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SPIRIT OF EXCELLENCE

TECHNICAL

DESCRIPTION

MSX-E3701 and MSX-E3700

Ethernet system for length measurement

DIN EN ISO 9001:2008 certified

Edition: 03.02-09/2014

Product information
This manual contains the technical installation and important instructions for correct commissioning and usage, as well as production information according to the current status before printing.
The content of this manual and the technical product data may be changed without prior notice. ADDI-DATA GmbH reserves the right to make changes to the technical data and the materials included herein.

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Warning!

The following risks result from the improper implementation of the Ethernet system and from use contrary to the regulations:

Personal injury

Damage to the Ethernet system, the PC and peripherals

Pollution of the environment.

- Protect yourself, others and the environment!
- Read the safety precautions (yellow leaflet) carefully!

  If this leaflet is not enclosed with the documentation, please contact us and ask for it.
- Observe the instructions of this manual!

  Make sure that you do not forget or skip any step!
  We are not liable for damages resulting from the wrong use of the Ethernet system.
- Pay attention to the following symbols:

NOTICE!
Designates hints and other useful information.

NOTICE!
Designates a possibly dangerous situation.
If the instructions are ignored, the Ethernet system, the PC and/or peripherals may be **destroyed**.

WARNING!
Designates a possibly dangerous situation.
If the instructions are ignored, the Ethernet system, the PC and/or peripherals may be **destroyed** and persons may be **endangered**.

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Chapter overview

In this manual, you will find the following information:

Chapter	Content
1	Important information on the application, the user and on handling the MSX-E system as well as safety precautions
2	Brief description of the MSX-E system (functions, features, block diagram)
3	Information on inductive displacement transducers
4	Exceptions with the **MSX-E3700** (pin assignments and cascading)
5	Function description (transducer inputs) including pin assignments
6	Description of the function-specific pages of the MSX-E web interface
7	Description of the acquisition modes (Auto-refresh and Sequence modes)
8	List of technical data and limit values of the MSX-E system
9	Appendix with glossary and index
10	Contact and support address

1 Definition of application, user, handling

1.1 Definition of application

1.1.1 Intended use

The Ethernet systems **MSX-E3701** and **MSX-E3700** for the acquisition, processing and transferring of displacement transducer signals are intended for the connection to a network, which is used as electrical equipment for measurement, control and laboratory pursuant to the norm EN 61010-1 (IEC 61010-1).

1.1.2 Usage restrictions

The Ethernet systems **MSX-E3701** and **MSX-E3700** must <u>not</u> be used as safety-related parts (SRP).

The Ethernet systems **MSX-E3701** and **MSX-E3700** must <u>not</u> be used for safety-related functions.

The Ethernet systems **MSX-E3701** and **MSX-E3700** must <u>not</u> be used in potentially explosive atmospheres.

The Ethernet systems **MSX-E3701** and **MSX-E3700** must <u>not</u> be used as electrical equipment according to the Low Voltage Directive 2006/95/EC.

1.1.3 Limits of use

All safety information and the instructions in the manuals must be followed to ensure proper intended use.

Uses of the Ethernet system beyond these specifications are considered as improper use.
The manufacturer is not liable for damages resulting from improper use.

The Ethernet system must remain in its anti-static packaging until it is installed.

Please do not delete the identification numbers of the Ethernet system or the warranty claim will be invalid.

1.2 Safety precautions

1.2.1 Current sources

All connected devices must be supplied from current sources that comply with SELV according to IEC 60950 or EN 60950; or PELV according to IEC 60204-1 or EN 60204-1.

1.2.2 Degrees of protection

NOTICE!
The protection according to the defined degree of protection (see Chapter 8.4) is only given if the openings are protected with adequate protection caps or connectors.

If you are not sure, please contact us:

Phone: +49 7229 1847-0

E-mail: info@addi-data.com

1.2.3 Cables

The cables must be installed safely against mechanical load.

1.2.4 Housing

The housing must not be opened. It may only be opened by persons who have been authorised by ADDI-DATA.

1.3 User

1.3.1 Qualification

Only persons trained in electronics are entitled to perform the following works:

- Installation
- Commissioning
- Use
- Maintenance.

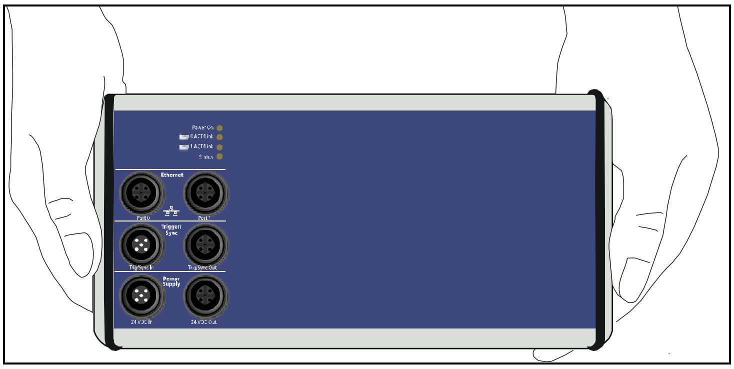
1.3.2 Country-specific regulations

Do observe the country-specific regulations regarding

- the prevention of accidents
- electrical and mechanical installations
- Electromagnetic compatibility (EMC).

1.4 Handling of the Ethernet system

Fig. 1-1: Correct handling



- Hold the Ethernet system by the bottom and the grey sides.
- Do not hold the Ethernet system by the connectors!

1.5 Questions and updates

You can send us any questions by e-mail or call us:

E-mail: info@addi-data.com
Phone: +49 7229 1847-0.

Manual and software download from the Internet

The latest versions of the technical manual and the standard software for the Ethernet systems **MSX-E3701** and **MSX-E3700** can be downloaded for free at:

www.addi-data.com

NOTICE!
Before using the Ethernet system or in case of malfunction during operation, check if there is an update (manual, driver, firmware) available on our website or contact us directly.

2 Brief description

In this chapter, the functions and features of the Ethernet systems **MSX-E3701** and **MSX-E3700** are described in brief. Furthermore, you will find a general block diagram that applies to both MSX-E systems.

2.1 Functions and features

With the intelligent Ethernet systems **MSX-E3701** and **MSX-E3700**, 4, 8 or 16 HB, LVDT, Mahr or Knäbel displacement transducers can be acquired with 24-bit resolution.
The 4-input version of the **MSX-E3701** is also available with a digital 24 V output with compare logic.

Measurement sequences on multiple systems can be started simultaneously over an external trigger (synchronisation). The individual systems can be configured and the acquisition can be started over either the integrated web interface or SOAP or Modbus commands. These interfaces also enable transducer data to be accessed.

Over an integrated Ethernet switch, the systems can be cascaded with other MSX-E systems. This also applies to the voltage supply and the trigger/synchro line, which facilitates wiring between the single systems.

The Ethernet system **MSX-E3701** is mounted in a robust EMC-protected metal housing, which complies with the degree of protection IP 65. In this way, the Ethernet system is able to cope with daily stresses and strains such as current peaks, vibrations, dirt or extreme temperatures. Moreover, it can be used in the extended operating temperature range from -40 °C to +85 °C and is equipped with numerous protective circuits. The "Status" LED provides for a quick and easy error diagnosis.

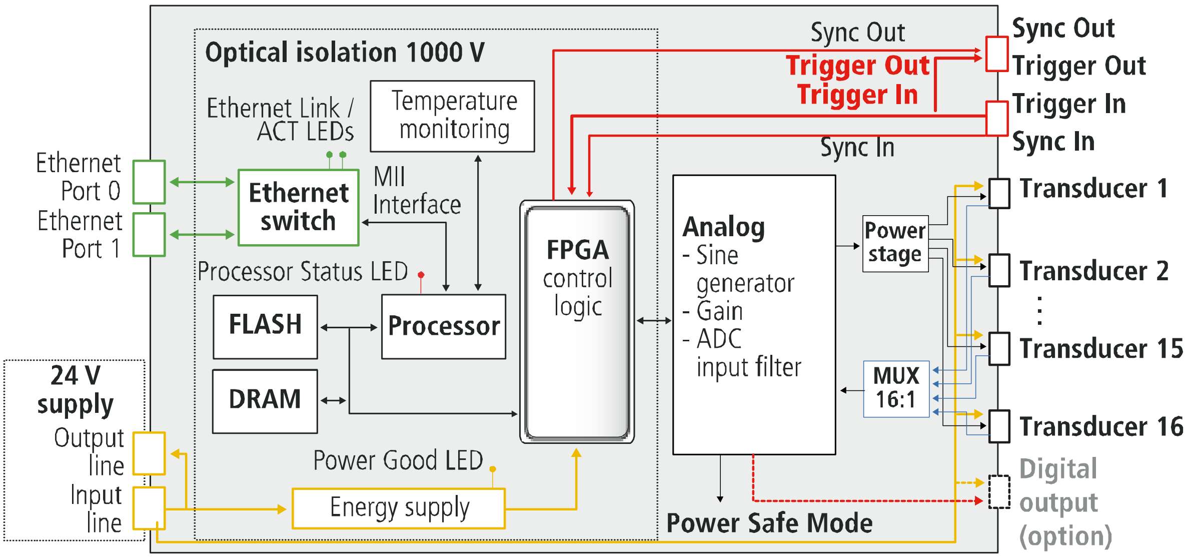
The electronics are no longer in the computer itself but in an external housing connected to the computer via Ethernet. As the Ethernet system is attached directly to the signal generator (measuring point), the measurements are no longer affected by long cables. The length of the (Ethernet) connection cable from the Ethernet system to the computer may be up to 150 m. The systems must be supplied with external voltage (24 V).

Features:

- Acquisition of 4, 8 or 16 inductive displacement transducers (HB, LVDT, Mahr, Knäbel)
- **MSX-E3701-x-4:** digital 24 V output with compare logic for input 0
- Acquisition: can be controlled by means of an external trigger (digital 24 V trigger input)
- Web interface to configure, control and monitor the acquisition
- Data access via SOAP or Modbus (always TCP or UDP)
- Optical isolation
- Degree of protection: IP 65 **(MSX-E3701)** or IP 40 **(MSX-E3700)**
- Cascadable; synchronisation in the µs range
- Extended operating temperature range from -40 °C to +85 °C

2.2 Block diagram

Fig. 2-1: MSX-E3701 and MSX-E3700: Block diagram



3 Displacement transducers

In this chapter, the properties of the different displacement transducers are described in more detail. This should help you to find the right transducer for your measuring system and to identify and prevent possible measuring errors in advance.

3.1 Inductive transducers

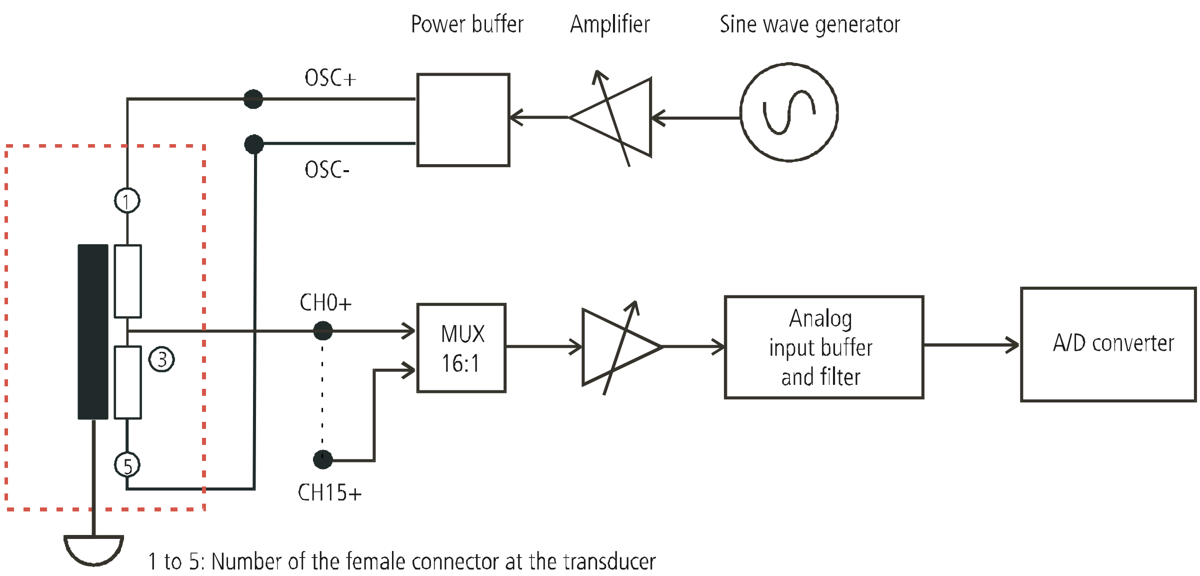
Inductive transducers are used for precise measurement of a defined distance. They are displacement/ voltage sensors, whose output voltage changes linearly along with the moving magnetic core (ferrite).

The magnetic core moves according to a straight line in a transformer, which consists of a central primary coil and two external secondary coils (cylindrical windings). The power buffer provides an AC voltage source to the primary coil. The secondary voltage changes according to the position of the magnetic core.

3.1.1 Half-bridge transducers

A half-bridge transducer consists of two inductive coils (windings). These are fed directly with two sinusoidal voltage signals, i. e. a positive and a negative oscillator voltage.
A measuring bolt moves along the two coils with a ferromagnetic core. Depending on its position, this core changes the voltages in the two coils. The measuring bolt thus functions like a variable voltage distributor. The change in voltage at the coils results in the sinusoidal measurement signal to be evaluated.

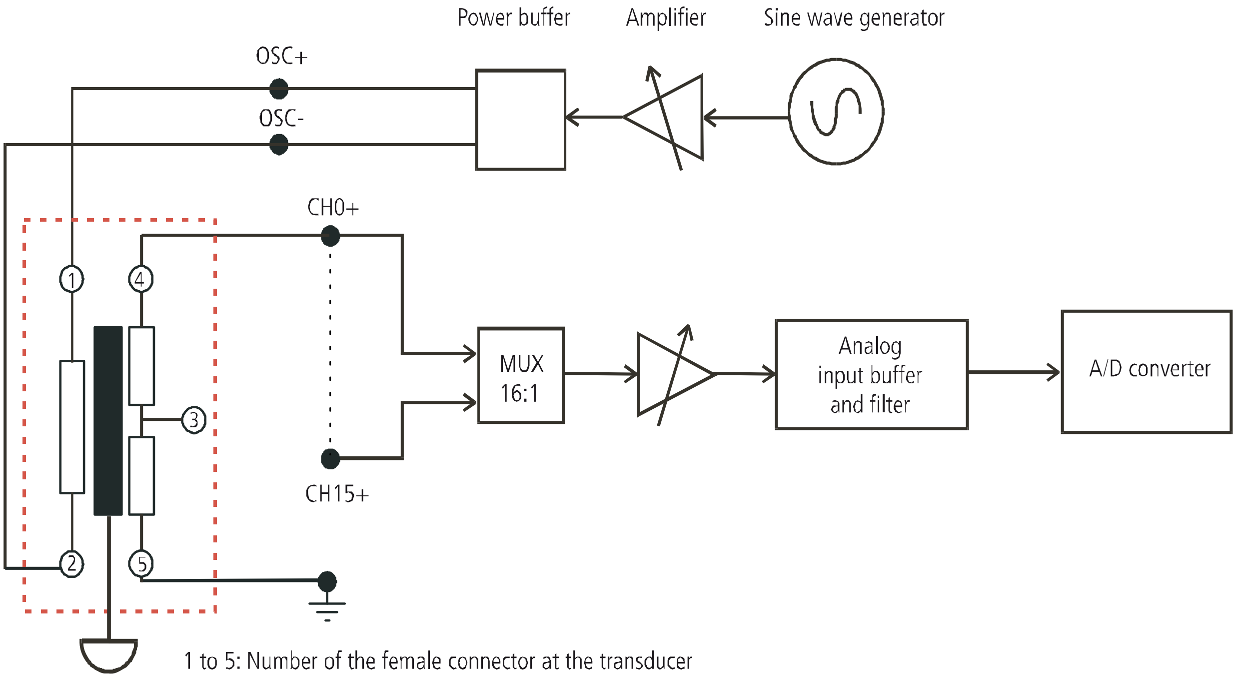
Fig. 3-1: Half-brige transducer



3.1.2 LVDT transducers

An LVDT transducer features three coils: a primary coil and two secondary coils. These coils are positioned concentrically around the mobile core and form two symmetrical transformers with respect to the electrical zero point of the transducer.
The primary coil is fed by two sinusoidal voltage signals, i. e. a positive and a negative one, whereas both secondary coils (switched in phase opposition) produce an electrical signal proportional to the measured displacement.

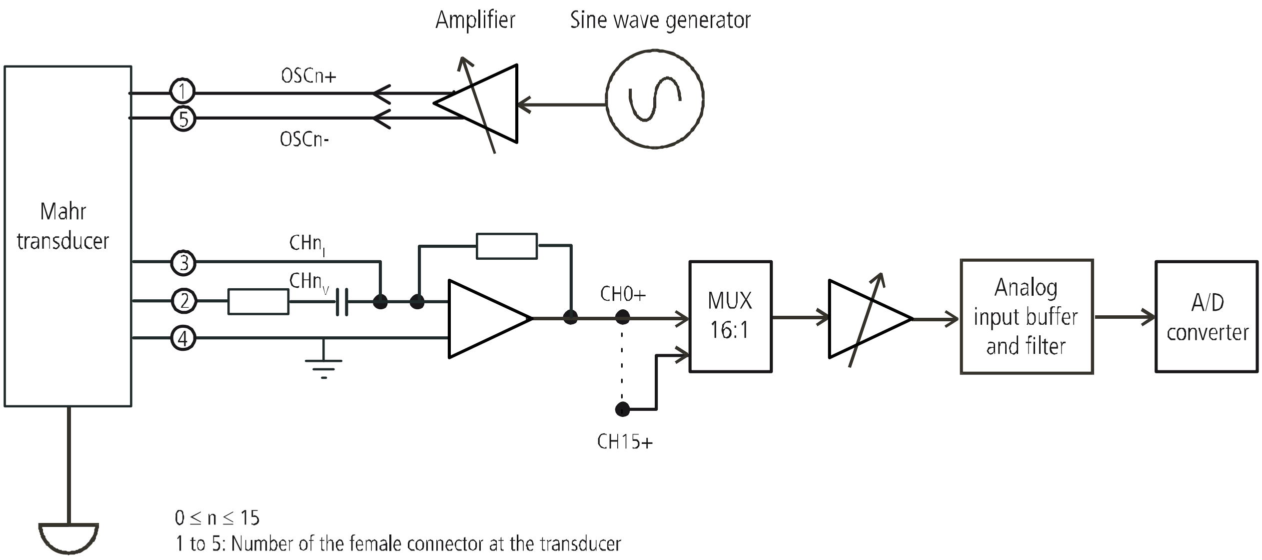
Fig. 3-2: LVDT transducer



3.1.3 Mahr transducer

A Mahr transducer is a highly linear patented VLDT sensor (Very Linear Differential Transducer).

Fig. 3-3: Mahr transducer



3.2 Transducer properties

In the **ConfigTools** program, in the User database, the following properties of a transducer can be defined:

- Name
- Type
- Nominal frequency (Hz)
- Impedance (ohms)
- Nominal supply voltage V_{eff} (V_{rms})
- Sensitivity (mV/V/mm)
- Measurement range (mm).

4 MSX-E3700: Exceptions

4.1 Pin assignment

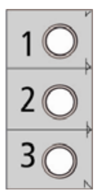
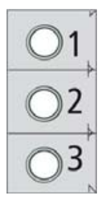
4.1.1 Ethernet

Table 4-1: Pin assignment (MSX-E3700): Ethernet Port 0 and Port 1

	Ethernet Port 0		Ethernet Port 1
Pin No.	**RJ45 connector**	**Pin No.**	**RJ45 connector**
1	TD0+	9	TD1+
2	TD0-	10	TD1-
3	RD0+	11	RD1+
4	not connected	12	not connected
5	not connected	13	not connected
6	RD0-	14	RD1-
7	not connected	15	not connected
8	not connected	16	not connected

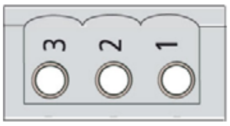
4.1.2 Trigger/Synchro

Table 4-2: Pin assignment (MSX-E3700): Trigger/Synchro

	Trigger	Synchro	
Pin No.	**3-pin terminal, 3.81 mm grid**	**3-pin terminal, 3.81 mm grid**	**Note**
1	Trigger input +	Synchro In	twisted pair
2	Trigger input -	Synchro Out	
3	Ground	Ground	
			

4.1.3 Voltage supply

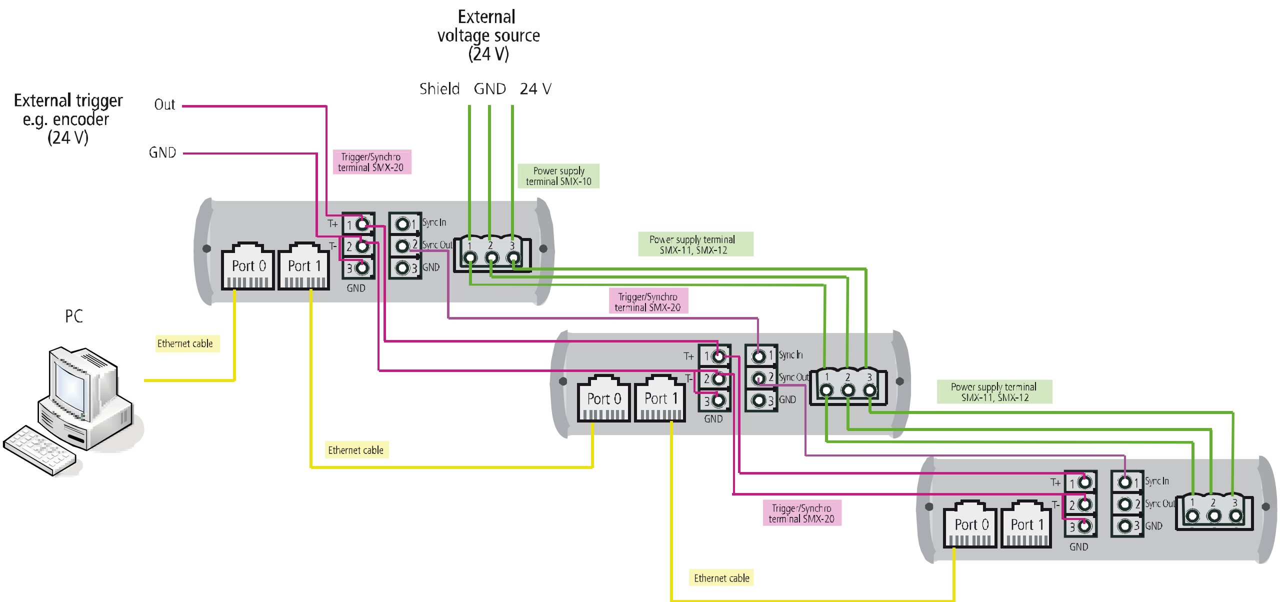
Table 4-3: Pin assignment (MSX-E3700): Voltage supply

	Power Supply In	**Power Supply Out**
Pin No.	**3-pin terminal, 5.08 mm grid**	**3-pin terminal, 5.08 mm grid**
1	24 V	24 V
2	Ground	Ground
3	Shield	Shield
		

4.2 Cascading

In order to connect multiple **MSX-E3700** to one another, you have to proceed as follows:

Fig. 4-1: MSX-E3700: Cascading



5 Function description: Transducer inputs

The Ethernet systems **MSX-E3701** and **MSX-E3700** have 4, 8 or 16 single-ended inputs for inductive displacement transducers.

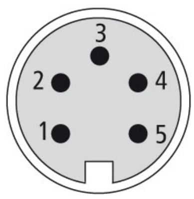
5.1 Pin assignment

To each M18 female connector, one displacement transducer can be connected. The differential transducer supply consists of OSC+ and OSC-.

NOTICE!
With the Ethernet systems MSX-E3701 and MSX-E3700, only one type of transducer can be connected to each system.

Table 5-1: Pin assignment: Transducer inputs

	Half-bridge	LVDT	Mahr
Pin No.	**Female connector, 5-pin, M18**	**Female connector, 5-pin, M18**	**Female connector, 5-pin, M18**
1	OSC+	OSC+	OSC+
2	Ground	OSC-	Voltage input (transducer n)
3	Transducer signal	not connected	Current input (transducer n)
4	not connected	Transducer signal	Ground
5	OSC-	Ground	OSC-



OSC = oscillator voltage = supply voltage

Mahr version: compatibility code M

To avoid any confusion, a red ring is placed on the cable connector in addition to the letter code on the transducer.

5.2 Acquisition principle

The Ethernet system **MSX-E3701** or **MSX-E3700** provides all signals required for the supply of the inductive transducers.
By means of a sine wave generator, the primary side of the transducer is supplied. The output frequency and the gain of the sine wave generator can be programmed through software. The transducers are supplied via a differential power buffer.

The incoming measurement signals are led over a multiplexer:

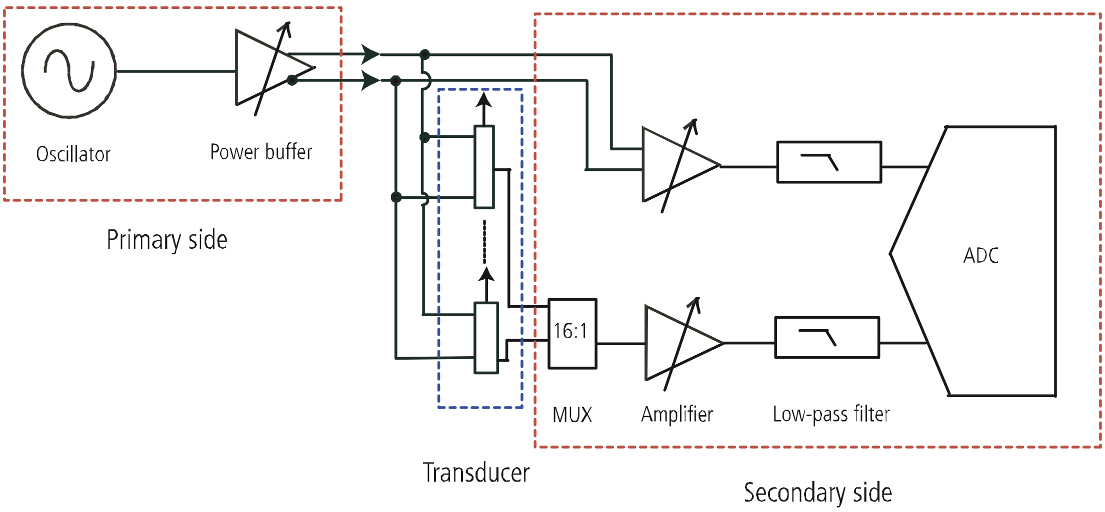
Table 5-2: Multiplexers

	Multiplexer
MSX-E370x-4	4:1
MSX-E370x-8	8:1
MSX-E370x-16	16:1

The measurement signal passes through a software-programmable amplifier. Then the signal is led over an analog low-pass filter and acquired by a 24-bit ADC.

Parallel to the measurement signal, the supply signal of the transducer is monitored via a second input at the ADC.

Fig. 5-1: MSX-E3701 and MSX-E3700: Acquisition principle



5.3 Calibration

The gain and the offset error of the **MSX-E3701** or **MSX-E3700** can be corrected by means of the **ConfigTools** program. When the MSX-E system is booting up, the calibration values are read from the flash and uploaded to the system.

5.4 Diagnostic function

Each input has a diagnostic function in order to detect errors like a short-circuit or line break.

If one of these errors occurs, the respective input is switched off.
As soon as the short-circuit or line break has been eliminated, a rearm has to be carried out to reactivate the input (see also Chapter 6.1.1). This means that the input is set to the status value that was programmed before the error occurred. A new value can only be defined after the rearm event.

5.4.1 Diagnostic function (Mahr version)

NOTICE!
As to the Mahr version, a short-circuit or line break cannot be detected by all diagnostic functions.

Using the function "MX370x__TransducerTestPrimaryShortCircuit", you can check if one of the connected transducers causes a short-circuit on the primary side.

The function "MX370x__TransducerTestSecondaryConnection" can be used to check if there is an error at the transducers.
In case of a short-circuit relating to ground or a line break on the primary or secondary side of the transducer type Mahr **13xx**, this function indicates an error.
As the Mahr types **PM2xxx** use two secondary lines, an error is only indicated if both primary lines are broken or at least one primary line is short-circuited relating to ground or if both secondary lines are broken or short-circuited.

The following functions cannot be used for the Mahr version:

- MX370x__TransducerInitPrimaryConnectionTest
- MX370x__TransducerTestPrimaryConnection
- MX370x__TransducerTestSecondaryShortCircuit.

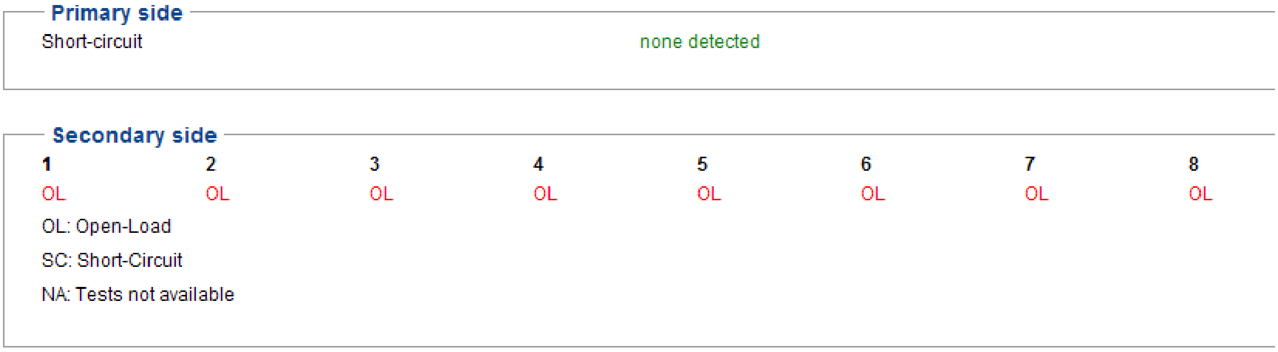
6 Web interface: Quick access to the MSX-E system

6.1 "I/O Configuration"

In this manual, the function-specific pages of the **MSX-E3701** or **MSX-E3700** web interface, which are located under the menu item "I/O Configuration", are described.
For further information on the MSX-E web interface, please refer to the general manual of the MSX-E systems (see PDF link).

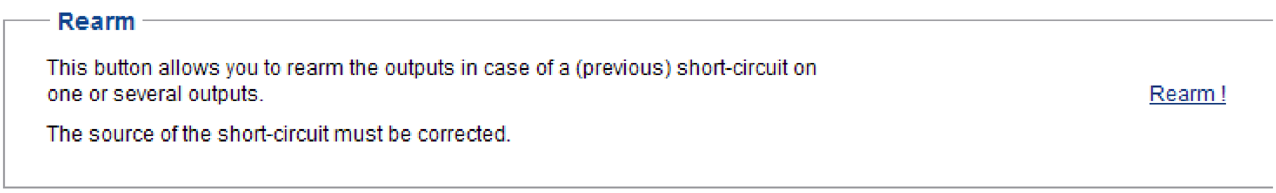
6.1.1 Menu item "Diagnostic"

Fig. 6-1: I/O Configuration: Diagnostic



If a short-circuit or line break occurs at the transducer inputs, this will be specified on this page.
Please find further information on the diagnostic function in Chapter 5.4 of this manual.

Fig. 6-2: Diagnostic: Rearm



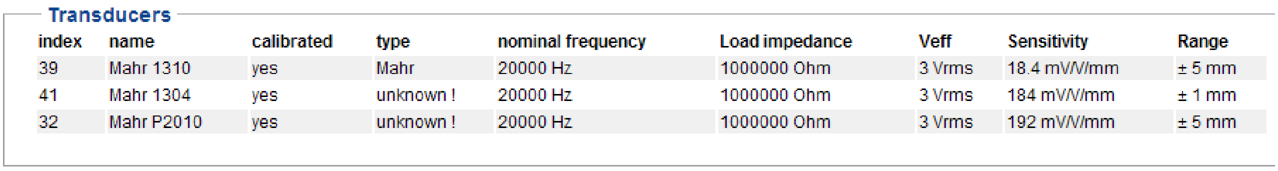
After a short-circuit or line break occurred, the required rearm (see Chapter 5.4) can be carried out via the correspondent button.

Fig. 6-3: Diagnostic: Refresh

The diagnostic overview should be refreshed in case of transducer changes, errors such as a short-circuit or after a certain time.

6.1.2 Menu item “Database”

Fig. 6-4: Database: Transducers



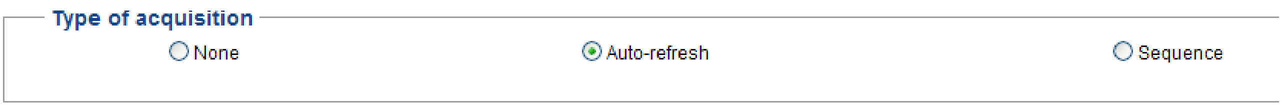
Transducers

index	name	calibrated	type	nominal frequency	Load impedance	Veff	Sensitivity	Range
39	Mahr 1310	yes	Mahr	20000 Hz	1000000 Ohm	3 Vrms	18.4 mV/V/mm	± 5 mm
41	Mahr 1304	yes	unknown !	20000 Hz	1000000 Ohm	3 Vrms	184 mV/V/mm	± 1 mm
32	Mahr P2010	yes	unknown !	20000 Hz	1000000 Ohm	3 Vrms	192 mV/V/mm	± 5 mm

The list above contains the transducers listed in the **ConfigTools** program in the MSX-E database. In the User database of this program, the transducer properties may be changed (see also Chapter 3.1.3).

6.1.3 Menu item “Transducers”

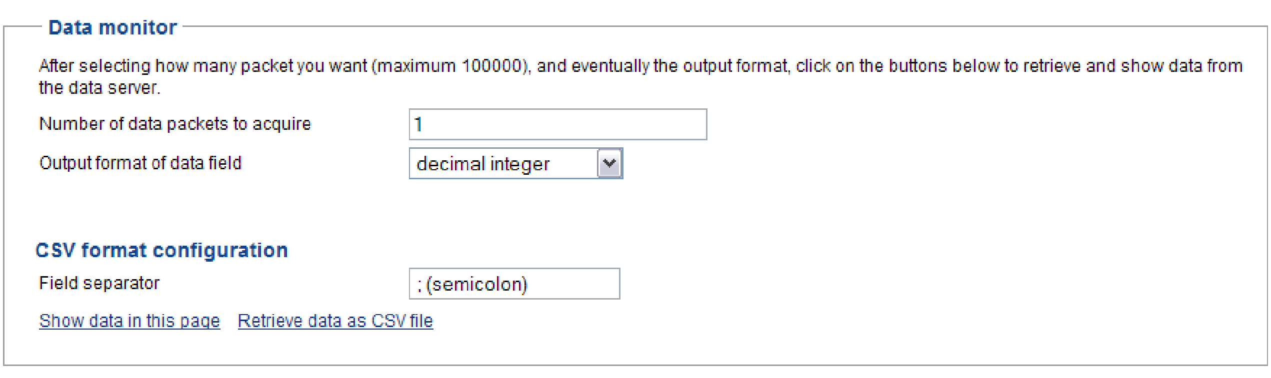
Fig. 6-5: Transducers: Type of acquisition



For the acquisition, the Auto-refresh mode and the Sequence mode are available. A detailed description of these modes can be found in Chapter 7 of this manual.

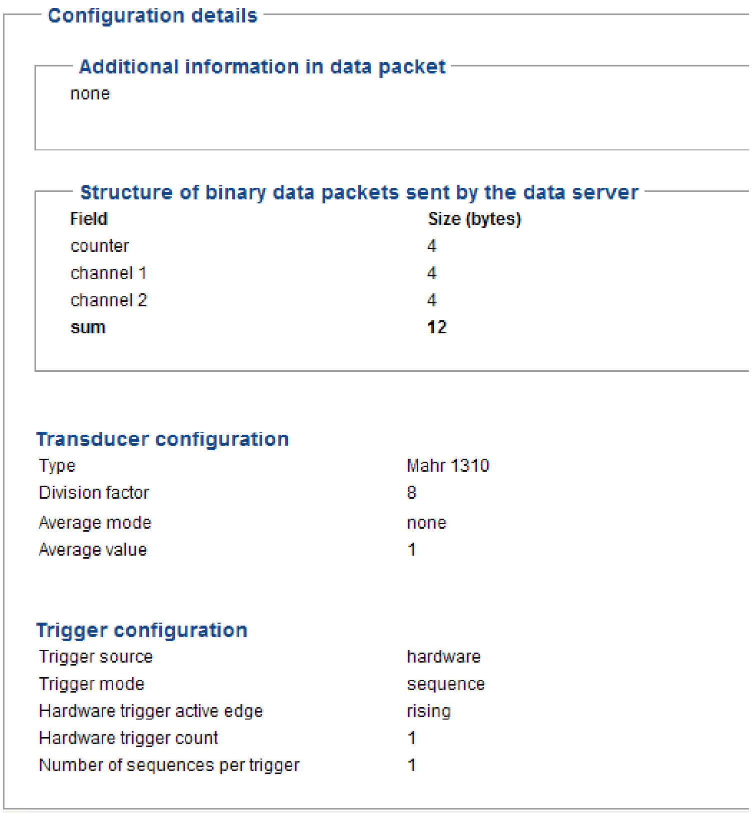
6.1.4 Menu item "Monitor"

Fig. 6-6: Monitor: Data monitor



The acquired data can be displayed either directly on the web interface or in a CSV file. For this, the number of data packets and the output format of the data fields have to be defined.

Fig. 6-7: Monitor: Configuration details



Also under this menu item, information on the current configuration as well as on data packets from the data server is listed.

Data format

In Auto-refresh mode, the following data format applies:

Table 6-1: Auto-refresh mode: Data format

tv_sec	tv_usec	Auto-refresh counter	Auto-refresh data
4 bytes	4 bytes	4 bytes	4 bytes x amount of data
optional (if data format has time stamp)	optional (if data format has time stamp)	always available	The amount of data depends on the setting.

In Sequence mode, the data format is as follows:

Table 6-2: Sequence mode: Data format

tv_sec	tv_usec	Sequence counter	Sequence data
4 bytes	4 bytes	4 bytes	4 bytes x amount of data
optional (if data format has time stamp)	optional (if data format has time stamp)	optional (if data format has Sequence counter)	The amount of data depends on the Sequence channel list.

To both modes applies:

Data format = without conversion into an analog value

Data x	32-bit digital value

Data format = with conversion into an analog value

Data x	32-bit floating point value (analog value) in V/A

For more information on the data format, see Chapter 7.3.5.

7 Acquisition modes

This chapter exemplifies how to configure and start an acquisition via the web interface of the Ethernet system **MSX-E3701** or **MSX-E3700**. Moreover, you can use Modbus or SOAP functions (see MSX-E CD or driver download on the ADDI-DATA website) to perform these steps.

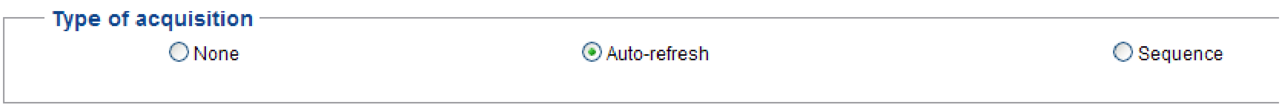
7.1 Auto-refresh mode

In Auto-refresh mode, one or more channels can be acquired. It is possible to start the acquisition by means of a trigger. Directly on the MSX-E system, an average value can be calculated.

- On the web interface, from the menu on the left, under "I/O Configuration", select the menu item "Transducers".

7.1.1 "Type of acquisition"

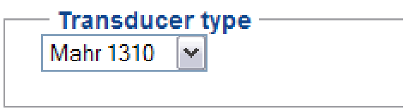
Fig. 7-1: Transducers: Type of acquisition



- In the section "Type of acquisition", select the acquisition mode "Auto-refresh".

7.1.2 "Transducer type"

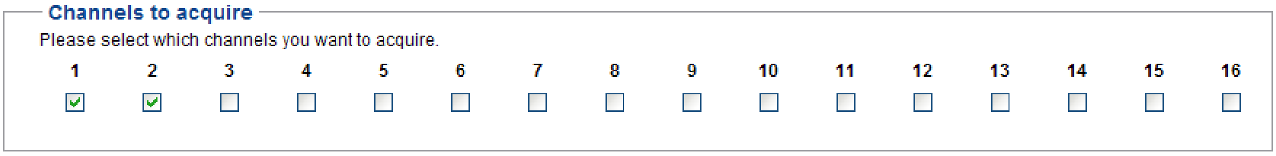
Fig. 7-2: Transducers: Transducer type



- Select the connected transducer type.

7.1.3 "Channels to acquire"

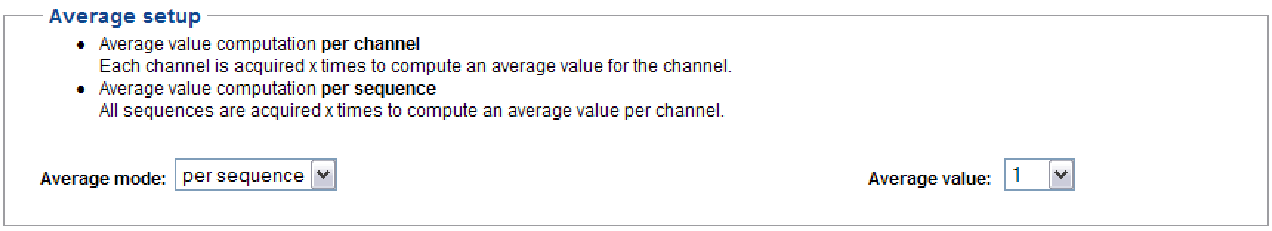
Fig. 7-3: Transducers: Channels to acquire



- In the section "Channels to acquire", select the channels you want to acquire.

7.1.4 "Average setup" (average value calculation)

Fig. 7-4: Auto-refresh mode: "Average setup"



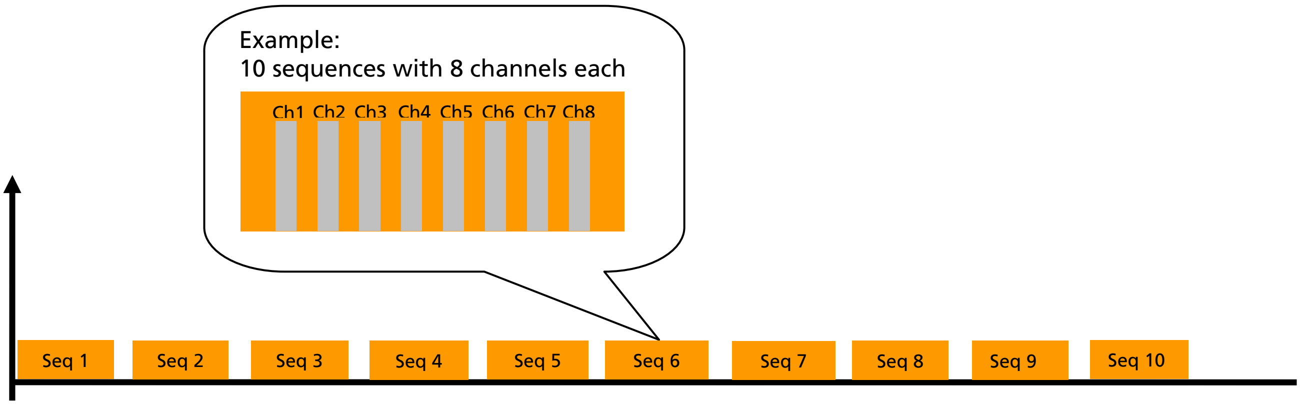
The MSX-E system is capable of calculating an average value for each channel. In the field "Average value", you have to enter the number of acquisitions after which this value should be calculated.

Acquisition "per sequence" means that all selected channels are acquired simultaneously.
If an acquisition "per channel" is to take place, the selected channels are acquired individually.

a) Acquisition per sequence

Example: The MSX-E system acquires channels 1 to 8. "Number of acquisitions" contains the value 10. This means that ten sequences run down, with each sequence consisting of eight channels to be acquired.

Fig. 7-5: Auto-refresh mode: Acquisition per sequence



After these ten sequences have run down, the MSX-E system performs the following calculation:

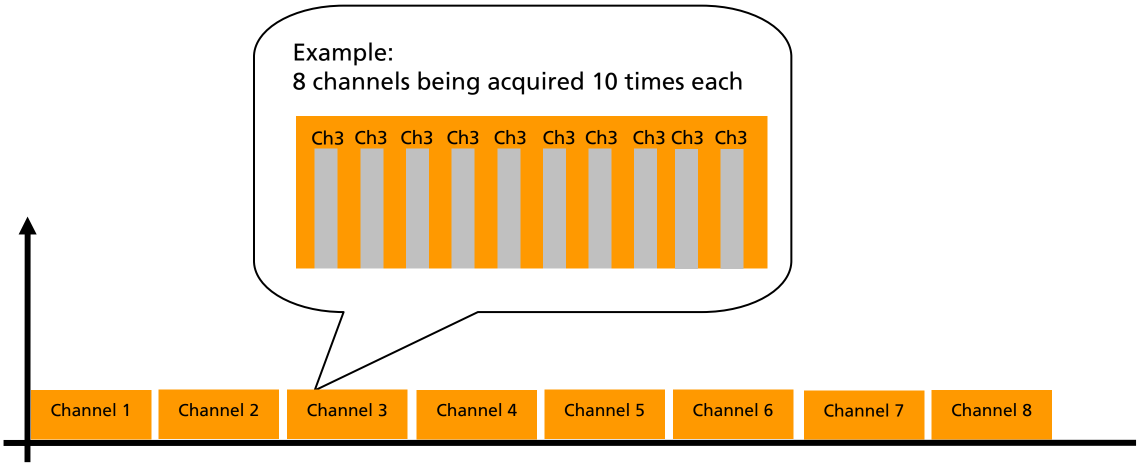
Average value of channel 1 = (sequence 1, value of channel 1 + sequence 2, value of channel 1 + … + sequence 10, value of channel 1) / 10 Average value of channel 2 = (sequence 1, value of channel 2 + sequence 2, value of channel 2 + … + sequence 10, value of channel 2) / 10 … Average value of channel 8 = (sequence 1, value of channel 8 + sequence 2, value of channel 8 + … + sequence 10, value of channel 8) / 10

The network client will not receive ten data packets with eight values in each packet, but only one data packet with the average values from channels 1 to 8.

b) Acquisition per channel

Example: The MSX-E system acquires channels 1 to 8. “Number of acquisitions” contains the value 10. This means that each of the eight channels is acquired ten times.

Fig. 7-6: Auto-refresh mode: Acquisition per channel



After all of the eight channels have been acquired, the MSX-E system performs the following calculation:

Average value of channel 1
= (value of channel 1 + value of channel 1 + … + value of channel 1) / 10

Average value of channel 2
= (value of channel 2 + value of channel 2 + … + value of channel 2) / 10

…

Average value of channel 8
= (value of channel 8 + value of channel 8 + … + value of channel 8) / 10

The network client will not receive eight data packets with ten values in each packet, but only one data packet with the average values from channels 1 to 8.

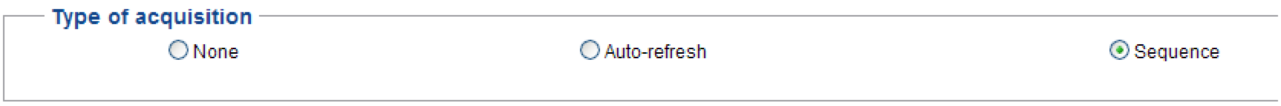
7.2 Sequence mode

The Sequence mode enables you to acquire one or more channels. The acquisition can be started by a trigger. There is a definable delay between the individual sequences.

- On the web interface, from the menu on the left, under "I/O Configuration", select the menu item "Acquisition".

7.2.1 "Type of acquisition"

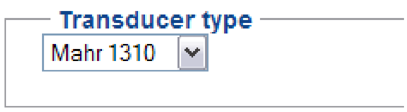
Fig. 7-7: Transducers: Type of acquisition



- In the section "Type of acquisition", select the acquisition mode "Sequence".

7.2.2 "Transducer type"

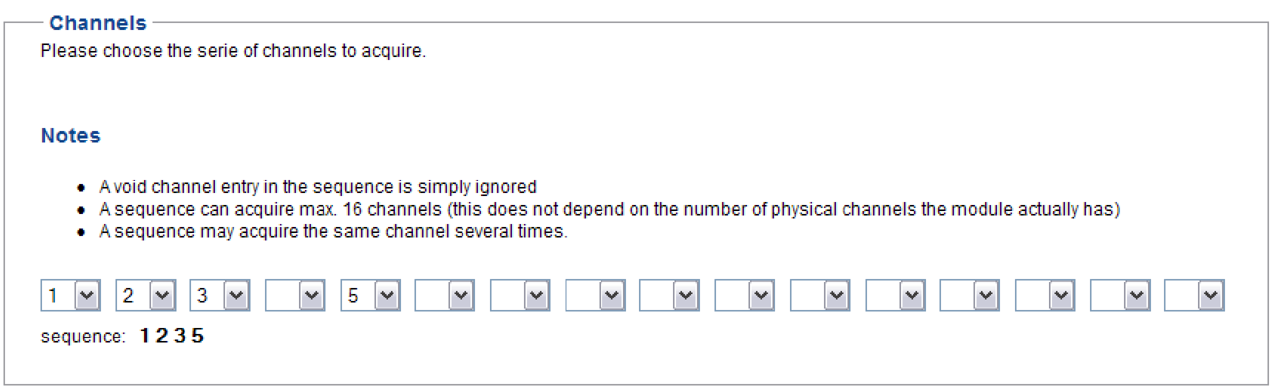
Fig. 7-8: Transducers: Type of acquisition



- Select the connected transducer type.

7.2.3 "Channels"

Fig. 7-9: Transducers: Channels

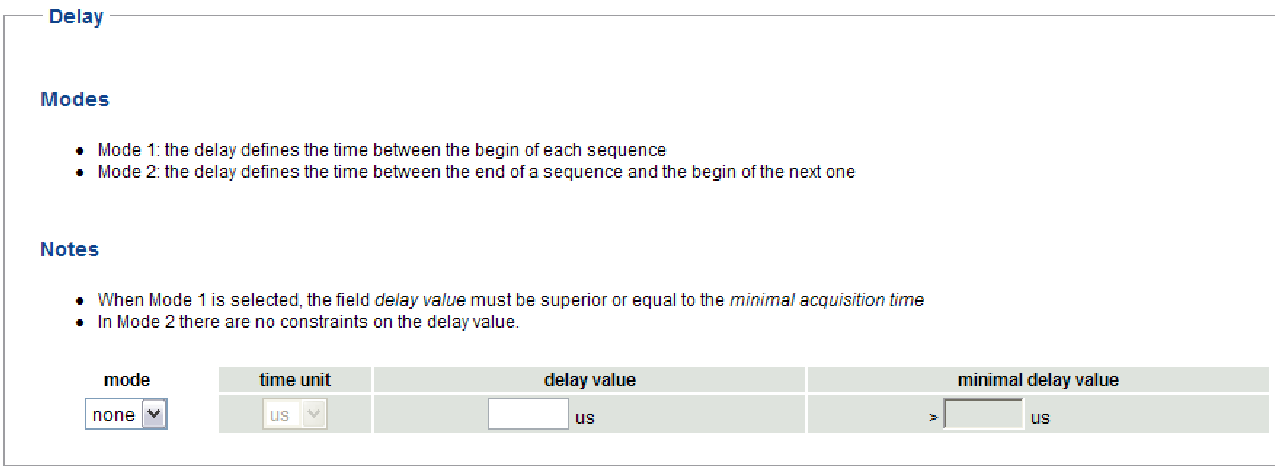


- In the section "Channels", select the channels you want to acquire.

You can define the order of the channels. A channel can be acquired several times per sequence.

7.2.4 "Delay" (wait time)

Fig. 7-10: Transducers: Delay

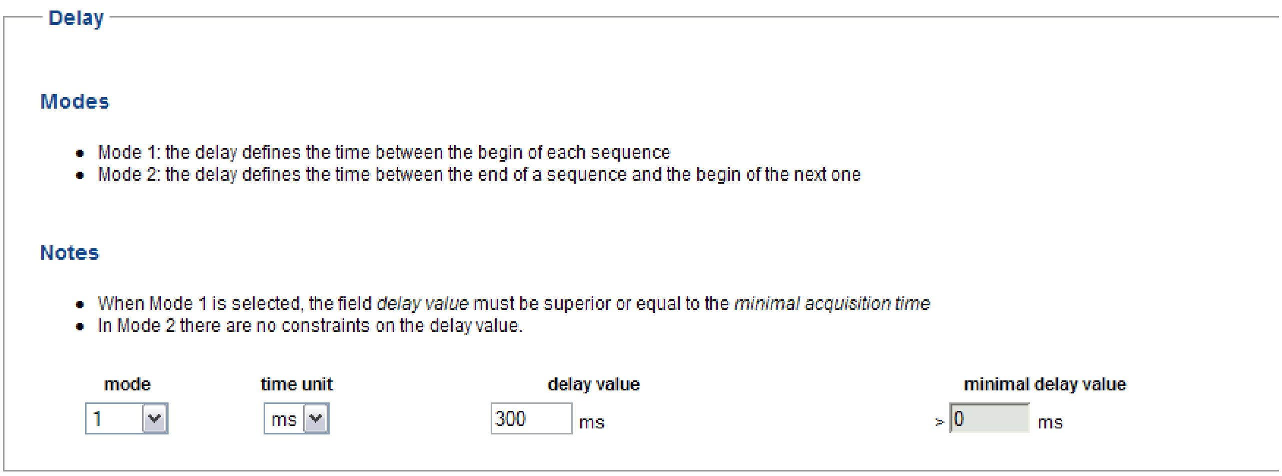


In the "Delay" section, you can define the wait time between the individual sequences. There are two modes, which are explained below.
With "time unit", you can select the unit of the delay (µs, ms or s). Enter the value of the delay in the field "Delay value". The minimal delay value is displayed in the field behind.

a) Mode 1

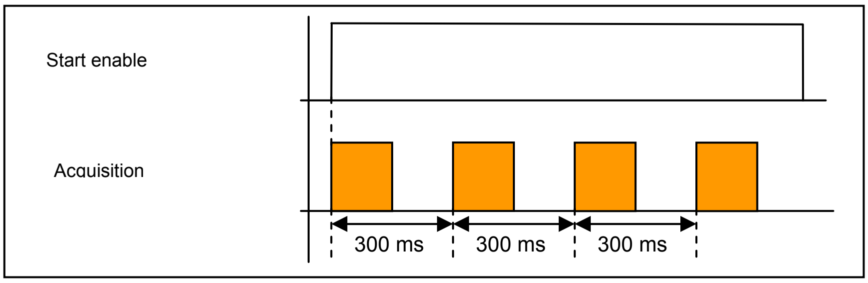
The time between the start of two subsequent sequences is defined as the delay.

Fig. 7-11: "Delay": Mode 1



Example

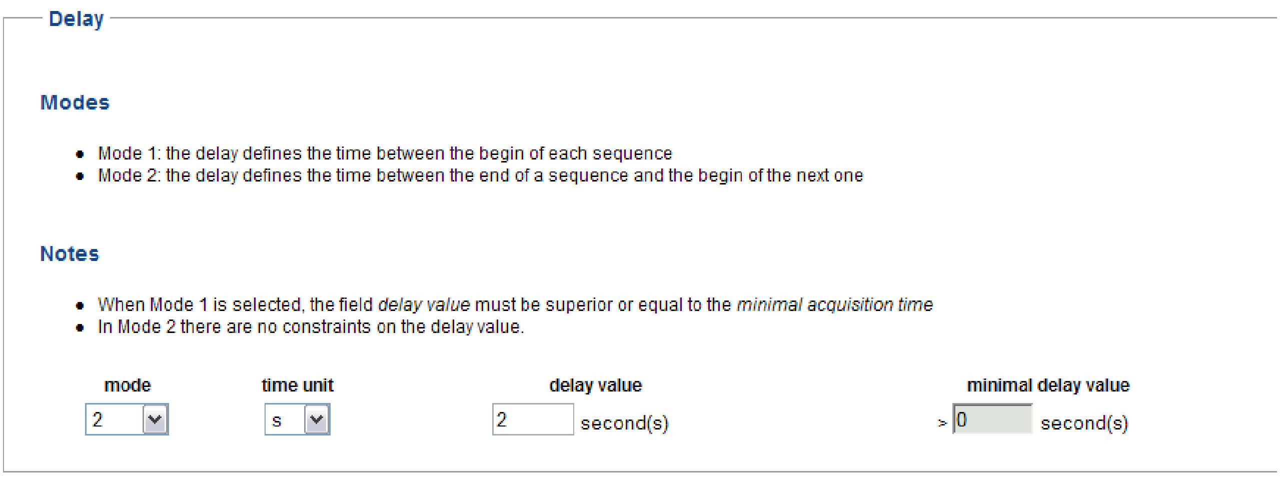
After the start of the acquisition (see Fig. 7-14), the delay between the start of the individual sequences is 300 ms.



b) Mode 2

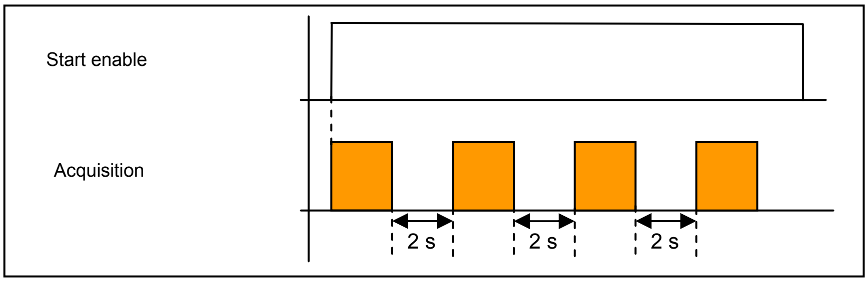
The time between the end of a sequence and the start of the subsequent sequence is defined as the delay.

Fig. 7-12: "Delay": Mode 2



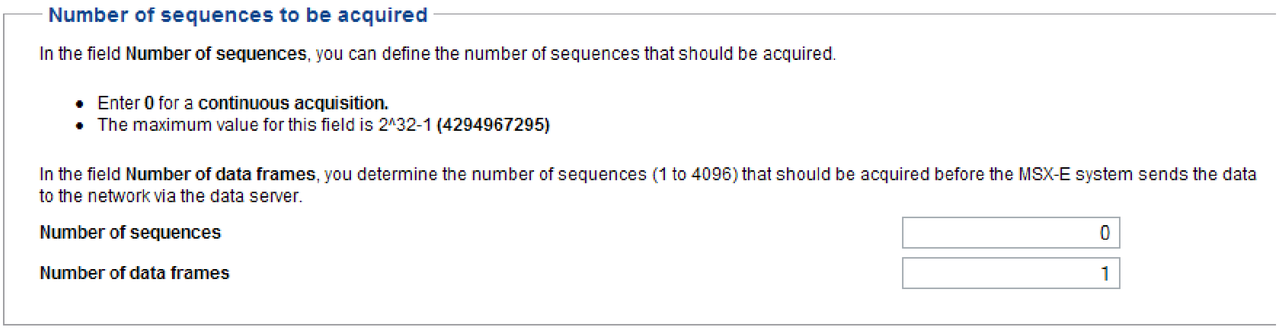
Example

After the start of the acquisition (see Fig. 7-14), the delay between the end and the start of the individual sequences is 2 s.



7.2.5 “Number of sequences to be acquired”

Fig. 7-13: Transducers: Number of sequences to be acquired

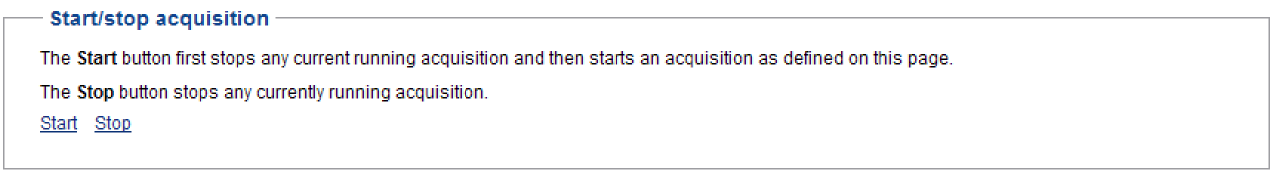


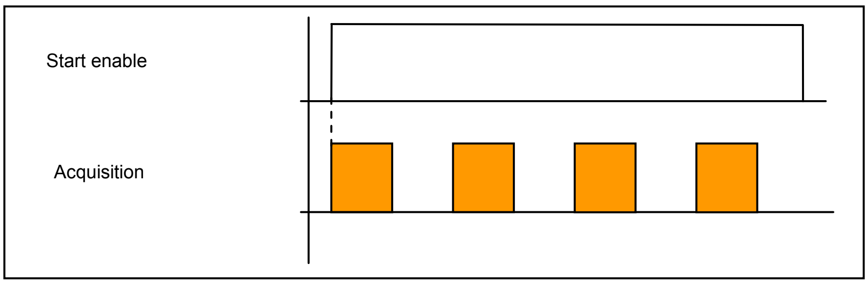
In the field “Number of sequences”, you enter the number of sequences to be acquired. If this value is 0, the acquisition is continuous. If it is a value between 1 and 4294967295, the number of sequences is predefined.

Example

To acquire four sequences, the field “Number of sequences” must contain the value 4. As a result, when you start (“Start” button in the section “Start/stop/monitor acquisition”, see the following figure) four sequences are acquired.

Fig. 7-14: Transducers: Start/stop acquisition

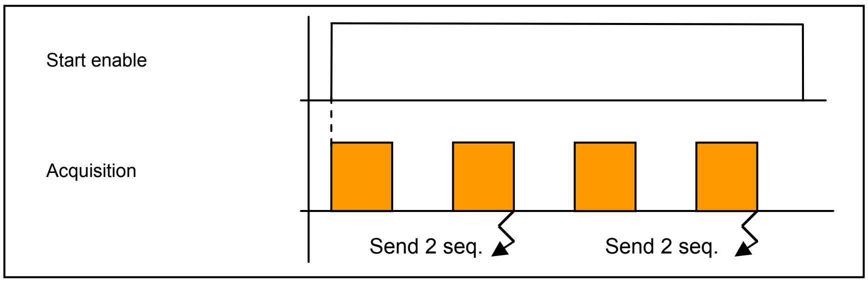




In the field “Number of data frames”, you define the maximum number of sequences that have to be acquired before the measurement values are sent to the target system. If the MSX-E system does not have sufficient memory to store the required number of sequences, the measurement values are sent earlier, that is, before the maximum number of sequences to be acquired is reached. This helps to reduce the network traffic load and the CPU resources of the MSX-E systems.

Example

When you start (see Fig. 7-14), the acquisition begins. If two sequences are acquired, the measurement values are sent to the client.

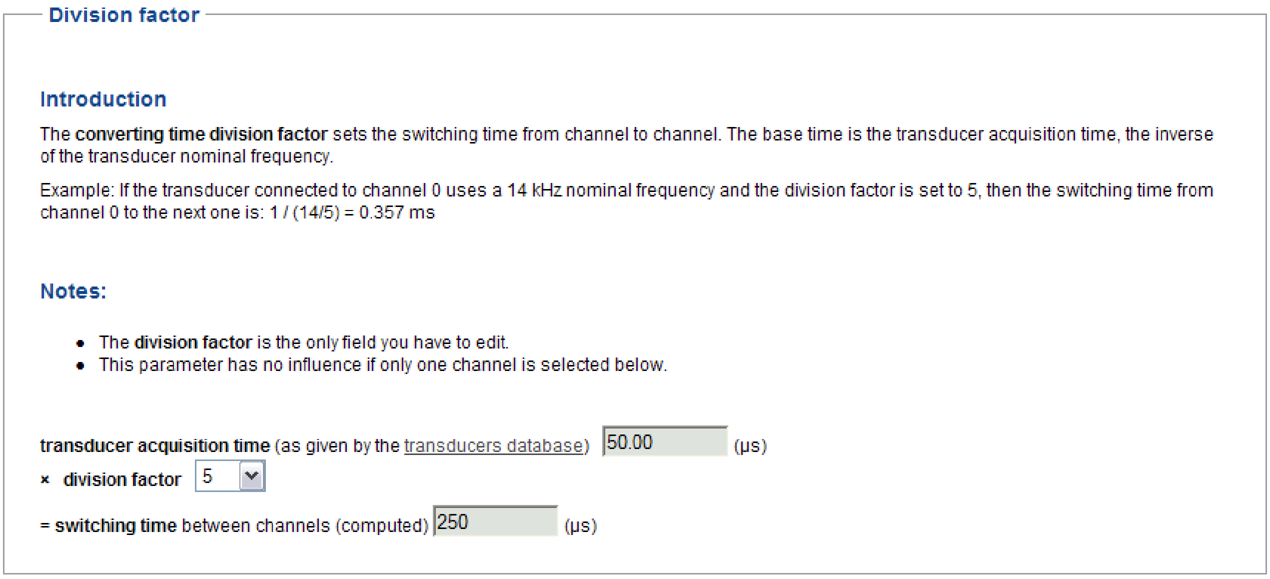


7.3 Common functions

The following functions are available both in Auto-refresh mode and in Sequence mode.

7.3.1 "Division factor"

Fig. 7-15: Transducers: Division factor

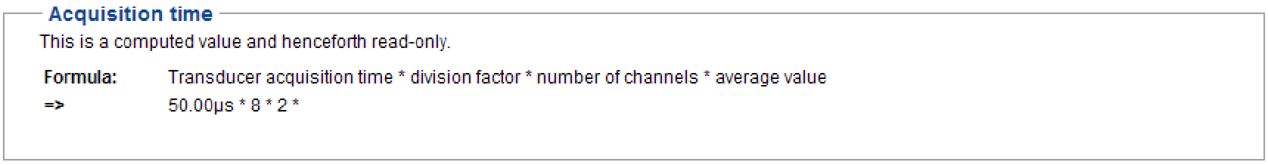


In this section, the settling time is computed, i. e. the time required to switch from one channel to another.
If only one channel is selected, this parameter is insignificant.

- Select the "Division factor".

7.3.2 "Acquisition time"

Fig. 7-16: Transducers: Acquisition time

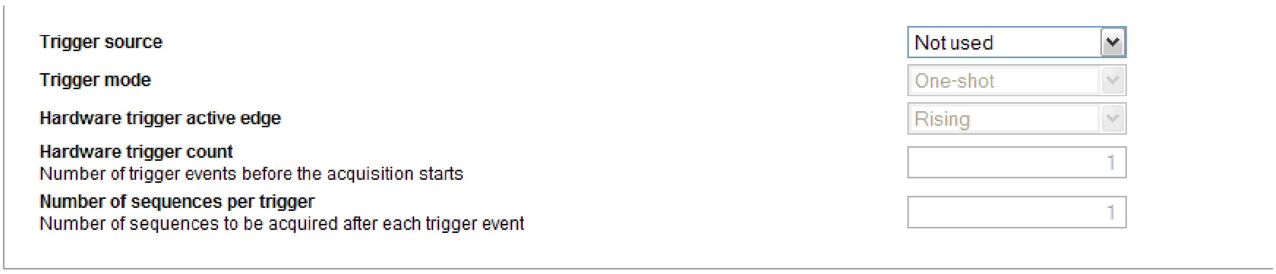


The duration of the acquisition is calculated automatically.

7.3.3 Trigger configuration

The acquisition can be started by an external signal.
The synchro trigger configuration has to be set both on the master's and slave's web interface.

Fig. 7-17: Acquisition: Trigger configuration

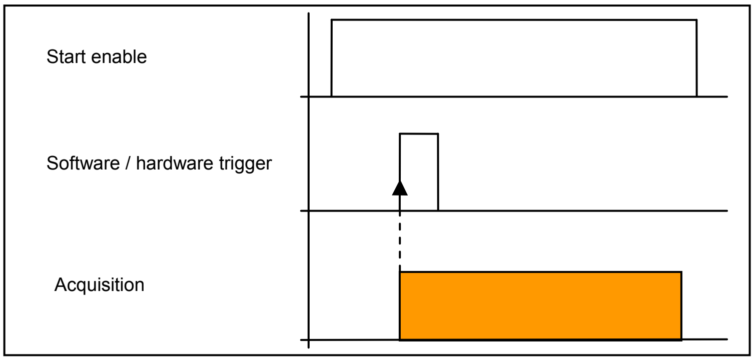


- **Trigger source:** Available trigger types are hardware trigger and synchro trigger.
- **Trigger mode:** If the trigger mode "One-shot" is selected, only one acquisition starts after a trigger. If the option "Sequence" (= "multi-shot") is activated, a defined number of acquisitions starts (see field "Number of sequences per trigger").
- **Hardware trigger active edge:** Here, the type of edge is defined in case of which the MSX-E system identifies a trigger.
- **Hardware trigger count:** This field defines the number of edges after which an acquisition is started.
- **Number of sequences per trigger:** In the trigger mode "Sequence" (see field "Trigger mode"), the number of sequences that are acquired after a trigger is defined. This value must be between 1 and 65535.

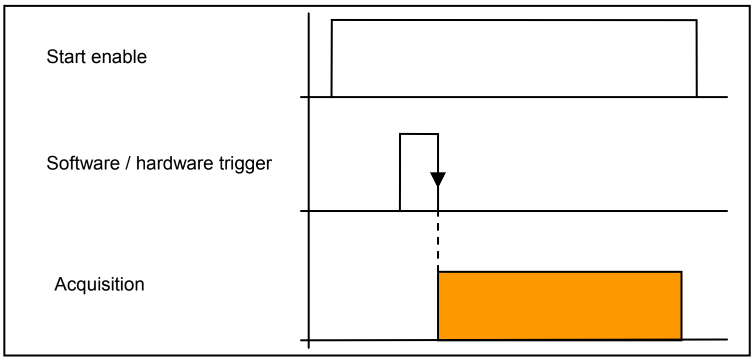
The following pages contain examples of the hardware trigger.
For further information on the hardware or synchro trigger, please refer to the general manual of the MSX-E systems (see PDF link).

1) Examples of edges

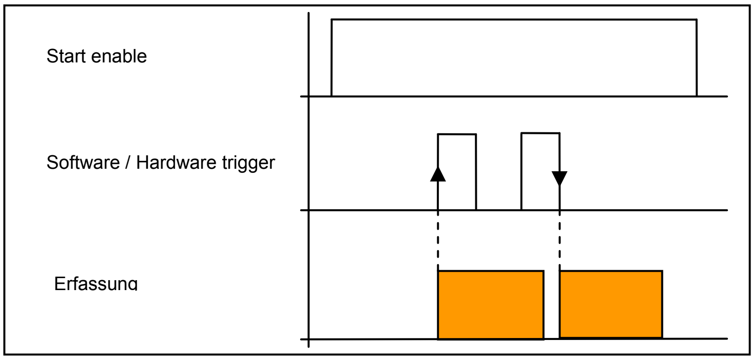
a) Rising: Rising edge



b) Falling: Falling edge



c) Both: Rising and falling edges



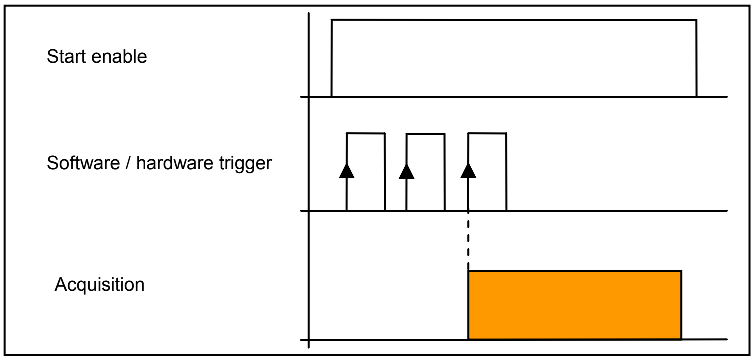
2) Examples of hardware triggers with "One-shot"

a) To start the acquisition once only after three rising edges, you can use the following parameters:

Fig. 7-18: Hardware trigger with "One-Shot" (a)

Trigger source	Hardware trigger
Trigger mode	One-shot
Hardware trigger active edge	Rising
Hardware trigger count Number of trigger events before the acquisition starts.	3
Number of sequences per trigger Number of sequences to be acquired after each trigger event	1

After the start (see Fig. 7-14), the MSX-E system waits for three rising hardware edges. Once the three edges have been identified, the acquisition starts.

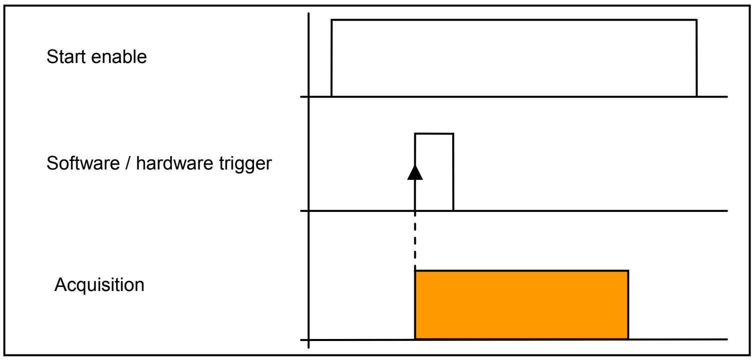


b) With "Hardware trigger active edge", "Rising" is selected again, and with "Hardware trigger count", the value 1 is entered.

Fig. 7-19: Hardware trigger with "One-Shot" (b)

Trigger source	Hardware trigger
Trigger mode	One-shot
Hardware trigger active edge	Rising
Hardware trigger count Number of trigger events before the acquisition starts.	1
Number of sequences per trigger Number of sequences to be acquired after each trigger event	1

The trigger starts only one acquisition, which begins with the first hardware edge after you start (see Fig. 7-14).

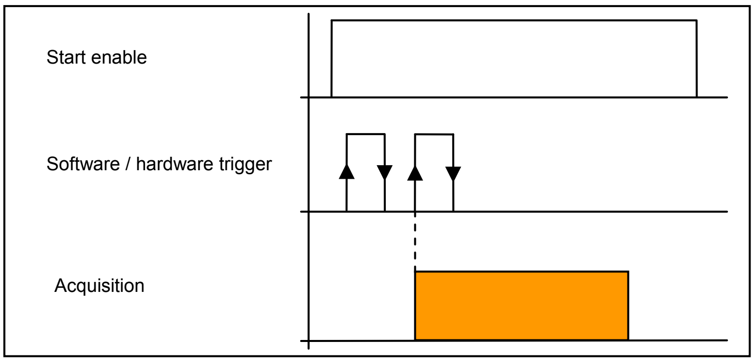


c) With "Hardware trigger active edge", "Both" is selected, and with "Hardware trigger count", the value 3 is entered.

Fig. 7-20: Hardware trigger with "One-Shot" (c)

Trigger source	Hardware trigger
Trigger mode	One-shot
Hardware trigger active edge	Both
Hardware trigger count Number of trigger events before the acquisition starts.	3
Number of sequences per trigger Number of sequences to be acquired after each trigger event	1

After the start (see Fig. 7-14), the MSX-E system waits for three rising and falling hardware edges. Once the three edges have been identified, the acquisition starts.

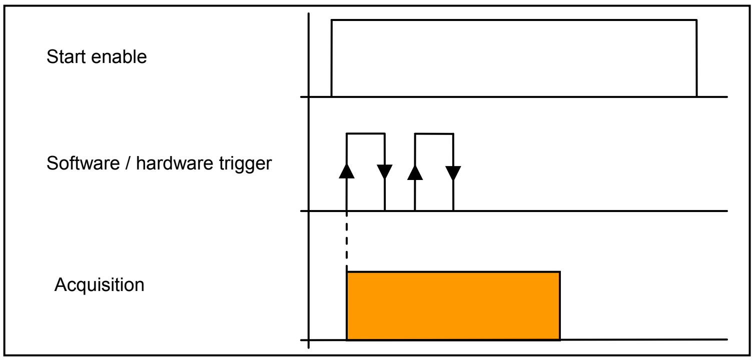


d) With “Hardware trigger active edge”, the option “Both” is selected again, and with “Hardware trigger count”, the value 1 is entered.

Fig. 7-21: Hardware trigger with “One-Shot” (d)

Trigger source	Hardware trigger
Trigger mode	One-shot
Hardware trigger active edge	Both
Hardware trigger count Number of trigger events before the acquisition starts.	1
Number of sequences per trigger Number of sequences to be acquired after each trigger event	1

If several edges occur after you start (see Fig. 7-14), the acquisition is started (triggered) with the first edge. The subsequent edges are ignored.

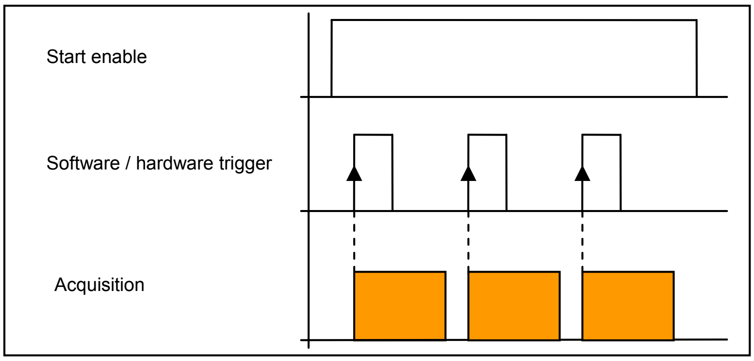


3) Examples of hardware triggers with “Sequence”

a) To start each acquisition after one rising edge, you can use the following parameters:

Fig. 7-22: Hardware trigger with “Sequence” (a)

Trigger source	Hardware trigger
Trigger mode	Sequence
Hardware trigger active edge	Rising
Hardware trigger count Number of trigger events before the acquisition starts.	1
Number of sequences per trigger Number of sequences to be acquired after each trigger event	1

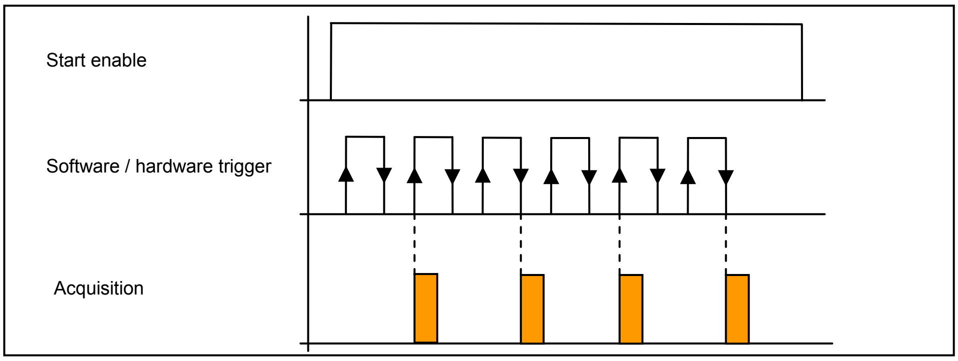


b) With "Hardware trigger active edge", "Both" is selected, and "Hardware trigger count" contains the value 3.

Fig. 7-23: Hardware trigger with "Sequence" (b)

Trigger source	Hardware trigger
Trigger mode	Sequence
Hardware trigger active edge	Both
Hardware trigger count Number of trigger events before the acquisition starts.	3
Number of sequences per trigger Number of sequences to be acquired after each trigger event	1

After you start (see Fig. 7-14), the acquisition is started after three rising and falling edges. After the end of this sequence, the next sequence is started after three rising and falling edges, and so on.



NOTICE!
Edges that occur during an acquisition are ignored. Only those edges are considered that occur after the end of an acquisition (see the previous and following examples).

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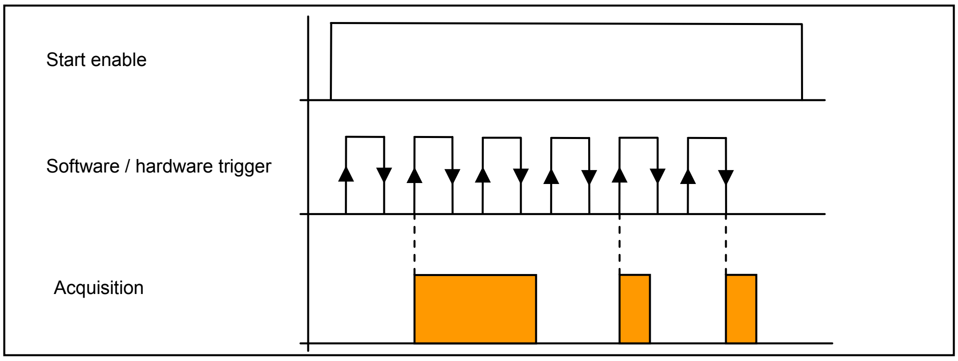
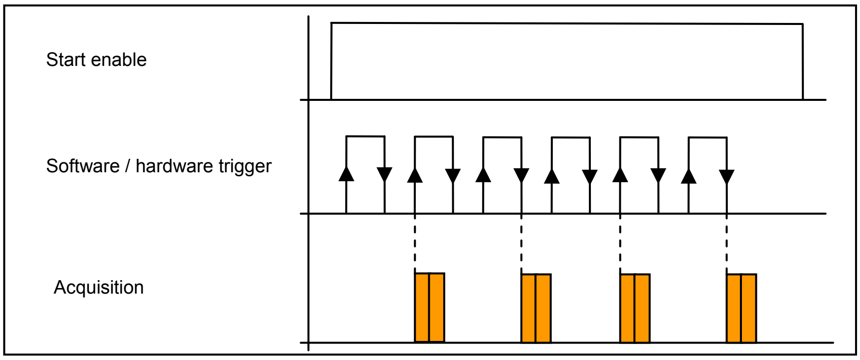


c) The settings correspond to example 2 with the exception of "Number of sequences per trigger", where value 2 is entered.

Fig. 7-24: Hardware trigger with "Sequence" (c)

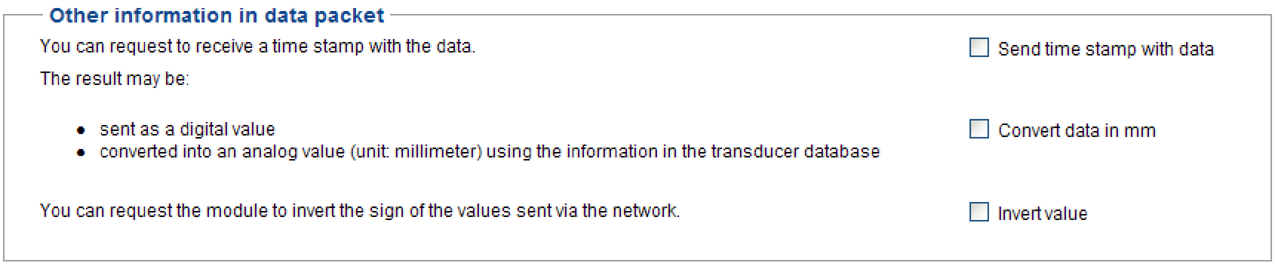
Trigger source	Hardware trigger
Trigger mode	Sequence
Hardware trigger active edge	Both
Hardware trigger count Number of trigger events before the acquisition starts.	3
Number of sequences per trigger Number of sequences to be acquired after each trigger event	2

After each trigger, two sequences are acquired.



7.3.4 "Other information in data packet"

Fig. 7-25: Transducers: Other information in data packet

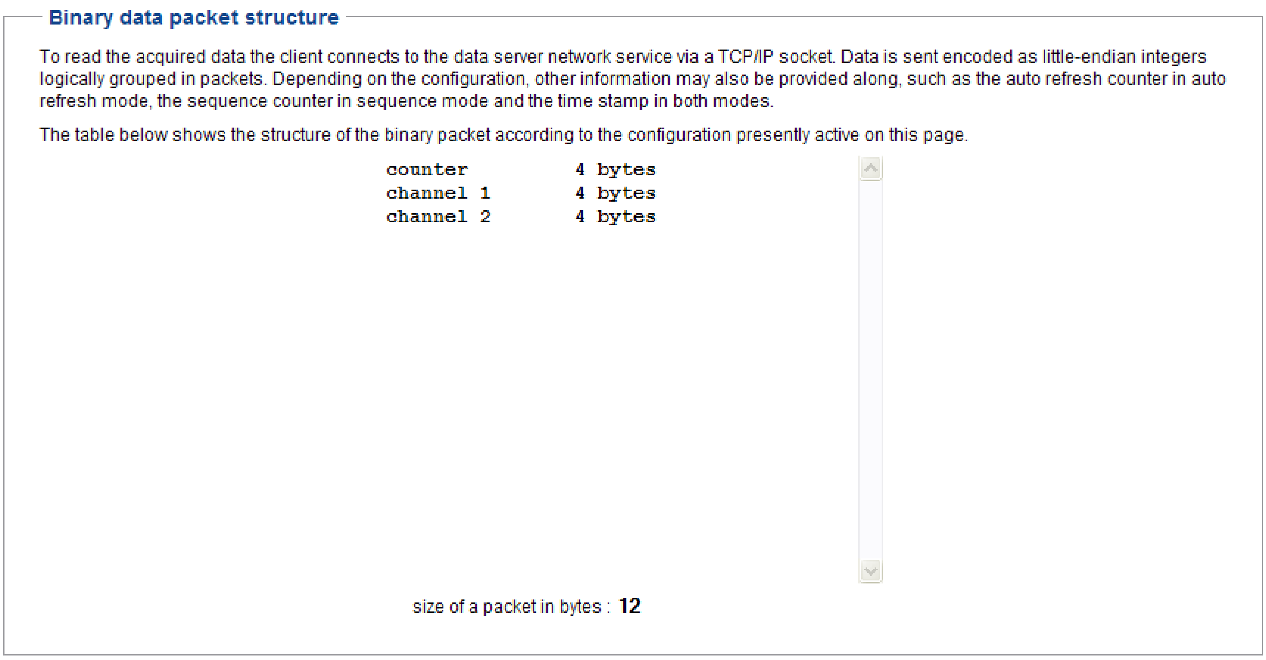


By default, only the acquisition values are sent to the client. However, it can also receive additional information if you activate the following options.

- **Send time stamp with data:** A time stamp is sent that contains the date of the acquisition.
- **Convert data in mm:** With this option, the MSX-E system can convert the raw values immediately to the correct unit. This unit depends on the system type. With an **MSX-E3701** and **MSX-E3700**, the unit is millimetres (mm). As the conversion affects the MSX-E CPU to a certain extent, this can result in slower sending speed.
- **Invert value:** It is possible to invert the sign of the measurement value.

7.3.5 "Binary data packet structure" (packet format)

Fig. 7-26: Transducers: Binary data packet structure



The MSX-E system sends the data over the network to one or more clients. In order that the client can interpret the values correctly, these are formatted. The format is defined as "Binary data frame packet structure". All measurement values and the additional data such as the time stamp form a group of values that is called a packet.

NOTICE!
The MSX-E system sends the packets in the Intel format (Little Endian).

More detailed information on the data format can be found in Chapter 6.1.4.

Example

A packet consists of a counter value and eight measurement values. The MSX-E system always sends one or more of these packets. The data client has to be programmed in such a way that it can receive a packet and interpret it correctly.

8 Technical data and limit values

8.1 Electromagnetic compatibility (EMC)

The Ethernet systems **MSX-E3701** and **MSX-E3700** comply with the European EMC directive.
The tests were carried out by a certified EMC laboratory in accordance with the norm from the EN 61326 series (IEC 61326). The limit values as set out by the European EMC directive for an industrial environment are complied with.

The respective EMC test report is available on request.

8.2 Mechanical structure

Fig. 8-1: Dimensions

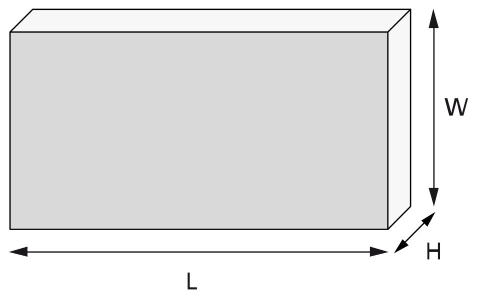


Table 8-1: Dimensions

	Dimensions (L x W x H)
MSX-E3701	215 mm x 110 mm x 50 mm
MSX-E3700	215 mm x 110 mm x 39 mm

Table 8-2: Weight

	Weight
MSX-E3701-4	519 g
MSX-E3701-8	551 g
MSX-E3701-16	741 g
MSX-E3700-4	474 g
MSX-E3700-8	513 g
MSX-E3700-16	707 g

Fig. 8-2: MSX-E3701-4: View from above

Fig. 8-3: MSX-E3701-16: View from above

Fig. 8-4: MSX-E3700-16: View from above

8.3 Versions

The Ethernet systems **MSX-E3701** and **MSX-E3700** are available in the following versions:

Table 8-3: Versions

Version	Transducer type
MSX-E3701-4	HB, LVDT, Mahr
MSX-E3701-8	HB, LVDT, Mahr, Knäbel
MSX-E3701-16	HB, LVDT
MSX-E3700-4	HB, LVDT
MSX-E3700-8	HB, LVDT
MSX-E3700-16	HB, LVDT

The specific version name can be found on the type label of your Ethernet system (see also Chapter 1.1 of the general MSX-E manual).

8.4 Limit values

Height:	2000 m over NN
Operating temperature:	-40 °C to +85 °C
Storage temperature:	-40 °C to +85 °C
Relative air humidity at indoor installation:	50 % at +40 °C 80 % at +31 °C (Ice formation from condensation must be prevented.)
Current supply:	
Nominal voltage:	24 VDC
Supply voltage:	18-30 V
Current consumption (at 24 V):	see Table 8-4
Safety:	
Degree of protection:	IP 65[1]
Optical isolation:	1000 V

Table 8-4: Current consumption (at 24 V)

MSX-E3701 / MSX-E3700	Current consumption (at 24 V)
Typ. in Power Safe mode / Idle	90 mA (± 10 %)
Power On	120 mA (± 10 %)
DAC Init / Sine On / Buffer Off	150 mA (± 10 %)
Typ. without load (transducer) at ± 9 V power (Buffer On)	200 mA (± 10 %)
Typ. with 16 Solartron AX1S transducers at ± 7 V power, 5 kHz and 3 V_{rms}	320 mA (± 10 %)
Typ. with 8 Knäbel IET0200 transducers at ± 5 V power, 50 kHz and 1 V_{rms}	330 mA (± 10 %)

NOTICE!
After boot-up, the MSX-E system should warm up for a minimum 15 minutes so that a constant internal temperature will be reached.

[1] The degree of protection is only provided when the relevant protection caps are used.

8.4.1 Ethernet

Number of ports:	2
Optical isolation:	1000 V
Cable length:	150 m (max. for CAT5E UTP)
Bandwidth:	10 Mbps (auto-negotiation) 100 Mbps (auto-negotiation)
Protocol:	10 Base-T according to IEEE 802.3 100 Base-TX according to IEEE 802.3
MAC address:	00:0F:6C:##:##:## (unique for each device)

8.4.2 Trigger input

24 V trigger input

Number of inputs:	1
Filter/Protective circuit:	low-pass/transorb diode
Optical isolation:	1000 V (via opto-couplers)
Nominal voltage:	24 VDC
Input voltage:	0-30 V
Input current:	11 mA typ. (at nominal voltage)
Max. input frequency:	2 MHz (at nominal voltage)
Logic input levels:	UH_{max}: 30 V UH_{min}: 19 V UL_{max}: 14 V UL_{min}: 0 V

5 V trigger input (optional)

Number of inputs:	1
Filter/Protective circuit:	low-pass/transorb diode
Optical isolation:	1000 V (via opto-couplers)
Nominal voltage:	5 VDC
Input voltage:	0-5 V
Input current:	12 mA typ. (at nominal voltage)
Max. input frequency:	1 MHz (at nominal voltage)
Signal threshold:	2.2 V typ.

8.4.3 Synchro input and output

Number of inputs:	1
Number of outputs:	1
Optical isolation:	1000 V
Output type:	RS422
Driver level (master) V_{A-B}:	≤ -1.5 V (low) ≥ 1.5 V (high)
Receiver level (slave) V_{A-B}:	≤ -200 mV (low) ≥ 200 mV (high)

8.4.4 Transducer inputs

Number of inputs:		4, 8 or 16 (multiplexed)
Input type:		single-ended
Coupling:		DC
Resolution:		24-bit
Transducer accuracy:		Please contact us for more information.
Sampling frequency f_S:	on 1 channel: $f_S = f_P$	at a primary frequency f_P of: 5 kHz 7.69 kHz 10 kHz 12.5 kHz 20 kHz 50 kHz
	from n ≥ 2 channels: $f_S = \frac{f_P}{SP \cdot n}$	f_P = primary frequency SP = settling period (5 ≤ SP ≤ 255) f_S: applies to all n channels here
	Example with TESA GT21 on 1 channel: $f_S = f_P$	= 12.5 kHz
	from n ≥ 2 channels:	
	on 4 channels: $f_S = \frac{12.5\,\text{kHz}}{5 \cdot 4}$	= 625 Hz
	on 8 channels: $f_S = \frac{12.5\,\text{kHz}}{5 \cdot 8}$	= 312.5 Hz
	on 16 channels: $f_S = \frac{12.5\,\text{kHz}}{5 \cdot 16}$	= 156.25 Hz
Input level:		
Input impedance (software-programmable):		2 kΩ 10 kΩ 100 kΩ 10 MΩ
Input range:		± 3.3 V max. (programmable)

NOTICE!
In addition to the transducers listed in Table 8-3, other transducers are supported as well. If you need information on this, do not hesitate to contact us.

8.4.5 Sine wave generator

Number of outputs:	2
Coupling:	AC
Programmed signals:	
Type:	sine (differential)
Output frequency:	5 kHz typ. 7.69 kHz typ. 10 kHz typ. 12.5 kHz typ. 20 kHz typ. 50 kHz typ.
Output level:	
Output range:	± 11 V max.
Output impedance:	< 0.1 Ω typ. > 30 kΩ typ. (in shut-down mode)
Short-circuit current:	0.7 A typ. (at 25 °C with thermal protection)
Switching time Buffer Off/On:	1 µs typ.
Bandwidth (-3 dB):	0.65 Hz high-pass filter On 50 kHz low-pass filter
Frequency response:	10 Hz to 20 kHz 0.7 dB min. 0 dB max.
Output voltage:	High Z (after Power On) 0 V (after Reset)
FIFO depth:	64 DWord (for each analog output)

8.4.6 Digital output (MSX-E3701-4)

Number of outputs:	1 (M12 female connector)
Optical isolation:	1000 V (via opto-couplers)
Output type:	high-side (load to ground according to IEC 1131-2)
Nominal voltage:	24 VDC
Supply voltage:	18-30 V
Output current:	0.8 A
Short-circuit current per output:	0.8 A max.
R_{DS} ON resistance:	1 mΩ max.
Switch-on time:	21 µs (typ. R_L = 270 Ω)
Switch-off time:	11 µs (typ. R_L = 270 Ω)
Overtemperature (shut-down):	150 °C max. (output driver)
Temperature hysteresis:	10 °C typ. (output driver)

9 Appendix

9.1 Glossary

ADC
= A/D converter

Buffer
The buffer is used for the temporary storage of information that is only needed at a later time.

Cascading
Cascading means connecting multiple similar elements together to enhance their individual effect. The individual elements must be such that the outputs of a given element are compatible with the inputs of the subsequent element in terms of values and functionality.

Counter
A counter is a circuit that counts pulses or measures pulse duration.

Data acquisition
Data acquisition means gathering information from sources such as sensors and transducers in an accurate, timely and organised manner. Modern systems convert this information to digital data which can be stored and processed by a computer.

Digital signal
A digital signal is a digital representation of a constantly changing value or other piece of information. Digital signals consist of a finite number of values. The smallest possible difference between two digital values is referred to as the resolution. Digital signals are discontinuous in terms of value and time ranges.

Driver
A driver is a series of software instructions written specifically to manage particular devices.

EMC
= Electromagnetic Compatibility

The definition of the VDE regulation 0870 states: Electromagnetic compatibility is the ability of an electrical installation to function satisfactorily within its electromagnetic environment without unduly affecting its environment and the equipment it contains.

Ethernet
The Ethernet is a baseband bus system originally developed in order to connect mini-computers. It is based on the CSMA/CD access method. Coaxial cables or twisted-pair cables are used as the transmission medium.
The transmission speeds are 10 Mbit/s (Ethernet), 100 Mbit/s (Fast Ethernet) and 1 Gbit/s or 10 Gbit/s (Gigabit-Ethernet). This widely used technology for computer networking in a LAN has been standardised since 1985 (IEEE 802.3 and ISO 8802-3).
Ethernet technology is now common practice in the office environment. After making even very tough real-time requirements possible and adapting the device technology (bus cables, patch fields, junction boxes) to the harsh application conditions of the industrial environment, Ethernet is now also increasingly used in the field areas of automation technology.

Ground line
Ground lines should not be seen as potential-free return lines. Different ground points may have small potential differences. This is always true with large currents and may cause inaccuracy in high-resolution circuits.

IEC
= International Electrotechnical Commission

The IEC is a UN body affiliated to the ISO (International Standards Organisation) which sets standards for electrotechnical parts and components.

Input impedance
The input impedance is the ratio of voltage to current at the input terminals when the output terminals are open.

Input level
The input level is the logarithmic ratio between two electrical values of the same type (voltage, current or power) at the signal input of any receiving unit. This unit is often configured as a logical level related to the input of the circuit. The input voltage corresponding to logic "0" is between 0 V and 15 V and the voltage corresponding to logic "1" is between 17 V and 30 V.

IP degree of protection
The IP standard defines the degree of protection of a system against dirt and water. The first figure after the "IP" (e.g. 6 in IP 65) indicates the degree of protection against solid objects penetrating the housing. The second figure indicates the degree of protection against liquids penetrating the housing.
In IP 65, the figures 6 and 5 have the following meaning: 6 = full protection against moving parts and against dirt penetration;
5 = protection against jets of water from any direction.
In IP 40, the figure 4 equates to protection against contact with small objects and protection against small foreign bodies (larger than 1 mm). The figure 0 means that there is no protection.

Level
Logic levels are defined for processing and displaying information.
In binary switches, voltages are used for digital values. Here, the two voltage ranges "H" (high) und "L" (low) represent the information.
The "H" range is closer to plus infinity; the "H" level corresponds to digital 1. "L" denotes the range closer to minus infinity; the "L" level corresponds to digital 0.

Limit value
Exceeding the limit values, even for a short time, can easily result in the destruction of the component or the (temporary) loss of functionality.

MAC address
MAC = Media Access Control

This is the hardware address of network components used to identify them uniquely within the network.

Optical isolation
Optical isolation means that there is no flow of electrical current between the circuit to be measured and the measuring system.

Protective circuit
A protective circuit is set up on the actuator side to protect the control electronics and provide adequate EMC safety. The simplest protective circuit involves connecting a resistor in parallel.

Resolution
The resolution indicates how precisely a signal or value is held within the computer.

Short-circuit
A short-circuit exists between two terminals of an electric circuit if the relevant terminal voltage is zero.

SOAP
= Simple Object Process Protocol

SOAP is a simple extensible protocol for exchanging information in distributed environments. It defines XML messages that can be exchanged between heterogeneous applications via HTTP.

SOAP is independent of operating systems and can be integrated into existing Internet structures, including Ethernet TCP/IP-based automation concepts. SOAP is based on Remote Procedure Calls and XML. This means that functions from other platforms can be called and used from any point within the network. Any results data can also be returned using XML schemas. This enables distributed computing capacity and non-redundant data storage in distributed systems.

TCP/IP

= Transmission Control Protocol/Internet Protocol

TCP/IP is a family of network protocols and therefore often just referred to as Internet protocol. The computers that are part of the network are identified via their IP addresses. UDP is another transport protocol that belongs to the core group of this protocol family.

Trigger

A trigger is a pulse or signal for starting or stopping a special task. Triggers are often used for controlling data acquisition.

UDP

= User Datagram Protocol

This is a minimal connection-free network protocol which is part of the transport layer within the Internet protocol family. The purpose of UDPs is to ensure that data transmitted over the Internet reach the correct application.

9.2 Index

10 Contact and support

Do you have any questions? Write or phone us:

Address: ADDI-DATA GmbH
Airpark Business Center
Airport Boulevard B210
77836 Rheinmünster
Germany

Phone: +49 7229 1847-0
Fax: +49 7229 1847-222

E-mail: info@addi-data.com

Manual and software download from the Internet:

www.addi-data.com