



# moTrona SI220 SinCos Interpolator For Encoders And Measuring Systems User Manual

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moTrona SI220 SinCos Interpolator For Encoders And Measuring Systems



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## Important Information

SI220

SinCos interpolator for encoders and measuring systems with SinCos output

### Product features

- Converts 1 Vss standard sinus wave signals into incremental square wave signals
- Outputs A, /A, B, /B, Z, /Z (RS422 / HTL)
- Adjustable multiplier for interpolation rates from 1 : 5 ... 1 : 50
- Adjustable divider 1 : 1 ... 1 : 255 to reduce the output frequency
- Sine input frequency 0 ... 400 kHz
- Quadrature output frequency up to 4 MHz
- Adjustable glitch-filter
- Power supply 18 ... 30 VDC

The English description is available at:

[https://www.motrona.com/fileadmin/files/bedienungsanleitungen/Si220\\_e.pdf](https://www.motrona.com/fileadmin/files/bedienungsanleitungen/Si220_e.pdf)



Version:	Description:
Si220_01a/Nov. 23/af/mbo	First Version

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## Safety Instructions and Responsibility

### 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 this manual. The unit must be installed, connected and put into operation 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 and operation. 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 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.**

## Use according to the intended purpose

The unit is intended exclusively for use in industrial machines, constructions and systems. Nonconforming usage does not correspond to the provisions and lies within the sole responsibility of the user. The manufacturer is not liable for damages which has 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, see chapter 12). The device is not suitable for operation in explosion-proof areas or areas which are excluded by the EN 61010-1 standard.

## Installation

The device is only allowed to be installed and operated within the permissible temperature range. Please ensure an 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 a double resp. increased isolation.

All selected wires and isolations must be conformed 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 (see below).

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.

Over voltages at the connections must be limited to values in accordance to the overvoltage category II

## EMC Guidelines

All motrona units are designed to provide high protection against electromagnetic interference. Nevertheless, you must minimize the influence of electromagnetic noise to the unit 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 unit 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>

### 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 and reparation (if necessary). Unauthorized opening and repairing can have negative effects or failures to the protection-measures of the unit.

### Compatibility Hint

The main differences between the SI220 and its previous model, the SI251, are listed below:

	SI220	SI251
Housing	<b>dimensions (w x h x d):</b> 34 x 118 x 135 mm / 1.34 x 4.65 x 5.31 inches (inclusive connections) <b>weight:</b> approx. 160 g	<b>dimensions (w x h x d):</b> 40 x 79 x 91 mm / 1.57 x 3.11 x 3.58 inches (inclusive connections) <b>weight:</b> approx. 200 g
Incremental Output HTL / RS 422	only one output connector, 9-pin switchable via DIL switch HTL / RS422	parallel outputs SUB-D connector, 9-pin (RS422) screw terminal (HTL)
Connection Power Supply	connector, 9-pin	screw terminals
Connection Control Output	connector, 9-pin	screw terminals
Connection Control Input	connector, 9-pin	screw terminals
Encoder Supply	switchable via DIL switch	via external bridge
Single-track SIN/COS Signals (SIN/COS/REF)	currently no support	support

### Features for SI220:

- Automatic generation of one Z-pulse per input period selectable
- Separate Z divider
- Extension of the A/B divider
- Stop input for output signals

### Introduction

SI220 represents an encoder interface unit, designed to convert output signals of so-called "sine-cosine-encoders" and similar measuring systems into incremental quadrature impulse signals, according to the A/B (2 x 90°) standard.

Under consideration of an adjustable multiplier the unit interpolates a corresponding number of impulses from every sine wave. An additional programmable divider provides division of the impulses if applicable, before they appear at the output. Impulses are available both on the RS422 and with HTL standard.

The maximum sine input frequency is 400 kHz. The interpolation rate can be set in a range from 5 to 50, i.e. the unit can generate up to 50 pulses from one sine period.

The maximum output frequency is 4 MHz. Where applicable, the output frequency can be reduced by a selectable divider 1 : 1 ... 1 : 255.

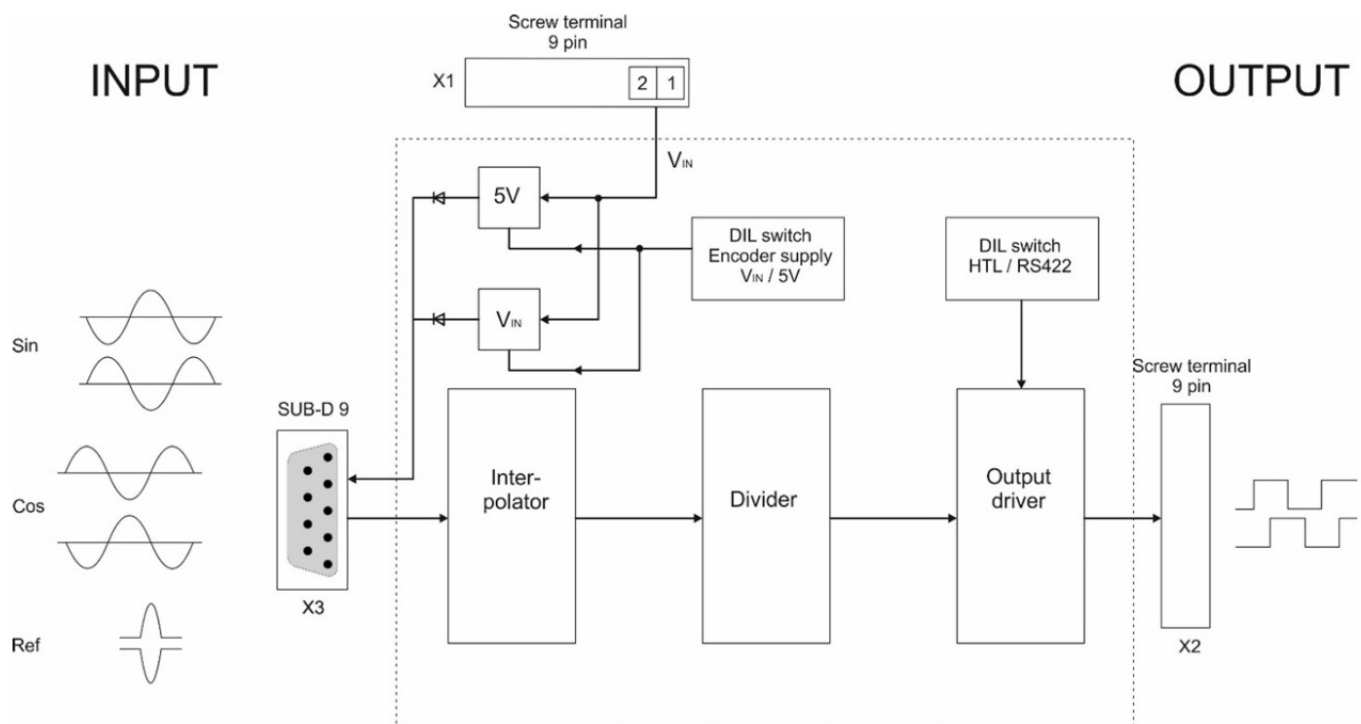
Independent of the selected interpolation rate, an interpolation time can be set in order to limit the output frequency to a desired maximum value. The unit provides auxiliary output voltages of 5.2 volts and  $V_{IN}$ , all short-circuit-protected, for power supply of the sine/cosine encoder. Errors will be indicated by a LED and at the same time by a digital control output. Errors can be reset by means of a pushbutton on the unit, or by a remote reset signal.

All settings are done by means of two 12-pin DIL switches which are accessible from the top site and the bottom site of the housing. The mechanical construction provides a compact housing for rail mounting, with screw terminals and one SUB-D-connector.



Power must be disconnected before making DIL switch settings.

## Block Diagram



## Connections

The unit provides a 9-pin SUB-D connector (female on the unit site) for connection of the SinCos sensor. For easy power supply of the encoder, an auxiliary voltage of either 5.2 V or approx. 24 V can be connected to the SUB-D socket.

The incremental output impulses are available with RS422 standard and HTL standard (pushpull) at the same time, and one output of both or both outputs at a time may be used, quite according to the application.



**All inputs and outputs as well as the power supply refer to the same reference potential (GND)!**

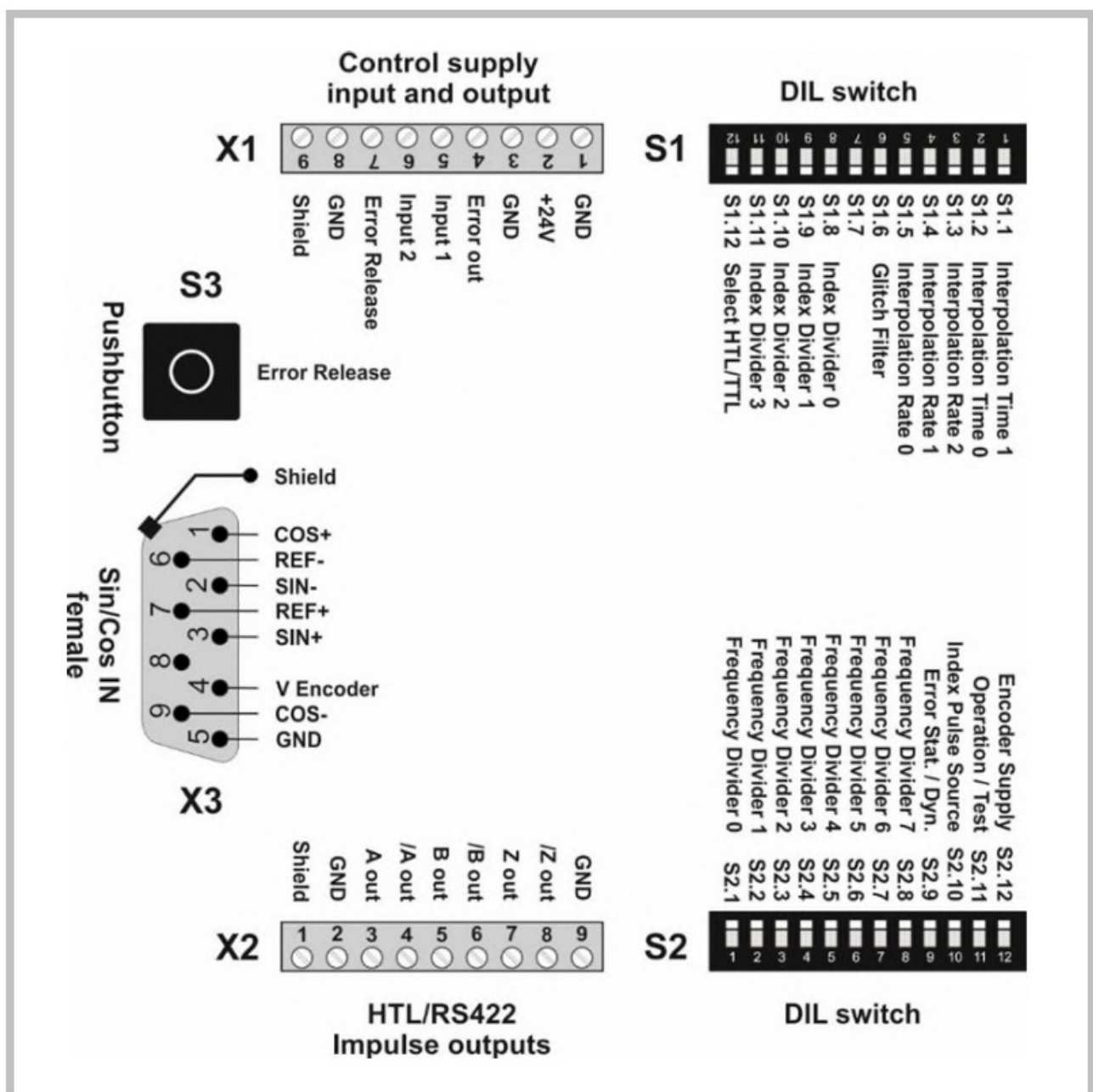
In case of errors the Error Output switches to HIGH. At the same time the yellow front LED will be lit. To release an Error state, a HIGH signal must be applied to the Error Release input (PNP, HTL, a positive signal of 10 ... 30 VDC will release the error). Errors may be cleared also by pushing the small button on the top site of the unit.

The unit operates with a 18 ... 30 VDC power applied to terminals 1 (GND) and 2 (+24V) of X1.

Input 1 can be used to stop the output independently of the input. If a high signal is present, there are no more output pulses.

Input 2 can be used to switch off the Z-divider. If a high signal is present, a Z output signal is no longer visible.

### Connection Overview



At any time, the over-all transmission characteristics of encoder, external components and capacity of cable must



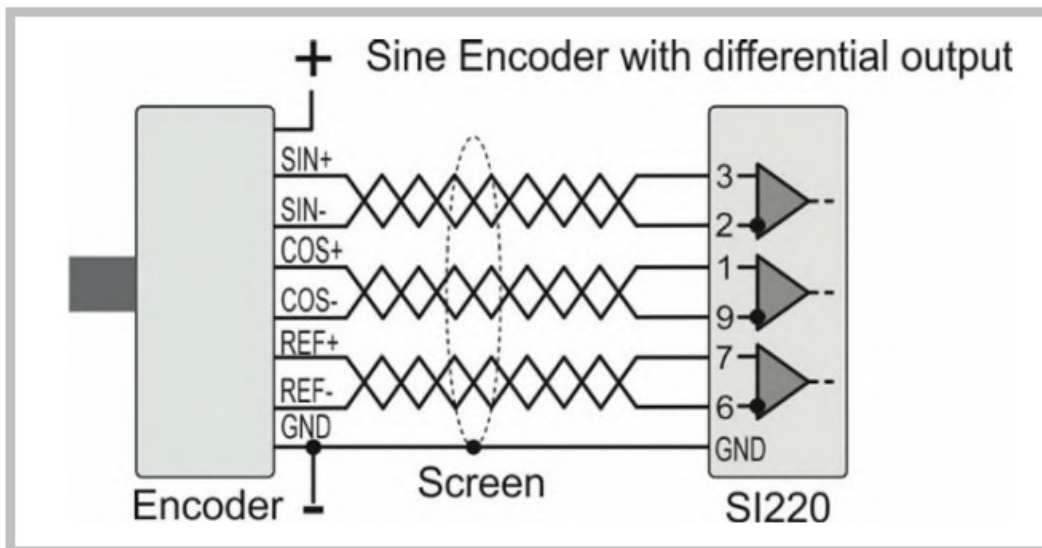
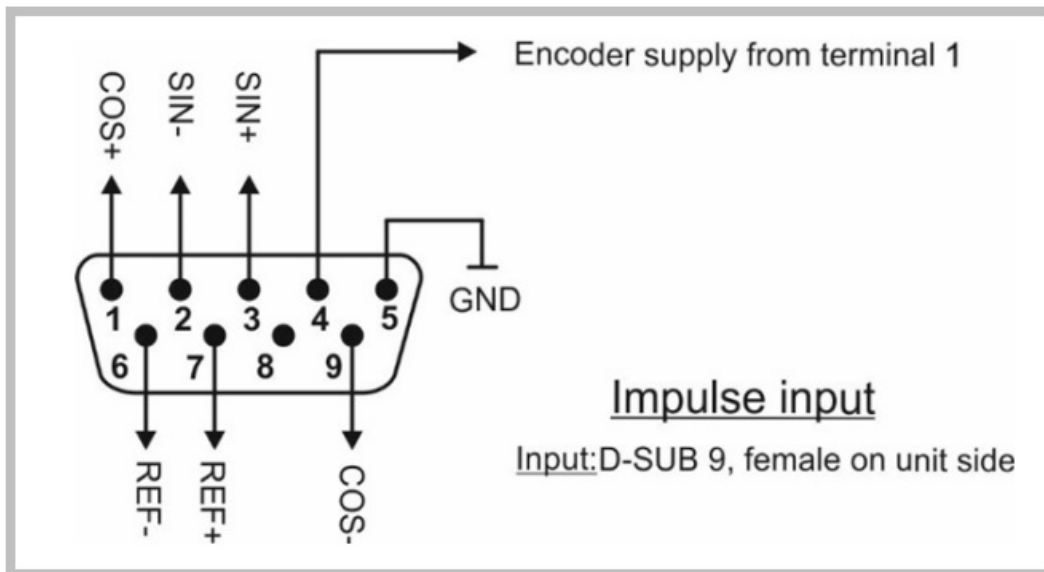
ensure proper signals at the input of the unit, with respect to levels, shape and phase displacement A/B.

The output swing of the **HTL push-pull outputs** corresponds to the input supply voltage on terminals 1 (GND) and 2 (+24V) of X1.

## Pin assignment of SUB-D-connectors

### SinCos-Inputs (X3)

Standard encoders with differential outputs can be connected directly to the corresponding pins **SIN+**, **SIN-**, **COS+**, **COS-**, **REF+**, **REF-**. Where longer cables must be used, terminating resistors between the non-inverted and the inverted signal of each channel may be of advantage.

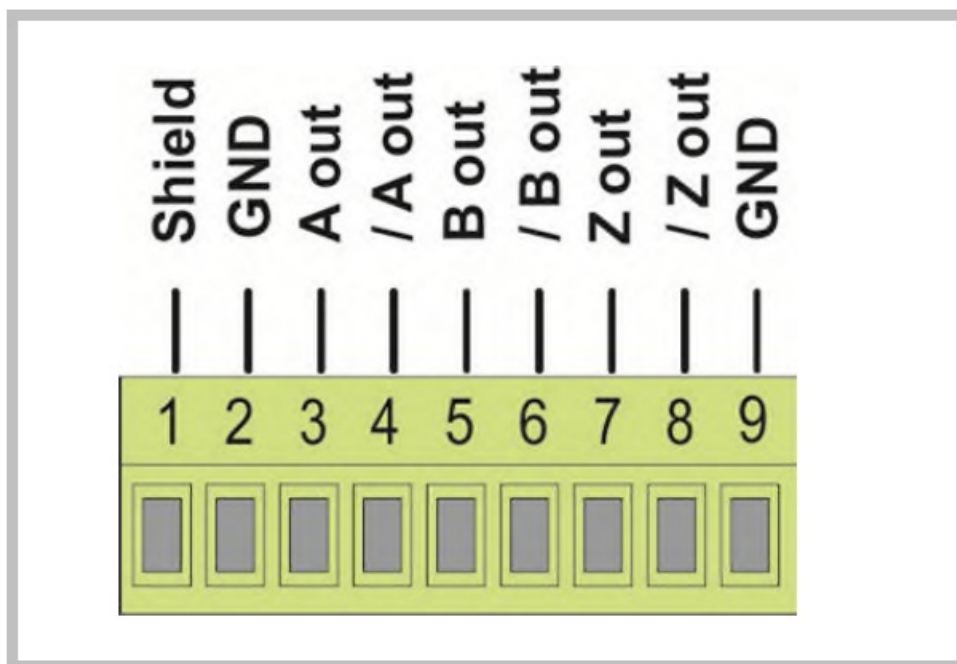


Using the DIL switch, the Z pulse can be switched on the input or a Z pulse is automatically generated with each sine period.

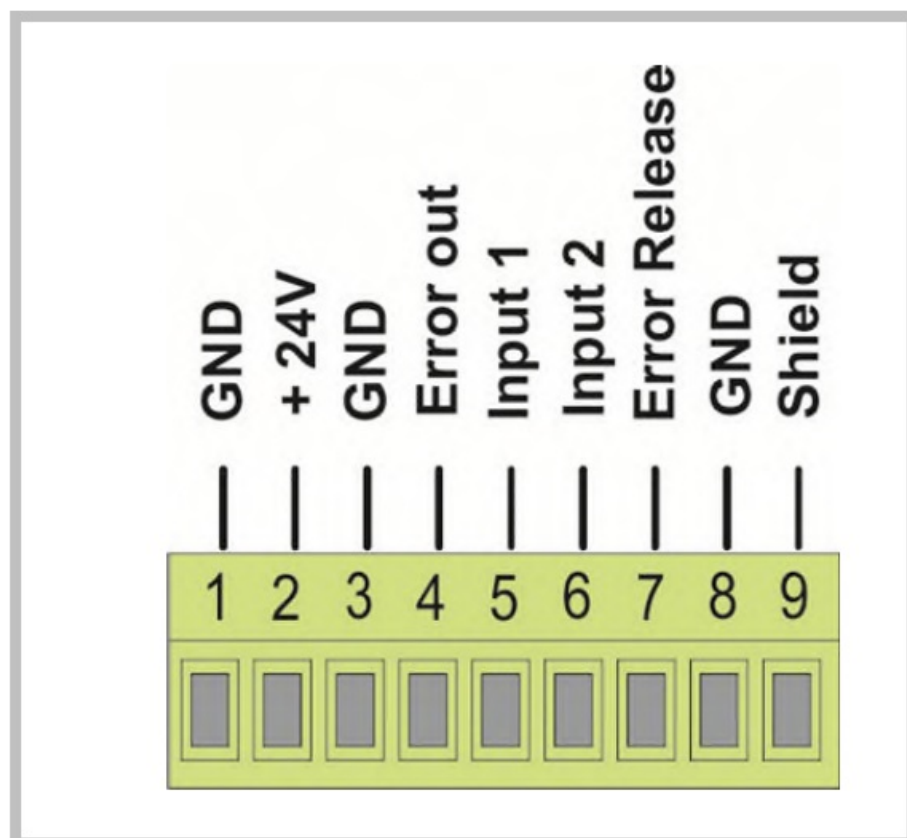


The sine-cosine signals on the input site are highly sensitive analogue signals! Therefore, it is mandatory to use proper screening. Use of cables with pair wise twisted leads is highly recommended. The cable length should not exceed 5 meters if possible.

## RS422 Impulse Outputs (X2)



## Control Input and Output (X1)








## Switch Settings

DIL switch S1 is used to set the filter, the interpolation factor, the interpolation time and the programmable Z divider.

DIL switch S2 allows the activation of a programmable A/B divider and the selection of test modes.



Changes of the DIL switch positions will become active only after the next power-up of the unit!

DIL switch	Status	Comment
S1.12 	ON	Output signals at X2 have VIN level (24V)
	OFF	Output signals at X2 have 5V level
S2.12 	ON	Encoder supply at X3 has VIN level (24V)
	OFF	Encoder supply at X3 has 5V level
S2.11 	ON	Test active, Error Out at X1 reserved for test
	OFF	Test inactive, Error Out on X1 has normal function
S2.10 	ON	Automatic generation of the REF pulse
	OFF	REF inputs at X3 are used
S2.09 	ON	Error is not static and is always deleted
	OFF	Error is static and saved

DIL switch S1						Interpolation and Filtering	
6	5	4	3	2	1		
ON						Glitch filter ON	Filtering
	OFF	OFF	OFF			40	Interpolation factor
	ON	OFF	OFF			20	
	OFF	ON	OFF			10	
	ON	ON	OFF			5	
	OFF	OFF	ON			50	
	ON	OFF	ON			25	
	OFF	ON	ON			12,5	
	ON	ON	ON			6,25	
				OFF	OFF	25 ns	Interpolation time
				OFF	ON	100 ns	
				ON	OFF	400 ns	
				ON	ON	1600 ns	



#### Hints for settings of DIL switch S1:

- Distortions of the input signal result in fluctuation of the output frequency.
- Use of the glitch filter results in increased interpolation times at standstill or with low input frequencies, therefore, reduces noise and jitter of the output signal by a few increments up and down in standstill. However, when the glitch filter is switched on, fast changes of the speed can result in temporary proportional errors between input frequency and output frequency during acceleration.

**The subsequent table shows the limits of input and output frequencies with respect to the DIL switch settings:**

Interpolation rate	Interpolation time	Maximum output frequency	Maximum input frequency
x5	25 ns	2 MHz	400 kHz
	100 ns	2 MHz	400 kHz
	400 ns	625 kHz	125 kHz
	1600 ns	156.25 kHz	31.25 kHz
x6,25	25 ns	2,5 MHz	400 kHz
	100 ns	2,5 MHz	400 kHz
	400 ns	625 kHz	100 kHz
	1600 ns	156.25 kHz	25 kHz
x10	25 ns	4 MHz	400 kHz
	100 ns	2,5 MHz	250 kHz
	400 ns	625 kHz	62.5 kHz
	1600 ns	156.25 kHz	15.625 kHz

Interpolation rate	Interpolation time	Maximum output frequency	Maximum input frequency
x12,5	25 ns	4 MHz	320 kHz
	100 ns	2.5 MHz	200 kHz
	400 ns	625 kHz	50 kHz
	1600 ns	156.25 kHz	12.5 kHz
x20	25 ns	4 MHz	200 kHz
	100 ns	2.5 MHz	125 kHz
	400 ns	625 kHz	31.25 kHz
	1600 ns	156.25 kHz	7.8125 kHz
x25	25 ns	4 MHz	160 kHz
	100 ns	2.5 MHz	100 kHz
	400 ns	625 kHz	25 kHz
	1600 ns	156.25 kHz	6.25 kHz
x40	25 ns	4 MHz	100 kHz
	100 ns	2.5 MHz	62.5 kHz
	400 ns	625 kHz	15.625 kHz
	1600 ns	156.25 kHz	3.90625 kHz
x50	25 ns	4 MHz	80 kHz
	100 ns	2.5 MHz	50 kHz
	400 ns	625 kHz	12.5 kHz
	1600 ns	156.25 kHz	3.125 kHz

## Frequency Divider and Error Signals

The programmable frequency divider provides decrease of the output frequency by an adjustable division rate between 1 : 1 and 1 : 255.

The following errors are detected and indicated by the yellow LED and the Error output:

- Wire break with one of the signals SIN+, SIN-, COS+ or COS-
- Too low amplitude on one of above signal lines
- The REF+ and REF- signals are not monitored for errors The input frequency exceeds its maximum level, the output frequency is unable to follow.

**Depending on the settings on the DIL switch S2, error signals remain active until remote acknowledgement, or reset automatically upon elimination of the error. In case of an error the proper function of the unit is not ensured and a loss of encoder pulses can occur.**

In case of an error, the error output switches to HIGH. At the same time, the yellow front LED will be lit. An error is acknowledged via the Error Release input or via the small pushbutton on the front of the device. If the input frequencies are too high, resetting an error may fail.



**Changes of the DIL switch positions will become active only after the next power-up of the unit!**

DIL switch S2:							A/B divider			
8	7	6	5	4	3	2	1			
OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	1 : 1	Division rate	
OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	1 : 2		
OFF	OFF	OFF	OFF	OFF	OFF	ON	OFF	1 : 3		
OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	1 : 4		
OFF	OFF	OFF	OFF	OFF	ON	OFF	OFF	1 : 5		
OFF	OFF	OFF	OFF	OFF	ON	OFF	ON	1 : 6		
OFF	OFF	OFF	OFF	OFF	ON	ON	OFF	1 : 7		
OFF	OFF	OFF	OFF	OFF	ON	ON	ON	1 : 8		
OFF	OFF	OFF	OFF	ON	OFF	OFF	OFF	1 : 9		
OFF	OFF	OFF	OFF	ON	OFF	OFF	ON	1 : 10		
OFF	OFF	OFF	OFF	ON	OFF	ON	OFF	1 : 11		
OFF	OFF	OFF	OFF	ON	OFF	ON	ON	1 : 12		
-----								-----		
ON	ON	ON	ON	ON	ON	ON	ON	1 : 255		



DIL switch S1:					Z divider
11	10	9	8		
OFF	OFF	OFF	OFF	1 : 1	Division rate
OFF	OFF	OFF	ON	1 : 2	
OFF	OFF	ON	OFF	1 : 3	
OFF	OFF	ON	ON	1 : 4	
OFF	ON	OFF	OFF	1 : 5	
OFF	ON	OFF	ON	1 : 6	
OFF	ON	ON	OFF	1 : 7	
OFF	ON	ON	ON	1 : 8	
ON	OFF	OFF	OFF	1 : 9	
ON	OFF	OFF	ON	1 : 10	
ON	OFF	ON	OFF	1 : 11	
ON	OFF	ON	ON	1 : 12	
ON	ON	OFF	OFF	1 : 13	
ON	ON	OFF	ON	1 : 14	
ON	ON	ON	OFF	1 : 15	
ON	ON	ON	ON	1 : 16	

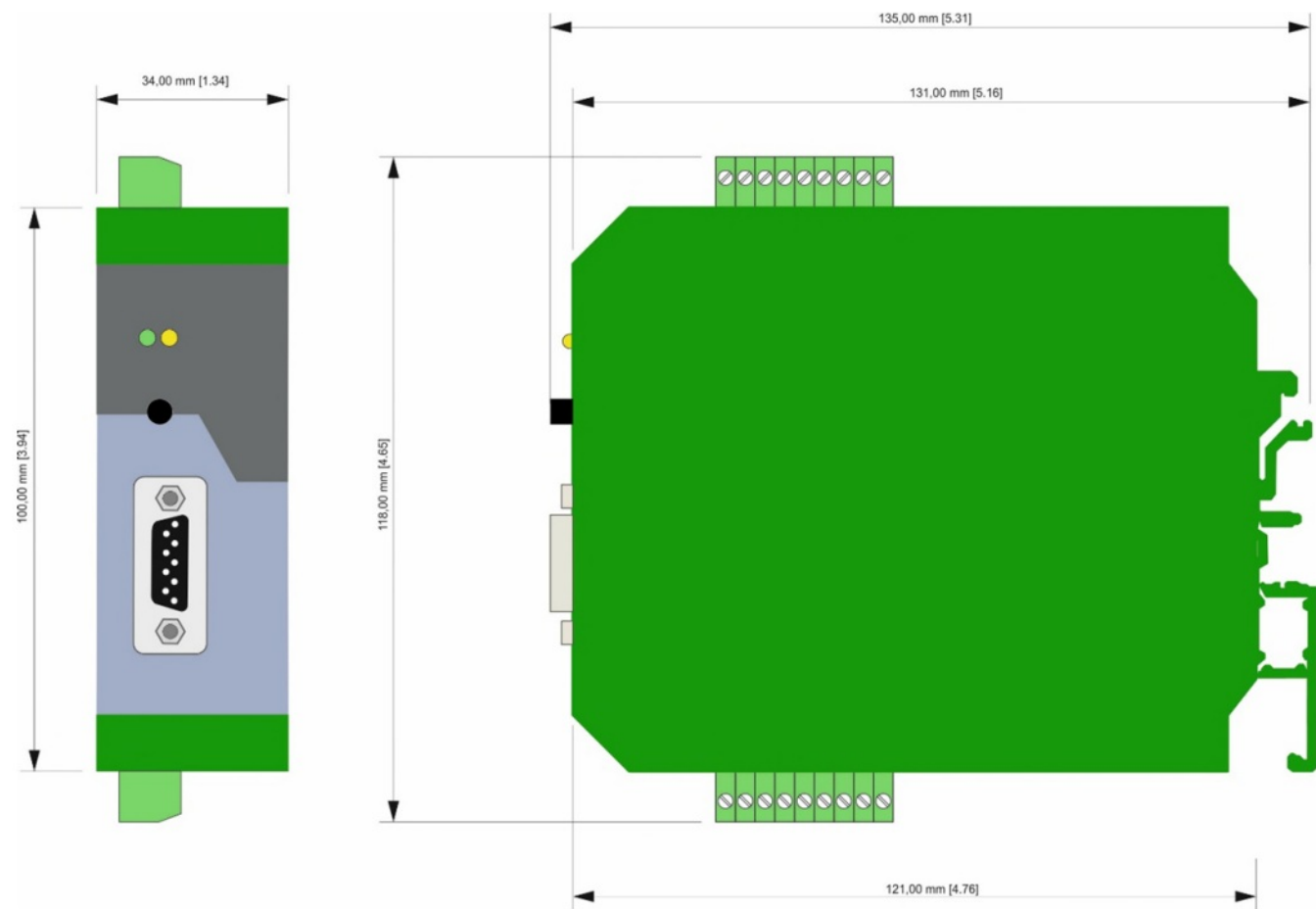
## Delays

There is a delay time between the analogue input signals and the incremental output signals, which is typically 3  $\mu$ sec. when the divider is switched off. Use of the divider function will extend the delay time correspondingly. The delay time is constant, and causes a frequency dependent phase shift between the input and output signals.

## Miscellaneous Hints

- The unit will reach full accuracy only after a transient period of approximately 20 full sine cycles at the input. Before that, the input frequency should not exceed about 50 % of the normal maximum frequency.
- The application of digital interpolation procedures requires use of quantization steps, which can cause a certain dither of the output signal.
- The quality of the output signal depends essentially on the input signals. Therefore, maximum elaborateness is recommended with screening, running of cables and cable length.
- SI220 does not possess a potential separation, i.e. the unit GND is at the same time also GND of the sensor. Therefore, it is important to ensure clear conditions with earthing and to prevent earth loops and balance currents flowing through the unit. Where unrulable potential situations should come up, it is recommended to use a fully separate power supply for the SI 220 unit.

Dimensions




Technical Specifications

Technical Specifications:		
Power Supply:	Input voltage: Ripple: Consumption: Connections:	18 ... 30 VDC with reverse polarity protection $\leq 10\%$ at 24 VDC approx. 150 mA at 18 V / approx. 60 mA at 30 V (unloaded) Screw terminal, 1,5 mm <sup>2</sup> / AWG 16
Encoder Supply:	Number of auxiliary voltages:	2
	Encoder supply 1:	+ 5,2 VDC
	Encoder supply 2:	Input voltage (VIN) minus approx. 2 VDC
	Output current:	each max. 150 mA
	Connections:	SUB-D (female), 9 pin. , switchable via DIL switch
SinCos Input:	Amplitude:	min. 0,8 Vpp ... max.1,2 Vpp
	DC offset:	min. 1,8 V ... max. 3,1 V
	Channels:	SIN+, SIN-, COS+, COS-, REF+, REF-
	Frequency:	max. 400 kHz

	Differential REF-input signal:	HIGH 130 mV, LOW 40 mV
	Connections:	SUB-D (female), 9 pin.
Control Input:	Signal level: Internal resistance: Connections:	10 ... 30 V, HTL / PNP, LOW: 0 ... 4 V, HIGH: 10 ... 30 V Ri ≈ 7 kOhm Screw terminal, 1,5 mm <sup>2</sup> / AWG 16
Incremental Output	Signal level:	Supply voltage (VIN) minus 2 VDC, 5 VDC
HTL / RS422:	Channels:	A, /A, B, /B, Z, /Z
	Frequency:	up to 4 MHz
	Connections:	Screw terminal, 1,5 mm <sup>2</sup> / AWG 16, switchable via DIL switch
Control Output:	Signal level: Output current: Connections:	HTL, supply voltage (VIN) minus 2 VDC max. 30 mA Screw terminal, 1,5 mm <sup>2</sup> / AWG 16
Housing:	Material: Mounting: Dimensions (w x h x d): Protection: Weight:	Plastic to 35 mm top hat rail (according to EN 60715) 34 x 100 x 131 mm / 1.34 x 3.94 x 5.16 inches (without connections) 34 x 118 x 135 mm / 1.34 x 4.65 x 5.31 inches (inclusive connections) IP20 approx. 160 g
Ambient temperature:	Operation: Storage:	0 °C ... +45 °C / 32 °F ... 113 °F (not condensing) -25 °C ... +70 °C / -13 °F ... 158 °F (not condensing)
Ambient conditions:	Altitude: Humidity: Pollution Degree:	max. 2000 m (6560 ft) above sea level max. 80% relative humidity up to bis 30 °C (86 °F) 2
Failure rate:	MTBF in years:	63,3 a (continuous operation at 60 °C / 140 °F)
Conformity & standards:	EMC 2014/30/EU: RoHS (II) 2011/65/EU RoHS (III) 2015/863:	EN 61326-1: 2013 for industrial location EN 55011: 2016 + A1: 2017 + A11: 2020 Class A EN IEC 63000: 2018



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References

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