Synchronous Serial Data Transmission

Commissioning- and

Interface description

Please keep for further use !

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Printing

This manual was produced on a DOS personal computer using MS-Word for Windows 6.0. The text was printed in *Arial* type.

Notation

Italics or **bold** type are used for the title of a document or to emphasize text passages.

`Courier` type is used for text which is visible on the screen/display and for software menu selections.

″ < > ″ refers to keys on your computer keyboard (e.g. <RETURN>).

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Revision index

i ***Note***
The cover of this document shows the current revision status and the corresponding date. Since each individual page has its own revision status and date in the footer,, different revision statuses may exist within the same document.

Document produced: 27.04.2000

Revision	Date

Table of Contents

1 Safety

1.1 General hazard potential

The TR encoder can't function as a stand-alone unit, i.e. it is a component part that is intended to be installed in a complete system consisting of several such components working together. For this reason, the encoder does not have a protective device of its own.

Depending of the encoder type, via the transmission protocol different status bits can be read-out such as "encoder error" or "parity". This means that it is crucial to **integrate the error bits into your own safety concept** by means of the PLC's evaluation software. Further information about encoder control mechanisms can be taken from the documentation of the respective encoder type. If the encoder SSI-transmission protocol offers no possibility to check the encoder actual values or the transferred data to the control the user must take up corresponding measures.

All persons involved in the assembly, start-up and operation of the device.

- must be appropriately qualified
- must follow the instructions in this manual exactly.

This is for your own safety and the safety of your equipment!

1.2 Safety information

This operating manual contains information which have to be considered to ensure your personal safety and to avoid damage to property. The information is emphasized by warning triangles, which have different appearances according to the degree of danger:

Warning
Means that death, severe injury or considerable damage to property can occur if the relevant safety measures are ignored.

Caution
Means that slight injury or damage to property can occur if the relevant safety measures are ignored.

i ***Note***
Emphasizes important information about the product, its properties or helpful hints for using it.

1.2.1 Hints on installation

In view of the fact that the TR encoder is normally used as a component part of a larger system, this information is intended as a guideline for the safe integration of the rotary encoder into its environment.

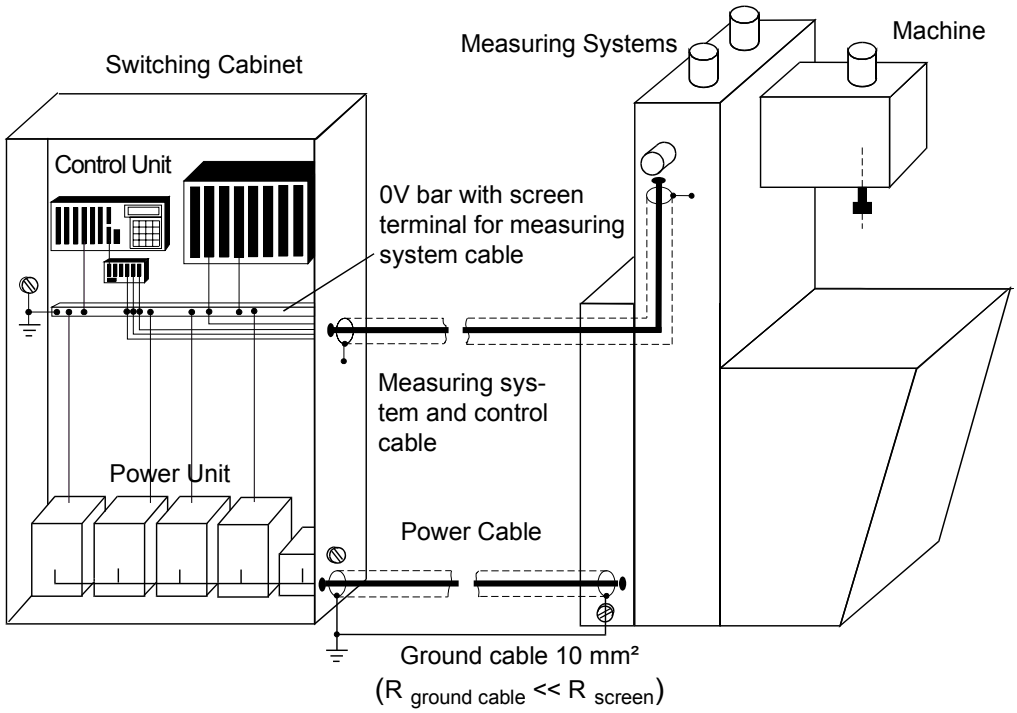
Warning

- Observe the safety and accident prevention regulations relevant to the specific application.
- In the case of equipment with a fixed connection (stationary installations/systems) without all-pole mains switches and/or fuses, you must install a mains switch or fuse in the system and connect the equipment to a protective earth conductor.
- Before starting up devices that are run on mains voltage, check to make sure the set rated voltage range matches the local mains voltage.
- With a 24-V supply, ensure safe electrical isolation of the extra-low voltage. Only use mains units that comply with the standards IEC 364-4-41 or HD 384.04.41 (VDE 0100 Part 410).
- Fluctuations or deviations from the rated mains voltage may not exceed the tolerances stated in the technical data. If they do, functional failures of the electrical components and hazardous conditions cannot be ruled out.
- You must take precautions to ensure that an interrupted program can be resumed normally following voltage dips and failures. In this context, no dangerous operating status conditions may occur even for a brief period of time. If necessary, you must force an **EMERGENCY STOP.**
- EMERGENCY STOP devices that comply with EN 60204/IEC 204 (VDE 0113) must remain effective in all the operating modes of the automation equipment. Unlocking the EMERGENCY STOP devices must not result in an uncontrolled or undefined restart.
- Install the connecting and signal lines so that inductive and capacitive interference does not adversely affect the automation functions.
- Install automation technology equipment and its operator input elements so that they are sufficiently protected against accidental actuation.
- Take appropriate hardware and software precautions in the I/O link to prevent possible cable or wire breakages on the signal side leading to undefined status conditions in the automation equipment.

1.2.1.1 Screening

The use of electronic sensor active systems in modern machines necessitates a consistent and correctly executed interference suppression and wiring strategy.
These conditions are the only guarantee that systems containing electronic measuring systems will function properly.

Recommended screened cable wiring



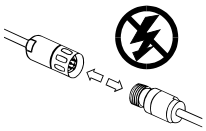
1.2.1.2 General interference suppression measures

- Route (screened) lines connecting to the encoder either a long way from or completely physically separated from energy lines that carry disturbances.
- Only use completely screened lines for data transfer and ensure that they are well earthed. In the case of differential data transfer, (RS422, RS485 etc.), you must use twisted-pair lines in addition.
- Use cables with a minimum cross-section of 0.22 mm² for data transfer**.**
- Use a ground cable with a minimum cross-section of 10 mm² to avoid equipotential bonding via the screen. Please note that the ground cable resistance must be much lower than that of the screen.
- Wire the screen continuously keeping a large area in contact with special screen connecting terminals.
- Avoid crossing cables. If this is not possible, the cables should only cross at right-angles.

1.3 Intended use

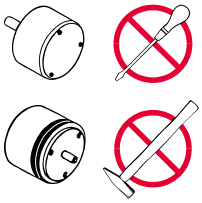
The SSI encoder are used for the electronic interception of a rotating or linear movement as well as for the preparation of measured data for a controller with a synchronous serial interface connected on the load side.

Warning



De-energize the system before carrying out wiring or opening and closing electrical connections!
Short-circuits, voltage peaks etc. can lead to malfunctions and uncontrolled states in the system or to serious personal injury or damage to property.

Check all electrical connections before switching on the system!
Connections that are made incorrectly can lead to system malfunctions; wrong connections may result in serious personal injury or damage to property.



Mechanical or electrical modifications to the measuring systems ***are prohibited for safety reasons!***

Note
Always follow the start-up, operating and programming instructions specified in this manual or in the corresponding encoder documentation.

1.4 Authorised operators

The start-up and operation of this device may only be performed by qualified personnel. In the context of the safety-related information in this document, the term "qualified personnel" refers to persons who are authorized to commission, ground and mark circuits, equipment and systems in accordance with recognized safety standards.

1.5 Safety measures at the assembly site

Warning

Do not carry out welding if the encoder has already been wired up or is switched on!
Potential fluctuations can destroy the encoder or impair its operation.

Do not touch connector contacts with the hands!
Static chargings could destroy electronic components of the encoder.

Unused inputs may not be connected (see pin assignment)!

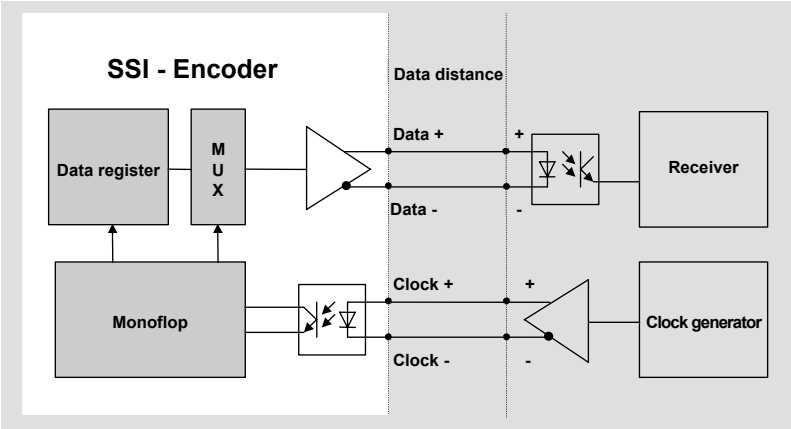
Keep to the supply voltage range

Note
Ensure that the area around the assembly site is protected from corrosive media (acid, etc.)

2 Synchronous - Serial - Interface

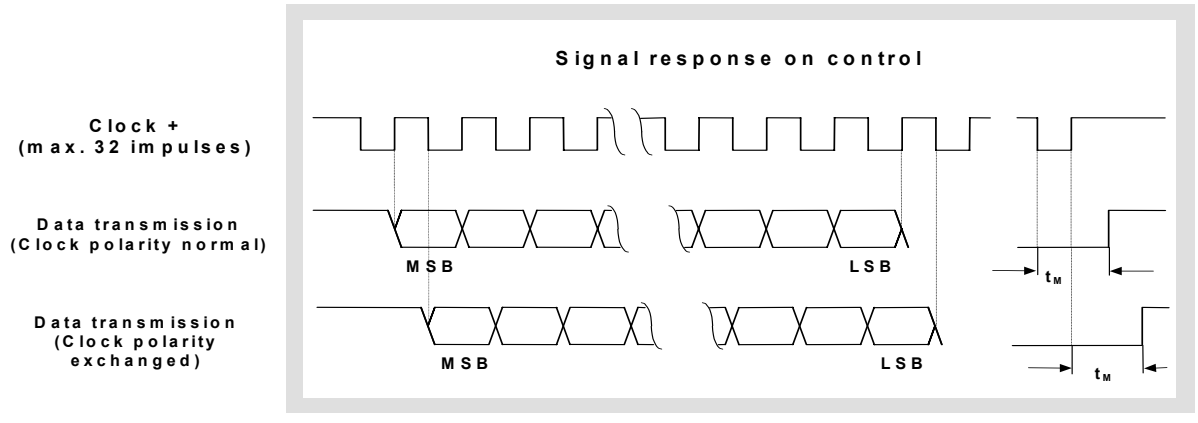
2.1 Shaft Encoder

Functional diagram



2.1.1 Output-Format "Standard"

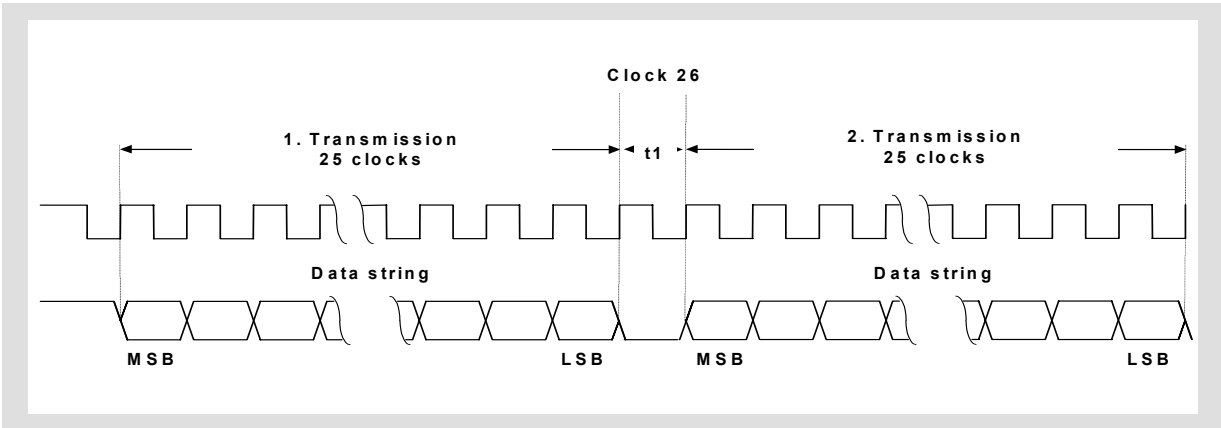
At rest, Data+ and Clock+ are +5V (High). Data transfer starts with the MSB and is initiated by the first falling clock edge. Data is changed by a positive clock edge. Depending on the receiver, data is accepted with a rising or a falling edge.
When the clock sequence is over, the system keeps the data lines at 0V (Low) for the duration of the mono period, $\mathbf{t_M}$. Time $\mathbf{t_M}$ is set to 20 µs and it determines the lowest transfer frequency of approximately 80 kHz. The upper limit frequency results from the total of all the signal propagation delays and is limited additional by the built-in filter circuits to approx. 820 kHz.



The inverted signals Data- and Clock- are not represented.

2.1.2 Output-Format "Multiple" (26 bit repetition)

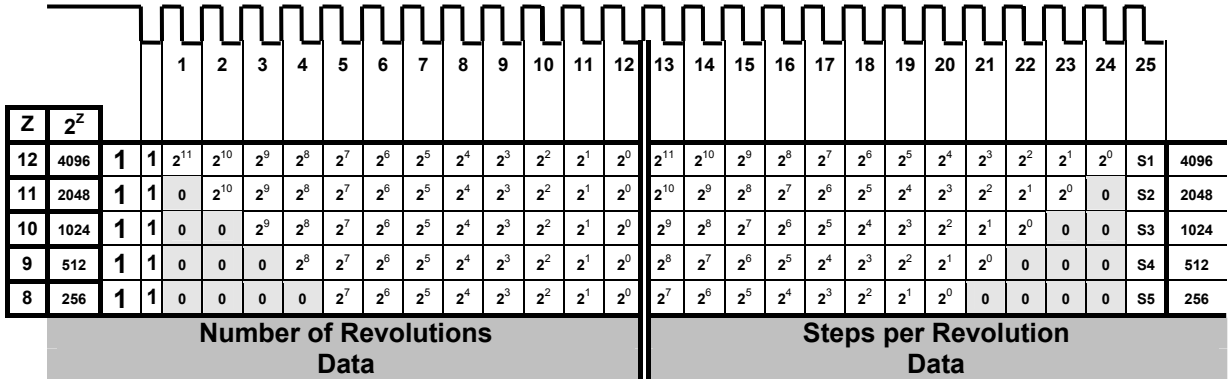
By a multiple transmission of the same data string via the SSI-interface it is possible to detect transmission errors. At the multiple transmission, 25 bits are transmitted per data string in the standard format. After the first transmission, clock 26 controls the data repetition.
If the clock 26 follows after a time (t1) which is < 20 µs, the same data string is transmitted with the following clocks again.
If the clock 26 follows after a time (t1) which is > 20 µs, a new data string is transmitted with the following clocks.



2.1.3 Output-Format "Tree Format"

To transmit synchronous serial data organized, it is possible to transfer the data in tree-format. At this, the data bits are added behind each other (see diagram). On the left side of the central axes are always 12 bits present which contains the number of the revolutions. On the right side of the central axes, at least 13 bits are present which contains the steps per revolution. If less than 12 bits are required for the number of the revolutions, the signal is filled with leading "zeros" up to the required length of 12 bits. If no 13 bits are required for the steps per revolution, "zeros" are added in order to get the required length.
To these 25 data bits up to eight special bits (in case of encoders with the programming possibility "With Repetition", six) which can be programmed via the programming terminal PT100N can be added. If it´s necessary to add "zeros" for the "Steps per Revolution" it is to be considered that these "zeros" are created by the special bits and therefore the eight (or six) special bits aren't always available.

Diagram: 5 examples of synchronous serial data outputs in Tree-Format



				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
Z	2^Z																												
12	4096	1	1	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{11}	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	S1	4096
11	2048	1	1	0	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^{10}	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	0	S2	2048
10	1024	1	1	0	0	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^9	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	0	0	S3	1024
9	512	1	1	0	0	0	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^8	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	0	0	0	S4	512
8	256	1	1	0	0	0	0	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0	0	0	0	0	S5	256
				Number of Revolutions Data												Steps per Revolution Data													

Continuation clock 26

Clock +

		25	26	27	28	29	30	31	32
Example 1		S1	S2	S3	S4	S5	S6	0	0
Example 2		S2	S3	S4	S5	S6	0	0	0
Example 3		S3	S4	S5	S6	0	0	0	0
Example 4		S4	S5	S6	0	0	0	0	0
Example 5		S5	S6	0	0	0	0	0	0

Note:

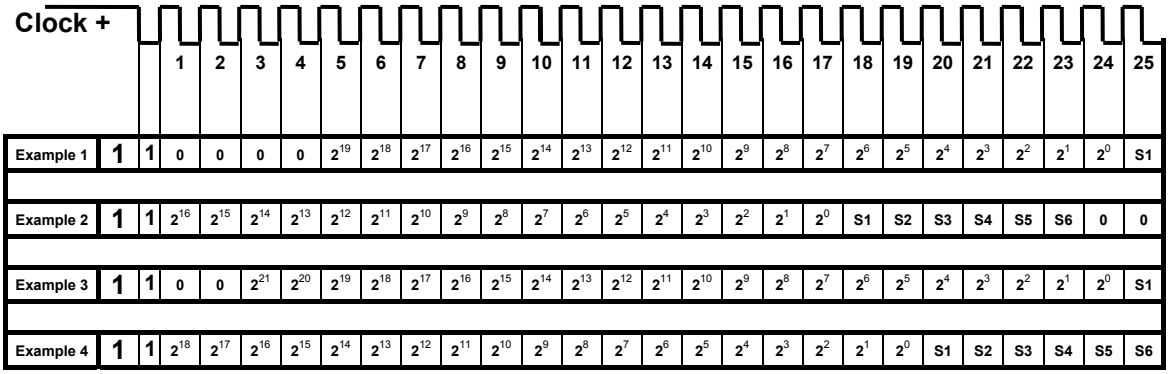
The special bits 7 and 8 are available as parallel outputs, but must be connected at the connector!

S = Special bit

2.1.4 Output-Format " Left adjusted "

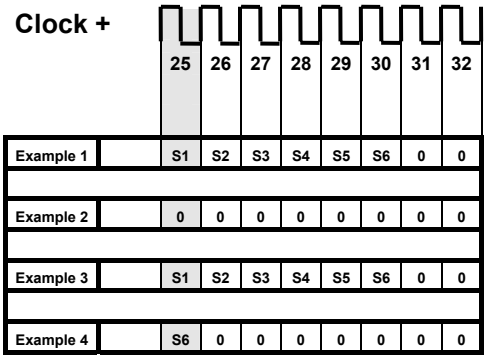
Synchronous serial data without tree-format consist of at least 16 bits and eight programmable special bits (in case of encoders with the programming possibility "With Repetition", six). It exists the possibility to displace these data as desired within the 32 clocks. The data can be transmitted right-justified or left-justified, with leading "zeros" and without leading "zeros". Leading "zeros" are created if the number of the position bits is programmed larger, as it would be necessary from the encoder. After the position bits, the eight special bits (or six) which can be programmed by the customer with different options are following.

Diagram: 4 examples of synchronous serial data outputs without Tree-Format



			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Example 1	1	1	0	0	0	0	2^{19}	2^{18}	2^{17}	2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	S1
Example 2	1	1	2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	S1	S2	S3	S4	S5	S6	0	0
Example 3	1	1	0	0	2^{21}	2^{20}	2^{19}	2^{18}	2^{17}	2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	S1
Example 4	1	1	2^{18}	2^{17}	2^{16}	2^{15}	2^{14}	2^{13}	2^{12}	2^{11}	2^{10}	2^{9}	2^{8}	2^{7}	2^{6}	2^{5}	2^{4}	2^{3}	2^{2}	2^{1}	2^{0}	S1	S2	S3	S4	S5	S6

Continuation clock 26



	25	26	27	28	29	30	31	32
Example 1	S1	S2	S3	S4	S5	S6	0	0
Example 2	0	0	0	0	0	0	0	0
Example 3	S1	S2	S3	S4	S5	S6	0	0
Example 4	S6	0	0	0	0	0	0	0

Note:

The special bits 7 and 8 are available as parallel outputs, but must be connected at the connector!

S = Special bit

Example 1: Encoder with 20 data bits

	- 1024	Revolutions	x	1024	Steps per Revolution
or	- 256	Revolutions	x	4096	Steps per Revolution
or	- 4096	Revolutions	x	256	Steps per Revolution
or	- 512	Revolutions	x	2048	Steps per Revolution
or	- 2048	Revolutions	x	512	Steps per Revolution

Number of leading "zeros" 4, Number of the position bits to be programmed 24, Number of the special bits to be programmed 6

Example 2: Encoder with 17 data bits

	- 128	Revolutions	x	1024	Steps per Revolution
or	- 256	Revolutions	x	512	Steps per Revolution
or	- 512	Revolutions	x	256	Steps per Revolution
or	- 32	Revolutions	x	4096	Steps per Revolution
or	- 64	Revolutions	x	2048	Steps per Revolution

Number of leading "zeros" none, Number of the position bits to be programmed 17, Number of the special bits to be programmed 6

Example 3: Encoder with 22 data bits

	- 2048	Revolutions	x	2048	Steps per Revolution
or	- 1024	Revolutions	x	4096	Steps per Revolution
or	- 4096	Revolutions	x	1024	Steps per Revolution

Number of leading "zeros" 2, Number of the position bits to be programmed 24, Number of the special bits to be programmed 6

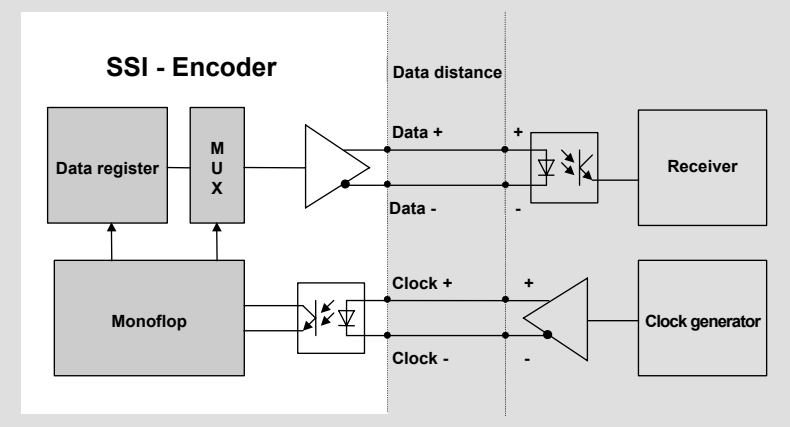
Example 4: Encoder with 19 data bits

	- 512	Revolutions	x	1024	Steps per Revolution
or	- 1024	Revolutions	x	512	Steps per Revolution
or	- 128	Revolutions	x	4096	Steps per Revolution
or	- 4096	Revolutions	x	128	Steps per Revolution
or	- 256	Revolutions	x	2048	Steps per Revolution

Number of leading "zeros" none, Number of the position bits to be programmed 19, Number of the special bits to be programmed 6

2.2 Linear Encoder (LA, LP, Laser)

Functional diagram



2.2.1 Output-Format "Standard"

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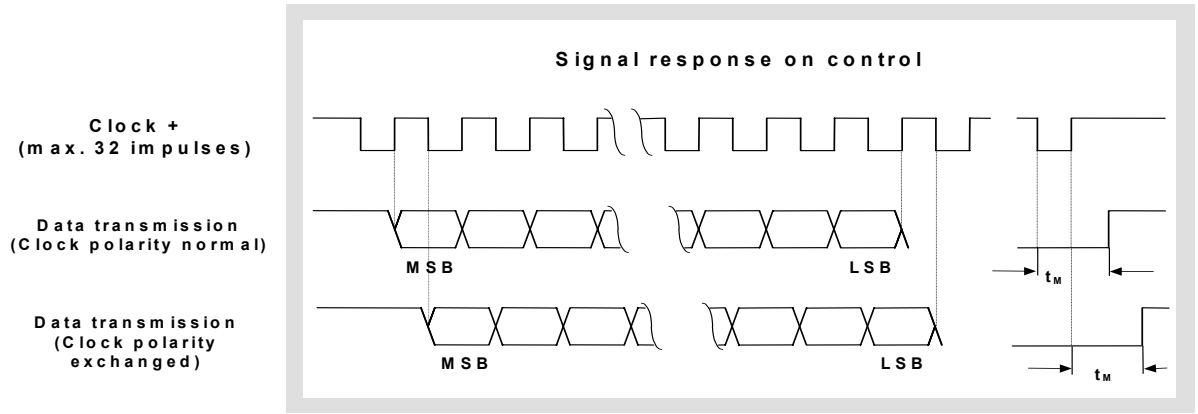
When the clock sequence is over, the system keeps the data lines at 0V (Low) for the duration of the mono period, $\mathbf{t_M}$. Time $\mathbf{t_M}$ is set to 20 µs and it determines the lowest transfer frequency of approximately 80 kHz. The upper limit frequency results from the total of all the signal propagation delays and is limited additional by the built-in filter circuits to approx. 820 kHz.



The inverted signals Data- and Clock- are not represented.

2.2.2 Output-Format "Multiple" (26 bit repetition), optional

By a multiple transmission of the same data string via the SSI-interface it is possible to detect transmission errors. At the multiple transmission, 25 bits are transmitted per data string in the standard format. After the first transmission, clock 26 controls the data repetition.
If the clock 26 follows after a time (t1) which is < 20 µs, the same data string is transmitted with the following clocks again.
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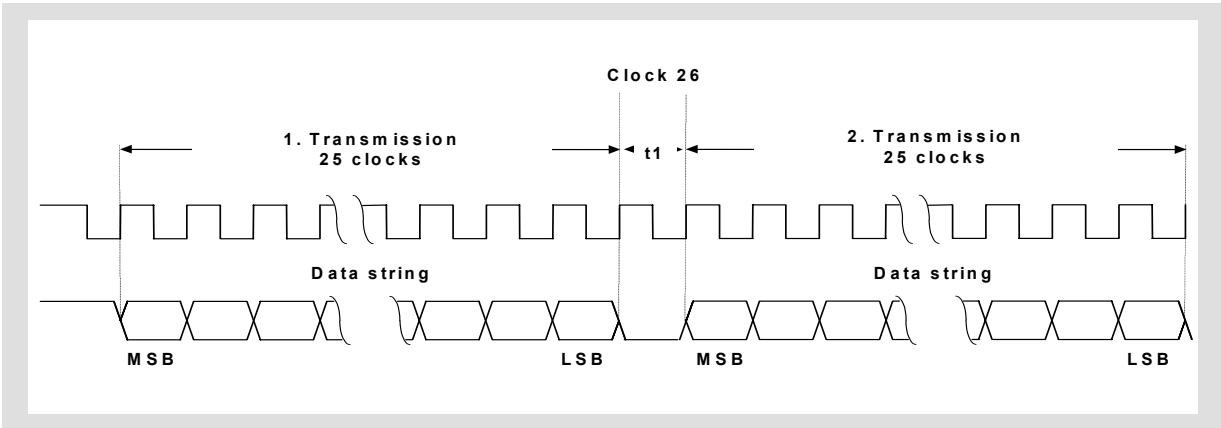


2.2.3 Output-Format " Left adjusted "

Synchronous serial data without tree-format consist of at least 16 bits and eight programmable special bits (in case of encoders with the programming possibility "With Repetition", six). It exists the possibility to displace these data as desired within the 32 clocks. The data can be transmitted right-justified or left-justified, with leading "zeros" and without leading "zeros". Leading "zeros" are created when the number of the position bits is programmed larger, as it would be necessary from the encoder. After the position bits, the eight special bits (or six) which can be programmed by the customer with different options are following.

i ***Note***

LSB bit 2^0 is always found at the 25th positive clock pulse edge (referring to clock+). The required number of bits depends on the "Measurement Range" in mm and the "Resolution" per mm.

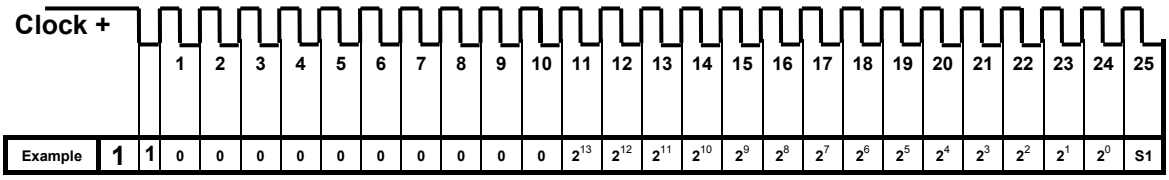
Example

Measurement range = 1000 mm, Resolution = 0,1 mm

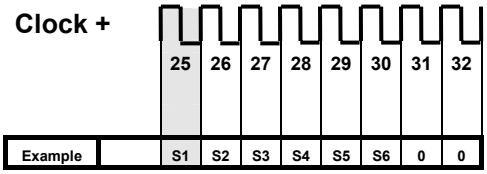
Total number of the measuring steps = measurement range / Resolution
= 1000 mm / 0,1 mm
= 10 000 measuring steps

To be able to carry out the output of 10 000 measuring steps, 14 bits are required.

Diagram



Continuation clock 26



Note:

The special bits 7 and 8 are available as parallel outputs, but must be connected at the connector!

S = Special bit

Number of leading "zeros" 10, Number of the position bits to be programmed 14, Number of the special bits to be programmed 6