ADDI-DATA®
SPIRIT OF EXCELLENCE

TECHNICAL

DESCRIPTION

MSX-E3121

Ethernet multifunction system

DIN EN ISO 9001:2008 certified

Edition: 02.01-04/2013

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.

Warranty and liability

The user is not permitted to make changes to the product beyond the intended use, or to interfere with the product in any other way.
ADDI-DATA shall not be liable for obvious printing and phrasing errors. In addition, ADDI DATA, if legally permissible, shall not be liable for personal injury or damage to materials caused by improper installation and/or commissioning of the product by the user or improper use, for example, if the product is operated despite faulty safety and protection devices, or if notes in the operating instructions regarding transport, storage, installation, commissioning, operation, thresholds, etc. are not taken into consideration. Liability is further excluded if the operator changes the product or the source code files without authorisation and/or if the operator is guilty of not monitoring the permanent operational capability of working parts and this has led to damage.

Copyright

ADDI-DATA software product licence

Please read this licence carefully before using the standard software. The customer is only granted the right to use this software if he/she agrees with the conditions of this licence.
The software must only be used to set up the ADDI-DATA products.
Reproduction of the software is forbidden (except for back-up and for exchange of faulty data carriers). Disassembly, decompilation, decryption and reverse engineering of the software are forbidden. This licence and the software may be transferred to a third party if this party has acquired a product by purchase, has agreed to all the conditions in this licence contract and the original owner does not keep any copies of the software.

Trademarks

- ADDI-DATA, APCI-1500, MSX-Box and MSX-E are registered trademarks of ADDI-DATA GmbH.
- Turbo Pascal, Delphi, Borland C, Borland C++ are registered trademarks of Borland Software Corporation.
- Microsoft .NET, Microsoft C, Visual C++, MS-DOS, Windows 95, Windows 98, Windows 2000, Windows NT, Windows EmbeddedNT, Windows XP, Windows Vista, Windows 7, Windows Server 2000, Windows Server 2003, Windows Embedded and Internet Explorer are registered trademarks of Microsoft Corporation.
- LabVIEW, LabWindows/CVI, DASYLab, DIAdem are registered trademarks of National Instruments Corporation.
- CompactPCI is a registered trademark of PCI Industrial Computer Manufacturers Group.
- VxWorks is a registered trademark of Wind River Systems, Inc.
- RTX is a registered trademark of IntervalZero.
- Mozilla Firefox is a registered trademark of Mozilla Foundation.
- SIMATIC S7 is a registered trademark of Siemens AG.

Warning

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

Personal injury

Damage to the Ethernet system, the PC and peripherals

Pollution of the environment

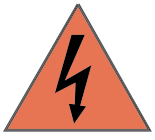
- Protect yourself, others and the environment!
- Read the safety precautions (yellow leaflet) carefully!

  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 a wrong use of the Ethernet system.
- Pay attention to the following symbols:

IMPORTANT!
Designates hints and other useful information.

WARNING!
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**.

Contents

Figures

Tables

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 and features)
3	Function description (analog inputs/outputs) including pin assignment
4	Function description (digital inputs/outputs) including pin assignment and connection examples
5	Description of the function-specific tabs of the MSX-E web interface
6	Description of the acquisition modes (Auto-refresh and Sequence modes)
7	List of technical data and limit values of the MSX-E system
8	Appendix with glossary and index
9	Contact and support address

1 Definition of application, user, handling

1.1 Definition of application

1.1.1 Intended use

The Ethernet system **MSX-E3121** for analog and digital input and output is 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 system **MSX-E3121** must not be used as safety-related part (SRP).

The Ethernet system **MSX-E3121** must not be used for safety-related functions.

The Ethernet system **MSX-E3121** must not be used in potentially explosive atmospheres.

The Ethernet system **MSX-E3121** must not 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

IMPORTANT!
The protection according to the defined degree of protection (see Chapter 7.4) 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.

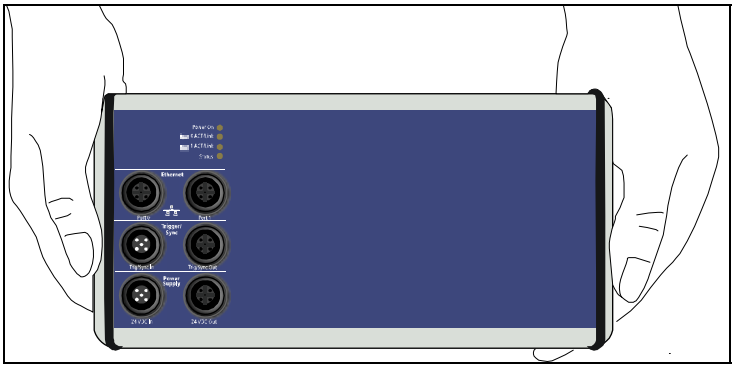
1.3.2 Country-specific regulations

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 system **MSX-E3121** can be downloaded for free at:

www.addi-data.com

IMPORTANT!

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 system **MSX-E3121** are described in brief. Furthermore, you will find a general block diagram of the MSX-E system.

2.1 Functions and features

The intelligent Ethernet multifunction system **MSX-E3121** has six analog inputs with 24-bit resolution and a sampling frequency of 100 kHz per channel as well as four analog outputs, 16-bit. In addition, the system is equipped with 32 digital I/O (24 V).

By means of an external trigger, the inputs and outputs on multiple systems can be updated simultaneously (synchronisation). The system can be configured and the acquisition can be started over either the integrated web interface or SOAP or Modbus commands. These interfaces also enable sensor data to be accessed.

Over an integrated Ethernet switch, the system 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 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. Error diagnoses are quickly identified by means of the “Status” LED display.

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 in direct vicinity of the sensor or actuator, the function of the latter is 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 system must be supplied with external voltage (24 V).

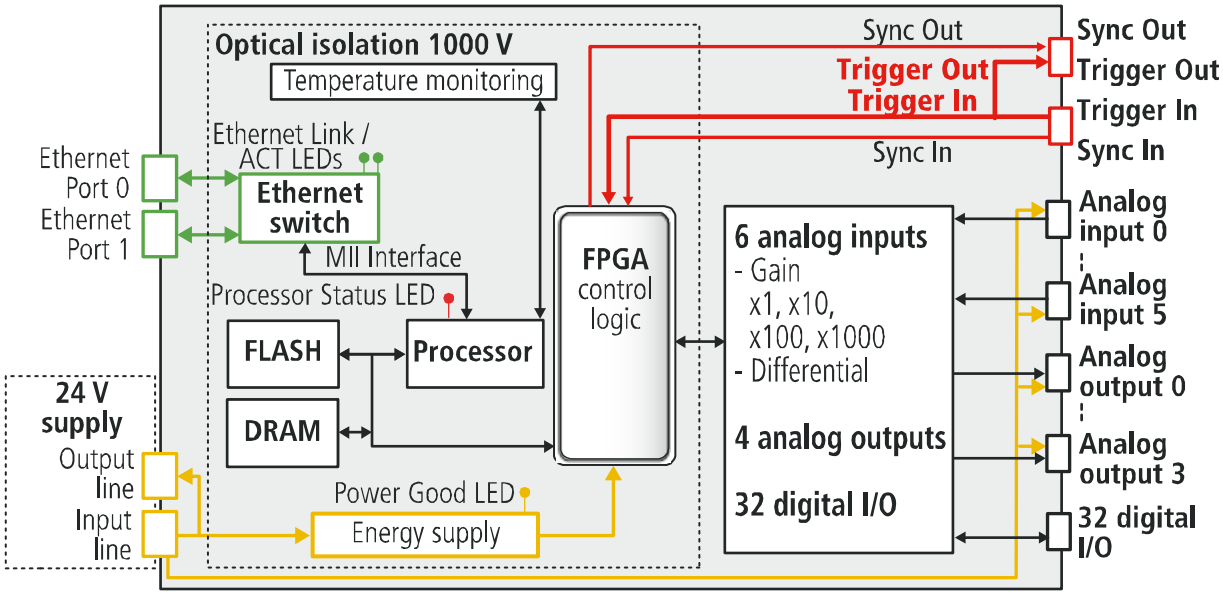
Features:

- 6 analog inputs, single-ended or differential, 24-bit
- 4 analog outputs (voltage or current version)[1], 16-bit
- 16 digital inputs and 16 digital outputs, 24 V
- Input/output: can be controlled by means of an external trigger (digital 24 V trigger input)
- Web interface to configure, control and monitor the inputs and outputs
- Data access via SOAP or Modbus (always TCP or UDP)
- Optical isolation
- Degree of protection: IP 65
- Cascadable; synchronisation in the µs range
- Extended operating temperature range from -40 °C to +85 °C

[1] Please specify when ordering (see Chapter 7.3)!

2.2 Block diagram

Fig. 2-1: MSX-E3121: Block diagram



3 Function description: Analog inputs/outputs

The Ethernet system **MSX-E3121** is equipped with 6 analog inputs for sensors and 4 analog outputs for actuators.

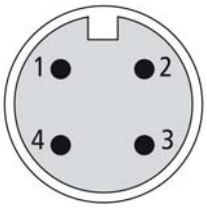
3.1 Analog inputs

3.1.1 Pin assignment

To each M12 female connector, one sensor can be connected. One analog input consists of input + and input -. Optionally, a 24 V voltage is available to supply a sensor if required.

Table 3-1: Pin assignment: Analog inputs

Pin No.	Female connector, 4-pin, M12	Cable (black)
		Lead colour
1	+24 V	brown
2	Differential input -	white
3	GND[1]	blue
4	Differential input +	black



[1] To use the inputs as single-ended inputs, pins 2 and 3 have to be connected externally with each other.

3.2 Analog outputs

3.2.1 Voltage and current outputs

The following versions of the MSX-E system are available:[1]

- Voltage version: 4 analog voltage outputs
- Current version: 2 analog current outputs (pin 4, see Table 3-2), 2 analog voltage outputs (pin 5)

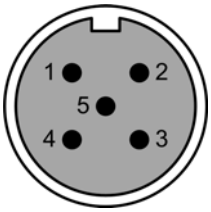
For the voltage outputs, you can also define if the voltage should be output in unipolar or bipolar mode. In unipolar mode, the resolution is reduced from 16-bit to 15-bit.

IMPORTANT!
The current outputs can only be used in unipolar mode!

3.2.2 Pin assignment

To each M12 female connector, two actuators can be connected. One analog output consists of output x+ and output -. Optionally, a 24 V voltage is available to supply an actuator if required.

Table 3-2: Pin assignment: Analog outputs

Pin No.	Female connector, 5-pin, M12	Cable (black)
		Lead colour
1	+24 V (supply)	brown
2	Analog output - *	white
3	GND (supply)	blue
4	Analog output 0+	black
5	Analog output 1+	grey
		

* Common GND for channels 0 and 1

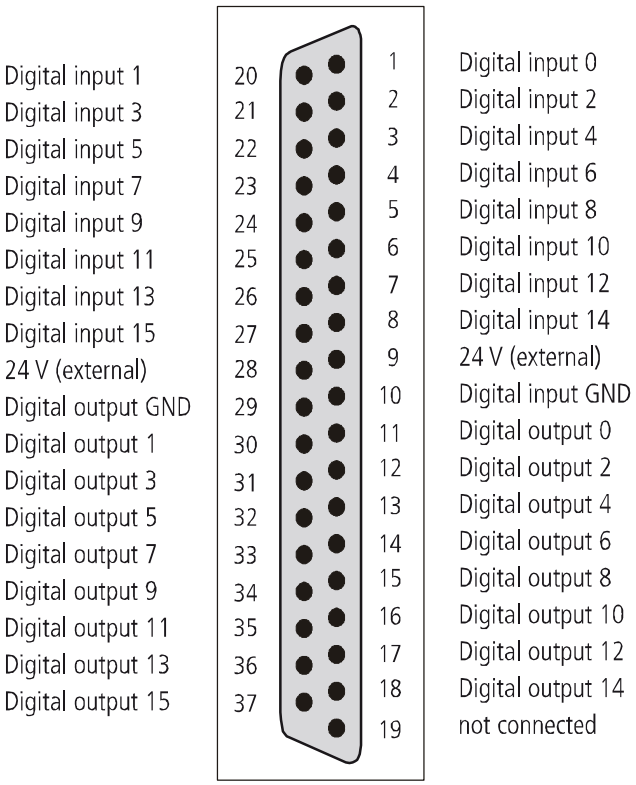
[1] Please specify when ordering (see Chapter 7.3)!

4 Function description: Digital inputs/outputs

The Ethernet system **MSX-E3121** has 16 digital inputs and 16 digital outputs for sensors or actuators.

4.1 Pin assignment

Fig. 4-1: Pin assignment: Digital I/O (37-pin D-Sub male connector)



4.2 SOAP/Modbus API

If you configure and control the digital I/O of the **MSX-E3121** via SOAP or Modbus, you have to use the software functions starting with “Ext”.

Example: A digital output can be set by the function “MSXExxxx__ExtDigitalIOWriteChannel (ulChannel, ulState, ulOption1, Response)”.

More information on the parameters and return values is to be found in the driver package, i.e. in the directory “SOAP\Documentation” or “Modbus\Documentation” and in the sample folder “ExtDigitalIO”.

4.3 Connection examples

Fig. 4-2: Connection example: Digital inputs (24 V)

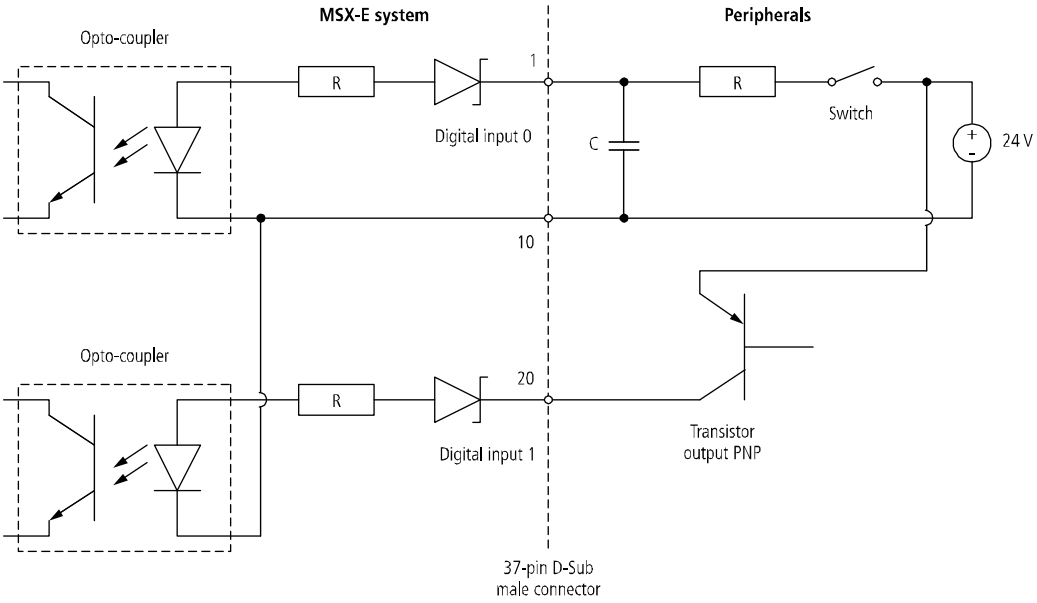
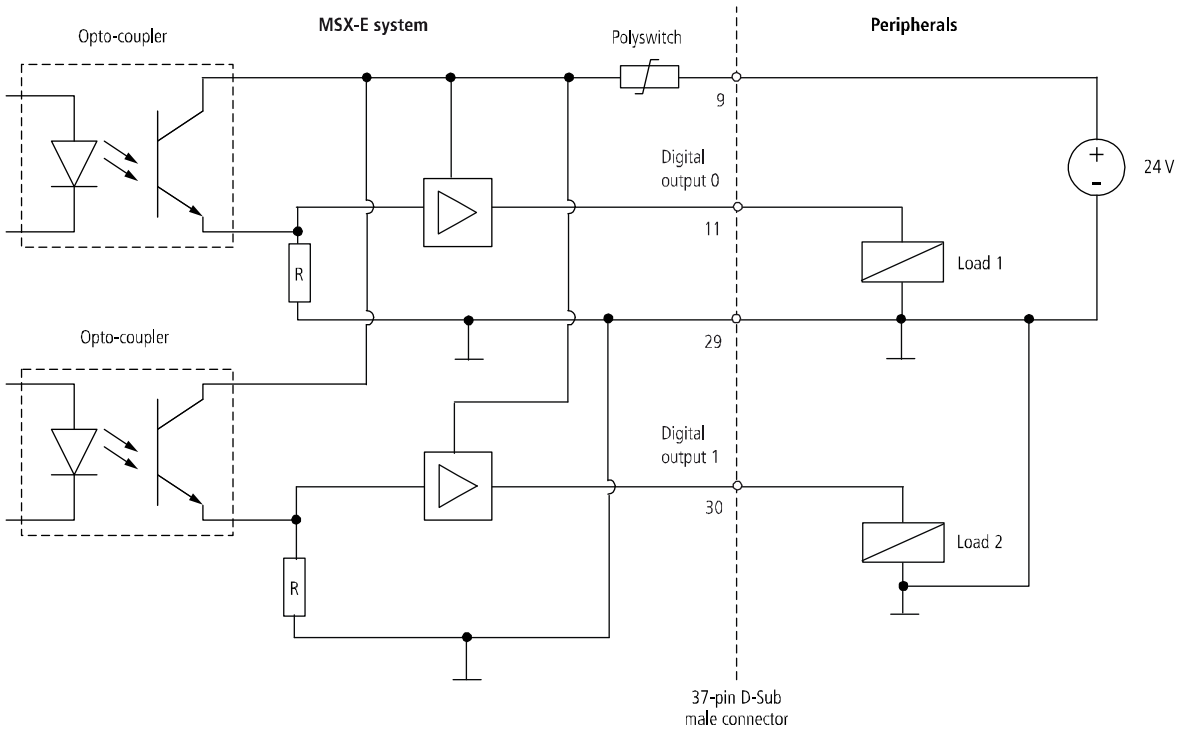


Fig. 4-3: Connection example: Digital outputs (24 V)



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

In this chapter, the system-specific parts of the **MSX-E3121** web interface 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).

5.1 Menu item "I/O Configuration"

5.1.1 "Analog I/O" tab

Fig. 5-1: I/O configuration: Analog inputs

Channel	Coupling	Signal type	Polarity	Gain
0	DC	Single	Bipolar	x1
1	AC	Single	Bipolar	x10
2	DC	Differential	Bipolar	x1
3	DC	Single	Unipolar	x100
4	AC	Differential	Bipolar	x1
5	DC	Differential	Unipolar	x1000

In this table, you can configure the analog inputs. Parameters include coupling, signal type, polarity and gain.

IMPORTANT!
The configuration only takes effect if you click on the "Set and save" button.

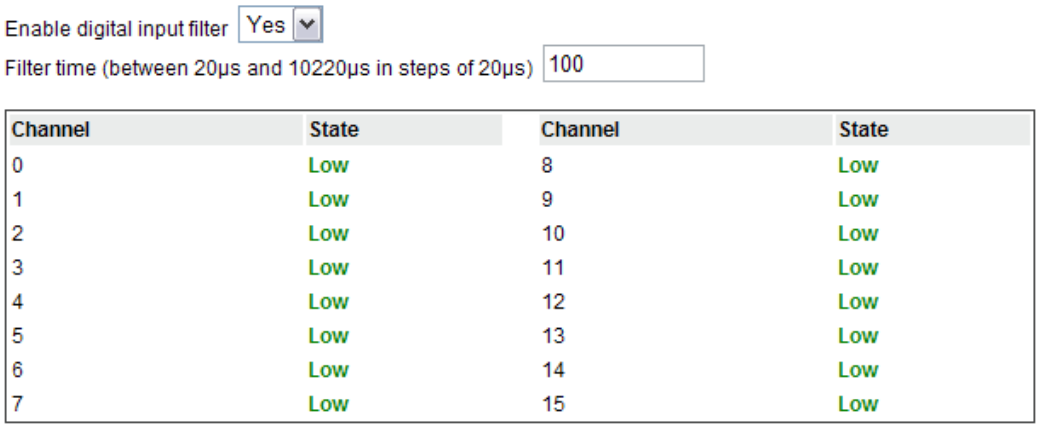
Fig. 5-2: I/O configuration: Analog outputs

Channel	Polarity	Analog Value (-10V - +10V)	Digital Value (0 - 65535)	
0	Unipolar	5.000	16382	Set
1	Bipolar	5.000	49152	Set
2	Bipolar	-5.000	16385	Set
3	Unipolar	0.000	0	Set

For each analog output, an analog value in the range from -10 V to +10 V (bipolar) or from 0 V to +10 V (unipolar) can be entered. If you click on the "Set" button, the output will be set and the corresponding digital value will be computed and displayed.
Instead of an analog value, a digital value (bipolar: 0-65535, unipolar: 0-32767) can be entered as well. The respective analog value will also be computed then.

5.1.2 “Digital I/O” tab

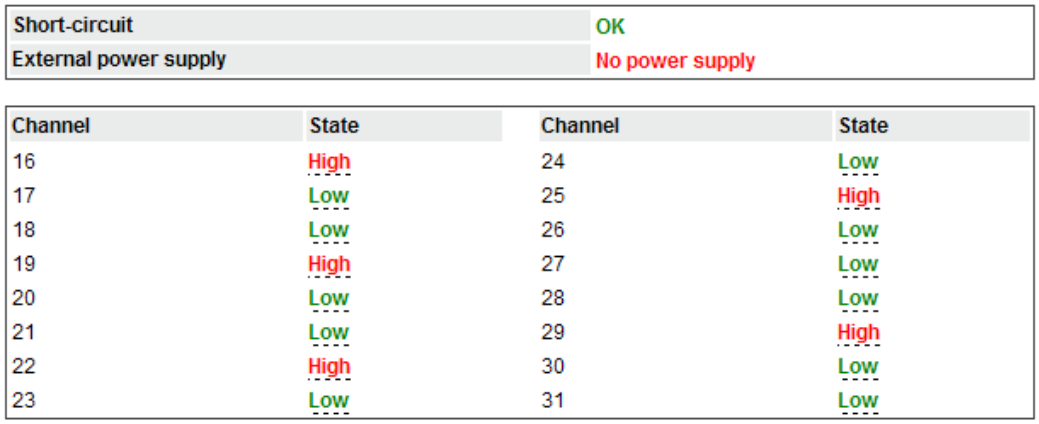
Fig. 5-3: I/O configuration: Digital inputs



For the digital inputs, a filter is available. The filter time can be set in the range from 20 µs to 10220 µs in steps of 20 µs.

IMPORTANT!
The configuration only takes effect if you click on the “Set and save” button.

Fig. 5-4: I/O configuration: Digital outputs



For each digital output, the status (“High” or “Low”) can be defined by clicking on the corresponding button.
If a short-circuit occurs or an external 24 V voltage is not applied, this will be specified above the channel table.

5.2 Menu item “Acquisition”

5.2.1 “Auto-refresh” and “Sequence” tabs

Fig. 5-5: Acquisition modes: Auto-refresh and Sequence

For the acquisition, the Auto-refresh mode and the Sequence mode are available. A detailed description of these modes can be found in Chapter 6 of this manual.

The acquisition is started and stopped in the tool bar above (“Start” and “Stop” buttons). In addition, the configuration can be saved in a file (“Save as”) and later be reloaded (“Load configuration”). Moreover, you can display the source code as a C sample (“Source code”).

On these tabs, also the data format (see Chapter 6.3.4) is shown for each analog input.

5.2.2 “Monitor” tab

When the acquisition has been started, the number of data packets to be transferred can be entered. The respective transfer time is automatically displayed in the line below.
Via the button “Display as table”, all the values sent for each analog input are listed.

5.2.3 “Help” tab

Here, you can find detailed information on the channel selection in Sequence mode and the data transfer in both acquisition modes.

5.3 Menu item “Cycle mode”

The Cycle mode is a programming mode for the analog and digital I/Os of the MSX-E system.
In this mode, the input and output is carried out in a cyclic manner. The clock time, i.e. the time between the beginnings of two cycles, can be programmed in the range from 1 ms to 65535 ms in steps of 1 ms.

5.3.1 “Initialisation” tab

The source code of the Cycle mode program must be written on this tab using the programming language Instruction List. For each cycle, this source code is called up anew.
The Cycle mode is started and stopped in the tool bar above (“Start” and “Stop” buttons).

5.3.2 “Inputs/Outputs” tab

Here, the I/O access possibilities via IEC address are listed.

5.3.3 “Monitor” tab

Fig. 5-6: Cycle mode: Monitor

Clock time (ms)	Counter	Cycle time
100	361	0s 2usec

Local variable name	Value
counter	0

When the Cycle mode has been started, the clock time, the Cycle mode counter with the number of completed cycles, the cycle time and the values of the variables are displayed.

5.3.4 “Help” tab

On this tab, you can find a description of the possible commands (e.g. IEC address, types of variables, arithmetic operation commands) along with samples.

6 Acquisition modes

This chapter exemplifies how to configure and start an acquisition via the web interface of the Ethernet system **MSX-E3121**. Moreover, you can use Modbus or SOAP functions (see MSX-E CD or driver download on the ADDI-DATA website) to perform these steps.

6.1 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 computed.

- On the web interface, from the menu on the left, select the item "Acquisition", and on the right, select the "Auto-refresh" tab.

6.1.1 "Channel configuration" (channel selection)

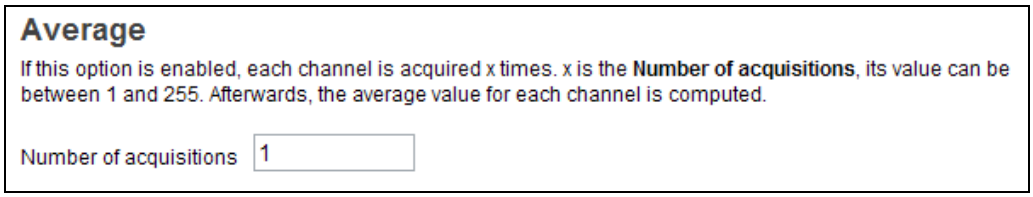
Fig. 6-1: Auto-refresh mode: "Channel configuration"

Designation	Type/Description	Selection
Channel 0	Analog input 0	☑
Channel 1	Analog input 1	☑
Channel 2	Analog input 2	☑
Channel 3	Analog input 3	☑
Channel 4	Analog input 4	☑
Channel 5	Analog input 5	☑

- Select the channels you want to acquire.

6.1.2 "Average" (average value computation)

Fig. 6-2: Auto-refresh mode: "Average"

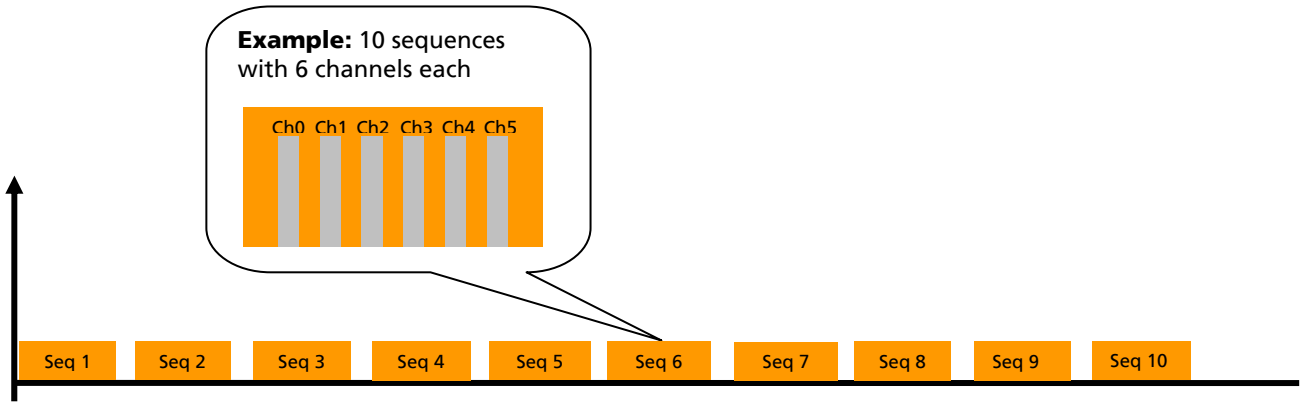


The MSX-E system is capable of computing an average value for each channel.
In the field "Number of acquisitions", you have to enter the number of acquisitions (1 to 255) after which this value should be computed.

Example

The MSX-E system acquires channels 0 to 5. “Number of acquisitions” contains the value 10. This means that ten sequences run down, with each sequence consisting of six channels to be acquired simultaneously.

Fig. 6-3: Auto-refresh mode: Acquisition example



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

Average value of channel 0
= (sequence 1, value of channel 0 + sequence 2, value of channel 0 + … + sequence 10, value of channel 0) / 10

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 5
= (sequence 1, value of channel 5 + sequence 2, value of channel 5 + … + sequence 10, value of channel 5) / 10

The network client will not receive ten data packets, with six values in each packet, but only one data packet containing the average values from channels 0 to 5.

6.2 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, select the item “Acquisition”, and on the right, select the “Sequence” tab.

6.2.1 "Channel configuration" (channel selection)

Fig. 6-4: Sequence mode: "Channel configuration"

Designation	Type/Description	Selection	Acquisition order
Channel 0	Analog input 0	☑	2
Channel 1	Analog input 1	☑	5
Channel 2	Analog input 2	☑	0
Channel 3	Analog input 3	☑	4
Channel 4	Analog input 4	☑	1
Channel 5	Analog input 5	☑	3

You can define the acquisition order of the channels. This is displayed in the correspondent column as soon as you have selected a channel. Each channel can be acquired only once per sequence.

- Select the channels you want to acquire.

6.2.2 "Sequence measurement" (number of sequences)

Fig. 6-5: Sequence mode: "Sequence measurement"

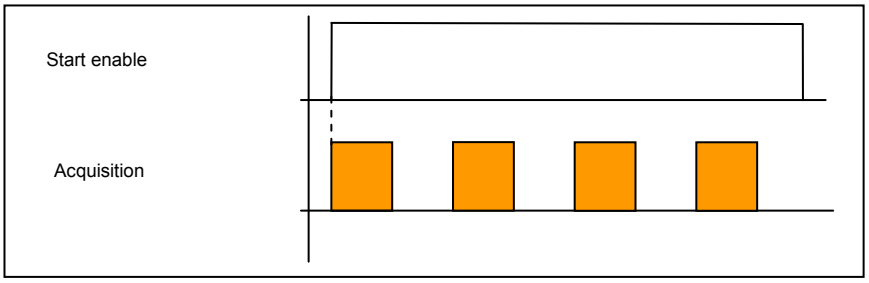
Number of sequences	0
Number of data frames	1

In the field "Number of sequences", you have to enter the number of sequences to be acquired (1 to 4294967295). If this value is 0, the acquisition is continuous.

Example

To acquire four sequences after the start, the field "Number of sequences" must contain the value 4.

Fig. 6-6: "Number of sequences" (example)



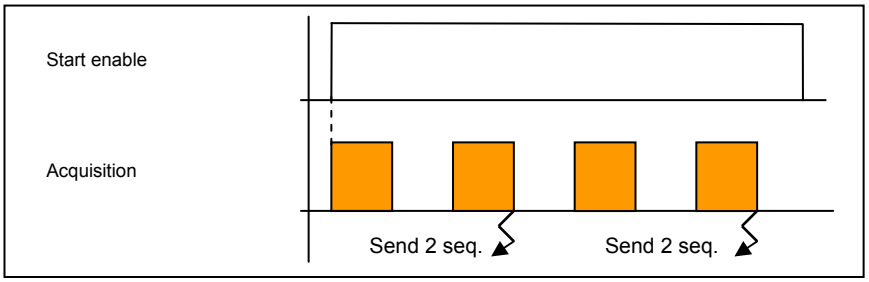
In the field "Number of data frames", you need to define the number of sequences (1 to 4096) that have to be acquired before the measurement values are sent to the target system.

IMPORTANT!
The value entered must not be higher than the value in the field “Number of sequences”. The latter must be divisible by this value.

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
After the start, two sequences are acquired. Then the measurement values are sent to the client.

Fig. 6-7: “Number of data frames” (example)



6.3 Common functions

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

6.3.1 “Refresh time”

Fig. 6-8: Acquisition: Refresh time

Refresh time unit	Refresh time range
Microsecond	10 to 65535
Millisecond	1 to 65535
Second	1 to 65535

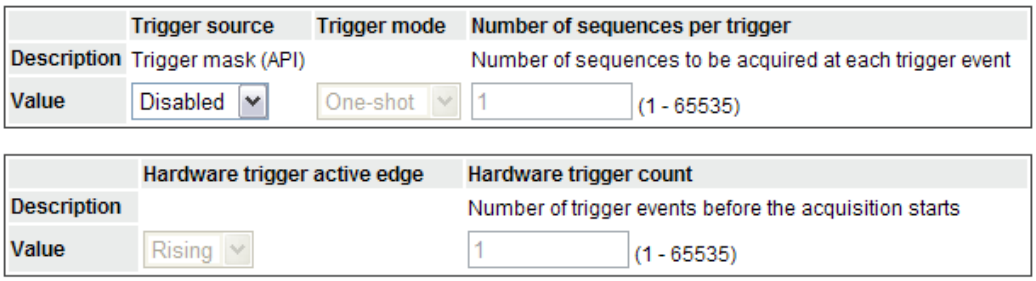
Selection 10 Microseconds

In Auto-refresh mode, the refresh time is the time between the refreshing of the single sequences (acquisition refresh time). In Sequence mode, it is the time between the acquisitions of single sequences (delay).
As the unit of this acquisition refresh time or delay, microseconds, milliseconds or seconds can be defined. The range in which this time can lie is based on the selected unit.

6.3.2 "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. 6-9: Acquisition: Trigger configuration



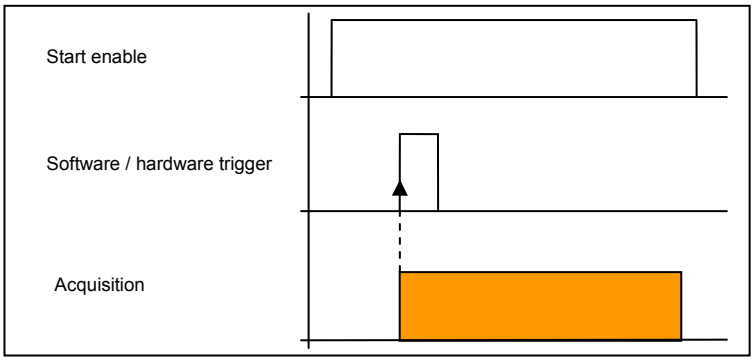
- **Trigger source:** Available trigger types are hardware trigger and synchro trigger.
- **Trigger mode:** If the trigger mode "One-shot" is selected, only one acquisition starts after a trigger. If the option "Sequence" (= "Multi-shot") is activated, a defined number of acquisitions starts (see field "Number of sequences per trigger").
- **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.
- **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.

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).

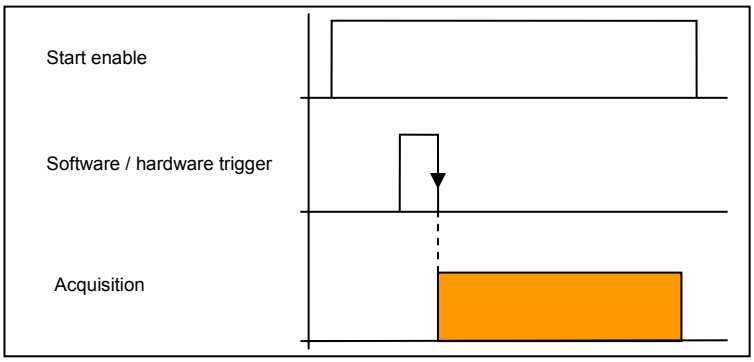
Hardware trigger

1) Examples of edges

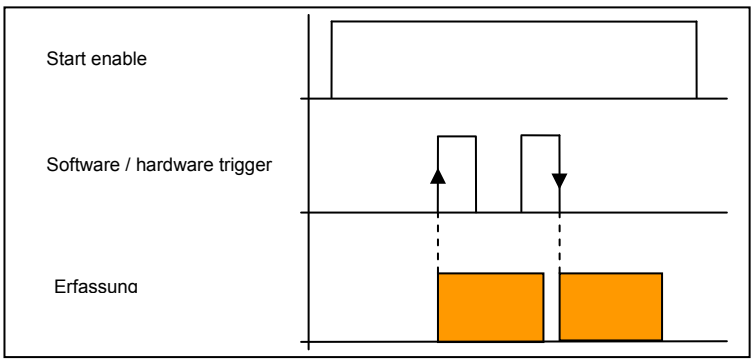
a) Rising: Rising edge



b) Falling: Falling edge



c) Both: Rising and falling edges



2) Examples of hardware triggers with “One-shot”

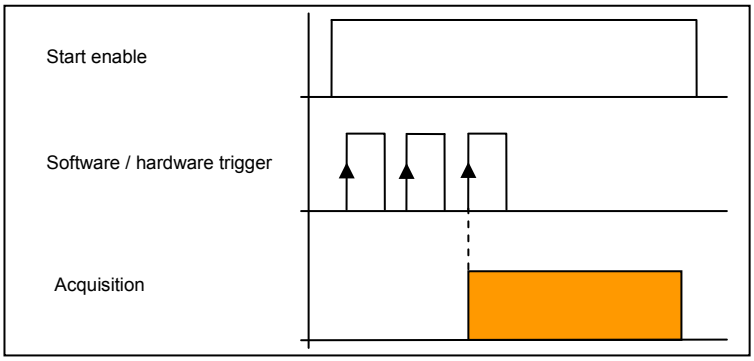
a) To start the acquisition only once after three rising edges, you can use the following configuration:

Fig. 6-10: Hardware trigger with “One-Shot” (a)

	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask (API)		Number of sequences to be acquired at each trigger event
Value	Hardware	One-shot	1 (1 - 65535)

	Hardware trigger active edge	Hardware trigger count
Description		Number of trigger events before the acquisition starts
Value	Rising	3 (1 - 65535)

After the start, the MSX-E system waits for three rising hardware edges. Once the three edges have been identified, the acquisition starts.



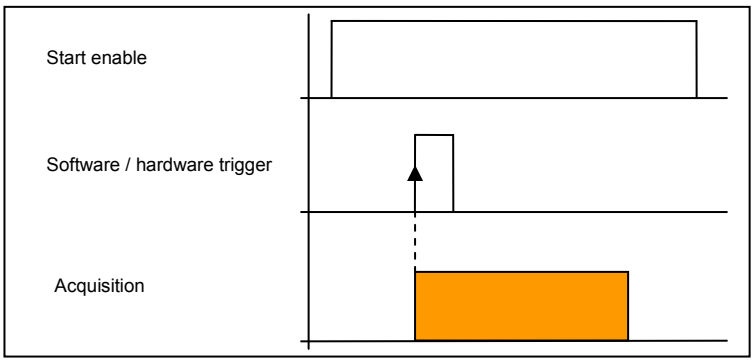
b) With “Hardware trigger active edge”, “Rising” is selected again, and with “Hardware trigger count”, the value 1 is entered.

Fig. 6-11: Hardware trigger with “One-Shot” (b)

	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask (API)		Number of sequences to be acquired at each trigger event
Value	Hardware	One-shot	1 (1 - 65535)

	Hardware trigger active edge	Hardware trigger count
Description		Number of trigger events before the acquisition starts
Value	Rising	1 (1 - 65535)

The trigger starts only one acquisition, which begins with the first hardware edge after the start.



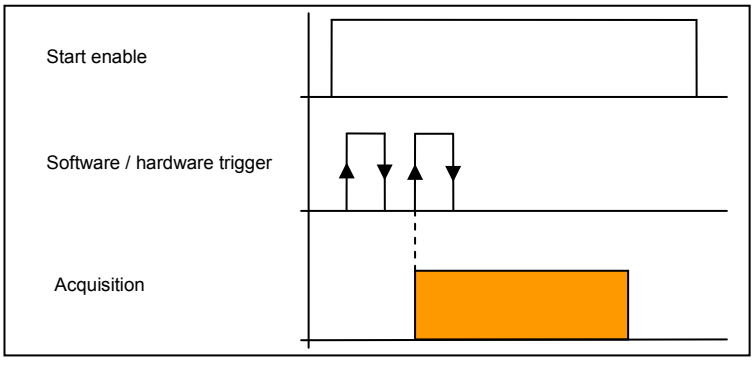
c) With “Hardware trigger active edge”, the option “Both” is selected, and with “Hardware trigger count”, the value 3 is entered.

Fig. 6-12: Hardware trigger with “One-Shot” (c)

	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask (API)		Number of sequences to be acquired at each trigger event
Value	Hardware	One-shot	1 (1 - 65535)

	Hardware trigger active edge	Hardware trigger count
Description		Number of trigger events before the acquisition starts
Value	Both	3 (1 - 65535)

After the start, the MSX-E system waits for three rising and falling hardware edges. Once the three edges have been identified, the acquisition starts.



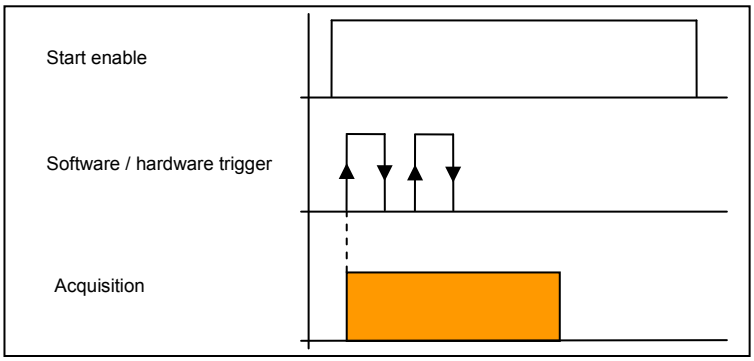
d) With “Hardware trigger active edge”, the option “Both” is selected again, and with “Hardware trigger count”, the value 1 is entered.

Fig. 6-13: Hardware trigger with “One-Shot” (d)

	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask (API)		Number of sequences to be acquired at each trigger event
Value	Hardware	One-shot	1 (1 - 65535)

	Hardware trigger active edge	Hardware trigger count
Description		Number of trigger events before the acquisition starts
Value	Both	1 (1 - 65535)

If several edges occur after the start, the acquisition is started (triggered) with the first edge. The subsequent edges are ignored.



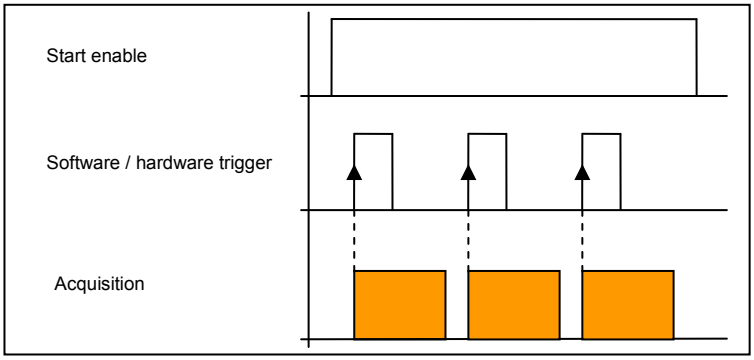
3) Examples of hardware triggers with “Sequence”

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

Fig. 6-14: Hardware trigger with “Sequence” (a)

	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask (API)		Number of sequences to be acquired at each trigger event
Value	Hardware	Sequence	1 (1 - 65535)

	Hardware trigger active edge	Hardware trigger count
Description		Number of trigger events before the acquisition starts
Value	Rising	1 (1 - 65535)



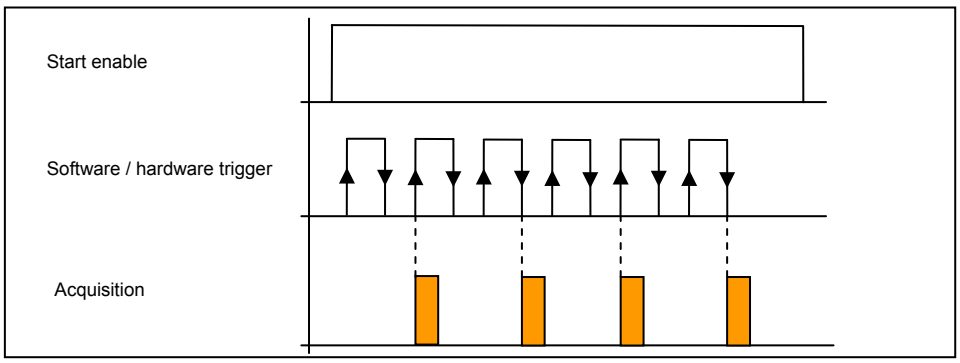
b) With “Hardware trigger active edge”, “Both” is selected, and with “Hardware trigger count”, the value 3 is entered.

Fig. 6-15: Hardware trigger with “Sequence” (b)

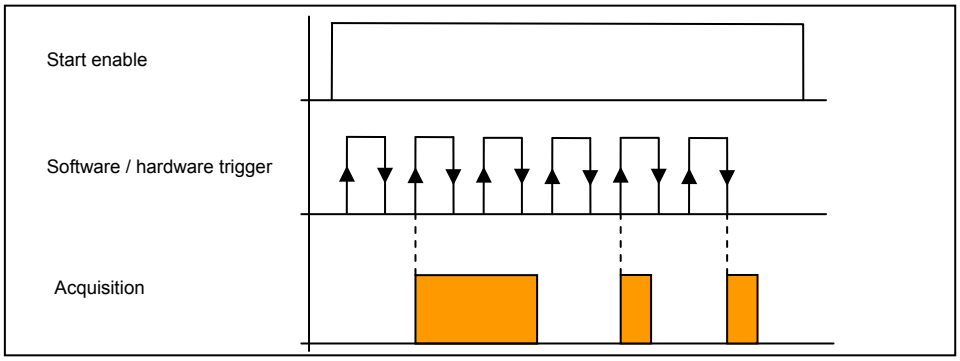
	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask (API)		Number of sequences to be acquired at each trigger event
Value	Hardware	Sequence	1 (1 - 65535)

	Hardware trigger active edge	Hardware trigger count
Description		Number of trigger events before the acquisition starts
Value	Both	3 (1 - 65535)

After the start, 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.



IMPORTANT!
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 example).



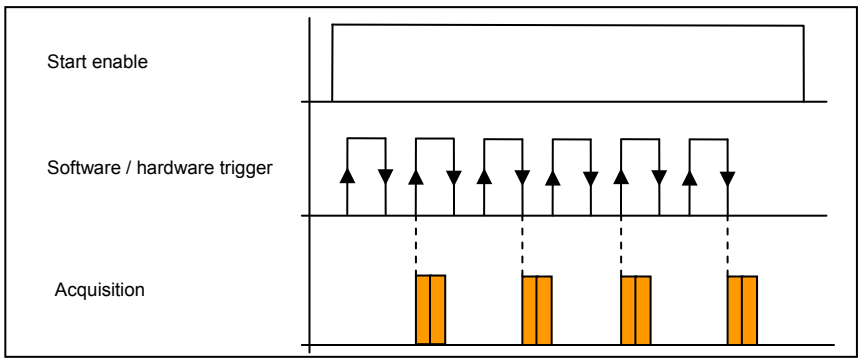
c) The settings correspond to example 2 b) with the exception of “Number of sequences per trigger”, where the value 2 is entered.

Fig. 6-16: Hardware trigger with “Sequence” (c)

	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask (API)		Number of sequences to be acquired at each trigger event
Value	Hardware	Sequence	2 (1 - 65535)

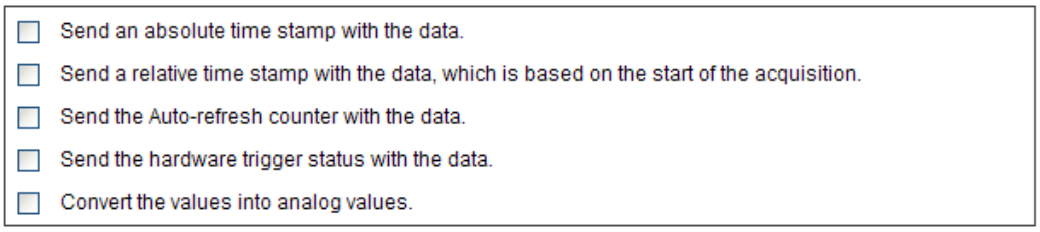
	Hardware trigger active edge	Hardware trigger count
Description		Number of trigger events before the acquisition starts
Value	Both	3 (1 - 65535)

After each trigger, two sequences are acquired.



6.3.3 “Data server frame configuration” (supplementary data)

Fig. 6-17: Acquisition: Data server frame configuration



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 an absolute time stamp with the data:** A time stamp is sent, which contains the date of the acquisition.
- **Send a relative time stamp with the data:** The date of the time stamp relates to the starting point 0 of the acquisition.
- **Send the Auto-refresh (or “Sequence”) counter with the data:** The value of the Auto-refresh or Sequence counter is sent. In Auto-refresh mode, not all sequences are acquired so that the succession of the counter values is incomplete (e. g. 1, 3, 7). In Sequence mode, however, all sequences are acquired. Thus, the succession of these counter values is complete (1, 2, 3, etc.).
- **Send the hardware trigger status with the data:** The current status of the hardware trigger is indicated, i. e. if a rising or falling edge occurred.
- **Convert the values into analog values:** 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-E3121**, the unit is volts (V). As the conversion affects the MSX-E CPU to a certain extent, this can result in slower sending speed.

6.3.4 “Data server frame format” (data format)

Fig. 6-18: Acquisition: Data server frame format

Size	Name	Description
4 bytes	Analog input 0	Value of the analog input, encoded on 24 bits. 0 corresponds to -10V, 0xFFFFFF corresponds to +10V (depending on the gain)
4 bytes	Analog input 1	Value of the analog input, encoded on 24 bits. 0 corresponds to -10V, 0xFFFFFF corresponds to +10V (depending on the gain)
4 bytes	Analog input 2	Value of the analog input, encoded on 24 bits. 0 corresponds to -10V, 0xFFFFFF corresponds to +10V (depending on the gain)
4 bytes	Analog input 3	Value of the analog input, encoded on 24 bits. 0 corresponds to -10V, 0xFFFFFF corresponds to +10V (depending on the gain)
4 bytes	Analog input 4	Value of the analog input, encoded on 24 bits. 0 corresponds to -10V, 0xFFFFFF corresponds to +10V (depending on the gain)
4 bytes	Analog input 5	Value of the analog input, encoded on 24 bits. 0 corresponds to -10V, 0xFFFFFF corresponds to +10V (depending on the gain)

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. All measurement values and the additional data such as the time stamp form a group of values that is called packet.

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

Example

A packet consists of a time stamp and six 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.

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

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

tv_sec	tv_usec	Auto-refresh counter	Hardware trigger	Auto-refresh data
4 bytes	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 Auto-refresh counter)	optional (if data format has hardware trigger)	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	Hardware trigger	Sequence data
4 bytes	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)	optional (if data format has hardware trigger)	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

7 Technical data and limit values

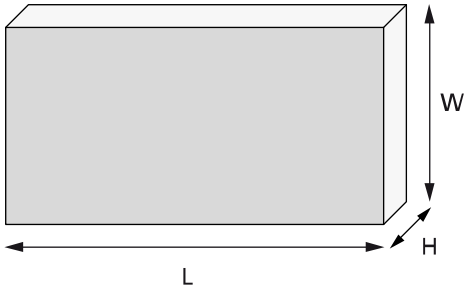
7.1 Electromagnetic compatibility (EMC)

The Ethernet system **MSX-E3121** complies 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.

7.2 Mechanical structure

Fig. 7-1: MSX-E3121: Dimensions



Dimensions (L x W x H):	270 x 140 x 35 mm
Weight:	1200 g 1260 g (with MX-Rail)

Fig. 7-2: MSX-E3121: View from above

7.3 Versions

The Ethernet system **MSX-E3121** is available in the following versions:

Table 7-1: MSX-E3121: Versions

Version	Features
MSX-E3121-6-4	6 analog inputs, 4 analog outputs (voltage)
MSX-E3121-6-4C	6 analog inputs, 2 analog outputs (voltage), 2 analog outputs (current)

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).

7.4 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):	390 mA typ. (±10 %)
Safety:	
Degree of protection:	IP 65[4]
Optical isolation:	1000 V

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

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

7.4.1 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)

7.4.2 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.

7.4.3 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)

7.4.4 Analog inputs

Number of inputs:	6 (1 A/D converter per channel)
Input type:	single-ended or differential (software-selectable)
Coupling:	DC, AC (software-selectable)
Resolution:	24-bit
Input ranges:	see Table 7-2
Sampling frequency:	100 kHz (per channel)
Gain:	x1, x10, x100 (software-selectable)
ADC type:	oversampled SAR with linear-phase FIR anti-aliasing digital filter
Oversampling:	8 x f_s
Frequency accuracy:	±50 ppm
Input stage:	
Input impedance:	1 MΩ // 300 pF typ., DC-coupled
AC cut-off frequency (-3dB):	0.48 Hz typ.
Overvoltage protection (max. continuous current):	positive input: -14 V to +27 V, ±100 mA negative input: ±14 V, ±100 mA
ESD protection:	> 30 kV (Human Body Model)
Filter properties:	
Passband:	DC up to 0.453 x f_s typ.
Passband ripple:	±0.1 dB max., DC up to 0.453 x f_s
Bandwidth (-3 dB):	0.49 x f_s typ.
Stop-band:	0.547 x f_s typ.
Stop-band attenuation:	100 dB min.
Group delay:	37 / f_s (µs) typ.
Settling time:	74 / f_s (µs, complete settling)
Dynamic properties:	
Signal-to-noise ratio (SNR):	FSR, f_{in} = 1 kHz, see Table 7-3
Total harmonic distortion (THD):	FSR, f_{in} = 1 kHz, see Table 7-3
Dynamic range:	short-circuited inputs, see Table 7-3
Crosstalk:	between channels 0-1, 2-3, 4-5, 6-7, with gain x1, see Table 7-4
Phase mismatch:	between channels 1-2, 3-4, 5-6, 7-8, with gain x1, see Table 7-5
Amplitude accuracy:	±0.009 dB max. at f_{in} = 1 kHz (sine signal), gain: x1, x10, x100
Common-mode rejection ratio (CMRR):	> 110 dB typ. at DC > 90 dB typ. at f_{in} < 1 kHz
Offset error:	±90 µV after calibration at 25 °C
Onboard DC calibration:	software-selectable
Calibration voltage:	see Table 7-6
Temperature drift:	±8 ppm/°C typ.
Sensor supply:	
Voltage source:	24 V / 100 mA max.

Table 7-2: Input ranges

Gain	Input ranges (V)	
	single-ended	differential
x1	±10	±5
x10	±1	±0,5
x100	±0,1	±0,05

Table 7-3: Dynamic properties

Gain	SNR (dB)	THD (dB)	Dynamic range (dB)
x1	≥ 95	≥ 100	≥ 105
x10	≥ 94	≥ 100	≥ 100
x100	≥ 75	≥ 90	≥ 85

Table 7-4: Crosstalk

Input signal frequency	Crosstalk (dB)
Short-circuited input, f_{in} = 100 Hz	≥ 104
Short-circuited input, f_{in} = 1 kHz	≥ 100
50 Ω input, f_{in} = 100 Hz	≥ 104
50 Ω input, f_{in} = 1 kHz	≥ 100

Table 7-5: Phase mismatch

Input signal frequency	Phase mismatch (°)
f_{in} < 100 Hz	±0.001
f_{in} < 2 kHz	±0.01
f_{in} < 10 kHz	±0.1

Table 7-6: Calibration voltage

Gain	Calibration voltage (typ.)
x1	5 V
x10	900 mV
x100	90 mV

7.4.5 Analog outputs

Output type:	voltage output (single-ended)
Number of outputs:	4 **(MSX-E3121-6-4)** 2 **(MSX-E3121-6-4C)**
Resolution:	15-bit (unipolar) 16-bit (bipolar)
Output range:	0-10 V (unipolar) ±10 V (bipolar)
LSB:	305.176 µV
Integral nonlinearity (INL) of the D/A converter:	±1 LSB max.
Differential nonlinearity (DNL) of the D/A converter:	±1 LSB max.
Accuracy (±10 V, after calibration):	±4 LSB typ. ±8 LSB max.
Output current/load:	±5 mA / 2 kΩ min. (per output)
Short-circuit current:	±28 mA (temporary)
Output voltage after reset:	0 V (not calibrated)
Overvoltage protection:	±13 V
Current supply of actuators:	300 mA max. (per M12 female connector)
Output type:	current output
Number of outputs:	2 **(MSX-E3121-6-4C)**
Resolution:	15-bit (unipolar)
Output range:	0-20 mA
LSB:	610.35 nA
Load (at 20 mA):	10 Ω min. 510 Ω max.
Output current after reset:	0 mA

7.4.6 Digital inputs

Number of inputs:	16 (common GND according to IEC 1131-2)
Optical isolation:	1000 V (via opto-couplers)
Nominal voltage:	24 VDC
Input voltage:	0-30 V
Input current (at nominal voltage):	Channels 1-15: 3.9 mA typ. Channel 0: 6 mA

Max. input frequency (at nominal voltage):	Channels 1-15: 5 kHz Channel 0: 100 kHz
Logic input levels:	UH_{max}: 30 V / 6 mA typ. UH_{min}: 19 V / 2 mA typ. UL_{max}: 14 V / 0.7 mA typ. UL_{min}: 0 V / 0 mA typ.

7.4.7 Digital outputs

Number of outputs:	16
Optical isolation:	1000 V (via opto-couplers)
Output type:	high-side (load to ground according to IEC 1131-2), driver type: Infineon BTS4880R (8-channel type)
Nominal voltage:	24 VDC
Supply voltage:	11-36 V
Current:	1.5 A (per 8 channels, via PTC)
Output current per output:	150 mA max.
Short-circuit current per output:	1.1 A typ. (pulse current) shutdown logic at 24 V, $R_{Load} < 0.1\ \Omega$
R_{DS} ON resistance:	0.2 Ω max. at 25 °C
Switch-on time:	50 µs typ.
Switch-off time:	75 µs typ.
Overtemperature (shutdown):	135 °C
Temperature hysteresis:	10 °C
Diagnosis:	common diagnostic bit for all 16 channels at overtemperature of one channel

8 Appendix

8.1 Glossary

ADC
= A/D converter

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.

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.

Edge
Edges can either be rising or falling.
Logic levels are defined for processing and displaying information. In binary circuits, 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. The rising edge is the transition from the status “0” to “1”; the falling edge is the opposite transition.

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.

ESD
= Electrostatic Discharge

On non-conductive surfaces, an electric charge is conducted away very slowly. If the dielectric strength is overcome, there is a fast potential equalisation between the surfaces involved. The often very sudden equalisation process is referred to as electrostatic discharge (ESD). Currents of up to 20 A may occur in this process.

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.

FSR
= Full Scale Range

FSR is the usable measurement range.

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.

Hysteresis
Hysteresis is the difference between the start-up and shut-down voltage. In TTL circuits, it is typically 0.8 V; in CMOS circuits, it depends on the supply voltage.

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.

PTC
= Positive Temperature Coefficient

The best-value resistance sensors are either specified as PTC or NTC thermistors. A PTC thermistor has a positive temperature coefficient, hence, "PTC".

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.

Short-circuit current
A short-circuit current is the current between two short-circuited terminals.

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.

Switch-off time
The switch-off time is the time between the control current being switched off and the output voltage falling to 10% of its original value.

synchronous
Two time-dependent events, time slots, or signals are synchronous if their respective significant dates correspond with each other and are divided by requested time intervals that are nominally the same.

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.

8.2 Index

9 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