NUMERIK JENA

SIMPLY PRECISE

INTERFACES

of NUMERIK JENA Encoders

Interfaces

As the defined link between encoders anddownstream electronics, interfaces ensure the reliable exchange of information. NUMERIK JENA offers encoders withinterfaces for many common downstream electronics. The specific interface that can be used depends on the encoder's method of measurement and other factors.

Methods of measurement

In the **incremental measuring metho**d, the position information is obtained **by counting** the individual increments (measuring steps) starting from a selected point of origin. An absolute reference point is needed for determining the position, so a reference-mark signal is output as well. Incremental encoders generally output **incremental signals**. Some incremental encoders with integrated signal converters have a counting function: once the reference mark is traversed, an absolute position value is generated and transmitted via a serial interface.

In the **absolute measuring method**, the absolute position information is acquired directly **from the grating of the measuring standard**. The position value is available from the encoder immediately upon switch-on and can be requested at any time by the downstream electronics. Encoders that use the absolute measuring method output **position values**. Some interfaces provide incremental signals as well. Since absolute encoders do not require a reference run, they are ideal for use in concatenated manufacturing systems, transfer lines, and multi-axis machines. They are also highly immune to EMC disturbances.

Note

Specialized encoders can have other interface characteristics (e.g., with regard to shielding).

Index

[1] HIPERFACE is a trade mark of SICK Stegmann GmbH
[2] *BiSS* is a trade mark of iC-Haus GmbH

1. Interface Driver

The interface driver circuit is displayed in the following figure. The differential transmission lines have to be terminated on the customer's side (Typ.: R = 120 Ω).

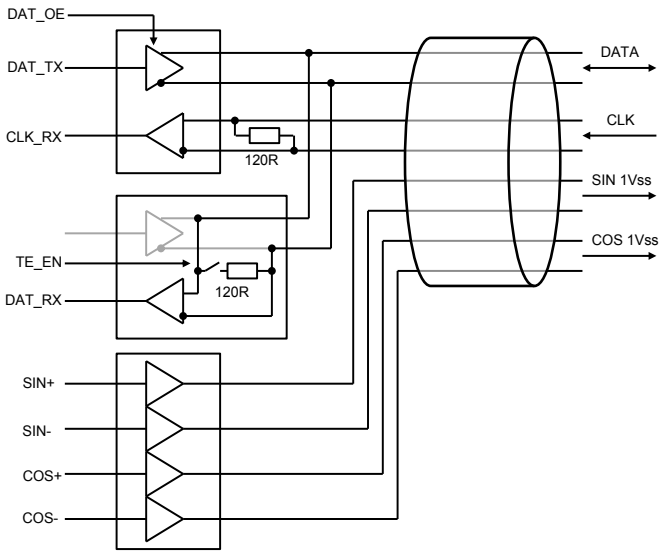


Image 1

1.1 Interface Driver for EnDat 2.2

The interface driver circuit is displayed in the following figure. The differential transmission lines have to be terminated on the customer's side (Typ.: R = 120 Ω).

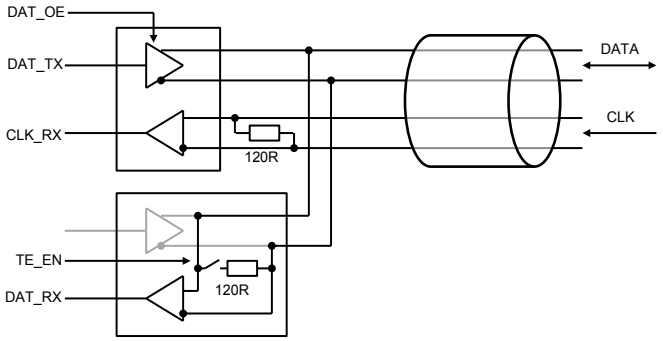


Image 2

2. EnDat 2.2 Interface

The EnDat interface from HEIDENHAIN is a digital, bidirectional interface for encoders. It is capable both of transmitting position values from incremental and absolute encoders as well as transmitting or updating information stored in the encoder, or saving new information.

Thanks to the serial transmission method only four signal lines are required. The data are transmitted in synchronism with the clock signal from the subsequent electronics. The type of transmission (position values, parameters, diagnostics, etc.) is selected by mode commands that the subsequent electronics send to the encoder.

2.1 Protocol Description

Parameter	Value
Position word	32 bit
Mono flop time	5 µs
Max. clock frequency	16 MHz

Chart 1

2.2 Status LED

The function of the EnDat-Interface can be checked by using the LED display. The following chart describes the two possible states.

LED display	Information	Note
green	System ready for use	--
red	System has an error	check mechanical mounting, clean scale tape[1,2] [1] As long as the EnDat-Interface has not been disconnected from the power supply, the red LED will continue to light up even after the fault has been rectified. [2] See also 10.3 Extended error diagnosis with the ABSOFLEX Pro Software

Chart 2

2.3 Cable length

The clock frequency is variable between 100 kHz and 2 MHz depending on the cable length (maximum: 150 m). With propagation-time compensation in the downstream electronics, clock frequencies of up to 16 MHz or cable lengths of up to 100 m are possible.

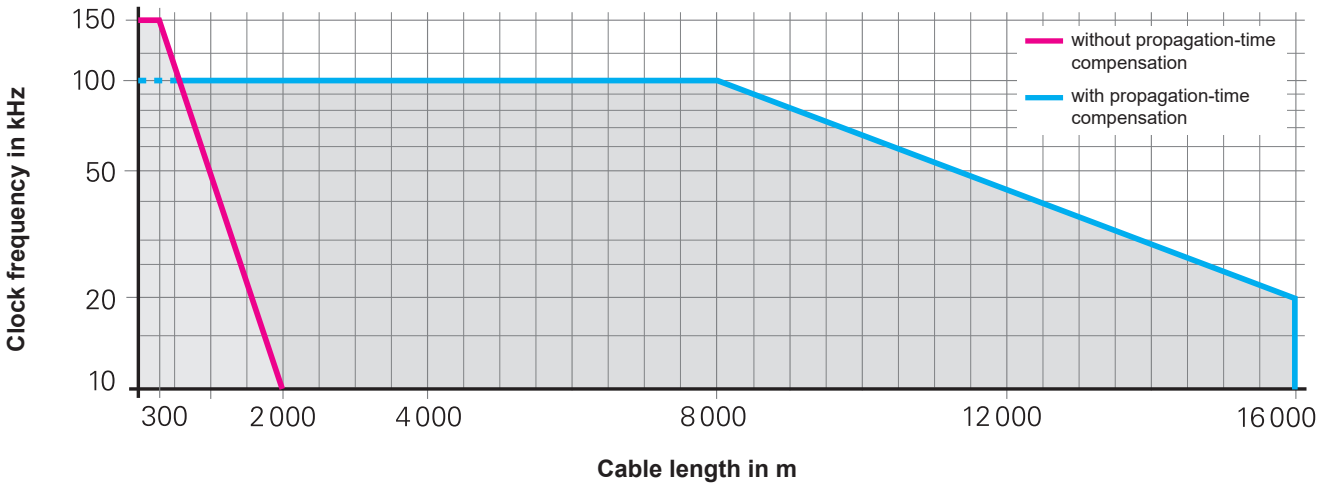


Image 3

Further information and data sheets regarding the EnDat 2.2 interface are available on the website of the Dr. Johannes Heidenhain GmbH „www.heidenhain.com“.

3. SSI Interface

The SSI interface is a serial, synchronous protocol which supports position and error transmission exclusively. Due to its simple structure, integration on the customer’s side is easy.

For verification purposes of the received position value, multi-cycle readout is supported.

3.1 Protocol Description

Parameter	Value
Position word	25 (Position bits = 24 + leading „0“, starts with MSB) 33 (Position bits = 32 + leading „0“, starts with MSB)
Mono flop time	5 µs, 10 µs or 20 µs
Max. clock frequency	2.0 MHz
Number format (gray/binary)	binary
Parity bits	none
Multi-cycle readout	yes
Error signaling	DAT = HIGH, if critical errors occur, HIGH remains until reset

Chart 3

3.2 Readout Cycle

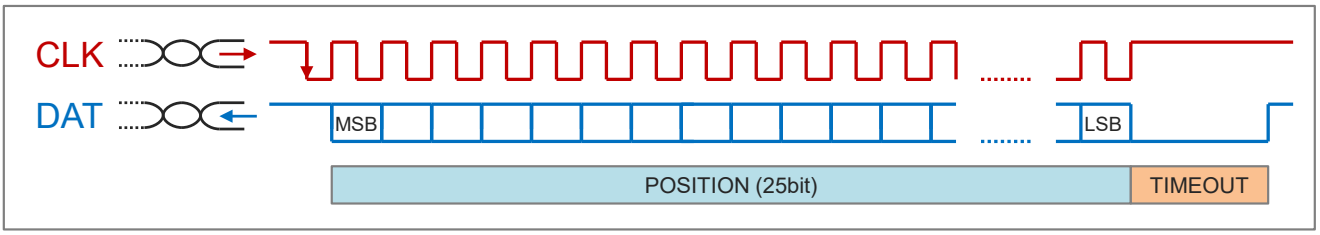


Image 4

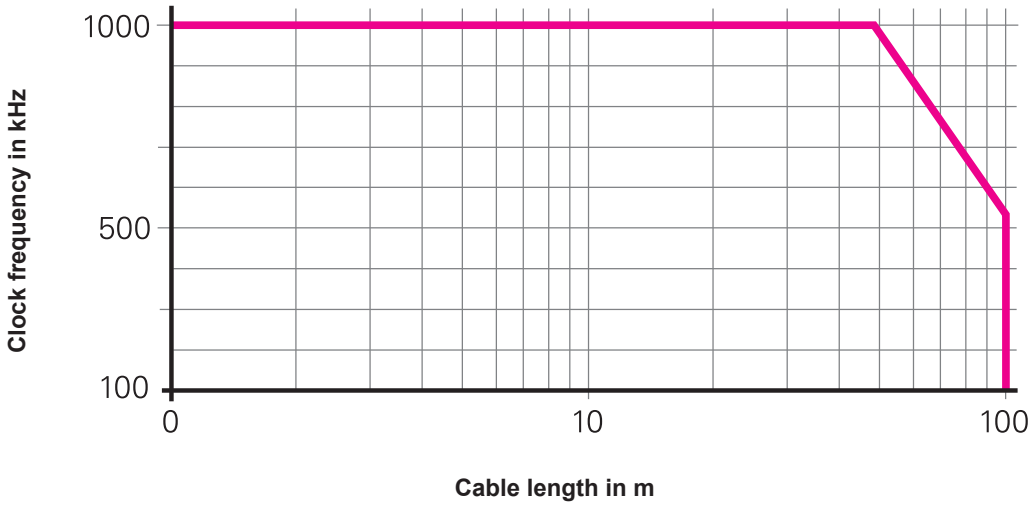
When the first falling edge is detected, the position value is loaded into the output register. Every rising edge provides a single bit at the output which can be taken over with the following falling edge.

When the last bit is taken over the data line level is “LOW”. Once the mono flop time passes, the protocol goes back into Idle-mode and waits for a new cycle.

3.3 Multi-Cycle Readout

To verify that the data transmission works properly it is possible to read the same position information multiple times without changing it. In order to do that new clock cycles have to be applied during the mono flop time. The position information will be provided repeatedly by the feedback shift register.

3.4 Cable length



Permissible clock frequency as a function of cable length.

Image 5

4. HIPERFACE Compatible Interface[1]

4.1 Protocol Description

Parameter	Value
Position word	4 x 8 Bit starting with LSB, 24 Bit position value + leading zeroes
Timeout time	11 / baud rate and 44 / baud rate
Max. clock frequency	921.6 kHz, smaller baud rates adjustable
Number format (gray/binary)	binary
Parity bits	none, even, odd
Check sum	yes, EXOR operation on transmitted Bytes
User access memory	approx. 2 kByte dividable in arrays of 16 to 128 Bytes

Chart 4

4.2 Readout Cycle

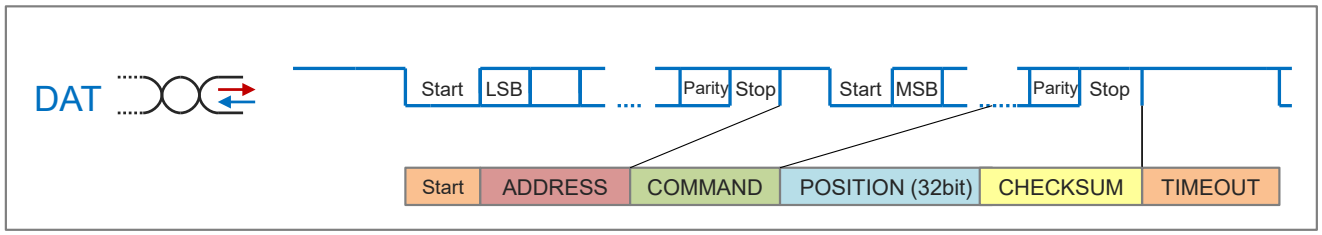


Image 6

The figure above shows a response of the measuring system to a position request. When the falling edge of the start bit is detected the position value is loaded into the output register. The communication on a HIPERFACE[1] compatible bus always begins with the device address, followed by a command, data to be transmitted and a check sum.

It is possible to add a parity bit to every byte transmitted. Each of those is followed by a stop bit. The time between two bytes in a transmission cycle has to be smaller than the set timeout. Once the timeout passes the device expects a new command.

4.3 Device Settings at Delivery

Unit type (Kommando 52h)	FFh
Available EEPROM-storage [Bytes]	1024
Unit adress	40h
Interface mode	E4h
Access codes 0 .. 3	55h
Counter	0

Chart 5

[1] HIPERFACE is a trade mark of SICK Stegmann GmbH

4.4 Supported Commands

Command	Function	Code 0	Comment
42h	Read position		20µm; 8 Bit per Sine-/Cosine period
43h	Set position	x	
44h	Read analogue value		Channel no. 40h: Temperature [°C]
46h	Read counter		
47h	Increment counter		
49h	Delete counter	x	
4Ah	Read data		
4Bh	Store data		
4Ch	Determine status of a data field		
4Dh	Create data field		
4Eh	Determine available memory area		
4Fh	Change access code		
50h	Read encoder status		
52h	Read out type label		Unit type = FFh
53h	Encoder reset		
55h	Allocate encoder address	x	
56h	Read SN and program version		
57h	Configure serial interface	x	
67h	Temporarily configure serial interface		

Chart 6

4.5 Status Codes

Category	Code	Description	Commands
	00h	No error	
	03h	Partition table damaged	4Ah, 4Bh, 4Ch, 4Dh, 4Eh
Interface	09h	Parity error	all
	0Ah	Check sum error	all
	0Bh	Command unknown	all
	0Ch	Invalid number of data bytes	all
	0Dh	Invalid argument	all
Data	0Eh	the field is write-protected	4Bh
	0Fh	Wrong access code	43h, 49h, 4Ah, 4Bh, 4Dh, 4Fh, 55h, 57h
	10h	Field size cannot be changed	4Dh
	11h	Address is outside the field	4Ah, 4Bh
	12h	Invalid array number	4Ah, 4Bh, 4Ch, 4Dh
	13h	Not enough free memory	4Dh
	14h	Max. number of data arrays reached	4Dh
	15h	EEPROM error while reading	47h, 49h, 4Bh, 4Dh, 4Fh, 55h, 57h
Position	20h	Error while reading absolute track	independent
	21h	Connection error during absolute track evaluation	independent
	22h	Error in incremental channel	independent
	1Eh	Device temperature too high	independent

Chart 7

4.6 RS-485 Settings

Bit

R	T	P	P	B	B	B	B

B [3..0]	Baud rate
0100	9600
0101	19200
0110	38400
0111	57600
1000	115200
1001	230400
1010	460800
1011	921600

UART	
00 = 8 Databit, no parity	
10 = 8 Databit, parity = Σ Databits odd	DEFAULT
11 = 8 Databit, parity = Σ Datenbits even	

Time out	
0 = 1*11/Baud rate	
1 = 4*11/Baud rate	DEFAULT

BUS-MFB	
0 = BUS	
1 = Standard	DEFAULT

4.7 Data field for additional status information

In addition to the predefined data field FFh, which contains the type plate, there is another data field FEh in the Kit LA with additional status information. This field has the following structure:

Adress	Description	Bytes
00h - 01h	Device temperature in C°	2
02h - 03h	Error/warning bits (see chart „Overview error and warning bits“)	2
04h - 05h	Firmware revision	2
06h	Firmware version, 1st digit = major version, 2nd digit = minor version	1
07h	Valuation number (system reserve) absolute track	1
08h	Valuation number (system reserve) incremental track	1
09h	Valuation number (system reserve) code connection	1

Chart 8

4.8 Overview error and warning bits

Bit	Description
0	PRC decoding failed
1	Code connection failed
2	Malfunction in the incremental system
3	Incremental signals out of tolerance
4	EEPROM checksum error
5	Temperature too high
6	Note: Travel speed too high for absolute system **This is not an error. The system continues to work properly.**

Chart 9

4.9 Valuation number

The valuation numbers correspond to the values displayed on the main screen of the ABSOFLEX Pro Software. A description can be found in the section „Evaluation of signal quality“ in the ABSOFLEX operating instruction.

4.10 Cable length

At a data rate of max. 38.4 kBaud, the maximum cable length is 100 m.

5. BiSS C Interface[2]

The unidirectional *BiSS* protocol[2] provides additional WARN and ERROR Bits additionally to the SSI protocol. A CRC-6 check sum has been added to ensure safe transmission of data.

5.1 Protocol Description

Parameter	Value
Position word	24 (starts with MSB) 32 (starts with MSB)
Timeout time	20 µs
Acknowledge time	equals calculation time
Max. clock frequency	2.0 MHz (without line delay compensation) 5.0 MHz (with line delay compensation)
ERROR Bit, aktive LOW 1 - no error, 0 - error	• if critical errors occur, remains active for the duration of the error • exeption: when using the ABSOFLEX Pro Software, the error remains until reset
WARN Bit, aktive LOW 1 - no warning, 0 - warning	if critical warnings occur, 0 remains for the duration of the warning
Check sum	industry standard CRC-6 (starts with MSB) Polynomial: $x^6 + x^1 + x^0$ Seed: 0x00

Chart 10

5.2 Readout Cycle

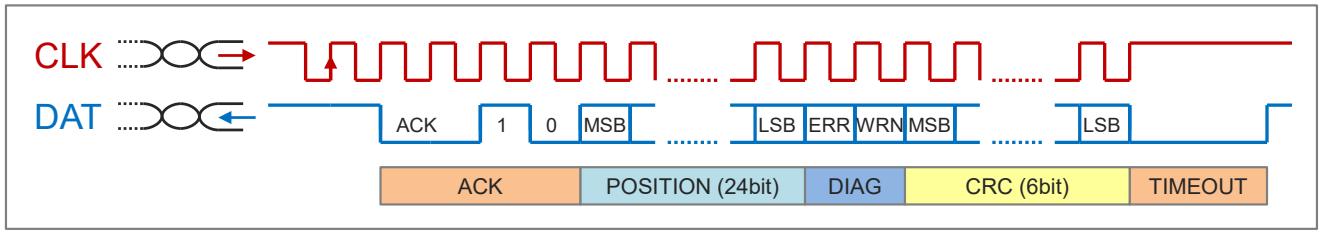


Image 7

The readout starts with two rising edges from the master. The position is sampled at the first rising edge. Necessary operations are made during acknowledge time. The following start bit initiates the data transmission.

Every rising edge provides a bit at the output, which can be taken over when a falling edge is detected.

When the last bit is taken over the data line level is LOW. Once the mono flop time passes, the protocol goes back into Idle-mode and waits for a new cycle.

[2] *BiSS* is a trade mark of iC-Haus GmbH

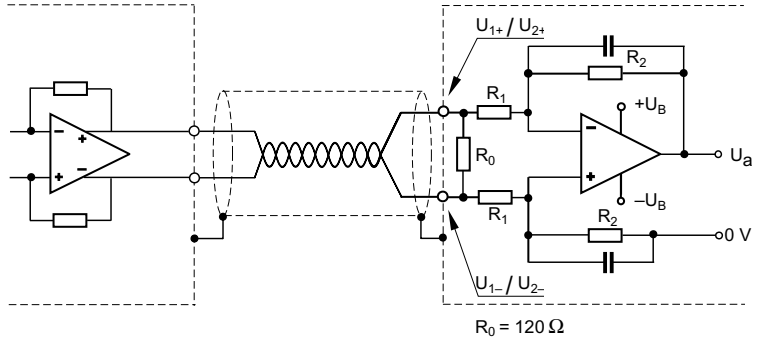
5.3 Cable length

Clock frequency	Max. cable length	
	without propagation-time compensation	with propagation-time compensation
250 kHz	95 m	100 m
1 MHz	20 m	100 m
2 MHz	8 m	100 m
5 MHz	0.5 m	100 m
10 MHz	-	50 m

Chart 11

5.4 Analogue 1 V_{PP} Interface

Schematic



Signal pattern

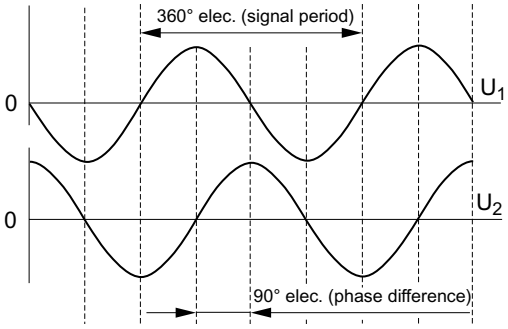


Image 8

Parameter	Min.	Typ.	Max.
Signal $U_1 = U_{1+} - U_{1-}$ (0°)	0.6 V_{PP}	1.0 V_{PP}	1.2 V_{PP}
Signal $U_2 = U_{2+} - U_{2-}$ (90°)	0.6 V_{PP}	1.0 V_{PP}	1.2 V_{PP}
Signal period	20 µm		
Phase difference	90°		
Cut-off frequency 3 dB	-	-	500 kHz

Chart 12

6. USB 2.0 Interface

USB 2.0 is integrated in the LAK read head, which allows to have access to the read head via diagnostic software.

An adapter can be used to connect the encoder to a PC for configuaration purposes. It is also possible to pick off data by an adapter between the LAK connector and the controller.

Once the connection is established the user has several options (please see chapter 7).

7. ABSOFLEX USB-Adapter

The absolute encoders from NUMERIK JENA provide a USB 2.0 interface which alows the user to connect it to a PC and use the ABSOFLEX Pro Software. The ABSOFLEX USB-Adapter allows to connect the encoders D-Sub connector directly to a USB port.

Image 9

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Original documentation
1504453 · Ver00 · 02 · 03/2026

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