PMA Prozeß- und Maschinen-Automation GmbH

rail line
Field bus coupler RL ETH

Interface desciption

Ethernet MODBUS/TCP

9499-040-77911

Valid from:10/2005

Legend of symbols:

(i) General information

⚠ General warning

⚠ Caution: ESD-hazarded components

Content

1   General

Thank you very much for buying a *rail line* series device. This document describes the Ethernet interface functions of field bus coupler RL ETH, which is called bus coupler in the following description, and the system capability of the various module versions of the *rail line* series (CI45-1xx-2.., KS45-1xx-2..., TB45-1xx-2....), called "function module" in the following description. The term " device" applies to both bus coupler and function modules.

Bus couplers with a Ethernet - 150 interface permit the transmission of process, parameter and configuration data. Field bus connection is via a RJ 45 socket at the top of the bus coupler. The serial communication interface facilitates connections to supervisory systems, visualization tools, etc.

Another standard interface is the <u>non</u>-bussable 'BluePort®' front-panel (PC) interface. It is used for direct connection of the 'BlueControl®' tool which runs on a PC.

The most important features of the bus connection with their physical and electrical properties are:

- Transfer rate
  The Ethernet coupler operates as a Modbus/TCP server with a maximum transfer rate of 10 / 100 Mbit/s

- Clients
  The Ethernet bus coupler permits communication with up to 4 clients using the TCP/IP protocol

- Physical layer
  10/100BaseT

- Connection
  RJ45 socket

1.1   References

Additional information
[1] Homepage of the MODBUS - User Organization
   – http://www.modbus-IDA.org
[2] MODBUS Messaging on TCP/IP
   - Implementation Guide V1.0a
[3] MODBUS Application Protocol Specification V1.1a
[4] MODBUS over Serial Line
   - Specification & Implementation Guide V1.0

Other documentations of *rail line* series s:
[5] Universal transmitter UNIFLEX CI 45

– Data sheet CI 45	9498 737 48313
– Operating note CI 45	9499 040 71441
– Operating manual CI 45	9499 040 71711

[6] Universal controller KS 45

– Data sheet KS 45	9498 737 48513
– Operating note KS 45	9499 040 71541
– Operating manual KS 45	9499 040 71811

[7] Temperature limiter TB 45

– Data sheet TB 45	9498 737 48413
– Operating note TB 45	9499 040 71641
– Operating manual TB 45	9499 040 71911

1.2   Additional information

Information on bus coupler and function module parameter addresses is given in documentation 9499-040-78111.

2   Safety hints

This device was built and tested in compliance with VDE 0411-1 / EN 61010-1 and was shipped in safe condition.
The device meets European guideline 89/336/EEC (EMC) and is provided with the CE-marking.
The device was tested before delivery and has passed the tests stipulated in the test plan. To maintain this condition and to ensure safe operation, the user must follow the hints and warnings given in this operating manual and operate the device in compliance with the information provided in this manual.

⚠ **Warning**
The device is provided exclusively for use as a measuring and control unit in technical systems.

⚠ **Warning**
If the device is damaged to an extent that safe operation is not possible, it must not be taken into operation.

ELECTRICAL CONNECTIONS

The electrical connections must conform to local standards (e.g. VDE 0100). The input leads must be kept separate from signal and mains leads.
A circuit breaker or a power switch must be provided for the device and marked accordingly in the installation. The circuit breaker or power switch must be installed near the device and should be easily accessible for the operator.

COMMISSIONING

Before device switch-on, ensure that the rules given below were followed:

- Ensure that the supply voltage corresponds to the specification on the type label.
- All covers required for contact safety must be fitted.
- Before device switch-on, check, if other equipment and/or facilities connected in the same signal loop is / are not affected. If necessary, appropriate protective measures must be taken.
- The device may be operated only when mounted in its enclosure.
- The temperature limits specified for operation of the device must be met before and during operation.

⚠ **Warning**
During operation, the ventilation slots of the housing must not be covered.

⚠ **Warning**
The measurement inputs are designed for measurement of circuits which are not connected directly with the mains supply (CAT I). The measurement inputs are designed for transient voltage peaks up to 800V against PE.

SHUT-DOWN

For permanent shut-down, disconnect the instrument from all voltage sources and protect it against accidental operation.
Before instrument switch-off, check that other equipment and / or facilities connected in the same signal loop is / are not affected. If necessary, appropriate measures must be taken.

2.1	**Maintenance, modification and repair**

The devices need no particular maintenance.
No operable controls are mounted inside the device, i.e. the operator must not open it.

Modification, maintenance and repair may be carried out only by trained, authorized persons. For this purpose, the user is invited to contact the PMA service.

Warning
When opening the devices, or when removing covers and components, live parts or terminals can be exposed.

Caution
When opening the devices, electrostatically sensitive components can be exposed.

The PMA service address and contact information are as given below:

PMA Prozeß- und Maschinen-Automation GmbH
Miramstraße 87
D-34123 Kassel

Phone +49 (0)561 / 505-1257
Fax +49 (0)561 / 505-1357
e-mail: mailbox@pma-online.de

2.2	**Cleaning**

Housing and front panel of the device can be cleansed using a dry, lint-free cloth.

2.3	**Spare parts**

The following accessories are permitted as spare parts for the device:

Description	Order no.
Connector set with screw terminals	9407-998-07101
Connector set with spring clamp terminals	9407-998-07111
Bus connector for fitting in top-hat rail	9407-998-07121

3   Quick entry

For installing a *rail line* system, please, proceed as follows:

➔ Determine system concept and function modules.

➔ Determine the function module order behind the bus coupler.

➔ Mount a bus connector for each module on the top-hat rail and push them together.

➔ To mount the bus coupler, snap it onto the left bus connector.

➔ Mount the function modules analogously in the planned order.

➔ Connect the bus coupler to the supply voltage.

➔ Specify an IP address for the bus coupler.

➔ Set a unique address for each function module, which should start with 1 for the module next to the bus coupler, followed by module no. 2, etc. Please, don't leave an address gap.
Adjusting the addresses can be done via front-panel keyboard or BlueControl® engineering tool.

➔ Write the engineering for each individual function module. Determine which data should be read and / or written via the field bus (menu Bus data (read) / Bus data (write)). Note the order of selected data.

➔ Make the function module wiring.

➔ Configure the bus coupler with the order of fitted function modules. Please, specify the actually fitted device types exactly.

➔ Connect the Ethernet cable with the device.

➔ Start the data exchange with the coupler !

| 4 | **Commissioning** |

| **4.1** | Hints for installation |

- Measurement and data lines should be kept separate from control and power supply cables.
- Sensor measuring cables should be twisted and screened, with the screening connected to earth.
- External contactors, relays, motors, etc. must be fitted with RC snubber circuits to manufacturer specifications.
- The unit must not be installed near strong electric and magnetic fields.

The unit is not suitable for installation in explosion-hazarded areas.

Faulty connection can lead to the destruction of the instrument.

The device may be operated only in environments for which it is suitable due to its protection type.

The housing ventilation slots must not be covered.

In plants where transient voltage peaks are susceptible to occur, the devices must be equipped with additional protective filters or voltage limiters!

Caution!
The device contains electrostatically sensitive components.

Please, follow the instructions given in the safety hints.

| **4.2** | Dimensions |

The bus coupler dimensions are shown in the following drawing. For the function module data, see the relevant operating manuals.

Fig. 2: Dimension
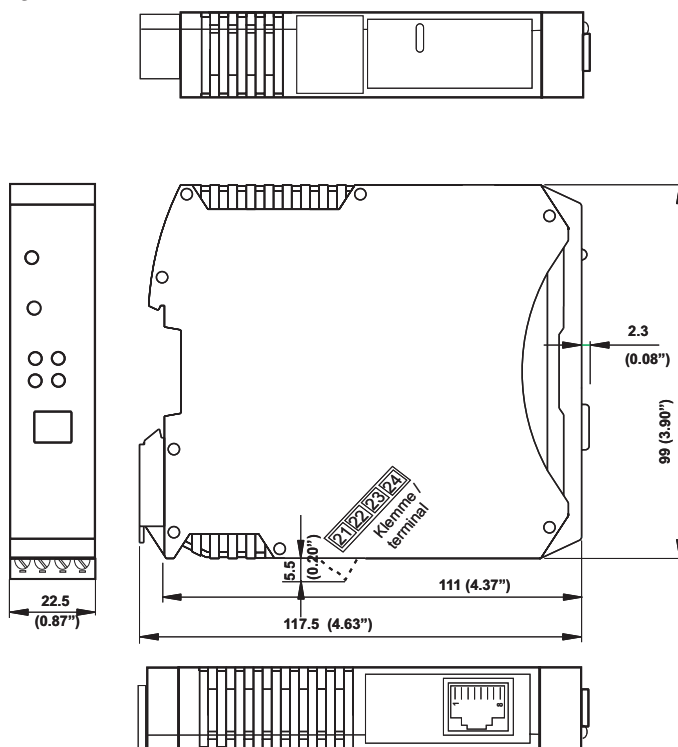
4.3	Mounting

Connection between bus coupler and function modules is via bus connectors, which snap onto the top-hat rail. Several devices are mounted side by side with high packing density. The bus links between the devices are made directly via the bus connectors.

Fig. 3   Mounting steps
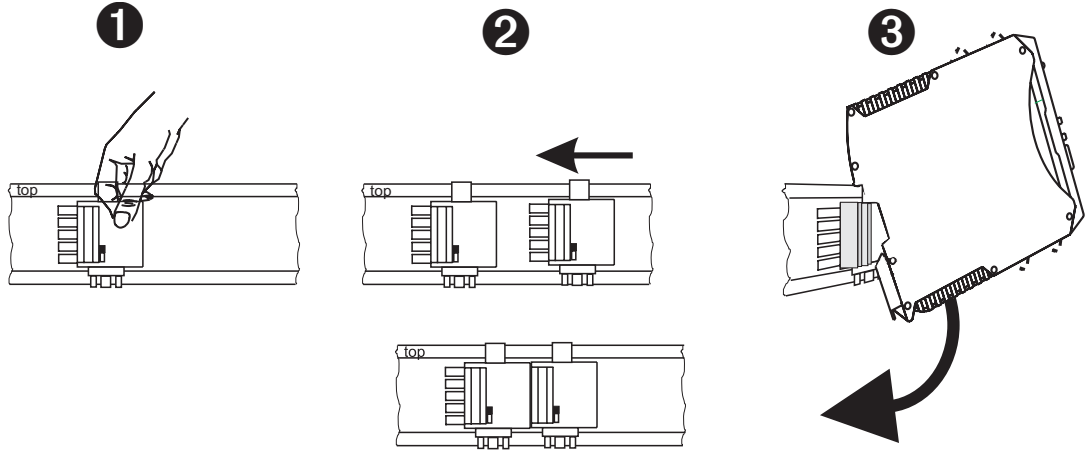
The instruments are provided for vertical mounting on 35 mm top-hat rails to EN 50022.

If possible, the place of installation should be exempt of vibration, aggressive fluids (e.g. acid, lye), liquids, dust or other suspended matters.

Instruments of the *rail line* family can be mounted directly side by side. For mounting and dismounting, the min. distance above and below the instrument from other equipment should be 8 cm.

For installation of the bus connection, proceed as follows:

❶   Snap on the bus connectors (delivered with the device) onto the top-hat rail

❷   For high-density mounting, push the bus connectors together.

❸   Clip the instruments onto the top-hat rail via the bus connectors
          - the internal system bus connection is ready!

Please, mount the bus coupler in the leftmost position and fit the function modules right of the bus coupler in the required order.

rail line **instruments do not contain parts for which maintenance is compulsory and need not be opened by the customer.**

Warning
A field bus coupler can energize max. 16 function modules. For connecting a higher number of modules RL PWR power supply modules must be used.

4.3.1	Dismounting

Dismounting is in the inverse order of the steps described above.

Fig. 4: Dismounting
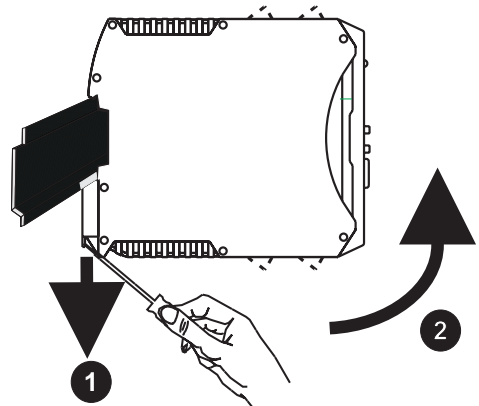
4.4	**Electrical connections**

4.4.1	**Bus coupler supply voltage**

A system comprising bus coupler and one or several function modules is energized centrally via the bus coupler. Central energization reduces the wiring expenditure considerably.

Fig. 5: Bus coupler energy supply conn.
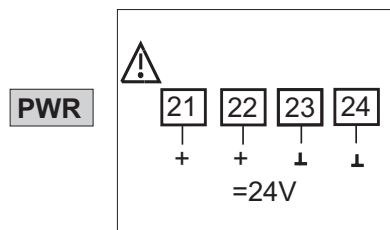
Warning
Energization at the function modules is not permissible.

A bus coupler can energize max. 16 function modules. For extension possibilities, see chapter 4.4.2.

4.4.2	**Energization via RL PWR power supply module**

Power supply module RL PWR is used for energization of function modules with system interface via the bus connector in the top-hat rail.

For connecting a higher number of function modules to the bus coupler than permissible for energization, additional power supply modules must be used.
Applications:
- Supplementary energization of additional function modules
- Repartition to different installation levels (e.g. two rows in a control cabinet)
- Construction of separate potential levels
- A power supply module can energize up to 16 function modules.

Fig. 6:   Energy supply connection   *Fig. 7: Ex: power supply module*

Warning
Energ. at the function modules is not permitted.

Warning
High-density mounting with other partial systems is not permissible.

Cascade connection of power supply modules is not permissible (see above).

4.4.3 Physical connection

Ethernet connection is via the front-panel bus coupler RJ45 interface.
10/100BaseT is used as physical layer.

Physical connection is via Ethernet using twisted two-wire cable (CAT5 cable, 8-pole in RJ-45 connection technique).

The connection is made by means of an RJ-45 socket.

Pin allocation RJ-45:

Contact	Signal	Description
1	TD +	Transmit +
2	TD -	Transmit -
3	RD +	Receive +
4	-	Not used
5	-	Not used
6	RD -	Receive -
7	-	Not used
8	-	Not used

Fig. 8: RJ45 socket

4.4.4 Cable layout

For connecting the field instruments, suitable bus cables for the application must be used. The wiring must comply with the general hints and regulations (e.g. VDE 0100):
- Cable layout in buildings (inside and outside cabinets)
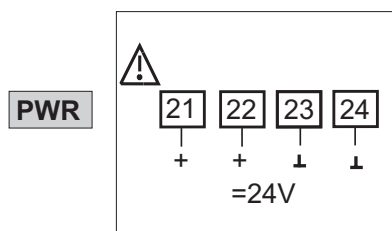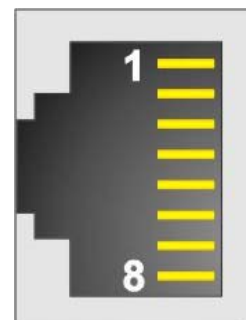- Cable layout outside buildings
- Potential compensation
- Cable screening
- Measures against interference voltages
- Length of tap line

In particular, the following information must be taken into account:
- With RS 485 technology, max. 32 field units can be connected in a segment at a bus cable. Several segments can be coupled by means of repeaters.
- The bus topology should be a line of max. 1000m length per segment. Extension by means of repeaters is permissible.
- The bus cable connection must be a "daisy chain" between field instruments rather than star-shaped.
- If possible, tap lines should be avoided to prevent reflections causing communication trouble. With higher transfer rates, tap lines are not permissible.
- The general hints for low-interference signal and bus cable wiring are applicable (see operating note „EMC – General information" (9407-047-09118)).

To increase the transfer safety, pairwisely twisted and screened bus cables can be used.

4.4.5 Screening

The type of screening connection is dependent mainly on the expected interference.
- For suppression of electric fields, one end of the screening must be connected to earth. Always realize this measure at first.
- However, suppression of interference due to an alternating magnetic field is possible only, when the both ends of the screening are connected to earth. With earth circuits, however, note the screening effect is reduced by galvanic interference on the reference potential.
- If several devices are linked to a single bus, the screen must be connected at each device, e.g. by means of screen clamps.
- Short distance bus screening must have a large-surface, low-resistance connection to a central protective earth, e.g. via screening terminals

4.5	**Ethernet settings**

4.5.1	**TCP port**

The ModbusTCP server expects TCP messages on TCP port 502. This port is reserved for ModbusTCP.

(i) When Port 502 is connected, LED 'BS' is lit.

4.5.2	**IP address and IP netmask**

The IP address can be determined in two different ways:
- via parameters by means of the BlueControl® engineering tool
- via BOOTP (Bootstrap protocol)

☞ For detailed information on the modes and settings, see chapter 4.6 .

The IP netmask is adjustable via parameter "IPSub". The default value is 255.255.255.0 .

4.5.3	**Connections**

(i) RL ETH can operate max. 4 connections at a time. Up to 16 messages can be handled.

4.6	**IP address definition**

The unique MAC-ID is specified in item "Mac-Adr." on the type label.
The IP address can be determined using two different methods.

☞ The allocated IP address must be unique in the network.

4.6.1	**Parameter setting via BlueControl®**

The IP address (4 byte) and subnet mask (4 bytes) can be set in the coupler via the BlueControl® software.

(i) If IP address 0.0.0.0 is specified, no valid address is provided (factory setting). In this case, the address can be defined via the BootP protocol.

4.6.2	**BOOTP (Bootstrap Protocol)**

BOOTP is a TCP/IP configuration service. A BOOTP client sends a BOOTREQUEST broadcast via address 255.255.255.255 into the network. BOOTP awaits a server reply (BOOTREPLY) during a defined time. Unless a reply is received, the client sends the broadcast again. BOOTP uses the UDP protocol for communication.

Procedure:
- To determine the IP address of Ethernet coupler RL ETH via BOOTP, a BOOTP server replying the Ethernet coupler inquiry must be provided.
- On Ethernet coupler RL ETH, the switch for the IP address must be set to 0.0.0.0.
- After switching on the Ethernet coupler, the sequence described above is started, the address is determined and stored in the Ethernet coupler EEPROM.
- When starting up the Ethernet coupler for the next time, the IP address is loaded from the EEPROM.

☞ In networks in which the IP addresses are defined via a DHCP server, a special BOOTP server is not required. The DHCP server allocates an IP address to Ethernet coupler RL ETH dynamically.

4.7 Switching on the device

After switching on the overall module, the Ethernet starts the start-up phase. The following tasks are completed:
- detection and interpretation of the IP address
- detection of fitted modules
- initialization of detected modules
- handling of already pending input data

4.8 Displays

Five bus coupler indicator LEDs indicate various operating statuses.
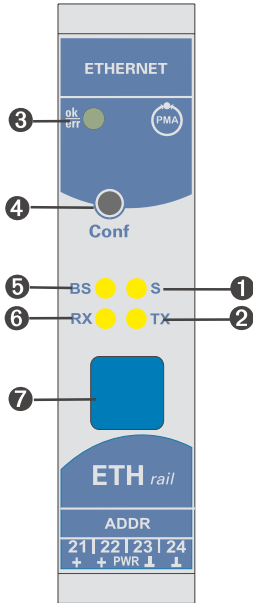
	Signification
1	System bus status indicator LED off: off blinks: searching modules on: communication active
2	**LED "TX" Ethernet Transmit** on:: send operation
3	Device status indicator LED * green: ok yellow: initialization yellow blinking: configuration difference red: no configuration red blinking: module failure
4	no function
5	**LED "BS" Ethernet connection** off no connection on connected
6	**LED "RX" Ethernet Receive** on receive operation
7	PC connection for engineering tool

* " green- yellow- red- off" alternating display: internal error status

5   System design

Up to 16 function modules can be connected and energized at a bus coupler. System extension is possible by using power supply modules:

- Up to 62 function modules can be addressed logically by a bus coupler.
- Up to 4 installation levels can be built up.
- The max. permissible extension is 10 m.

5.1   System structure

Using power supply modules offers many advantages:

- The number of function modules connectable to a bus coupler can be extended.
- The function modules can be distributed to different levels in the control cabinet.

A potential-isolated energy supply is possible.

ⓘ **The overall system length including cables must not exceed 10 m. Max. 3 m cable length between two**

Fig. 9: Possible system structure

interner Systembus / internal system bus

Versorgung / Power supply
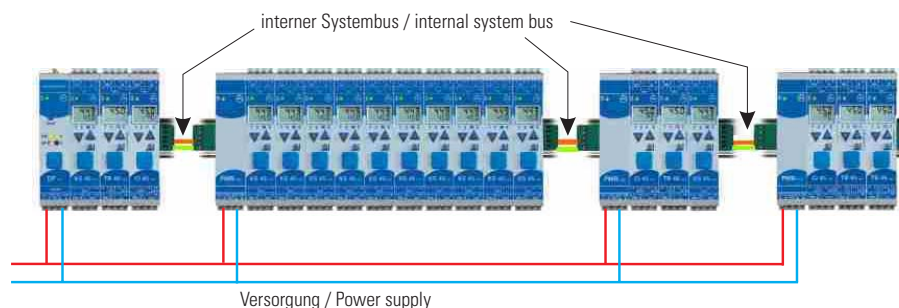
groups is permissible.

5.1.1   Hints for connection

For connecting the function modules energized by the bus coupler and the function modules energized by the power supply module, proceed as follows:

❶ Insert a connector (e.g. 9407-998-07141) on the right side of the group with the bus coupler into the bus connector in the top-hat rail.

❷ Insert a connector (e.g. 9407-998-07131) on the left side of the group with the power supply module into the bus connector.

❸ Use twisted and screened two-wire bus cable.
Connect conductor 1 with the lower contact S5 and conductor 2 with contact S4.

❹ Terminate the system bus with a terminating resistor LT = 100.
For this, insert a connector (e.g. 9407-998-07141) on the right side of the last group with a power supply module into the bus connector. Connect the resistor across terminals S4 - S5.

Fig. 10: Connecting
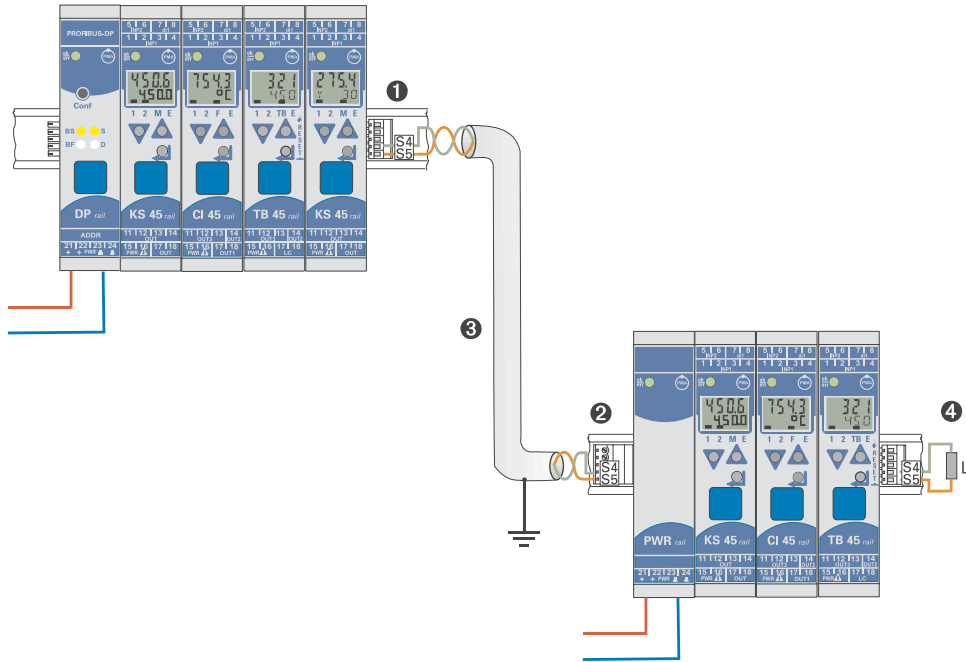
⚠️ **Don't interconnect a bus coupler and one or several power supply modules via bus connector. Connections via contacts S1 to S3 can lead to damage of the connected devices!**

5.1.2 Operation without bus coupler

ⓘ Power supply module RL PWR can be used also for energization of function modules with system interface, if the use of a bus coupler is planned only for the future, or if only a single function module version may be available due to reduced stock-keeping.

6 Bus protocol

6.1 General message structure

The maximum length of a Modbus/TCP message must not exceed 260 bytes.

The message is composed of the following elements:

MBAP header	Function code	Data
7 bytes	1 byte	N * 1 byte
	PDU (Process Data Unit)	

- MBAP header
  The MODBUS Application Protocol Header (MBAP) identifies the message and is composed of 4 information items.
  - Transaction Identifier (2 bytes) : identification of a transaction
  - Protocol Identifier (2 bytes) : protocol type (0 = MODBUS)
  - Length (2 bytes) : number of following bytes
  - Unit identify (1 byte) : identification of underlying slave

- Function code
  The function code defines the message type. The function codes supported by the RL ETH are described in chapter "function codes" ($\rightarrow$ p. 18).

- Data
  The data block includes the further specification of the action defined by the function block. The data block length is dependent on the function code.

The MBAP header structure and data origin are described in the following table :

Field	Length (bytes)	Description	Client	Server
Transaction identifier	2	Identification of MODBUS inquiry/reply message	Determined by client	Copied into reply of inquiry message
Protocol identifier	2	0 = MODBUS protocol	Determined by client	Copied into reply of inquiry message
Length	2	Number of following bytes	Determined in reply by client	Determined in reply by server
Unit identifier	1	Addressing of a remote slave which is connected to a subordinate.	Determined by client	Copied into reply of inquiry message

Further information is given in [1] … [4].

6.2 Module addressing

The access to the data of a special function module or of the bus coupler is controlled via the unit identifier in the MBAP header.

Unit Identifier	Description
0	Bus coupler addressing
1 … 62	Function module addressing

6.3 Function codes

The following MODBUS RTU protocol function codes are realized in the RL ETH:

Function code hex	dec	Description	Signification
0x03	3	Read Holding (Output) Register	Wordwise reading of process data, parameters and configuration data
0x04	4	Read Input Register	Wordwise reading of process data, parameters and configuration data
0x06	6	Preset Single Register (Output)	Writing a register wordwisely with word address
0x10	16	Preset Multiple Register (Output)	Writing several process data, parameters and configuration data wordwisely (also for floating point values)
0x17	23	Read/Write Registers	Writing outputs wordwisely with start address and number of outputs Reading inputs wordwisely with start address and number of inputs
0x2B	43	Read Device Identification	Manufacturer name, product code and software version read-out

ⓘ **Function codes 03 and 04 are not distinguished and are identical as to processing.**

ⓘ **Function codes 0x17 and 0x2B are supported directly only for data from the bus coupler . They can be used for access to the process data caches. Free access to any other data of the *rail line* devices are not possible with this function code.**

The message structure (PDU) is shown using examples in the following chapters.

6.3.1 Function: read output words / read holding register (FC= 3)

Inquiry:

Field name	Value (Hex)	Signification
Function	03	Wordwise output read-back
Start address High Startaddress Low	01 00	Start address 256_{dec}
Number of values	00 02	Number of values : 2 words

Reply:

Field name	Value	Signification
Function	03	Wordwise output read-back
Number of bytes	04	4 data bytes are sent
Value1	02 4B	Value1
Value2	01 03	Value2

6.3.2 Function: read input words / read input register (FC= 4)

Inquiry:

Field name	Value (Hex)	Signification
Function	04	Wordwise input reading
Start address High Start address Low	01 00	Start address 256_{dec}
Number of values	00 02	Number of values: 2 words

Reply:

Field name	Value	Signification
Function	04	Wordwise input reading
Number of bytes	04	4 data bytes are sent
Value1	02 4B	Value1
Value2	01 03	Value2

6.3.3 Function: write an output word / preset single register (FC= 6)

Inquiry:

Field name	Value (Hex)	Signification
Function	06	Write a register (wordwisely)
Register address High Register address Low	01 00	Start address 256_{dec}
Value	00 64	Set value to 100

Reply:

Field name	Value	Signification
Function	06	Write a register (wordwisely)
Register address High Register address Low	01 00	Start address 256_{dec}
Value	00 64	Set value to 100

6.3.4 Function: write output words / preset multiple register (FC= 16)

Inquiry:

Field name	Value (Hex)	Signification
Function	10	Write registers wordwisely
Bit address High Bit address Low	01 00	Start address 256_{dec}
Numb. bits High Numb. bits Low	00 02	Write 2 registers
Number bytes.	04	Number of bytes
Value 1	0201	
Value 2	05DC	

Replyt:

Field name	Value	Signification
Function	10	Write a register (wordwisely)
Bit address High Bit address Low	01 00	Start address 256_{dec}
Numb. bits High Numb. bits Low	00 02	

6.3.5 Function: read/write words / read/write register (FC= 23)

This function supports writing of several output words and read-in of several input words in a message.

Inquiry:

Field name	Value (Hex)	Signification
Function	17	Wordwise output writing and wordwise input reading
Read address High Read address Low	01 00	Start address 256_{dec}
Numb. read reg. High Numb. read reg. Low	00 03	Read 3 registers

Reply:

Field name	Value	Signification
Function	17	Wordwise output writing and wordwise input reading
Number read bytes	6	Read 3 registers
Value1	45 27	

Field name	Value (Hex)	Signification	Field name	Value	Signification
Write address High Write address Low	01 20	Start addres 288$_{dec}$	*Value2*	01 00	
Numb. write reg. High Numb. write reg. Low	00 02	Write 2 registers	Value 3	00 02	
Numb. bytes.	04	Number bytes			
Value 1	0201				
Value 2	05DC				

6.3.6 Function: encapsulated interface transport (FC=43)

RM 204 supports MEI index 14 (0x0E), which describes the data exchange for a device identification (Read Device Description). As access type, the basic device identification data are available:

- VendorName = PMA Prozess- und Maschinen-Automation GmbH
- ProductCode = Mod I/O RM204
- MajorMinorRevision = Mod I/O RM204

Inquiry:

Field name	Value (Hex)	Signification
Function	2B	Embedded interface transport
MEI type Read Device ID code	0E 01	Read Device Identification Read basic data
Object Identifier	00	0x00 VendorName 0x01 ProductCode 0x02 MajorMinorRelease

Reply:

Field name	Value
Function	2B
MEI type	0E
Read Device ID code	01
Conformity level	01
More Follows	00
NextObjectID	00
Number of Objects	03
Object Id	00
Object Length	2A
Object Value	"PMA Prozess- und Maschinen-Automation GmbH"
Object Id	01
Object Length	0D
Object Value	"Mod I/O RM204"
Object Id	02
Object Length	05
Object Value	"V1.02"

6.3.7	**Error reply**	

If the addressed device detects an error when evaluating the inquiry message, it sends an error telegram instead of the reply, which is composed of

- **address**
- **function, increased by 80$_{hex}$**
- **error code**

Inquiry:

Field name	Value (Hex)	Signification
Function	02	Read input bits
Start address High	01	Start address 256$_{dec}$
Start address Low	00	
Number of values	00	Number of values 22
	16	

Reply:

Field name	Value	Signification
Function	82	Error message
Num ber of bytes	02	Error code

Supported error codes are

- **01 Illegal function**　　　 **- function not supported**
- **02 Illegal data address**　 **- invalid data address**
- **03 Illegal data value**　　 **- invalid data value**
- **06 Slave device busy**　　 **- device busy handling tasks**

7   Address areas and -formats for function modules CI 45, KS 45, TB 45

The area definitions following are valid for the *rail line* function modules CI 45, KS 45, TB 45

7.1   Area definitions

The address is coded in 2 bytes. The most significant 3 bits determine the data transmission format.
The following formats are available for *rail line* devices:

- **Integer**
- **Integer with 1 decimal**
- **(Float acc. to IEEE)**

| Address area | | Data transfer format | Smallest | Largest | Resolution |
hex	dez.		transferable value	transferable value	
0x0000 ... 0x1FFF	0 ... 8191	Integer without decimals	-30000	+32000	+/- 1
0x2000 ... 0x3FFF	8192 ... 16383	Integer with 1 decimal	-3000.0	+3200.0	+/- 0.1
0x6000 ... 0x7FFF	24576 ...32767	Float (IEEE format)	-1.0 E+037	+1.0 E+037	+/-1.4E-045

ⓘ **For integer numbers with and without decimals, the value range -30000 to +32000 is transmitted via the interface. Scaling with the factor 1 or 10 must be carried out by the transmitting device as well as by the receiving device.**

7.2   Special values

The following special values are defined for transmission in the **integer format:**

- 31000 Sensor fault
  This value is returned for data that do not represent a meaningful value due to a sensor fault.
- 32000 Switch-off value
  The function is disabled.
- 32500 Undefined value
  The device returns this value, if a datum is not defined within the requested range
  („NOT DEFINED VALUE").
- 32768 Corresponds to 0x8000 hex.
  The value to be transmitted lies outside the transferable
  integer value range.

The following special values are defined for transmission in the **Float format:**

- 1.5E37 This datum is not defined.
  The device returns this value, if a datum is not defined within the requested range.

7.3   Composition of the address tables

In the address tables shown in Section 5, the addresses for every parameter of the corresponding data format are specified in decimal values.
The tables are structured as follows:

Name	R/W	Address	Integer	Real	Type	Value/off	Description
		base 1dP					

- Name   Description of the datum
- r/w   permitted type of access: R = read, W = write
- Address integer   Address for integer values
- base   Integer without decimals
- 1 dP   Integer with 1 decimal
- Real   Floating point number / Float (IEEE format)
- Type   internal data type
- Value/off   permissible value range, switch-off value available
- Description   Explanations

7.4   Internal data types

The following data types are assigned to data used in the device:

- Float
  Floating point number
  Value range: -1999 ... -0.001, 0, 0.001 ... 9999
- INT
  Positive whole integer number
  Value range: 0 ... 65535
  Exception: Switch-off value '-32000'
- Text
  Text string consisting of n characters, currently defined   n = 5
  Permissible characters: 20H...7FH
- Long
  Positive whole Long number
  Value range: 0 … 99999
- Enum
  Selection value

7.5   Address tables

(i) **For address tables related to process values, parameters and configuration datafor function modules UNIFLEX CI 45, KS 45 and TB 45,   see documentation 9499-040-78111.**

| 7.6 | **Annex of status / control information** |

The signification of selectable status and control information for the transmitted bus data (read / write) are explained in this chapter.

| 7.6.1 | **Transmitter UNIFLEX CI 45** |

Status words

Name	r/w	Type	Value/off	Description
St.Di	r	Int	...	Status of digital inputs or of keys (in binary code).
			Bit 0: input di1, Bit 8: status of Enter key Bit 9: status of decrement key, Bit 10: status of increment key	
St.Ain	r	Int	0...127	Analog input status in bit code (error, e.g. short circuit)
			Bit 0 break at input 1 Bit 1 wrong polarity at input 1 Bit 2 short circuit at input 1 Bit 3 not used Bit 4 break at input 2 Bit 5 wrong polarity at input 2 Bit 6 short circuit at input 2 Bit 7-15 not used	
St.Ala	r	Int	...	Alarm status: the status of individual alarms such as exceeded limit value in bitwise code
			Bit 0 pending/stored exceeded limit value 1 Bit 1 pending/stored exceeded limit value 2 Bit 2 pending/stored exceeded limit value 3 Bit 3-7 not used Bit 8 pending exceeded limit value 1 Bit 9 pending exceeded limit value 2 Bit 10 pending exceeded limit value 3 Bit 11-15 not used	
St.Do	r	Int	0...15	Digital output status
			Bit 0 digital output 1 Bit 1 digital output 2 Bit 2 digital output 3	
Fail	r	Enum	*Enum_InpFail*	Error at input, faulty or incorrectly connected sensor
			0 no error 1 sensor break 2 faulty input polarity 4 short circuit at input	

Control words

Name	r/w	Type	Value/off	Description
F.Di	r/w	Int	0...1	Digital input forcing. Forcing means external control of a device input, the device stores the value on this input (defined for device inputs by the supervisory system, e.g. for function testing) .
			Bit 0 Forcing for digital input 1	
F.Do	r/w	Int	0...15	Digital output forcing. Forcing means external control of at least one output, the device does not influence this output (use of free device outputs by the supervisory system)
			Bit 0 digital output 1 forcing Bit 1 digital output 2 forcing Bit 2 digital output 3 forcing	

7.6.2   Universal controller KS 45

Status words

Name	r/w	Type	Value/off	Description
St.Di	r	Int	...	Status of digital inputs or of keys (in binary code).
			Bit 0: input di1 Bit 8: Enter key status Bit 9: Decrement key status Bit 10: Increment key status	
St.Ain	r	Int	0...127	Status of analog inputs (error, e.g. short circuit in bit code)
			Bit 0 break at input 1 Bit 1 wrong polarity at input 1 Bit 2 short circuit at input 1 Bit 3 not used Bit 4 break at input 2 Bit 5 wrong polarity at input 2 Bit 6 short circuit at input 2 Bit 7-15 not used	
St.Ala		Int	...	Status of alarms: the status of individual alarms such as exceeded limit value and loop in bitwise code
			Bit 0 pending or stored exceeded limit value 1 Bit 1 pending/stored exceeded limit value 2 Bit 2 pending/stored exceeded limit value 3 Bit 3 not used Bit 4 pending/stored loop alarm Bit 5 pending/stored heating current alarm Bit 6 pending/stored SSR alarm Bit 7 not used Bit 8 pending exceeded limit value 1 Bit 9 pending exceeded limit value 2 Bit 10 pending exceeded limit value 3 Bit 11 not used Bit 12 pending loop alarm	

Bit 13 pending heating current alarm
Bit 14 pending SSR alarm
Bit 15 not used

St.Do	r	Int	0...15		Digital output status

Bit 0 digital output 1
Bit 1 digital output 2
Bit 2 digital output 3

Fail	r	Enum	*Enum_InpFail*		Error at input, faulty or incorrectly connected sensor

0	no error error
1	sensor break
2	faulty polarity at input
4	short circuit at input

Ada.St		Enum	*Enum_AdaStart*		starting / stopping the adaptation

After the start signal, the controller waits, until the process has reached the process at rest condition
(PIR) and starts self-tuning. Self-tuning can be cancelled manually at any time.

After successful self-tuning, the controller resets the signal automatically .

0	Stopping the adaptation leads to cancelation of the adaptation, the controller changes to control operation with the parameter values valid before adaptation start.
1	Adaptation start is from manual or from control operation.

St.Tune	r	Int	0...65535		Self-tuning status information, e.g. the actual condition and any results, warnings and error messages

Bit 0	process at rest; 0 no; 1 yes
Bit 1	controller self-tuning mode; 0 off; 1 on
Bit 2	controller self-tuning result; 0 OK; 1 error
Bit 3 - 7	not used
Bit 8 - 11	result of heating attempt
0 0 0 0	no message /attempt running
0 0 0 1	successful
0 0 1 0	successful with exceeded set-point hazard
0 0 1 1	error: faulty output action
0 1 0 0	error: no process reaction
0 1 0 1	error: low return point
0 1 1 0	error: exceeded limit limit value hazard
0 1 1 1	error: output step change too small
1 0 0 0	error: set-point reserve too small
Bit 12 - 15	result of cooling attempt

(as heating attempt)

Name	r/w	Type	Value/off	Description
St.Prog	r	Int	0...255	The programmer status contains e.g. at which point of the program sequence the program is in bit code .

Bit 0,1,2	segment type	
	0: rising,	
	1: falling	
	2: holding	
Bit 3	program run	
Bit 4	program end	
Bit 5	program reset	
Bit 6	program start flank missing	
Bit 7	program BandHold + FailHold	
Bit 8	programmer active	

Control words

Name	r/w	Type	Value/off	Description
F.Di	r/w	Int	0...1	Digital input forcing. Forcing means external control of a device input, the device stores the value on this input (defined for device inputs by supervisory system e.g. for function testing.)
			Bit 0 forcing for digital input 1	
F.Do	r/w	Int	0...15	Forcing of digital outputs. Forcing means external control of at least one output, the device does not influence this output (use of free device outputs by supervisory system)
			Bit 0 digital output 1 forcing	
			Bit 1 digital output 2 forcing	
			Bit 2 digital output 3 forcing	

7.6.3   Temperature limiter TB 45

Status words

Name	r/w	Type	Value/off	Description
St.Di	r	Int	...	Status of digital inputs or of keys (in binary code).
			Bit 0: input di1	
			Bit 8: Enter key status	
			Bit 9: Decrement key status	
			Bit 10: Increment key status	
St.Ain	r	Int	0...127	Status of analog inputs (error, e.g. short circuit) in bit code)
			Bit 0 break at input 1	
			Bit 1 wrong polarity at input 1	
			Bit 2 short circuit at input 1	
			Bit 3 not used	
			Bit 4 break at input 2	
			Bit 5 wrong polarity at input 2	
			Bit 6 short circuit at input 2	
			Bit 7-15 not used	

St.Ala	r	Int	...	Status of alarms: the status of individual alarms such as exceeded limit value in bitwise code
			Bit 0 pending/stored exceeded limit value 1	
			Bit 1 pending/stored exceeded limit value 2	
			Bit 2 pending/stored limit value 3	
			Bit 3-7 not used	
			Bit 8 pending exceeded limit value 1	
			Bit 9 pending exceeded limit value 2	
			Bit 10 pending exceeded limit value 3	
			Bit 11-15 not used	

St.Do	r	Int	0...15	digital output status
			Bit 0 digital output 1	
			Bit 1 digital output 2	
			Bit 2 digital output 3	

Fail	r	Enum	Enum_InpFail	error at input, faulty or incorrectly connected sensor
			0 no error	
			1 sensor break	
			2 faulty input polarity	
			4 input short circuit	

8 Bus coupler data

Bus coupler data are accessible directly. Included are coupler parameters and the function module process data which are kept directly on the coupler for fast communication.

ⓘ For bus coupler data addressing, set the unit identifier to 0.

8.1 Survey

Address range from		Data content	Access
hex	dec		
0x0001 ...	1	Function module process information	read
0x1000	4096	Data memory (cache) read data; integer format	read
0x1800	6144	Data memory (cache) write data; integer format	read / write
0x2000	8192	Bus coupler parameters	read / write
0x2900	10496	Coupler IP parameters	read / write
0x6000	24576	Data memory (cache) read data; floating point format	read
0x7000	28672	Data memory (Cache) write data; floating point format	read / write

8.2 Function module status information

There is one status word per function module.

- Address 1:   module 1
- Address 2:   module 2
  ...
- Address 62: module 62

For status word definition, see chapter 8.3, page 32 .

9   BlueControl® engineering tool

This chapter describes how to handle the BlueControl® system assistant for rail line instruments.

ⓘ **Only the expert system assistant version is available.**

☞ **The procedure described below is not necessary with the PROFIBUS-DP bus coupler RL DP, because the settings are made via the bus master parameter setting tool.**

9.1   Defining the configuration

Before taking a field bus node into operation, the configuration must be defined. Enter order, function module type and device version.

The coupler module selected in **Device selection** is always set into position "0" automatically. This is the head station of the *rail line* system. All communication via the field bus is via this module.
The following modules are called function modules.

❶ Select the function module type
by means of double click on the module or by clicking on the function module and on button "Add entry" (1) in window "System configuration".

❷ Define the exact device configuration

ⓘ Only versions with 24V and system interface are permissible.

❸ Determine the order.
The order can be changed by one position at a time using "Move entry up" (3) or "down" (4). Click on button "Remove entry" (2) to remove an entry.

Allocated buttons:
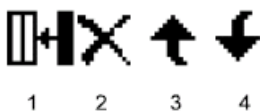
ⓘ See also on-line help of the tools, which can be called up via button "Help".

Fig. 11: Function module selection in system view

❹ On page "Parameter", the module settings for the behaviour in the system are adjustable.
– The data type describes the format of process data transmitted via the bus (integer / floating point).
The process data are determined when setting the parameters of the individual modules.
– The group parameter determines which values are output by the modules in case of bus transmission failure between external master (PLC) and bus coupler. (see chapter xxxx)
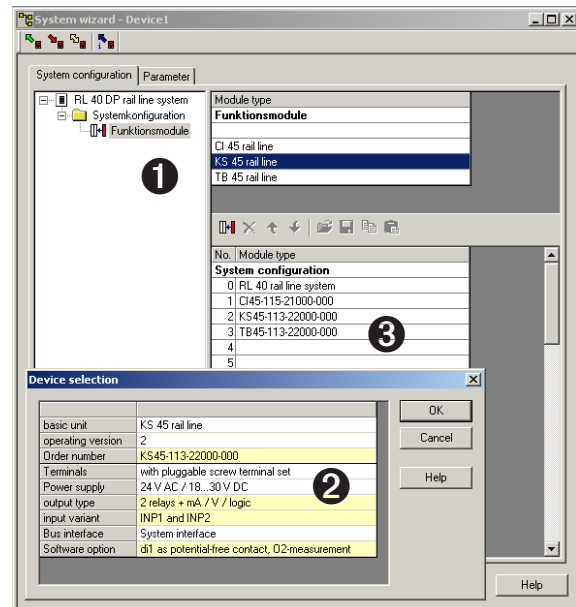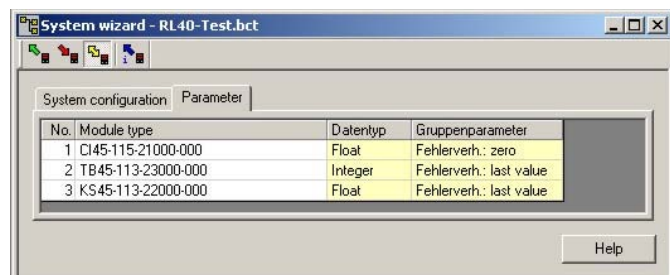
Fig. 12: Instrument behaviour configuration
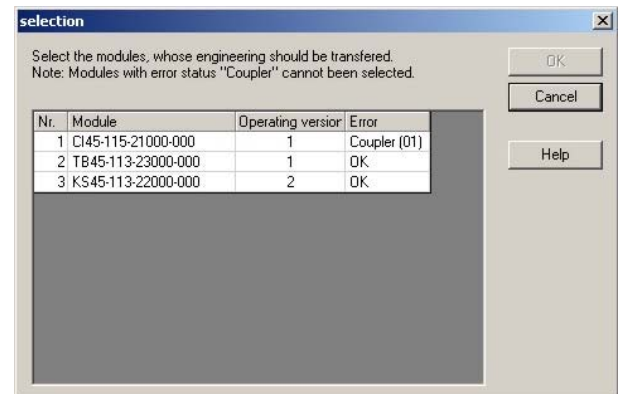
❺ Assign addresses 1 to n (via front panel keys or engineering tool) to the function modules in mounting order starting at the coupler).

❻ The defined configuration is sent to the bus coupler via the front-panel interface, and stored.

👉 **Unless the defined configuration corresponds to the actually provided function modules, an error is output.**

Error message explanation:

Fig. 13: Error display

Error	Description	Causes
OK	Everything ok	
Coupler (01)	Communication error	• Module not fitted • Module failed • Error on system bus
Coupler (02)	Deviation from defined configuration	• Defined configuration does not correspond to the fitted module.
Module (01)	A sensor alarm was output	• Sensor break detected • Short circuit or wrong polarity detected
Module (02)	A limit value was exceeded	• Limit value exceeded • Heating current alarm generated
Module (04)	Device-specific information	• Device error occurred • Maintenance manager signal (operating hours, number of switching cycles)
Module(08)	Write value out of limits	• Setpoint out of adjusted limits • Value out of permissible limits

The error code digits are in HEX format.

👉 **Error messages can be generated also in combination.**

Examples:
- Module (03) = exceeded limit value + sensor alarm
- Coupler (03) = communication error + configuration divergence;
  cause e.g. faulty module address
- Module (0E) = exceeded write value + device error + limit value exceeded.

☞ **Reset of error messages can be displayed also only after a second read operation.**

9.2	**Comparison with actual configuration**

When loading the engineering from the field bus coupler, the defined configuration is read. Unless error "coupler (xx)" is displayed, the defined configuration corresponds to the actual configuration.

9.3	**Viewing the process data on the bus coupler**

On on-line connection to the bus coupler is built up via button "Connection to device" .
The following information per configured function module is provided:

❶ Function module type with position number
❷ Error status (see below)
❸ Read process data, values read by the module (defined in the module engineering)
❹ Written process data, data written by the bus coupler (defined in the module engineering)

Fig. 14: Process data survey

Status information structure:

D7	D6	D5	D4	D3	D2	D1	D0

Bit no.	Signification (with Dx = 1)	Cause	corresponds to error
D0	Sensor alarm generated	• Sensor break detected • Short circuit or wrong polarity detected	Module (01)
D1	Limit value exceeded	• Limit value exceeded • Heating current alarm generated	Module (02)
D2	Device-specific information	• Device error detected • Maintenance manager signal (operating hours, number of switching cycles)	Module (04)
D3	Write value out of limits	• Setpoint out of the adjusted limits • Value out of the permissible limits	Module (08)
D4	Communication error	• Module not fitted • Module failed • Error on system bus	Coupler (01)
D5	Divergence from defined configuration	• Defined configuration does not correspond to actually inserted module.	Coupler (02)
D6-D7	Reserved		

ⓘ **Write values can be defined during on-line mode, unless a field bus interface is connected.**

9.4	**Processing a function module engineering**

| 9.4.1	**Individual engineering**

A device engineering can be transmitted into the function module in different modes:

- connection via the module front-panel interface
- connection via the bus coupler front-panel interface and further transmission via internal system bus

In the second case, the module is addressed as follows:

❶ Click on the selected module in the system assistant.
❷ Click on button "Parameter and configuration" or select menu "View - Parameter".
❸ Load the device engineering from the module, process it and restore it in the device.

Fig. 15: Function module engineering

System assistant   Parameter and Configuration
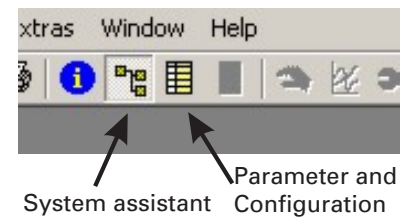
ⓘ When transmitting the information, "Front" must be defined in item "Device connection" . The module index is entered automatically.

Fig. 16: Select transmission path
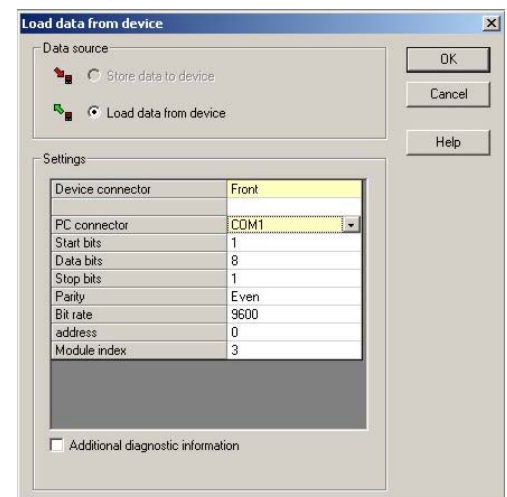
9.5   Ethernet coupler parameter setting

The IP address of bus coupler RL ETH is adjustable on the parameter page.
Proceed as follows:

- Click on module type no. 0 "RL 40 rail line system" in the system assistant.
- Press button "Parameter and configuration" or select menu "View - Parameter".
- Click on button Bus coupler.
- Determine the IP address.

Fig. 17: Bus coupler parameters
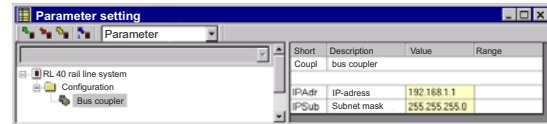
☞ **The IP address must be determined in format "xxx.xxx.xxx.xxx" , leading zeros should be omitted.**
Example: "169.254.85.1"

ⓘ **Address 0.0.0.0 is an invalid address (default setting). In this case, the IP address can be assigned via a BootP protocol.**

A sub-network is created by dividing all possible IP addresses into partial networks. The logical network division into sub-networks normally corresponds to the physical division into partial networks.
Subnet mask IPSub defines the available address space for networks.
All network mask bits set to 1 mark the corresponding bit of the IP address as network part addressing the relevant sub-network. The bits set to 0 mark the host part for addressing each individual computer in the subnet.

10   Index

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