



Modular Controller System KS vario



Interface Description

EtherNet/IP

9499 040 79311

valid from 09/2005

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1.

General

Modular controller system KS vario permits connection of various fieldbus interfaces. For this purpose, the relevant bus coupler is used as a head station for a controller system.

Via one of these bus couplers, the EtherNet/IP protocol is supported by means of a front-panel interface (RJ 45 connector). Hereby, transmission of all process, parameter and configuration data is possible. This communication interface permits communication with supervisory systems, visualization tools, etc.

Another standard interface is provided on the KS vario controller modules. This full RS 232 interface is used for connection to the 'BlueControl®' tool, which runs on a PC.

Transfer rate
Capacity

The EtherNet/IP bus coupler works as a communication adapter with a maximum transfer rate of 100Mbit.

The EtherNet/IP bus coupler permits up to 16 EtherNet/IP connections / sessions as well as one Modbus-TCP connection (alternative connection BlueControl®).

2.

Hints for operation

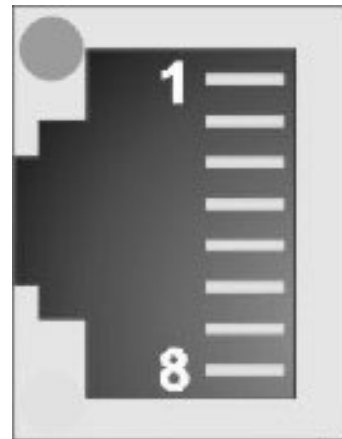
2.1. Connecting the interface

The physical Ethernet connection is provided via the front RJ 45 interface using twisted-pair cable (CAT5 cable, 8 poles with RJ 45 connectors). 10BaseT or 100BaseT is used as physical layer.

Pinning of RJ 45 connector

Pin	Signal	Description
1	TD +	transmit +
2	TD -	transmit -
3	RD +	receive +
4	-	unused
5	-	unused
6	RD -	receive -
7	-	unused
8	-	unused

Figure 1: Connector for RJ 45



Green LED (Link Status):

- off: no link
- on: link

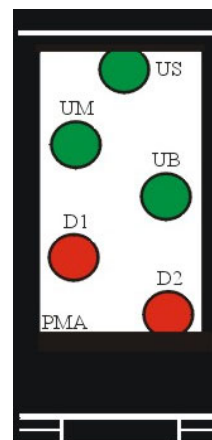
Yellow LED (Activity):

- off: no activity
- flashing: port activity

2.2. Signification of indicator LEDs on the bus coupler

LED no.	LED colour	Function
US	green	24V segment voltage provided
UM	green	24V main supply provided (presently not used)
UB	green	24V ₊ coupler voltage provided
D1	red	ON: no connection to PLC FLASHING: connection to PLC (idle mode) OFF: connection to PLC (run mode)
D2	red	FLASHING: faulty communication to controller OFF: communication to controller is ok

Figure 2: LEDs



2.3. Forcing

Physical Inputs / Outputs

All physical inputs can be overwritten (configurable) via Ethernet. Thus e.g. process value measurement via remote I/O (e.g. VARIO I/O system) and entry via the bus are possible.

2.4. Fail-safe

In case of bus failure or PLC Idle mode the instrument operates according to the following rules:

- forced analog inputs are set to FAIL
- forced digital inputs are set to zero
- forced outputs are set to zero

2.5. Run / Idle Mode

The EtherNet/IP bus coupler supports evaluation of the Run / Idle message via a 32-bit header in accordance with CIP specification (Common Industrial Protocol Specification, Edition 2.1, Chapter 3-6.5).

Consequently, the data written by the PLC are only transferred to the controller during the Run mode. When changing to the Idle mode, the fail-safe function (see above) is activated.

3. Communication via Ethernet

3.1. Physical Layer

10BaseT or 100BaseT is used as physical layer (std. IEEE 802.3).

3.2. Data Link Layer Ethernet / MAC-ID

Ethernet transports Ethernet packets from a sender to one or several receivers without acknowledgement and without repetition of lost packets.

Senders and receivers of Ethernet packets are addressed via the MAC-ID. The MAC-ID is a 6-byte ident code, which is unambiguous, i.e. worldwide different for each unit connected to Ethernet. The MAC-ID consists of two parts. The first part, i.e. the first 3 bytes, are a manufacturer identification. PMA GmbH uses the identification 00 0E 0D. The next 3 bytes are determined by the manufacturer and correspond to a series number. They are unique. The MAC-ID can be used, for instance, for the BootP protocol for adjustment of the IP address.

For this purpose, a telegram is sent to the relevant node, including information such as name or IP address.

3.3. Network Layer IP

Basis of data communication is the Internet Protocol (IP). IP transports data telegrams between communicating units connected in the same or a different network and provides address management (finding and assignment of MAC-IDs), segmenting and routing.

3.4. Transport Layer

The IP based Transmission Control Protocol TCP is known as a connection-oriented protocol, which means that a connection is established and maintained until such time as the message or messages to be exchanged by the application programs at each end have been exchanged. It includes treatment mechanisms. Lost telegrams are repeated.

UDP is a connection-less transport protocol. It does not include control mechanisms during data exchange between sender and receiver. This results in a higher processing speed than e.g. with TCP. Checking whether the telegram has arrived must be done by the superordinate protocol.

3.5. Application Layer EtherNet/IP

EtherNet/IP (EtherNet / Industrial Protocol) is an industrial communication system for exchanging CIP (Common Industrial Protocol) based application information. EtherNet/IP uses standard Ethernet and TCP/IP technology to transport CIP objects. EtherNet/IP provides a producer/consumer model for data exchange. The producer/consumer allows transfer of application data between a sending device (producer) and many receiving devices (consumers) without the need to send multiple times to multiple destinations (by the use of IP Multicast technology). For more details see "The CIP Network Library, Volume 2, EtherNet/IP Adaption of CIP".

3.6. IP address of the KS vario system via BootP protocol

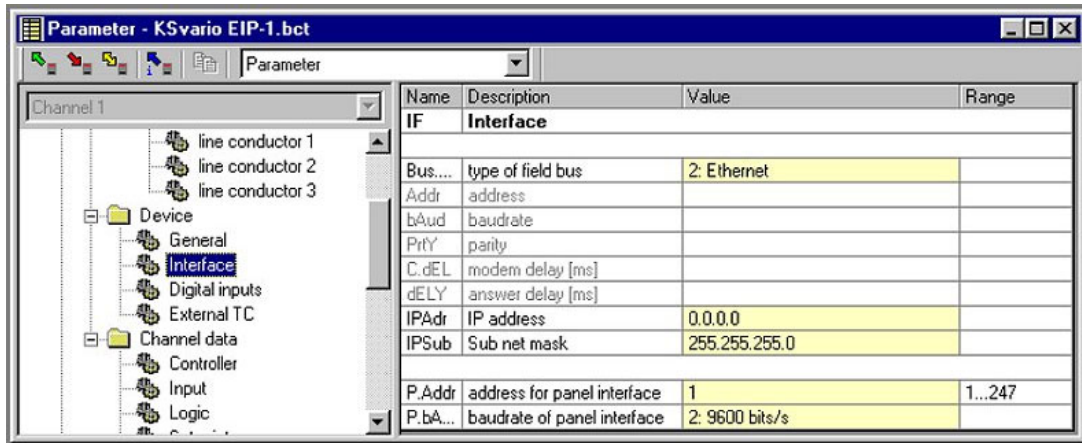
IP address and sub-net mask can be requested with the BootP protocol. After power-on, the BootP protocol is always sent, unless an own IP address is known. Known means that it was determined using the "BlueControl®" engineering tool .

Hint: If an IP address is known, NO BootP request is sent after power-on!
See page 12 - 5.

3.7. IP address of the KS vario system via engineering tool "BlueControl"

IP address (4 bytes) and sub-net mask (4 bytes) can be entered into KS vario by the BlueControl® tool. KS vario transmits this information to the bus coupler during initialization. If the IP address is determined as "0:0:0:0" via the tool, the bus coupler detects this address as invalid and address determination via BootP becomes relevant.

Figure 3: Set parameters of IP address and sub-net-mask of KS vario.



4.

Addressing in the EtherNet/IP bus coupler

4.1.

Access to data of the cache memory in the bus coupler

Any process data and parameters can be selected in KS vario using the "BlueControl®" engineering tool. This data is updated continuously in the bus coupler cache memory. The process data cover a maximum data range of 1080 word data in write cache and read cache.

4.1.1

Definition of transmitted values in the engineering tool "BlueControl"

BlueControl® provides two methods for selecting the data to be read or to be written:

- Any max. 120 parameters and process data from different channels for writing and max. 120 for reading. The position determines the order of transmission.
- Additionally or as an alternative, any max. 32 parameters and process data can be selected in common for all channels. Thus e.g. the process values from all channels (max. 30) can be transmitted by selecting one data. In total, max. 960 write and read data can be defined (32 data x 30 channels).

These selected data (max. 1080 write and 1080 read data) are available in the bus coupler as cache memory in the order defined in BlueControl®. The indices or offsets of the individual data are displayed via the BlueControl® engineering tool or can be printed out.

4.1.2

Structure of and access to the data cache in the EtherNet/IP bus coupler

The basic structure of write and read cache is identical and is shown in the following table:

Cache-Index	Content
1 max.120	any data from any channels
max. 121 max. 1080	Selected data (identical for all channels): all channel 1 data all channel 2 data ... all channel 30 data

Hint:

Independent from the internal data processing (INT / REAL), cache data are transferred in 16-bit (word) format only (REAL is converted to FixPoint1).

Limitation by EtherNet/IP protocol:

Due to the maximum "connection size" (502 byte) of the CIP Forward_Open command maximally 250 "bus data (read)" and 248 "bus data (write)" can be transferred with **one** EtherNet/IP connection (session) from the cache. I.e. cache data with larger indices are not transmitted !

Figure 4: Example – The configuration of 4 data as receive data (16 bits each).

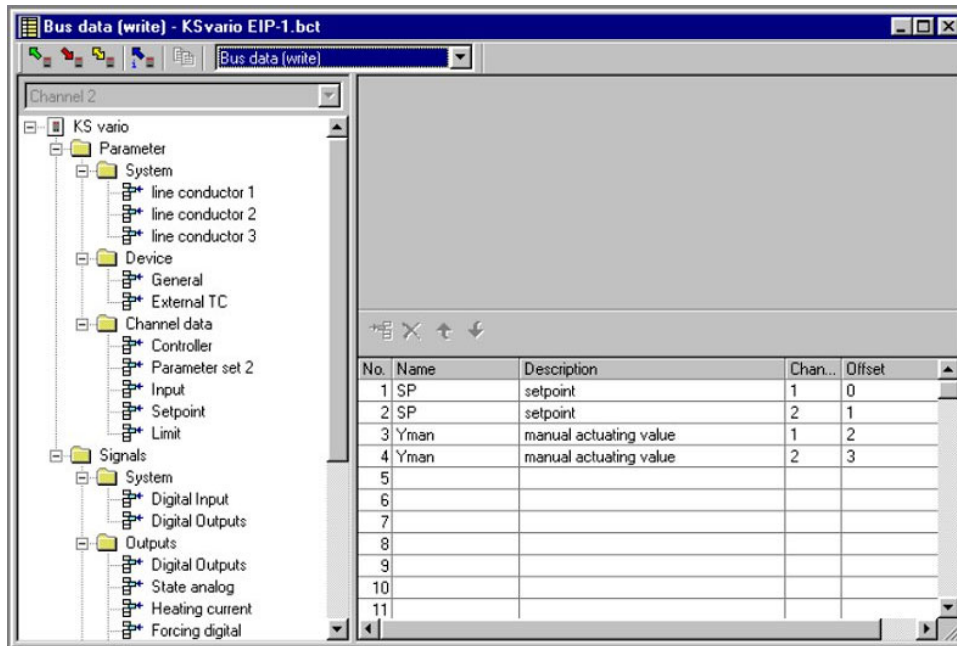
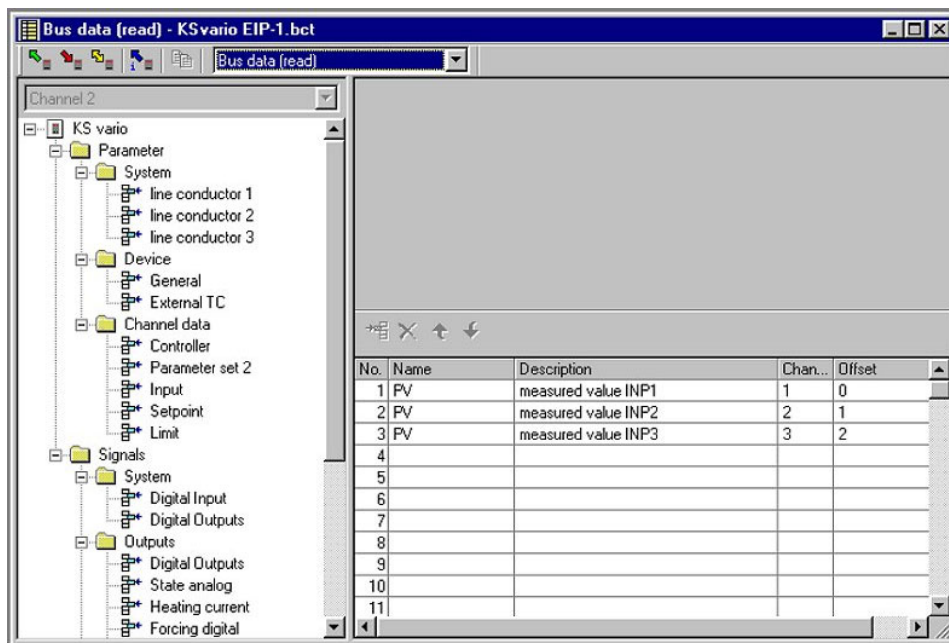


Figure 5: Example – The configuration of 3 data as transmit data.



4.2. Explanation of the data presentation in the KS vario

Transferable values:

Integer:	-30000 ... +32000	(resolution: ± 1)
Fix Point 1:	-3000.0 ...+3200.0	(resolution: $\pm 0,1$)
Float:	-1.0 E+037...+1.0 E+037	(resolution: $\pm 1.4E-045$)

The following special values are defined for transferring values in integer format:

-31000	fail signal (e.g. with input not connected)
-32000	function is switched off
-32500	invalid cache value (not configured)

Hint:

Instead of the value "-32500" the value "0" can be shown, if the number of receive data "bus data (write)" is bigger than the number of transmit data "bus data (read)".

4.3. Access via Explicit Messaging

The data (- objects) of the KS vario are described in the parameter table (9499-040-72911). The selective access to an individual object is made via the CIP specific addressing with "class, instance, attribute". BlueControl® can export a download list, which provides the address assignment of the data (- objects) used in the engineering. As the implementation of the "Explicit Message" access depends on the used PLC programming environment (e.g. "MSG command" with Rockwell RSLogix 5000), this document does not describe the "Explicit Message" access in details.

5. PLC communication example with Rockwell (RSLogix 5000)

Quickstart for the communication with a PLC

5.1. IP address assignment via BootP

If no valid IP address has been adjusted in BlueControl® (page 8 - 3.7.), the assignment must be done via a BootP server. The Rockwell BootP/DHCP is a suitable server. For this, the EtherNet/IP bus coupler transmits BootP requests cyclically.

Figure 6: The BootP server shows the cyclical requests (here: EtherNet/IP bus coupler) with the associated MAC-ID.

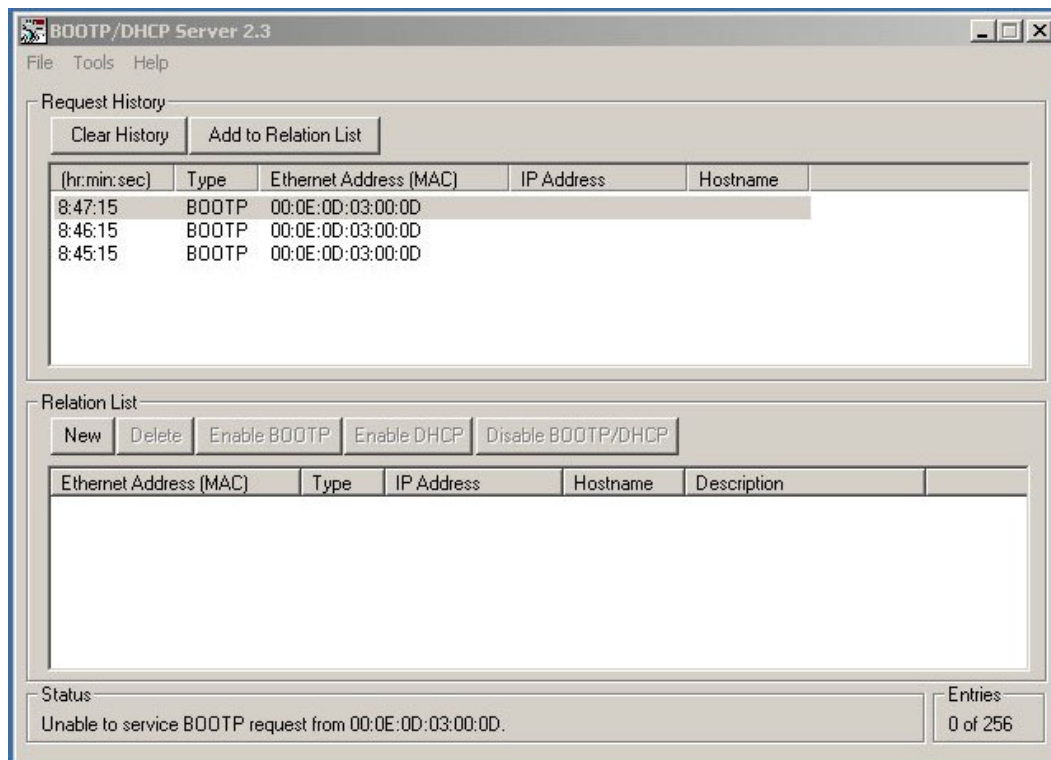


Figure 7: Double-clicking (or right mouse key → Add to Relation List) on the required MAC-ID opens the dialog box, in which the assigned IP address is entered.

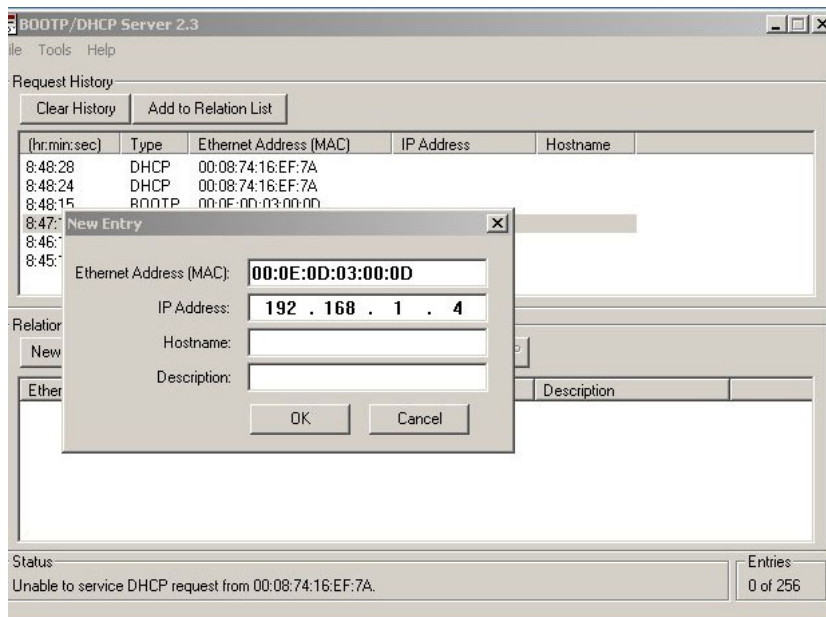
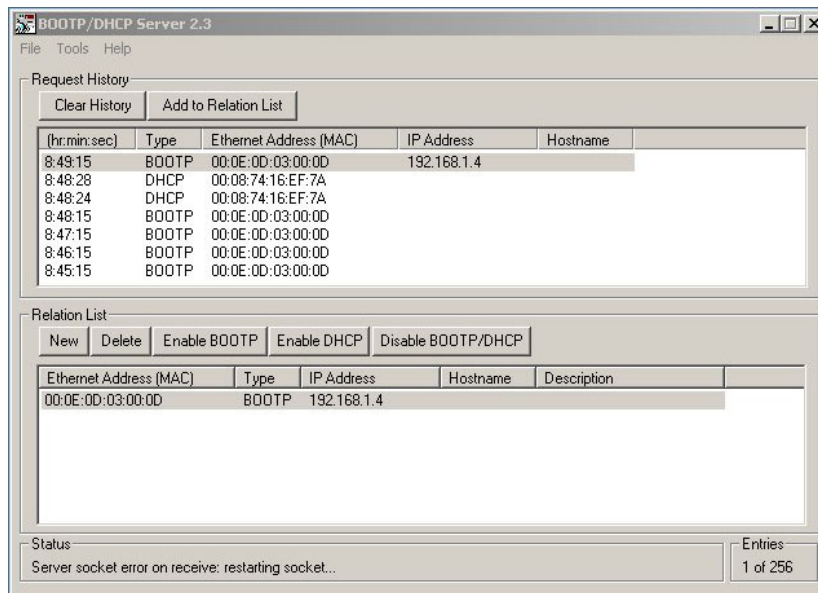


Figure 8: Subsequently, the assignment can be verified in the Relation List. (The Rockwell server offers the possibility of storing the assignment list.) The next BootP request from the bus coupler is then processed in accordance with the adjustments (see Request History).



Important: After the next PowerOff/On, another BootP request is issued, i.e. a BootP server must be running in parallel!

Alternative (recommended): Permanent setting of the IP address via configuration with BlueControl®.

5.2. Assignment / definition of bus data

The transmit and receive data required for the application can be assigned/defined easily with BlueControl® (see Page 9 - 4.1.1).

Figure 9: After setting the values 1200, 1100, and 1000 in the PLC, and changing to the Run mode, the setpoints are also shown in BlueControl®. See also Figure 10, below. However, this does not apply for Channel 3, as this channel indicates a FAIL signal at its input.

	device	Channel 1	Channel 2	Channel 3	Channel 4	
Overview						
process value		200.1	200.2	FAIL	FAIL	F
Internal setpoint		0.00	0.00	234.0	320.1	3:
Effective setpoint		0.00	0.00	234.0	320.1	3:
control deviation						
Actuating variable		-100.0	-100.0	0.0	0.0	0:
Manual operation		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2nd setpoint		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
controller off		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Boost		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gradient active		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soft start function active		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All channels automatic		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All channels off		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Loaded setpoint	inactive					

Figure 10: OnlineMode of BlueControl® engineering tool

	device	Channel 1	Channel 2	Channel 3	Channel 4	
Overview						
process value		200.1	200.0	FAIL	FAIL	F
Internal setpoint		120.0	110.0	234.0	320.1	3:
Effective setpoint		120.0	110.0	234.0	320.1	3:
control deviation						
Actuating variable		-100.0	-100.0	0.0	0.0	0:
Manual operation		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2nd setpoint		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
controller off		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Boost		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gradient active		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soft start function active		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All channels automatic		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All channels off		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Loaded setpoint	inactive					

5.3. Configuration of the bus coupler in the PLC (using RSLogix5000)

Within the PLC project, the bus coupler must be integrated and configured as a new module. It is entered via the menu item "I/O Configuration".

Figure 12: First, the associated Ethernet bridge (here: 1788-ENBT) must be selected via "I/O Configuration". Subsequently, clicking the right mouse key in the context menu permits the item "New Module" to be selected.

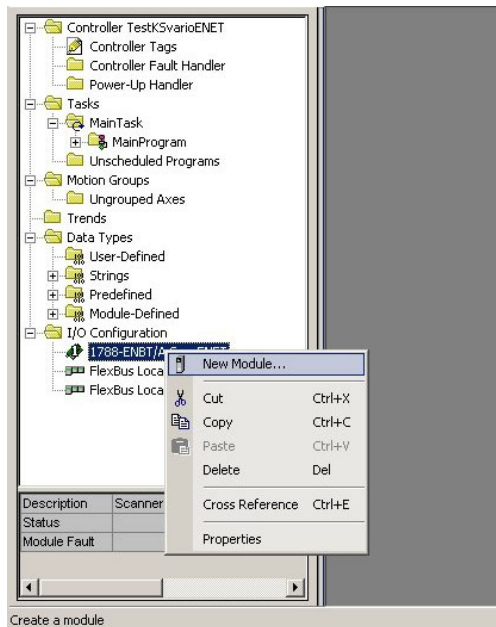


Figure 11: Next, the "Generic Ethernet Module" is selected. All "non-Rockwell" modules are entered under this module type.

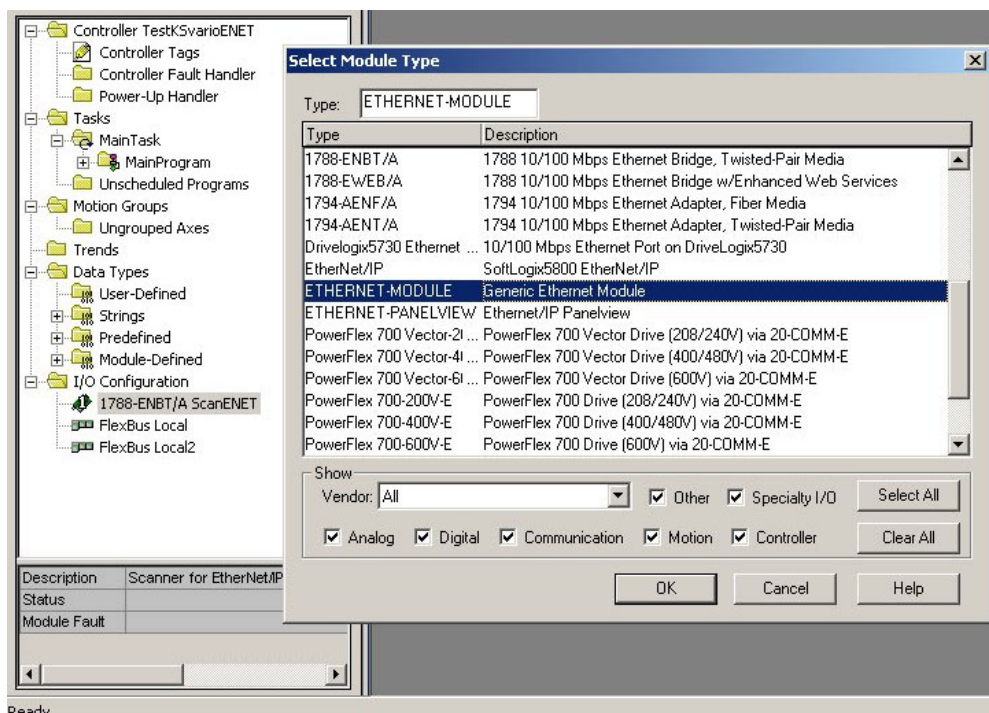
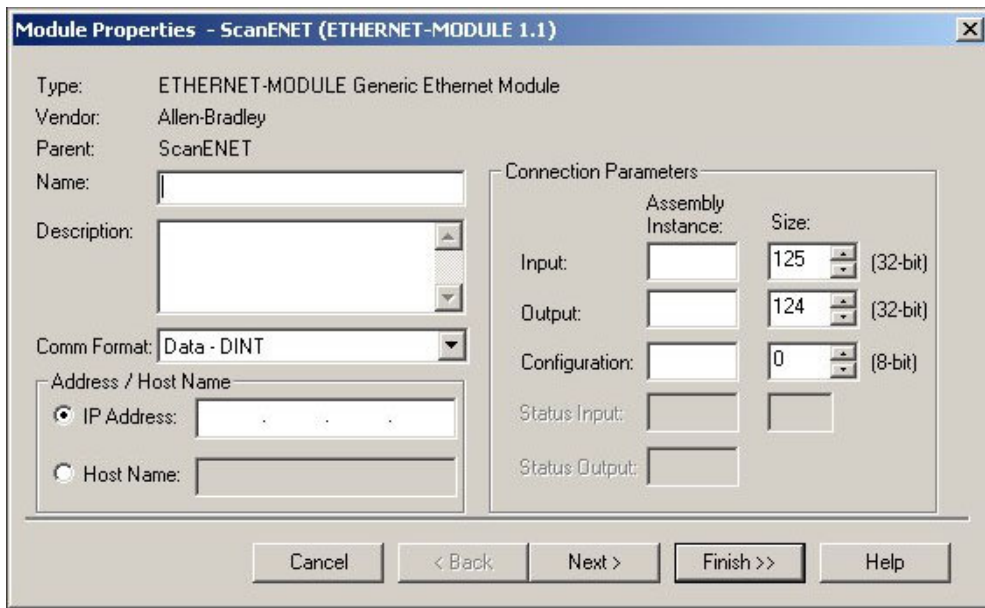
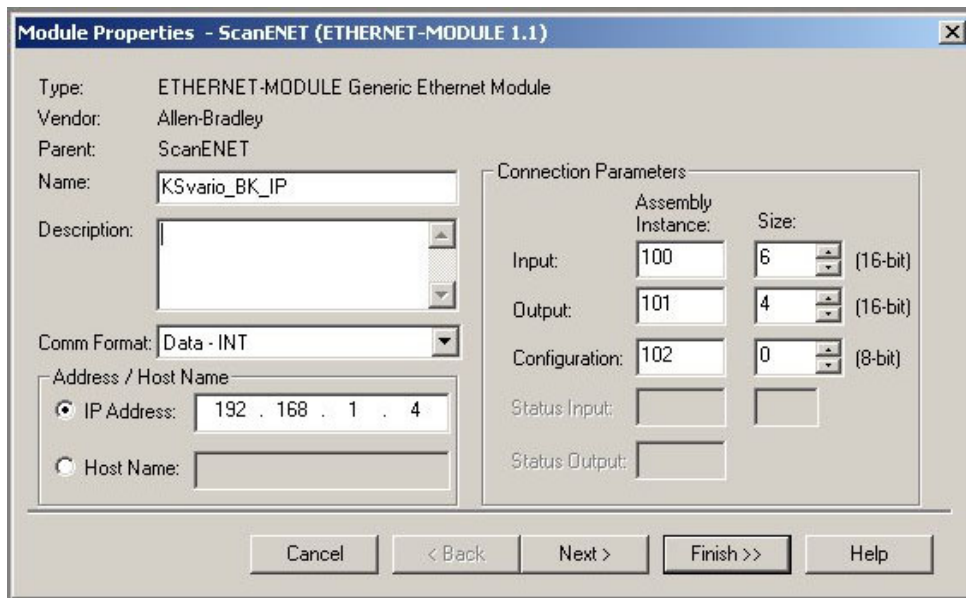


Figure 13: The "Module Properties" window is opened, in which the following entries are required: Name, Comm Format, IP Address, Connection Parameters.



!!!! Important: The Comm Format must be changed to Data - INT (16-bit) (after clicking on "Finish", these entries cannot be changed !!!).

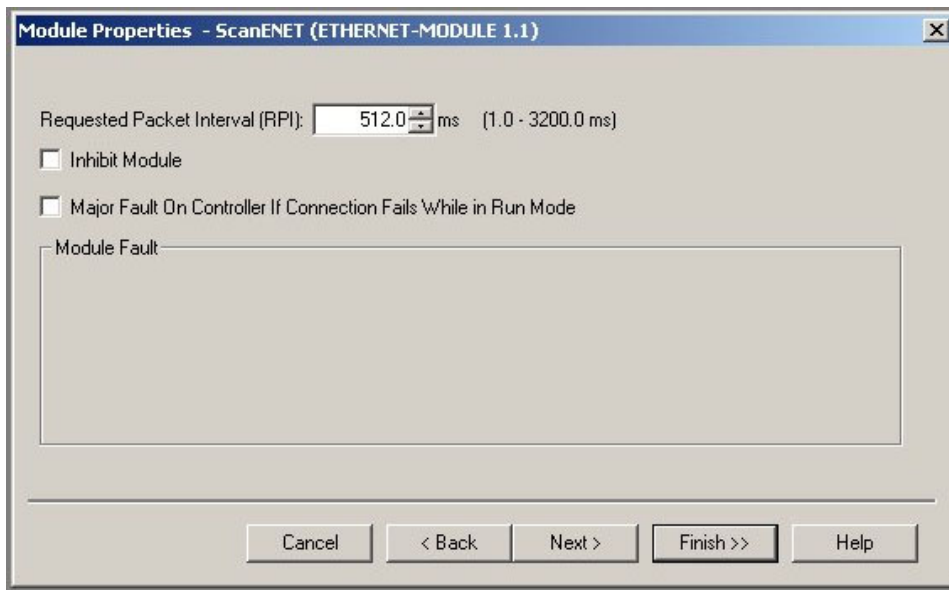
Figure 14: The number of data (Input / Output Size) should correspond to the values composed with BlueControl® (Configuration Size: 0)! In this example, this has deliberately NOT been done, in order to show some later details more clearly.



Continue by clicking "Next >" (not "Finish >>")!

Note: The bus coupler does not use any Assembly Instances, because everything can be adjusted quasi dynamically via BlueControl®. However, values must be entered here (e.g. 100, 101, 102 for manufacturer-specific instances).

Figure 15: The RPI (Requested Packet Interval) setting determines the communication interval between PLC and bus coupler. (Note: Values smaller than 100 ms make no sense.)



At present (09/2005), there is a bug in the Rockwell software: Entered values are always rounded down to the next smaller power of 2. This means that an entered value of 500 results in a true RPI of 256 ms !!

Figure 16: The new module is located under the menu item "I/O Configuration". Via the context menu (right mouse key) and "Properties" you open the next window. Here you can check the number of I/Os (Size) and the IP address, and change them if necessary.

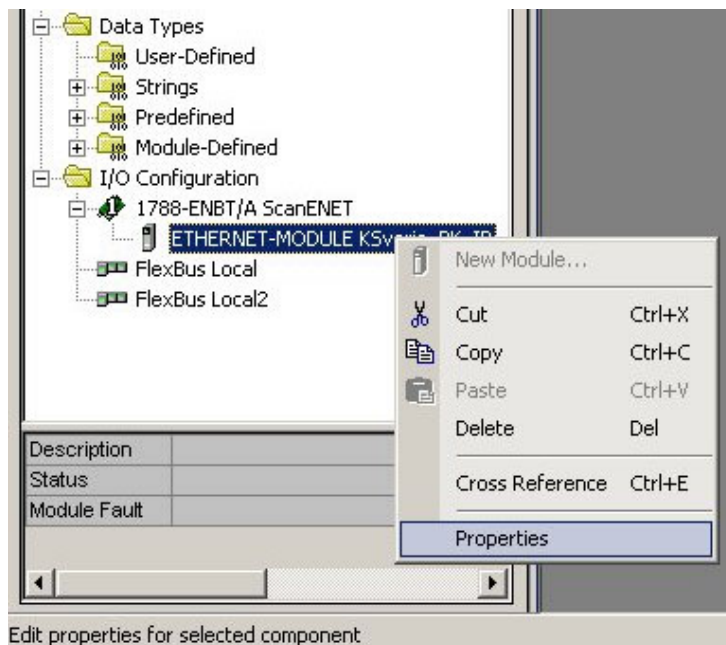
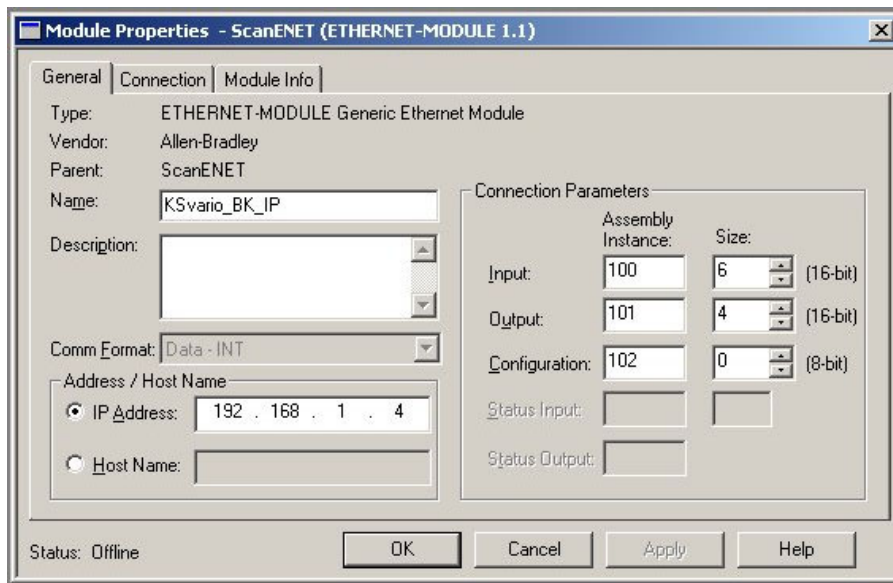


Figure17 : Survey of the current settings, with the possibility to change them. (Remember: The "Comm Format" cannot be changed!) The RPI can be changed under "Connection".



5.4. Test of the bus coupler configuration in the PLC (with RSLogix5000)

For debugging and testing the newly downloaded program, you can access the data via the Controller Tags.

Figure 18: After the program download, double-clicking on the Controller Tags and selecting "Monitor Tags", opens the following window, which shows the previously configured Input (I) and Output (O) data:

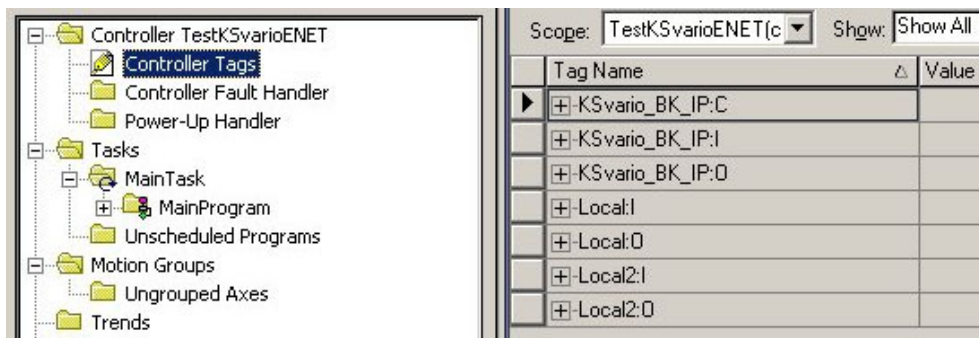


Figure 19: Survey of the Monitor Tags for the I/O data (Offline mode)

Tag Name	Value	Force Mask	Style	Type
KSvario_BK_IP:C	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:I	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:I.Data	{...}	{...}	Decimal	INT[6]
KSvario_BK_IP:I.Data[0]	0		Decimal	INT
KSvario_BK_IP:I.Data[1]	0		Decimal	INT
KSvario_BK_IP:I.Data[2]	0		Decimal	INT
KSvario_BK_IP:I.Data[3]	0		Decimal	INT
KSvario_BK_IP:I.Data[4]	0		Decimal	INT
KSvario_BK_IP:I.Data[5]	0		Decimal	INT
KSvario_BK_IP:O	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:O.Data	{...}	{...}	Decimal	INT[4]
KSvario_BK_IP:O.Data[0]	0		Decimal	INT
KSvario_BK_IP:O.Data[1]	0		Decimal	INT
KSvario_BK_IP:O.Data[2]	0		Decimal	INT
KSvario_BK_IP:O.Data[3]	0		Decimal	INT
Local:I	{...}	{...}		AB:1794_AVB_8
Local:O	{...}	{...}		AB:1794_AVB_8
Local2:I	{...}	{...}		AB:1794_AVB_8
Local2:O	{...}	{...}		AB:1794_AVB_8

Figure 20: In the Online mode (PLC: Idle), the input data are already being read cyclically. Data[0] and Data[1] (2001/2002) return the fixed point values of Inputs 1 and 2 with 200,1 and 200,2 respectively. Data[2] returns -31000 for FAIL. Data[3] to Data[5] return -32500, as nothing has been defined in the cache (undefined Entry).

Tag Name	Value	Force Mask	Style	Type
KSvario_BK_IP:C	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:I	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:I.Data	{...}	{...}	Decimal	INT[6]
KSvario_BK_IP:I.Data[0]	2001		Decimal	INT
KSvario_BK_IP:I.Data[1]	2002		Decimal	INT
KSvario_BK_IP:I.Data[2]	-31000		Decimal	INT
KSvario_BK_IP:I.Data[3]	-32500		Decimal	INT
KSvario_BK_IP:I.Data[4]	-32500		Decimal	INT
KSvario_BK_IP:I.Data[5]	-32500		Decimal	INT
KSvario_BK_IP:O	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:O.Data	{...}	{...}	Decimal	INT[4]
KSvario_BK_IP:O.Data[0]	0		Decimal	INT
KSvario_BK_IP:O.Data[1]	0		Decimal	INT
KSvario_BK_IP:O.Data[2]	0		Decimal	INT
KSvario_BK_IP:O.Data[3]	0		Decimal	INT
Local:I	{...}	{...}		AB:1794_AVB_8
Local:O	{...}	{...}		AB:1794_AVB_8
Local2:I	{...}	{...}		AB:1794_AVB_8
Local2:O	{...}	{...}		AB:1794_AVB_8

Figure 21: If the values to be written (here e.g. 120,0; 110,0; and 100,0 as setpoints) are entered, and the PLC is switched to Run mode, the cyclic transfer of the 'write' data is also started. This can be observed in the BlueControl® OnlineMode, as shown in next Figure.

Tag Name	Value	Force Mask	Style	Type
KSvario_BK_IP:C	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:I	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:I.Data	{...}	{...}	Decimal	INT[6]
KSvario_BK_IP:I.Data[0]	2001		Decimal	INT
KSvario_BK_IP:I.Data[1]	2000		Decimal	INT
KSvario_BK_IP:I.Data[2]	-31000		Decimal	INT
KSvario_BK_IP:I.Data[3]	-32500		Decimal	INT
KSvario_BK_IP:I.Data[4]	-32500		Decimal	INT
KSvario_BK_IP:I.Data[5]	-32500		Decimal	INT
KSvario_BK_IP:O	{...}	{...}		AB:ETHERNET_
KSvario_BK_IP:O.Data	{...}	{...}	Decimal	INT[4]
KSvario_BK_IP:O.Data[0]	1200		Decimal	INT
KSvario_BK_IP:O.Data[1]	1100		Decimal	INT
KSvario_BK_IP:O.Data[2]	1000		Decimal	INT
KSvario_BK_IP:O.Data[3]	0		Decimal	INT
Local:I	{...}	{...}		AB:1794_AVB_8
Local:O	{...}	{...}		AB:1794_AVB_8
Local2:I	{...}	{...}		AB:1794_AVB_8
Local2:O	{...}	{...}		AB:1794_AVB_8

Figure 22: BlueControl® OnlineMode

	device	Channel 1	Channel 2	Channel 3	Channel 4
process value		200.1	200.0	FAIL	FAIL
Internal setpoint		120.0	110.0	234.0	320.1
Effective setpoint		120.0	110.0	234.0	320.1
control deviation					
Actuating variable		-100.0	-100.0	0.0	0.0
Manual operation		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2nd setpoint		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
controller off		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Boost		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gradient active		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Soft start function active		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
All channels automatic					
All channels off					
Loaded setpoint	inactive				

Subject to alterations without notice.
Bei Änderungen erfolgt keine Mitteilung.
Sous réserve de modifications sans avis préalable

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