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5.4 SINEC L1

The operating terminals allow for a simple connection to the Siemens S95 - S155 programmable controllers thus making the operating terminals the perfect man-machine-interface for your Siemens PLC.

With the programmable controllers 95U, 100U (CPU 103) and 155U, the operating terminal can be connected to the PU interface of the PLC. An additional communications module is not necessary.
With the programmable controllers 115U, 135U and 155U, a connection is possible via a CP530 communications processor.
In either case, the operating terminal is the master of the bus.

The software components of the system are fully adapted to the parameters and marginal conditions of the SINEC L1 protocol.
This offers the user the following advantages:

- Random write and read access to any data within the PLC. Data of existing PLC programs can be displayed and modified directly in the operating terminal. It is not necessary to adapt the PLC program to the operating terminal in any respect, since it is not required that communications data be stored in a specified address area or data type area.

- The operating terminal automatically polls the freely definable data areas for cyclic data.

- Use of a PU multiplexer allows simultaneous connection of the operating terminal and a hand-held programming unit (PU).

- Only a minimum of configuration is required for the installation of the supplied function blocks into the PLC.

- Minimal increase of the cycle time of the PLC.

- The protocol provides error control. Transmission errors are detected and, if possible, eliminated by repeating the transmission. A noise-immune interface hardware in accordance with the 20 mA current loop interface standard permits the application even in a harsh industrial environment.

- The parameters of the interface SER1 are assigned in the programming software in a protocol-specific manner and are stored in the application description. Modifying of the parameters is possible in the setup mask or in each other I/O-mask of the terminal at any time.

- The programming system provides a maximum of support to the operator in programming the operating terminal. The definitions (abbreviations) used here are identical with the definitions used within the PLC program.

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5.4.1 Protocol Parameters SINEC L1

To ensure proper communication, the parameters must **not** be altered.
The parameters of the interface SER1 are set to the following values:

Baud rate:	300, 600, 1200, 2400, 4800, **9600**, 19200, 38400, 375000, 500000 Baud
Parity:	none, **even**, odd
Data length:	5, 6, 7, **8** bits
Stopbits:	**1**, 1.5, 2
Handshake:	**No Handshake**, Hardware, Software

The default values are printed in **bold**.

The operating terminal adapts to the default parameters of the SINEC L1 interface. Therefore it is **not** necessary to modify the interface parameters in the PLC.

5.4.1.1 Parameter Maximum Waiting Time for Response

This timer indicates the length of time that the operating terminal (master) will wait for the response from the PLC (slave).
Permitted values are in the range of 0 ms to 65535 ms.
The default value is 500 ms.

5.4.1.2 Parameter Delay Until Connection Setup

Specifies the period of time that the terminal allows to elapse after an unsuccessful attempt to establish the communication and before making another attempt.
Permitted values are in the range of 0 ms to 65535 ms.
The default value is 10000 ms.

5.4.2 Data Types

Random read and write access is possible to any data in the PLC. All byte-structured data types can also be accessed in bit-mode. The size of the address area depends on the PLC being used.

Access to the individual bytes of a data word within a data block is also possible.

Direct access is possible to the following data types:

Type	Description	Access
E	Input Bits	Read-only
A	Output Bits	
M	Flag Bits	
EB	Input Bytes	Read-only
AB	Output Bytes	
MB	Flag Bytes	
EW	Input Word	Read-only
AW	Output Word	
MW	Flag Word	
ED	Input Double Word	Read-only
AD	Output Double Word	
MD	Flag Double Word	
DW	Data Word	
DL	Data Word, Left-hand (High)	
DR	Data Word, Right-hand (Low)	
DD	Data Double Word	
T	Timer	Read-only
Z	Counter	Read-only

Table 5.4-1: Data types

The size of each data area is governed by the CPU of the PLC.

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5.4.2.1 Data Type Structure

a) Alphanumerical Text
Is stored in the memory byte for byte in ascending address order.

b) Counter
A distinction is made between variables which have been assigned a counter address and variables which have been assigned another PLC address.

Counter address
When accessing counter addresses, the count value is interpreted in the binary format, the control bits of the counter are masked out. Therefore, to avoid control bits from being erased, counter addresses should be accessed in the **read- mode** only.

All other addresses
The count value is interpreted in BCD-code. This allows the transfer of this value within the PLC program to the counter by means of the accumulator. This function should be used for indirect write-operations of count values since the values are available in the Siemens conformal format.

c) Timer
Timer functions consist of a time value and a time base. The terminal operates with imaginary unsigned 4-byte variables, even though the data stored in the PLC comprise only 2 bytes.

When read-accessing the timer, the terminal converts the time value and time base into a terminal-internal unsigned 4-byte number, which represents the time value in reference to the time base of 0.01 seconds.

Example: A range of 10 (time base is 1.0 second) and a time value of 999, are represented or edited, respectively, in the terminal by the value 99900. Scaling of this value to other value ranges is possible by specifying a factor and divisor within the variable definition.

Before writing a timer variable to the PLC, the time value and the smallest possible time base are formed from the terminal-internal unsigned 4-byte value.

In addition, a distinction is made between variables which have been assigned a timer address and variables which have been assigned another PLC address.

Timer address
When accessing timer addresses, the time value is interpreted in the binary format. To avoid timer control bits from being erased, this access should occur in the **read-mode** only.

All other addresses
The time value is interpreted BCD-coded. This access should be used for indirect write-operations of time values since the values are available in the Siemens conformal format.

d) Floating Point Number
The data are interpreted in the Siemens floating point format.

e) Binary Variables with a Length of 1, 2 or 4 Bytes
Data with a length of 2 bytes are interpreted in the PLC-conformal byte order for words.
Data with a length of 4 bytes are interpreted in the PLC-conformal byte order for long words.

5.4.3 Configuring the PLC

Before a communication between the operating terminal and the Siemens PLC is possible, the supplied function blocks must be installed and executed during the PLC start-up or at cyclic intervals, respectively, and a communications data block must be specified in the RAM of the PLC.

5.4.3.1 Status Data Area

In addition to the random read and write access to PLC variables, an area comprising 6 words (DW70 - DW75) is available in the data block which allows the PLC to influence the terminal (status data area). The transmission of the entire area to the terminal is activated as soon as the value 128 is written into DL69. After the transmission, DL69 will be reset to 0 by the FB201.

The status data area is word-structured and has been assigned to fixed addresses:

Word Address	Reference	DL	DR
Word Address + 0	DW70	Write Coordination Byte	Reserved
Word Address + 1	DW71	Message Channel High Byte	Message Channel Low Byte
Word Address + 2	DW72	Function Keys LED 1 to 4	Function Keys LED 5 to 8
Word Address + 3	DW73	Function Keys LED 9 to 12	Function Keys LED 13 to 16
Word Address + 4	DW74	Function Keys LED 17 to 20	Function Keys LED 21 to 24
Word Address + 5	DW75	Function Keys LED 25 to 28	Function Keys LED 29 to 32

Table 5.4-2: Word-structured poll area

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5.4.4 Physical Interfacing

Pin	Designation	Function
1	Shield	Shielding
2	T+	Transmit Data, Positive Polarity
3	S1+	Power Source 1, Positive Polarity
4	R+	Receive Data, Positive Polarity
5	S2+	Power Source 2, Positive Polarity
6	T-	Transmit Data, Negative Polarity
7	S1-	Power Source 1, Negative Polarity
8	R-	Receive Data, Negative Polarity
9	S2-	Power Source 2, Negative Polarity

Table 5.4-3: Pin assignment X2 TTY / 20 mA

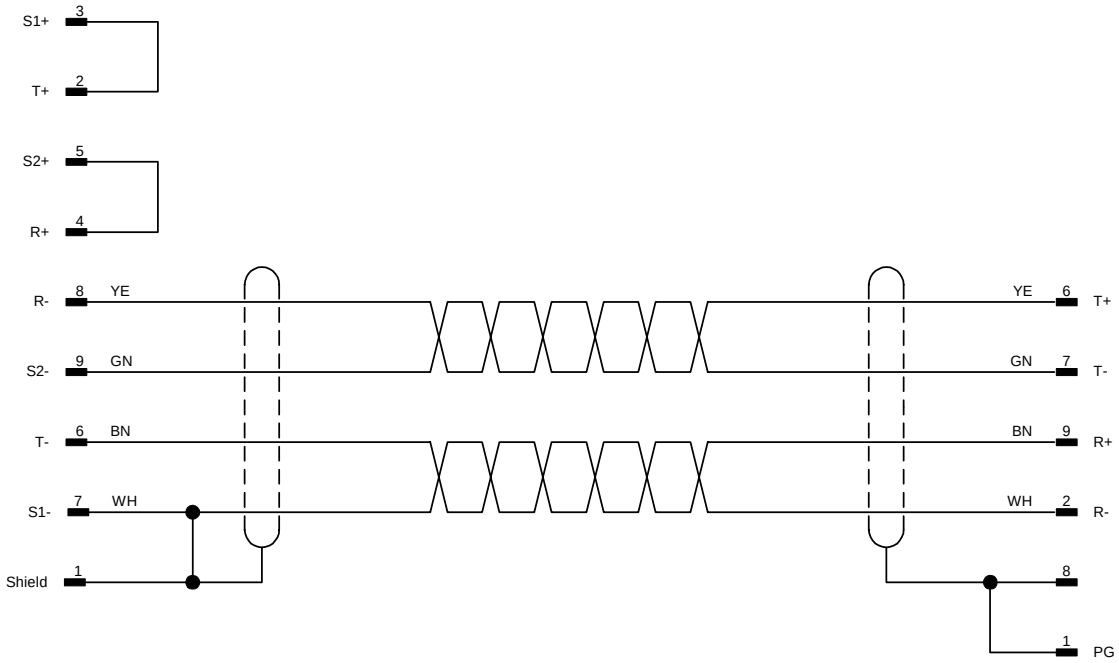
Pin	Designation	Function
10	T+	Transmit Data, Positive Polarity
12	S1+	Power Source 1, Positive Polarity
13	R+	Receive Data, Positive Polarity
14	R-	Receive Data, Negative Polarity
16	S2+	Power Source 2, Positive Polarity
19	T-	Transmit Data, Negative Polarity
21	S1-	Power Source 1, Negative Polarity
24	S2-	Power Source 2, Negative Polarity

Table 5.4-4: Pin assignment universal interface SER1 TTY / 20 mA

5.4.4.1 Connecting Cable TTY / 20 mA - Siemens PG / L1

The following wiring diagram does not apply to terminals with universal interface.

TesiMod Operating Terminal	Siemens Simatic S5-115U L1-PU Interface
Transmitter active Receiver active	Transmitter passive Receiver passive



D-Subminiature Male Connector 9-pin	D-Subminiature Male Connector 15-pin

Each end of the shield is connected to the metallic enclosure.

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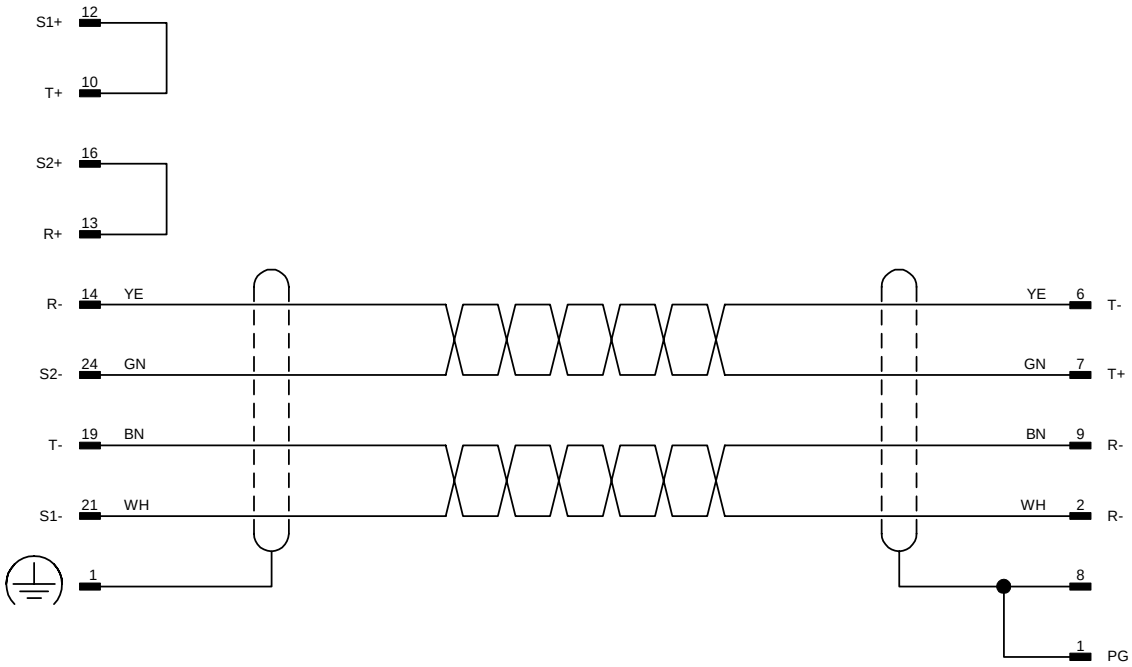
5.4.4.2 Connecting Cable Universal Interface SER1 TTY / 20 mA - Siemens PG / L1

The following wiring diagram applies to operating terminals with universal interface only.

TesiMod
Operating Terminal

Transmitter active
Receiver active

Siemens
Simatic S5-115U
L1-PU Interface
Transmitter passive
Receiver passive



D-Subminiature
Male Connector
25-pin

Pin 1 is connected to
the shield / metallic enclosure.

D-Subminiature
Male Connector
15-pin

Pin 1 and Pin 8 are connected
to the shield / metallic enclosure.

5.4.5 Error Messages

Code 1 E_SLAVE_NOT_READY ..... The slave address has been sent, however, no response has been received within the specified time period of 5 milliseconds.

Possible causes for the error:
- Incorrect slave address.
- No hardware connection.

2 E_FRAME ..... The SIO has detected a framing error.

Possible cause for the error:
- Incorrect interface parameter in the terminal or in the PLC.

4 E_TIMEOUT ..... After successful completion of the addressing phase and after sending the telegram from the terminal to the PLC, the response telegram from the PLC has not been received within the bus monitoring time period of 300 ms.

5 E_CRC_BCC ..... Checking of BCC1 or BCC2 has revealed a transmission error.

6 E_PARITY ..... Detection of a parity error.

16 E_OVERRUN ..... The interrupt service routine has not picked up the received characters quickly enough from the SIO.

Possible cause for the error:
- Programming error in the terminal.

17 E_NAK ..... Error bit in ZBS has been set.

Possible causes for the error:
- The PLC has detected that an error (e.g. parity error) has occurred during transmission of the telegram from the Terminal to the PLC.
- PLC is in the stop-mode.

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40 E_SYS_ADDRESS ..... Undefined system variable or invalid slave number 255

51 E_POLL_NR ..... After transmitting a write or read request to the function block in the PLC, no response has been received within the maximum number of poll attempts (100).

Possible causes for the error:
- Function block FB201 in the PLC is not being executed.
- PLC is in the stop mode.
- PLC is overloaded and is therefore not capable of assembling the response quickly enough (unlikely).

52 E_RECV_ADDR ..... The address received during the addressing phase does not correspond to the transmitted address.

Possible cause for the error:
- Transmission error not identified despite of parity check.

53 E_QV_BIT ..... The request bit (ZBS) for internode communication is set to logic 1.

Possible cause for the error:
- The SINEC L1 interface in the PLC is not accessed by the function block FB201 exclusively (PLC-application program error).

54 E_RECV_LEN ..... The length of the data received, exceeded 64 bytes.

55 E_DEST ..... The destination in the telegram from the PLC to the terminal does not correspond to 0 (master address).

Possible cause for the error:
- The SINEC L1 interface in the PLC is not accessed by the function block FB201 exclusively (PLC-application program error).

56 E_DATA_TYPE ..... An attempt was made to read a data type which is not supported by the function block FB201.

Possible causes for the error:
- Function block FB201 has been reduced in order to save memory space and no longer supports all data types.
- Attempt to write-access inputs, timers or counters
- Mask definition in the FLASH-EPROM contains errors

5.4.6 SINEC L1 - Data Handling Software for S5 115U

5.4.6.1 Installation

The interfacing of the operating terminals to the Simatic S5 115U via the PU-interface by means of the SINEC L1 protocol requires the installation of the supplied data handling software into the PLC. To install the software, carry out the following steps:

– The four supplied function blocks FB200, FB201, FB202 and FB203 must be installed.

– A data block (L1DB) must be created in the RAM of the PLC. The minimum size required for this data block is 77 data words. The data block can either be created with the aid of the programming unit or through the start-up OBs. This process must be carried out before one of the function blocks mentioned above is executed for the first time.

– FB200 must be executed through the start-up blocks OB21 and OB22. FB200 will parameterize the system data area for the SINEC L1 communication and perform the required initialization of data in L1DB.

– FB201 must be executed through OB1. FB201 controls the data exchange with the operating terminal. When necessary, it will execute FBs 202 or 203 for this process. These two function blocks may not be executed directly by the application software.

The function blocks use flag words FW252 and FW254 as scratch flags. This means that if you wish to retain the information in the flags, it will be necessary to transfer the contents of these flag words before the communications function blocks are executed.

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5.4.6.2 Interface to the Application Software

The interface to the PLC application software is not of a very complex design. This is due to the fact that the supplied function blocks handle the entire data exchange process with the operating terminal via the send mail box and receive mail box. The function blocks merely need to be executed as described above.

The function blocks also control every access, read-access as well as write-access, to data in the PLC.

Again, there is no need for an application software for this process.

The only task remaining for the application software is the transfer of the status data area. For this process, an area comprising 6 words (DW70 to DW75) has been reserved in the communications data block L1DB. This area allows the PLC to influence the terminal.
The entire area will be transferred to the terminal whenever the value 1 is written into DL69. After the transmission has been completed, the supplied function blocks will reset DL69 to 0. Thus DL69 represents a coordination byte which is used to control the points of time at which the status data area is to be transferred or indicates whether the transfer has already been effected.

The coordination byte can also be used by the application software for the function communication monitoring. This is possible since the coordination byte is reset to 0 after a specified period of time only if the PLC is still connected to the operating terminal. The timeout period should logically be greater than 1 second.

All other data of the L1DB, with the exception of the data mentioned above, may not be accessed by the application software.

5.4.6.3 Initialization Function Block FB200

The process of executing FB200 through the start-up blocks OB21 and OB22 must be carried out only once. Prior to this, however, the communications data block L1DB must have been created since access to certain words of this data block is required for the execution process.

This function block initializes the system data area of the PLC using SINEC L1 communication parameters.

The following values are entered for the parameters:

PU-number:	not relevant here
Slave-number:	as specified during programming of the terminal
KBE:	DW1 in L1DB
KBS:	DW0 in L1DB
Receive mail box:	DW36 to DW68 in L1DB
Send mail box:	DW2 to DW34 in L1DB

In addition, FB200 performs the required initialization processes in L1DB.

The only parameter to be defined for FB200 is the number of the communications data block L1DB.

5.4.6.4 Communications Function Block FB201

FB201 must be executed by OB1 at cyclic intervals. The handling of the data exchange with the operating terminal is performed entirely by this function block. This process involves that the FB, each time it is being executed, verifies whether a read or write request has been received from the terminal and carries out such a request, if necessary. To carry out a read or write request, it will execute FB202

or FB203, respectively, which are responsible for reading or writing to variables, respectively.

In the event that the terminal has not sent a request, the FB will check whether the status data area is to be transferred to the terminal and will, if necessary, carry out this process.

The only parameter to be defined for FB201 is the number of the communications data block L1DB.

5.4.7 SINEC L1 - Data Handling Software for S5 135U with CP530

5.4.7.1 Installation

The interfacing of the operating terminals to the Simatic S5 135U via the CPU 530 requires the installation of the supplied data handling software into the PLC. To install the software, carry out the following steps:

– The four supplied function blocks FB200, FB201, FB202 and FB203 must be installed.

– A data block (L1DB) must be created in the RAM of the PLC. The minimum size required for this data block is 93 data words. The data block can either be created with the aid of the programming unit or through the start-up OBs. This process must be carried out before one of the function blocks mentioned above is executed for the first time. The block must be assigned the number 15, since this is the number that is being used for the parameterization of the SEND and RECEIVE data handling block FB201. In the event that DB-number 15 has already been used elsewhere, another option is to alter the DBNR parameter when executing the data handling blocks in FB 201.

– FB200 must be executed through start-up blocks OB20, OB21 and OB22. FB 200 will handle the synchronization with the CP530 and also carry out the required initialization of the data in L1DB.

– FB201 must be executed through OB1. FB 201 controls the data exchange with the operating terminal. When necessary, it will execute FBs 202 or 203 for this process. These two function blocks may not be executed directly by the application software.

The function blocks use flag words FW248 to FW254 as scratch flags. This means that if you wish to retain this information, it is necessary to transfer the contents of these flag words before the communications function blocks are executed.

5.4.7.2 Interface to the Application Software

The interface to the PLC application software is not of a very complex design which is due to the fact that the supplied function blocks handle the entire data exchange process with the operating terminal via the send mail box and receive mail box. The function blocks merely need to be executed as described above.

The function blocks also control every access, read as well as write access, to data in the PLC. Again, there is no need for an applications software for this process.

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The only task remaining for the application software is the transfer of the status data area. For this process, an area comprising 6 words (DW70 to DW75) has been reserved in the communications data block L1DB. This area allows the PLC to influence the terminal.
The entire area will be transferred to the terminal whenever the value 80H is written into DL69. After the transmission has been completed, the supplied function blocks will reset DL69 to 0. Thus, DL69 represents a coordination byte which is used to control the points of time at which the status data area is to be transferred or indicates whether the transfer has already been completed.

The coordination byte can also be used by the application software for the function communication monitoring. This is possible since the coordination byte is reset to 0 after a specified period of time only if the PLC is still connected to the operating terminal. The timeout period should logically be greater than 1 second.

All other data of the L1DB, with the exception of the data mentioned above, may not be accessed by the application software.

5.4.7.3 Initialization Function Block FB200

The process of executing the FB200 through the start-up blocks OB20, OB21 and OB22 must be carried out only once. Prior to this, however, the communications data block L1DB must have been created since access to certain words of this data block is required for the execution process.

This function block synchronizes the CP530. The interface number which is required for the synchronization must be assigned to the FB as parameter.

FB200 also carries out the initialization processes required in L1DB. The number (SSNR) of the L1DB must be assigned to the FB as parameter as well.

The error output (FEHL) is set, whenever an error has occurred during the process of synchronization.

5.4.7.4 Communications Function Block FB201

FB201 must be executed by OB1 at cyclic intervals. The handling of the data exchange with the operating terminal is performed entirely by this function block. This process involves that the FB, each time it is being executed, verifies whether a read or write request has been received from the terminal and carries out such a request if necessary. To carry out a read or write request, FB will execute FB202 or FB203, respectively, which are responsible for reading or writing to variables, respectively.

In the event that the terminal has not sent a request, the FB will verify whether the status data area is to be transferred to the terminal and will, if necessary, carry out this process.

The only parameter to be defined for FB201 is the number of the communications data block L1DB.

5.4.7.5 Parameterizing the CP530

Addressing of the communications processor CP530 must occur using the interface number specified

during the execution of FB200.

In addition, the CP530 must be operated as a SINEC L1 slave. The slave number assigned to the communications processor must coincide with the number defined during the programming of the operating terminal (preferably 1).

Programming of polling lists and interrupt lists is not required for a SINEC L1 slave.

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