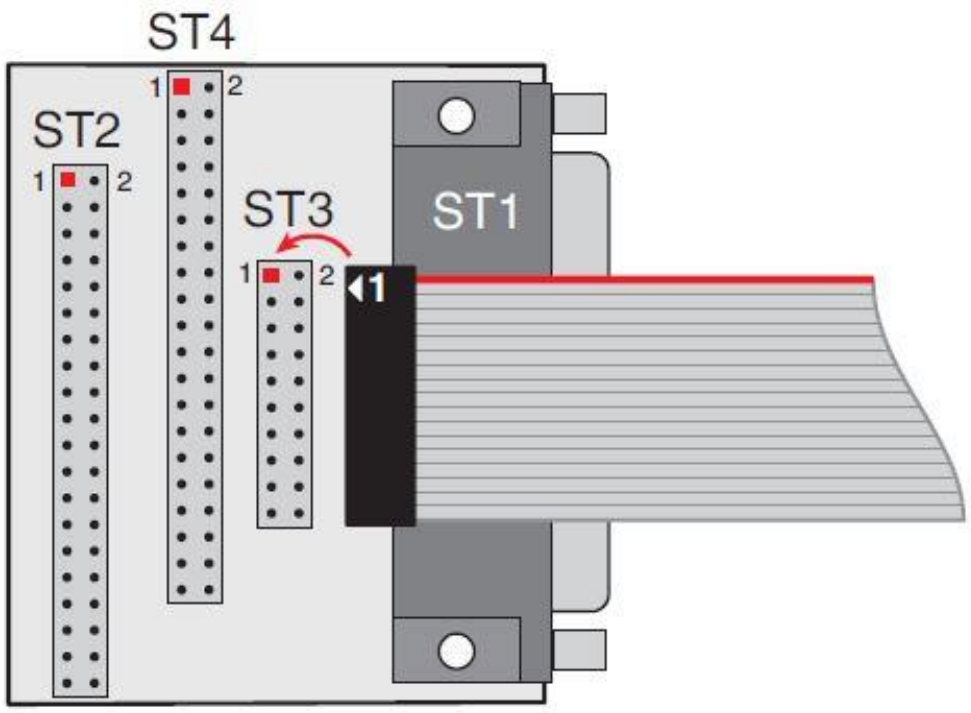

Diagram 16: Adapter board – ME AB-D78/IDC (plan view)

The pin assignment of the 78-pin D-Sub connector ST1 corresponds to ST1 on the ME-5100 (see Diagram 15).

Additional signals (ST3):

ST3 Pin	Name (ST1 pin)	ST3 Pin	Name (ST1 pin)
1	TRIG_A (31)	2	GND_PC
3	TRIG_B (11)	4	GND_PC
5	reserved (30)	6	GND_PC
7	DATA_VALID (10)	8	GND_PC
9	L_CLK (29)	10	GND_PC
11	reserved (70)	12	GND_PC
13	GND_PC	14	GND_PC
15	GND_PC	16	GND_PC

17	GND_PC	18	GND_PC
19	GND_PC	20	GND_PC

Table 6: Control line pin assignments (ST3)

Subdevice 0 (ST4)

ST4 Pin	Name (ST1 pin)	ST4 Pin	Name (ST1 pin)
1	DIO_A0/FI_A0 (20)	2	GND_PC
3	DIO_A1/FI_A1 (39)	4	GND_PC
5	DIO_A2/FI_A2 (58)	6	GND_PC
7	DIO_A3/FI_A3 (77)	8	GND_PC
9	DIO_A4 (18)	10	GND_PC
11	DIO_A5 (37)	12	GND_PC
13	DIO_A6 (56)	14	GND_PC
15	DIO_A7 (75)	16	GND_PC
17	DIO_A8 (16)	18	GND_PC
19	DIO_A9 (35)	20	GND_PC
21	DIO_A10 (54)	22	GND_PC
23	DIO_A11 (73)	24	GND_PC
25	DIO_A12 (14)	26	GND_PC
27	DIO_A13 (33)	28	GND_PC
29	DIO_A14 (52)	30	GND_PC
31	DIO_A15 (71)	32	GND_PC
33	GND_PC	34	GND_PC
35	GND_PC	36	GND_PC
37	GND_PC	38	GND_PC
39	GND_PC	40	GND_PC

Table 7: ST4 pin assignments

Subdevice 1 (ST2)

ST2 Pin	Name (ST1 pin)	ST2 Pin	Name (ST1 pin)
1	DIO_B0/ (FO_B0)	2	GND_PC
3	DIO_B1/(FO_B1)	4	GND_PC
5	DIO_B2/(FO_B2))	6	GND_PC
7	DIO_B3/(FO_B3))	8	GND_PC

9	DIO_B4	10	GND_PC
11	DIO_B5	12	GND_PC
13	DIO_B6	14	GND_PC
15	DIO_ B7	16	GND_PC
17	DIO_ B8	18	GND_PC
19	DIO_ B9	20	GND_PC
21	DIO_ B10	22	GND_PC
23	DIO_ B11	24	GND_PC
25	DIO_ B12	26	GND_PC
27	DIO_ B13	28	GND_PC
29	DIO_ B14	30	GND_PC
31	DIO_ B15	32	GND_PC
33	GND_PC	34	GND_PC
35	GND_PC	36	GND_PC
37	GND_PC	38	GND_PC
39	GND_PC	40	GND_PC

Table 8: ST2 pin assignments

C Accessories

We recommend to use high-quality connector cables with single-shielded lines per channel.

For further accessories please refer to the current Meilhaus Electronic catalog and the internet:
www.meilhaus.de/en/pc-boards/accessories/

D Technical Questions

D1 Hotline

Should you have questions or inquiries concerning your Meilhaus device, please contact us:

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