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5.16 SUCOnet K

5.16.1 Technical Description

TesiMod operating terminals allow for a simple connection to the Moeller field bus SUCOnet K thus making TesiMod operating terminals the perfect man-machine-interface for systems using the SUCOnet K bus system. Via the SUCOnet K it is also possible to connect a specific number of operating terminals to one master controller.
Benefits of using the SUCOnet K are:

Bus Topology
The SUCOnet K bus topology is based on the EIA-RS 485 specification. A linear bus topology has been implemented. Tree and star topologies are not possible on account of the high transmission rate. A tree'd bus structure (tree structure) can, however, be achieved by using active interfaces (repeaters). This allows even systems that branch over a large area to be globally networked.
The SUCOnet protocol permits the transmission of data as well as command- and status information between a master and up to a maximum of 124 slaves. Transmissions occur exclusively from the master to the slaves.
On account of their current carrying capacity, RS 485 transceivers are capable of accommodating only up to 32 active stations. Because of the address 0 being reserved, there are typically up to 31 stations connected to the SUCOnet bus.

High-Speed Transmission Medium
SUCOnet K is operated with RS 485 signal levels and a transmission rate of 187,5 kBaud or 375 kBaud. The maximum distance for a transmission rate of 187,5 kBaud is 600 m, for 375 kBaud it is 300 m. Repeaters must be used if greater distances are to be covered.

Spurs should exceed a length of 0,3 m.

Technical Data
- Bus interface conforming to the RS 485 standard
- Linear bus structure
- Shielded, twisted pair wire
- Max. length of 600 m (without repeaters)
- Up to 124 stations can be accommodated on one bus cable
- Bus access in accordance with the master/slave principle
- Data transfer at 187,5/375 kBaud
- Asynchronous and half-duplex data transmission
- UART-character format in accordance with IEC FT1.2
- Variable message length
- Error control by means of longitudinal and vertical parity
- Data security process CRC16 selectable

TesiMod operating terminals are integrated into the SUCOnet K field bus (9-pin Submin D) as slaves. The connection to the field bus is achieved by means of an additional hardware which is currently

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available for the BT14, BT20, BT22, BT25 and BT30 operating terminals. For reasons of noise immunity and operating safety, electrically isolated RS 458 drivers are used for the connection.

The slave number addresses must be in the range of 2 to 31. The address 0 is reserved. The address 1 is occupied by the master.

Please note carefully:
The address 0 is indicated for the master by the function device configurator of the PLC software SUCOsoft S 30-S 4-200. Therefore, the indicated address must be increased by +1 in order to obtain the real address of the SUCOnet K devices in the network. **The addressing method utilized by the TesiMod software is identical to that used by the PLC software SUCOsoft S 30-S 4-200.** The address used under the TesiMod software to address a station connected to the network is the same address as is used under the PLC software SUCOsoft S 30-S 4-200 in the menu device configurator.

5.16.1.1 Communications Procedure

The poll cycle time of the entire network largely depends on the number of slaves and the variable message lengths as well as on the program cycle time of the PLC program. The poll cycle and the program cycle are continuously resynchronized.

Theoretically it is possible to access the inputs and outputs of all stations connected to the bus. However, on account of the inputs and outputs not being placed at fixed addresses but being loaded dynamically into the memory of the PLC in accordance with the configuration when the controller is started, efficient access to these data it is not possible. The flag area, by contrast, is a linear memory area thereby allowing an extremely efficient access and requiring only a relatively small amount of decoding effort. Because of the above-stated reasons, TesiMod operating terminals are only capable of accessing the **flag area of the master**. To be able to access further SUCOnet K devices it is necessary to modify the corresponding program block of the master. The inputs and outputs of these devices must be copied to the flag area of the master which again can be accessed by the TesiMod operating terminals.
It is principally necessary to execute a program block in the main program of the master. A separate program block must be available for each TesiMod operating terminal. This program block is currently available for the Klöckner-Moeller PLC PS 4-201. For other PLC types it should look nearly the same. If necessary, the program block evaluates the data received from the terminal. Additional program blocks are executed during this process, depending on whether a bit or byte is read or written. The length of the transmitted message must be defined by the user when the PLC is being programmed. This can be accomplished by means of the programming software SUCOsoft S30-S 4-200 via the menu device configurator. If necessary, the data will be updated by the PLC after every program cycle. In this way, the PLC has control over which data are written or read by the operating terminal.

1st poll cycle / program cycle:

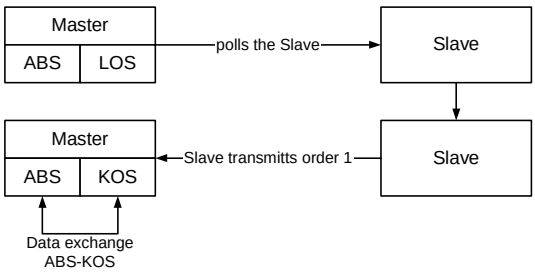


Figure 5.16-1: First poll / program cycle

2nd poll cycle / program cycle:
Master processes order 1

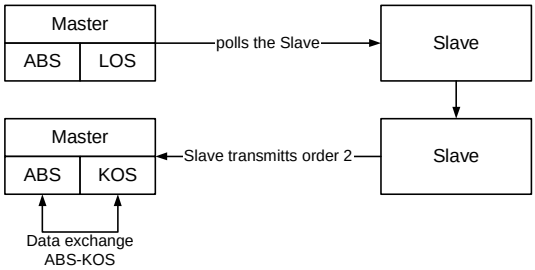


Figure 5.16-2: Second poll / program cycle

3rd poll cycle / program cycle:
Master processes order 2

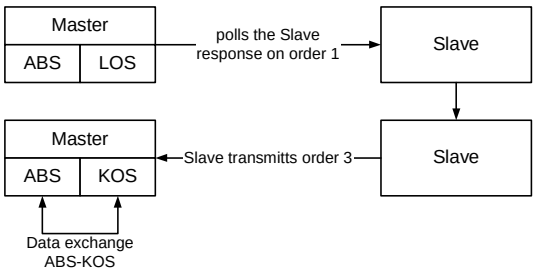


Figure 5.16-3: Third poll / program cycle

ABS = Memory image
KOS = Communication memory

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5.16.1.2 Structure of the Control Bytes and User Data

Five control bytes are required to ensure a problem-free communication. The structure of these control bytes is described below. If the user develops his own PLC-program for the communication, he must make these functions available in the control bytes.
Message structure:

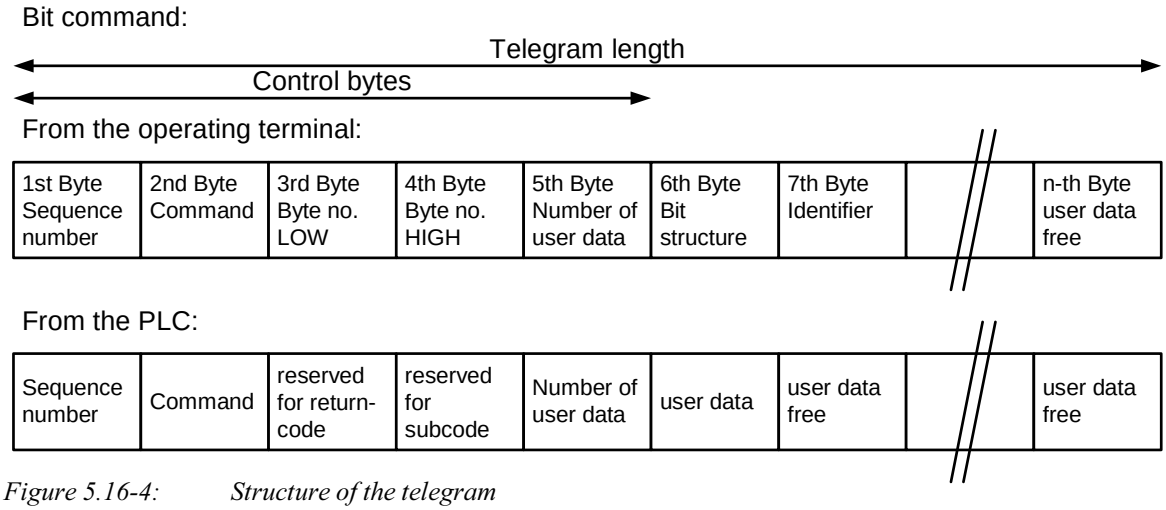


Figure 5.16-4: Structure of the telegram

Sequence number
This byte contains the number of the command from the operating terminal to the PLC. This number must be copied by the PLC program into the response message.

Command
This byte defines the access method. The access methods bit access, read or write respectively, and byte access, also read and write respectively, are permitted. The command-byte must be copied by means of the PLC program. The following commands are currently supported:

Command	Function	
0x00	Bit-read access	(user data PLC -> BT)
0x01	Byte-read access	(user data PLC -> BT)
0x02	Bit-write access	(user data BT -> PLC)
0x03	Byte-write access	(user data BT -> PLC)

Byte Number LOW and HIGH
These two bytes contain the byte number of the flag byte to which the operation refers. The PLC program accesses these memory locations to obtain the destination address. In the response message, these memory locations are reserved for the return code and subcode and are therefore not available for utilization by the user.

Number of User Data
Contains the number of user data of the message. This memory location must be copied into the response message by the PLC.

Bit Structure and Identifier
The bit structure contains useful data only in the case of a write request. If the identifier is a **0**, t he bit structure must be linked with the memory location by applying the **AND**-function. If the identifier is a **1**, it must be linked by applying the **OR**-function.

User Data
In case of a bit-read request, the flag byte which contains the corresponding bit is copied to the response message by the PLC subsequently to the copying of the byte "Number of User Data". The remaining user data are not used during a bit access.

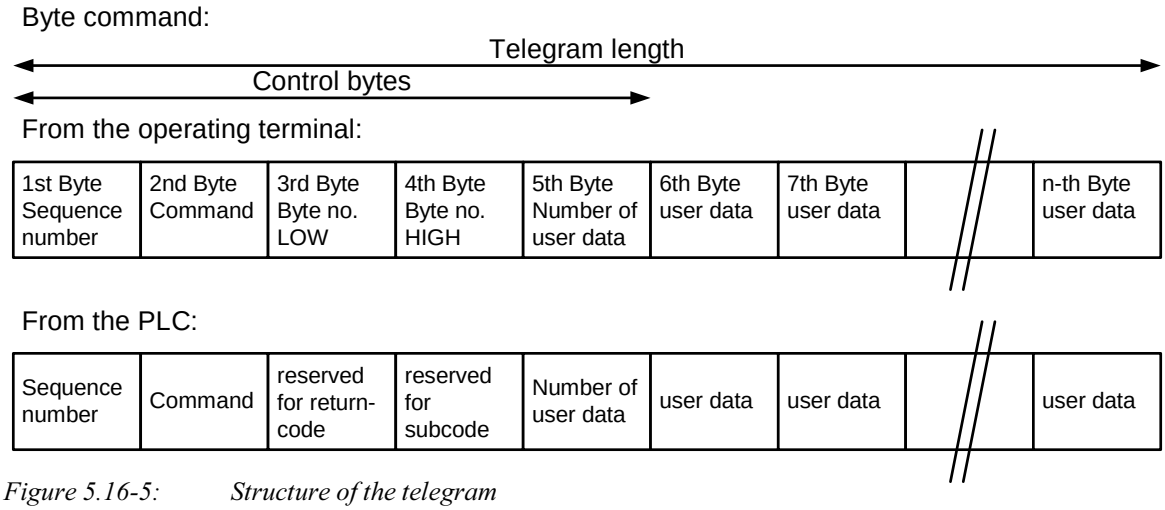


Figure 5.16-5: Structure of the telegram

Sequence Number
See bit-request

Command
See bit-request

Byte Number LOW and HIGH
See bit-request

Number of User Data
See bit-request

User Data
From here, the user data to be transmitted are located. In case of a byte-write request, the values from the operating terminal to the PLC are located here. These values must be copied by the PLC from the transmission message to the flag area. In the event of a byte-read request, the PLC must copy the values contained in the flag area to this location in the response message.

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5.16.1.3 PLC-Example Program for the PLC PS4-201

A separate program block must be available in the PLC PS4-201 for each operating terminal that is connected to the SUCOnet K network. This program block must be integrated at the end of the actual PLC program using "include< file name>". At the beginning of the PLC program, the program block of the include-file $INI_BTn is executed by means of an unconditional jump. These include files plus the associated program blocks are available for 8 operating terminals. These operating terminals must be assigned to the addresses 1-8 (addressing in accordance with the PLC software SUCOsoft S30-S 4-200 device configuration). If the operating terminal is assigned to a higher address, the user has the option of adapting an existing include-file to the required address. Shown below is a PLC main program to illustrate how to connect two operating terminals with the addresses 1 and 2 and the include-file for the operating terminal with the address 1. Those elements which would have to be modified by the user in the event that the operating terminal is assigned a higher address are represented in bold print.

Flag byte FB 200 is used as a scratch flag within the program blocks. The user also has the option of using another flag byte as scratch flag. In this case, however, the user will need to modify the program blocks accordingly.

PLC Main Program:

```
00000 KONFIG    "associated configurations file
001             #include "suc.k42"
002
00001 START     "Start of the program for connecting the SUCOnet K
001             "to the operating terminals
002
003             "Execution program block for operating terminal 1
004             CM  $INI_BT1
005             "Execution program block for operating terminal 2
006             CM  $INI_BT2
007
00002 ENDE      "End of the main program
001             EP
002
003             "Include-File for operating terminal 1
004             #include <sucbt1.q42>
005             "Include-File for operating terminal 2
006             #include <sucbt2.q42>
```

Include-File for an operating terminal at the address 1:

```
00000 $INI_BT1  "Start of the program for connecting the SUCOnet K-
001             "to the operating terminal BT1 with the address 1
002             #include "sucbt1.z42"
003
004             "new communicationsdata ???
005             L RDB1.1.0.0
006             CP KB 0
007             BNE WEITER1
008             L KB 0
```

```
009             = MB2001
010              JP ENDE
00001 WEITER1     "
001             L RDB1.1.0.0
002             CP MB2001
003             BE ENDE
004
005             L RDB1.1.0.0
006             = SDB1.1.0.0
007             = MB2001
008
009             "uccopy sequence number
010             L RDB1.1.0.0
012             = SDB1.1.0.0
013             "uccopy command
014             L RDB1.1.0.1
015             = SDB1.1.0.1
016             "ucNumberUserData
017             L RDB1.1.0.4
018             = SDB1.1.0.4
019            "calculate offset
020             L& MB0
021             ADD RDW1.1.0.2
022             = ICPY1 SADR
023
00002 KDO1      "Kommando auswerten
001             "Bit-read access
002             L RDB1.1.0.1
003             CP KB 0
004             BNE  WEITER2
005             CM  $BIT_L1
006             JP  ENDE
00003 WEITER2   "Byte-read access
001             L RDB1.1.0.1
002             CP KHB 1
003             BNE  WEITER3
004             CM  $BIT_L1
005             JP  ENDE
00004 WEITER3   "Bit-write access
001             L RDB1.1.0.1
002             CP KHB 2
003             BNE  WEITER4
004             CM  $BIT_S1
005             JP  ENDE
00005 WEITER4   "Byte-write access
001             L RDB1.1.0.1
002             CP KHB 3
003             BNE  ENDE
004             CM  $BYTE_S1
005
00006 ENDE      "End of program block operating terminal 1
```

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```
001             EM
002
00007 $BIT_L1   "Programmbaustein 1
001             "Bit-/Byte-read access
00008 START     "Start
001
002             ICPY1
003           [ ] MOD:  K  1
004           [&] SADR:
005           [&] DADR: & SDB1.1.0.5
006           [b] NO:   RDB1.1.0.4
007           [b] ERR:
008
00009 ENDE      "End of program block 1
001             EM
002
00013 $BIT_S1 "Program block 2
001            "Bit-write access
00014 START     "Start
001
002             ICPY1
003           [ ] MOD:  K  1
004           [&] SADR:
005           [&] DADR: & MB2000
006           [b] NO:   KB 1
007           [b] ERR:
008
009             L RDB1.1.0.6
010             CP KB 0
011             BE  UND
012             "OR-Mask
013             L MB2000
014             O RDB1.1.0.5
015             = MB2000
016             JP  SPEICHER
00015 UND       "Insert AND-Mask here
001             L MB2000
002             A RDB1.1.0.5
003             = MB2000
00016 SPEICHER  "store bit variable
001             L& MB0
002             ADD RDW1.1.0.2
003             = ICPY1 DADR
004
005             ICPY1
006           [ ] MOD:  K  1
007           [&] SADR: & MB2000
008           [&] DADR:
009           [b] NO:   KB 1
010           [b] ERR:
011
```

```
00017 ENDE      "End of program block 3
001             EM
002
00018 $BYTE_S1  "Program block 4
001             "Byte-write access
00019 START     "Start
001             "Calculate Offset
002             L& MB0
003             ADD RDW1.1.0.2
004             = ICPY1 DADR
005
006             ICPY1
007           [ ] MOD:  K  1
008           [&] SADR: & RDB1.1.0.5
009           [&] DADR:
010           [b] NO:   RDB1.1.0.4
011           [b] ERR:
012
00020 ENDE      "End of program block 4
001             EM
```

5.16.2 Specification within the SUCOnet K

When the SUCOnet K protocol is used, TesiMod operating terminals are operated with the following parameters:

Network Station Address:
The addresses of the network stations are automatically assigned by the software SUCOsoft S 30-S 4-200 during the configuration of a SUCOnet K network. The user must ensure that the addresses of the TesiMod operating terminals correspond with the predetermined addresses.

Size of the Data Channel:
The size of the data channel in the TesiMod operating terminal and of that in the PLC must be identical. Five bytes of the defined message length are utilized for the control bytes. This must be taken into consideration when defining the message length.

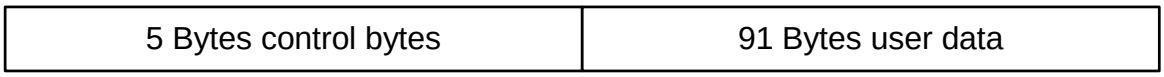


Figure 5.16-6: Structure of the telegram

Please note carefully:
If several stations connected to the master, it is necessary to take the available memory space of the communication buffer of the master into consideration when defining the message length. It is, however, permitted that the memory areas for transmitted and received data overlap.

Identification:
TesiMod operating terminals are defined in the SUCOnet K network as PS 4-201PLCs (ident number 0xA010).

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Baud Rate:
Depends on the master and is recognized automatically. The baud rate must be identical for all stations. If there is a combination of SUCOnet K/K1 stations connected to the network, the baud rate must be 187,5 kBaud.

Error Correction:
The TesiMod operating terminal is capable of automatically recognizing whether the CRC 16 error correction process is activated. With the high-speed data transmission of the SUCOnet K, the data security process CRC 16 increases operating safety.

5.16.2.1 Internal Data Transmission

The statuses of the central inputs of the PLC (master) are transferred to the memory image (ABS) before a user program is executed. The user program in the PLC scans the memory image for the statuses, processes them and stores the results in the memory image again.
To ensure consistency of the data during one program cycle, the results are only transmitted to the outputs after the program has been executed.
The memory image also contains the input/output statuses of the decentral stations. The data exchange between the memory image and the decentral stations (e.g. TesiMod operating terminal) is only possible via a communication memory (KOS) which buffers the input/output statuses of the decentral stations.
The data exchange between the individual decentral stations and the communication memory occurs at cyclic intervals. The master polls each decentral device (slave) one after the other and effects the data exchange. At the end of the program cycle, the data are transferred from the communication memory to the memory image.

5.16.2.2 Cycle Synchronization

To ensure that the data of the decentral stations are also consistent, the program cycle and the poll cycle are synchronized, i.e. both cycles are started simultaneously at all times.

If the program cycle is longer than the poll cycle, the exchange of data between the image buffer and communication buffer will only be effected after the program cycle has been completed. Subsequently, both cycles will be restarted.
If the program cycle is shorter than the poll cycle, further program cycles are started until the poll cycle has been completed as well. Subsequently, the process will continue as described above.

5.16.3 Protocol Parameters

5.16.3.1 Parameter Maximum Waiting Time for Response

Specifies the waiting time in milliseconds that the terminal waits for a poll cycle of the master. If a connection has not been established with the master within this period of time, the terminal indicates a communications error.
Permitted values are in the range of 10 ms to 2550 ms.
The default value is 100 ms.

5.16.3.2 Delay until Connection Setup

This delay time (referring to the unit seconds) specifies the period of time that is allowed to elapse until the first poll cycle of the master is to occur. This prevents the terminal from indicating a communications error during the power-up phase on account of the bus and/or controller not being ready for operation yet. If the power-up phase of the PLC is longer than that of the terminal, the delay time can be increased to compensate for the difference.
Permitted values are in the range of 1 s to 25 s.
The default value is 10 s.

5.16.3.3 Parameter Slave Number of the Terminal

This parameter sets the slave address of the operating terminal within the SUCOnet bus structure.
Permitted values are in the range of 1 to 126.
The default value is 2.

5.16.3.4 Parameter Message Length

This parameter is used to define the length of the message. A small value should be defined for the message length if the emphasis is to be on a smaller bus load. A larger value should be selected for the message length if an efficient data exchange is of primary importance.
Permitted values are in the range of 10 bytes to 64 bytes.
The default value is 20.

Because of the control bytes, the message length is actually 5 bytes smaller than the above-listed value. Depending on the access method, the data will be processed using the respective 1 or 2 byte access. If further data are to be processed, it is assumed that these data are **always located at the next higher variable number**.

5.16.3.5 Parameter Swap LED Output

By means of this parameter the byte order of the status LEDs is swapped. The bytes for controlling the status of the LEDs are located in the poll area.

5.16.4 Poll Area

The poll area is used to manage the write coordination byte (WCB), the serial message channel and the LEDs of the function keys. The terminal continuously polls this area. If the size of the poll area exceeds that of the message of the SUCOnet K network, several accesses are required to update the poll area. This, of course, increases the load on the network. Access to the poll area is only possible via the word mode, the poll area must therefore be located on even addresses. This must be taken into consideration by the user during the programming process.

5.16.5 Diagnostic-LED

The LED on the additional hardware visualizes the operating status of the network. If the LED is off, this indicates that the TesiMod operating terminal is polled by the master at regular intervals. If the LED

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flashes in a red color, this signals that there is no connection between the terminal and the master. The possible error messages are listed and explained in more detail at a later point.

5.16.6 Physical Interfacing

TesiMod operating terminals are provided with two plug connectors which are designed as female connectors. SUCOnet K cables are always fitted with male connectors. If SUCOnet K devices possessing only one female connector are to be connected to the SUCOnet K network, special T-couplers can be used to connect these devices to the bus cable.
Stubs from the bus cable to one of the stations should not exceed a length of 0,3 m.
Please note carefully:

The bus terminating resistor of the physically first station (master) and last station in the network must be activated. The terminating resistors of the stations located in between remain inactive. To activate the bus terminating resistor, the termination switch RD/TD must be set to ON.

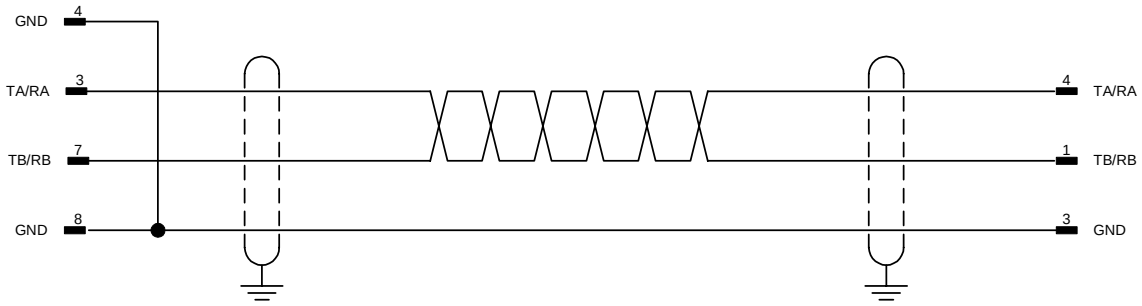
Pin	Designation	Function
1	nc	not connected
2	nc	not connected
3	TA/RA	Transmit- / Receive Channel A
4	GND	Signal Ground
5	nc	not connected
6	nc	not connected
7	TB/RB	Transmit- / Receive Channel B
8	GND	Signal Ground
9	nc	not connected

Table 5.16-1: Pin assignment of SUCOnet K connector

5.16.7 Connecting Cable SUCOnet K

TesiMod
Operating Terminal

SUCOnet K
Communication Module



D-Subminiature
Male Connector
9-pin

DIN 41512
Male Connector
5-pin

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

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5.16.8 Error Messages

Possible Error-Codes (**):

Code 50 Initialization Error
Possible errors:
– The connection between TesiMod operating terminal and the SUCOnet interface is faulty.

51 Timeout-Error ..... A timeout error occurs upon a request from the TesiMod operating terminal, i.e. the PLC does not send a response even though the network is in a proper physical condition. The subcode specifies the number of the flag byte which is to be accessed.

60
Subcode 2 Master in the Stop Mode
Possible errors:
– This error message is displayed if the master is in the stop mode (e.g. because a new program is being transferred to the PLC). The controller must be switched to the RUN mode.

Subcode 4 Received Message Length Incorrect
Possible errors:
– The message lengths specified for the PLC and the TesiMod operating terminal are not identical. These values must match, therefore, the lengths must be adjusted accordingly.

Subcode 64 Master Disconnected
Possible errors:
– A connection has not been established yet.
– The connection has been interrupted while operation.

(**) Sub code available from driver version 4.3 on up