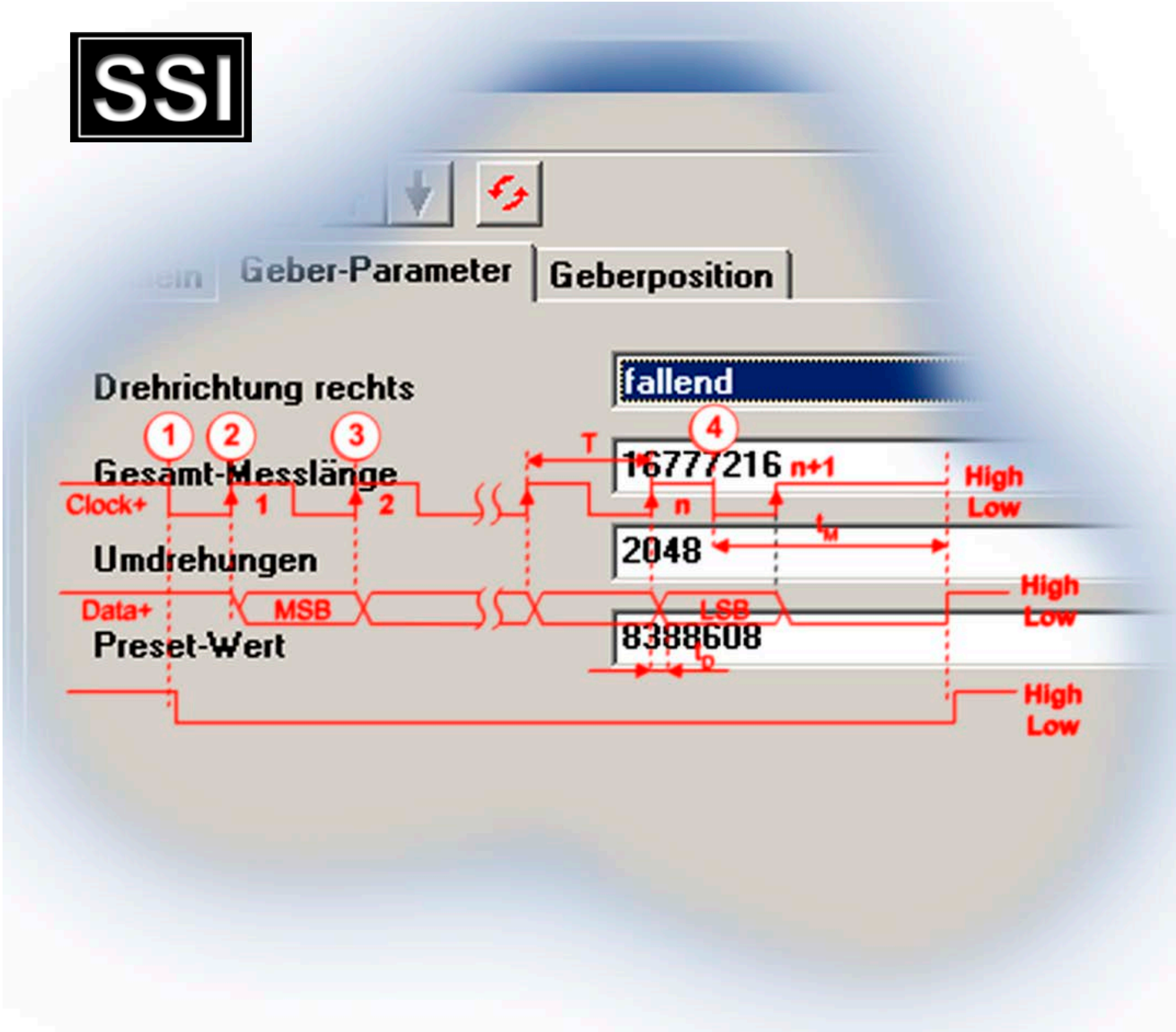
Rotary Encoders | Linear Encoders | Motion | System

SSI



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Technical Information

SSI interface with monitoring functions

- Monitoring functions
- SSI information
- Programmable parameter

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First release	10/16/06	01
With soft version 1.05, 08.2008: Resolution with integer values	03/10/09	02
Speed limit $\leq$ 3000 min $^{-1}$	03/24/09	03

1 General information

1.1 Abbreviations used / Terminology

SSI	***S***ynchronous-***S***erial-***I***nterface
LSB	***L***east ***S***ignificant ***B***it
MSB	***M***ost ***S***ignificant ***B***it
T	Period
t_M	SSI mono time
t_p	Pause time
t_D	Delay time

1.2 Definition of symbols and instructions

indicates important information's or features

2 Monitoring functions

2.1 Maximum permissible speed

To avoid malfunctions of the monitoring mechanisms, the measuring system must be operated within the rotational-speed range of ≤ 3.000 min^{-1}.

2.2 Implemented hardware

- Window comparator, for the monitoring of the controller operating voltage
- Reference element for the exact monitoring of the controller analog functions
- Electronic switch for switching off the operating voltage in case of disturbances which cannot be recognized or removed by the controller
- Test equipment, in order to be able to check these two components with each switch-on momentum
- Watchdog with undervoltage detection

2.2.1 Operating principle

The static monitoring of the 3.3 V by means of a window comparator serves for monitoring the controller operating voltage of 3.15 V – 3.6 V. Outside of these voltage limits it cannot be guaranteed that the controller operates still duly and error conditions can be diagnosed and reported certainly.
In this case the operating voltage of the controller is switched off, the communication is interrupted and the outputs are high-impedancely.

The monitoring of the 5 V is guaranteed by means of a RESET controller with Watchdog and voltage sensor. This function is checked if the operating voltage is switched on. In this case to the RESET controller a 10% undervoltage is supplied. From that a hardware RESET at the micro-controller results.
If the RESET is not executed, the further functions are stopped. If the hardware RESET could be performed duly, the test function is not executed at the second start after the manipulated RESET.

2.3 Implemented software modules

- **Module 1:**
  Monitoring of the plausibility of the position value, scan unit and transmitter diode
- **Module 2:**
  Monitoring of the external operating voltage
- **Module 3:**
  Monitoring of the own operating voltage or reference voltage
- **Module 4:**
  Monitoring of the temperature
- **Module 5:**
  Monitoring of the RAM-, ROM- and CPU

2.3.1 Operating principle

- **Module 1:**
  The bit **“Plausibility”** is set, if the plausibility of the measured value cannot be guaranteed. E.g. this is the case at a position jump, caused by a transmitter diode loss or a general defect of the scanning unit in the measuring system.

  The bit **“Transmitter diode”** is set, if the scanning unit in the measuring system executes an error interrupt.

- **Module 2:**
  The bit **“Operating voltage, external”** is set, if the operating voltage of the measuring system is < 11 V DC or > 27 V DC.

- **Module 3:**
  The bit **“Independent reference voltage”** or **“Operating voltage, internal”** is set, if the permissible ranges for the internal 2.5 V reference voltage or internal operating voltages of 3.3 V and 5 V of the measuring system can not be maintained. E.g. this can be caused by short-circuits or faulty internal components.

- **Module 4:**
  The bit **“Temperature”** is set, if the measuring system detected a temperature outside of the permissible range of < 0°C, or > 60°C.

- **Module 5:**
  With this module the RAM- and ROM-area with a special test pattern is tested and functionalities of the CPU unit. A detected error causes, that the measuring system does not start any longer and no communication can be established. The system is switched off, since no error free operation can be guaranteed.

2.4 Bit assignment and check time

Function	SSI bit	No SSI bit	Check
Plausibility	25	–	permanently
Transmitter diode	26	–	permanently
RESET function check	–	X	Switch-on momentum
ROM CRC check	–	X	Switch-on momentum
RAM check	–	X	Switch-on momentum
CPU check	–	X	Switch-on momentum
Operating voltage, external	27	–	permanently
Temperature	28	–	permanently
Independent reference voltage	29	–	Switch-on momentum
Operating voltage, internal	30	–	permanently

2.5 Reset of errors

An error bit in the SSI transmitting protocol is set at the moment of the error appearance and is reset automatically if the error was eliminated.

The position is also output in the case of error messages.

3 SSI information

The SSI procedure is a synchronous serial transmission procedure for the measuring system position. By using the RS422 interface for transmission, sufficiently high transmission rates can be achieved.

The measuring system receives a clock sequence from the control and answers with the current position value, which is transmitted serially and is synchronous to sent clock.

Since the data transfer is synchronized by the start of the sequence, it is not necessary to use single-step codes such as Gray code.

The data signals Data+ and Data– are transmitted by means of cable transmitters (RS422). The clock signals Clock+ and Clock– are received by means of optocouplers to protect them from damage resulting from interference, potential differences, or polarity reversal.

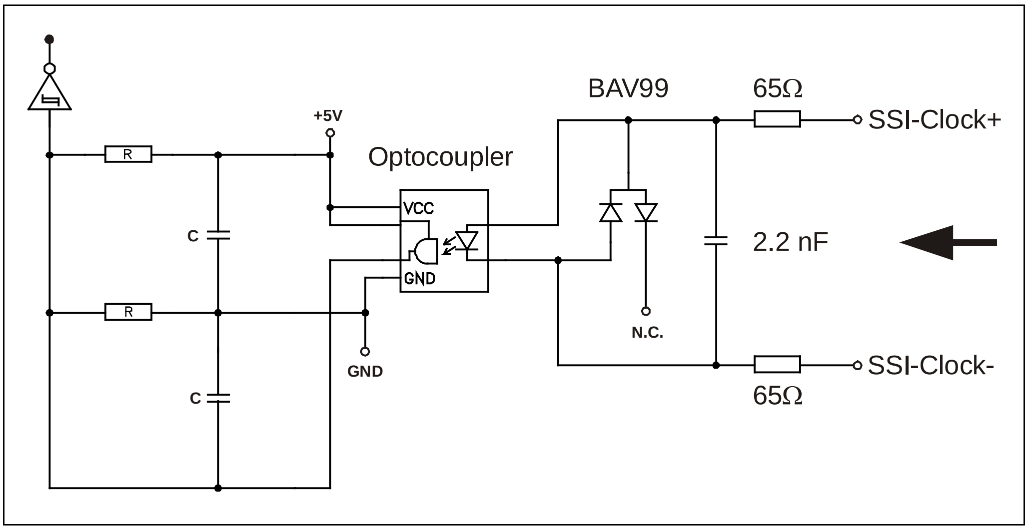


Figure 1: SSI Principle input circuit

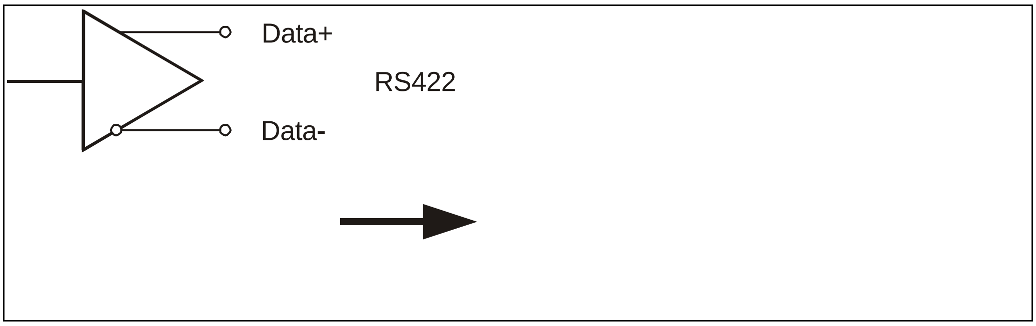
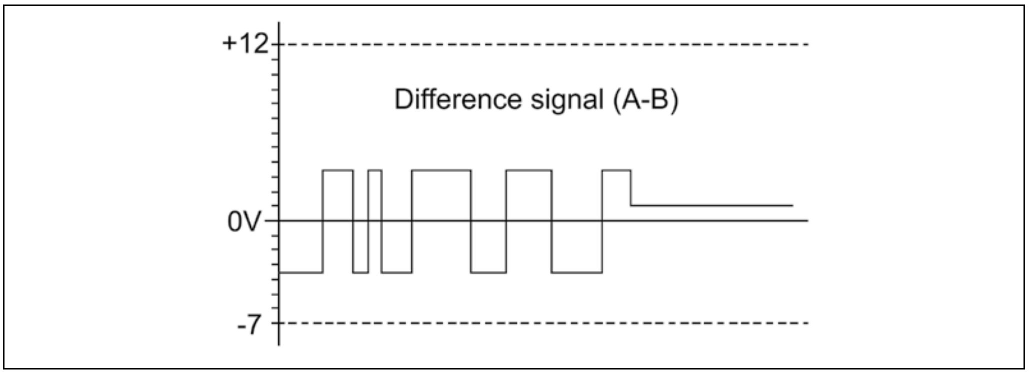


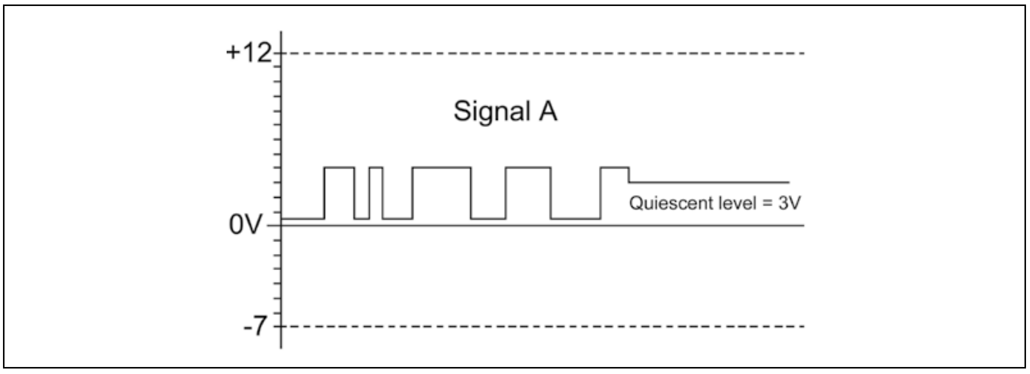
Figure 2: SSI Output circuit

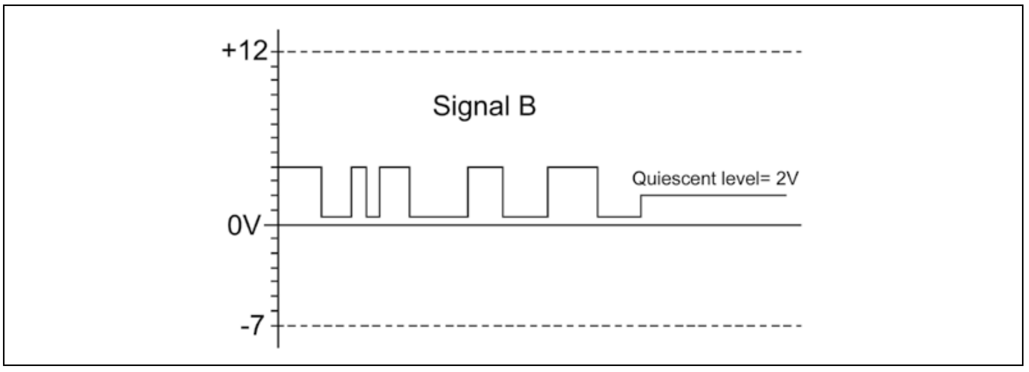
3.1 RS422 Data transmission technology

With the RS422 transmission one line-pair is used for the signals Data+ and Data– and one line-pair for the signals Clock+ and Clock–.

The serial data are transmitted without mass reference as a voltage difference between two corresponding lines.
The receiver evaluates only the difference between the two lines. Therefore common-mode interferences on the transmission line do not lead to a corruption of the useful signal.
By the use of shielded and twisted pair cable, data transmissions over distances from up to 500 meters with a frequency of 100 kHz can be realized.
Under load RS422 transmitters provide output levels of ±2V between the two outputs. RS422 receivers still recognize levels of ±200mV as valid signal.







3.2 SSI data transmission

In the idle condition the signals Data+ and Clock+ are high. This corresponds the time before item **(1)** is following, see chart indicated below.
With the first change of the clock pulse from high to low **(1)** the internal-device-monoflop (can be retriggered) is set with the monoflop time t_M.
The time t_M determines the lowest transfer frequency ($T = t_M / 2$). The upper limit frequency results from the total of all the signal delay times and is limited additional by the built-in filter circuits.

With each further falling clock edge the active condition of the monoflop extends by the time t_M, at last at item **(4)**.
With setting of the monoflop **(1)**, the bit-parallel data on the parallel-serial-converter will be stored via an internal signal in the input latch of the shift register. This ensures that the data cannot change during the transmission of a position value.

With the first change of the clock pulse from low to high **(2)** the most significant bit (MSB) of the device information will be output to the serial data output. With each following rising edge of the clock pulse, the next lower significant bit is set on the data output.
When the clock sequence is finished, the system keeps the data lines at 0V (Low) for the duration of the mono period, t_M **(4)**. With this, the minimum break time t_p between two successive clock sequences is determined and is $2 * t_M$.

Already with the first rising clock edge the data are read in by the evaluation electronics. Due to different factors a delay time results to t_V > 100ns, without cable. Thereby the measuring system shifts the data with the time t_V retarded to the output. Therefore at item **(2)** a "Pause 1" is read. This must be rejected or can be used for the line break monitoring in connection with a "0" after the LSB data bit. Only to item **(3)** the MSB data bit is read. For this reason the number of clock pulses corresponds the number of data bits +1 (n+1).

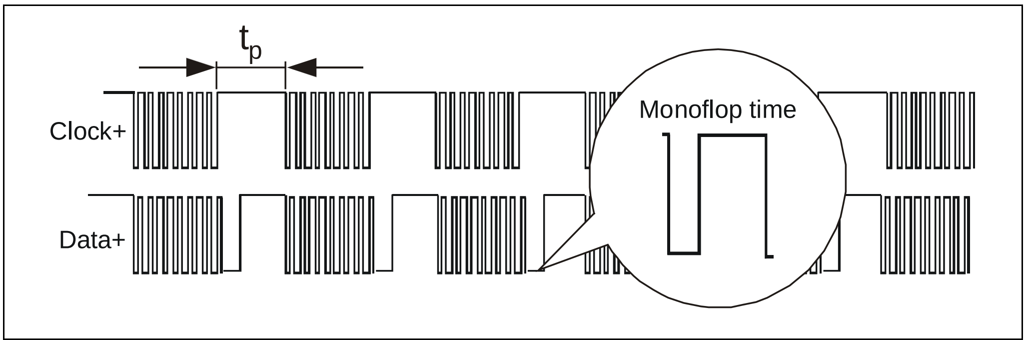


Figure 3: Typical SSI - transmission sequences

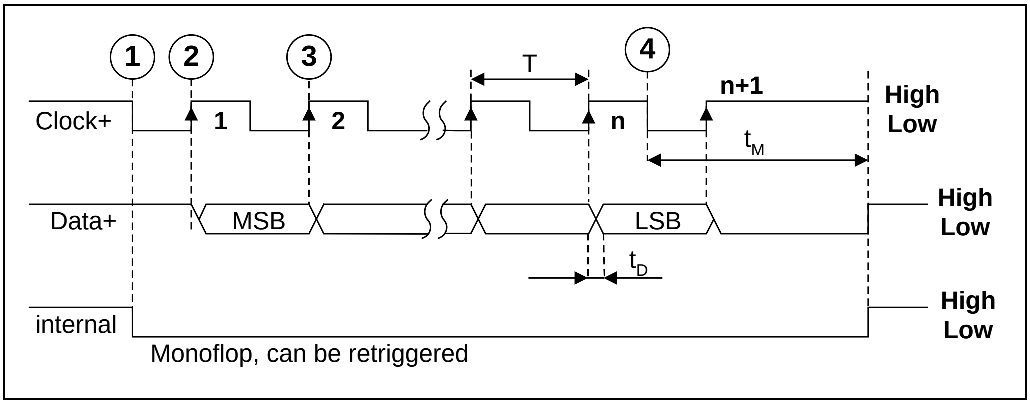


Figure 4: SSI transmission format

3.3 SSI transmission format with monitoring bits

MSB LSB

0 – 24	25	26	27	28	29	30
$P\ 2^{24} – P\ 2^{0}$	S1	S2	S3	S4	S5	S6

P = Position data

S1 = Plausibility

S2 = Transmitter diode

S3 = Supply voltage, external

S4 = Temperature

S5 = Independent reference voltage

S6 = Supply voltage, internal

- The bits are high-active
- With programming's of position data < 25 bits, up to the bit position 2^{24} "0" bits are output, afterwards the monitoring bits follow.

4 Programmable parameters

4.1 Encoder parameter

4.1.1 Count direction, clockwise

Selection	Description	Default
`Increasing`	Measuring system position increasing clockwise (view onto the shaft)	X
`Decreasing`	Measuring system position decreasing clockwise (view onto the shaft)	

4.1.2 Scaling parameters

With the scaling parameters the physical resolution of the measuring system can be changed. The position value output is Gray decoded and is calculated with a zero point correction and the count direction set.

Ensure that the parameter ***Number of revolutions*** is an exponent of 2 of the group 2^0, 2^1, 2^2…2^{12} (1, 2, 4…4096).

4.1.2.1 Total number of steps

Defines the ***Total number of steps*** of the measuring system before the measuring system restarts at zero.

lower limit	2 steps
upper limit	16 777 216 steps (24 bit)
default	***16777216***

As the value "0" is already counted as a step,
the end value = Total number of steps – 1.

Total number of steps = Number of steps per revolution * Number of revolutions

To calculate, the parameters ***Number of steps per revolution*** and the ***Number of revolutions*** can be read on the measuring system nameplate.

4.1.2.2 Revolutions

Defines the ***Number of revolutions*** of the measuring system before the measuring system restarts at zero.

lower limit	1
upper limit	4096
default	***2048***

4.1.3 Preset value

Defines the position value to which the measuring system is adjusted with the leading edge of the external preset input. To suppress interference, however, the preset is only carried out if the preset signal is present without interruption during the entire response time of 30 ms. A re-execution of the preset is not possible until the input signal has been reset again and a filter time of 30 ms has been waited.

lower limit	0
upper limit	programmed total measuring length in increments – 1, within ≤ 16 777 215
default	***8388608***