Safety Manual

DS230 / DS240 Series
Safety Monitors for SinCos and Incremental Encoders / Sensors

Product features:

- Monitoring of underspeed, overspeed, standstill and direction of rotation
- SIL3 and PLe certification
- Safety functions equivalent to EN 61800-5-2
  (SS1, SS2, SOS, SLS, SDI, SSM, SLI, SBC, STO, SMS)
- Inputs for: 2 SinCos encoders
  2 RS422 incremental encoders
  2 HTL/PNP incremental encoders, proximity switches or
  2 - 4 control signals
- Outputs: 1 relay output 5 … 36 VDC (NO), (safety related)
  1 analog output 4 … 20 mA, (safety related)
  4 HTL control outputs, (safety related)
- Signal splitter: 1 SinCos Splitter Output, (safety related)
  1 RS422 Splitter Output, (safety related)
- Mounting to 35 mm top hat rail (according to EN 60715)
- USB interface for simple parametrization by the OS operator surface
- Optionally available: display and programming unit BG230 for parametrization and indication

Available Models:

- DS230: includes all inputs, all outputs and signal splitter
- DS236: includes all inputs, all outputs, but no signal splitter
- DS240: 1 SinCos input (SIL3/PLe), all control inputs, all outputs and signal splitter
- DS246: 1 SinCos input (SIL3/PLe), all control inputs, all outputs no signal splitter

Die deutsche Beschreibung ist verfügbar unter:
https://www.motrona.com/fileadmin/files/bedienungsanleitungen/Ds230_d.pdf

The English description is available at:
https://www.motrona.com/fileadmin/files/bedienungsanleitungen/Ds230_e.pdf

La description en français est disponible sur:
https://www.motrona.com/fileadmin/files/bedienungsanleitungen/Ds230_f.pdf

The operator software OS (freeware) is available at:
https://www.motrona.com/en/support/software.html

Version:	Description:
Ds23001a_oi/mb/07/14	First edition pre series
Ds23003a_oi/sn/ag/06/15	First edition series
Ds230_03b_oi/Oct-15/ag	Diverse adaptations and extensions
Ds230_04a_oi/Dez.-15/af-ag	Adaptations and extensions of parameters
Ds230_04b_oi/af-ag	Parameter description and list removed (separate manual). Extensive changes and extensions. New chapters added.
Ds230_04c_oi/af-ag	Chapter 11. Monitoring Functions supplemented Supplementation in chapters 6.4 / 6.6 / 6.7 / 6.11 New images : 1 x in chapter 8.2 and 2 x in 8.3
Ds230_04d_oi/af-ag	Changes in chapter "Runtime Test" Small corrections in chapter "Monitoring Functions" New chapter "Response times" added
Ds230_04e_oi/af/hk	Various adaptions and modifications Additional chapter for wiring of inputs, outputs, EDM function Extensions and amendments in chapter „Setup"
DS230_04f_oi/sn	Adaptations of safety characteristic data
Ds230_05a_oi/af	New parameters and functions
DS230_06coi/af-cn	New parameters and functions
Ds230_07a_oi/cf	New parameters and functions (Overlap, Delay, Switch Mode = 21, 22)
Ds230_07b_oi/mbo/05/21	Revised version

Important note about this document:

In addition to this manual, the separate parameter description **Ds230_07x_pd** must be used.

It contains a detailed description and a list of all parameters for setup and operation.

Further important manuals:

- OS Operating Manual
- OS User Installation Manual
- BG230 Operating Manual (optionally)

Table of Contents

1. Safety Instructions and Responsibility

1.1. General Safety Instructions

This operation manual is a significant component of the unit and includes important rules and hints about the installation, function and usage. Non-observance can result in damage and/or impairment of the functions to the unit or the machine or even in injury to persons using the equipment!

Please read the following instructions carefully before operating the device and observe all safety and warning instructions! Keep the manual for later use.

A pertinent qualification of the respective staff is a fundamental requirement in order to use these manual. The unit must be installed, configured, commissioned and serviced by a qualified electrician.

Liability exclusion: The manufacturer is not liable for personal injury and/or damage to property and for consequential damage, due to incorrect handling, installation, operation and maintaining. Further claims, due to errors in the operation manual as well as misinterpretations are excluded from liability.

In addition the manufacturer reserves the right to modify the hardware, software or operation manual at any time and without prior notice. Therefore, there might be minor differences between the unit and the descriptions in operation manual.

The raiser respectively positioner is exclusively responsible for the safety of the system and equipment where the unit will be integrated.

During installation, operation or maintenance all general and also all country- and application-specific safety rules and standards must be observed.

If the device is used in processes, where a failure or faulty operation could damage the system or injure persons, appropriate precautions to avoid such consequences must be taken.

1.2. Use according to the intended purpose

The unit is intended exclusively for use in industrial machines, constructions and systems. Non-conforming usage does not correspond to the provisions and lies within the sole responsibility of the user. The manufacturer is not liable for damages which are arisen through unsuitable and improper use. Please note that device may only be installed in proper form and used in a technically perfect condition in accordance to the technical Specifications. The device is not suitable for operation in explosion-proof areas or areas which are excluded by the EN 61010-1 standard.

1.3. Installation

The device is only allowed to be installed and operated within the permissible temperature range. Please ensure adequate ventilation and avoid all direct contact between the device and hot or aggressive gases and liquids.

Before installation or maintenance, the unit must be disconnected from all voltage-sources. Further it must be ensured that no danger can arise by touching the disconnected voltage-sources.

Devices which are supplied by AC-voltages, must be connected exclusively by switches, respectively circuit-breakers with the low voltage network. The switch or circuit-breaker must be placed as near as possible to the device and further indicated as separator.

Incoming as well as outgoing wires and wires for extra low voltages (ELV) must be separated from dangerous electrical cables (SELV circuits) by using double resp. increased isolation.

All selected wires and isolations must be conforming to the provided voltage- and temperature-ranges. Further all country- and application-specific standards, which are relevant for structure, form and quality of the wires, must be ensured. Indications about the permissible wire cross-sections for wiring are described in the technical specifications.

Before first Start-up it must be ensured that all connections and wires are firmly seated and secured in the screw terminals. All (inclusively unused) terminals must be fastened by turning the relevant screws clockwise up to the stop.

Overvoltage at the connections must be limited to values in accordance to the overvoltage category II.

1.4.   EMC Guidelines

All motrona devices are designed to provide high protection against electromagnetic interference. Nevertheless you must minimize the influence of electromagnetic noise to the device and all connected cables.

Therefore the following measures are mandatory for a successful installation and operation:
- **Use shielded cables for all signal and control input and output lines.**
- **Cables for digital controls (digital I/O, relay outputs) must not exceed a length of 30 m and are allowed for in building operation only**
- Use shield connection clamps to connect the cable shields properly to earth
- The wiring of the common ground lines must be star-shaped and common ground must be connected to earth at only one single point
- The device should be mounted in a metal enclosure with sufficient distance to sources of electromagnetic noise.
- Run signal and control cables apart from power lines and other cables emitting electromagnetic noise.

Please also refer to motrona manual "General Rules for Cabling, Grounding, Cabinet Assembly". You can download that manual by the link
https://www.motrona.com/en/support/general-certificates.html

1.5.   Cleaning, Maintenance and Service Notes

To clean the front of the unit please use only a slightly damp (not wet!), soft cloth. For the rear no cleaning is necessary. For an unscheduled, individual cleaning of the rear the maintenance staff or assembler is self-responsible.

During normal operation no maintenance is necessary. In case of unexpected problems, failures or malfunctions the device must be shipped for back to the manufacturer for checking, adjustment or reparation. Unauthorized opening and repairing can have negative effects or failures to the protection-measures of the unit.

In case of continuous operation the DS unit must be switched on and off for at least 1 times a year.

2.   Introduction

This series of speed monitors is suitable for safety-related monitoring tasks, e.g. over-speed, under-speed, standstill and direction of rotation. This SIL3/PLe certified generation of devices was developed to achieve functional safety by supporting a wide range of sensors and encoders in different combinations.

Due to parallel encoder inputs these devices are perfectly suitable for the retrofitting of existing plants and machines which are using "non-safe" sensors. This offers a great opportunity to save costs for expensive and certified sensors. Also the costs for new installations and adjustments can be reduced significantly by using the existing components and wiring.

Typical examples are centrifuges, cranes, wind power or hauling plants.

Special features:

- Additionally suitable for use with setup operations,
  e. g. for manual settings in plants with open protection doors and reduced speed

- All models are safety-related and dually certified according to
  EN 61508, EN 62061 / SIL3 and EN ISO 13849-1 Cat. 3 / PLe,
  even when using "non-safety-related" standard sensors or encoders

- Generally, the use of 2 sensors / encoders is required because only then SIL3 / PLe can be achieved. The only exception is the use of a SIL3 PLe certified SinCos encoder.

- Wide input frequency range and fast response time

- Very versatile range of possible monitoring functions

- It is recommended to setup the DS unit via the front USB port by using a PC and the OS operator software.

- The final Safety Integration Level (SIL) results from the selected configuration and from external components connected to the unit.

- The additional display and operating unit BG230 (optional accessory, not included in the delivery) is used to display the encoder frequencies in converted operator units and further for visual monitoring of the DS unit. The BG230 can also be used for a simple configuration as well as for setup tasks.

3.   Available Models

<div style="text-align:right">D   S   2   x   x</div>

Unit

| D = | Speed Monitor |

Application

| S = | Safety Applications |

Housing

| 2 = | Housing for DIN rail mounting in a control cabinet (according to EN 60715) |

Inputs

| 3 = | 2 Inputs for SinCos encoders
2 Inputs for incremental RS422 encoders
2 Inputs for HTL/PNP incremental   encoders or HTL/PNP control signals |
| 4 = | 1 Input for SinCos encoder with SIL3 / PLe
2 Inputs for HTL/PNP control signals |

Outputs

| 0 = | 1 Relay Output
1 Analog Output
4 Control Outputs
1 SinCos Splitter Output
1 RS422 Splitter Output |
| 6 = | 1 Relay Output
1 Analog Output
4 HTL Control Outputs |

4. Block Diagrams and Connections

4.1. DS230 Block Diagram
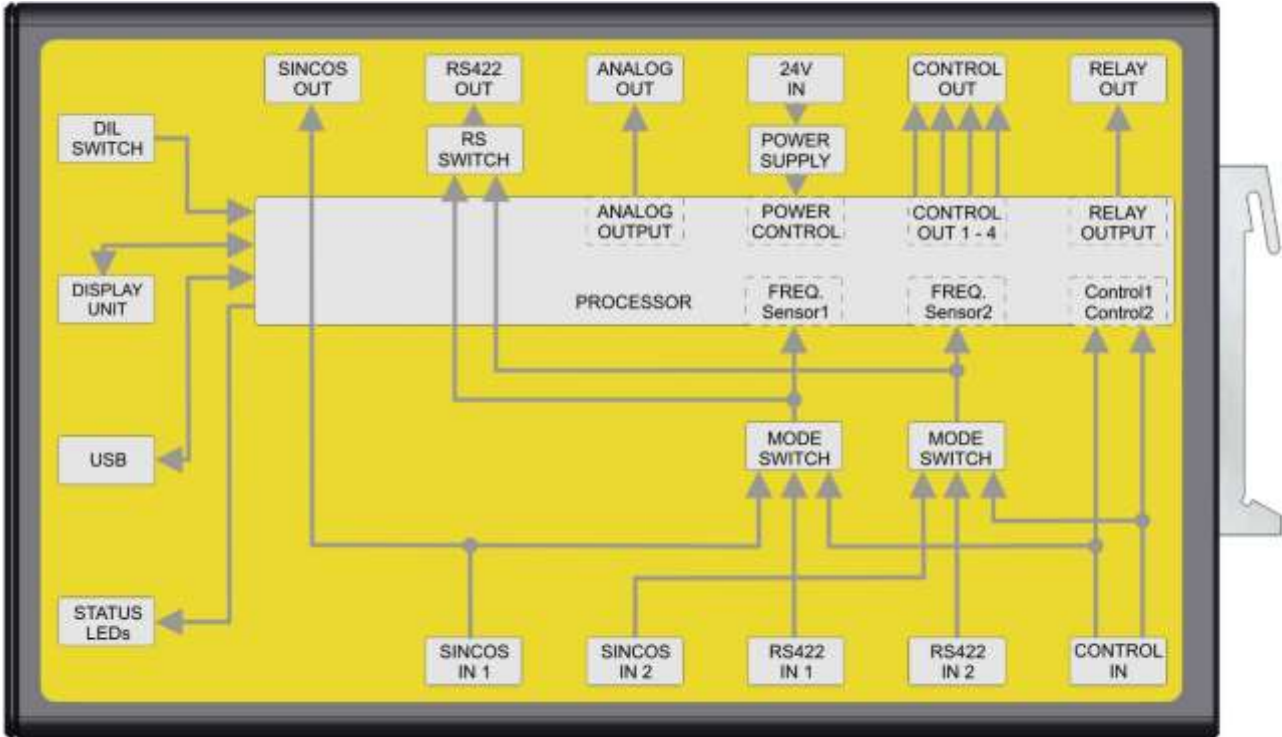
4.2. DS230 Connections

(The figure shows the available ports)

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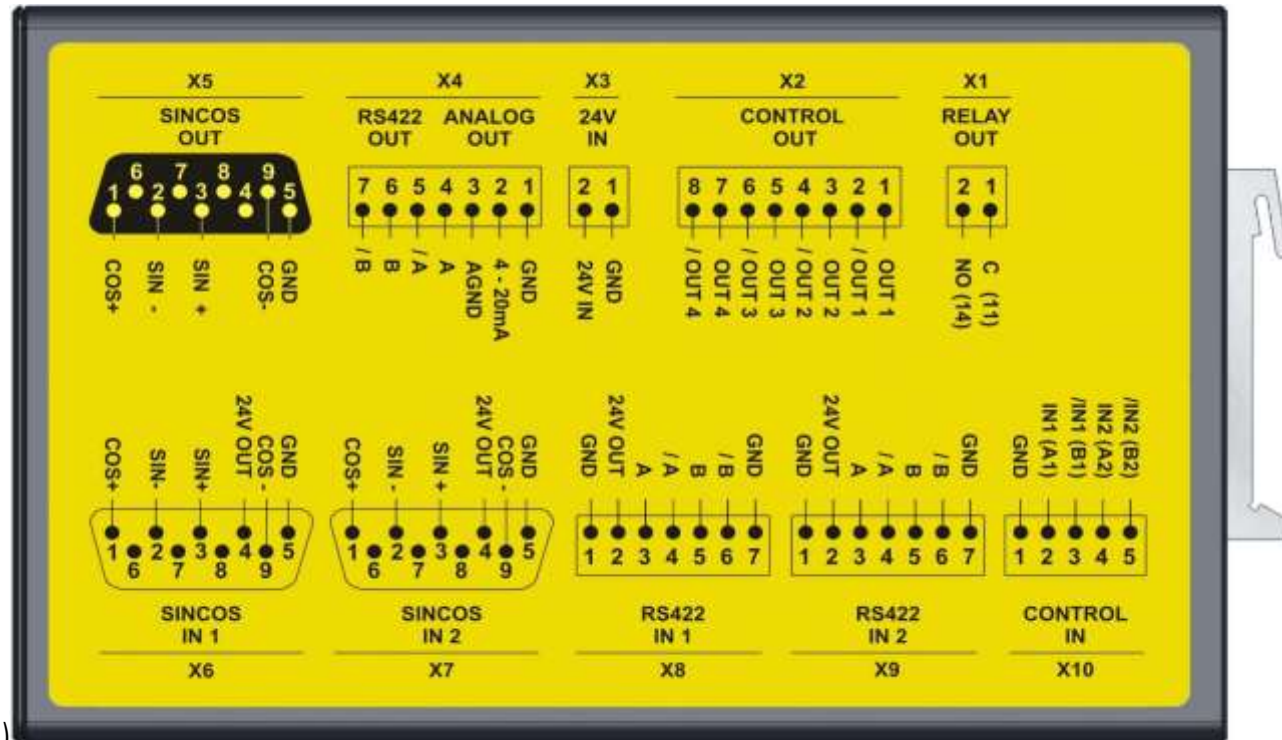
4.3. DS236 Block Diagram
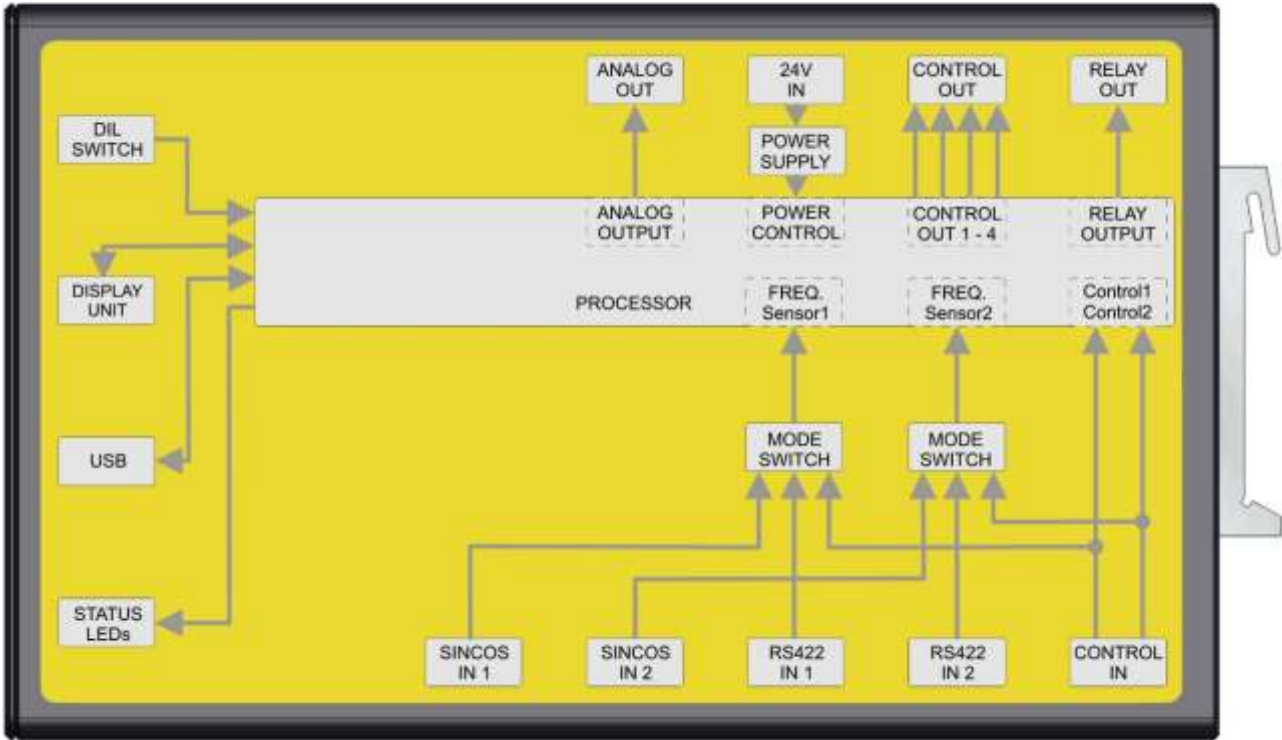
4.4. DS236 Connections

(The figure shows the available ports)
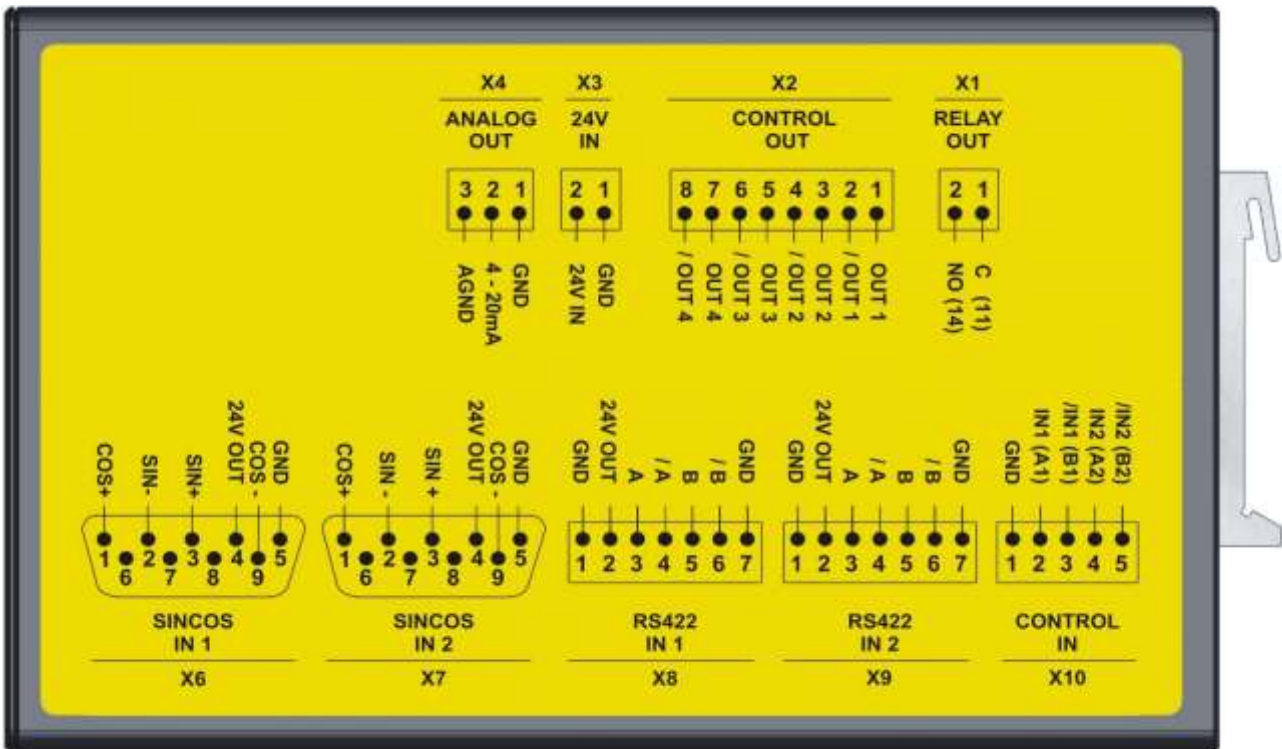
4.5.   DS240 Block Diagram
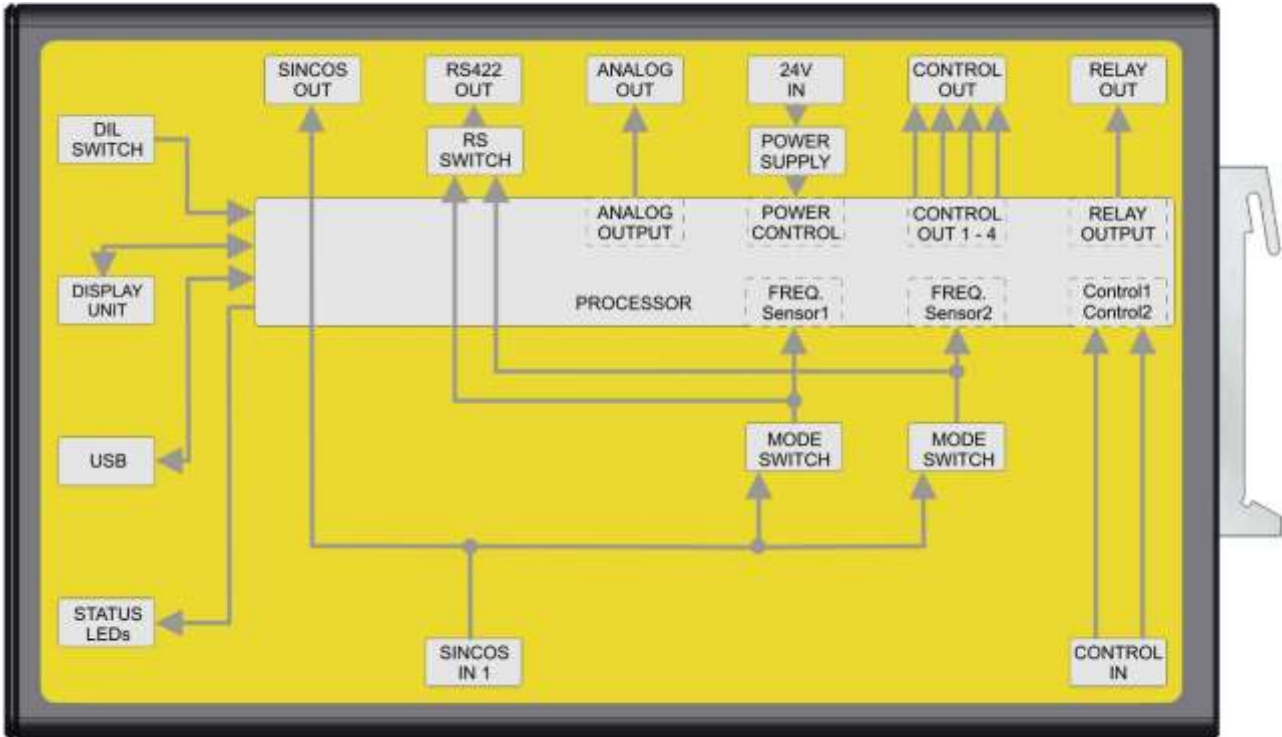
4.6.   DS240 Connections

(The figure shows the available ports)
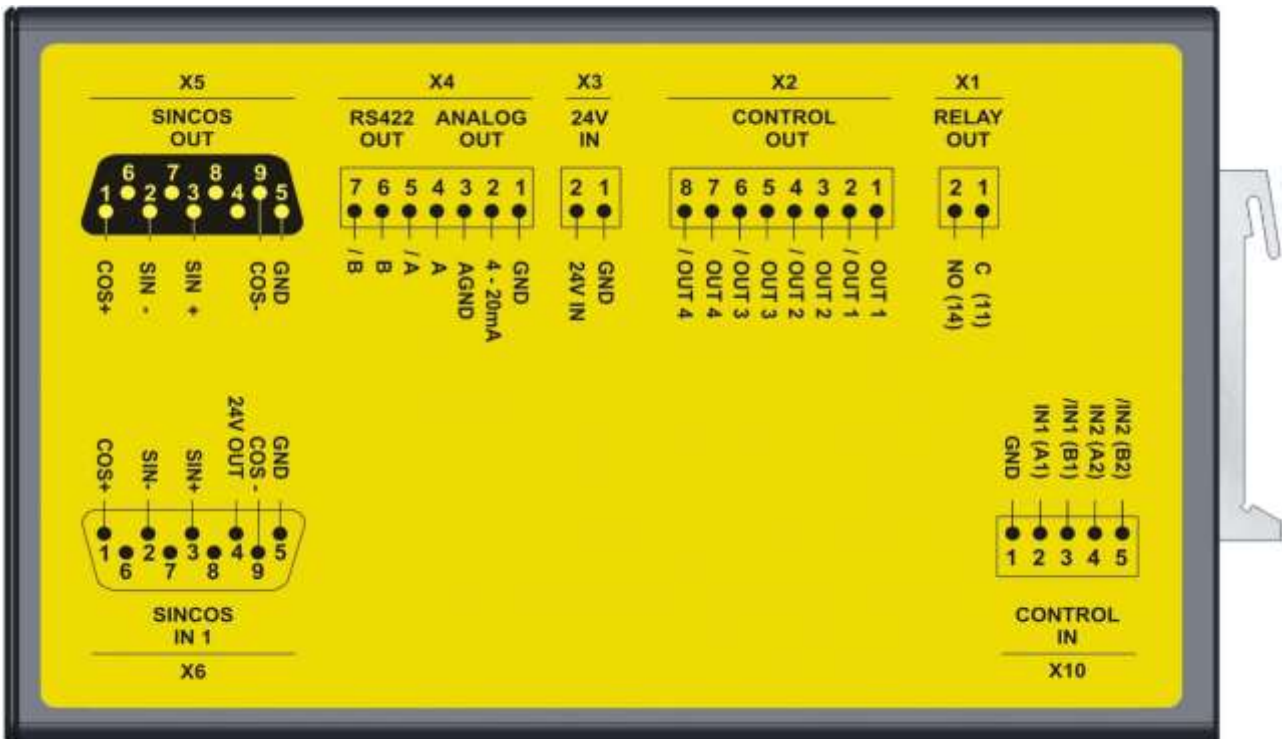
4.7.   DS246 Block Diagram
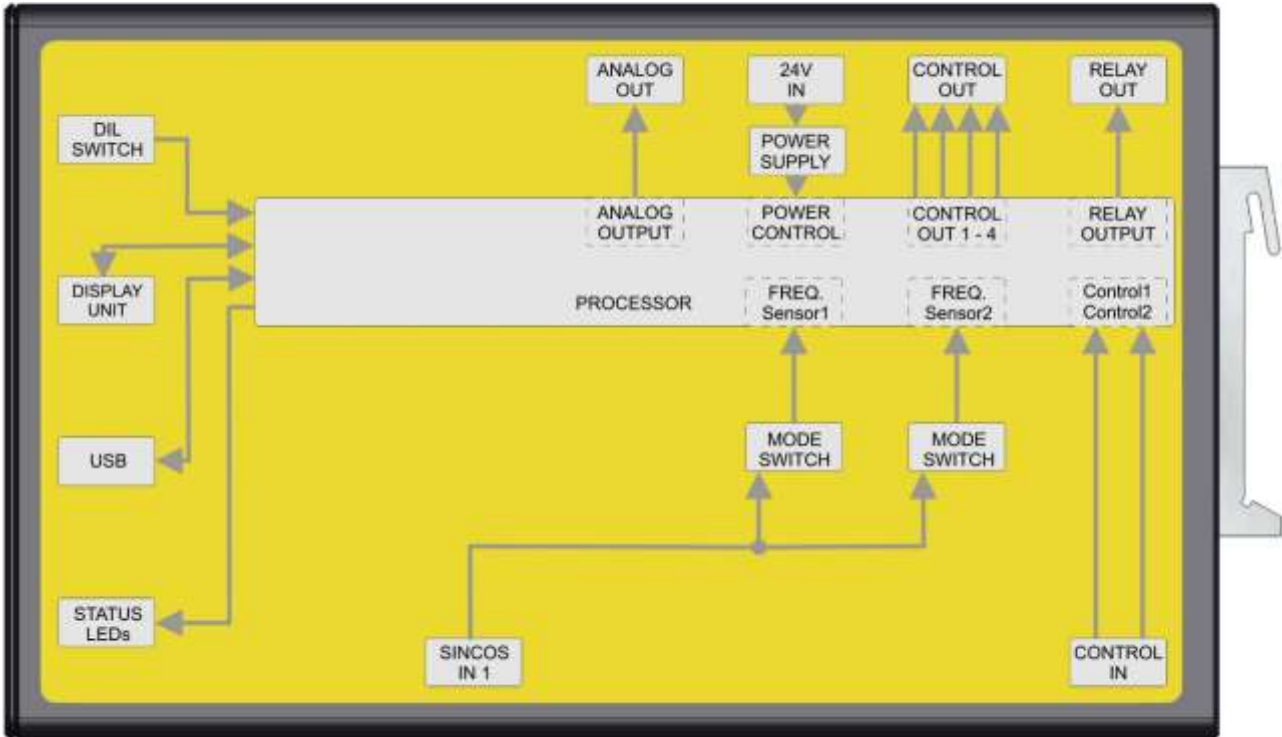
4.8.   DS246 Connections

(The figure shows the available ports)
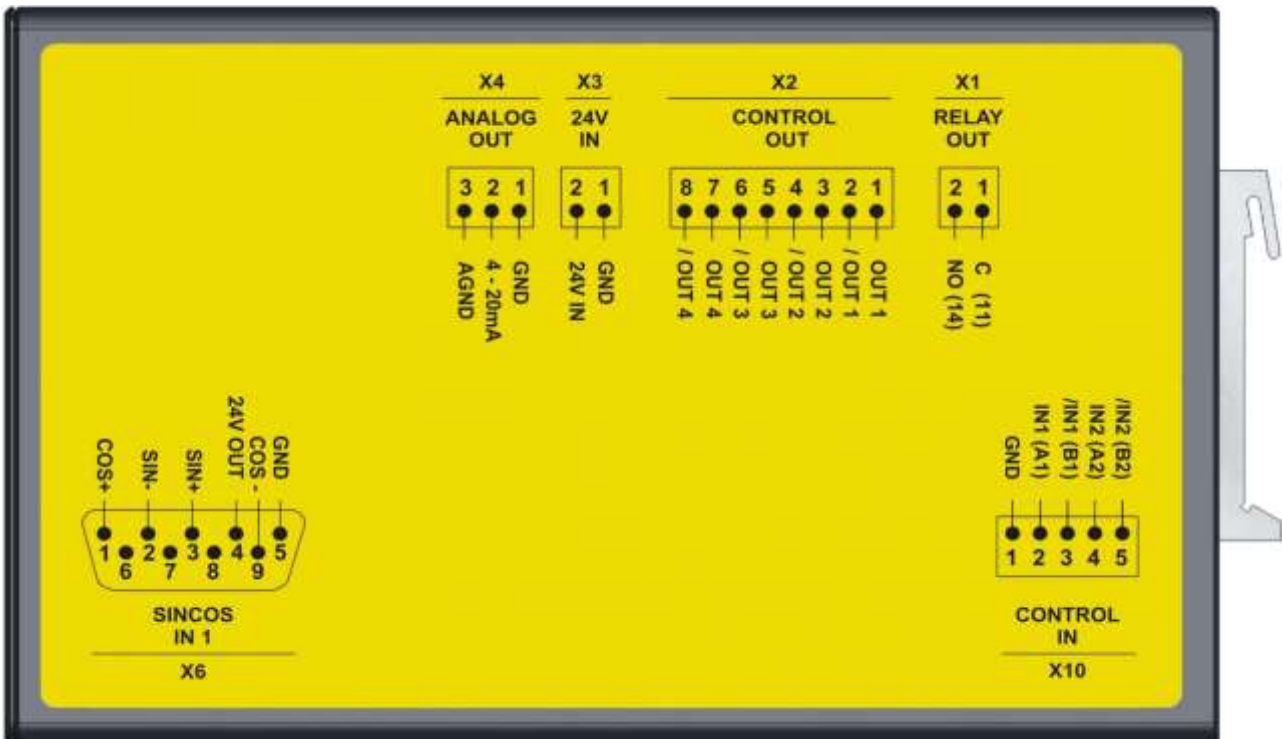
5.   Description of Connections

This chapter describes only the electrical connections and their general function.

Name	Description see chapter
X1 | RELAY OUT	0 Relay Output
X2 | CONTROL OUT	0 Control Outputs
X3 | 24V IN	0 Power Supply
X4 | ANALOG OUT	0 Analog-Output 4 to 20 mA
X4 | RS 422 OUT	0 RS422-Splitter-Output
X5 | SINCOS OUT	0 SinCos-Splitter-Output
X6 | SINCOS IN 1	0 SinCos Encoder Inputs
X7 | SINCOS IN 2	0 SinCos Encoder Inputs
X8 | RS422 IN 1	0 RS422 Encoder Inputs
X9 | RS422 IN 2	0 RS422 Encoder Inputs
X10 | CONTROL IN	5.5 HTL Encoder Inputs / Control Inputs
X11	0 BG230 Operator Interface
X12	5.13 USB Interface for the OS Operator Surface
S1	0 DIL Switch
ERROR - ON	0 LEDs / Status Indication

The connection to the outputs is only safe when the follower unit is able to detect the fault status of each output and when the outputs are configured accordingly.

In order to prevent simultaneous damages to the cables by external influences, the encoder resp. sensor lines must be kept physically apart from each other.

5.1. Power Supply

If the unit is connected to a DC power supply network which also supplies further devices or systems, it must be ensured that no voltages $\geq$ 60 V can occur at the terminals [X3:1] und [X3:2].

If this cannot be ensured, the unit must be supplied by a separate DC power pack, which must not be connected to further devices or systems.

The requirements for both kinds of power supplies are:

- Nominal voltage range from 18 … 30 VDC
- Ripple < 10% @ 24 V
- External fuse (2.5 A, medium time lag) required

A separate power pack must cover the following requirements:

- The switch-on current of the unit is not higher than 2.5 A
- The consumption of the unit is approx. 23 W (at permissible load and without short-circuit)

The 18 … 30 VDC power supply must be connected via the pluggable 2-position screw terminal strip [X3]. The power supply input is protected by an internal reverse polarity protection.

pluggable 2-position screw terminal [X3]

- The DC input must be protected by an external fuse
  (type and value see technical specifications).
- The DS unit has <u>no</u> internal galvanic isolation, thus all GNDs are interconnected. Please avoid any GND loops to the power supply input [X3].
- Even with use of a SIL3 certified power supply (U_{FAIL} < 60 V), an external fuse must be installed.

5.2. Encoder Supply

The unit offers an auxiliary voltage output for separate supply of the encoders or sensors in use. The encoder supply must be taken directly from the safety monitor, or via relay contact when using an indirect power supply.

Encoder supply: SinCos inputs [X6] [X7]

Encoder supply: RS422 inputs [X8] [X9]
HTL encoders or sensors must also be connected to the encoder supply terminals of the RS422 inputs
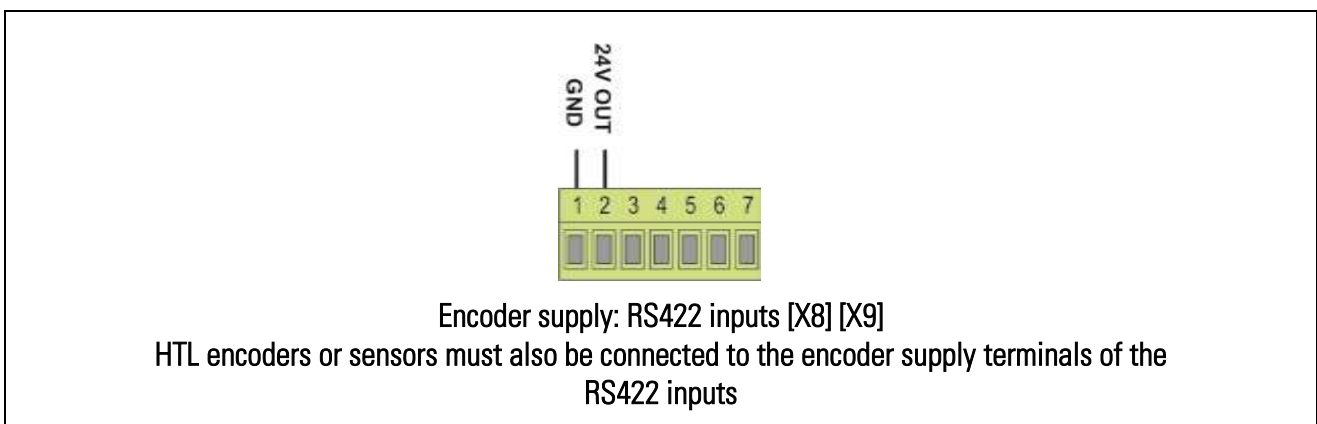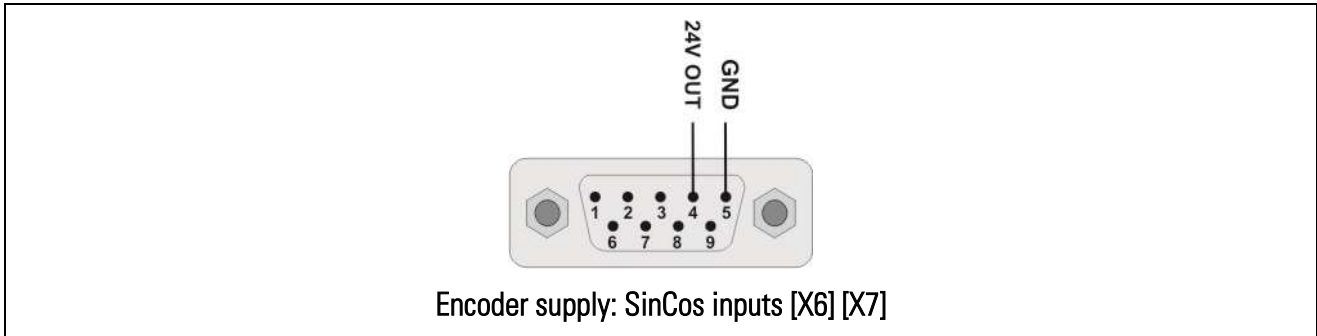
The maximum load of the encoder supply is 200 mA per channel (Sensor 1 and Sensor 2). The unit provides an auxiliary encoder supply for each sensor channel (HTL encoders will be supplied by the encoder supply of the RS422 inputs). The level of the supply voltage is approximately by 2 V lower than the 18 … 30 VDC power supply at terminal [X3].

Supply	SinCos inputs	RS422 inputs	HTL inputs
Sensor 1	[X6:4] [X6:5]	[X8:1] [X8:2]	[X8:1] [X8:2]
Sensor 2	[X7:4] [X7:5]	[X9:1] [X9:2]	[X9:1] [X9:2]

When powering up the encoder supply, the maximum input current of the safety unit could be exceeded, depending on the encoders in use. In this case, the encoder supply would not be enabled and an error appears.

In case of such problems, or if another voltage level is required, the encoder supply can be switched on from an external voltage source via remote relay. In this case, it is mandatory to energize the relay from the internal encoder supply of the DS unit.

- In case of a direct encoder supply it is mandatory to operate the encoders with the auxiliary voltage from the unit.
- Indirect encoder supply must in any case be carried out via relay, energized by the auxiliary voltage of the DS unit.

5.2.1. Direct Encoder Supply

With direct encoder supply, the encoder must be connected as shown in the figure below:

Example of direct encoder supply
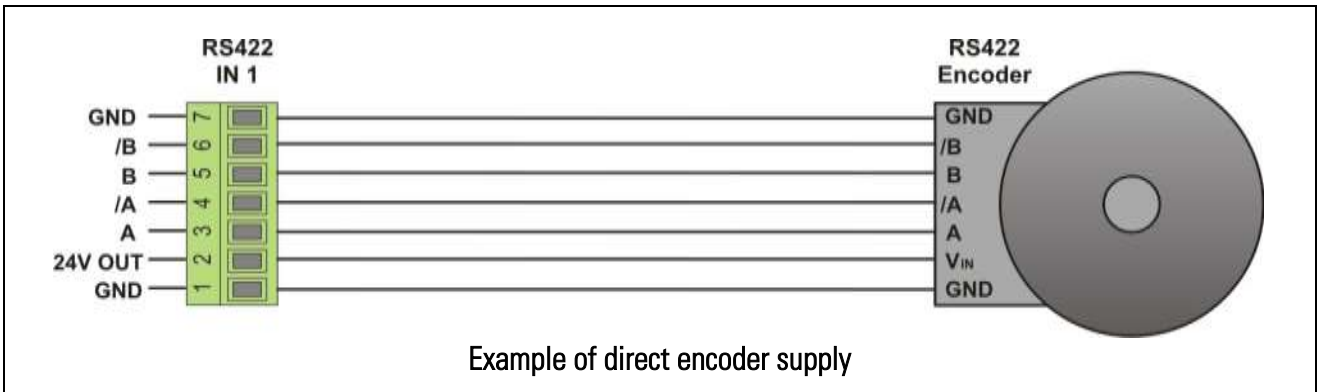
5.2.2. Indirect Encoder Supply

Indirect encoder supply must necessarily, and each separately, be switched on by use of a relay, energized with the auxiliary voltage of the unit. This is necessary, because no encoder signals must be applied to the safety monitor before the unit has successfully completed its initialization and self-test.

Example of indirect encoder supply (1 encoder is switched via 1 relay)
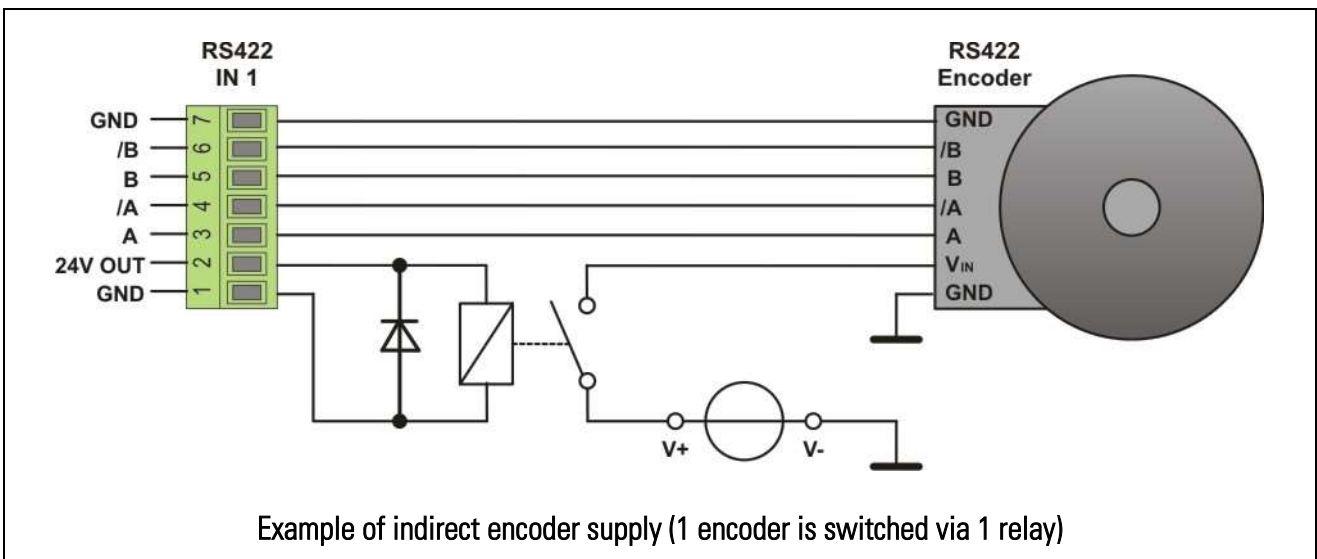
Continuation "External Encoder Supply"

Example of indirect encoder supply (2 encoders are switched via 2 relays)
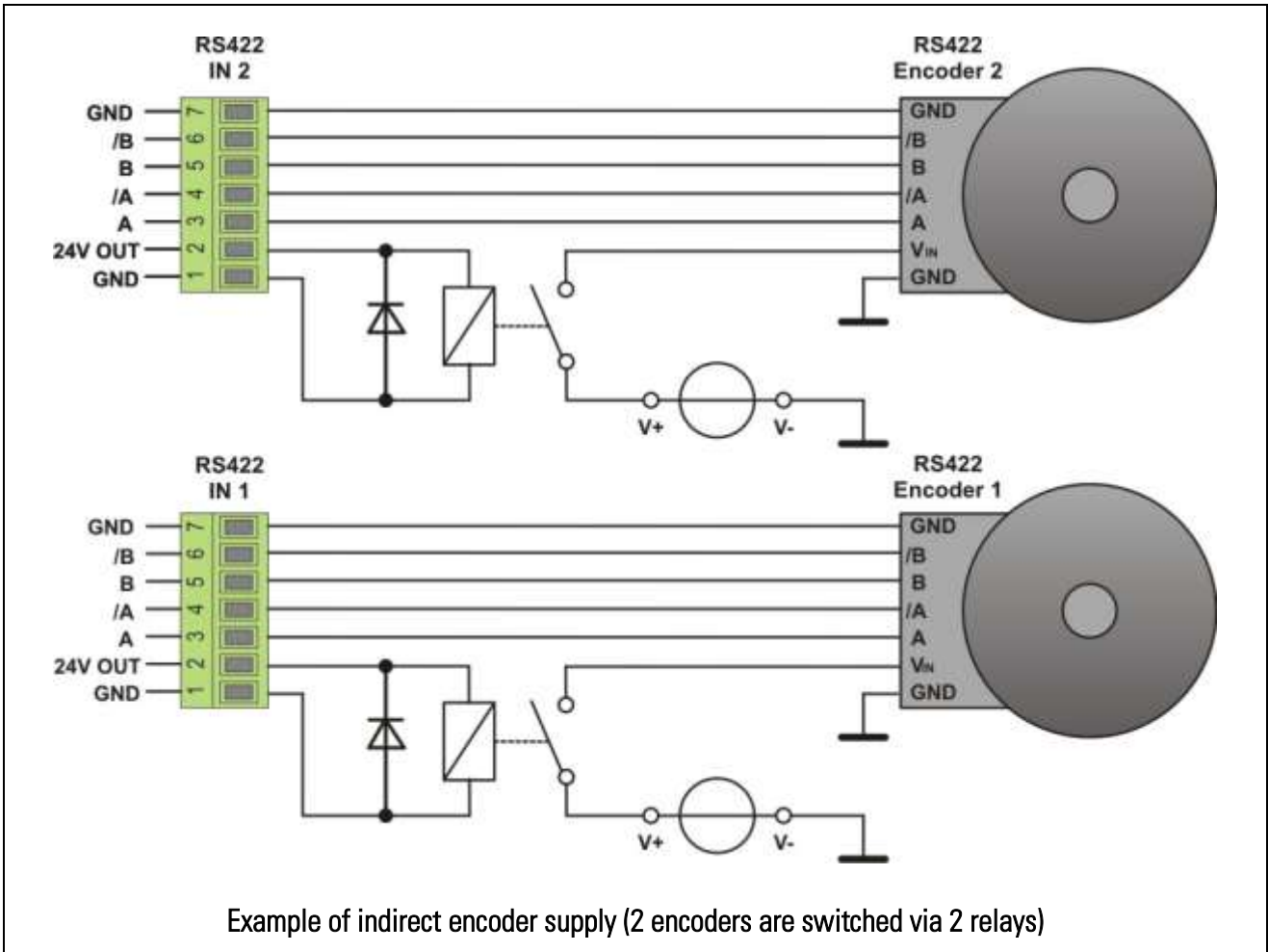
	• Indirect encoder supply must necessarily and each separately be switched on via relay, energized by the auxiliary voltage of the unit. • In case of indirect supply of both encoders, two independent supply sources and two separate relays must be used.

5.3.   SinCos Encoder Inputs

The unit is suitable for operation with SinCos sensors or encoders using differential sine-cosine signal outputs of 1 Vpp and 2.5 V DC offset.

- **DS23x:** Parameter "Operational Mode" must be set to 0, 1, 2 or 6. The SinCos encoder can be connected by one of the two or by both 9-pin SUB-D connectors [X6] and [X7].

- **DS24x:** Parameter "Operational Mode" must be set to 0.
  Connections use connector [X6] only.

It is mandatory to wire all available signal lines (SIN+, SIN-, COS+ and COS-).

The internal SinCos signal monitor checks the offset range of the signals as well as the Lissajous figure resulting from the signals.

There is no option for evaluating any zero or index pulses.

All input lines are already terminated by internal 120 Ohm load resistors.

The SinCos encoder must use the corresponding encoder supply at pins 4 and 5 of the connector.
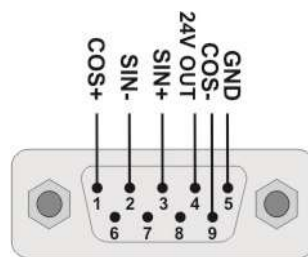
Male SUB-D connectors [X6], [X7]

Activating SinCos error is preferable to de-activating SinCos Error to avoid any subsequent errors. The parameter SIN Err TimeX can suppress SinCos error in 20 ms intervals. Disturbed SinCos signals can produce SinCos errors and frequency errors.

With models DS23x only:

In following cases you must switch off the SinCos error detection in order to avoid continuous SinCos error indications:

- with use of SinCos encoders providing a different DC offset than specified
- with use of encoders providing a sine output and a sine-reference-output instead of two sine and two cosine signals

In these cases the encoders are suitable for frequency evaluation only, but not for signal forwarding, i.e. the SinCos output cannot be used.

5.4. RS422 Encoder Inputs

(DS230 and DS236 only)

If parameter "Operational Mode" is set to 7, 8 or 9, the unit will accept signals from incremental encoders with complementary TTL or differential RS422 levels.

Incremental encoders must be connected by one or both of the pluggable 7-pin screw terminals [X8] and [X9].

The RS422 input channels (A and /A resp. B and /B) are internally terminated by a dynamic terminating circuit (220 pF / 120 Ohm).

It is mandatory to connect up all signal lines (A, /A, B and /B).

There is no option for evaluation of any existing zero pulses (Z / Z).

It is mandatory to supply the RS422 encoder from terminals 1 and 2 of the respective terminal strip.
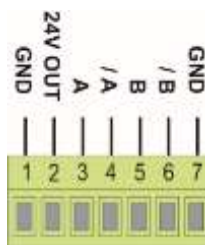
Pluggable 7-position screw terminal [X8], [X9]

5.5. HTL Encoder Inputs / Control Inputs

Screw terminal strip [X10 | CONTROL IN] provides 2 - 4 inputs for signals with HTL level and PNP switching characteristics.

Depending on the setting of parameter "Operational Mode" the control inputs [X10 | CONTROL IN] can be configured as frequency inputs or as control inputs:

Frequency input for HTL encoders (A / B / 90°):

Sensor 1	[X10	CONTROL IN]	incremental HTL encoder	[X10:2]	channel A
			[X10:3]	channel B
Sensor 2	[X10	CONTROL IN]	incremental HTL encoder	[X10:4]	channel A
			[X10:5]	channel B

HTL encoders must be supplied by the encoder supply of the RS422 inputs.
Please observe the permissible frequency ranges (see Technical Specifications).

Frequency input for HTL encoders (A) or a proximity switch:

Sensor 1	[X10	CONTROL IN]	incremental HTL encoder	[X10:2]	channel A
			[X10:3]	unconnected / direction signal
Sensor 2	[X10	CONTROL IN]	incremental HTL encoder	[X10:4]	channel A
			[X10:5]	unconnected / direction signal

The inputs [X10:3] resp. [X10:5] may remain unconnected (internal pull-down) or can be used for a static direction signal. HTL encoders must be supplied by the encoder supply of the RS422 inputs. Please observe the permissible frequency ranges (see Technical Specifications).

Two inverse control inputs for HTL commands:

Signal pair 1	[X10	CONTROL IN]	HTL/PNP control signal	[X10:2]	control signal 1
			[X10:3]	inverse control signal 1
Signal pair 2	[X10	CONTROL IN]	HTL/PNP control signal	[X10:4]	control signal 2
			[X10:5]	inverse control signal 2

Strictly always the inverse signals must be applied to the inverted inputs. Any other signal conditions are illegal and will be detected as an error. Please use the separate parameter description to find more information about the control inputs. The configuration of the inputs will affect the Safety Integration Level (SIL).

Two homogenous control inputs for HTL commands:

Signal pair 1	[X10	CONTROL IN]	HTL/PNP control signal	[X10:2]	control signal 1
			[X10:3]	homogenous control signal 1
Signal pair 2	[X10	CONTROL IN]	HTL/PNP control signal	[X10:4]	control signal 2
			[X10:5]	homogenous control signal 2

Strictly the inverted input must always receive the same signal as the non-inverted input. Any other signal conditions are illegal and will be detected as an error. Please use the separate parameter description to find more information about the control inputs. The configuration of the inputs will affect the Safety Integration Level (SIL).

Four single control inputs HTL commands:

Signal 1	[X10 | CONTROL IN]	HTL/PNP control signal	[X10:2]	control signal 1
Signal 2	[X10 | CONTROL IN]	HTL/PNP control signal	[X10:3]	control signal 2
Signal 3	[X10 | CONTROL IN]	HTL/PNP control signal	[X10:4]	control signal 3
Signal 4	[X10 | CONTROL IN]	HTL/PNP control signal	[X10:5]	control signal 4

Please use the separate parameter description to find more information about the control inputs. The configuration of the inputs will affect the Safety Integration Level (SIL).

One homogenous/inverse control input and two single control inputs for HTL commands:

Signal pair 1	[X10 | CONTROL IN]	HTL/PNP control signal	[X10:2]	control signal 1
			[X10:3]	homogenous/inverse signal 1
Signal 2	[X10 | CONTROL IN]	HTL/PNP control signal	[X10:4]	control signal 2
Signal 3	[X10 | CONTROL IN]	HTL/PNP control signal	[X10:5]	control signal 3

Strictly always the homogenous or inverse signal must be applied to the inverted input. Any other signal conditions are illegal and will be detected as an error. Please use the separate parameter description to find more information about the control inputs. The configuration of the inputs will affect the Safety Integration Level (SIL).
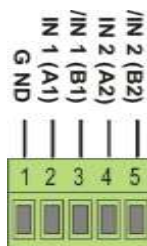
Pluggable 5-pin screw terminal [X10]

- It does not make sense to configure the unit for connection of 2 HTL encoders simultaneously, since then no more inputs for external commands would be available.
- With DS24x units, all 4 channels can be used as control-inputs for external commands.
- When using a single-channel encoder, the associated second input is not suitable
- Transitionally, on some housing prints IN1… IN4 can be found as designation for the CONTROL IN signals of terminal X10.
  The correspondences of these terms are:
  IN1 = IN1,   / IN1 = IN2,   IN2 = IN3 and   / IN2 = IN4.

5.6.   SinCos-Splitter-Output

(DS230 and DS240 only)

DS230 and DS240 units provide a safety-related SinCos-Splitter-Output. Depending on the setting of parameter "Operational Mode" (0, 1, 2 or 6), the integrated splitter function allows to reproduce the signal of input terminal [X6 | SINCOS IN1] to the female 9-pin SUB-D connector [X5 | SINCOS OUT]. Thus the encoder signal connected to [X6 | SINCOS IN1] can be processed by a further target device.

The signal delay time between SinCos input and SinCos output is approx. 200 ns.

The channels SIN+ and SIN- resp. COS+ and COS- must be terminated by 120 Ohm load resistors on site of the target device.

In case of errors, the DC-offset of the SinCos output will be shifted in order to signalize the error condition to the target device.

The connection to the SinCos splitter output is only safe, when the follower unit includes a SinCos monitoring system which can detect offset errors.
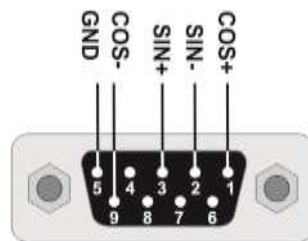
Female SUB-D Connector [X5]

	• It is mandatory to terminate the SIN+ and SIN- resp. COS+ and COS- channels by a 120 Ohm resistor on the target device.
	• SinCos input signals must consist of two sine-shaped and two cosine-shaped signal pairs.
	• On the output site the DC offset value is typically 2.5 V, fully independent of the input offset.
	• A SinCos error at the input can also produce an error at the SinCos output.

5.7. RS422-Splitter-Output

(DS230 and DS240 only)

DS230 and DS240 units provide a safety-related RS422-Splitter-Output.

The monitor evaluates two frequency channels (Sensor 1 and Sensor 2), which are determined by "Operational Mode".

The splitter-output allows reproducing the input frequency of Sensor 1 or Sensor 2.

Regardless of the input signal (SinCos or HTL), the output [X4 | RS422 OUT] always delivers incremental RS422 square-wave signals.

The signal delay between the RS422 input and the RS422 output is approx. 600 ns.

In case of an error, no more incremental signals will be available at the RS422 output (Tri-State, internally with 1 kOhm pull-down resistors).

Connections to the RS422 Splitter output are only safe if the following device is capable to detect the error state of the monitor.

SinCos input signals are reproduced as 1:1 square wave output.
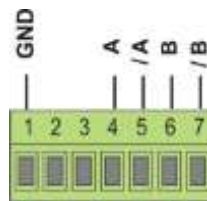
Pluggable 7-pin screw terminal [X4]

Screw terminal [X4] provides 7 connections:
[X4 | ANALOG OUT]   analog output   [X4:1-3]
[X4 | RS422 OUT]   RS422 output   [X4:4-7]

- When using the converted SinCos input as a RS422 output, a SinCos error at the input can also produce an error at the RS422 output.

5.8. Analog-Output 4 to 20 mA

A safety-related analog output is available at terminal strip [X4]. The current output is freely scalable by setting parameters "Analog Start" and "Analog End". It delivers an output signal, which is proportional to one of the two input frequencies. Where the analog output is not used, terminals [X4:2] and [X4:3] must be bridged. An open analog output (e.g. wire fracture) will produce an error status.

During normal operation, the output moves in a proportional range between 4 and 20 mA.
In case of errors, the analog output delivers 0 mA.

The connection to the analog output is only safe if the follower unit is capable to detect the error state of the safety monitor.

With versions DS230 / DS240, screw terminal [X4] provides 7 connections:
[X4 | ANALOG OUT]   analog output   [X4:2-3]
[X4 | RS422 OUT]   RS422 output   [X4:4-7]
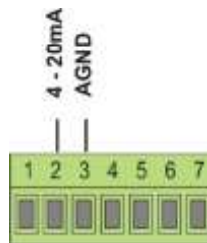
Pluggable 7-position screw terminal [X4] at DS230/DS240

With unit versions DS236 / DS246, screw terminal [X4] provides only 3 connections:
[X4 | ANALOG OUT]   analog output   [X4:2-3]
[X4 | RS422 OUT]   not available!
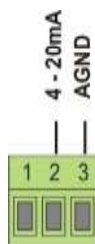
Pluggable 3-position screw terminal [X4] at DS236/DS246

- In case of an unused analog output [X4:2] and [X4:3] must be bridged.
- An open analog output (e.g. wire fracture) will produce an error status.

5.9. Control Outputs

Four inverse/homogeneous HTL control outputs are available at the screw terminal [X2 | CONTROL OUT].

The switching points and switching conditions can be programmed by parameters.

In HIGH state, the output level is approximately 2 V lower than the supply voltage at terminal [X3 | 24V IN]. The outputs are short-circuit proof push-pull outputs. When switching inductive loads, additional external suppression measures are recommended.

In case of errors all outputs go to LOW state (no more inversion).

Connections to the analog output are only safe if the target device is able to detect the error state of the safety monitor.

The output configuration will affect the Safety Integrity Level (SIL).
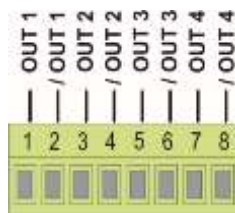
Pluggable 8-position screw terminal [X2]

Wiring example:

5.10. Relay Output

The safety-related relay output consists of two independent relays with forcibly guided contacts. The normally open contacts of the two relays (NO) are internally co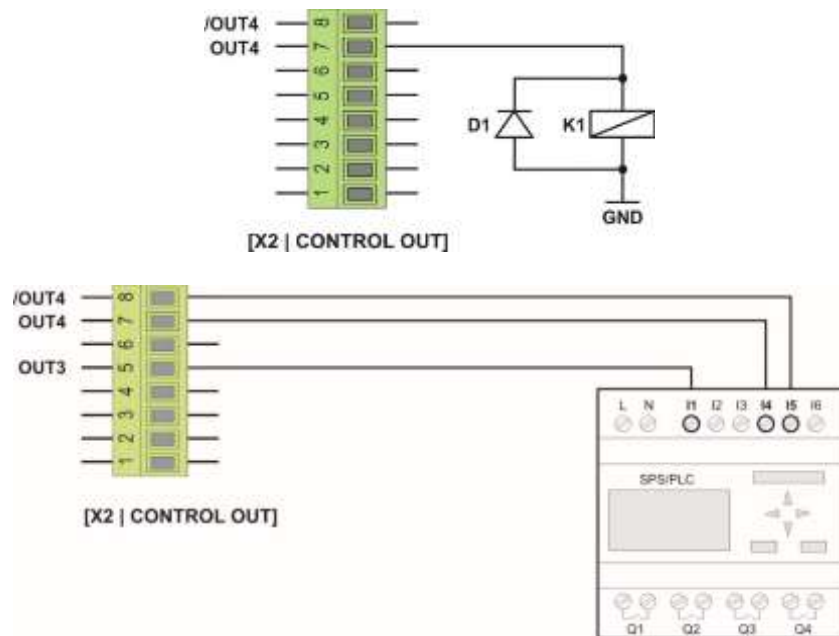nnected in series. This series-relay-contact is accessible by the 2-pin screw terminal [X1 | RELAY OUT], for integration into a Safety Circuit.

- The contacts are only closed during normal and disturbance-free operation. They will open to a safety state in case of errors or when the programmed switching condition occurs.
- In the de-energized state of the unit the contacts are also open.
- Switching points and switching conditions can be set by the corresponding parameters.
- An internal, forcibly guided opener of the relay is used to monitor the relay status by the unit itself.
- In case of an error the contact will change to the open and safe switching state.
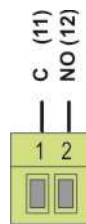
Pluggable 2-position screw terminal [X1]
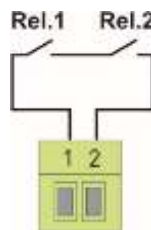
Internal connection [X1]

- The operator is responsible to ensure a safe state of all relevant parts and components of the equipment, whenever the relay contact is open.
- The target unit must be able to evaluate edges, in order to determine dynamical conditions of the relay output, too.
- With frequencies close to the switching point, relay bouncing may occur in consequence of variation of the frequency measurement. To prevent this, a hysteresis should be set.
- If also short overshoots of the switching point should be detected, a lock function should be set to the output.

5.11. DIL Switch

A 3-position DIL switch [S1] is located at the front of the unit
(only accessible when no display and programming unit BG230 is connected).

3-pos DIL switch [S1]

The DIL switch is used to set the operation state of the monitor:

DIL1	DIL3	Status	LED
ON	ON	Normal Operation	Off (lights up permanently at error state)
ON	OFF	Programming / Test - Mode	Flashes slowly (lights up permanently at error state)
OFF	ON	Factory Settings	Flashes slowly (lights up permanently at error state)
OFF	OFF	Factory Settings	Flashes slowly (lights up permanently at error state)

DIL2	Status	Operational readiness
ON	Normal Operation	Ready for operation approx. 2 s after power up
OFF	Self-Test Message	Ready for operation approx. 8 s after power up

	• The Programming Mode (DIL switch) is used for Start-up and testing • All DIL switch sliders must be set to „ON" after Start-up and testing • After Start-up the DIL switch sliders should be protected against manipulation (e. g. by covering with an adhesive tape) • Normal operation is only permitted when the yellow LED is permanently off • The safety function of the unit cannot be guaranteed before the commissioning has been completed.

5.12. BG230 Operator Interface

On the front site the unit provides a serial interface for communication with BG230 operator units (optional accessory), allowing display and parameter setting.

8-pin female connector [X11]

The BG230 unit and the safety monitor are connected by plugging the BG230 directly onto the female 8-pin connector [X11] at the front.

This operator unit is intended for display of the encoder signals (in user units) and for visual monitoring of the DS unit. Although parameters can be set or changed by using the BG230, it is recommended to use the OS PC software for Start-up and commissioning purpose.

 The female connector [X11] is reserved for exclusive use with a BG230 unit.

5.13. USB Interface for the OS Operator Surface

For communication between the unit and a PC or a superordinate controller, a virtual COM port is accessible at the USB connector. A standard USB-cable with a Type B connector is used for connection. This USB cable is available as an option. The USB port serves for PC setup of the DS monitors.

USB type B

A separate manual is available describing the installation procedure of the USB driver (see page 2).

5.14. LEDs / Status Indication

Two status LEDs are located on the front of the unit.
The green one is marked as [ON] and the yellow one as [ERROR].

Status LEDs

The green status LED uses the following conditions:

| Green LED	Status
OFF	Power off (no power supply voltage)
ON	Power on (power supply voltage ok)

The yellow status LED uses the following conditions:

Yellow LED	Status
OFF	Normal operation, self-test successfully completed, no error messages
ON	During the self-test or with error state
Flashes slowly	Factory Settings or Programming / Test - Mode

6.   Operational Modes

6.1.   Application: 2 SinCos Encoders

| Device	DS23x		
Operational Mode	0		
Sensor 1	[X6 | SINCOS IN 1]	SinCos encoder	SIN+, SIN-, COS+, COS-
Sensor 2	[X7 | SINCOS IN 2]	SinCos encoder	SIN+, SIN-, COS+, COS-
Control Inputs	[X10 | CONTROL IN]	HTL/PNP control signal	2 - 4 available
Safety Level	Speed → SIL3 / PLe achievable (see below) Direction → SIL3 / PLe achievable (see below) Standstill → SIL3 / PLe achievable (see below)		
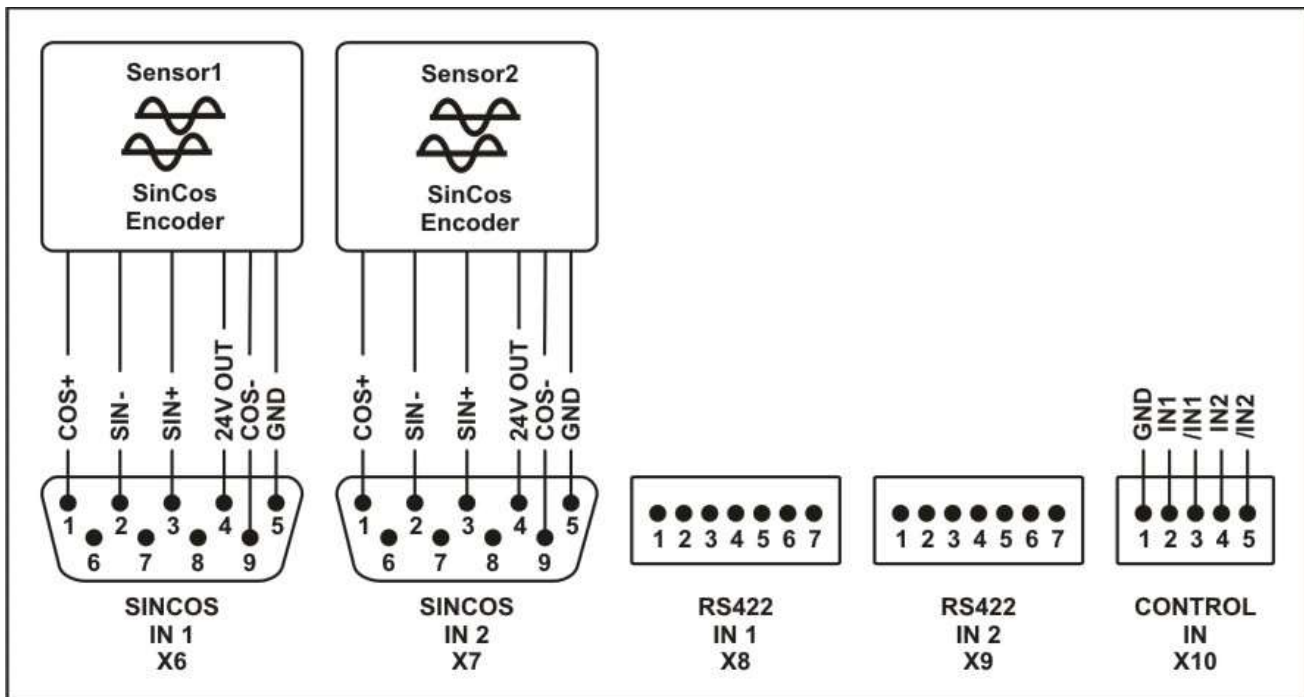
This mode is used to evaluate a dual channel system equipped with two SinCos sensors /encoders.

	• With DS230 models this mode can be used to reproduce the input frequency of [X6 | SINCOS IN1] to the splitter output [X5 | SINCOS OUT]. • 2 - 4 inputs for control signals are available at terminal [X10 | CONTROL IN]. • The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.

6.2. Application: 1 SIL3 SinCos Encoder only

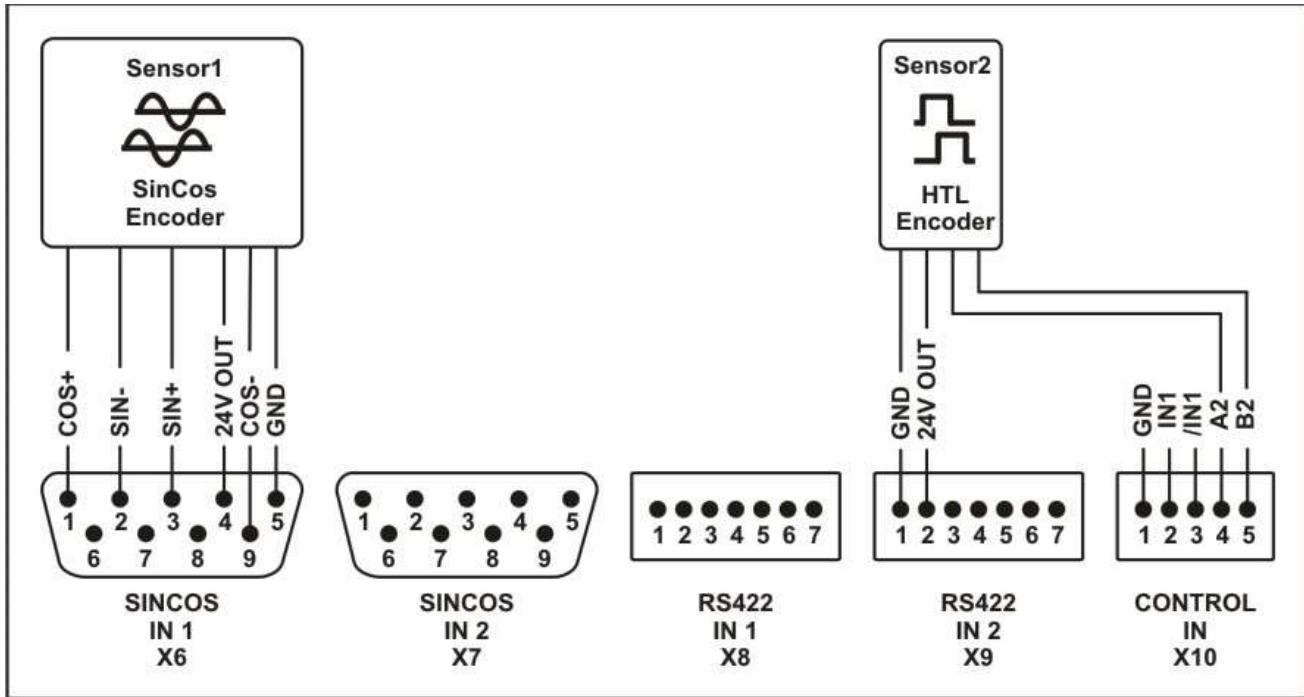| Device	DS24x
Operational Mode	0
Sensor 1	[X6 | SINCOS IN 1] SIL3 SinCos encoder SIN+, SIN-, COS+, COS-
Sensor 2	Sensor 1 and Sensor 2 are bridged internally
Control Inputs	[X10 | CONTROL IN] HTL/PNP control signal 2 - 4 available
Safety Level	Speed → SIL3 / PLe achievable (see below) Direction → SIL3 / PLe achievable (see below) Standstill → SIL3 / PLe achievable (see below)
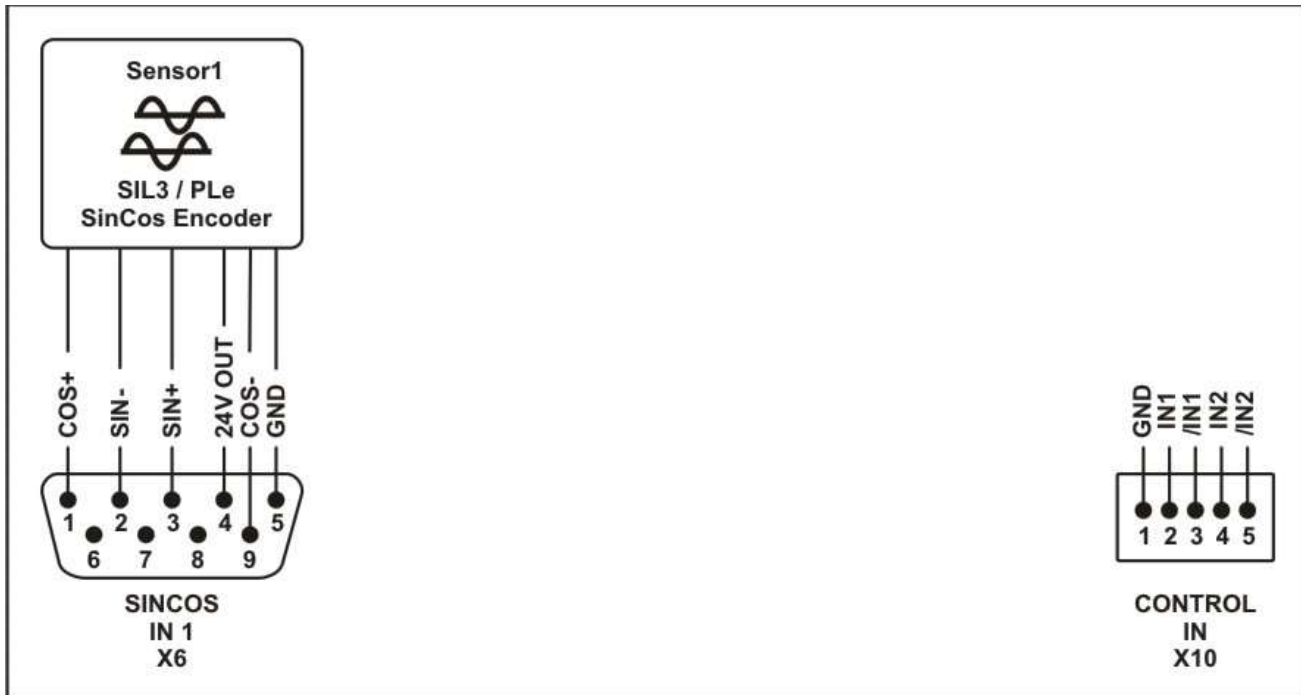
This mode is exclusively used for connection of a SIL3-certified or a PLe-certified
SinCos sensor / encoder.

	• With DS230 models, this mode can be used to reproduce the input frequency of [X6 | SINCOS IN1] to the splitter output [X5 | SINCOS OUT]. • 2 - 4 inputs for control signals are available at terminal [X10 | CONTROL IN]. • The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.

6.3.   Application: 1 SinCos Encoder and 1 HTL Encoder (quadrature)

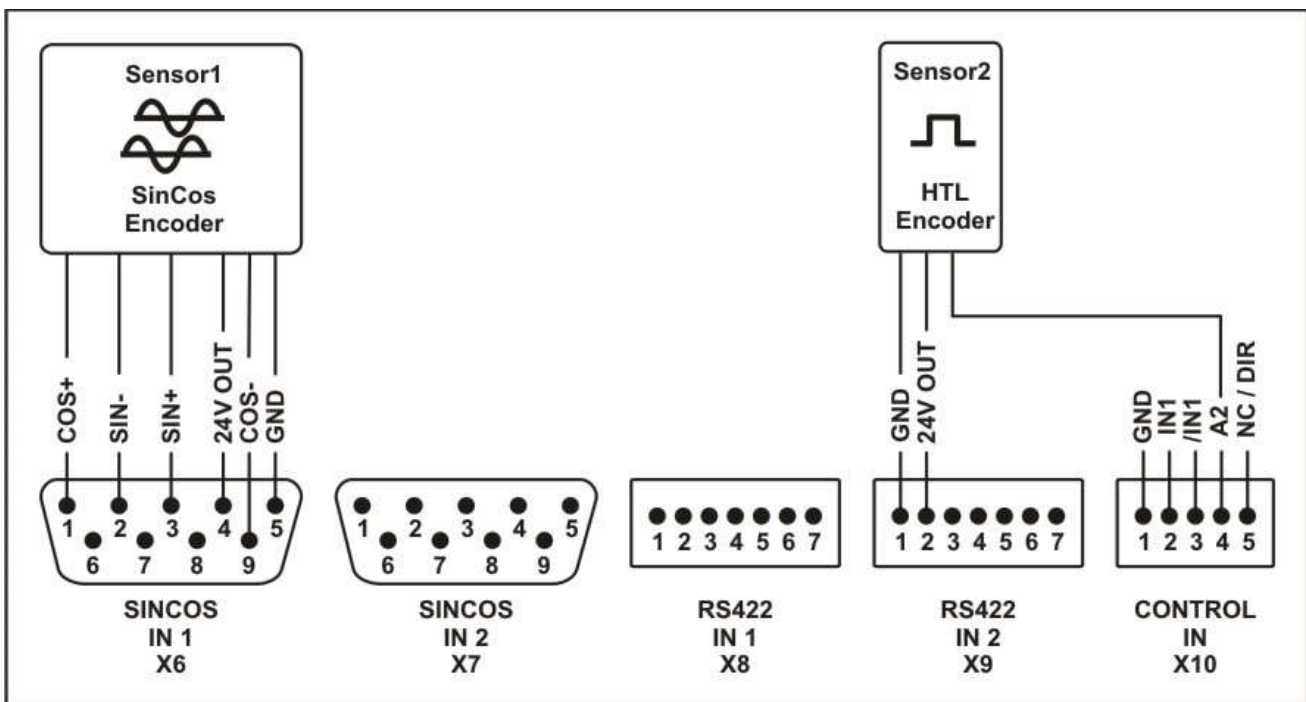| Device	DS23x		
Operational Mode	1		
Sensor 1	[X6 | SINCOS IN 1]	SinCos encoder	SIN+, SIN-, COS+, COS-
Sensor 2	[X10 | CONTROL IN]	Incremental HTL encoder	A, B, 90°
Control Inputs	[X10 | CONTROL IN]	HTL/PNP control signal	1 - 2 available
Safety Level	Speed → SIL3 / PLe achievable (see below) Direction → SIL3 / PLe achievable (see below) Standstill → SIL3 / PLe achievable (see below)		

This mode allows evaluation of a dual channel system, equipped with a combination of one SinCos encoder and one incremental quadrature HTL encoder.

	• With DS230 models this mode can be used to reproduce the input frequency of [X6 | SINCOS IN1] to the splitter output [X5 | SINCOS OUT]. • 1 - 2 inputs for control signals are available at terminal [X10 | CONTROL IN]. • The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.

6.4. Application: 1 SinCos Encoder and 1 HTL Encoder (single channel)

Device	DS23x
Operational Mode	2
Sensor 1	[X6 | SINCOS IN 1] SinCos encoder SIN+, SIN-, COS+, COS-
Sensor 2	[X10 | CONTROL IN] Incremental HTL encoder A, single channel
Control Inputs	[X10 | CONTROL IN] HTL/PNP control signal 1 - 2 available
Safety Level	Speed → SIL3 / PLe achievable (see below) Direction → SIL3 / PLe* achievable (see below) Standstill → SIL3 / PLe* achievable (see below). With single channel encoders, jitter around an edge can be misinterpreted as a frequency.

This mode allows evaluation of a dual channel system, equipped with a combination of one SinCos encoder and one incremental single channel HTL encoder.

- With DS230 models this mode can be used to reproduce the input frequency of [X6 | SINCOS IN1] to the splitter output [X5 | SINCOS OUT].
- 1 - 2 inputs for control signals are available at terminal [X10 | CONTROL IN].
- The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.
- For unbalanced single channel signals, the parameter A-Edge 2/1 must be set to 1, so that a stable frequency can be detected.

*) To achieve a safety level with this configuration, the user must be sure that the equipment will physically be able to rotate or move in one direction only (no reversals!). This could e.g. be ensured by use of a self-locking gearbox.

6.5.   Application: 2 Quadrature HTL Encoders

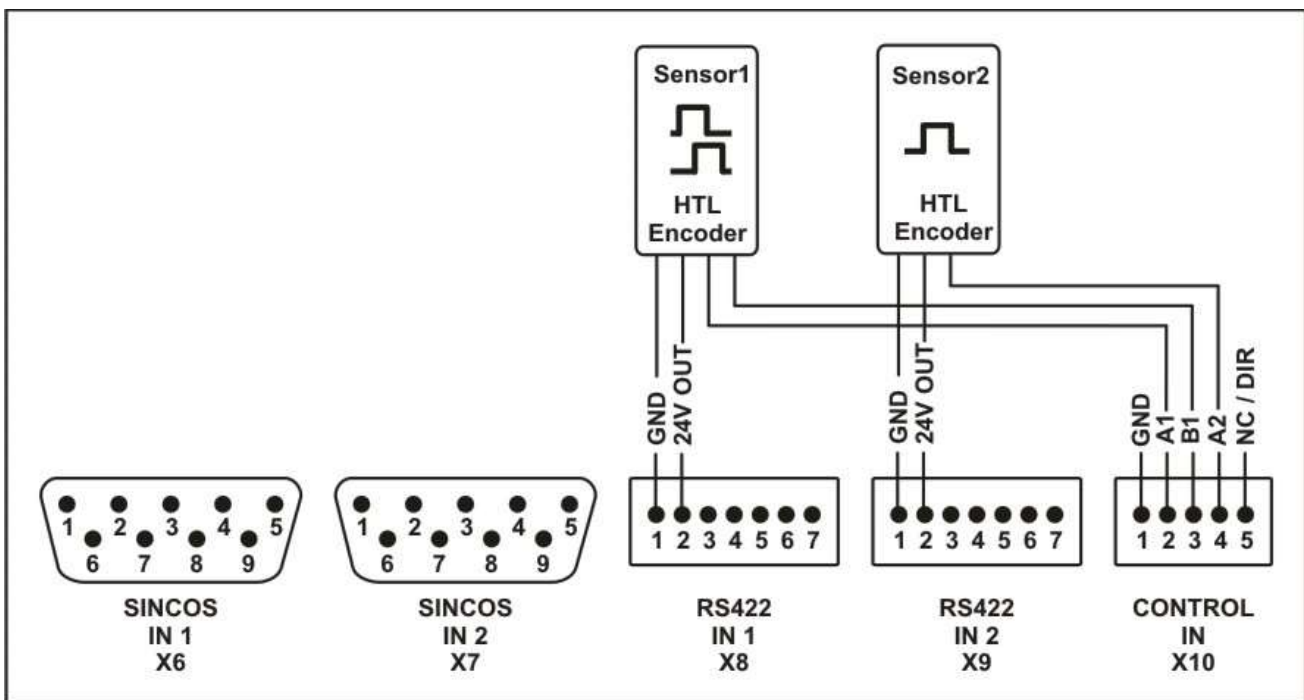| Device	DS23x
Operational Mode	3
Sensor 1	[X10	CONTROL IN] Incremental HTL encoder A, B, 90°
Sensor 2	[X10	CONTROL IN] Incremental HTL encoder A, B, 90°
Control Inputs	[X10	CONTROL IN] HTL/PNP control signals not available
Safety Level	Speed → SIL3 / PLe achievable (see below) Direction → SIL3 / PLe achievable (see below) Standstill → SIL3 / PLe achievable (see below)
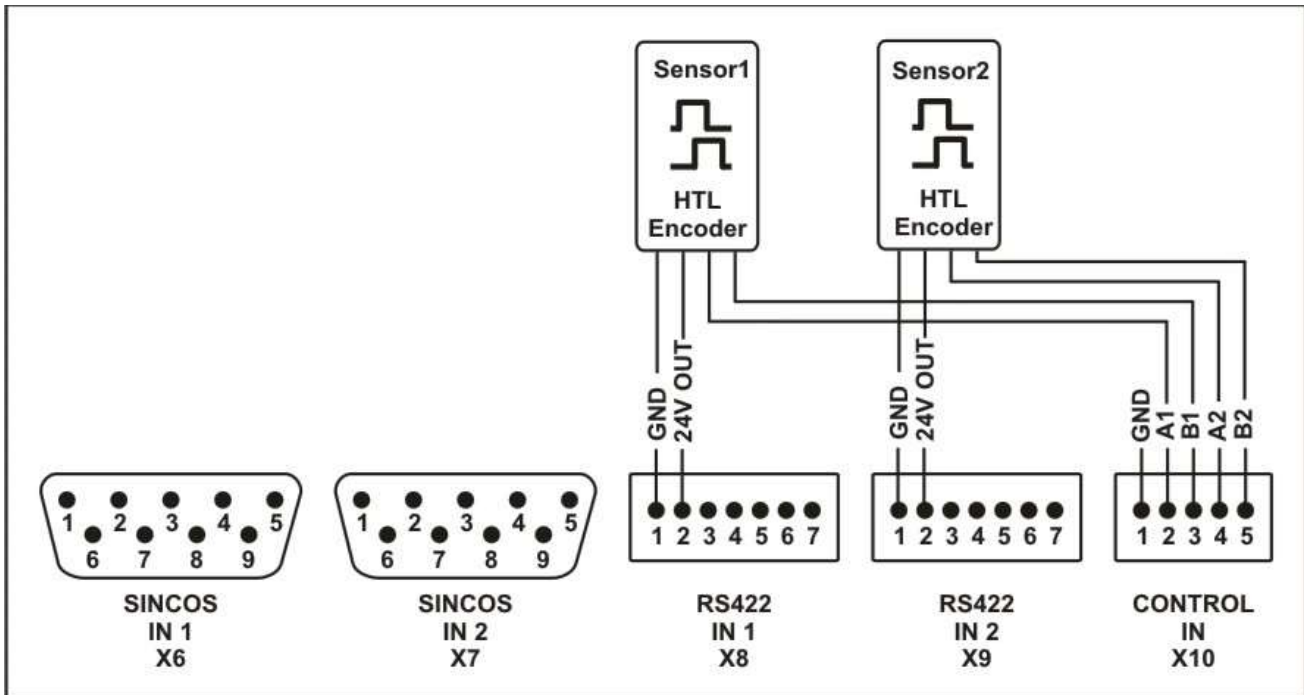
This mode allows evaluation of a dual channel system, equipped with two incremental dual channel HTL encoders.

- No inputs for control signals are available at terminal [X10 | CONTROL IN].
- The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.

6.6. Application: 1 Quadrature Encoder and 1 Single Channel HTL Encoder

Device	DS23x
Operational Mode	4
Sensor 1	[X10	CONTROL IN]　　Incremental HTL encoder　A, B, 90°
Sensor 2	[X10	CONTROL IN]　　Incremental HTL encoder　A, single channel
Control Inputs	[X10	CONTROL IN]　　HTL/PNP control signal　not available
Safety Level	Speed　　　→ SIL3 / PLe achievable (see below) Direction　→ SIL3 / PLe* achievable (see below) Standstill　→ SIL3 / PLe* achievable (see below). With single channel encoders, jitter around an edge can be misinterpreted as a frequency.

This mode allows evaluation of a dual channel system, equipped with a combination of one incremental quadrature HTL encoder and one single channel HTL encoder.
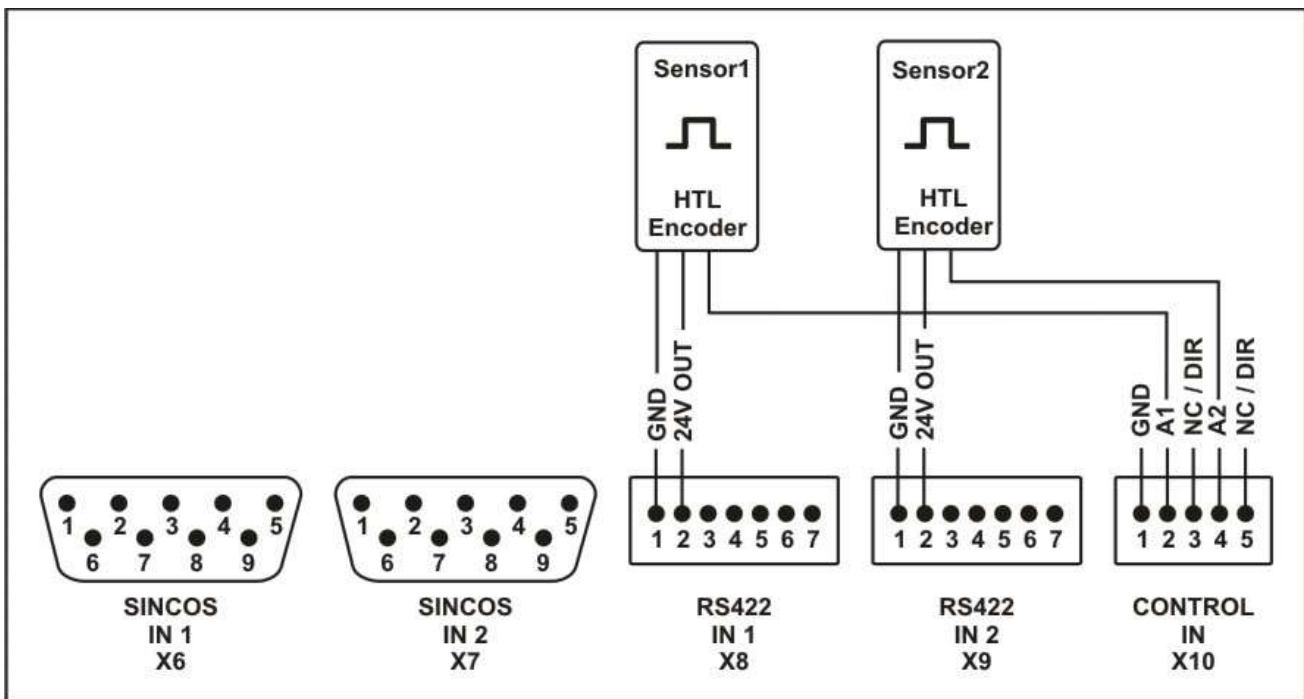
- No inputs for control signals are available at terminal [X10 | CONTROL IN].
- The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.
- For unbalanced single channel signals, the parameter A-Edge 2/1 must be set to 1, so that a stable frequency can be detected.

*) To achieve a safety level with this configuration, the user must be sure that the equipment will physically be able to rotate or move in one direction only (no reversals!). This could e.g. be ensured by use of a self-locking gearbox.

6.7.   Application: 2 Single Channel HTL Encoders

Device	DS23x
Operational Mode	5
Sensor 1	[X10	CONTROL IN] Incremental HTL encoder A, single channel
Sensor 2	[X10	CONTROL IN] Incremental HTL encoder A, single channel
Control Inputs	[X10	CONTROL IN] HTL/PNP control signal not available
Safety Level	Speed → SIL3 / PLe achievable (see below) Direction → SIL3 / PLe* achievable (see below) Standstill → SIL3 / PLe* achievable (see below). With single channel encoders, jitter around an edge can be misinterpreted as a frequency

This mode allows evaluation of a dual channel system, equipped with two single-channel HTL encoders.
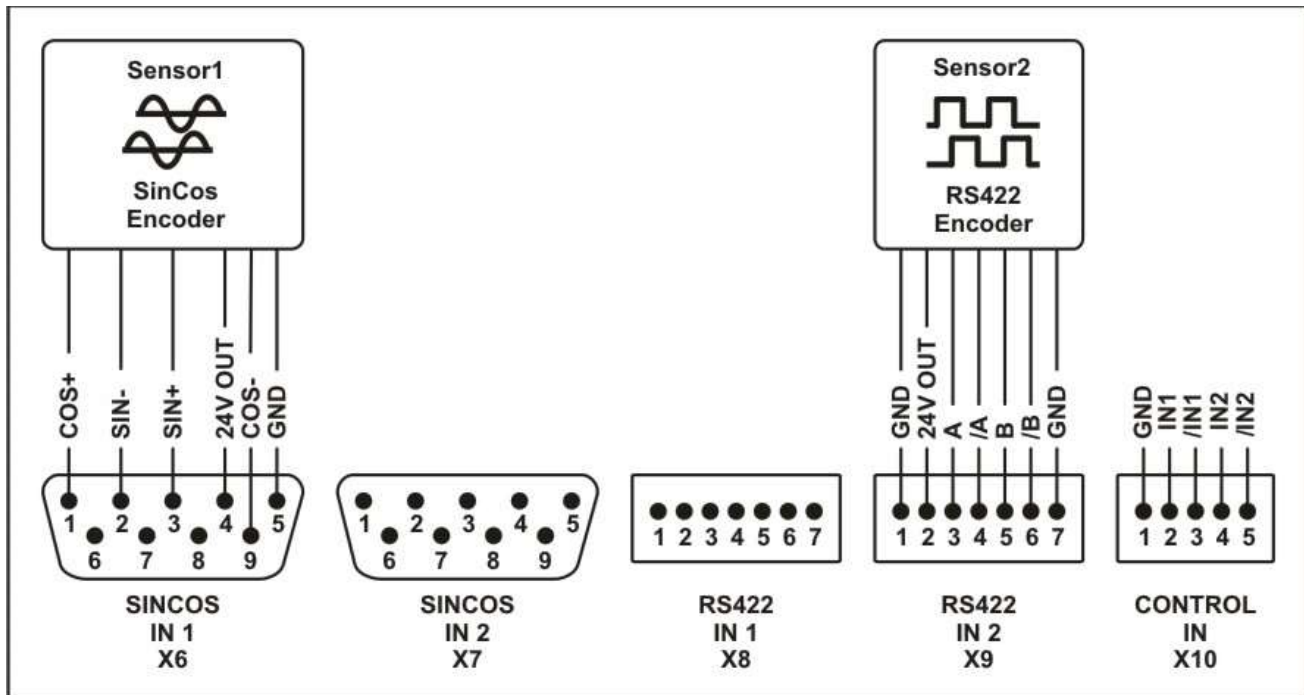
> • No inputs for control signals are available at terminal [X10 | CONTROL IN].
> • The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.
> • For unbalanced single channel signals, the parameter A-Edge 2/1 must be set to 1, so that a stable frequency can be detected.

> *) To achieve a safety level with this configuration, the user must be sure that the equipment will physically be able to rotate or move in one direction only (no reversals!). This could e.g. be ensured by use of a self-locking gearbox.

6.8. Application: 1 SinCos and 1 RS422 Encoder

Device	DS23x
Operational Mode	6
Sensor 1	[X6	SINCOS IN 1] Incremental HTL encoder SIN+, SIN-, COS+, COS-
Sensor 2	[X9	RS422 IN 2] Incremental HTL encoder A, /A, B, /B
Control Inputs	[X10	CONTROL IN] HTL/PNP control signal 2 - 4 available
Safety Level	Speed → SIL3 / PLe achievable (see below) Direction → SIL3 / PLe achievable (see below) Standstill → SIL3 / PLe achievable (see below)

This mode allows evaluation of a dual channel system, equipped with a combination of one SinCos encoder and one RS422/TTL encoder.

- With a DS230 model this mode can be used to reproduce the input frequency of [X6 | SINCOS IN1] to the splitter output [X5 | SINCOS OUT].
- 2 - 4 inputs for control signals are available at terminal [X10 | CONTROL IN].
- The final Safety Integrity Level (SIL) depends on the selected configuration and on external components connected to the unit.