ADDI-DATA®
SPIRIT OF EXCELLENCE

TECHNICAL

DESCRIPTION

MSX-E3311

Ethernet system for pressure and force measurement

Edition: 02.03-11/2012

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
This manual, which is intended for the operator and its staff only, is protected by copyright.
Duplication of the information contained in the operating instructions and of any other product information, or disclosure of this information for use by third parties, is not permitted, unless this right has been granted by the product licence issued. Non-compliance with this could lead to civil and criminal proceedings.

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.

ADDI-DATA®
SPIRIT OF EXCELLENCE

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:

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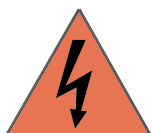
⚡   **WARNING!**
       Designates a possibly dangerous situation.
       If the instructions are ignored, the Ethernet system, the PC and/or peripherals may be **destroyed** and persons may be **endangered**.

ADDI-DATA®
SPIRIT OF EXCELLENCE

Contents

ADDI-DATA®
SPIRIT OF EXCELLENCE

Figures

Tables

ADDI-DATA®
SPIRIT OF EXCELLENCE

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 strain gauge sensors and the Wheatstone bridge
4	Function description (strain gauge inputs) including pin assignments and connection examples
5	Description of the function-specific pages 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

ADDI-DATA®
SPIRIT OF EXCELLENCE

1   Definition of application, user, handling

1.1   Definition of application

1.1.1   Intended use

The Ethernet system **MSX-E3311** for the acquisition, processing and transferring of strain gauge sensor signals 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-E3311** must <u>not</u> be used as safety-related part (SRP).

The Ethernet system **MSX-E3311** must <u>not</u> be used for safety-related functions.

The Ethernet system **MSX-E3311** must <u>not</u> be used in potentially explosive atmospheres.

The Ethernet system **MSX-E3311** 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

i   **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.

ADDI-DATA
SPIRIT OF EXCELLENCE

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 <u>not</u> 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-E3311** can be downloaded for free at:

www.addi-data.com

i   **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.

ADDI-DATA®
SPIRIT OF EXCELLENCE

2   Brief description

In this chapter, the functions and features of the Ethernet system **MSX-E3311** are described in brief. Furthermore, you will find a general block diagram of the MSX-E system.

2.1   Functions and features

With the Ethernet system **MSX-E3311**, up to 16 strain gauge sensors can be acquired.
The voltage sources are integrated in the system in order for measurement bridges to be used.

Measurement sequences on multiple systems can be started simultaneously over an external trigger. The system can be configured over either the integrated web interface or SOAP 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 directly to the signal generator (measuring point), the measurements can no longer be 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:

- 8 or 16 differential inputs for strain gauge sensors

- Internal voltage sources for sensor supply

- Sampling frequency: can be configured in groups in the range from 5 Hz to 2 kHz

- 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

- Cascadable; synchronisation in the µs range

- Extended operating temperature range from -40 °C to +85 °C

ADDI-DATA®
SPIRIT OF EXCELLENCE

2.2 Block diagram

Fig. 2-1: MSX-E3311: Block diagram

ADDI-DATA®
SPIRIT OF EXCELLENCE
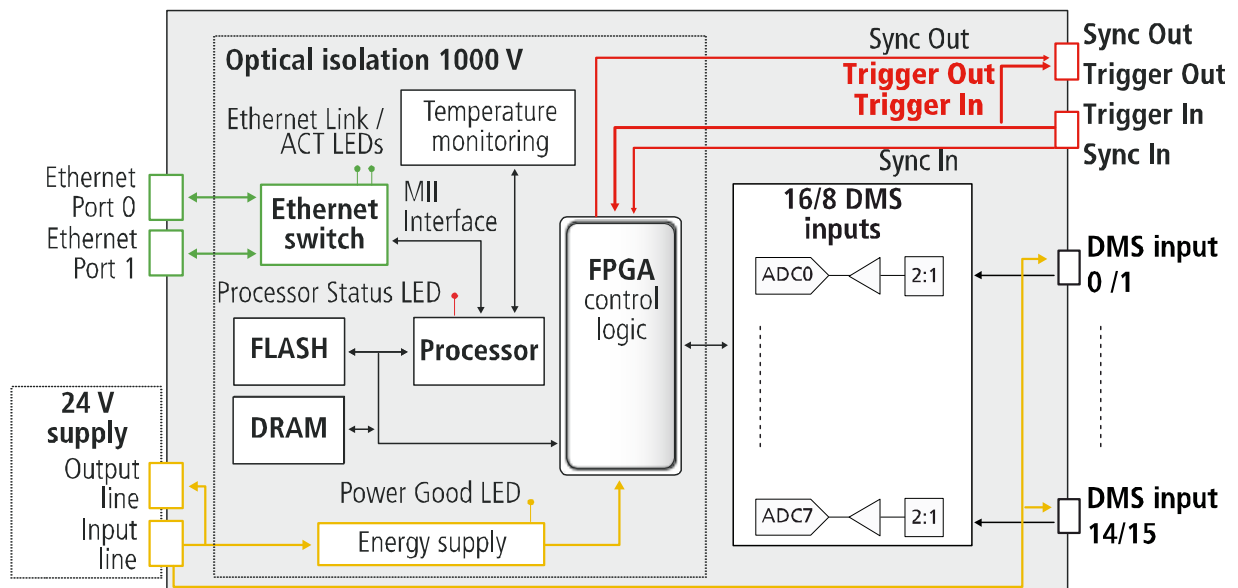
3   Strain gauge sensors

In this chapter, the properties of the different strain gauge sensors are described in more detail.[1] This should help you to find the right strain gauge sensor for your measuring system and to identify and prevent possible measuring errors in advance.

A strain gauge sensor is a strain gauge that has been glued on the test item with a special adhesive. Pressure or force applied on the test item affects its form (compression or extension) and accordingly, the form of the strain gauge.
This deformation of the strain gauge again leads to a change in its electrical resistance. If the strain gauge gets longer or its cross-section smaller, its resistance increases and vice versa, it decreases.

Strain gauges are used, for example, for strain measurement at machines, wooden constructions and buildings as well as for load measurement at load cells, force or torque sensors and pressure converters.

Usually, foil strain gauges are used. They consist of a measuring grid made of resistance wire, which is embedded between two thin plastic foils and which has electrical leads. The form of the measuring grid, which can be up to 150 mm long, varies according to the application. The measuring grid of metal foil strain gauges is mostly made up of constantan or a nickel-chrome compound, whereas silicon serves as a semiconductor gauge material.

The ratio of change in resistance to strain, that is the sensitivity of the strain gauge, is indicated by the gauge factor. This factor depends on the measuring grid material of the strain gauge. Therefore, some semiconductor gauges have considerably higher gauge factors than metal foil gauges, because their resistivity changes with volume (piezoresistive effect). Length and cross-section are of rather little importance with semiconductor gauges.

Table 3-1: Strain gauge sensors: Gauge factor

	Measuring grid material	Composition	Gauge factor
Metal foil strain gauge	Constantan	54 % Cu, 45 % Ni, 1 % Mn	2.05
	Platinum	100 % Pt	6.0
Semiconductor strain gauge	Silicon	100 % p-type Si: B (Bor in ppm range)	+80 … +190

The resistance of the unloaded strain gauge can be calculated as follows:

$$R = \rho \frac{l}{S} = \rho \frac{4 \cdot l}{d^2 \cdot \pi}$$

ρ = Resistivity
l = Wire length
S = Cross-sectional area
d = Wire diameter

---

[1] Source: http://de.wikipedia.org/wiki/Dehnungsmessstreifen (23/05/2011)

ADDI-DATA®
SPIRIT OF EXCELLENCE

General change in resistance under load:

$$\Delta R = \frac{\partial R}{\partial \rho} \cdot \Delta \rho + \frac{\partial R}{\partial l} \cdot \Delta l + \frac{\partial R}{\partial d} \cdot \Delta d$$

Relative change in resistance:

$$\frac{\Delta R}{R} = \frac{\Delta \rho}{\rho} + \frac{\Delta l}{l} - \frac{2 \cdot \Delta d}{d}$$

Longitudinal and transverse strain from which the relative change in resistance depends:

$$\varepsilon = \frac{\Delta l}{l} \quad \text{and} \quad \varepsilon_q = \frac{\Delta d}{d} = -\mu \cdot \varepsilon$$

ε = Relative change in length

ε_q = Relative change in cross-section

μ = Poisson's ratio

This results in the following equation:

$$\frac{\Delta R}{R} = k \cdot \frac{\Delta l}{l} = k \cdot \varepsilon$$

k = Gauge factor

To the gauge factor, the following equation applies:

$$k = \frac{\Delta \rho}{\rho \cdot \varepsilon} + 1 + 2 \cdot \mu$$

The maximum elasticity of the strain gauge depends on the elasticity of the measuring grid material, carrier foil and adhesive used.
A maximum frequency is not known yet, but measurements in the range from 5 MHz to 8 MHz have still provided correct results.
The resistance of the connected, but unloaded strain gauge is considered as the nominal resistance.
Typical values are 120 Ω, 350 Ω, 700 Ω and 1000 Ω.

ADDI-DATA
SPIRIT OF EXCELLENCE

The maximum voltage that may be applied to a strain gauge depends on the size of the strain gauge and the material on which it is affixed. As voltage losses have to be diverted via the surface of the strain gauge, it is quite possible that a voltage not higher than 0.5 V may be connected to small strain gauges and poor heat conductors, whereas up to 10 V may be connected to strain gauges of a normal size and good heat conductors.

Interfering factors such as temperature can lead to incorrect measurement results, since materials stretch with rising temperature even without load. In order to compensate for this temperature error to the greatest possible extent, bridge circuits such as the Wheatstone bridge are often used. The latter is composed of four resistors to which a voltage source and a voltage meter are connected (see also Fig. 4-1).

Fig. 3-1: Wheatstone bridge
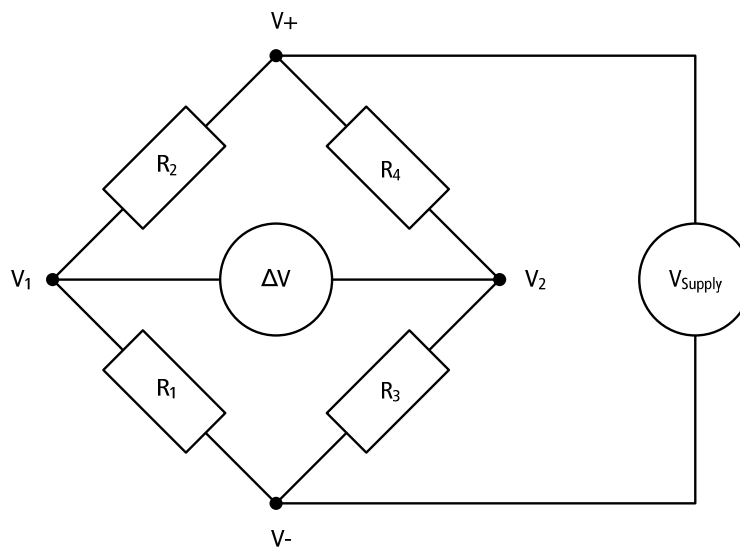
Full bridges are always used in the manufacture of transducers; whereas in the experimental stress analysis rather quarter or half bridges are used. In the latter case, three or two fixed resistors are added to the strain gauges. These four resistors and also the entire bridge have the same nominal resistance R1 = R2 = R3 = R4. All of these strain gauges have the same gauge factor.

Table 3-2: Wheatstone bridge: Bridge factor

Bridge type	Bridge factor	Number of strain gauges
Full bridge	4	4
Full bridge with transverse contraction	2 (1+v)	4
Half bridge	2	2
Half bridge with transverse contraction	1+v	2
Quarter bridge	1	1

v is the Poisson's ratio of the material on which the strain gauge is affixed.

ADDI-DATA®
SPIRIT OF EXCELLENCE

For the Wheatstone bridge, the following equations apply:

$$\frac{\Delta V}{V_s} = \frac{1}{4} \cdot \left(\frac{\Delta R_1}{R_1} - \frac{\Delta R2}{R2} - \frac{\Delta R3}{R3} + \frac{\Delta R4}{R4} \right)$$

V_s = Supply voltage

$$\frac{\Delta R}{R} = k \cdot \varepsilon$$

Full bridge with R1 = R2 = R3 = R4:

$$\frac{\Delta V}{V_s} = \frac{1}{4} \cdot k \cdot \left(\varepsilon_1 - \varepsilon_2 - \varepsilon_3 + \varepsilon_4 \right)$$

Quarter bridge: $\varepsilon_2 = \varepsilon_3 = \varepsilon_4 = 0$
Half bridge: $\varepsilon_3 = \varepsilon_4 = 0$
Full bridge: ε_2 and ε_3 = negative

$$\frac{\Delta V}{V_s} = \frac{1}{4} \cdot k \cdot \varepsilon \cdot B$$

B = Bridge factor

Further factors that may interfere with strain gauge measurements are moisture, creep, hysteresis, cross-sensitivity, electromagnetic fields, hydrostatic pressure and nuclear radiation.

ADDI-DATA®
SPIRIT OF EXCELLENCE

4 Function description: Strain gauge inputs

The Ethernet system **MSX-E3311** has 16 differential inputs for strain gauges.

4.1 Pin assignment

To each M12 female connector, up to two strain gauge sensors can be connected.
The differential sensor input 1 or 2 consists of DMSx+ and DMSx-. One input channel consists of sensor input DMSx+ and DMSx- signals and of the voltage sources V+ and V-. The voltage sources V+ and V- are used in parallel for channels 1 and 2.

Table 4-1: Pin assignment: Strain gauge inputs

Pin No.	Female connector, 8-pin, M12	Cable (black) Lead colour
1	DMS1+	white
2	DMS1-	brown
3	V-	green
4	GND	yellow
5	DMS2+	grey
6	DMS2-	pink
7	V+	blue
8	GND	red
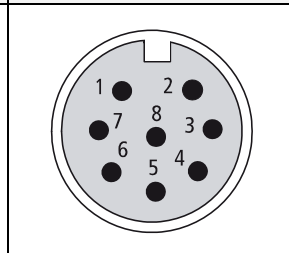
DMS = Strain gauge

V = Supply voltage

ADDI-DATA®
SPIRIT OF EXCELLENCE

4.2 Connection example

Fig. 4-1: Connection example: Strain gauge sensors

ADDI-DATA®
SPIRIT OF EXCELLENCE
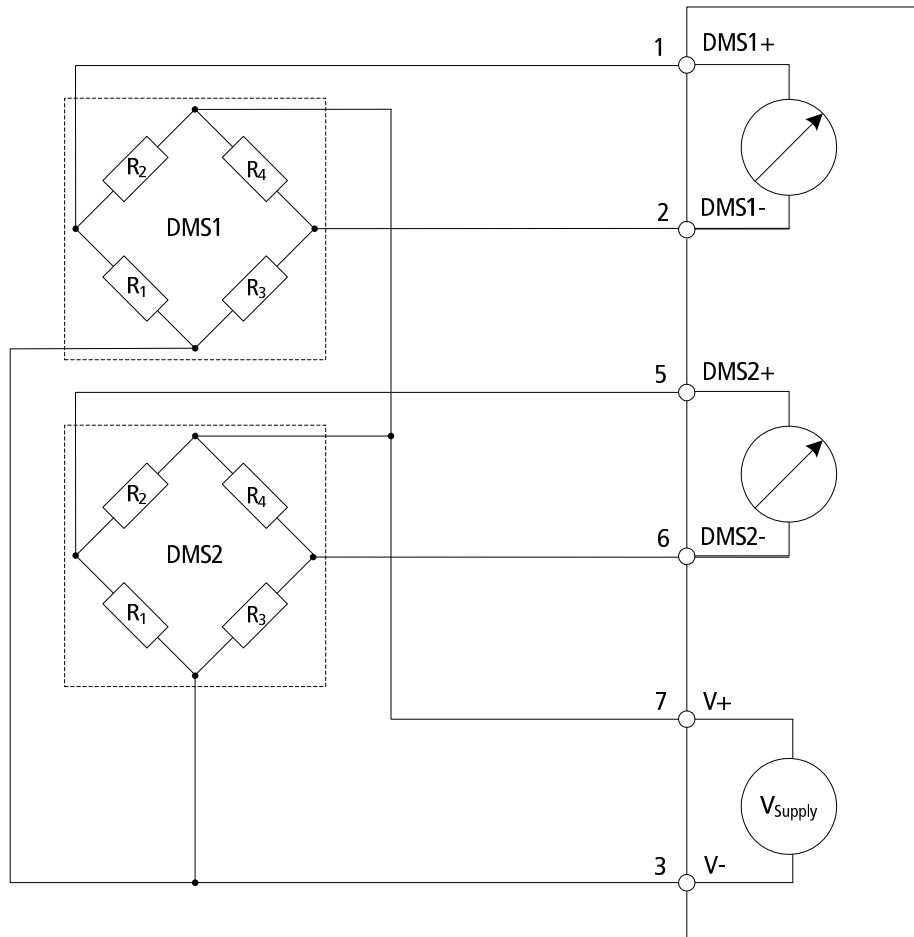
5 Web interface: Quick access to the MSX-E system

5.1 "I/O Configuration"

In this manual, the function-specific pages of the **MSX-E3311** 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).

5.1.1 Menu item "Base configuration"

Fig. 5-1: Base configuration: Pressure channels

On this page, you can configure the strain gauge inputs by defining sensitivity and offset for each channel (see datasheet for the sensor) as well as by selecting the respective filter time.
If a short-circuit occurs, this will be specified in the table above under "Line diagnosis".

5.1.2   Menu item "Acquisition"

Fig. 5-2: MSX-E web interface: "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 6 of this manual.

Data format

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

Table 5-1: 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.

ADDI-DATA®
SPIRIT OF EXCELLENCE

In Sequence mode, the data format is as follows:

Table 5-2: 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

i

IMPORTANT!
Please note that the digital value is an internal value of the A/D converter and thus not suitable for pressure or force value calculation. Please only use the analog value for this purpose!

Data format = with conversion into an analog value

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

With an **MSX-E3311**, the unit depends on the type of sensor data. In order to get correct values of pressure, force, etc., it is absolutely necessary for the correct sensitivity and offset values of the sensor to be specified (see Chapter 5.1.1).

The supply voltage is continuously monitored on the MSX-E system and set off against the analog value.

For more information on the data format, see Chapter 6.3.4.

ADDI-DATA®
SPIRIT OF EXCELLENCE

6 Acquisition modes

This chapter exemplifies how to configure and start an acquisition via the web interface of the Ethernet system **MSX-E3311**. 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 calculated.

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

6.1.1 "Type of acquisition"

Fig. 6-1: Acquisition: Type of acquisition

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

6.1.2 "Channels to be acquired"

Fig. 6-2: Acquisition: Channels to be acquired

■ In the section "Channels to be acquired", select the channels you want to acquire.

ADDI-DATA
SPIRIT OF EXCELLENCE

6.1.3   "Average" (average value calculation)

Fig. 6-3: Auto-refresh mode: "Average"

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

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 simultaneously.

Fig. 6-1: Auto-refresh mode: Acquisition example
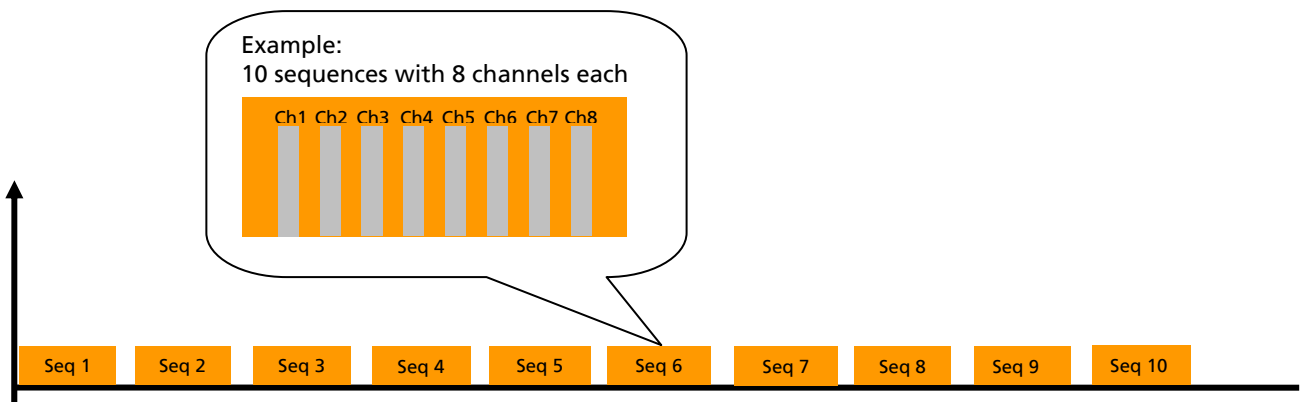
After these ten sequences have run down, the MSX-E system performs the following calculation:

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 containing the average values from channels 1 to 8.

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, under "I/O Configuration", select the menu item "Acquisition".

6.2.1 "Type of acquisition"

Fig. 6-4: Acquisition: Type of acquisition

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

6.2.2 "Channels to be acquired"

Fig. 6-5: Acquisition: Channels to be acquired

■ In the section "Channels to be acquired", select the channels you want to acquire.

You can define the order of the channels. Each channel can be acquired only once per sequence.

ADDI-DATA
SPIRIT OF EXCELLENCE

6.2.3 "Number of sequences to be acquired"

Fig. 6-6: Acquisition: 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. 6-7: Acquisition: Start/stop/monitor 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. 6-7), the acquisition begins. If two sequences are acquired, the measurement values are sent to the client.
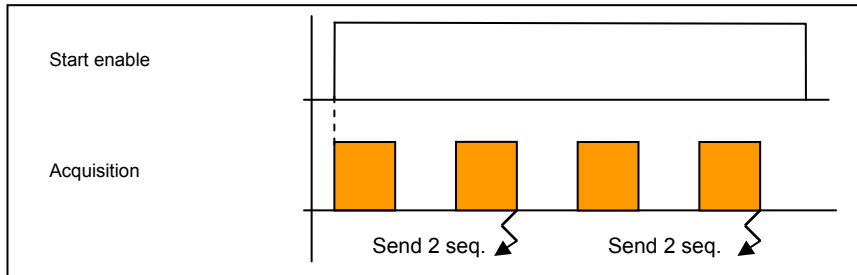
6.3 Common functions

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

6.3.1 Acquisition refresh time or delay

Fig. 6-8: Auto-refresh mode: "Acquisition refresh time"

In Auto-refresh mode, the time between the refreshing of the single sequences is called acquisition refresh time.

Fig. 6-9: Sequence mode: "Acquisition time"

In Sequence mode, the delay is the time between the acquisitions of single sequences.

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 unit that is selected:

Microseconds: 1000 to 65535

Milliseconds: 1 to 65535

Seconds: 1 to 65535

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. 6-10:   Acquisition: Trigger configuration

Trigger source	Not used
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

- **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).

ADDI-DATA®
SPIRIT OF EXCELLENCE

1) Examples of edges

a) **Rising:** Rising edge

b) **Falling:** Falling edge

c) **Both:** Rising and falling edges

ADDI-DATA®
SPIRIT OF EXCELLENCE
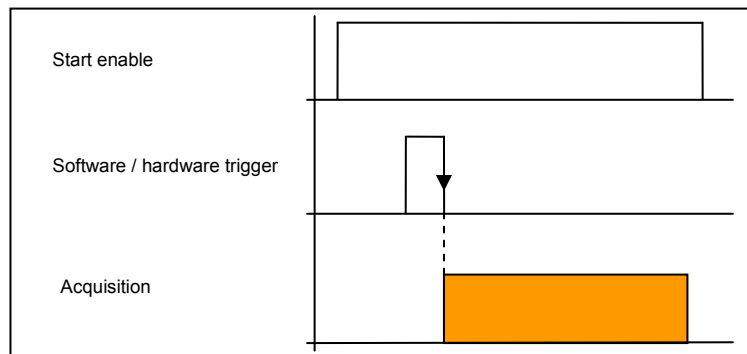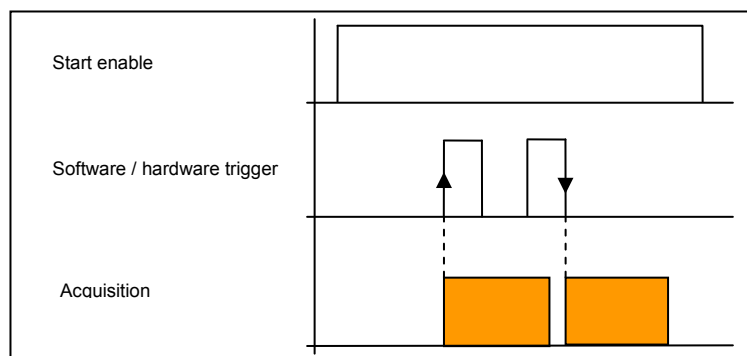
2) Examples of hardware triggers with "One-shot"

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

Fig. 6-11: 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. 6-7), the MSX-E system waits for three rising hardware edges. Once the three edges have been identified, the acquisition starts.
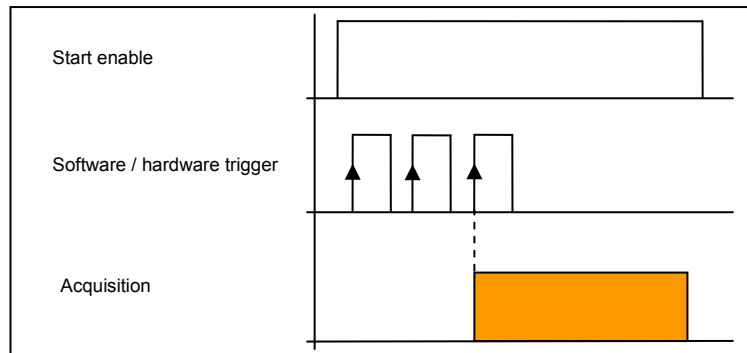
b) With "Hardware trigger active edge", "Rising" is selected again, and with "Hardware trigger count", the value 1 is entered.

Fig. 6-12: 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

ADDI-DATA®
SPIRIT OF EXCELLENCE

The trigger starts only one acquisition, which begins with the first hardware edge after you start (see Fig. 6-7).
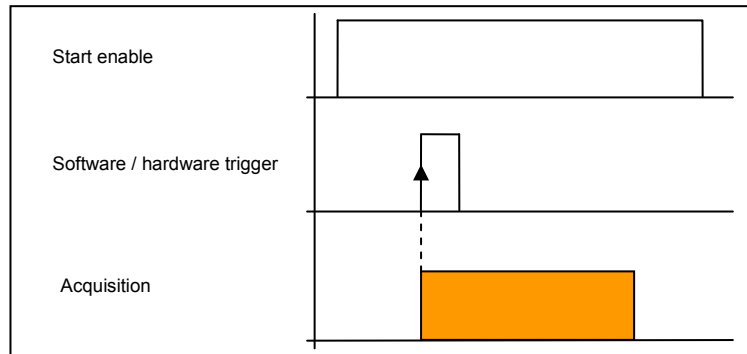
c)   With "Hardware trigger active edge", "Both" is selected, and with "Hardware trigger count", the value 3 is entered.

Fig. 6-13:   Hardware trigger with "One-Shot" (c)

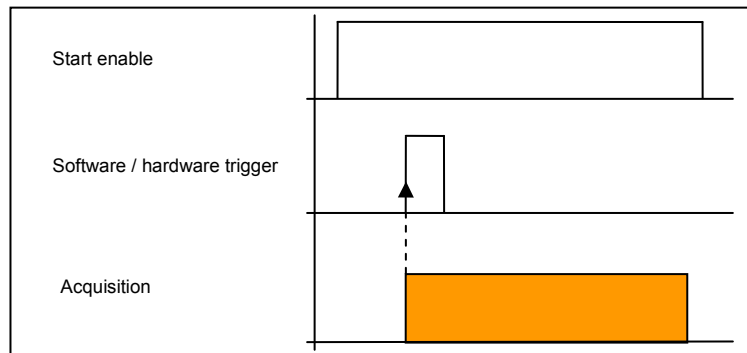| Trigger source	Hardware trigger
Trigger mode	One-shot
Hardware trigger active edge	Both
Hardware trigger count Number of trigger events before the acquisition starts.	3
Number of sequences per trigger Number of sequences to be acquired after each trigger event	1

After the start (see Fig. 6-7), the MSX-E system waits for three rising and falling hardware edges. Once the three edges have been identified, the acquisition starts.

ADDI-DATA®
SPIRIT OF EXCELLENCE
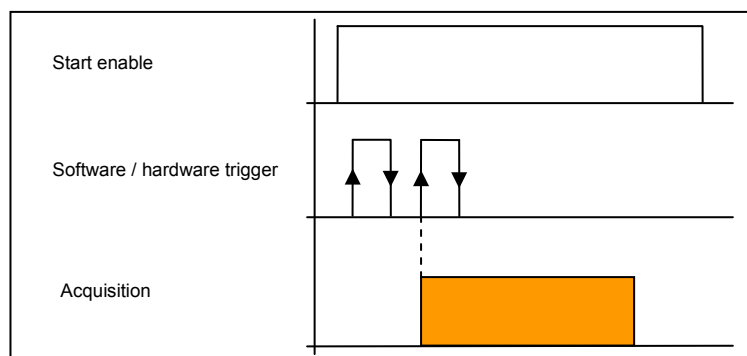
d) With "Hardware trigger active edge", the option "Both" is selected again, and with "Hardware trigger count", the value 1 is entered.

Fig. 6-14: 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. 6-7), the acquisition is started (triggered) with the first edge. The subsequent edges are ignored.
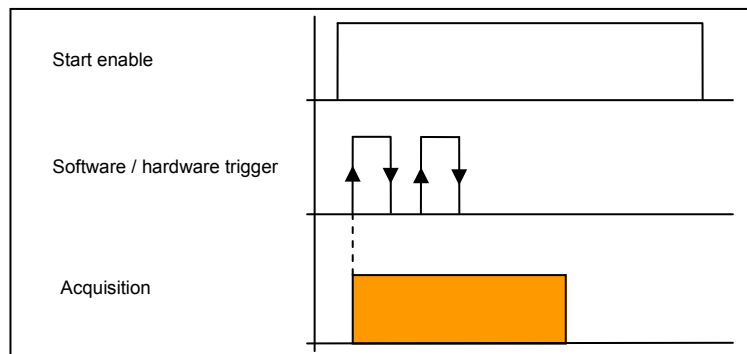

3) Examples of hardware triggers with "Sequence"

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

Fig. 6-15: 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

ADDI-DATA
SPIRIT OF EXCELLENCE
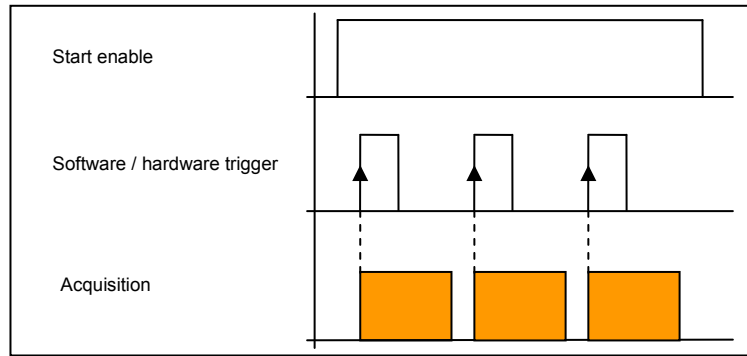
b) With "Hardware trigger active edge", "Both" is selected, and "Hardware trigger count" contains the value 3.

Fig. 6-16:   Hardware trigger with "Sequence" (b)

After you start (see Fig. 6-7), 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.
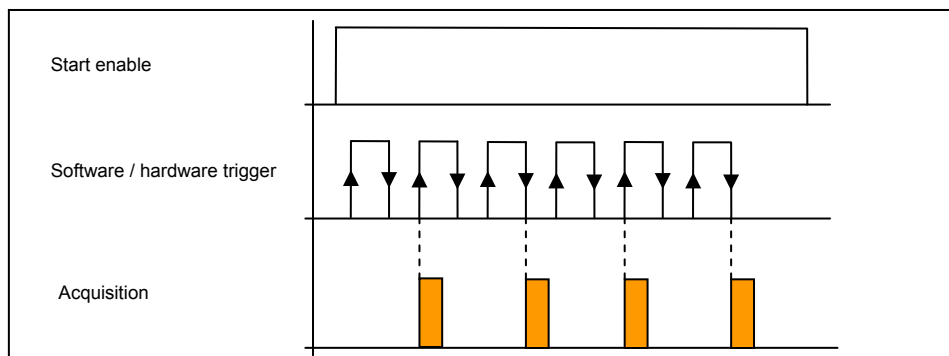
IMPORTANT!

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 examples).

ADDI-DATA®
SPIRIT OF EXCELLENCE
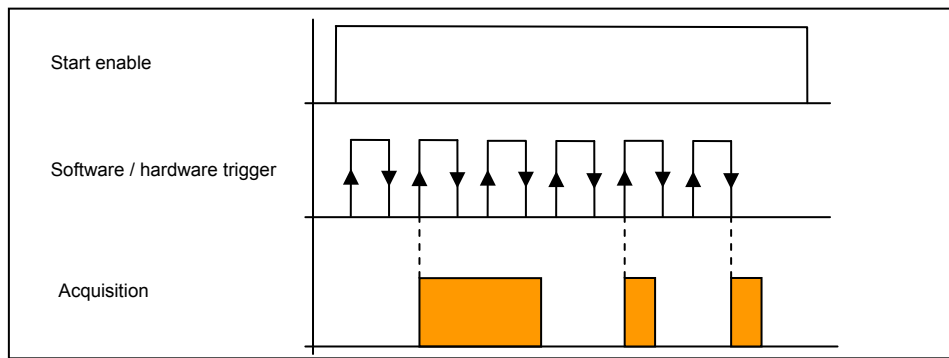
c) The settings correspond to example 2 with the exception of "Number of sequences per trigger", where value 2 is entered.

Fig. 6-17: Hardware trigger with "Sequence" (c)

After each trigger, two sequences are acquired.

ADDI-DATA®
SPIRIT OF EXCELLENCE
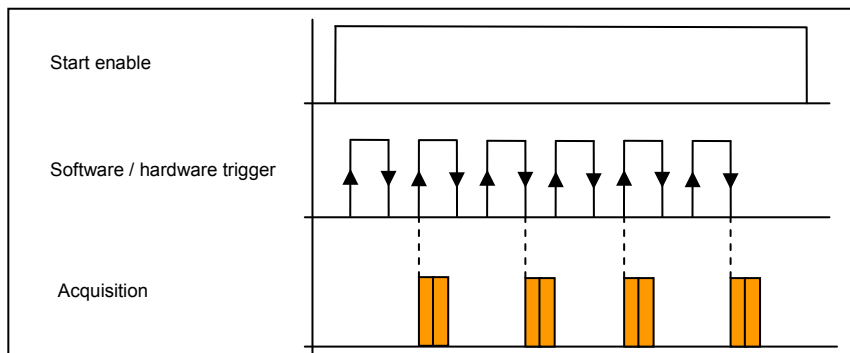
6.3.3 "Data frame" (additional data)

Fig. 6-18: Acquisition: Data frame
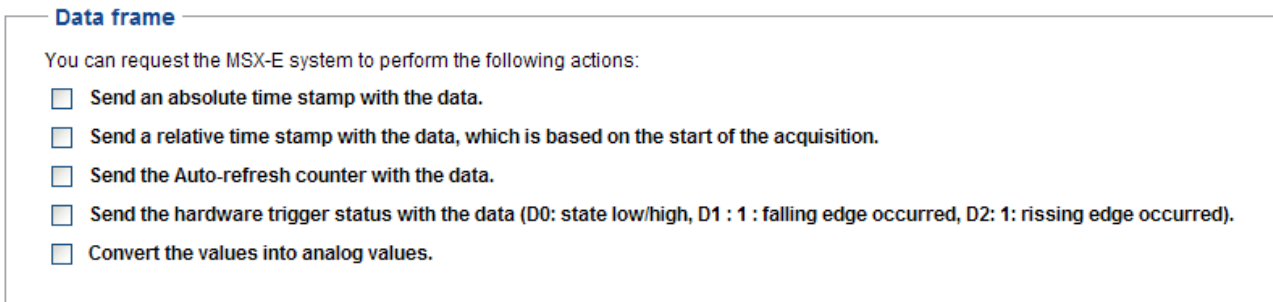
By default, only the acquisition values are sent to the client. However, it can also receive additional information if you activate the following options.

- **Send an absolute time stamp with the data:** A time stamp is sent that 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 (bzw. „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 converts the raw values immediately to the correct unit. With an **MSX-E3311**, the unit depends on the type of sensor data. In order to get correct values of pressure, force, etc., it is absolutely necessary for the correct sensitivity and offset values of the sensor to be specified (see Chapter 5.1.1).
As the conversion affects the MSX-E CPU to a certain extent, this can result in slower sending speed.

i

IMPORTANT!
Please note that the digital value is an internal value of the A/D converter and thus not suitable for pressure or force value calculation. Please only use the analog value for this purpose!

6.3.4 "Binary data frame packet structure" (packet format)

Fig. 6-19: Acquisition: Binary data frame packet structure

Binary data frame packet structure

To read the acquired data, the client connects to the data server network service via a TCP/IP socket. Data are sent in encoded form as little-endian integers, which are logically grouped in packets.

DWword 0
Pressure channel 0 (decimal)

Auto-refresh data frame size: 1 DWord(s) => 1 * 4 = 4 bytes
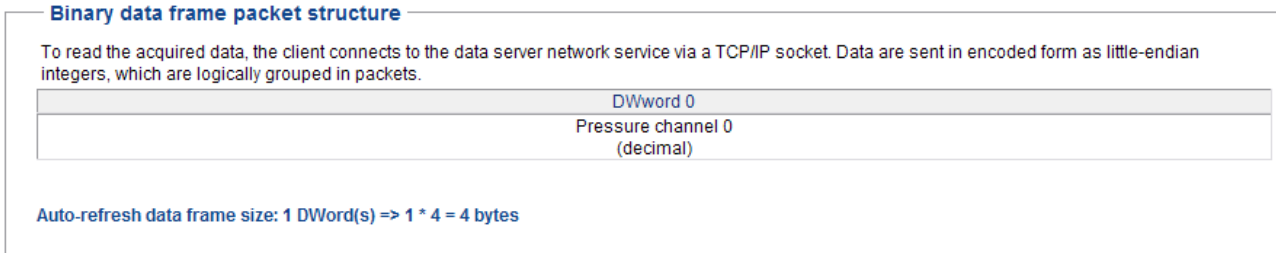
The MSX-E system sends the data over the network to one or more clients. In order that the client can interpret the values correctly, these are formatted. The format is defined as "Binary data frame packet structure". All measurement values and the additional data such as the time stamp form a group of values that is called a packet.

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

For more information on the data format, see Chapter 5.1.2.

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.

ADDI-DATA®
SPIRIT OF EXCELLENCE

7 Technical data and limit values

7.1 Electromagnetic compatibility (EMC)

The Ethernet system **MSX-E3311** 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-E3311: Dimensions
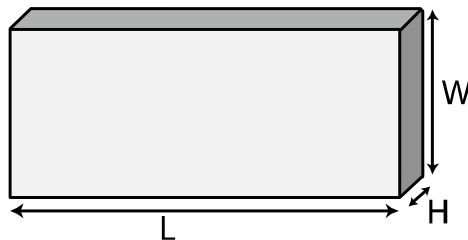
220,4 mm (L) x 140 mm (W) x 50 mm (H)

Weight:	950 g
	1010 g (with MX-Rail)

Fig. 7-2: MSX-E3311: View from above

7.3 Versions

The Ethernet system **MSX-E3311** is available in the following versions:

Table 7-1: MSX-E3311: Versions

Version	Sensor type
MSX-E3311-8	for 8 strain gauge measuring bridges
MSX-E3311-16	for 16 strain gauge measuring bridges

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):	300 mA (±10 %)
Safety:	
Degree of protection:	IP 65[2]
Optical isolation:	1000 V

i **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.

---

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

ADDI-DATA®
SPIRIT OF EXCELLENCE

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)

ADDI-DATA®
SPIRIT OF EXCELLENCE

7.4.4   Strain gauge inputs

Number of inputs:	8 **(MSX-E3311-8)** 16 **(MSX-E3311-16)** (2 per female connector / common supply voltage)
Resolution:	24-bit
Real acquisition frequency:	see Table 7-2
Supply voltage (between V+ and V-):	~ 10 V / optional ~ 5 V (calibrated internally) 100 mA$_{max}$

Table 7-2: Real acquisition frequency

Real acquisition frequency		
on 1 channel	**on 2 channels**	**Sampling frequency (software-selectable)**
2.37 Hz	1.585 Hz	5 Hz
4.73 Hz	3.154 Hz	10 Hz
9.37 Hz	6.243 Hz	20 Hz
18.9 Hz	12.6 Hz	40 Hz
37.35 Hz	24.89 Hz	80 Hz
73 Hz	48.65 Hz	160 Hz
145 Hz	96.8 Hz	320 Hz
276.4 Hz	184.26 Hz	640 Hz
407.83 Hz	271.96 Hz	1 kHz
788 Hz	525.48 Hz	2 kHz

7.5 Sensor-specific properties

The sensor-specific properties were measured under the following conditions:

Height:	180 m over NN
Ambient temperature:	+25 °C
Air humidity:	70 %

ADDI-DATA®
SPIRIT OF EXCELLENCE

8 Appendix

8.1 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.

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.

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 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.

ADDI-DATA®
SPIRIT OF EXCELLENCE

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.

ADDI-DATA®
SPIRIT OF EXCELLENCE

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.

ADDI-DATA®
SPIRIT OF EXCELLENCE

8.2 Index

ADDI-DATA®
SPIRIT OF EXCELLENCE

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

ADDI-DATA®
SPIRIT OF EXCELLENCE