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TECHNICAL

DESCRIPTION

MSX-E1516

Ethernet digital I/O system

DIN EN ISO 9001:2008 certified

Edition: 02.02-03/2015

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.
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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**.

Contents

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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	Function description (digital inputs/outputs) including pin assignment and connection examples
4	Description of the function-specific pages of the MSX-E web interface plus information on the data format
5	List of technical data and limit values of the MSX-E system
6	Appendix with glossary and index
7	Contact and support address

1 Definition of application, user, handling

1.1 Definition of application

1.1.1 Intended use

The Ethernet system **MSX-E1516** for digital input or 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-E1516** must not be used as a safety-related part (SRP).

The Ethernet system **MSX-E1516** must not be used for safety-related functions.

The Ethernet system **MSX-E1516** must not be used in potentially explosive atmospheres.

The Ethernet system **MSX-E1516** 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

NOTICE!

The protection according to the defined degree of protection (see Chapter 5.4) 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.

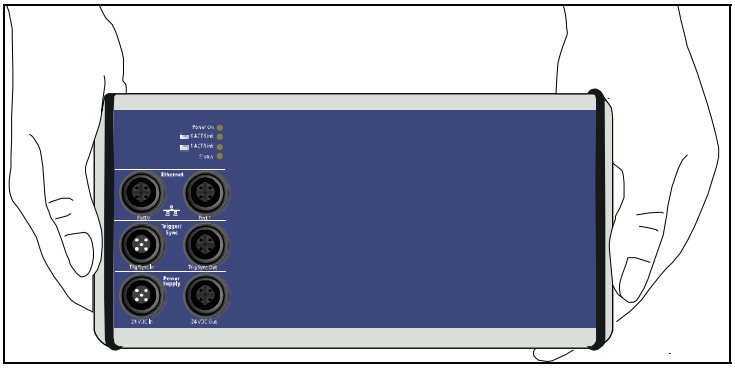
1.3.2 Country-specific regulations

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

If you have any questions, you can send them to us 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-E1516** can be downloaded for free at: www.addi-data.com

NOTICE!

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

2 Brief description

2.1 Functions and features

The intelligent Ethernet system **MSX-E1516** has eight times two digital 24 V lines, which can be configured as pairs of inputs or outputs.
The system provides an event logic for the inputs and outputs. Thus, an event datagram can be generated when their status changes.

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

Via 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. The “Status” LED provides for a quick and easy error diagnosis.

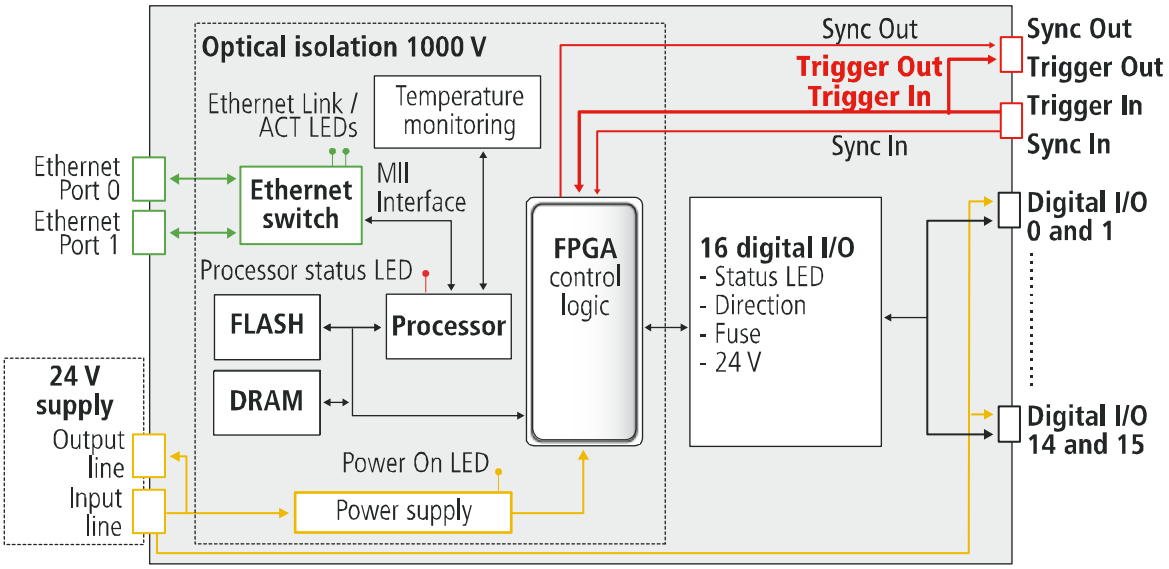
The electronics are no longer in the computer itself but in an external housing connected to the computer via Ethernet. As the Ethernet system is attached in direct vicinity of the sensor or actuator, the function of the latter is no longer affected by long cables. The length of the (Ethernet) connection 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:

- 16 digital inputs/outputs, 24 V, can be configured in pairs, LEDs to display level and direction
- Event logic for the inputs/outputs
- Watchdog for resetting the outputs to “0” (the latter are set to “0” at Power-On)
- Digital input/output: can be controlled by means of an external trigger (digital 24 V trigger input)
- Web interface to configure, control and monitor the digital input/output
- 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

2.2 Block diagram

Fig. 2-1: MSX-E1516: Block diagram



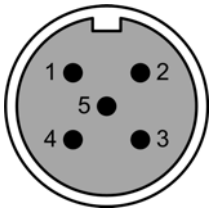
3 Function description: Digital inputs/outputs

The Ethernet system **MSX-E1516** has 16 digital inputs or outputs for sensors or actuators.

3.1 Pin assignment

To each M12 female connector, up to two sensors or actuators can be connected. In addition, a 24 V supply is available.

Table 3-1: Pin assignment: Digital inputs/outputs

Pin No.	Female connector, 5-pin, M12	Cable (black)
		Lead colour
1	24 V output	brown
2	Digital I/O (2n+1)*	white
3	GND	blue
4	Digital I/O (2n)*	black
5	not connected	grey
		

* Please note that the female connector (n) is dual-wired and that the digital I/Os are determined via (2n+1) or (2n) with 0 ≤ n ≤ 7.

Examples:

Female connector 0 (n=0) –> Pin 2: (2 x 0 + 1) –> Digital I/O 1
–> Pin 4: (2 x 0) –> Digital I/O 0

Female connector 7 (n=7) –> Pin 2: (2 x 7 + 1) –> Digital I/O 15
–> Pin 4: (2 x 7) –> Digital I/O 14

3.2 LED display

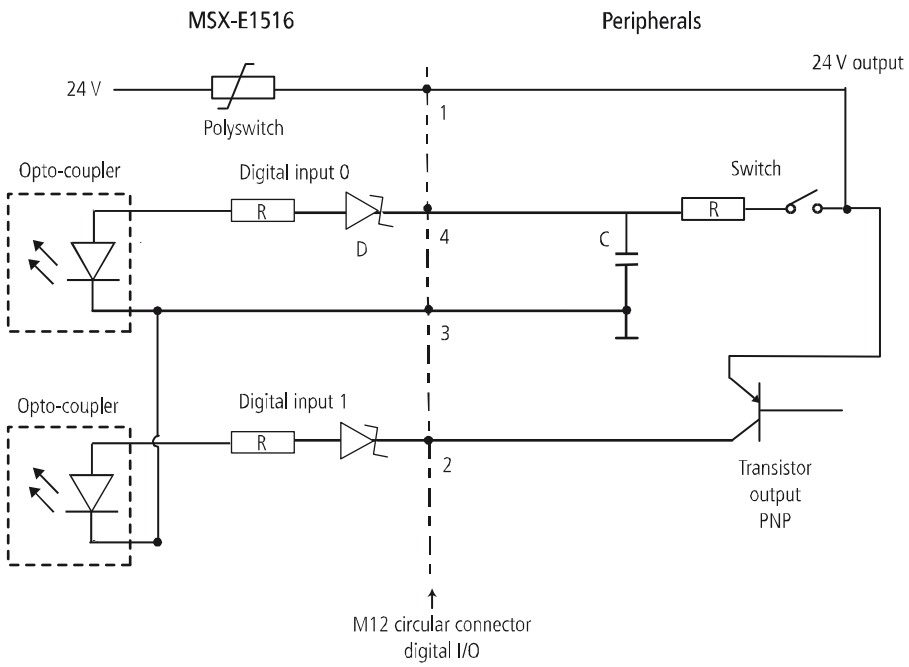
Table 3-2: LED display: Digital I/O

Direction	Status	LED	Meaning
Output	inactive	No display	- No output active - No voltage applied
Output	active	Lights red	- Output is active - No voltage applied **Caution, risk of short-circuit!**
Input	inactive	Lights green	- Input is ready for operation - Signals can be received
Input	active	Lights yellow	- Input is active - Signal is being received

3.3 Connection examples

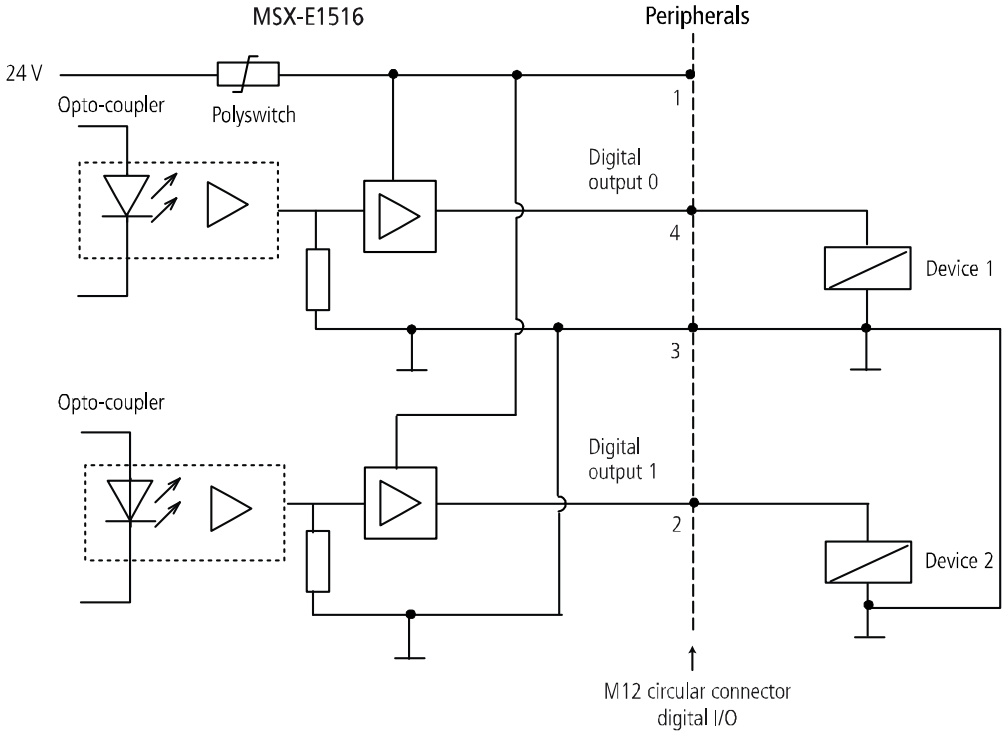
3.3.1 Digital inputs (24 V)

Fig. 3-1: Connection example: Digital inputs (24 V)



3.3.2 Digital outputs (24 V)

Fig. 3-2: Connection example: Digital outputs (24 V)



3.4 Digital outputs

By default, the digital channels of the **MSX-E1516** are configured as inputs.
A port, i.e. a pair of channels can be configured as an output via the web interface of the MSX-E system (see Chapter 4.1.1) or via the SOAP or Modbus function “DigitalIOInitPortConfiguration”.

NOTICE!
For each connector or port, only inputs or outputs can be configured. In the event of a system reboot, the configuration is only persistent if it has been changed on the web interface.

A port configured as an output is high-impedance. The status of the outputs can be read back by way of control.

If a short-circuit occurs at a connected output, this output will be deactivated.
As soon as the short-circuit has been eliminated, a rearm has to be carried out to reactivate the output (see Chapter 4.1.1). This means that the output is set to the status value that was programmed before the short-circuit occurred. A new value can only be defined after the rearm event.

3.5 Watchdog

The Ethernet system **MSX-E1516** has a 16-bit watchdog, which is programmable in three time units (µs, ms, s). The watchdog is used to reset the digital outputs to 0 V after a specific time.

Operation of the watchdog

1. After the system reboot, the watchdog is in "Uninitialised" state.
   It can be initialised and activated ("Running" state) over the web interface of the MSX-E system or by a software function.
2. With the first write access to the outputs, the watchdog is started: The watchdog time is loaded and the watchdog starts counting down.
   As long as the watchdog time has not elapsed, the watchdog is triggered with every further write access to the outputs, i.e. the watchdog time is reloaded.
3. When the watchdog time has elapsed, the watchdog is put in "Overrun" state and all digital outputs are set to 0 V or 0 mA. In "Overrun" state, any write access to the outputs is ignored.
4. To re-enable write access, the watchdog first has to be put in "Stopped" state (web interface) or deactivated by a software function.
   To reactivate the watchdog, it has to be put in "Running" state again or reinitialised and reactivated by a software function.

3.6 Event logic

The event logic function (OR logic) enables event datagrams to be generated when the status of the digital inputs or outputs changes.

On the web interface of the MSX-E system (see Chapter 4.1.1) or via the SOAP function "MSXE1516__DigitalIOInitAndEnableEvent", you can define the edge type of a specific channel for which such a datagram should be generated.

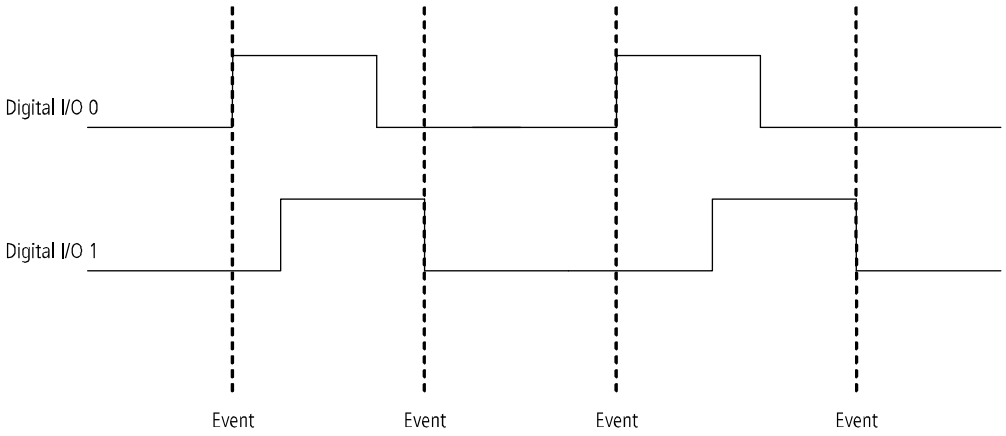
When an event occurs, the Ethernet system provides the following information (see also Chapter 3.7):

- Time stamp (optional)
- "Source event mask": Mask of the digital I/Os that generated the event
- "Digital I/O Status": Status of the digital I/Os when the event occurred.

Example

For each rising edge of the digital I/O 0 and for each falling edge of the digital I/O 1, an event datagram should be generated.

Fig. 3-3: Event logic



NOTICE!

If the digital input filter is activated, the event logic may be initialised only when the filter time has elapsed.

To avoid “false” events at the beginning of the application, a delay between the filter activation (SOAP function “MSXE1516__DigitalIOSetInputFilterTime”) and the event logic initialisation (SOAP function “MSXE1516__DigitalIOInitAndEnableEvent”) must be inserted. This delay should correspond to the longest possible filter time, i.e. 65535 µs.

When the filter is activated, the digital inputs are internally set to 0. If they are externally switched to 24 V, for example, they will only be set to 1 again when the complete filter time has elapsed.
By configuring a digital output via the web interface, all other information from the “Digital I/O” page including filter value and event logic is transferred to the MSX-E-System as well, and that at the same time, i.e. without delay. Since the digital inputs are set to 0 during the whole filter time, a “false” event is thus detected.
However, if you set an output directly via the SOAP function (e.g. sample in the CD directory “MSX-E1516\SOAP\Samples \Windows\C#.NET_2005\ReadWrite”), no “false” events will occur.

3.7 Data format

Table 3-3: Data format: Digital I/O

tv_sec	tv_usec	Source event mask	I/O status bitmap
4 bytes	4 bytes	4 bytes	4 bytes
Time stamp (in s) low (if data format has time stamp)	Time stamp (in µs) high (if data format has time stamp)	Mask of the event source: - Bit 0-15: Status change of the channel has generated the event - Bit 16-28 = 0 - Bit 29: Event logic bit is set when the status of the channel changes - Bit 30: Synchro trigger has generated the event - Bit 31: Hardware trigger has generated the event The event may be generated by several sources at the same time.	Status of the channels after latching

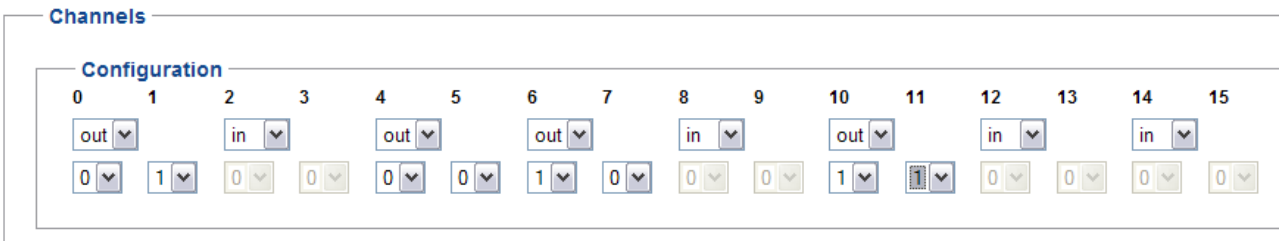
4 Web interface: Quick access to the MSX-E system

4.1 "I/O Configuration"

In this manual, the function-specific pages of the **MSX-E1516** 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).

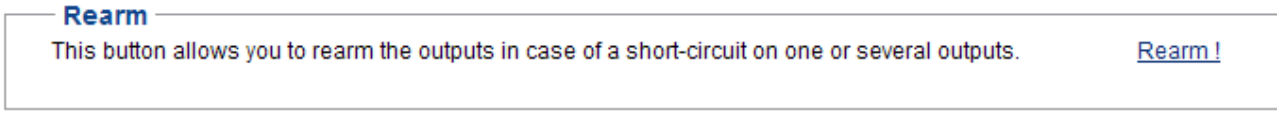
4.1.1 Menu item "Digital I/O"

Fig. 4-1: Digital I/O: Channels



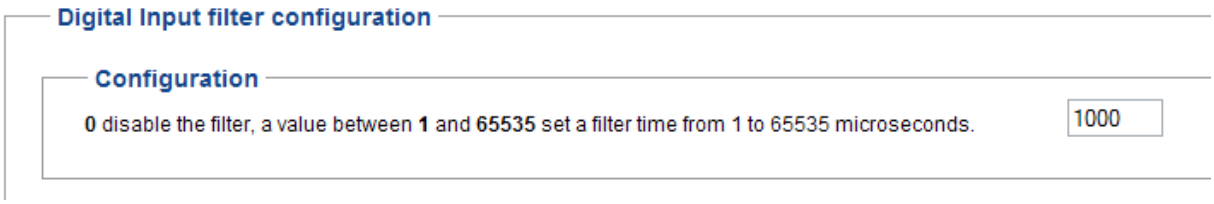
On this page, you can configure the digital channels as pairs of inputs or outputs. For each output, also the status (0 or 1) has to be defined.

Fig. 4-2: Channels: Rearm



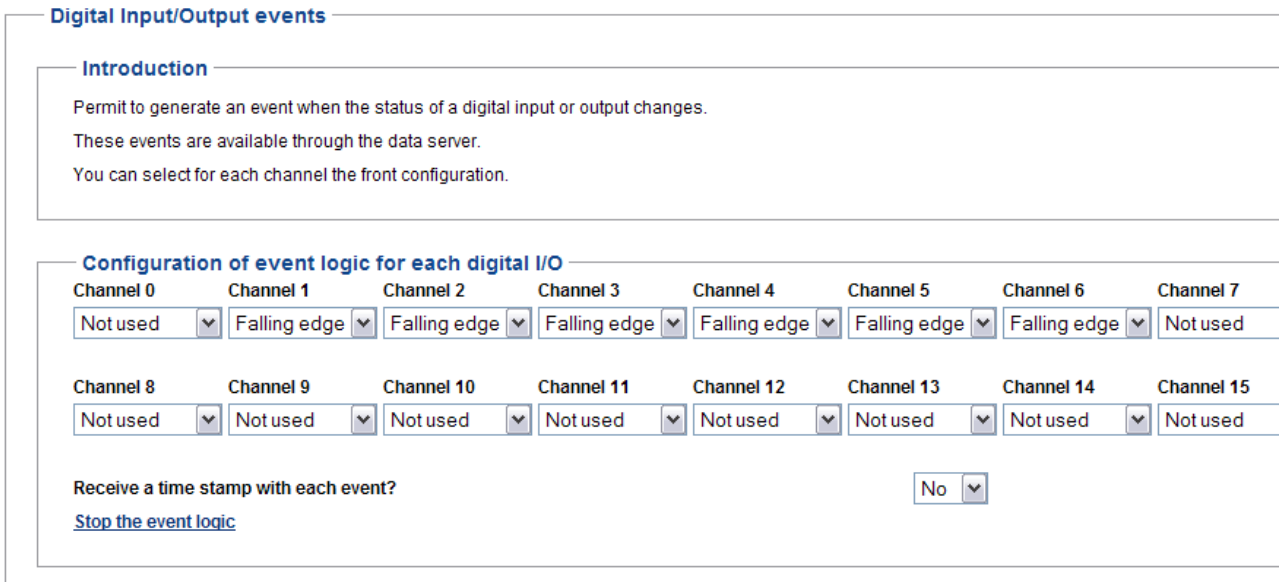
After a short-circuit occurred, the required rearm (see Chapter 3.4) can be carried out via the correspondent button.

Fig. 4-3: Digital I/O: Digital input filter configuration



For the digital inputs, a filter can be defined.
The filter time can be between 1 µs and 65535 µs. By entering the value 0, the filter will be deactivated.

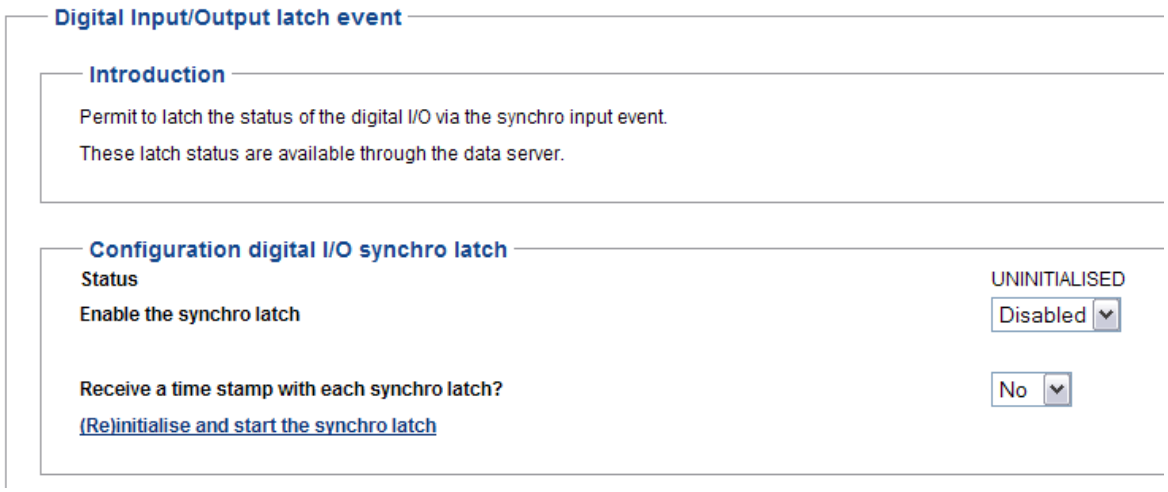
Fig. 4-4: Digital I/O: Digital Input/Output events



In this section, you can select for which channel and for which respective edge type an event datagram should be generated.
In addition, a time stamp can be set for each event. The event logic is stopped via the corresponding button.

NOTICE!
Please read Chapter 3.6 if you have activated the digital input filter!

Fig. 4-5: Digital I/O: Digital Input/Output latch event



The current status of the digital inputs or outputs can be saved via the synchro trigger and be sent via the data server. A time stamp is available as an option.

4.1.2 Menu item “I/O Watchdog”

Fig. 4-6: I/O Watchdog: Current state

On this page, the current status of the watchdog for the digital inputs and outputs is displayed.

Fig. 4-7: I/O Watchdog: Configuration

You can configure the watchdog by defining the time unit and the watchdog time.

5 Technical data and limit values

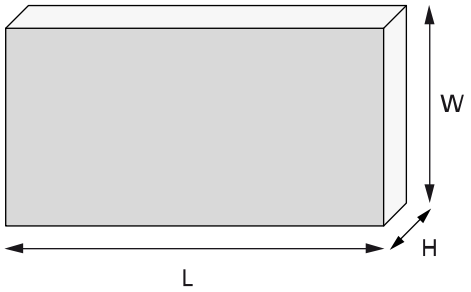
5.1 Electromagnetic compatibility (EMC)

The Ethernet system **MSX-E1516** 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.

5.2 Mechanical structure

Fig. 5-1: MSX-E1516: Dimensions



Dimensions (L x W x H):	215 x 110 x 50 mm
Weight:	900 g 960 g (with MX-Rail)

Fig. 5-2: MSX-E1516: View from above

NOTICE!
The connection lines must be installed in such a way that they are protected against mechanical loads.

5.3 Version

The Ethernet system **MSX-E1516** is available in the following versions:

Table 5-1: MSX-E1516: Versions

Version	Features
MSX-E1516	16 digital inputs/outputs, 24 V
MSX-E1516-NPN	16 digital inputs, 24 V (NPN)

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).

5.4 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):	200 mA ± 10 % (when the outputs are switched off)
Safety:	
Degree of protection:	IP 65[1]
Optical isolation:	1000 V
Reverse polarity protection:	1 A max.

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.

5.4.1 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)

5.4.2 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.

5.4.3 Synchro input and output

Number of inputs:	1
Number of outputs:	1
Optical isolation:	1000 V
Output type:	RS422
Output frequency:	800 kHz typ.
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)

5.4.4 Digital inputs

Number of inputs:	16 (2 per female connector / common GND according to IEC 1131-2)
Overvoltage protection:	30 V
Optical isolation:	1000 V (via opto-couplers)
Nominal voltage:	24 VDC
Input voltage:	0-30 V
Max. input frequency:	1 MHz (at nominal voltage)
Input impedance:	> 1 MΩ
Logic input levels:	UH_{max}: 30 V UH_{min}: 19 V UL_{max}: 14 V UL_{min}: 0 V

5.4.5 Digital outputs

Number of outputs:	16 (2 per 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
Current:	1.85 A max. (for each group[2]) via PTC
Output current per output:	500 mA max.
Short-circuit current per output:	1.7 A max. shut-down logic at 24 V, R_{Load} = 10 mΩ
R_{DS} ON resistance:	280 mΩ max.
Switch-on time:	100 µs (max. R_L = 48 Ω of 80 % V_{out})
Switch-off time:	150 µs (max. R_L = 48 Ω of 10 % V_{out})
Overtemperature (shut-down):	135 °C max. (output driver)
Temperature hysteresis:	15 °C typ. (output driver)
Diagnosis:	at overtemperature of one or more outputs

5.4.6 Watchdog

Number:	1
Resolution:	16-bit
Time base:	µs, ms, s (programmable)
Time value range:	1 to 65535

[2] Group 1: Digital outputs 0 to 3, 8 to 11 and the respective 24 V output
Group 2: Digital outputs 4 to 7, 12 to 15 and the respective 24 V output

6 Appendix

6.1 Glossary

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.

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.

Event
An event is an occurrence detected by the MSX-E system. Where e. g. a short-circuit is detected and an event is activated, a short-circuit warning can be sent via the event server.

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.

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.

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.

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.

Watchdog
A watchdog is an electronic delay switch used to monitor key components or devices. It is activated periodically and triggers an alarm after a specified time. If the unit to be monitored is working correctly, the watchdog is reset before triggering the alarm.

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7 Contact and support

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