Technical Description

MSX-E3711

Ethernet system for length measurement

DIN EN ISO 9001:2015 certified

Edition: 02.05-11/2022

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Warning!

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

Personal injury

Damage to the Ethernet system, the PC and peripherals

Pollution of the environment.

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

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

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

NOTICE!
Designates hints and other useful information.

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

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

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Chapter overview

In this manual, you will find the following information:

Chapter	Content
1	Important information on the application, the user and on handling the MSX-E system as well as safety precautions
2	Brief description of the MSX-E system (functions, features, block diagram)
3	Information on inductive displacement transducers
4	Information on TC and RTD temperature sensors
5	Function description (transducer inputs) including pin assignment
6	Function description (incremental counter input) including pin assignment and connection example
7	Function description (temperature sensor input) including pin assignment and connection examples
8	Description of the function-specific pages of the MSX-E web interface plus information on the data format
9	Description of the acquisition modes (Auto-refresh and Sequence modes)
10	List of technical data and limit values of the MSX-E system
11	Appendix with glossary and index
12	Contact and support address

1 Definition of application, user, handling

1.1 Definition of application

1.1.1 Intended use

The Ethernet system **MSX-E3711** for the acquisition, processing and transferring of displacement transducer signals is intended for the connection to a network, which is used as electrical equipment for measurement, control and laboratory pursuant to the standard DIN EN IEC 61010-1.

1.1.2 Usage restrictions

The Ethernet system **MSX-E3711** must <u>not</u> be used as a safety-related part (SRP).

The Ethernet system **MSX-E3711** must <u>not</u> be used for safety-related functions.

The Ethernet system **MSX-E3711** must <u>not</u> be used in potentially explosive atmospheres.

The Ethernet system **MSX-E3711** must <u>not</u> be used as electrical equipment according to the European Low Voltage Directive.

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 ES1 according to DIN EN IEC 62368-1 or PELV according to DIN EN 60204-1.

1.2.2 Degrees of protection

NOTICE!
The protection according to the defined degree of protection (see Chapter 10.4) 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.

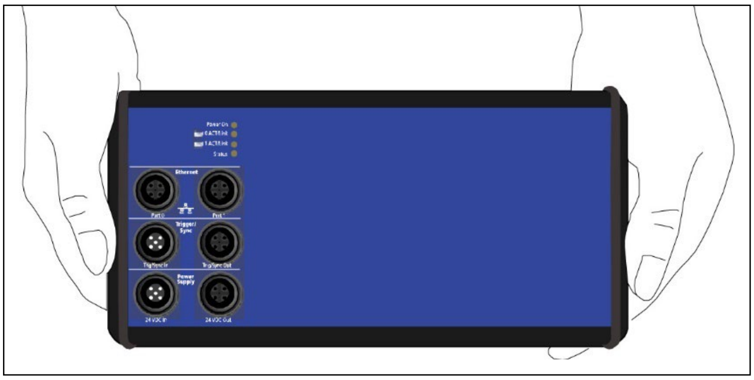
1.3.2 Country-specific regulations

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 black sides.
- Do not hold the Ethernet system by the connectors!

1.5 Questions and updates

If you have any questions, do not hesitate to call us or to send us an e-mail:

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

Manual and software download from the Internet

The latest versions of the technical manual and the standard software for the Ethernet system **MSX-E3711** 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

With the intelligent Ethernet system **MSX-E3711**, up to eight HB, LVDT, Mahr or Knäbel displacement transducers can be acquired simultaneously with 24-bit resolution.
An incremental counter input and an input for temperature measurement add temperature and position references to the measurement values.

Measurement sequences on multiple systems can be started simultaneously over an external trigger (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 transducer 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.

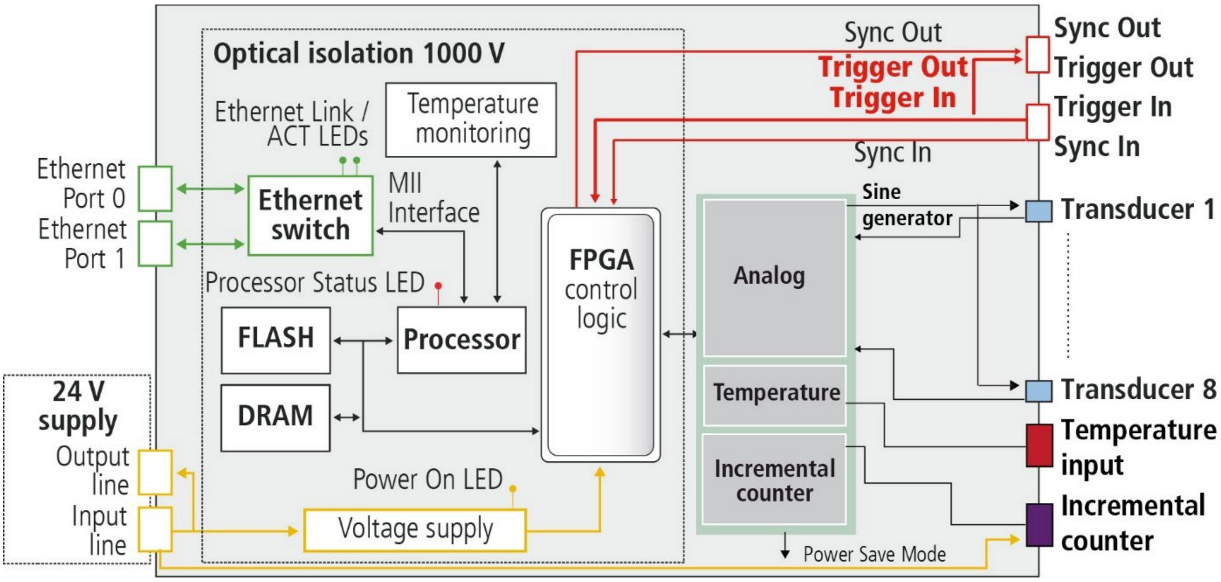
The Ethernet system is connected to the computer via Ethernet. As the Ethernet system is attached directly to the signal generator (measuring point), the measurements are not affected by long cables. The length of the (Ethernet) connection cable from the Ethernet system to the computer may be up to 150 m. The system must be supplied with external voltage (24 V).

Features:

- Simultaneous acquisition of up to 8 inductive displacement transducers (HB, LVDT, Mahr, Knäbel)
- 1 incremental counter input (32-bit)
- 1 temperature sensor input for a resistance temperature detector (Pt100, Pt500 or Pt1000) or optionally for a thermocouple
- 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

2.2 Block diagram

Fig. 2-1: MSX-E3711: Block diagram



3 Displacement transducers

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

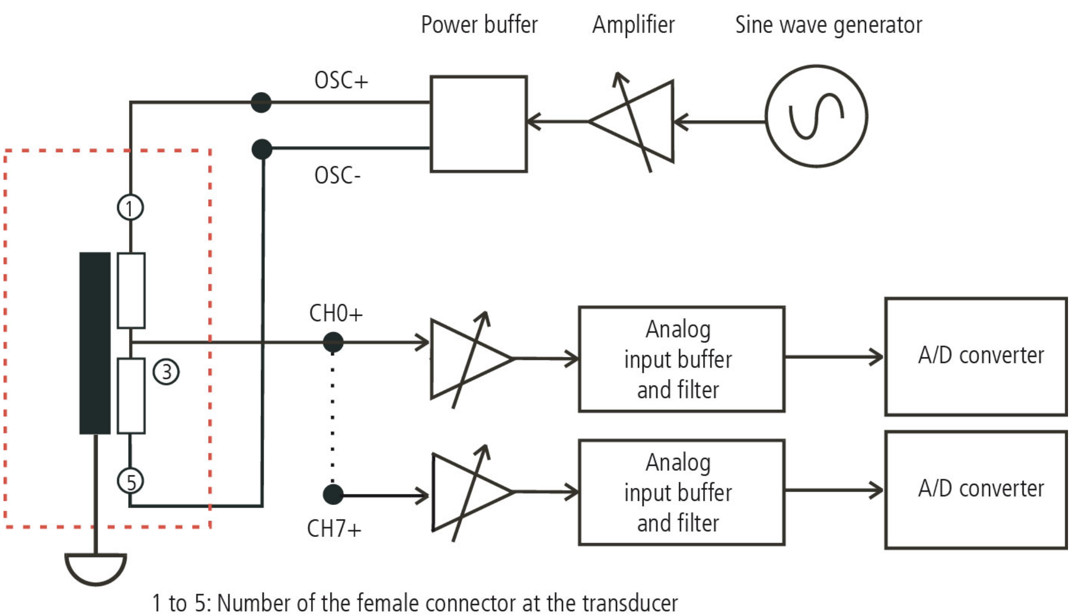
3.1 Inductive transducers

Inductive transducers are used for precise measurement of a defined distance. They are displacement/ voltage sensors, whose output voltage changes linearly along with the moving magnetic core (ferrite).
The magnetic core moves according to a straight line in a transformer, which consists of a central primary coil and two external secondary coils (cylindrical windings). The power buffer provides an AC voltage source to the primary coil. The secondary voltage changes according to the position of the magnetic core.

3.1.1 Half-bridge transducer

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

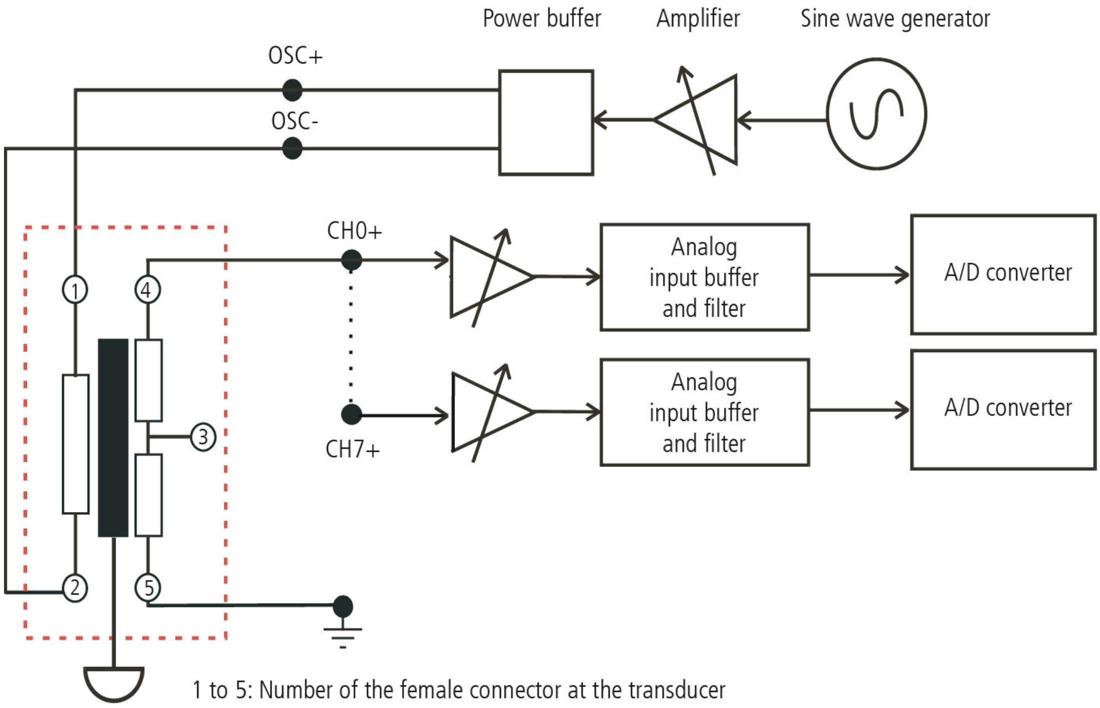
Fig. 3-1: Half-bridge transducer



3.1.2 LVDT transducer

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

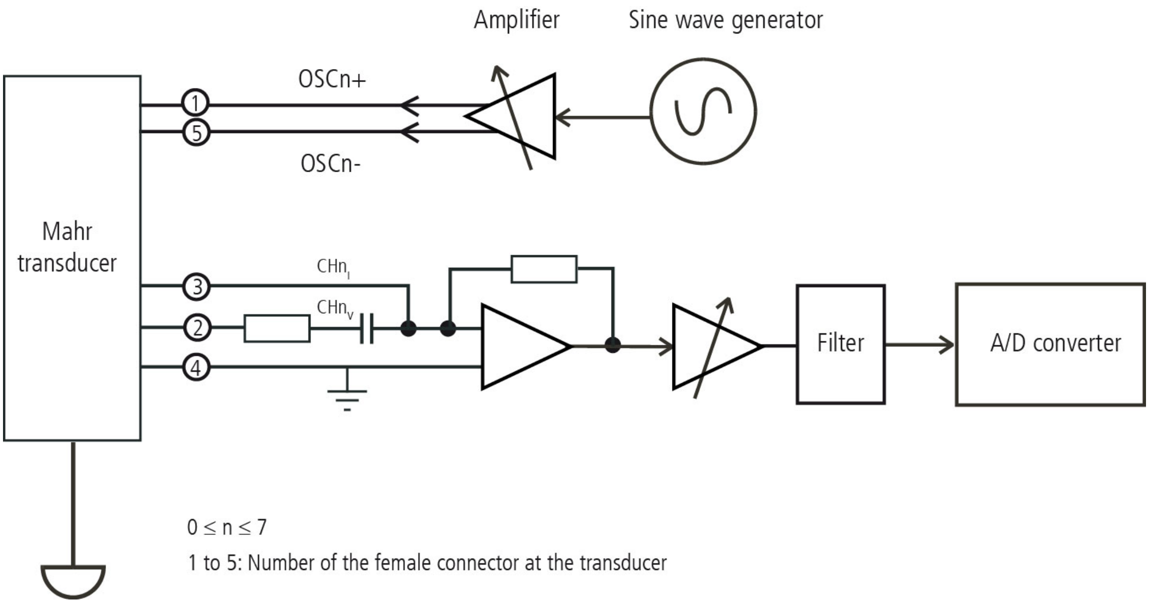
Fig. 3-2: LVDT transducer



3.1.3 Mahr transducer

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

Fig. 3-3: Mahr transducer



3.2 Transducer properties

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

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

4 Temperature sensors

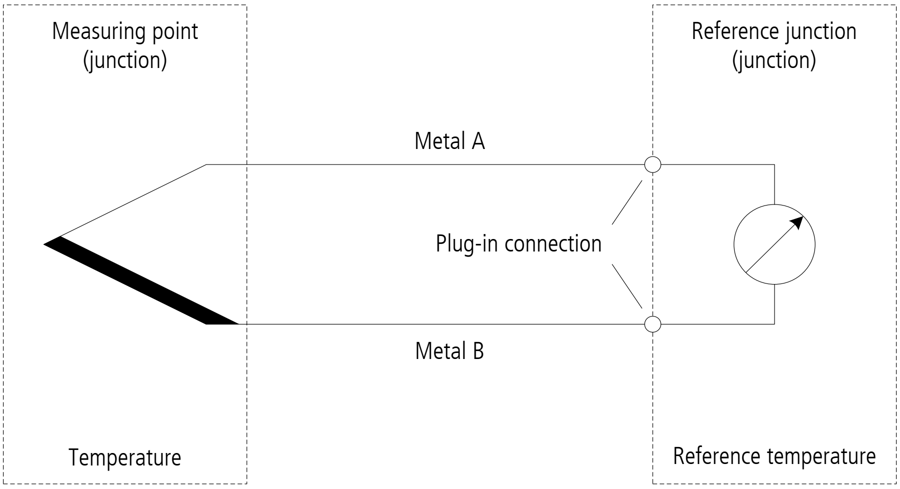
In this chapter, the properties of the different temperature sensors are described in more detail. This should help you to find the right temperature sensor for your measuring system and to identify and prevent possible measuring errors in advance.

4.1 Thermocouples (TC)

Thermocouples consist of two different metallic conductors (metals A and B) that are welded with each other at one end.
If at the junction of the two conductors the temperature differs from the ambient temperature, a voltage is generated. The value of this voltage depends on the temperature difference and the materials used. The ratio of the generated voltage to the temperature difference is approximately proportional. In order to linearise this ratio, polynomials are used which correct the measurement values.

If a thermocouple is connected to a measuring system, another thermocouple is produced at this junction, that is between the two thermocouple metals and the metal of the connector at the measuring system. To correct the measuring error occurring at this junction through the additional thermocouple, the temperature at this junction (reference temperature) has to be known. For this, it is acquired by a Pt1000 sensor and used to calculate the temperature at the measuring point.
Strictly speaking, there are different metal combinations at each junction between connectors, conductors and components that can take effect like a thermocouple. However, measuring errors come to an insignificant extent, because these are pairs of identical metals.

Fig. 4-1: Thermocouple with reference junction



NOTICE!
Further junctions between a thermocouple and the **MSX-E3211-TC** may produce additional thermoelectric effects which lead to an incorrect measurement result. Therefore, you should try to avoid further junctions (e.g. through extension cables)!

4.1.1 Types of thermocouples

Table 4-1: Thermocouples according to DIN EN IEC 60584-1

Type designation	Positive leg: material	Colour code (positive pole)	Negative leg: material	Colour code (negative pole)
B	platinum 30% rhodium	grey	platinum 6% rhodium	white
E	nickel-chromium	purple	copper-nickel	white
J	iron	black	copper-nickel	white
K	nickel-chromium	green	nickel-aluminium	white
N	nickel-chromium-silicum	pink	nickel-silicum	white
R	platinum 13% rhodium	orange	platinum	white
S	platinum 10% rhodium	orange	platinum	white
T	copper	brown	copper-nickel	white

Table 4-2: Minimum and maximum thermocouple temperature

Type designation	Material	Colour code (positive pole)	Minimum temperature (°C)	Maximum temperature (°C)	Defined up to (°C)
B	Pt30Rh-Pt6Rh	grey	0	1700	1820
E	NiCr-CuNi	purple	-270	900	1000
J	Fe-CuNi	black	-210	750	1200
K	NiCr-Ni	green	-270	1200	1370
N	NiCrSi-NiSi	pink	-270	1200	1300
R	Pt13Rh-Pt	orange	-50	1600	1760
S	Pt10Rh-Pt	orange	-50	1600	1540
T	Cu-CuNi	brown	-270	350	400

With thermocouples, the temperature/voltage ratio is approximated by means of a polynomial. This approximation leads to additional deviation errors.

Table 4-3: Deviation limits for thermocouples according to DIN EN IEC 60584-1

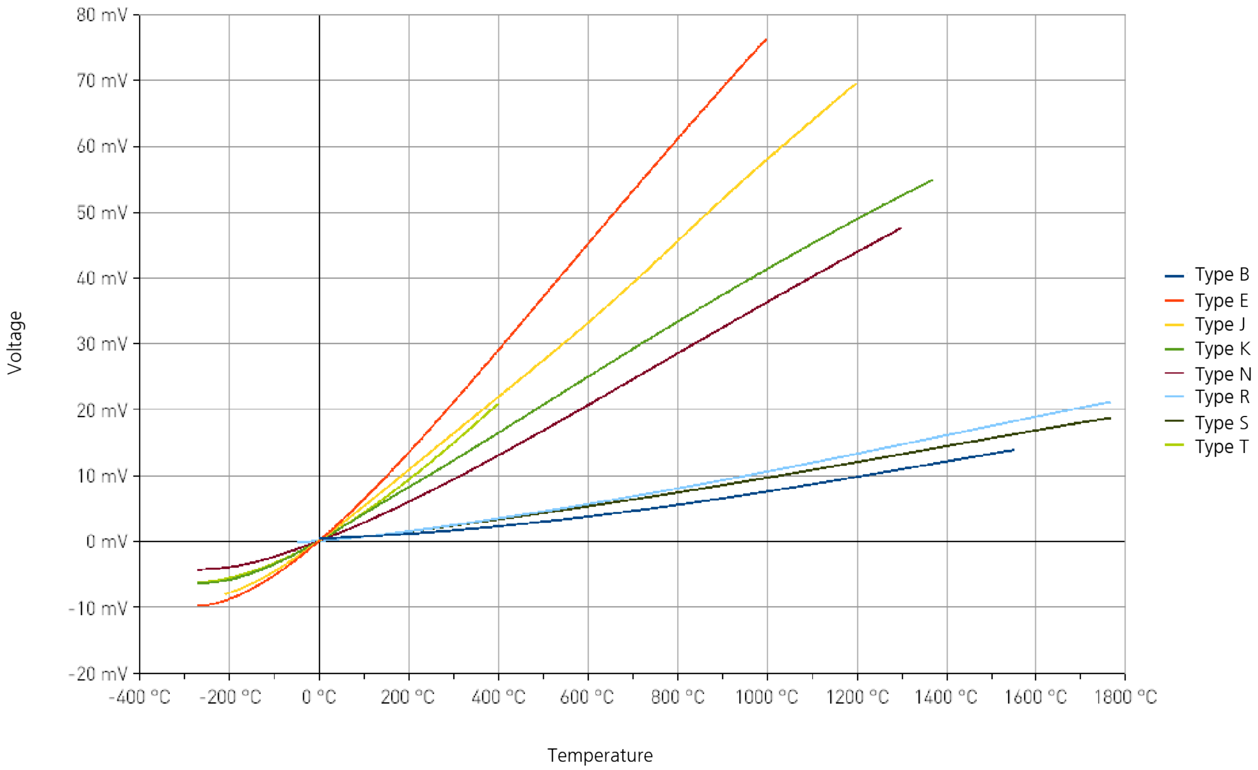
Type designation	Tolerance class	Temperature range (°C)	Tolerance
B	Class 1	600 to 1700	$\pm 0.0025 \cdot t$ or ±1.5 °C
	Class 2	600 to 1700	$\pm 0.005 \cdot t$ or ±4 °C
	Class 3		
E	Class 1	-40 to +900	$\pm 0.004 \cdot t$ or ±1.5 °C
	Class 2	-40 to +900	$\pm 0.0075 \cdot t$ or ±2.5 °C
	Class 3	-200 to +40	$\pm 0.0015 \cdot t$ or ±2.5 °C
J	Class 1	-40 to +750	$\pm 0.004 \cdot t$ or ±1.5 °C
	Class 2	-40 to +750	$\pm 0.0075 \cdot t$ or ±2.5 °C
	Class 3		
K. N	Class 1	-40 to +1000	$\pm 0.004 \cdot t$ or ±1.5 °C
	Class 2	-40 to +1200	$\pm 0.0075 \cdot t$ or ±2.5 °C
	Class 3	-200 to +40	$\pm 0.0015 \cdot t$ or ±2.5 °C
R. S	Class 1	0 to 1600	$\pm[1 + 0.003 \cdot (t - 1100°C)]$ or ±1 °C
	Class 2	0 to 1600	$\pm 0.0025 \cdot t$ or ±1.5 °C
	Class 3		
T	Class 1	0 to 350	$\pm 0.004 \cdot t$ or ±0.5 °C
	Class 2	-40 to +350	$\pm 0.0075 \cdot t$ or ±1 °C
	Class 3	-200 to +40	$\pm 0.0015 \cdot t$ or ±1 °C

Table 4-4: Polynomial errors

Type designation	Temperature range (°C)	Temperature range (µV)	Polynomial error (°C)	
			min	max
B	250 to 700	291 to 2431	-0.02	0.026
	700 to 1820	2431 to 13820	-0.007	0.012
E	-200 to 0	-8825 to 0	-0.01	0.022
	0 to 1000	0 to 76373	-0.012	0.016
J	-210 to 0	-8095 to 0	-0.048	0.028
	0 to 760	0 to 42919	-0.035	0.037
	760 to 1200	42919 to 69553	-0.037	0.024
K	-200 to 0	-5891 to 0	-0.018	0.041
	0 to 500	0 to 20644	-0.047	0.033
	500 to 1372	20644 to 54886	-0.046	0.054
N	-200 to 0	-3990 to 0	-0.013	0.027
	0 to 600	0 to 20613	-0.016	0.027
	600 to 1300	20613 to 47513	-0.039	0.021
R	-50 to +250	-226 to +1923	-0.011	0.018
	250 to 1064	1923 to 11361	-0.003	0.005
	1064 to 1664.5	11361 to 19739	0.000	0.001
	1664.5 to 1768.1	19739 to 21103	0.001	0.001
S	-50 to +250	-235 to +1874	-0.011	0.02
	250 to 1064	1874 to 10332	-0.009	0.006
	1064 to 1664.5	10332 to 17536	0.000	0.000
	1664.5 to 1768.1	17536 to 18694	-0.002	0.001
T	-200 to 0	-5603 to 0	-0.017	0.038
	0 to 400	0 to 20872	-0.025	0.025

4.1.2 Selection criteria for thermocouple types

Fig. 4-2: Thermocouple types: Selection criteria



4.2 Resistance temperature detectors (RTD)

4.2.1 Resistors depending on temperature (PTC)

The electrical conductivity of a metal depends on the mobility of its conduction electrons. These move to the positive pole when a voltage is applied to the ends of the metal. Since with rising temperature the atoms of the metal lattice oscillate more intensely about their rest position, the electron movement is increasingly hindered. The electrical resistance in the metal grows and thus directly depends on the temperature. For this reason, this is called a positive temperature coefficient, i.e. a PTC resistor.

4.2.2 Platinum resistors

In industrial measurement, platinum RTDs are generally used, since this material offers advantages such as high chemical resistance, easy workability and good reproducibility of the electrical properties. The latter are defined in the standard DIN EN IEC 60751 so that platinum resistors are universally interchangeable.
The EN standard defines, for example, the variation of resistance with temperature, the nominal value, the permissible deviation limits as well as the temperature range.
For the temperature/resistance ratio, which is not directly proportional, the temperature range from -200 °C to 0 °C is covered by a third-order polynomial:

$$R(t) = R_0\,(1 + A \cdot t + B \cdot t^2 + C \cdot [t - 100\,°C] \cdot t^3)$$

A second-order polynomial covers the temperature range from 0 °C to 850 °C:

$$R(t) = R_0\,(1 + A \cdot t + B \cdot t^2)$$

The coefficients are calculated as follows:

$$\begin{aligned} A &= 3.9083 \cdot 10^{-3} \cdot °C^{-1} \\ B &= -5.775 \cdot 10^{-7} \cdot °C^{-2} \\ C &= -4.183 \cdot 10^{-12} \cdot °C^{-4} \end{aligned}$$

The nominal value R_0 is the resistance at 0 °C. For a Pt100 resistor, a nominal value of 100 Ω is defined by the EN standard.

From the temperature sensor resistance, you can calculate the respective temperature.
In terms of permissible temperatures deviating from actual sensor temperatures, the EN standard distinguishes between the following accuracy classes. Class A only applies to thermometers with 3-wire and 4-wire circuit connections.

Table 4-5: Accuracy classes of resistance temperature detectors

Tolerance class	Applicable range (°C)		Deviation limit* (°C)
	Wire-wound resistors	Film resistors	
AA	-50 to +250	0 to +150	$\pm\,(0.1 + 0.0017 \cdot \lvert t \rvert)$
A	-100 to +450	-30 to +300	$\pm\,(0.15 + 0.002 \cdot \lvert t \rvert)$
B	-196 to +600	-50 to +500	$\pm\,(0.3 + 0.005 \cdot \lvert t \rvert)$
C	-196 to +600	-50 to +600	$\pm\,(0.6 + 0.01 \cdot \lvert t \rvert)$

* t = Temperature in °C (without sign)

4.2.3 Nickel resistors

Nickel is another resistance material, but much more rarely used as a resistance temperature detector than platinum. It is much cheaper than platinum; however, due to its low chemical resistance, the measurement range only extends from -60 °C to +250 °C.

For the variation of resistance with temperature, the following formula applies:

$$R(t) = R_0\,(1 + A \cdot t + B \cdot t^2 + C \cdot t^4 + D \cdot t^6)$$

Calculating the coefficients:

$$\begin{aligned} A &= 0.5485 \cdot 10^{-2} \cdot °C^{-1} \\ B &= 0.665 \cdot 10^{-5} \cdot °C^{-2} \\ C &= 2.805 \cdot 10^{-11} \cdot °C^{-4} \\ D &= 2.111 \cdot 10^{-17} \cdot °C^{-6} \end{aligned}$$

The nominal value R_0 at 0 °C is 100 Ω.

Deviations from actual sensor temperatures are defined as follows:

0 °C to 250 °C:

$$\Delta t = \pm (0.4 + 0.007 \cdot t)$$

-60 °C to 0 °C:

$$\Delta t = \pm (0.4 + 0.028 \cdot t)$$

t = Temperature in °C (without sign)

Defining these accuracy classes allows for replacing Ni100 sensors by one another without recalibration.

5 Function description: Transducer inputs

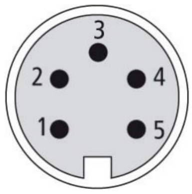
The Ethernet system **MSX-E3711** has 8 single-ended inputs for inductive displacement transducers.

5.1 Pin assignments

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

Table 5-1: Pin assignment: Transducer inputs

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



OSC = oscillator voltage = supply voltage

Mahr version: compatibility code M

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

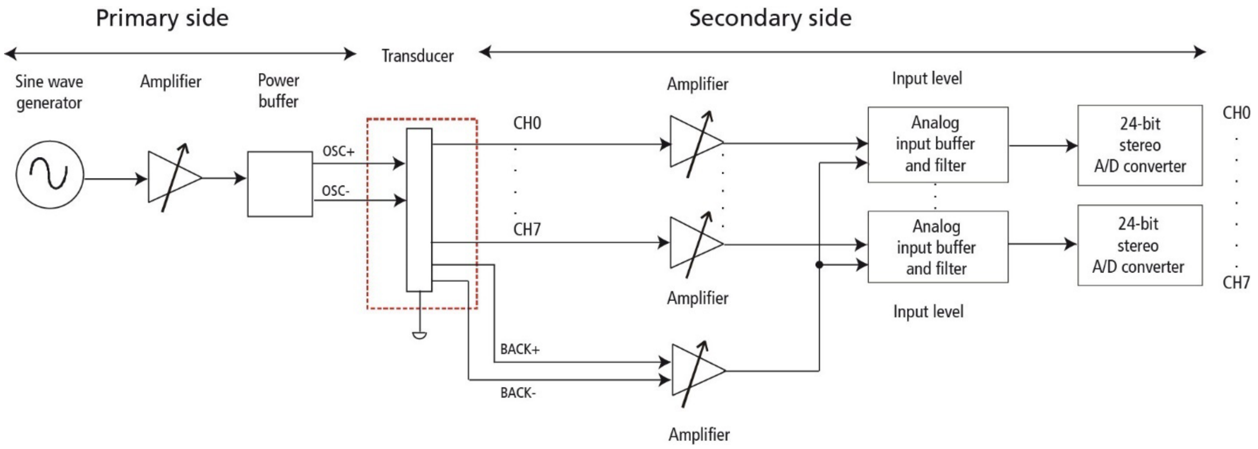
5.2 Acquisition principle

The Ethernet system **MSX-E3711** provides all signals required for the supply of the inductive transducers.
By means of a sine wave generator, the primary side of the transducer is supplied. The output frequency and the gain of the sine wave generator can be programmed through software.
The transducers are supplied via a differential power buffer.

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

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

Fig. 5-1: MSX-E3711: Acquisition principle



5.3 Calibration

At each input of the **MSX-E3711**, the gain and the offset error can be corrected by means of the **ConfigTools** program. When the MSX-E system is booting up, the calibration values are read from the flash and uploaded to the system.

5.4 Diagnostic function

Each input has a diagnostic function in order to detect a short-circuit, for example.

If such an error occurs, the respective input is switched off.
As soon as the short-circuit has been eliminated, a rearm has to be carried out to reactivate the input (see also Chapter 8.1.1). This means that the input is set to the status value that was programmed before the error occurred. A new value can only be defined after the rearm event.

5.4.1 Diagnostic function (Mahr version)

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

Using the function "MX371x__TransducerTestPrimaryShortCircuit", you can check if one of the connected transducers causes a short-circuit on the primary side.

The function "MX371x__TransducerTestSecondaryConnection" can be used to check if there is an error at the transducers.

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

The following functions cannot be used for the Mahr version:

- MX371x__TransducerInitPrimaryConnectionTest
- MX371x__TransducerTestPrimaryConnection
- MX371x__TransducerTestSecondaryShortCircuit.

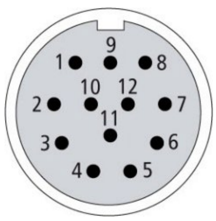
6 Function description: Incremental counter input

The Ethernet system **MSX-E3711** is equipped with an incremental counter input.

6.1 Pin assignment

One rotary encoder can be connected to the M23 female connector.

Table 6-1: Pin assignment: Incremental counter input

Pin No.	Female connector, 12-pin, M23
1	B-
2	Voltage supply 24 V or 5 V[1]
3	C+ (index)
4	C- (index)
5	A+
6	A-
7	not connected
8	B+
9	not connected
10	GND
11	GND
12	Voltage supply 24 V or 5 V[1]
	

NOTICE!
If you have selected the 5 V supply voltage, the voltage is only 2 V before a sensor is connected.

[1] see Chapter 6.2

6.2 Selecting the supply voltage

At pins 2 and 12 of the M23 female connector, you can select between a supply voltage of 24 V and 5 V. This voltage is set by means of a jumper.
The jumper is fitted inside the housing of the MSX-E system on the upper printed circuit board.
In order to set the jumper to the desired position, the left-hand side of the housing (see Fig. 5-1) needs to be opened.

Risk of injury!
Please note the following to avoid property damage and personal injury:

- The housing of the MSX-E system may be opened only for this purpose (see also Chapter 1.2.4)!
- Use safeguarding against electrostatic charge!
- The MSX-E system must not be connected to a voltage source during work at the housing and the jumper!
- When the housing is opened, neither solid nor liquid foreign bodies (dirt, moisture, etc.) may enter the inside of the housing!
- The jumper on the lower printed circuit board must not be set to another position!

Fig. 6-1: MSX-E3711: Left-hand side of the housing

Fig. 6-2: 24 V supply: Jumper at positions 1 and 2

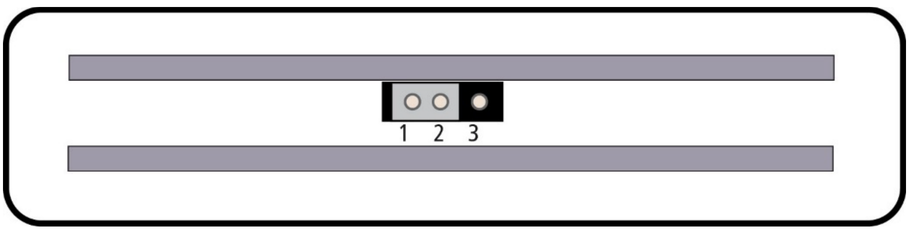
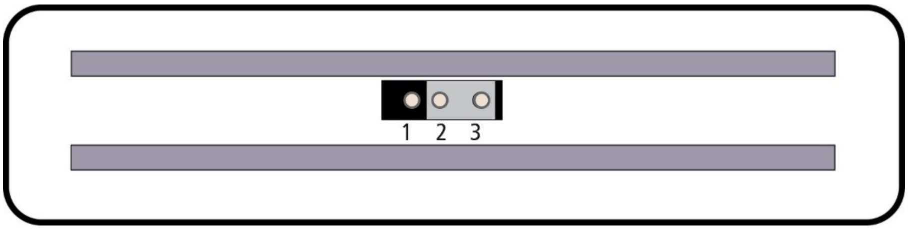


Fig. 6-3: 5 V supply: Jumper at positions 2 and 3



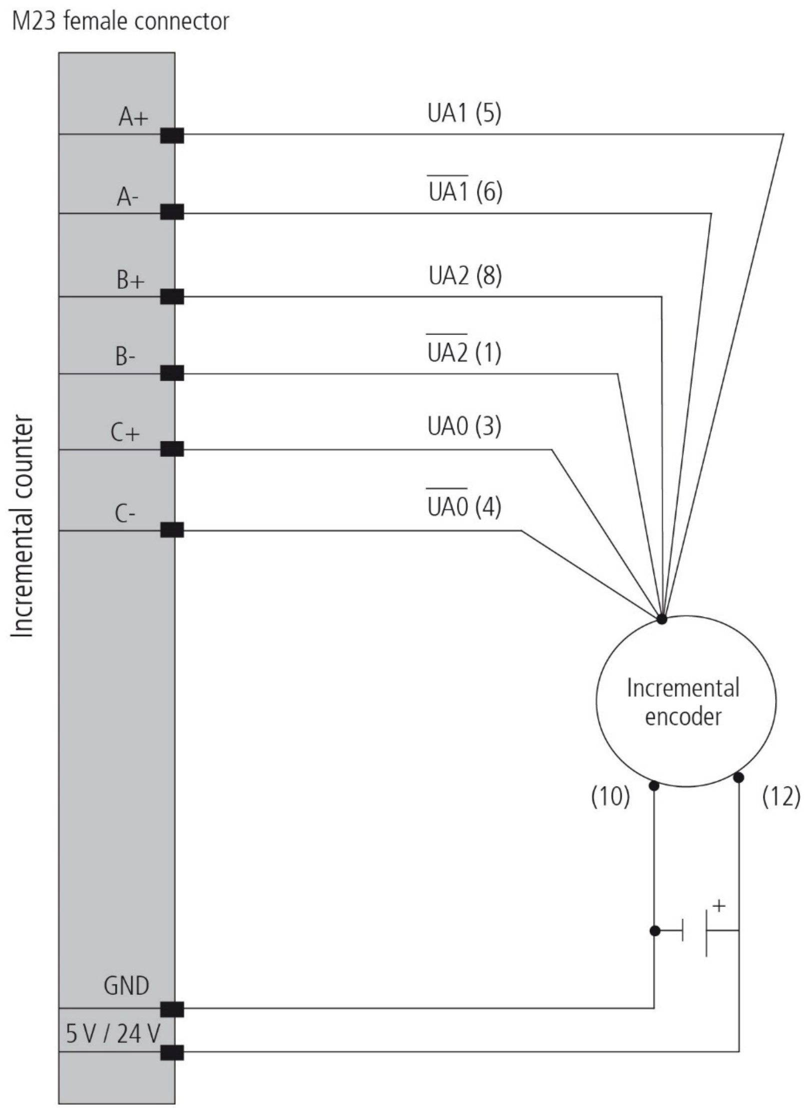
6.3 Connection of a displacement measurement system

6.3.1 Displacement measurement system with differential signals

Table 6-2: Displacement measurement system: Differential signals

Female connector, 12-pin, M23	Pin No.	Function
A+	5	Differential RS422 signal, trace A of the incremental displacement measurement system
A-	6	
B+	8	Differential RS422 signal, trace B of the incremental displacement measurement system
B-	1	
C+	3	Differential RS422 signal, trace C (index) of the incremental displacement measurement system
C-	4	
GND	10, 11	Ground (voltage supply of the sensor)
24 V / 5 V	2, 12	Voltage supply of the sensor

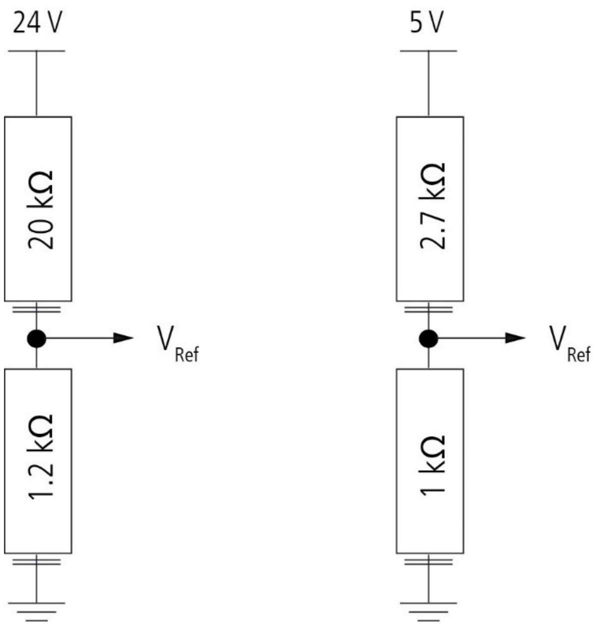
Fig. 6-4: Connection example: Incremental encoder



6.3.2 Displacement measurement system with TTL/5 V signals

In order to connect a TTL/5 V signal to the differential inputs A and B of the incremental counter, a reference voltage has to be applied to inputs A- and B-.
Depending on the voltage supply at pins 2 and 12 (24 V or 5 V), voltage dividers have to be connected to inputs A- and B- (see Fig. 5-4 for the resistance values). The sensor signal is connected to inputs A+ and B+.

Fig. 6-5: Voltage divider: 24 V and 5 V



6.3.3 Displacement measurement system with 24 V signals

NOTICE!
Sensors with 24 V signals may only be connected to a system of the version **MSX-E3711-xx-24V** (see Chapter 10.3).

6.4 Acquisition modes

There are four modes available for the acquisition of incremental encoder signals.

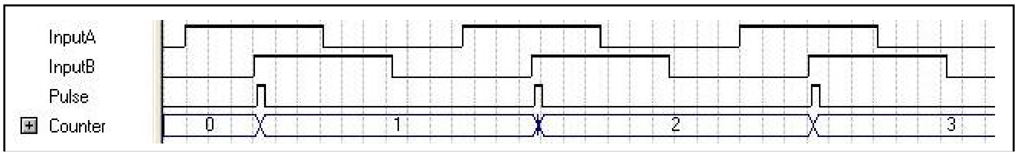
Table 6-3: Incremental counter: Acquisition modes

Mode	Feature
Single	Acquisition with a quarter of the highest possible resolution
Double	Acquisition with half of the highest possible resolution
Quadruple	Acquisition with the highest possible resolution
Direct	Acquisition without detection of the direction

a) Single mode

In Single mode, if trace A of the incremental encoder signal is on "high", the system counts with each rising edge of trace B.

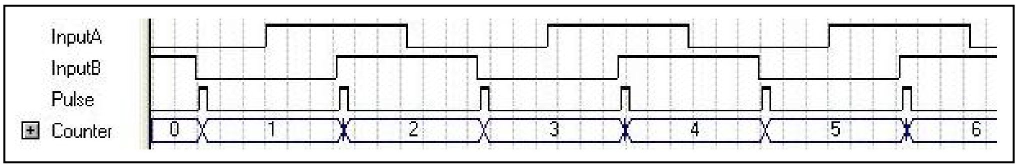
Fig. 6-6: Incremental counter: Single mode



b) Double mode

In Double mode, the system counts with each rising and falling edge of trace B.

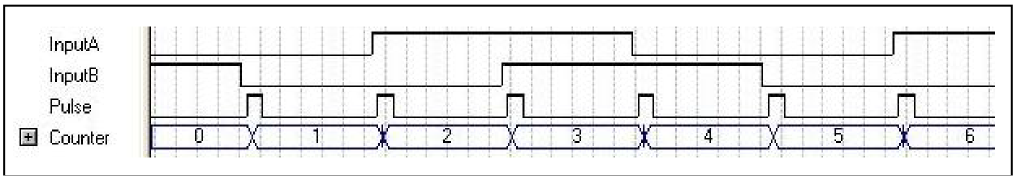
Fig. 6-7: Incremental counter: Double mode



c) Quadruple mode

In Quadruple mode, the system counts with each rising and falling edge of traces A and B.

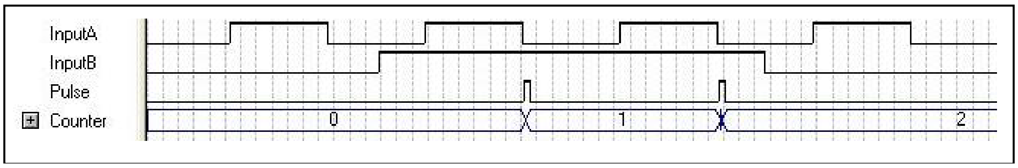
Fig. 6-8: Incremental counter: Quadruple mode



d) Direct mode

In Direct mode, the system counts with each falling edge of trace A, with input B serving as a gate input. The system counts only if trace B is on "high".
Moreover, in Direct mode, the direction of counting can be programmed through software.

Fig. 6-9: Incremental counter: Direct mode

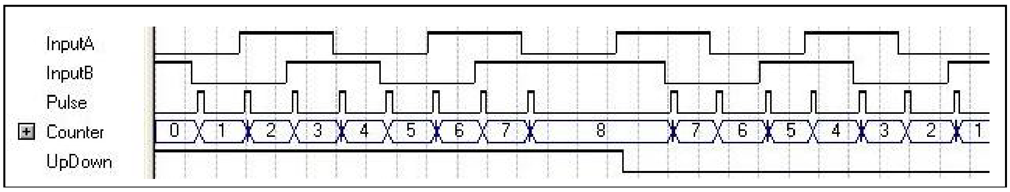


6.4.1 Options

1) Hysteresis function

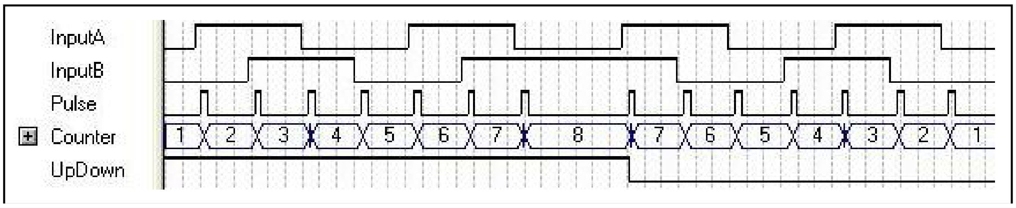
The hysteresis function can be used in Single, Double and Quadruple mode.

Fig. 6-10: Quadruple mode: Hysteresis "on"



With hysteresis "on", the first counting pulse after a change of rotational direction is not evaluated.

Fig. 6-11: Quadruple mode: Hysteresis "off"



2) Way of counting

In Direct mode, counting can be either upwards or downwards.

6.5 Compare logic

By means of the compare logic, an acquisition in Auto-refresh or Sequence mode can be triggered (see Chapter 9.3.2. In addition, there is the possibility to generate a synchro trigger signal for triggering further systems.

There are two compare logic modes:

a) Simple mode

In Simple mode, a reference value can be indicated. As soon as the counter value corresponds to the reference value, a trigger or synchro trigger is released.

b) Modulo mode

In Modulo mode, a reference value is indicated as well. When the counter value corresponds to the reference value or a multiple of it, a trigger or synchro trigger is released.

6.6 Index logic

In Sequence mode, the status of the index input can be acquired, too (see Chapter 9.3.3).

7 Function description: Temperature sensor input

The Ethernet system **MSX-E3711** has an input for a temperature sensor, i.e. for a resistance temperature detector (RTD) or a thermocouple (TC).

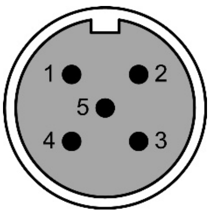
7.1 Pin assignment

7.1.1 RTD input (MSX-E3711)

One resistance temperature detector (Pt100, Pt500 or Pt1000) can be connected to the M12 female connector. The differential sensor input consists of RTD+ and RTD-.

Table 7-1: Pin assignment: RTD input

Pin No.	Female connector, 5-pin, M12	Cable (black) Lead colour
1	EXC+	brown
2	RTD+	white
3	RTD-	blue
4	GND	black
5	not connected	grey



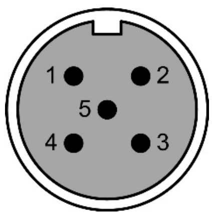
RTD = Resistance temperature detector
EXC = Current source (excitation)

7.1.2 TC input (MSX-E3711 with OPT. MSX-E-TC)

One thermocouple can be connected to the M12 female connector. The differential sensor input consists of TC+ and TC-.

Table 7-2: Pin assignment: TC input

Pin No.	Female connector, 5-pin, M12	Cable (black)
		Lead colour
1	CJC+	brown
2	TC+	white
3	TC-	blue
4	CJC-	black
5	not connected	grey



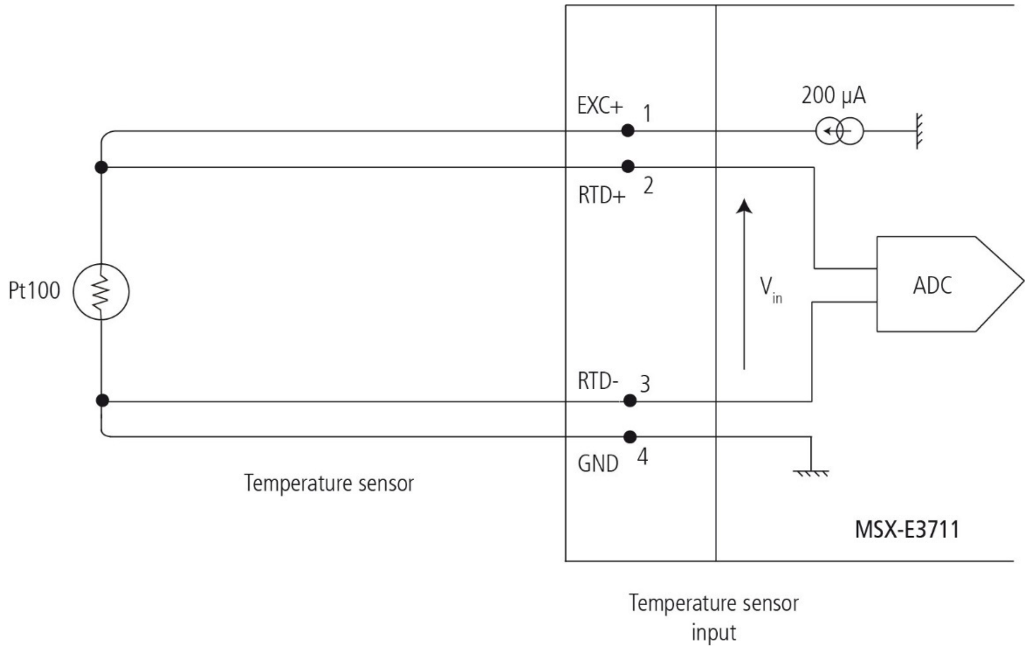
TC = Thermocouple
CJC = Cold junction compensation

OPT. MSX-E-TC: The Pt1000 sensor for the cold junction compensation (CJC) is integrated in the supplied connector **SC-M12-5-TC**.

7.2 Connection examples

7.2.1 RTD sensor (MSX-E3711)

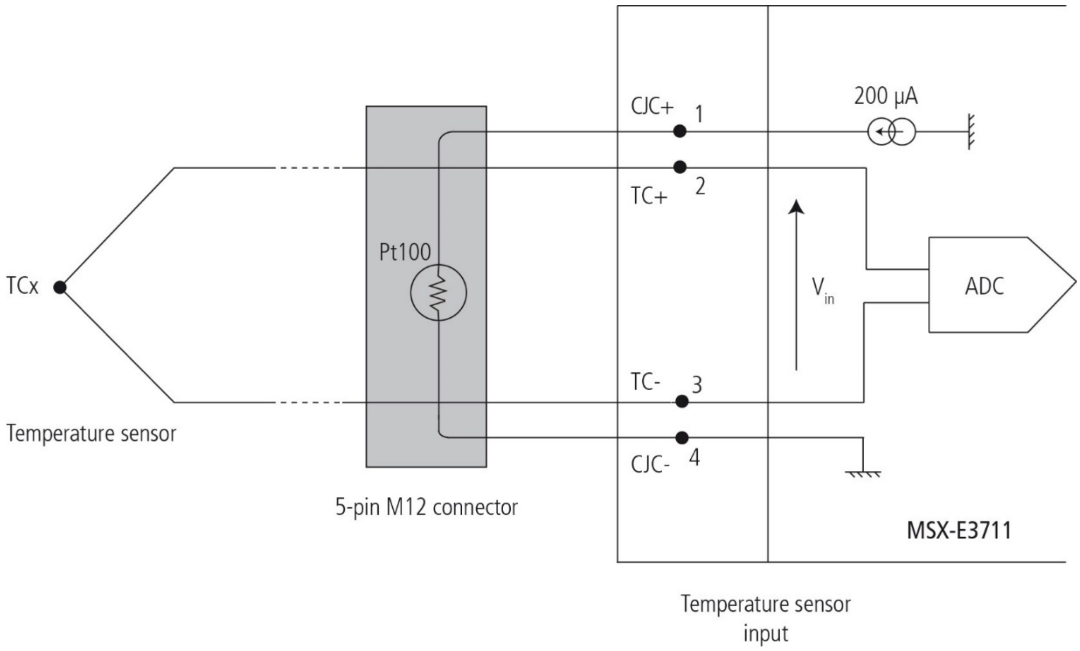
Fig. 7-1: Connection example: Pt100 sensor (4-wire circuit)



The current supply and ground lines are lead independently of the voltage line to the resistor. The line resistance does not impact the measurement result.

7.2.2 TC sensor (MSX-E3711 with OPT. MSX-E-TC)

Fig. 7-2: Connection example: TCx sensor (4-wire circuit)



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

In this chapter, the system-specific parts of the **MSX-E3711** 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).

8.1 Menu item “I/O Configuration”

Under this menu item, you can configure the inputs and outputs of the MSX-E system.

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

By clicking on the ”Reload” button, the configuration that has been saved last is displayed.

8.1.1 “Transducers” tab

On this tab, you can find the pin assignment of the transducer inputs (see also Chapter 5.1).

8.1.2 “Incremental counter” tab

Besides the pin assignment of the incremental counter input (see also Chapter 6.1), this tab contains the following sections:

Fig. 8-1: Incremental counter: Acquisition mode configuration

Current Counter state	UNINITIALISED
Acquisition mode	Single
Direct mode options	Increment
Simple/double/quadruple options	Hysteresis on

In this section, you can select the acquisition mode of the incremental encoder signal and the corresponding options. A description of these is to be found in Chapter 6.4.
The current state of the incremental counter is indicated in the first line of this table.

Fig. 8-2: Incremental counter: Compare logic configuration

Current counter state	NOT INITIALISED
Synchro trigger state	INACTIVE
Reference value	0
Compare logic mode	Modulo
Synchro trigger	Yes
Reference value	

If in Auto-refresh or Sequence mode, you have selected the compare logic as the trigger type (see Chapter 9.3.2), you can define in the section above whether this should generate a synchro trigger. Here, you can also select the compare logic mode and enter the reference value.
For more information on the compare logic, read Chapter 6.5.
The current states of the incremental counter and the synchro trigger are indicated in the first two lines of the table above.

When the acquisition is running, the current value of the incremental counter is displayed in the section "Incremental counter data".

8.1.3 "Temperature" tab

On this tab, you can find the pin assignment of the temperature sensor input (see also Chapter 7.1) as well as the following section:

Fig. 8-3: Temperature: Temperature sensor configuration

Current configuration state	UNINITIALISED
Sensor type	PT100
Gain	Auto gain mode
Acquisition frequency	10 Hz
Acquisition format	mOhm

For the temperature acquisition, you can select the sensor type, the acquisition frequency and the measurement unit of the acquired values ("Acquisition format"). For the gain, the Auto-gain mode is preset.

When the acquisition is running, the current value of the temperature sensor is displayed in the section "Temperature data".

8.2 Menu item “Transducers”

8.2.1 “Database” tab

Fig. 8-4: Transducers: Database

Index	Name	Calibrated	Type	Nominal frequency (Hz)	Load impedance (ohms)	Vrms (V)	Sensitivity (mV/V/mm)	Range (mm)
1	TESA GT21/GT22	Yes	HB	12500	2000	3.00	73.75	± 2.00
209	WAYCON LVT25 Test100k	Yes	HB	5000	100000	3.00	42.93	± 25.00
211	WAYCON LVT10 100k	Yes	HB	5000	100000	3.00	68.45	± 5.00
212	WAYCON LV-T5 100K	Yes	HB	5000	100000	3.00	73.43	± 2.50
213	WAYCON LT10-100KRange10	Yes	HB	5000	100000	3.00	68.45	± 10.00
214	WAYCON LVT2 -100K	Yes	HB	5000	100000	3.00	79.30	± 1.00

In the **ConfigTools** program, transducers that are to be used for the acquisition must be copied into the MSX-E database. The transducer properties can be changed in the User database of this program (see also Chapter 3.2).

The table shown in the figure above displays the content of the MSX-E database. By clicking on the “Reload” button, the table is refreshed.

8.2.2 “Diagnosis” tab

Fig. 8-5: Transducers: Diagnosis

Task	Status	Result
Test Primary side short-circuit	Done	Ok
Initialise primary side connection line	Done	Ok
Test primary side connection line	Done	Ok
Test secondary side connection line of channel 0	Done	Ok
Test secondary side connection line of channel 1	Done	No transducer connected, or open line detected.
Test secondary side connection line of channel 2	Done	No transducer connected, or open line detected.

To carry out a transducer diagnosis, you have to select a transducer and click on “Start”.
From the list shown in the figure above, you can see if on the primary or secondary side of the transducer, a short-circuit has occurred. If no transducer is connected or if there is a line break, this is also indicated.

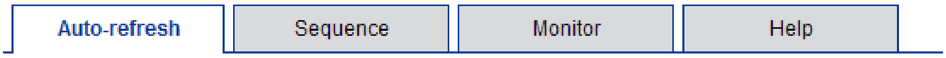
In case of a short-circuit, the required rearm can be carried out via the correspondent button. Please find further information on this in Chapter 5.4 of this manual.

The diagnosis should be repeated in the event of transducer changes, errors such as a short-circuit or after a certain time.

8.3 Menu item “Acquisition”

8.3.1 “Auto-refresh” and “Sequence” tabs

Fig. 8-6: 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 9 of this manual.

The acquisition is started and stopped in the tool bar at the top of the tab (“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 this tab, also the data format is shown for all data to be acquired. More detailed information on this can be found in Chapter 9.3.4.

8.3.2 “Monitor” tab

When the acquisition has been started, you can enter the number of data packets to be transferred. Via the button “Display as table”, all values that have been sent are listed.

8.3.3 “Help” tab

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

9 Acquisition modes

This chapter exemplifies how to configure and start an acquisition via the web interface of the Ethernet system **MSX-E3711**. Moreover, you can use Modbus or SOAP functions (see driver download on the ADDI-DATA website) to perform these steps.

9.1 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.
The measurement values are cyclically updated according to the set acquisition time. An average value can be calculated directly on the MSX-E system.

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

9.1.1 "Channel configuration" (channel selection)

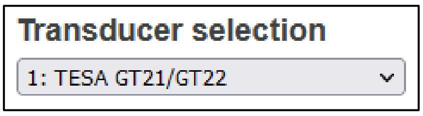
Fig. 9-1: Auto-refresh mode: "Channel configuration"

Channel	Transducer	Selection
Channel 0	Inductive transducer 0	☑
Channel 1	Inductive transducer 1	☑
Channel 2	Inductive transducer 2	☐
Channel 3	Inductive transducer 3	☐

- Select the channels you want to acquire.

9.1.2 "Transducer selection"

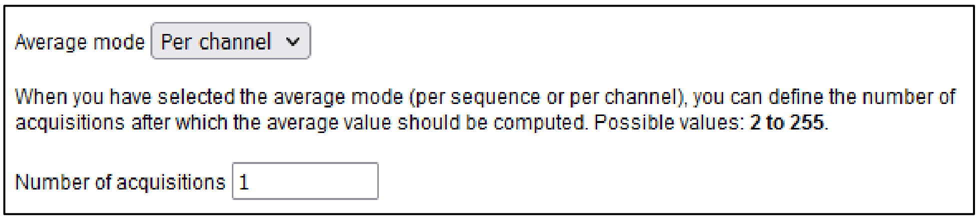
Fig. 9-2: Auto-refresh mode: "Transducer selection"



- Select the connected transducer type.

9.1.3 "Average" (average value calculation)

Fig. 9-3: Auto-refresh mode: "Average"

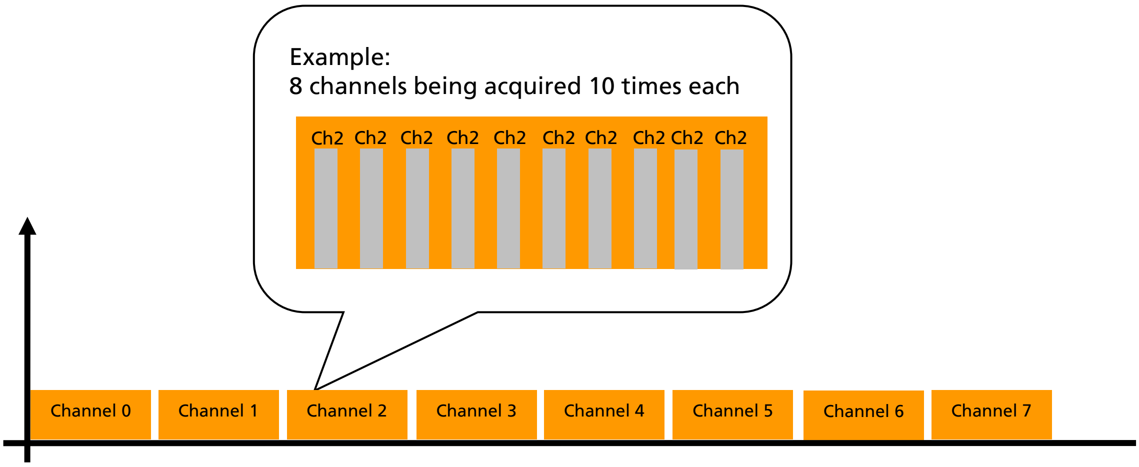


The MSX-E system is capable of calculating an average value for each channel.
In the field "Number of acquisitions", you have to enter the number of acquisitions (2 to 255) after which this value should be calculated.

Example

The MSX-E system acquires channels 0 to 7. "Number of acquisitions" contains the value 10. This means that each of the eight channels is acquired ten times.

Fig. 9-4: Auto-refresh mode: Acquisition example



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

Average value of channel 0 = (value of channel 0 + value of channel 0 + … + value of channel 0) / 10
Average value of channel 1 = (value of channel 1 + value of channel 1 + … + value of channel 1) / 10
…
Average value of channel 7 = (value of channel 7 + value of channel 7 + … + value of channel 7) / 10

The network client will not receive eight data packets, with ten values in each packet, but only one data packet containing the average values from channels 0 to 7.

9.2 Sequence mode

The Sequence mode enables you to acquire one or more channels per acquisition sequence.
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.

9.2.1 "Channel configuration" (channel selection)

Fig. 9-5: Sequence mode: "Channel configuration"

Channel	Transducer	Selection	Acquisition order
Channel 0	Inductive transducer 0	☑	4
Channel 1	Inductive transducer 1	☑	0
Channel 2	Inductive transducer 2	☑	2
Channel 3	Inductive transducer 3	☑	1
Channel 4	Inductive transducer 4	☑	7
Channel 5	Inductive transducer 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.

9.2.2 "Transducer selection"

Fig. 9-6: Sequence mode: "Transducer selection"

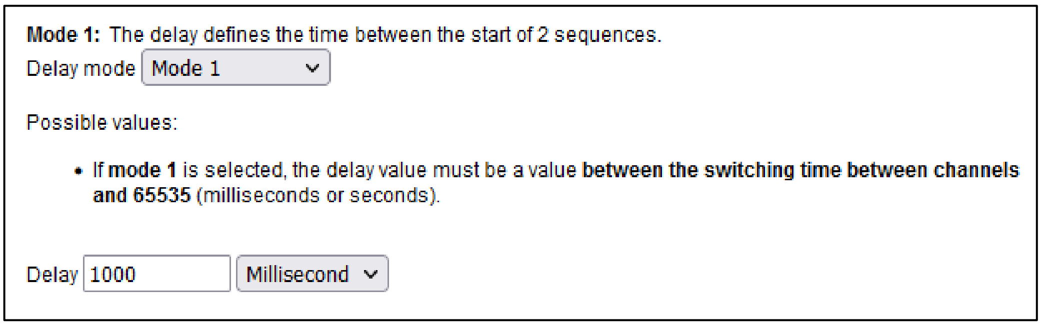
Transducer selection

1: TESA GT21/GT22

- Select the connected transducer type.

9.2.3 “Delay” (wait time)

Fig. 9-7: Sequence mode: “Delay”



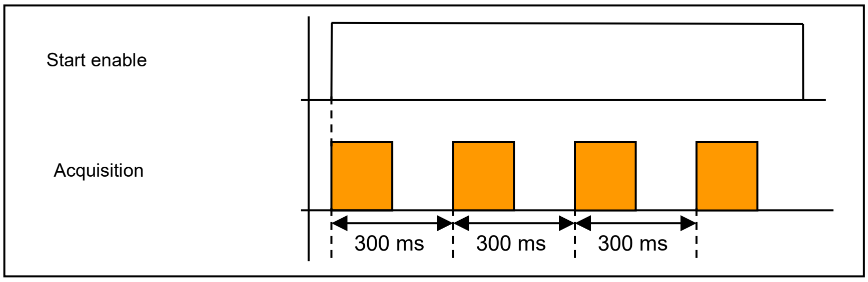
In the “Delay” section, you can define the wait time between the individual sequences.
You can define the value and the unit of the wait time in the “Delay” field.

In mode 1, the time between the starts of two subsequent sequences is defined as the delay. This value can range between 1 and 65535 (milliseconds or seconds).

Example

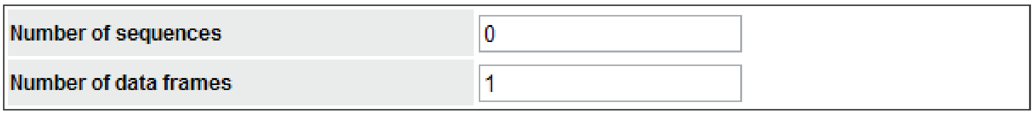
After the start of the acquisition, the delay between the starts of the individual sequences is 300 ms.

Fig. 9-8: Delay: Mode 1 (example)



9.2.4 “Sequence measurement” (number of sequences)

Fig. 9-9: Sequence mode: “Sequence measurement“

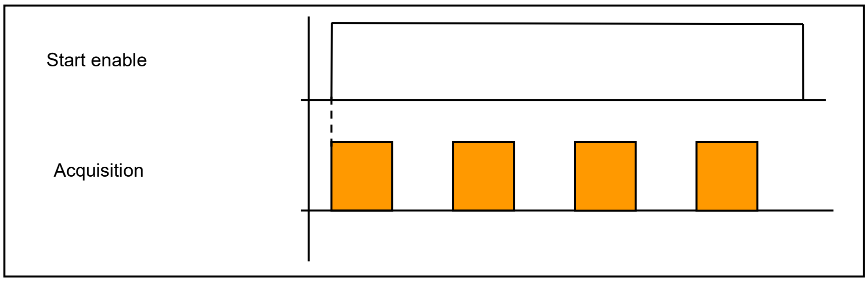


In the field “Number of sequences”, you have to enter the number of sequences to be acquired (1 to 4294967295). If this value is 0, the acquisition is continuous.

Example

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

Fig. 9-10: "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.

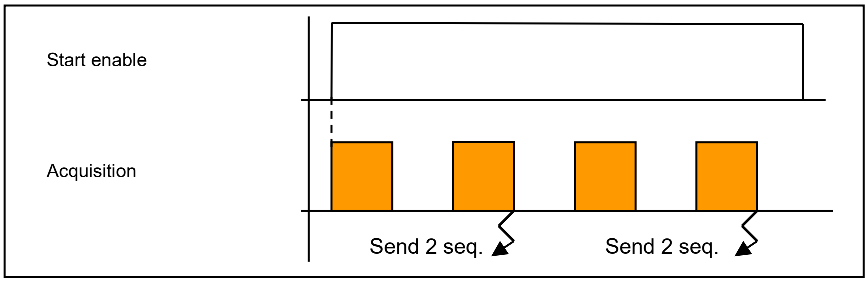
NOTICE!
The value entered must not be higher than the value in the field "Number of sequences". The latter must be divisible by this value.

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. 9-11: "Number of data frames" (example)



9.3 Common functions

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

9.3.1 "Acquisition time"

Fig. 9-12: Acquisition: Acquisition time

Nominal frequency of the transducer (Hz)	Transducer acquisition time (ms)
20000	0.05

The total acquisition time is automatically calculated according to the selected transducer.
In Sequence Mode, the total time also depends on the selected delay mode (see Chapter 9.2.3).

9.3.2 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. 9-13: Acquisition: Trigger configuration

	Trigger source	Trigger mode	Number of sequences per trigger
Description	Trigger mask		Number of sequences to be acquired for each trigger
Value	Disabled	One-shot	1 (1 - 65535)

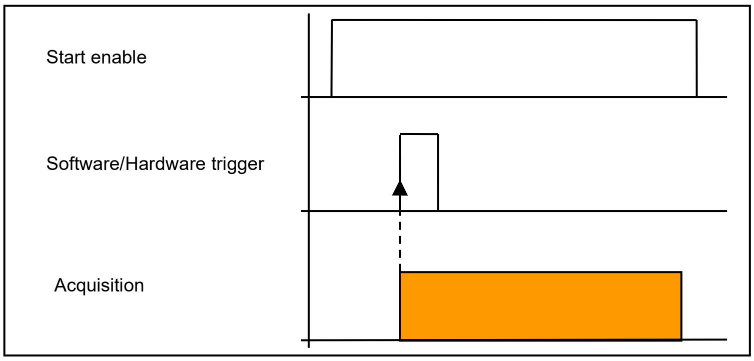
	Hardware trigger active edge	Hardware trigger count
Description	Type of edges before the acquisition starts	Number of edges before the acquisition starts
Value	Rising edge	0 (1-65535)

- **Trigger source:** Available trigger types are hardware trigger, synchro trigger and compare logic. If you select the latter, you have to configure it on the "Incremental counter" tab as well (see Chapter 8.1.2).
- **Trigger mode:** If the trigger mode "One-shot" is selected, only one acquisition starts after a trigger. If the option "Sequence" 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.

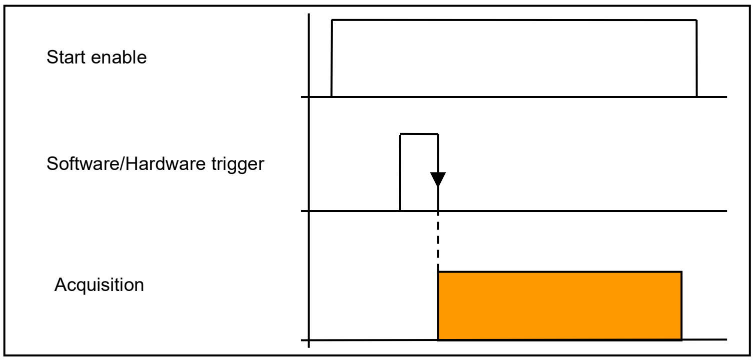
The following pages contain examples of the hardware trigger.
For further information on the hardware or synchro trigger, please refer to the general manual of the MSX-E systems (see PDF link).

1) Examples of edges

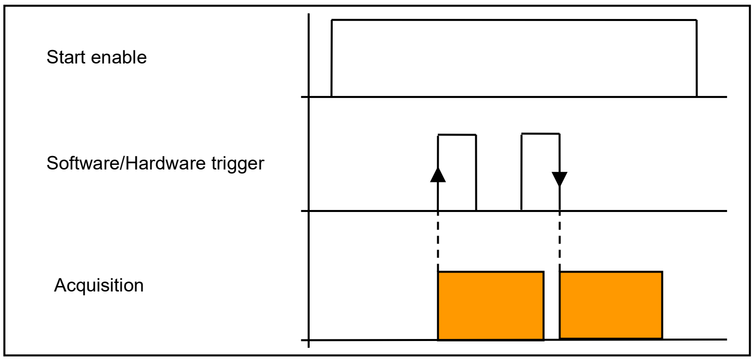
a) Rising: Rising edge



b) Falling: Falling edge



c) Both: Rising and falling edges



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

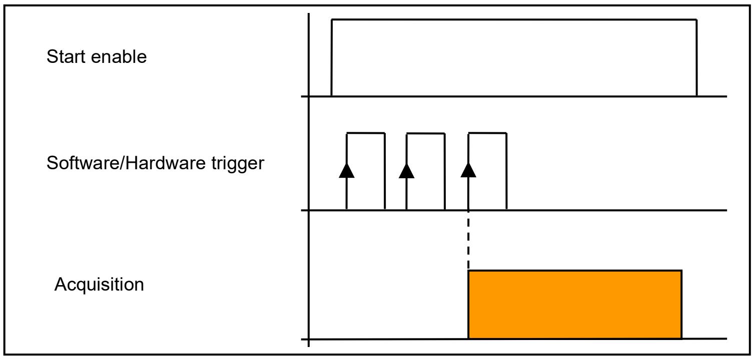
a) To start the acquisition once only after three rising edges, you can use the following configuration:

Fig. 9-14: Hardware trigger with "One-Shot" (a)

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

	Hardware trigger active edge	Hardware trigger count
Description	Type of edges before the acquisition starts	Number of edges before the acquisition starts
Value	Rising edge	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.



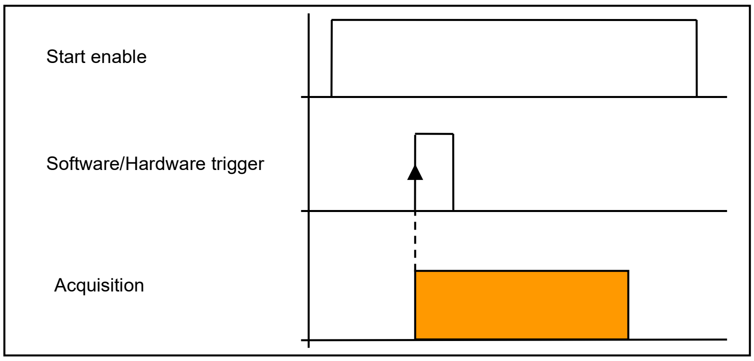
b) With "Hardware trigger active edge", "Rising" is selected again, and with "Hardware trigger count", the value 1 is entered.

Fig. 9-15: Hardware trigger with "One-Shot" (b)

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

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

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



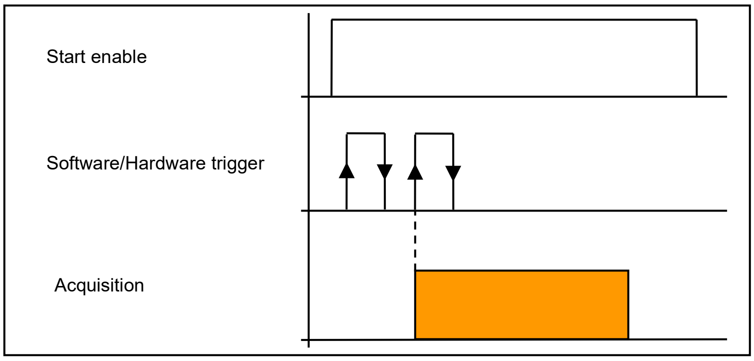
c) With “Hardware trigger active edge”, the option “Both” is selected, and with “Hardware trigger count”, the value 3 is entered.

Fig. 9-16: Hardware trigger with “One-Shot” (c)

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

	Hardware trigger active edge	Hardware trigger count
Description	Type of edges before the acquisition starts	Number of edges before the acquisition starts
Value	Both edges	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.



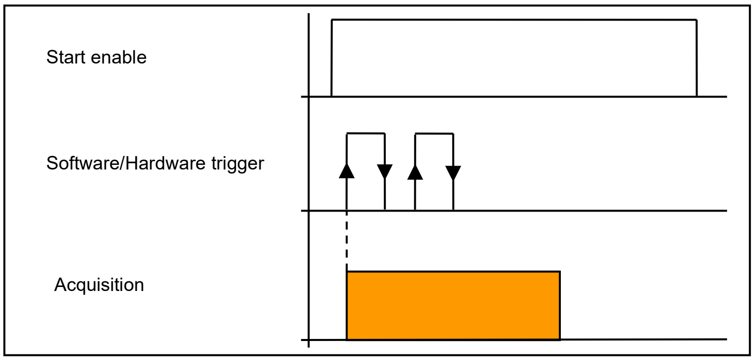
d) With “Hardware trigger active edge”, the option “Both” is selected again, and with “Hardware trigger count”, the value 1 is entered.

Fig. 9-17: Hardware trigger with “One-Shot” (d)

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

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

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



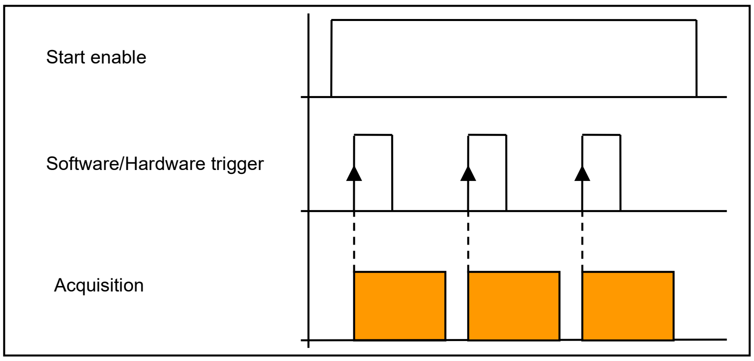
3) Examples of hardware triggers with “Sequence”

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

Fig. 9-18: Hardware trigger with “Sequence” (a)

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

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



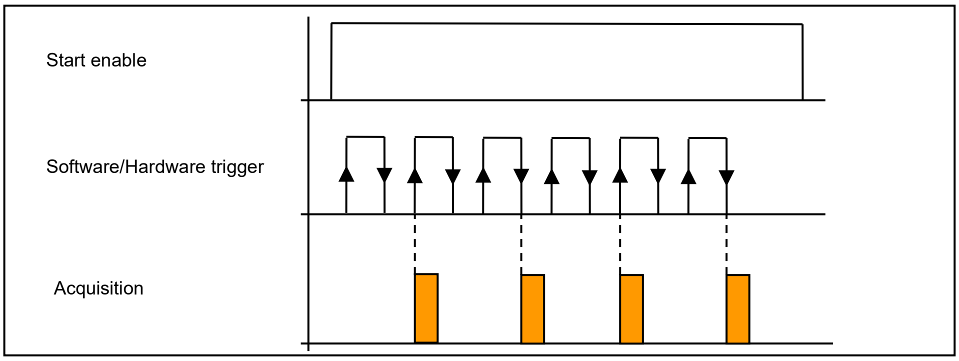
b) With “Hardware trigger active edge”, “Both” is selected, and with “Hardware trigger count”, the value 3 is entered.

Fig. 9-19: Hardware trigger with “Sequence” (b)

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

	Hardware trigger active edge	Hardware trigger count
Description	Type of edges before the acquisition starts	Number of edges before the acquisition starts
Value	Both edges	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.



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

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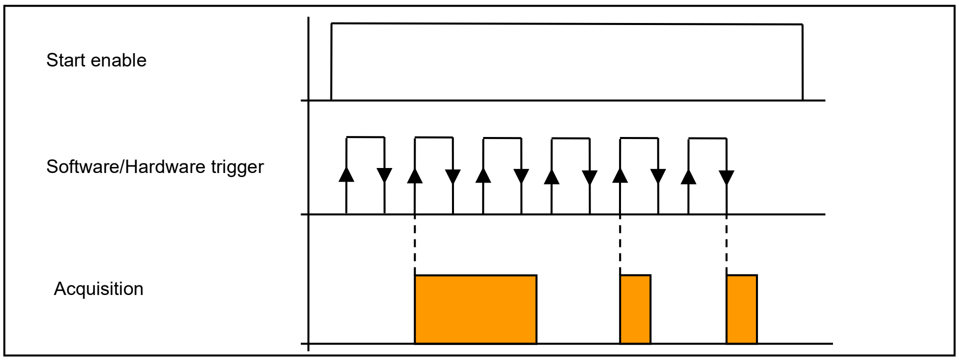


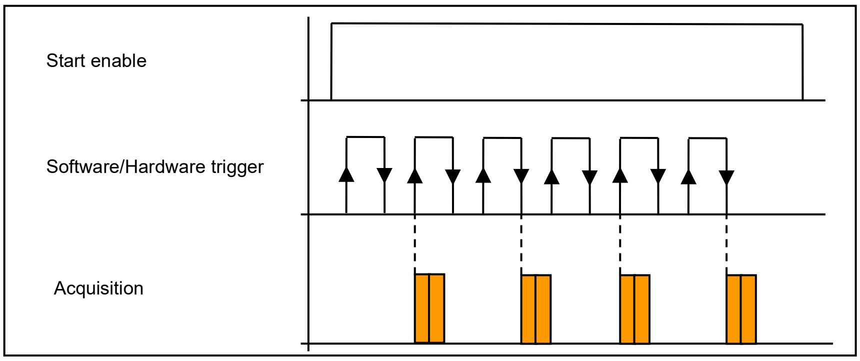
c) The settings correspond to example 3 b), with the exception of "Number of sequences per trigger", where the value 2 is entered.

Fig. 9-20: Hardware trigger with "Sequence" (c)

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

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

After each trigger, two sequences are acquired.



9.3.3 “Data server frame configuration” (supplementary data)

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

Fig. 9-21: Data server frame configuration (Auto-refresh mode)

- [x] Send an absolute time stamp with the data.
- [x] Convert the raw values into analog values.
- [ ] Invert the sign of the measured values.
- [ ] Send the temperature value
- [ ] Send the incremental counter value
- [x] Enable differential mode

- **Send an absolute time stamp with the data:** A time stamp is sent, which contains the date of the acquisition.
- **Convert the raw 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-E3711**, the unit is millimetres (mm). As the conversion affects the MSX-E CPU to a certain extent, this can result in slower sending speed.
- **Invert the sign of the measured values:** It is possible to invert the sign of the measurement value.
- **Send the temperature value:** The acquired temperature value is sent.
- **Send the incremental counter value:** The value of the incremental counter is sent.
- **Enable the differential mode:** In differential mode, the values of two transducer channels are added up automatically (channels 0+4, channels 1+5, etc.).

Fig. 9-22: Data server frame configuration (Sequence mode)

- [x] Send an absolute time stamp with the data.
- [x] Send the Sequence counter value.
- [ ] Convert the raw values into analog values.
- [ ] Invert the sign of the measured values.
- [x] Send the temperature value
- [x] Send the incremental counter value
- [ ] Enable differential mode
- [x] Send the hardware trigger status with the data
- [ ] Send index input information with the data.

In Sequence mode, there are further options available:

- **Send the "Sequence" counter value with the data:** The value of the Sequence counter is sent. In Sequence mode, all sequences are acquired so that 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.
- **Send the index input status with the data:** The status of trace C (index) of the incremental encoder signal is sent.

9.3.4 "Data server frame format" (data format)

Fig. 9-23: Acquisition: Data server frame format

Size	Field	Description
4 Bytes	Time stamp (s)	The seconds part of the system time stamp (encoded as integer)
4 Bytes	Time stamp (µs)	The microseconds part of the system time stamp (encoded as integer)
4 Bytes	Sequence counter	Number of acquired sequences (encoded as integer)
4 Bytes	Inductive transducer 0	Analog value, encoded in signed floating point format (mm)
4 Bytes	Inductive transducer 1	Analog value, encoded in signed floating point format (mm)
4 Bytes	Inductive transducer 2	Analog value, encoded in signed floating point format (mm)
4 Bytes	Inductive transducer 3	Analog value, encoded in signed floating point format (mm)
4 Bytes	Inductive transducer 4	Analog value, encoded in signed floating point format (mm)
4 Bytes	Inductive transducer 5	Analog value, encoded in signed floating point format (mm)
4 Bytes	Inductive transducer 6	Analog value, encoded in signed floating point format (mm)
4 Bytes	Inductive transducer 7	Analog value, encoded in signed floating point format (mm)
4 Bytes	Temperature	External temperature data
4 Bytes	Incremental counter	Incremental counter value
4 Bytes	Different mode	Enable diff mode. Channel X value = Channel X value + Channel (X+4) value
4 Bytes	External trigger	Current hardware trigger configuration information
4 Bytes	Counter index	Current index configuration information

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 a packet.

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

The type and the amount of the data sent depend on the respective configuration. The complete data format is as follows:

Table 9-1: Data format (Sequence mode)

Information	Size	Description	Format
Time stamp (s)	4 bytes	Seconds part of the acquisition time	Integer
Time stamp (µs)	4 bytes	Microseconds part of the acquisition time	Integer
Sequence counter	4 bytes	Number of the data packet	Integer
Transducer inputs	4 bytes	Acquired data of the selected transducer inputs	Floating point value
Temperature sensor input	4 bytes	Acquired temperature value	mΩ: Integer °C, °F: Floating point value
Incremental counter input	4 bytes	Acquired incremental counter value	Integer
Differential mode	4 bytes	Channel x value = Channel x value + Channel (x+4) value	Floating point value
Hardware trigger	4 bytes	Rising or falling edge of the hardware trigger	Integer
Index	4 bytes	Trace C of the incremental encoder signal	Integer

10 Technical data and limit values

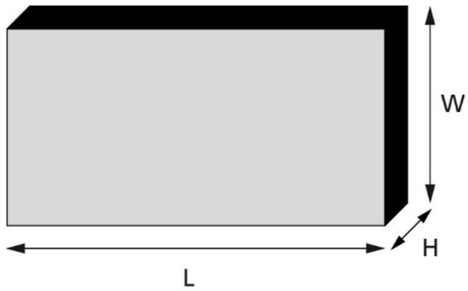
10.1 Electromagnetic compatibility (EMC)

The Ethernet system **MSX-E3711** complies with the European EMC directive. The tests were carried out by a certified EMC laboratory in accordance with the standard DIN EN IEC 61326-1. 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.

10.2 Mechanical structure

Fig. 10-1: MSX-E3711: Dimensions



Dimensions (L x W x H):	215 x 110 x 54 mm
Weight:	760 g 820 g (with MX-Rail)

Fig. 10-2: MSX-E3711: View from above

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

10.3 Versions

The Ethernet system **MSX-E3711** is available in the following versions:

Table 10-1: MSX-E3711: Versions

Version	Features
MSX-E3711-HB	for 8 HB displacement transducers, RS422 counter input
MSX-E3711-HB-24V	for 8 HB displacement transducers, 24 V counter input
MSX-E3711-LVDT	for 8 LVDT displacement transducers, 5 V counter input
MSX-E3711-LVDT-24V	for 8 LVDT displacement transducers, 24 V counter input
MSX-E3711-M	for 8 Mahr displacement transducers, 5 V counter input
MSX-E3711-K	for 8 Knäbel displacement transducers, 5 V counter input
Option	**Features**
OPT. MSX-E-TC	for 1 thermocouple, with **SC-M12-5-TC** connector incl. Pt1000 sensor for cold junction compensation

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).

10.4 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.)
Voltage supply:	
Nominal voltage:	24 VDC
Supply voltage:	18-30 V
Current consumption (at 24 V):	400 mA (±10 %)
Safety:	
Degree of protection:	IP 65[2]
Optical isolation:	1000 V

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.

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

10.4.1 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)

10.4.2 Trigger input

24 V trigger input

Number of inputs:	1
Filter/Protective circuit:	low-pass/TVS 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/TVS 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.

10.4.3 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)

10.4.4 Transducer inputs

Number of inputs:		8 x ADC (not multiplexed)
Input type:		single-ended
Coupling:		DC
Resolution:		24-bit
Transducer accuracy:		TESA GT21: ±61 nm (without average value) ±15 nm (with 16 values, moving average value)
Sampling frequency f_S:	on 8 channels: $f_S = f_P$ Example with TESA GT21 on all 8 channels: $f_S = f_P$	at a primary frequency f_P of: 5 kHz 7.69 kHz 10 kHz 12.5 kHz 20 kHz 50 kHz = 12.5 kHz
Input level:		
Input impedance (software-programmable):		2 kΩ 10 kΩ 100 kΩ 10 MΩ
Input range:		± 3.3 V max. (programmable)

NOTICE!
In addition to the transducers listed in Table 10-1, other transducers are supported as well. If you need more information on this, do not hesitate to contact us.

10.4.5 Sine wave generator (transducer supply)

Number of outputs:	2
Type:	sine differential (180° phase shift)
Coupling:	AC
Programmed signals:	
Output frequency f_P (primary frequency):	depending on the transducer: 5 kHz typ. 7.69 kHz typ. 10 kHz typ. 12.5 kHz typ. 20 kHz typ. 50 kHz typ. (Knäbel)
Output level:	
Output range:	± 11 V max.
Output impedance:	< 0.1 Ω typ. > 30 kΩ typ. (in shutdown mode)

Short-circuit current:	0.7 A typ. (at 25 °C with thermal protection)
Switching time buffer Off/On:	1 µs typ.
Bandwidth (-3 dB):	0.65 Hz high-pass filter On 50 kHz low-pass filter
Frequency response:	10 Hz to 20 kHz 0.7 dB min. 0 dB max.
Output voltage:	High Z (after power-on) 0 V (after reset)
FIFO depth:	64 DWord (for each analog output)

10.4.6 Incremental counter input

Number of inputs:	1 (including A, B, C and D signals)
Input type:	differential, TTL or 24 V
Sensor supply: Voltage: Current:	 5 V or 24 V (can be selected via jumper) 500 mA max. (for each female connector)
Differential inputs:	comply with EIA standards RS422A
Common mode range:	+12 V to -7 V
Input sensitivity:	±200 mV
Input hysteresis:	50 mV typ.
Max. input frequency:	5 MHz
Input impedance:	12 kΩ min.
"Open Circuit Fail Safe Receiver Design":	"1" = inputs open
ESD protection:	up to ±15 kV
TTL inputs:	see Chapter 6.3.2
24 V inputs:	version for the connection of 24 V encoders or 24 V signals
Nominal voltage:	24 VDC
Max. input frequency:	1 MHz (at nominal voltage)
Input impedance:	1 MΩ typ.
Logic input levels:	UH_{max}: 30 V UH_{min}: 19 V UL_{max}: 14 V UL_{min}: 0 V

10.4.7 Temperature sensor input (RTD)

Number of inputs:	1
Input type:	RTD (Pt100, Pt200, Pt500, Pt1000)
Connection:	4-wire connection
Temperature range:	-200 °C to +850 °C
Current source:	200 µA typ.
Acquisition frequency:	10 Hz, 50 Hz, 240 Hz (programmable)
Gain:	Auto-gain mode (automatically set by the processor to optimise accuracy)

Resolution:	±0.01 °C min. (if the acquisition frequency is 10 Hz using a Pt100 sensor)
Accuracy:	see Table 10-2 (maximum error if the acquisition frequency is 10 Hz or 240 Hz using a Pt100 sensor)
Measurement unit:	mΩ, °C, °F (programmable)

Table 10-2: RTD input: Accuracy

Temperature (°C)	Error (± °C)
0	0.30
10	0.35
20	0.40
30	0.45
40	0.50
50	0.55

10.4.8 Temperature sensor input (TC)

Number of inputs:	1
Input type:	TC (B, E, J, K, N, R, S, T)
Temperature range:	see Table 10-3
Acquisition frequency:	10 Hz, 50 Hz, 240 Hz (programmable)
Gain:	Auto-gain mode (automatically set by the processor to optimise accuracy)
Resolution:	±0.01 °C min. (if the acquisition frequency is 10 Hz)
Measurement unit:	mΩ, °C, °F (programmable)

Table 10-3: TC input: Temperature range

TC type designation	Temperature range (°C)
B	+250 to +1,820
E	-200 to +1,000
J	-210 to +1,200
K	-200 to +1,372
N	-200 to +1,300
R	-50 to +1,768.1
S	-50 to +1,768.1
T	-200 to +400

11 Appendix

11.1 Glossary

ADC
= A/D converter

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

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

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

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

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

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

EMC
= Electromagnetic Compatibility

According to the European EMC Directive, electromagnetic compatibility is "the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to other equipment in that environment."

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

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

IEC
= International Electrotechnical Commission

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

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

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

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

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

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

MAC address
MAC = Media Access Control

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

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

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

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

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

SOAP
= Simple Object Process Protocol

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

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

TCP/IP
= Transmission Control Protocol/Internet Protocol

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

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

UDP
= User Datagram Protocol

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

11.2 Index

12 Contact and support

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