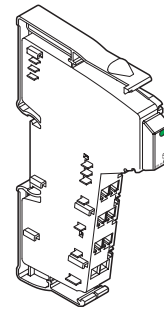


# IB IL SSI-IN IB IL SSI-IN-PAC

## Inline Terminal for Absolute Encoders With SSI Interface up to 25 Bits

Data Sheet 689700

10/2003



6897A000



The IB IL SSI-IN and IB IL SSI-IN-PAC only differ in the scope of supply (see "Ordering Data" on page 19). Their function and technical data are identical. For greater clarity, the Order Designation IB IL SSI-IN is used throughout this document.



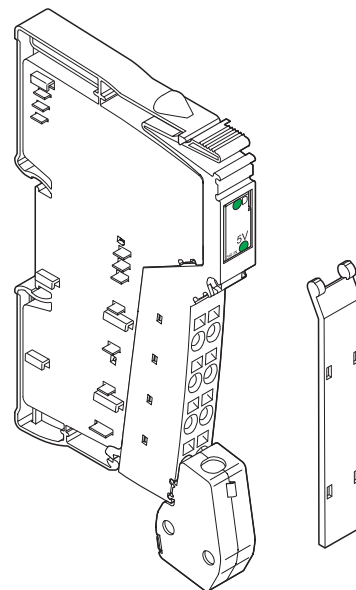
This data sheet is only valid in association with the IB IL SYS PRO UM E User Manual or the Inline System Manual for your bus system.

## Product Description

The Inline terminal is used to read data from absolute encoders with SSI interface up to 25 bits (single-turn, multi-turn or length measuring systems). It supports encoders with gray code and binary code and converts gray code into binary code.

The IB IL SSI-IN increases operational reliability, as it automatically checks the parity of received data at the SSI interface.

The terminal has a channel in the local bus protocol, which can be requested and configured via two process data words.



6897A001

Figure 1 IB IL SSI-IN-PAC terminal with connector and labeling field

## Features

- 5 V DC encoder supply
- LED diagnostic and status indicators
- 24 V encoders supplied via adjacent terminals

## IB IL SSI-IN (-PAC)

### Applications

All standard absolute encoders with SSI interface with the following features can be connected:

- Single-turn, multi-turn or length measuring systems
- 8 to 25 bits (configurable)
- Gray code, binary code
- No parity monitoring, even parity monitoring or odd parity monitoring
- Transmission speeds of 100 kHz, 200 kHz, 400 kHz, 800 kHz, 1 MHz

### Function

The IB IL SSI-IN terminal is part of the Inline product range. The terminal is a universal module designed for use within an Inline station. The IB IL SSI-IN terminal is used to read position and angular information and is designed for the connection of absolute encoders with SSI interfaces up to 25 bits (single-turn, multi-turn or length measuring systems with SSI interface).

The terminal outputs a clock pulse train when reading the encoder and provides the control system with the incoming data flow in bus-synchronous mode in the corresponding process data.

The bit patterns for selecting the various operating modes, e.g., transmission frequencies, bit widths, and code conversions, are permanently written to the terminal by the control system.

The evaluating logic of the terminal automatically generates a pulse train, which activates the serial output of a bit string on the connected encoder. The encoder uses these serial bits to indicate its current position. The terminal reads the position values synchronously with the bus cycle. The timing is designed in such a way that the time delay between the data being read from the encoder and forwarded to the bus is very short. This improves the position accuracy of the connected positioning control systems or position controllers.

The data width in the bus system is 32 bits. The IN register has seven bits available for LED status indicators and 25 bits available for actual position values. The OUT register has seven bits available for control codes and 25 bits available, 12 of which are used to specify the configuration of the SSI interface (see "Process Data Words" on page 8).

### Error Messages

The terminal has monitoring mechanisms, which are triggered in the event of the following errors and generate an error message:

1. I/O error (monitoring of the 5 V encoder power supply)
 

If the encoder supply fails or is overloaded, an I/O error is triggered. Only if the terminal is in the "Offline" state does it switch to the "Error" state and generate the appropriate message code.
2. Functional error
  - Parity monitoring of the encoder signals
 

If a parity error is detected, the terminal switches to the "Error" state and generates an appropriate message code. The cause of this error can be attributed to a transmission error or a broken wire in an encoder cable.
  - Invalid control code
 

If an invalid control code has been detected (word OUT[0] bits 15 to 9), the terminal switches to the "Error" state and generates the appropriate message code.
  - Invalid configuration data
 

If invalid configuration data has been detected (word OUT[0] bits 8 ... 0), the terminal switches to the "Error" state and generates the appropriate message code.

### **Position Detection**

In order to start position detection after the terminal has been switched on, the terminal must be adapted (configured) to the connected encoder. The following control bits are written to the terminal via OUT process data words OUT[0] and OUT[1]:

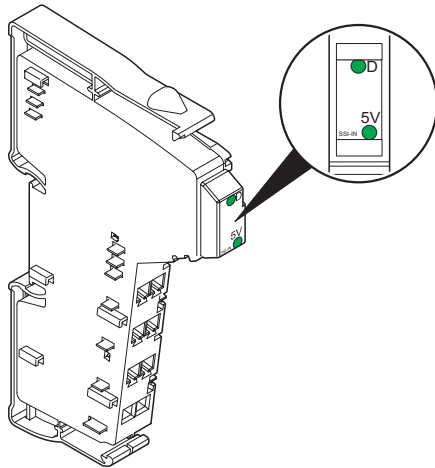
- Parity monitoring
- Reversal of direction of rotation
- Encoder resolution
- Transmission frequency of the SSI interface
- Encoder coding

The terminal then starts position detection. The actual position value (process data words IN[0] and OUT[1]) provides the position values until the operating state ("Read Position") changes.

The terminal outputs an absolute position value.

## IB IL SSI-IN (-PAC)

### Local LED Diagnostic and Status Indicators



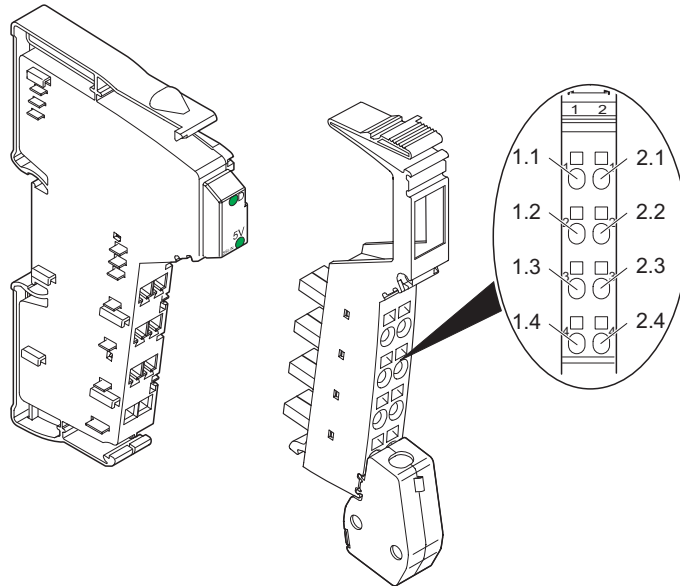
6897A002

Figure 2 Local LED diagnostic and status indicators

Des.	Color	Meaning
<b>D</b>	Green LED	Diagnostics
	ON	Bus active
	Flashing	
	0.5 Hz	Communications power present, bus not active
	2 Hz	Communications power present, bus active, I/O error
	4 Hz	Communications power present, previous terminal failed, subsequent terminals are not included in the configuration frame
	OFF	Communications power not present, bus not active
<b>5V</b>	Green LED	5 V encoder supply
	ON	5 V encoder supply present
	OFF	5 V encoder supply not present or short circuited

## IB IL SSI-IN (-PAC)

### Terminal Assignment



6897A003

Figure 3 Inline terminal with the appropriate connector

Terminal Point	Signal	Assignment
1.1	T	Clock
2.1	$\bar{T}$	Clock inverted
1.2	D	Data
2.2	$\bar{D}$	Data inverted
1.3	5 V	5 V encoder supply
2.3	0 V	0 V encoder supply
1.4, 2.4	Shield	Encoder cable shield

## IB IL SSI-IN (-PAC)

### Circuit Diagram

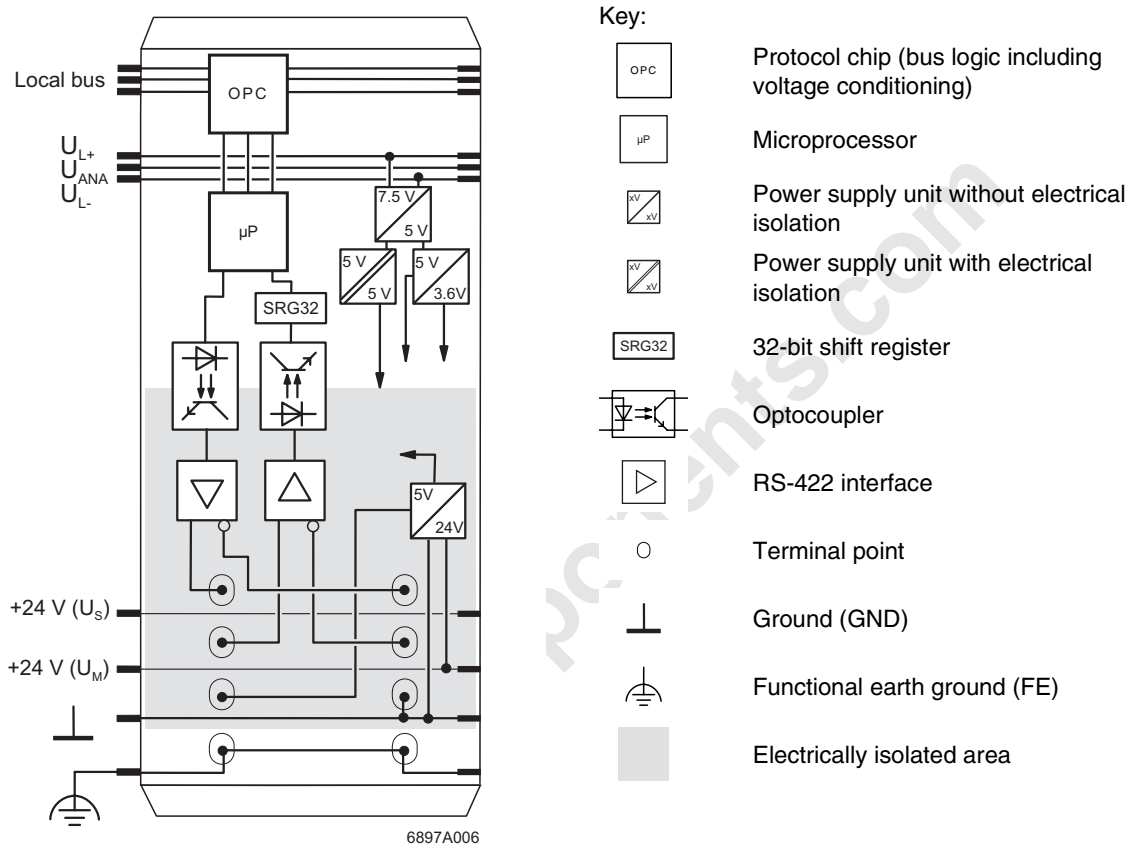
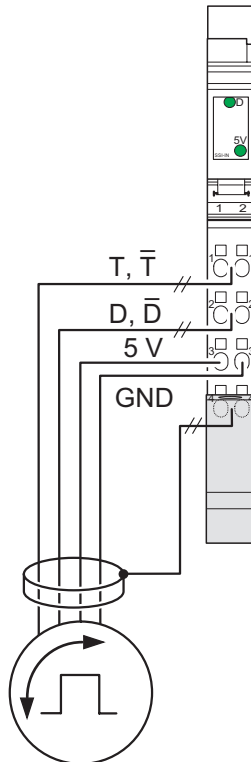


Figure 4 Internal wiring of the terminal points

## Connection Example



6897A004

Figure 5 Typical connection with 5 V encoder supply

Key:



Absolute encoder

## Connection Notes



Encoders should always be connected using **shielded** twisted pair cables. Unshielded cables may lead to erroneous results in environments susceptible to interference. On the terminal side, the shield is capacitively connected to functional earth ground (FE) via the shield connector. On the encoder side, the shield must be connected with the grounded encoder housing.

If the encoder does not have a shield connection, the shield can also be directly connected in the control cabinet to functional earth ground via an additional shield clamp.



Information on shielding and connecting shielded cables can be found in the IB IL SYS PRO UM E User Manual or the Inline System Manual for your bus system.



Please also observe the installation instructions of the manufacturer of the absolute encoder.

## IB IL SSI-IN (-PAC)

### Programming Data/Configuration Data

#### INTERBUS

ID code	5F <sub>hex</sub> (95 <sub>dec</sub> )
Length code	02 <sub>hex</sub> (2 <sub>dec</sub> )
Process data channel	32 bits
Input address area	2 words
Output address area	2 words
Parameter channel (PCP)	0 bytes
Register length (bus)	2 words
Firmware version and sub-ID (can only be read via process data)	OUT[1] XXXD <sub>hex</sub>

#### Other Bus Systems



For the configuration data of other bus systems, please refer to the appropriate electronic device data sheet (GSD, EDS).

### Process Data Words

#### IN Process Data Words

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
IN[0]	Assignment	Status								Actual position value (bits 16 to 25)							

(Word.bit) view	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
IN[1]	Assignment	Actual position value (bits 0 to 15)															

**Status:**

See "Status" on page 9

**Actual position value:**

See "Actual Position Value" on page 9

**Firmware version and sub-ID  
(control code 3C00):**

See "'Read Firmware Version and Sub-ID" Special Function" on page 11



## IB IL SSI-IN (-PAC)

### Status

IN[0] Bit 15 ... Bit 9		Description	Actual Position Value
bin	hex		
000 0000	00	<b>Offline:</b> The module is in the idle state. The configuration data is checked when the "Read Position" command is issued. If the data is valid, the module switches to the "Operating" state.	Invalid
000 0001	01	<b>Operating:</b> If bit 9 = TRUE, the measured value (position) of the position sensor is valid, i.e., the configuration data is valid and valid position values were read from the encoder.	Valid
X1X XXX0	XX	Acknowledgment for the "Acknowledge Error" control code. As soon as the control code changes to "Read Position" the terminal switches to the "Read Position" state (if the error was removed) or returns to one of the error states.	Invalid
100 0010	42	<b>Error:</b> Encoder supply not present or short circuited	Invalid
100 0100	44	<b>Error:</b> Parity error A transmission error occurred during serial data transmission from the absolute encoder to the terminal.	Invalid
100 1000	48	<b>Error:</b> Invalid configuration data The configuration data is outside the limit values.	Invalid
101 0000	50	<b>Error:</b> Unknown control code An unknown or invalid control code was transmitted.	Invalid

### Actual Position Value

The current absolute position is displayed in right-justified binary form.

Status (7 Bits)	Actual Position Value (25 Bits)	
IN[0] Bit 15 ... Bit 9	IN[0] Bit 8 ... Bit 0	IN[1] Bit 15 ... Bit 0
000 0001	X XXXX XXXX	XXXX XXXX XXXX XXXX

## IB IL SSI-IN (-PAC)

### OUT Process Data Words

OUT process data words are evaluated as soon as the control code is mirrored in the IN process data words.



OUT process data words specify the output values in each bus cycle. The configuration data must be complete. If the configuration data is not complete, the terminal will not switch to the ready state.

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
OUT[0]	Assignment	Control code								0	0	0	Parity	0	0	0	Rev

(Word.bit) view	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
OUT[1]	Assignment	0	0	0	Resolution					0	Speed			0	0	0	Code



#### Ensure data consistency

Ensure data consistency of two words to prevent the possibility of misinterpreting the values.

**Control code:** See "Control Code" on page 11  
**Parity:** See "Parity" on page 12  
**Rev:** See "Rev" on page 12  
**Resolution:** See "Resolution" on page 13  
**Speed:** See "Speed (SSI Frequency)" on page 14  
**Code:** See "Code" on page 14

**"0" (unused):**



"0" bits ("unused" bits) must **not** be set (unknown configuration).

## IB IL SSI-IN (-PAC)

### Control Code

The operating states of the terminal are selected with the control code. If the terminal has detected the control code, it is mirrored in the status (see "Status" on page 9).

Code OUT[0] Bit 15 ... Bit 9		Control Code
bin	hex	
000 0000	00	No action (ignored)
000 0001	01	<b>Read Position:</b> In the transition from the "Offline" state to the "Operating" state the configuration data is checked and the terminal is configured. If the position was determined successfully, the module switches to the "Operating" state, i.e., the configuration data is valid.
000 0010	02	<b>Switching "Offline":</b> The terminal switches from the "Operating" state to the "Offline" state; the configuration is reset.
010 0001	21	<b>Acknowledge Error:</b> The configuration is maintained during the transition from the "Error" state to the "Operating" state.

### "Read Firmware Version and Sub-ID" Special Function

The IB IL SSI-IN has a special function, which can be used to read its firmware version and the sub-ID. The sub-ID is used to distinguish between other Inline terminals that have the same ID code. The sub-ID of the IB IL SSI-IN is "D".



The firmware version and the sub-ID can only be requested in the "Offline" state. An error message is generated if this control command is issued during operation.

Process Data Word OUT[0]					Process Data Word OUT[1]				
Bit 15 ..... Bit 0					Bit 15 ..... Bit 0				
0011	1100	0000	0000	(bin)	0000	0000	0000	0000	(bin)
3	C	0	0	(hex)	0	0	0	0	(hex)
Process Data Word IN[0]					Process Data Word IN[1]				
Mirrored control code in the status					Firmware version (e.g., 100) and sub-ID				
Bit 15 ..... Bit 0					Bit 15 ..... Bit 0				
0011	1100	0000	0000	(bin)	0001	0000	0000	1111	(bin)
3	C	0	0	(hex)	1	0	0	D	(hex)

## IB IL SSI-IN (-PAC)

### Parity

This parameter is used to select the parity monitoring function for the SSI interface.

Parity OUT[0] Bit 4 ... Bit 5		Parity
bin	hex	
00	0	None
01	1	Odd
10	2	Even
11	3	Reserved

### Rev

The "Rev" parameter is used to reverse the direction of rotation. If reversal of direction of rotation is enabled, the terminal inverts all the position values read by the encoder, i.e., the position value is modified by activating this function.

Rev OUT[0] Bit 0		Reversal of Direction of Rotation
bin	hex	
0	0	OFF
1	1	ON

## IB IL SSI-IN (-PAC)

### Resolution

The "Resolution" parameter is used to adapt the terminal to the resolution of the relevant absolute encoder (8 to 25 bits).

Resolution OUT[1] Bit 8 ... Bit 12		Encoder Resolution
bin	hex	
0 0000	00	Reserved
0 0001	01	8
0 0010	02	9
0 0011	03	10
0 0100	04	11
0 0101	05	12
0 0110	06	13
0 0111	07	14
0 1000	08	15
0 1001	09	16
0 1010	0A	17
0 1011	0B	18
0 1100	0C	19
0 1101	0D	20
0 1110	0E	21
0 1111	0F	22
1 0000	10	23
1 0001	11	24
1 0010	12	25
1 0011	13	Reserved
...	...	
1 1111	1F	

## IB IL SSI-IN (-PAC)

### Speed (SSI Frequency)

The "Speed" parameter is used to set the transmission speed at which encoder data is to be read via the SSI interface.

Speed OUT[1] Bit 4 ... Bit 6		Transmission Speed
bin	hex	
000	0	Reserved
001	1	100 kHz
010	2	200 kHz
011	3	400 kHz
100	4	800 kHz
101	5	1 MHz
110	6	Reserved
111	7	Reserved

### Code

The parameter specifies which code the encoder uses to output information.

Code OUT[1] Bit 0		Code
bin	hex	
0	0	Binary code: The terminal forwards the data to the local bus without modifying it.
1	1	Gray code: The terminal converts the data from gray code into binary code and then forwards it to the local bus.

## IB IL SSI-IN (-PAC)

### Configuration Example

- SSI encoder
- No parity (OUT[0], bits 5 and 4)
- No reversal of direction of rotation (OUT[0], bit 0)
- Resolution of 13 bits (OUT[1], bits 12 to 8)
- 400 kHz clock pulse (OUT[1], bits 6 and 4)
- Binary code (OUT[1], bit 0)

(Word.bit) view	Word	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
OUT[0]	Assignment	Control Code								0	0	0	0	0	0	0	0

(Word.bit) view	Word	Word 1															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 2								Byte 3							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
OUT[1]	Assignment	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0





"0" bits ("unused" bits, OUT[0] bits 8, 7, 6, 3, 2, 1 and OUT[1] bits 15, 14, 13, 7, 3, 2, 1) must **not** be set (unknown configuration).



"Reserved" bits in individual configuration parameters must **not** be set (unknown configuration).


## IB IL SSI-IN (-PAC)

### Technical Data


General Data	
Order Designation (Order No.)	IB IL SSI-IN (28 19 30 9) IB IL SSI-IN-PAC (28 19 57 4)
Housing dimensions (width x height x depth)	12.2 mm x 120 mm x 71.5 mm (0.408 x 4.724 x 2.815 in.)
Weight (without connector)	50 g
Operating mode	Process data mode with 2 words
Permissible temperature (operation)	-25°C to +55°C (-13°F to +131°F)
Permissible temperature (storage/transport)	-25°C to +85°C (-13°F to +185°F)
Permissible humidity (operation)	75% on average, 85% occasionally
	In the range from -25°C to +55°C (-13°F to +131°F) appropriate measures against increased humidity (> 85%) must be taken.
Permissible humidity (storage/transport)	75% on average, 85% occasionally
	For a short period, slight condensation may appear on the outside of the housing if, for example, the terminal is brought into a closed room from a vehicle.
Permissible air pressure (operation)	80 kPa to 106 kPa (up to 2000 m [6562 ft.] above sea level)
Permissible air pressure (storage/transport)	70 kPa to 106 kPa (up to 3000 m [9843 ft.] above sea level)
Degree of protection	IP20 according to IEC 60529
Class of protection	Class 3 according to VDE 0106, IEC 60536
Interface	
SSI interface	Comprising a differential input and output according to RS-422
Encoder supply	5 V, GND; 250 mA, maximum
Power Consumption	
Communications power $U_L$	7.5 V
Current consumption from $U_L$	28 mA, maximum
Power consumption from $U_L$	0.21 W
I/O supply from $U_M$	24 V DC, typical
Current consumption from $U_M$	65.7 mA, maximum
Supply of the Module Electronics and I/O Through Bus Terminal/Power Terminal	
Connection method	Through potential routing



## IB IL SSI-IN (-PAC)

Absolute Encoder Inputs	
Number	1
Encoder signal	Clock, clock inverted Data, data inverted
Signal connection method	Shielded cables <div>  <p>Unshielded cables may lead to erroneous results in environments prone to interference.</p> </div>


Encoder	
Encoder types	Single-turn or multi-turn
Resolution	8 to 25 bits (configurable)
Code	Gray code, binary code (configurable)
Parity monitoring	None, even, odd (configurable)
Reversal of direction of rotation	Yes, no (configurable)
Transmission frequency	100 kHz, 200 kHz, 400 kHz, 800 kHz, 1 MHz (configurable)
Encoder supply	5 V; 250 mA, maximum
Cable length	< 30 m (98.43 ft.) for shielded cable (to ensure conformance with EMC directive 89/336/EEC)

Encoder Supply	
Voltage range	4.75 V to 5.25 V
Short-circuit protection	Electronic and thermal
Current carrying capacity	250 mA, maximum
<div>  <p>The status of the 5 V encoder supply is indicated via the green "5V" LED. If the internal voltage for the encoder electronics fails or is overloaded, an I/O error is generated. The diagnostic LED flashes at 2 Hz to indicate the error and it is transmitted to the controller board.</p> </div>	

Error Messages to the Higher-Level Control or Computer System	
Failure or overload of the encoder supply	Yes, I/O error message sent to the controller board


Limitation of Simultaneity, Derating	
Derating	No derating

## IB IL SSI-IN (-PAC)

Electrical Isolation/Isolation of the Voltage Areas		
	The logic level is electrically isolated from the I/O area by the optocoupler.	
Common Potentials		
The 24 V main voltage, 24 V segment voltage, and GND have the same potential. FE is a separate potential area.		
Separate Potentials in the System Consisting of Bus Terminal/Power Terminal and I/O Terminal		
Test Distance		Test Voltage
7.5 V supply (bus logic)/I/O		500 V AC, 50 Hz, 1 min
7.5 V supply (bus logic)/functional earth ground		500 V AC, 50 Hz, 1 min
24 V supply (I/O)/functional earth ground		500 V AC, 50 Hz, 1 min
Conformance With EMC Directive 89/336/EEC		
Noise Immunity Test According to EN 50082-2		
Electrostatic discharge (ESD)	EN 61000-4-2/IEC 61000-4-2	Criterion A 6 kV contact discharge 8 kV air discharge
Electromagnetic fields	ENV 50140 IEC 61000-4-3	Criterion A Field strength: 10 V/m
Fast transients (burst)	EN 61000-4-4/IEC 61000-4-4	Criterion A Supply lines: 2 kV Signal/data lines: 2 kV
Surge voltage	EN 61000-4-5:1995	Criterion B Supply lines: ±0.5 kV, symmetrical ±0.5 kV, asymmetrical Signal/data lines: up to ±1 kV, asymmetrical
Conducted interference	ENV 50141 IEC 61000-4-6	Criterion A Test voltage 10 V
Noise emission of housing	EN 55011	Class A

## IB IL SSI-IN (-PAC)

### Ordering Data

Description	Order Designation	Order No.
Inline terminal for absolute encoders, with connector and labeling field	IB IL SSI-IN-PAC	28 19 57 4
Inline terminal for absolute encoder, without connector and labeling field	IB IL SSI-IN	28 19 30 9
 One shield connector is needed for the complete fitting of the IB IL SSI-IN terminal.		
Connector with six terminals, spring-cage connection and shield connection (green, w/o color print); pack of 5	IB IL SCN-6 SHIELD	27 26 35 3
"Configuring and Installing the INTERBUS Inline Product Range" User Manual	IB IL SYS PRO UM E	27 43 04 8



Make sure you always use the latest documentation.  
It can be downloaded at [www.phoenixcontact.com](http://www.phoenixcontact.com).

Phoenix Contact GmbH & Co. KG  
Flachsmarktstr. 8  
32825 Blomberg  
Germany



+49 - 52 35 - 30 0



+49 - 52 35 - 34 12 00



[www.phoenixcontact.com](http://www.phoenixcontact.com)



Worldwide Locations:

[www.phoenixcontact.com/salesnetwork](http://www.phoenixcontact.com/salesnetwork)

© Phoenix Contact 10/2003 Technical modifications reserved TNR 90 14 91 3