PU10

Operating Manual
SSI / Parallel - Converter

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Please keep for further use!

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Revision History

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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, there may be different revision statuses within the document.

Drawings that are in the appendix have their own revision history.

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1 Safety

1.1 General Potential for Danger

The 32nd output (X4 pin 16) can be assigned with an error bit that signals errors of the output drivers; if checksum monitoring is activated, it also signals checksum errors.

Refer to the chapter entitled Checksum Monitoring on page 2-8.
the chapter entitled Fault Output on page 2-9
the chapter entitled Level Selection of Fault Output on page 2-10

If you use the cassette in conjunction with a programmable TR Encoder (Compact Encoder, CE), it is possible to integrate different signal bits in the SSI transfer protocol. Additional functions such as self-monitoring, detection of standstill and direction of rotation, speed control and end switches are provided by means of these signal bits.
Otherwise the cassette provides no diagnostics for errors that may occur, such as encoder speed too high, track errors, etc. This means that you must check the received data yourself for validity.

All the persons who are involved in the assembly, commissioning and operation of the device

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

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

1.2 Safety Information

This operating manual contains information that you must comply with to ensure your personal safety and to avoid damage to property. The information is emphasized by warning triangles, which have different appearances to match the level of danger:

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

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

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

1.2.1 Installation information

Due to the fact that the axis cassette is normally used as a component part of a larger system, this information is intended to provide a guideline for safe installation of the axis cassette in its environment.

Warning

- Observe the safety and accident prevention regulations that apply 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 a fuse in the system and connect the equipment to a protective earth.

- Before commissioning devices that are run with mains voltage, check whether the set rated voltage range matches the local mains voltage.

- With a 24-V supply, ensure safe electrical isolation of the extra-low voltage. Use only mains units that comply with IEC 364-4-41 or HD 384.04.41 (VDE 0100 Part 410) standards.

- Fluctuations in 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, following voltage dips and failures, it is possible to restart an interrupted program in an orderly manner. 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 such that inductive and capacitive interference does not adversely affect the automation functions.

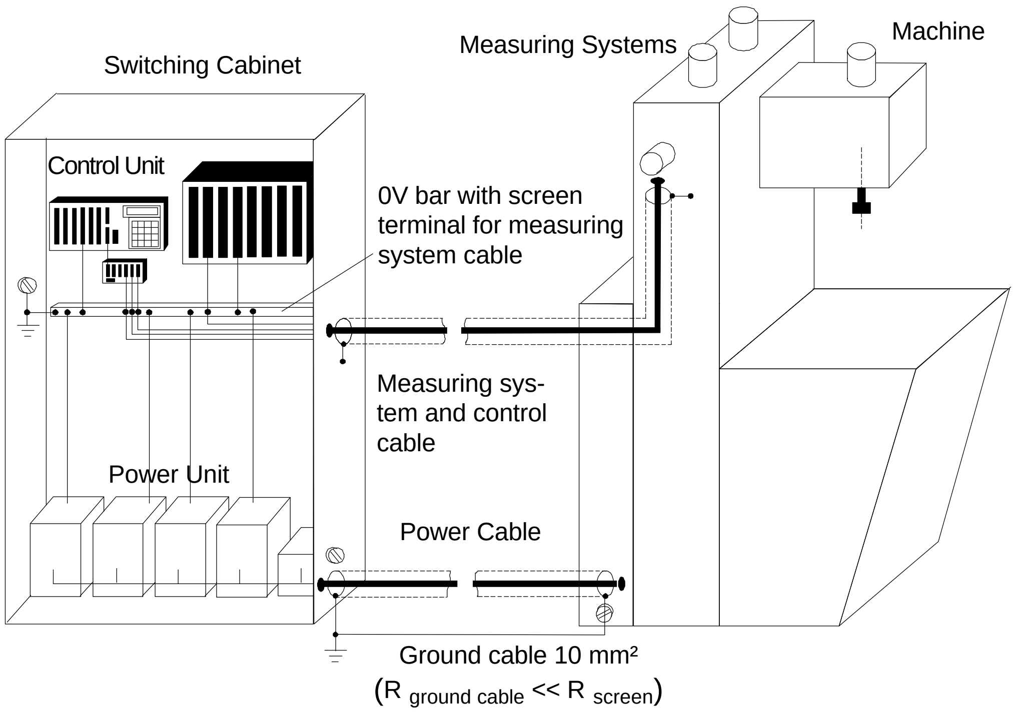
- Install automation technology equipment and its operator input elements such that they are sufficiently protected against being operated by mistake.

- Take appropriate hardware and software measures 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 makes it crucial to enforce a consistent and correctly executed interference suppression and wiring concept.
These conditions are the only guarantee that systems containing electronic measuring systems will function properly.

Recommended Screened Cable Wiring



1.2.1.2 Measures for Interference Suppression

- Feed the connecting line to the axis cassette at a large distance, or separately, from power lines carrying interference.
- Use only completely screened lines for data transfer and ensure they are well earthed. In the case of differential data transfer, (RS422, RS485, etc.), you must additionally use twisted-pair lines.
- 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. In this context, you should ensure that the ground cable's resistance is much lower than the screen's resistance.
- 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.

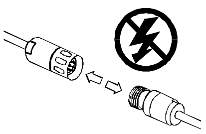
1.3 Appropriate Use

The PU10 axis cassette is for converting synchronous serial data to parallel data and it can therefore only be used in conjunction with encoders which transfer the data via SSI. Since the cassette does not itself manage any programming, such as scaling, direction of counting, etc., the encoder must condition the measuring data, if necessary. Programmable TR encoders are used for programming the zero point, the resolution and the measuring length and for adapting the system to the user's interfaces. In addition, they provide supplementary functions by means of their signal bits. They are parameterized using the **EPROG** PC software.

The PU10 axis cassette as supplied is configured as follows:

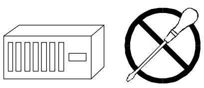
Encoder Interface:	SSI
Inputs:	Bus Latch
Outputs:	32-bit parallel (32 data bits or 31 data bits and 1 error bit)
Programming Interface:	EPROG

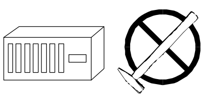
Warning



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

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





For safety reasons, mechanical or electrical changes to the axis cassette or to the measuring systems ***are prohibited!***

Note
Always keep to the commissioning and operating instructions specified in this manual.

1.4 Danger Due to Particular Types of Use

Caution
A current that is too high will destroy the axis cassette!

- A maximum current of 800 mA may be taken from the cassette's power supply (encoder connector). If the current is above 800 mA, the encoder must be fed from a separate supply.

- Encoders that have built-in heating must also be supplied separately.

1.5 Danger Due to Accessories

Caution
Mating connectors that are not plugged in correctly can lead to a cassette malfunction!

- Tightly screw the mating connector to its intended connector.

1.6 Authorized Operators

This/a device may only be commissioned by qualified personnel. In the context of the safety-specific information in this document, qualified personnel are considered to be persons who are authorized to commission, ground and mark circuits, equipment and systems in accordance with recognized safety standards.

1.7 Safety Measures at the Place of Assembly

Warning

Do not carry out welding if the axis cassette has already been wired-up or is switched-on!
Potential fluctuations can destroy the axis cassette or adversely affect its function.

Do not touch connector contacts with your hands!
Static charges could destroy the electronic components in the axis cassette.

Inputs that are not being used may not be connected (refer to the pin assignments)

Keep to the supply voltage range: 11-29 V DC (including residual ripple)

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Note
Ensure that the area around the place of assembly is protected from aggressive media (acid, etc.).

1.8 Protective Devices

The most significant bit of the 32 parallel outputs (O31/Error) can be assigned an error bit. For this, you must set DIP switch 14 to ON.

The errors listed below, which are logically ORed with one another, are possible for signalling at this output:

- Checksum error (assuming checksum monitoring is activated; only possible when using TR Electronic encoders with an SSI format of 64 data bits + a 15-bit checksum)
- At least one driver output is short-circuited
- At least one driver output is in the (100-mA) current limitation
- At least one driver has overtemperature

Refer to the chapter entitled Checksum Monitoring on page 2-8.
the chapter entitled Fault Output on page 2-9
the chapter entitled Level Selection of Fault Output on page 2-10

Warning
As soon as the system signals an error by means of a level for "not OK“ at the fault output, you must ensure that appropriate measures are taken to prevent injuries to people or damage to property, e.g. stopping the appropriate axis or system.
If necessary, you must force an **EMERGENCY STOP.**

2 Transportation/Commissioning

2.1 Transportation/Storage

Transportation Information

Do not drop axis cassettes or subject them to excessive jolting!
The device contains sensitive electronic components.

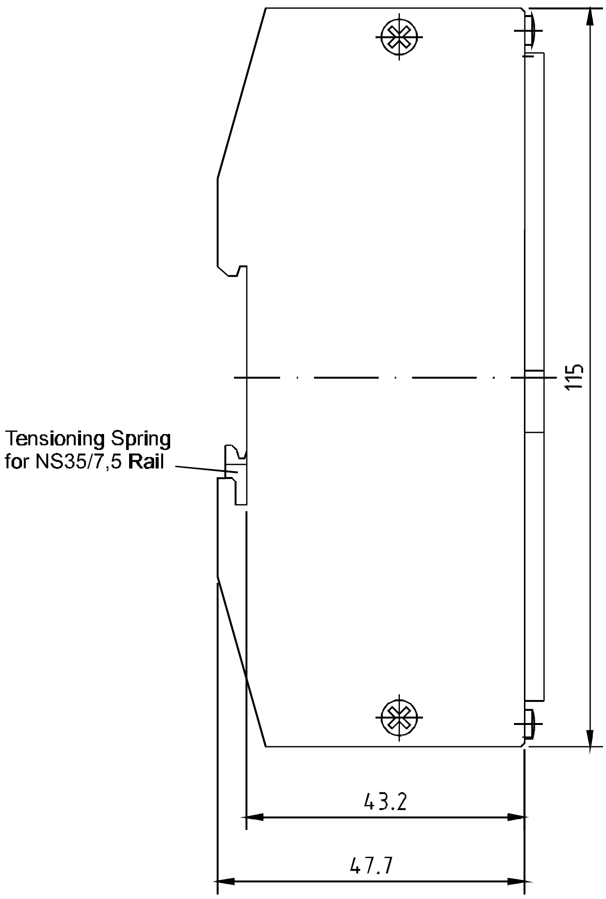
Use only the original packaging material!
Incorrect packaging material can cause damage to the device in transit.

Storage

- Storage temperature: -30 to +80°C
- Store in a cool place.

2.2 Assembly

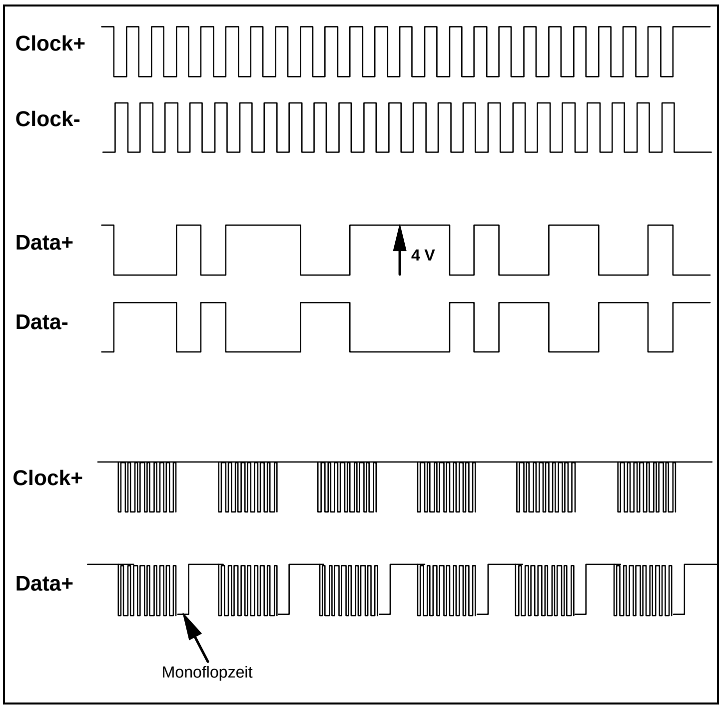
The axis cassette is intended for assembly on a mounting rail (NS35/7,5) in the switching cabinet.
You do not need any additional tools to snap home the axis cassette on the mounting rail.



2.3 Commissioning (Rotary Encoder)

2.3.1 Encoder Interface

The PU10 axis cassette can only be used in conjunction with encoders which transfer data via SSI.
The SSI procedure is a synchronous serial transmission procedure for the encoder data. It has become the virtual standard for absolute value encoders. Using the RS422 interface for transmission, it is possible to achieve sufficiently high transmission rates. In master mode (generating its own clock pulse), the cassette runs optionally at 250 kHz or 125 kHz. In monitoring mode, a controller supplies the clock pulse to the cassette and the frequency must be in the range between 80 kHz and 1 MHz.
During transmission, pulse groups are transmitted on the clock lines to the encoder. With each pulse that arrives, the encoder transmits its information contained in a shift register bit-by-bit on the data lines to the cassette, starting with the most significant bit. The last data bit is followed by zero bits only. During the break between the bundles, high bits are transferred. The break is identified by means of a retriggerable monoflop. A new bundle may not start until this has taken place.
In the example shown below, the receiver reads the value 001 0111 0011 1101 0011 0010 (173D32 hexadecimal) as the encoder position.



The clock pulses and data are differentially transmitted by means of cable transmitters with TTL levels and received by means of optocouplers to protect them from damage resulting from interference, potential differences, or polarity reversal.

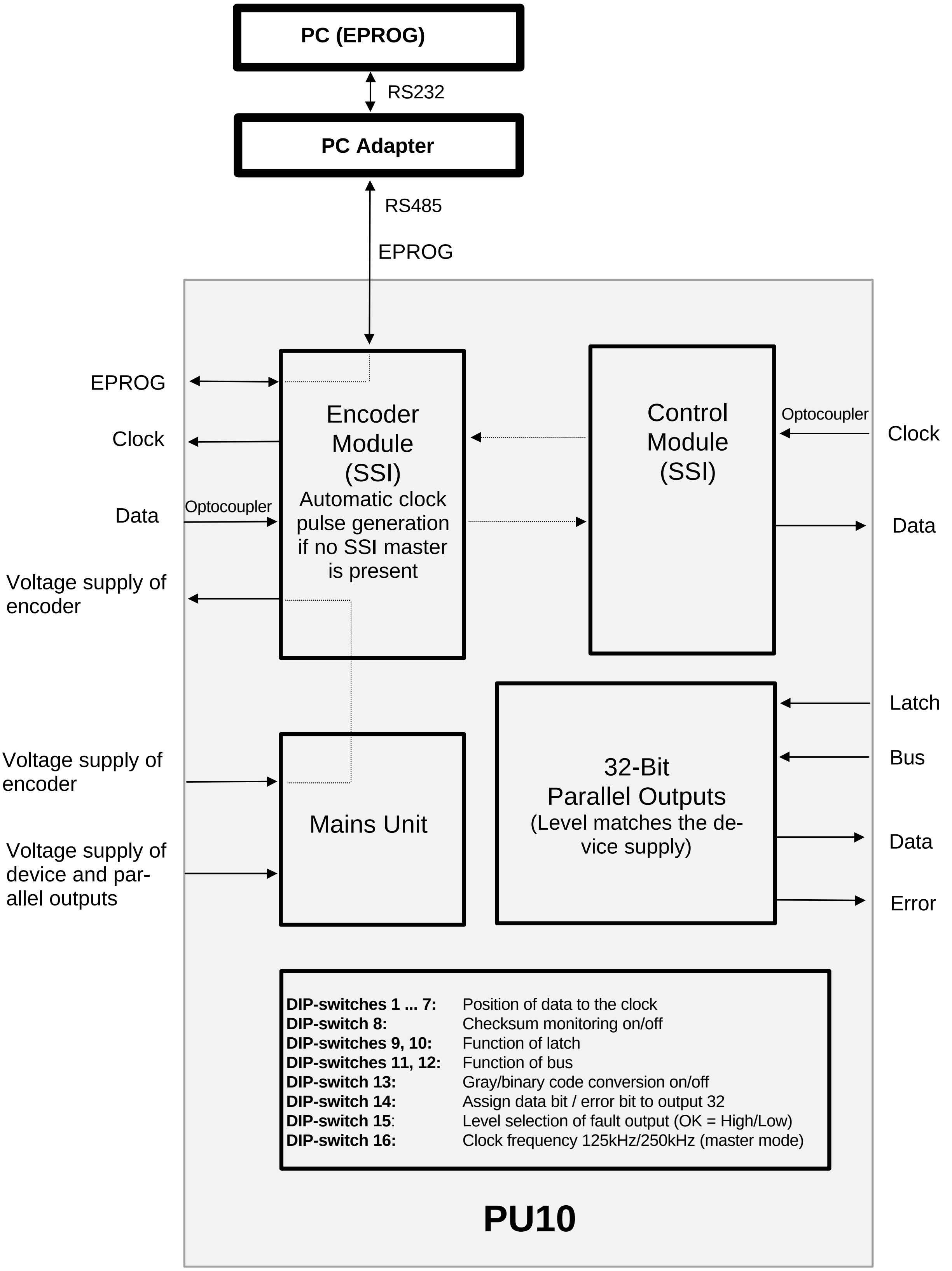
2.4 Function

The PU10 unit is for converting synchronous serial data to parallel data.

In the encoder, you can set whether position values, cam or status outputs such as up, down, overspeed, etc. are to be output via the serial port. Apart from this, the encoder manages programming steps, e.g. scaling or switching over the direction of rotation and preprocesses the measuring data. It is programmed via the EPROG parameterization interface and permanently stores the data.

The name EPROG is an acronym of **E**ncoder **Prog**ramming.
(for more information, refer to the Chapter entitled EPROG Programming Interface on page 2-6)

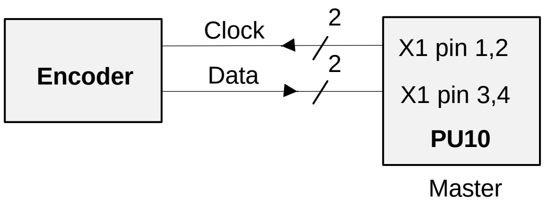
2.5 Block Diagram



2.6 Connection Variants

2.6.1 Master Mode

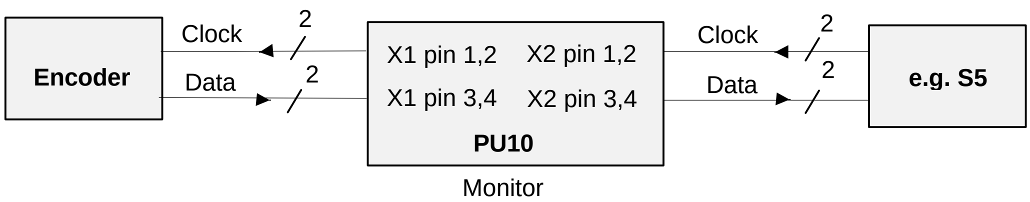
Master mode means that the PU10 SSI parallel converter generates the clock pulse *itself:* If no clock pulse is detected at pin 1 and pin 2 on connector X2, the PU10 automatically generates its own clock pulse and outputs it to pin 1 and pin 2 on connector X1. The clock frequency is either 250 kHz or 125 kHz.



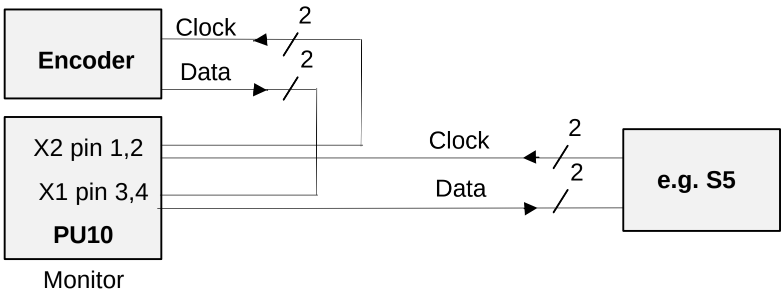
2.6.2 Monitor Mode

In monitor mode, the PU10 detects and uses a fed-in clock pulse and *does not* generate a clock pulse itself.

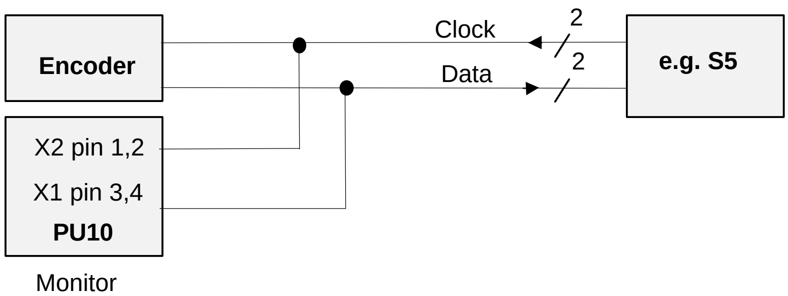
One Wire Per Terminal, Series-Connected
The disadvantage of this switching variant is that the signal propagation delay is slightly increased. With lines that are less than 50 metres long, this is of no consequence whatsoever.



Two Wires Per Terminal, Parallel-Connected



One Wire Per Terminal, Parallel-Connected via Additional Distribution Terminals



2.7 SSI Clock Frequency and Line Lengths

The relationship listed below exists between the line length and the maximum allowed SSI clock pulse frequency; this relationship was determined experimentally for 2 × 0.25 mm² twisted pair cables with 70 Ω/km, 80 pF/m.

Line length up to	Maximum allowed SSI clock pulse frequency
12.5 m	819 kHz
25 m	756 kHz
50 m	578 kHz
100 m	364 kHz
200 m	228 kHz
300 m	163 kHz
400 m	127 kHz
500 m	105 kHz

2.8 Functions

2.8.1 EPROG Programming Interface

The name EPROG is derived from **E**ncoder **Prog**ramming. It is a PC program that runs under MS-DOS and is used for parameterizing the encoder. The software runs in conjunction with an adapter that converts the PC's RS232 port to the RS485 interface that the encoder needs. We chose the RS485 interface because it only needs one pair of cables and can transfer data disturbance-free for several hundred metres at a maximum baud rate of 115,200 bps. At the same time, the PC adapter is for potential separation.

The 15-pin SUB-D female connector (X5) on the PU10 is the plug connection to the PC adapter and replaces the cubicle module that is normally present.

Under EPROG, you can program all the encoder's parameters, including, for example, the direction of rotation, scaling, selection of data in synchronous-serial data transfer, etc.
Additionally, archiving the data is carried out using the EPROG program.
For a more detailed description, refer to the separate EPROG operating instructions. (Document No. refer to the Chapter entitled Accessories on page 4-2)

2.8.2 Electrical Isolation

If necessary, the encoder can be run electrically isolated from the encoder. To do this, use separate terminals for the encoder and the PU10 supply. The encoder's power supply is only looped-through from X2 to X1, i.e. the converter does not use it. In addition, the input circuit (data) is in the form of an optocoupler. TR-Electronic encoders also have an optocoupler on the input (clock) side. If electrical isolation is not necessary, the encoder's voltage supply at X2 can be jumpered to the converter's voltage supply.

Electrical isolation towards the control can only be achieved if the control's SSI data and parallel inputs are read-in via an optocoupler. The PU10's clock input (on the control side) is already fitted with an optocoupler.

If you are not operating with electrical isolation on the control side opposite the PU10 converter, the control and the PU10 must either be fed by the same mains unit, or with separate mains units, both grounds must be connected to each other.

The levels of the parallel outputs is virtually the same as the device supply (less the threshold voltage of a reverse voltage protection diode and the saturation voltage of the output driver stage).

2.8.3 DIP Switches

Changing the DIP switches on the front panel has an **immediate** effect. The following functions are assigned:

DIP switch 1	LSB	Position of the data to the clock pulse, i.e. the number of clock pulses after which the serial data is latched (Binary-coded: OFF=0, ON=1) (DIP switches 1–7)
DIP switch 2		
DIP switch 3		
DIP switch 4		
DIP switch 5		
DIP switch 6		
DIP switch 7	MSB	
DIP switch 8	Checksum monitoring: OFF / ON (! latch function on error !)	
DIP switch 9	Latch function (if DIL10=ON):	OFF=latch on free or 0V ON=latch on US
DIP switch 10	Latch function: OFF=never latch, ON=latch enabled	
DIP switch 11	Bus function (if DIL12=ON):	OFF=tristate on free or 0V ON=tristate on US
DIP switch 12	Bus function: OFF=never tristate, ON=tristate enabled	
DIP switch 13	Gray/binary code conversion: OFF / ON	
DIP switch 14	Output 32 assigned with: OFF=data bit, ON=fault output	
DIP switch 15	Level of fault output: OFF=High for OK, ON=Low for OK	
DIP switch 16	Clock frequency / Mono time:	OFF=250 kHz (mono time / 2) ON=125 kHz (full mono time)

2.8.3.1 Position of the Data to the Clock Pulse

Using DIP switches, you specify with a binary number the number of clock pulses after which the data that is arriving serially is to be latched or retained. If, for example, you wanted 24 data bits and the least significant bit at output 1, you would set 24:

DIP switch	Value	Setting
1	1	OFF
2	2	OFF
3	4	OFF
4	8	ON
5	16	ON
6	32	OFF
7	64	OFF

2.8.3.2 Checksum Monitoring

DIP switch 8 = **OFF:** **No** checksum monitoring
DIP switch 8 = **ON:** Checksum monitoring **active**

You need TR encoders with an SSI format of 64 data bits + a 15-bit checksum for checksum monitoring. This is an SSI protocol with a Hamming distance of 6, i.e. up to five errors per code word will always be detected, regardless of how they are distributed. Since the code in question is cyclical, the system also definitely detects error bundles of 15 bits in length, e.g. up to 15 directly consecutive errors.
Since only code words with even-numbered weighting occur, the system additionally detects all error patterns with odd-numbered weighting (parity errors). In the case of SSI frames with checksum errors, the last value that was output remains pending at the parallel outputs (is latched), i.e. invalid data is not transferred to the parallel outputs.
After four checksum errors in a row, the system signals an error for one second by means of a level for "not OK“ (assuming the 32nd output is selected as the fault output) even if all the other frames were OK. If there are more faulty frame groups during the same second, the ongoing second is post-triggered and as a result the fault output stays at the level for error.

2.8.3.3 Latch Function of the Parallel Outputs

The latch input switches at 8 V and above. A maximum of 50 V is allowed. The input impedance is 10 kΩ.
The latch input is connected to X2, pin 5.

DIP switch 9	DIP switch 10	Latch Response
OFF	OFF	Never latch
ON	OFF	Never latch
OFF	ON	Latch on 0V or free
ON	ON	Latch on US

2.8.3.4 Bus Function of the Parallel Outputs

The bus input switches at 8 V and above. A maximum of 50 V is allowed. The input impedance is 10 kΩ.
The bus input is connected to X2, pin 6.

DIP switch 11	DIP switch 12	Bus Response
OFF	OFF	Never tristate
ON	OFF	Never tristate
OFF	ON	Tristate on 0V or free
ON	ON	Tristate on US

2.8.3.5 Gray/Binary Code Conversion

The system can process incoming data in two ways: data entering serially can be picked off in-parallel in unchanged code; Gray code entering serially can, if desired, be converted to binary.

Note: Binary data entering serially can **not** be converted to Gray code.

You activate Gray/binary code conversion for parallel data using DIP switch 13:

DIP switch 13 = **OFF** : **No** code conversion
DIP switch 13 = **ON** : Gray/binary code conversion **active**

2.8.3.6 Fault Output

You use DIP switch 14 to assign the 32nd output (X4, pin 16) with either a data bit **or** an error bit.

DIP switch 14 = **ON:** 32nd output is assigned with an **error bit.**
Example: Low level for everything OK, High level for error.
Note: You can use DIP switch 15 to choose the (Low/High) level.
The following errors are possible:
- Checksum error (assuming checksum monitoring is activated)
- At least one driver output is short-circuited
- At least one driver output is in the (100-mA) current limitation
- At least one driver has overtemperature

If there are four checksum errors in a row, the system signals an error for one second by means of the level for "not OK" (assuming the 32nd output is selected as the fault output) even if all the other frames were OK. If there are more faulty frame groups during the same second, the ongoing second is post-triggered and as a result the fault output stays on level for error.

If only one data output is short-circuited, for example, the fault output switches in time with the short-circuited track.
Note: All the possible error messages are logically ORed with one another.

DIP switch 14 = **OFF:** 32nd output is assigned with an **MSB data bit.**

2.8.3.7 Level Selection of Fault Output

Assuming that you programmed the 32nd parallel output as the fault output, it is also possible to select the level of the fault output (fault bit):

DIP switch 15 = **OFF:** **High** for everything OK
DIP switch 15 = **ON:** **Low** for everything OK

The reason for High for everything OK is that it allows monitoring for a possible wire break.

2.8.3.8 Clock Frequency

a) **Monitor mode:** The PU10 is switched with the clock and data lines either between the control supplying the clock pulse and the encoder, **or** parallel to the encoder. For reasons of terminal technology – only one wire is needed per terminal – the first variant is advisable in the case of line lengths below 50 metres per SSI interface. For each clock pulse bundle, at least the same number of clock pulses are needed as the desired number of parallel data. With DIL16 = OFF, the clock-pulse space must be 12 µs and with DIL16 = ON it must be 24 µs.

DIP switch 16 = **OFF:** Mono time 12 µs
DIP switch 16 = **ON:** Mono time 24 µs

Note: In monitor mode, the internally generated clock frequency is not needed; however, DIP switch 16 can be used to select the mono time. With devices that evaluate the encoder's mono time to immediately start a new bundle of pulses, the PU10's mono time must always be shorter than the encoder's.
As standard, all TR-Electronic SSI encoders have a 24-µs mono time, i.e. in monitor mode with the devices mentioned above (e.g. the TR-Systemtechnik IBX50) the PU10 **must** be set to 12 µs.

b) **Master mode:** In this operating mode, no controller is available for generating the clock pulse and evaluating the data. The PU10 generates the clock pulse itself and converts the received data in a parallel way. Clock generation is carried out automatically if no clock pulse is stored in the PU10. The system periodically transmits 81 clock pulses and a 17 clock pulse-long space. Using DIP switch 16, you can switch the clock frequency between 125 kHz and 250 kHz.

DIP switch 16 = **OFF:** clock frequency 250 kHz, mono time 12 µs
DIP switch 16 = **ON:** clock frequency 125 kHz, mono time 24 µs

3 Disturbances

If the 32nd output (X4 Pin 16) is assigned with the error bit, the system may signal a detected error with the level for "not OK".

3.1 Causes of Faults and Remedies

Disturbance	Cause	Remedy
The level for "not OK" is at the fault output	Checksum error	You need a TR encoder with an SSI format of 64 data bits + a 15-bit checksum for checksum monitoring. → If the fault keeps occurring with the special encoder, you must replace the encoder. → If you are using a different SSI encoder, you must deactivate checksum monitoring.
	Electrical disturbances	Use twisted-pair cables for data and supply. The cable screens should be grounded on both ends. You should only ground the screen on one end in the switching cabinet if the machine ground has more disturbances compared to the switching cabinet ground.
	Encoder lines wired wrong	Check all the cabling and wiring used for connecting the encoder.
	Loose contacts in the wiring	Check all the cabling and wiring used for connecting the encoder.
	At least one driver output is short-circuited	Check all the connections, lines and output loads that are connected to the wiring of the parallel outputs and remove the short-circuit, if necessary.
	At least one driver output is in the (100-mA) current limitation	Check all the connections, lines and output loads that are connected to the wiring of the parallel outputs and if necessary make a higher-resistance output load.
	At least one driver has overtemperature	→ Reduce the ambient temperature → Reduce the current

4 Appendix

4.1 Technical data

Voltage Supply	11 ... 29 V DC (incl. residual ripple)
Current Consumption	Approx. 50 mA (idling, i.e. with no output loading)
Encoder Module	SSI
Clock output	RS422 (two-wire)
Clock frequency	80 kHz ... 1 MHz
Data input	Optocoupler
Control Module	SSI
Clock input	Optocoupler
Clock frequency	80 kHz ... 1 MHz
Data output	RS422 (two-wire)
EPROG Connection	Connection for PC adapter (RS485) (parameterizing software for encoder)
Outputs	Parallel
32 bit	For the 32nd bit, choice of MSB data or fault output
Output code	Choice of equal to input code or binary if input code is Gray
Driver Type of Parallel Output	Push-pull, short-circuit-proof, 100 mA per output level approximately same as voltage supply
Inputs	Input impedance 10 kΩ
Bus, Latch	1-level > + 8 V, 0-level < + 2 V
Operating temperature range	0 to +60°C
Weight	430 g
Article Number	491-00002 → PU10 SSI/Parallel-Converter Standard Version

4.2 Accessories

62 220 012	Mating Connector Set comprising: 1 x 8-pin Type MINI-COMBICON 1 x 10-pin Type MINI-COMBICON 2 x 16-pin Type MINI-COMBICON
TR-E-BA-D-0011	Description (German): Operating Manual EPROG
TR-E-BA-GB-0011	Description (English): Operating Manual EPROG
490-00301	Equipment: PC Adapter
490-00404	3.5" floppy disk: EPROG program

4.3 General Instructions for Cabling

Power for the PU10 and encoder is supplied via the X2 connector. The X1 connector is for tapping the encoder power supply.
The connecting cables between the encoder and the X1 connector should be laid in a bunch to increase interference immunity. The best choice are three twisted-pair cables with the following assignments: SSI positive and negative clock pulses, SSI positive and negative data, US and 0V.

4.3.1 Plug Coding

Plug coding prevents you from accidentally mixing up mating connectors. Connectors are coded such that it is impossible to confuse them even if you are using other TR cassettes (e.g. AK40s) at the same time.

Explanation of Terms:

MINI-COMBICON:	Phoenix MINI-COMBICON connector 8A/125V, grid 3.81 mm
US:	Supply voltage of device and parallel outputs (11 ... 29 V)
US-E	Supply voltage of encoder (11 ... 29 V)
GND	0 V, Ground of device and parallel outputs
GND-E	0 V, Ground of encoder
US IN:	1-level > + 8 V, 0-level < + 2 V, up to ± 50 V, 10 kΩ
US OUT:	1-level > US - 2 V, 0-level < 1 V, up to 100 mA
TTL OUT:	1-level > + 2.0 V, 0-level < + 0.8 V, up to 40 mA
Opto:	Optocoupler for cable transmitter signal or TTL differential signal
PT-:	RS485 line for EPROG, in spaces to Low
PT+:	RS485 line for EPROG, in spaces to High