Parallel

Parallel data transmission

Technical Information

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TR-Electronic GmbH
D-78647 Trossingen
Eglishalde 6
Tel.: (0049) 07425/228-0
Fax: (0049) 07425/228-33
email: info@tr-electronic.de
www.tr-electronic.com

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Author:	MÜJ

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`Courier` font displays text, which is visible on the display or screen and software menu selections.

″ < > ″ indicates keys on your computer keyboard (such as <RETURN>).

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First release	20.02.01	00
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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 parallel interface different status bits can be transferred 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 interface 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.

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.

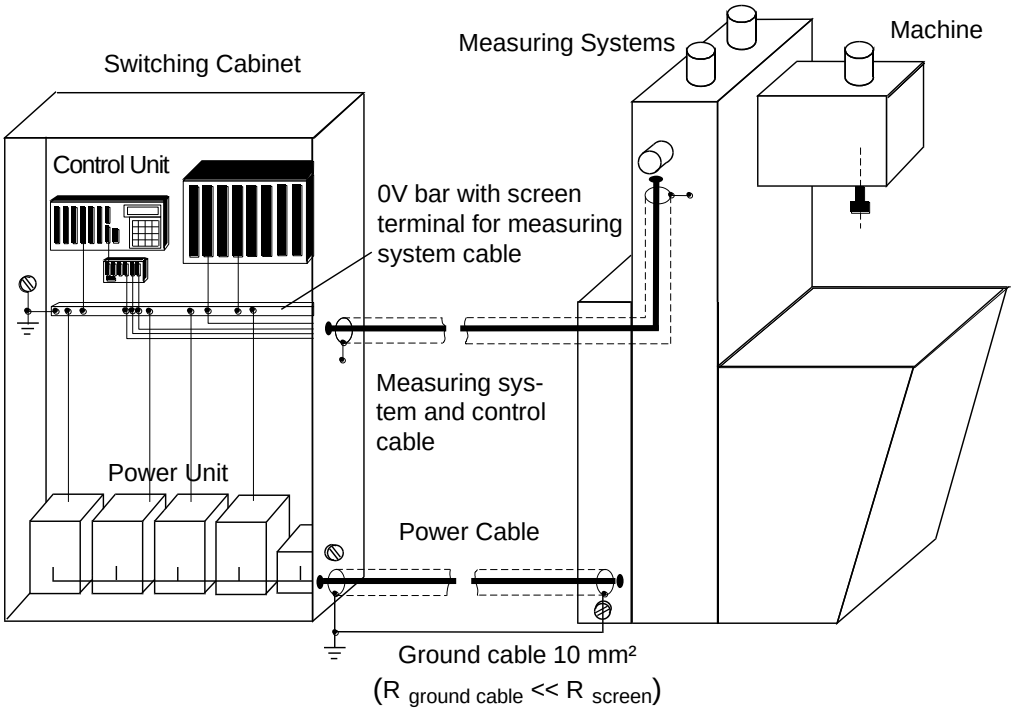
Warning

- 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 breakage's 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



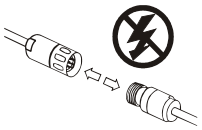
1.2.1.2 General interference suppression measures

- 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 current 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

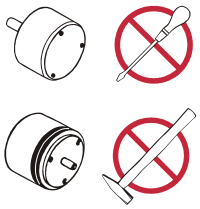
The parallel encoder are used for the electronic interception of a rotating or linear movement as well as for the preparation of measured data for a controller with a parallel interface connected on the load side.

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 Parallel - Interface

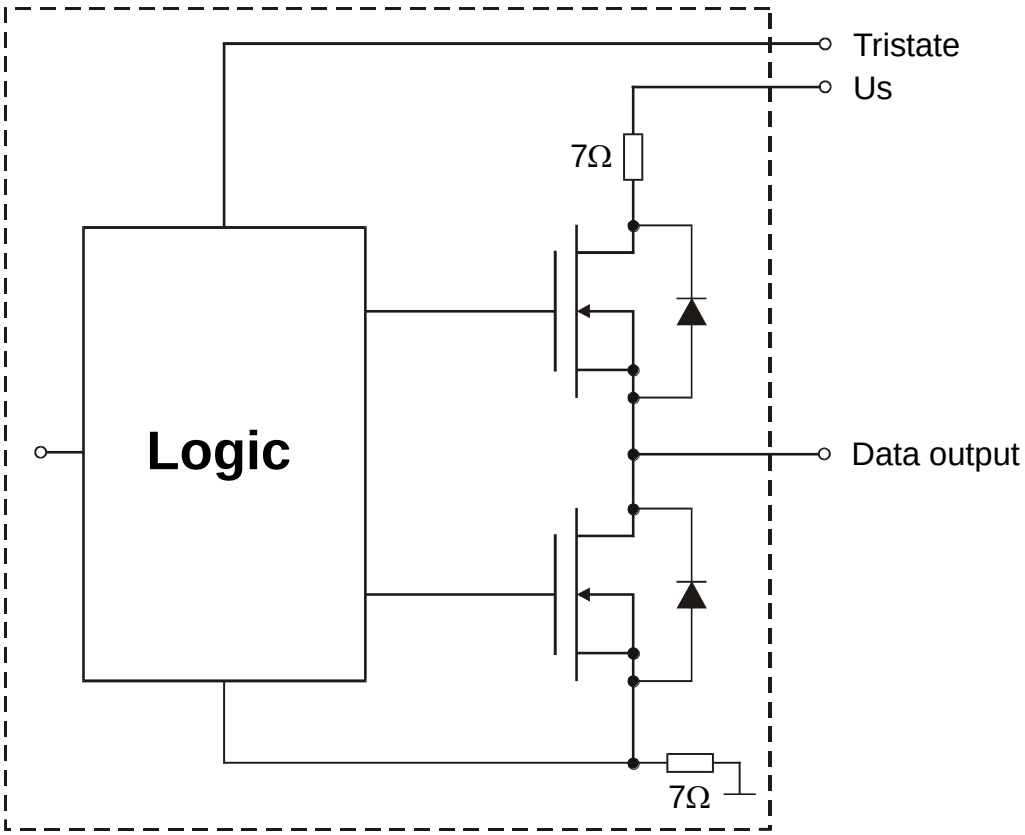
2.1 Description

The digital position value will transfer parallelly in the parallel interface. In this case, every signal bit has a separate physical line. In addition to the pure signal-lines, status -lines and control-lines exist, which activate special functions in the encoder or contain its output signals.

The transcription of the digital position value into a signal pattern can be realized according to different codes. The most essential codes are explained and itemized in this description.

The described signals refer to the at the moment available, maximum performance range. Among other things, the functions implemented in the encoder in actual fact are dependent from the encoder family and the chosen physical interface (number of possible lines, number of pins of the connector). Depending on expansion, some via signal-line accessible functions are also programmable. The represented input and output functions as well represent possibilities. The available functions are dependent on the encoder type. See the programming instructions and manuals of the respective devices to this.

2.1.1 Principle block circuit diagram Push-Pull



2.2 Control inputs

V/R

Absolute encoder
In the case of absolute encoders, the counting direction is defined as increasing with each clockwise rotation (in relation to the shaft). The V/R input can be used to reverse the counting direction while maintaining the same direction of rotation.

Linear-absolute position sensor
In the case of linear-absolute position sensors, the counting direction is defined as increasing as the position sensor moves towards the end of the rod. The V/R input can be used to reverse the counting direction while maintaining the same direction of rotation.

Latch

The latch input serves to "freeze" the output data, so that the application electronics reads a static value without edge transitions.

Preset

The preset input serves to set the position value at the outputs to the programmed preset value. This allows the measuring system to be electronically adjusted.

Bus

If several devices are operated in the data bus, the bus input can be used to transfer the relevant information of the data output to the bus line. This means, the output drivers are switched active or tristate.

PT+/PT-

Connection for programming terminal PT100N / PC adapter with PC software (e.g. EPROG) or TA-MINI display.

2.3 Control outputs

Going up, going down

This is a combination of direction indicator and zero-speed relay. The signal bit is set when the position moves in the relevant direction, and deleted once it has remained unchanged for 50 milliseconds.
The movement detector has a hysteresis for suppressing vibrations. This is one increment in relation to the resolution of the central wheel for hardware encoders (HE), and 2 mm for position sensors (LA). After a reversal of the rotational direction, a distance corresponding at least to the hysteresis must be traveled before a movement or change of direction is reported.

Gone up

This signal bit is set when "Going up" is set and deleted when "Going down" is set.
The movement detector has a hysteresis for suppressing vibrations. This is one increment in relation to the resolution of the central wheel for hardware encoders (HE), and 2 mm for position sensors (LA). After a reversal of the rotational direction, a distance corresponding at least to the hysteresis must be traveled before a movement or change of direction is reported.

Movement

This signal bit is set as long as either "Going up" or "Going down" is set.
The movement detector has a hysteresis for suppressing vibrations. This is one increment in relation to the resolution of the central wheel for hardware encoders (HE), and 2 mm for position sensors (LA). After a reversal of the rotational direction, a distance corresponding at least to the hysteresis must be traveled before a movement or change of direction is reported.

Static and dynamic error (watchdog)

As long as the position data can be measured and transferred without error, the signal bit "Static error" is deleted and the signal bit "Dynamic error" supplies a square-wave frequency of 250 Hz. In case of error, the "Static error" is set and the "Dynamic error" stops at an undefined level.
Where possible, the dynamic error should be used rather than the static error, as it increases the probability of detecting a faulty program sequence in the device.

Even parity, even error parity

Uneven parities are obtained by inversion.
The error parity corresponds exactly to the normal parity as long as there is no encoder error. In case of error, it is inverted. Its purpose is to save additional transmission of the encoder error.
The parity is calculated from the data bits only, i.e. either cams or positions with signs if applicable. All other bits are ignored.

Maximum speed

This signal bit is set if the set maximum speed is exceeded.

Overspeed

This signal bit is set if the set overspeed is exceeded.

Limit switch

The signal bit of a limit switch is set as long as the position is at or above the switch-on point and below the switch-off point.
The switch-off point must be higher than the switch-on point. If the opposite case is necessary, the two switching points must be reversed and the signal bit inverted.

Logical "0"

This signal bit is set to logical "0".

2^0 strobe

Siemens specification: with this method, the read-out is synchronized with the pos. and neg. edge of the 2^0 bit. In the case of multi-step codes (binary code), the 2^0 bit changes whenever any other bit is changed. When the 2^0 track changes, the data word is read out after a short delay. Incorrect values (pseudo-tetrades) are not possible. When this function is activated, the 2^0 bit switches from low to high approx. 5 to 10 times.
Since the 2^0 bit does not change (either "H" or "L") when the supply voltage is switched on and the shaft stationary, an initial data transfer would not normally be possible before the encoder shaft begins to move. For this reason, the 2^0 bit is allowed to jump four times (high, low, high, low) before switching on the encoder.

2.4 Codes

The code is a method of forming digital numbers. A code word is a bit pattern which expresses a numerical value. The code describes the assignment of values to code words.
In the case of multi-step codes, changing the numerical value by 1 results in a new code word which differs from the previous one in terms of several bits. In single-step codes, only one bit of the code word changes in this case.
In decade codes, four bits are grouped to form each decimal number.

The following codes are used:

Gray

As a single-step code, the Gray code can be transmitted parallel without synchronization and can be converted very easily to binary code.

To ensure a single-step transition from the lower to the upper range value, it is necessary to select clipped Gray code.

In clipped Gray code, the value range used, i.e. the measuring length in increments, is rounded up to the next highest 2^{nd} power. The value range is then set in the middle of this 2^{nd} power by adding half the difference between the 2^{nd} power and the value range before outputting the data. After decoding at the user end, this value must be subtracted again in order to obtain the actual position. Example: in clipped Gray code with 360 increments, half the difference equals $(2^9-360)/2=(512-360)/2=76$.
Clipped code is only possible when the lower range value is 0.

Gray code					
Decimal number	Significance				
	16	8	4	2	1
0	0	0	0	0	0
1	0	0	0	0	**1**
2	0	0	0	**1**	**1**
3	0	0	0	**1**	0
4	0	0	**1**	**1**	0
5	0	0	**1**	**1**	**1**
6	0	0	**1**	0	**1**
7	0	0	**1**	0	0
8	0	**1**	**1**	0	0
9	0	**1**	**1**	0	**1**
10	0	**1**	**1**	**1**	**1**
11	0	**1**	**1**	**1**	0
12	0	**1**	0	**1**	0
13	0	**1**	0	**1**	**1**
14	0	**1**	0	0	**1**
15	0	**1**	0	0	0
16	**1**	**1**	0	0	0
17	**1**	**1**	0	0	**1**
18	**1**	**1**	0	**1**	**1**
19	**1**	**1**	0	**1**	0
20	**1**	**1**	**1**	**1**	0

Binary

The binary code is a multi-step code which allows extremely simple switching circuits for arithmetical operations.

Binary code						
Decimal number	Significance					
	32	16	8	4	2	1
0	0	0	0	0	0	0
1	0	0	0	0	0	**1**
2	0	0	0	0	**1**	0
3	0	0	0	0	**1**	**1**
4	0	0	0	**1**	0	0
5	0	0	0	**1**	0	**1**
6	0	0	0	**1**	**1**	0
7	0	0	0	**1**	**1**	**1**
8	0	0	**1**	0	0	0
9	0	0	**1**	0	0	**1**
10	0	0	**1**	0	**1**	0
11	0	0	**1**	0	**1**	**1**
12	0	0	**1**	**1**	0	0
13	0	0	**1**	**1**	0	**1**
14	0	0	**1**	**1**	**1**	0
15	0	0	**1**	**1**	**1**	**1**
16	0	**1**	0	0	0	0
17	0	**1**	0	0	0	**1**
18	0	**1**	0	0	**1**	0
19	0	**1**	0	0	**1**	**1**
20	0	**1**	0	**1**	0	0

BCD

The BCD code is a multi-step decade code which allows extremely simple switching circuits for decimal displays.

BCD code (8-4-2-1)									
Decimal number	2nd decade					1st decade			
	8	4	2	1		8	4	2	1
0	0	0	0	0		0	0	0	0
1	0	0	0	0		0	0	0	**1**
2	0	0	0	0		0	0	**1**	0
3	0	0	0	0		0	0	**1**	**1**
4	0	0	0	0		0	**1**	0	0
5	0	0	0	0		0	**1**	0	**1**
6	0	0	0	0		0	**1**	**1**	0
7	0	0	0	0		0	**1**	**1**	**1**
8	0	0	0	0		**1**	0	0	0
9	0	0	0	0		**1**	0	0	**1**
10	0	0	0	**1**		0	0	0	0
11	0	0	0	**1**		0	0	0	**1**
12	0	0	0	**1**		0	0	**1**	0
13	0	0	0	**1**		0	0	**1**	**1**
14	0	0	0	**1**		0	**1**	0	0
15	0	0	0	**1**		0	**1**	0	**1**
16	0	0	0	**1**		0	**1**	**1**	0
17	0	0	0	**1**		0	**1**	**1**	**1**
18	0	0	0	**1**		**1**	0	0	0
19	0	0	0	**1**		**1**	0	0	**1**
20	0	0	**1**	0		0	0	0	0

Excess-3

Excess-3 is a decade code which, being a single-step code, can be transferred parallel without synchronization and can be converted to BCD code very easily.

To ensure a single-step transition from the lower to the upper range value, it is necessary to select clipped Gray excess-3 code.

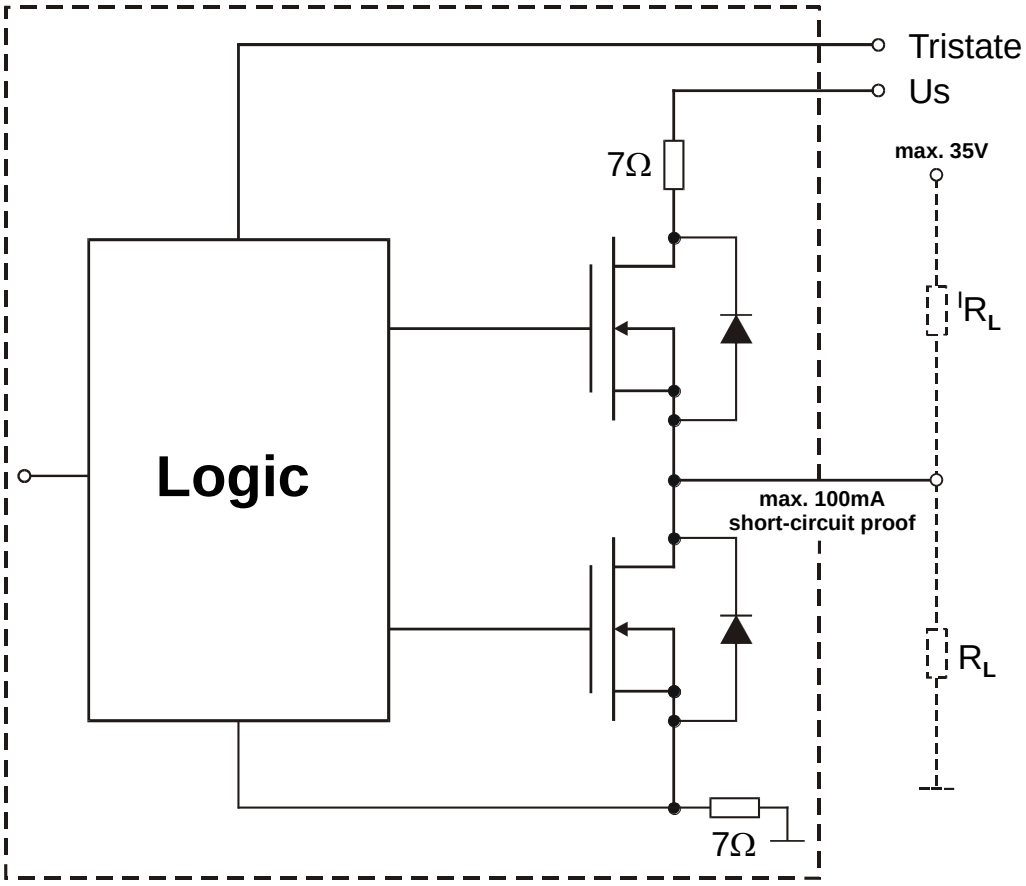
In clipped Gray excess-3 code, the value range used, i.e. the measuring length in increments, is rounded up to the next highest 10^{th} power. The value range is then set in the middle of this 10^{th} power by adding half the difference between the 10^{th} power and the value range before outputting the data. After decoding at the user end, this value must be subtracted again in order to obtain the actual position.
Example:
In clipped Gray excess-3 code with 720 increments, half the difference equals $(10^3\text{-}720)/2=(1000\text{-}720)/2=140$.

Clipped code is only possible if the lower range value is 0.

Excess-3 code									
Decimal number	2nd decade					1st decade			
	8	4	2	1		8	4	2	1
0	0	0	**1**	0		0	0	**1**	0
1	0	0	**1**	0		0	**1**	**1**	0
2	0	0	**1**	0		0	**1**	**1**	**1**
3	0	0	**1**	0		0	**1**	0	**1**
4	0	0	**1**	0		0	**1**	0	0
5	0	0	**1**	0		**1**	**1**	0	0
6	0	0	**1**	0		**1**	**1**	0	**1**
7	0	0	**1**	0		**1**	**1**	**1**	**1**
8	0	0	**1**	0		**1**	**1**	**1**	0
9	0	0	**1**	0		**1**	0	**1**	0
10	0	**1**	**1**	0		**1**	0	**1**	0
11	0	**1**	**1**	0		**1**	**1**	**1**	0
12	0	**1**	**1**	0		**1**	**1**	**1**	**1**
13	0	**1**	**1**	0		**1**	**1**	0	**1**
14	0	**1**	**1**	0		**1**	**1**	0	0
15	0	**1**	**1**	0		0	**1**	0	0
16	0	**1**	**1**	0		0	**1**	0	**1**
17	0	**1**	**1**	0		0	**1**	**1**	**1**
18	0	**1**	**1**	0		0	**1**	**1**	0
19	0	**1**	**1**	0		0	0	**1**	0
20	0	**1**	**1**	**1**		0	0	**1**	0

2.5 Data outputs

The data outputs transfer the encoder actual value with the corresponding code to a sequence electronics. If several devices are operated in the data bus, via the tristate input (optionally) the corresponding information of the data output can be transferred to the bus-line. Us corresponds to the encoder voltage supply and is dependent on the encoder type. The output load can be switched dependently by the used logic either to 0 V or to US.



3 Data Transmission / Data Consistency

Short-timely unvalid bit combinations can occur at multi-step codes such as Binary or BCD code.

As a rule, the read-in cycle of the evaluation electronic isn't synchronous to the output cycle of the encoder. This indicates that the evaluation electronic can carry out the read operation at the moment of the data freshening of the encoder.

At this a bit-combination-change takes place at which is changes more than one bit, the following problem results:

The outputs of the encoder have a different condition, therefore the loading- or unloading curves (i.e., no endless steep edges) of the output signal levels are different. Since the switching threshold between "1" and "0" is not in general in the middle of the level range, invalid bit combinations result on a short-term basis. These express in short-term value skips for the customer.
How long the unvalid (inconsistent) data be present depends of the cable capacity (quality/length) and also of the input time delay of the digital inputs.
Partly, these times absolutely are in the milliseconds area.

Remedies:

1. **Use of Gray code:**
   Function see chapter "Codes", page 14.

2. **Use of software filters in the PLC:**
   - Lock all interrupts
   - Read inputs and store intermediately
   - Read inputs again and compare them with the stored value
   - Are the values identical, takeover, goto *:END*
   - Are the values not identical, read inputs again, takeover
   : END
   - Unlock interrupts

Note
Short waiting times are requiredly possible between the individual read operations.

3. **Use of the Latch function:**
   Function see chapter "Control inputs", page 11.

Note
Two possible error sources:
Level assignment exchanged for latch function and delay time after connecting the latch input is too short.