FACTORY AUTOMATION

Manual

VBG-IP-K5-DM

AS-Interface/Ethernet TCP/IP

Gateway

PEPPERL+FUCHS

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1 Declaration of Conformity

The AS-iEthernet TCP/IP gateway VBG-IP-K5-DMhas been developed and produced in accordance with the applicable European standards and directives.

Note

The corresponding of conformity can be requested from the manufacturer.

The manufacturer of the product, Pepperl+Fuchs Group in D-68301 Mannheim, possesses a certified quality assurance system in accordance with ISO 9001.

CE

ISO9001

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2 The Used Symbols

Warning

This symbol warns the user of possible danger. Failure to heed this warning can lead to personal injury or death and/or damage to equipment.

Attention

This symbol warns the user of a possible failure. Failure to heed this warning can lead to total failure of the equipment or any other connected equipment.

Note

This symbol gives the user important hints.

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3 Safety

3.1 Intended Use

Warning

The protection of operating personnel and the system against possible danger is not guaranteed if the control interface unit is not operated in accordance with its intended use.
The device may only be operated by appropriately qualified personnel in accordance with this operating manual.

3.2 General Safety Information

Warning

Safety and correct functioning of the device cannot be guaranteed if any operation other than that described in this operation manual is performed.
The connecting of the equipment and any maintenance work to be carried out with voltage applied to the equipment must only be performed by appropriately qualified electrotechnical personnel.
In the case that a failure cannot be repaired, the device must be taken out of operation and kept from inadvertently put back into operation.
Repair work is to be carried out by the manufacturer only. Additions or modifications to the equipment are not allowed and void the warranty.

Note

The operator is responsible for the observance of local safety standards.

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4 General Information

This operating instruction is for use with the following device of the Pepperl+Fuchs GmbH:

- AS-i/Ethernet TCP/IP Gateway

The AS-i/Ethernet Gateway serves to connect the Actuator-Sensor-Interface to a hierachically higher Ethernet. The Gateway acts as 2 complete Masters for the AS-Interface and as a 256 bit digital input and digital 256 bit output module for Ethernet. All possibilities offered by AS-Interface can be used via Ethernet TCP/IP. During operation AS-i parameters can be transmitted to the AS-i slaves.

As with all Masters of Pepperl+Fuchs GmbH, commissioning, debuging and setting up of the AS-i parameters can be accomplished with the use of two push-buttons, the LCD display and the LEDs directly on the system, but it can also be handled via Ethernet TCP/IP.

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5 Connections, Displays and Operating Keys

On the front panel of the AS-i/Ethernet TCP/IP gateways are:

- terminals to connect the power supply and the AS-i circuit
- a RJ-45 connector as Ethernet TCP/IP interface according to IEEE 802.3, 10BaseT
- 7 LEDs
- a two-digit seven-segment display
- 2 push-buttons to configure the gateway

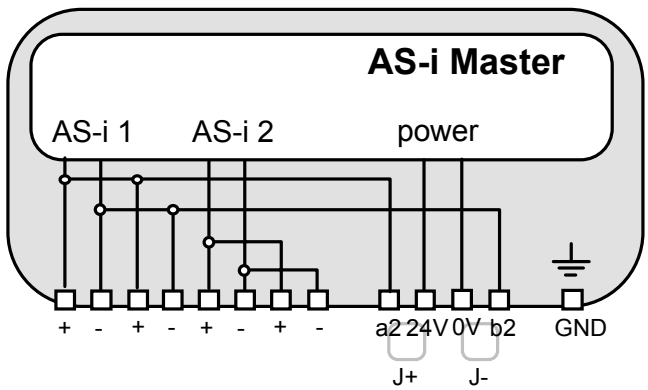
5.1 Power Supply Concepts and AS-i Connection Techniques

Note

The AS-i masters with master power supply A do not need a voltage supply of their own. They can be powered completely out of the AS-i line (the power consumption is about 200 mA from AS-i). An additional 24 V voltage source is not necessary. The AS-i master merely requires the connection to the AS-i line. When the AS-i power supply is switched on, the master starts to operate.

An AS-i power supply has to be used which also supplies the AS-i master with power and can be connected to the AS-i cable like all the other AS-i components at any place.

5.1.1 Master in IP20 with Power Supply A



The terminals have the following functions:

+	"AS-i +", Actuator Sensor Interface 1 or 2, positive terminal These terminals are connected internally with point a2 of jumper "J+".
-	"AS-i -", Actuator Sensor Interface 1 or 2, negative terminal These terminals are connected internally with point b2 of jumper "J-".
24V	Master power supply, positive terminal (18 - 31.6 V DC)
0V	Master power supply, negative terminal
GND	Ground terminal, used for better EMC. Should be connected with a short wire to machine GND.
J+, J-	Jumpers for selecting the power supply of AS-i

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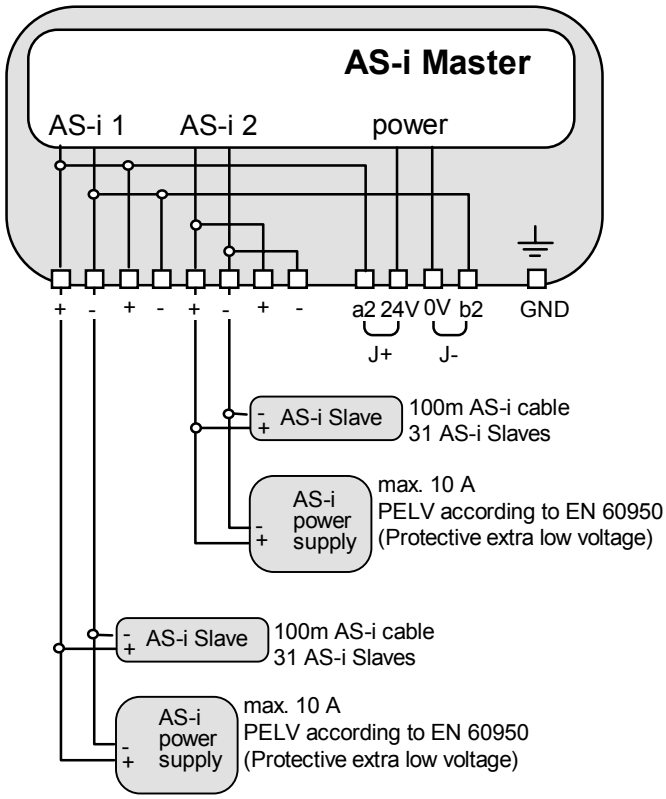
jumpers closed:

The AS-i master is powered out of AS-i circuit 1.
Master power supply and AS-i network are then decoupled with coils.

umpers open:

With the jumpers open (or missing), the AS-i master must be powered by a separate 24 V DC power supply.

Power supply out of AS i circuit 1



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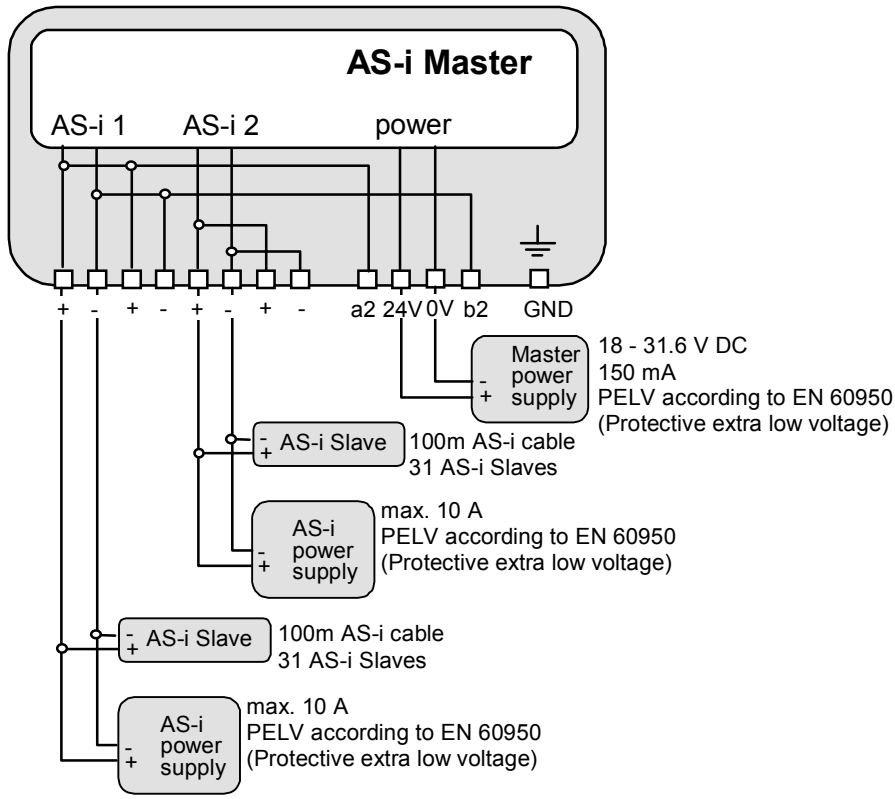
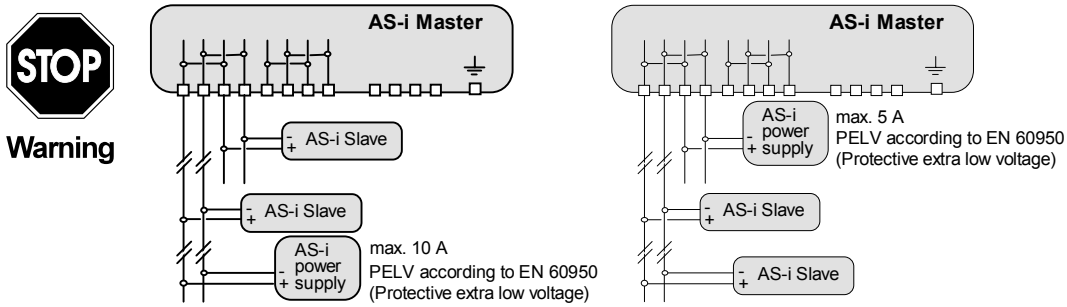
Operation with separate 24 V DC power supply



Connection variations for the AS-i circuits (here only displayed for one AS-i circuit)



In the wiring schemes above the current through the AS-i master must not exceed 5 A.

5.2 AS-i Master with Ethernet TCP/IP interface

The Ethernet TCP/IP interface is in accordance to the norm IEEE 802.3, 10BaseT. The connector for the Ethernet cable is realized as standard Ethernet RJ-45 connector.

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5.3 Display and Operating Elements

On the front panel of the AS-i/Ethernet TCP/IP gateway are seven light-emitting diodes, a two-digit display and two push buttons.

AS-i 2 Switching of the displays and push buttons between the two AS-i circuits.
If this LED lights up, all displays and button operations are related to AS-i circuit 2, otherwise AS-i circuit 1.

Ethernet Flash codes according chapter 8. Device OK and BOOTP ready, if steady.

config err Configuration error
At least one configured slave is missing, or at least one detected slave is not projected or for at least one projected and detected slave the actual configuration data does not match the nominal configuration data.

power The master's power supply is sufficient.

U ASI The AS-i circuit is sufficiently powered.

prg enable Automatic address programming enabled.
Exactly one slave is missing in protected operating mode. The slave can be replaced by another slave of the same type with address zero. The master addresses the new slave to the faulty address and thus eliminates the configuration error.

prj mode The AS-i master is in configuration mode.

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6 Operating the AS-i/Ethernet TCP/IP Gateway

6.1 Peculiarities with Double Masters

Note

*In **protected mode** the displays of the double Masters are switched over from AS-i circuit 1 to AS-i circuit 2 in a measure of 2 seconds.*

In **configuration mode** all detected AS-i slaves are displayed at first before the display switches to the other AS-i circuit.

The operation of the push buttons is always related to the currently displayed AS-i circuit (LED AS-i 1/AS-i 2). After a push button was pressed the display stays with the respective AS-i circuit until the operation is finished or the operator has not interfered for 10 seconds.

6.2 Master Start-Up

After powering on, all segments of the figure display and all LEDs light up for approximately one second (self-test). Afterwards, the LEDs display the condition of their respective flags. The figure display shows the condition of the master:

40 Off-line Phase
The AS-i master initializes - there is no data communication on the AS-i.

Attention

If the AS-i circuit is insufficiently powered ("U AS-i" does not light up)** or there is no communication relationship between the Ethernet TCP/IPmaster and the AS-i/Ethernet TCP/IP gateway**, the master remains in the off-line phase.

n configuration mode or when an AS-i Control program is started automatically the device can leave the off-line phase.
In protected mode, if the Ethernet TCP/IP communication is interrupted, the AS-i master switches to the off-line phase after the watchdog time of the Ethernet TCP/IP has expired unless an AS-i Control program is running and was started automatically.

41 Detection Phase
Start of the start-up phase, where the system looks for slaves located on the AS-i. The master remains in the detection phase until it finds at least one slave.

42 Activation Phase
Condition at the end of the start-up operation where the parameters are transmitted to all connected and recognized slaves. This enables access to the AS-i slaves' data connections.

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43[1] Start of Normal Operation
In normal operation the AS-i master can exchange data with all active slaves. It transmits management messages and looks for and activates newly connected slaves. During normal operation, the system keeps the maximum cycle time of 5 milliseconds.

6.3 Configuration Mode

The configuration mode serves to configure the AS-i circuit.


Attention

In the configuration mode, all recognized slaves are activated even when the desired and actual configurations do not match.

Pressing the “mode” button for at least five seconds switches the master to configuration mode. While in configuration mode, the yellow “prj mode” LED lights up.

The system then displays one after the other all detected slaves at a speed of two per second. If the display is empty, no slaves were detached on the AS-i circuit.

In configuration mode, all recognized slaves are activated except of slave zero. The AS-i master is in normal operation. There is data exchange between the AS-i master and all AS-i slaves detected by the master regardless of whether the detected AS-i slaves were projected before.


Attention

When delivered the device is in configuration mode.

6.4 Protected Operating Mode


Note

In contrast with the configuration mode in the protected mode there is only data exchange between the AS-i master and the projected AS-i slaves.

6.4.1 Switching to Protected Operating Mode

The configuration mode can be left by pressing the “mode” button.

Pressing the button shortly:
Exits the configuration mode without projecting the current AS-i configuration.

Pressing the button for more than five seconds:
Exits the configuration mode and projects the actual AS-i configuration. Simul-

1. Activation phase and the start of normal operation maybe so short that the numbers can not be seen in the display.

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taneously the actual AS-i configuration is stored as nominal configuration in the EEPROM.

Note

If the system detects an AS-i slave with address zero on the AS-i, it can not leave the configuration mode.

In the protected operating mode, only AS-i slaves that are projected and whose actual configurations match the nominal configurations will be activated.

6.4.2 Configuration Errors in Protected Operating Mode

As long as there is no configuration error, the numeric display is turned off while in protected operating mode. Otherwise, the address with a faulty assignment is displayed. A faulty assignment occurs when a slave has been recognized or projected but cannot be activated.

If there are more than one faulty assignments the one that was first detected is displayed. Pressing the “set” button shortly displays the next higher faulty address.

Shortly appearing configuration errors are stored in the device (advanced AS-i diagnosis). The last error that occurred can be displayed by pressing the set button. If a short AS-i power failure is responsible for the configuration error the display shows a “39”.

6.5 Assigning an AS-i Address in Configuration Mode

AS-i can be put into operation in a very comfortable manner by using the Windows software AS-i Control Tools (see chapter 9.1)(addressing directly or with the AS-i address assistant).

Furthermore you can use a hand held addressing device.

If you don’t have neither a PC nor a hand held addressing device, address assigning of the AS-i slaves is also possible with the AS-i gateway using the push buttons. How it works is described as follows.

6.5.1 Assigning a Slave Address

(assigning an available address to a slave with address zero)

In configuration mode, the addresses of all detected slaves are displayed one after the other. To display the next higher available operating address, press the “set” button shortly. Each time you press the “set” button, the next available address is displayed.

Choose the displayed address as your target address by pressing the button for more than five seconds. The address display blinks. The master is ready for programming; pressing the “set” button again addresses the connected slave with address zero to the target (blinking address).

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Any errors will be displayed by their error codes according to chapter 10. Otherwise, the detected slaves are displayed again as described in chapter 6.3..


Attention

There must not be two AS-i slaves with the same adrress on the AS-i circuit.

6.5.2 Erasing the Slave Address

(assigning address zero to a detected slave)

In configuration mode, the addresses of all recognized slaves are displayed one after the other. By pressing and releasing the “set” button, the master displays the next available address. If you press the button for more than five seconds while the address of a detected slave is displayed, this slave will get the address zero and the display shows “00”.

When you release the button, the display continues to display the detected slaves.

6.6 Programming the Address in Case of Configuration Errors

6.6.1 Automatic Address Assignment


Note

One of AS-i’s great advantages is the automatic address assignment. If a slave fails, it can be replaced by one of the same type with address zero. The master will detect the replacement and automatically addresses the new slave with the address of the faulty one.

For automatic programming to work, some requirements must be met:

1. The AS-i master must be in the protected operating mode.
2. The “Auto_Address_Assign” release flag must be set.
3. Only one of the projected slaves may not be detected.

If these requirements are met, the AS-i master’s “prg enable” LED lights up and a slave with address zero will be automatically assigned to the operating address of the missing slave.


Attention

If the two slaves have different configuration data, i.e. are not of the same type as far as AS-i is concerned, the automatic address assignment will not be carried out.

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6.6.2 Manual Address Assignment

Note

If several slaves fail, they cannot be replaced automatically by the AS-i master. Then these addresses have to be set manually. If this should not be done via the host interface (using the AS-i Control Tools) or with a hand held addressing device, the slave addresses can also be changed with the help of the push buttons and the figure display of the device.

In protected operating mode, wrong assignments are displayed as errors (see chapter 6.4). By pressing the “set” button, you can display all faulty assignments one after the other. By pressing the “set” button for more than five seconds, you can select the currently displayed address as a potential target address, and the display starts to blink.

If the faulty slave was previously replaced by a slave with address zero, the new slave can now be programmed for the blinking address by pressing the “set” key again. As a requirement, the new slave’s configuration data must match the configuration data for the blinking address.

After the address has been successfully set, the next faulty assignment is displayed and the address assignment can begin from the start. Otherwise, the system displays an error code (chapter 10). When all faulty assignments are eliminated the display is empty.

6.7 Setting of the Ethernet IP address using BOOTP

The Ethernet TCP/IP gateway has **no** switches for setting its IP address. Instead the gateway uses the Ethernet network itself for this purpose.

At power-up, the gateway broadcasts a standard BOOTP address determination request on the network. This message includes the Ethernet Hardware Address (aka IEEE GLOBAL ADDRESS) which is unique to Ethernet devices.

The gateway will repeat this interrogation request a number of times, a number of seconds apart, until either:

- it receives a valid BOOTP response from another device on the network, identifying the IP address associated with this particular Hardware Address.
- A 15 sec. timeout has elapsed, if the device had been previously authorized to retain an IP address.

You have to use BOOTP for the IP address assignment as default. To allow IP address assignment to be retained in the flash, you have to set the value of address 62480 to 1 (see chapter 8, “device related references similar to the Momentum Ethernet Adapter”).

For more details about configuration using BOOTP see the documentation “*Momentum Ethernet Adapter - Configuration and Use*” (also available in the internet: *http:// www.modicon.com/openmbus*).

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6.8 Error Messages

The system displays error codes for error messages that do not point to faulty assignments on the AS-i circuit. The code numbers are larger than 50 and are therefore outside the slave address range. These codes are described in the appendix, chapter 10.

issue date 14.12.2000

7 Operation via Ethernet TCP/IP (Modbus/TCP)

The AS-i/Ethernet TCP/IP Gateway acts as 2 complete Masters for the AS-Interface and as a 256 bit digital I/O module for Ethernet. All possibilities offered by AS-interface can be used via Ethernet TCP/IP.

The used Modbus/TCP protocol is similar to the Modbus protocol. Specifiacally, it covers the use of Modbus messiging in an Intranet or Internet enviroment using TCP/IP protocols. The only differences to the Modbus protocol are the form of any "framing" sequence, error check pattern and address interpretation.

All requests are sent via TCP on registered port 502.

7.1 Message Structure

Telegrams from the Modbus-Master (query-messages) and answers of the Modbus slaves have the same structure:

The request and response are prefixed by 6 bytes as follows:

T_1	T_2	P_1	P_2	B_1	B_2	UI	F	D_1	D_2		...		D_n

transaction identifier T_1,T_2:usually 0 - copied by server.

protocol identifier P_1,P_2:0

length field B_1: upper byte of the length field = 0 (since all messages are smaller then 256)

length field B_2: lower byte of the length field = number of bytes following

unit identifier UI:value to indentifying the client

function code F:Code of Modbus-function to be executed by the slave. Under certain circumstances the slave could answer with an error-telegram. In this case the function-code in the response-message is increased by 128.

data bytes D_1 ... D_n:Field to hold user-data.
The number of bytes is variable.

Note

Checksum fields are not needed, because the TCP/IP and link layer (eg. Ethernet) instad are used to verfiy accurate delivery of the packet.

Example transaction: Read 1 register at offset 4 from UI 9. Retrun value is 5

request:	00	00	00	00	00	06	09	03	00	04	00	01

response:	00	00	00	00	00	05	09	03	02	00	05

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7.2 Ethernet TCP/IP functions

In the following chapter are shown the support functions. Please note, that only the related bytes are shown (bytes 0 - 3 are let away, because the values are 0).

7.2.1 Function 3: "*Read multiple registers*"

This function allows to read the value of read/write-registers.

request:	3	R_1	R_2	N_1	N_2

response:	3	B_1	B_2	D_1	...	D_n

R: Reference number

N: Word count (1 - 125)

B: Byte count of response (B = 2 x word count)

D: Register values

Example:

Read 1 register at reference 0 resulting in value 4660

request					⇒	response			
03	00	00	00	01		03	02	46	60

7.2.2 Function 16: "*Write multiple registers*"

This function allows the setting of several read/write-registers:

request:	16	R_1	R_2	N_1	N_2	B_1	B_2	D_1	...	D_n

response:	16	B_1	B_2	D_1	...	D_n

R: Reference number

N: Word count (1 - 100)

B: Byte count of response (B = 2 x word count)

D: Register values

Example:

Write 1 register at reference 0 of value 4660

request								⇒	response				
16	00	00	00	01	02	46	60		16	00	00	00	01

7.2.3 Exception Codes

There is a defined set of exception codes to be returned by slaves in the event of problems. Note that masters may send out commands "speculatively", and use the success or exception codes received to determine which MODBUS commands the device is willing to respond to and to determine the size of the various data regions available on the slave.

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All exceptions are signaled by adding 128 to the function code of the request, and following this byte by a single reason byte for example as follows

03 46 60 00 01 => 128 02

request read 1 register at index 4660 response exception type 2 - "illegal data address"

The list of exceptions follows:

- 01 ILLEGAL FUNCTION
  The function code received in the query is not an allowable action for the slave. This may be because the function code is only applicable to newer controllers, and was not implemented in the unit selected. It could also indicate that the slave is in the wrong state to process a request of this type, for example because it is unconfigured and is being asked to return register values.
- 02 ILLEGAL DATA ADDRESS
  The data address received in the query is not an allowable address for the slave. More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, a request with offset 96 and length 4 would succeed, a request with offset 96 and length 5 will generate exception 02.
- 03 ILLEGAL DATA VALUE
  A value contained in the query data field is not an allowable value for the slave. This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the MODBUS protocol is unaware of the significance of any particular value of any particular register.
- 04 ILLEGAL RESPONSE LENGTH
  Indicates that the request as framed would generate a response whose size exceeds the available MODBUS data size. Used only by functions generating a multipart response, such as functions 20 and 21.
- 05 ACKNOWLEDGE
  Specialized use in conjunction with programming commands
- 06 SLAVE DEVICE BUSY
  Specialized use in conjunction with programming commands
- 07 NEGATIVE ACKNOWLEDGE
  Specialized use in conjunction with programming commands
- 08 MEMORY PARITY ERROR
  Specialized use in conjunction with function codes 20 and 21, to indicate that the extended file area failed to pass a consistency check.
- 0A GATEWAY PATH UNAVAILABLE
  Specialized use in conjunction with Modbus Plus gateways, indicates that the gateway was unable to allocate a Modbus Plus PATH to use to process the request. Usually means that the gateway is misconfigured.
- 0B GATEWAY TARGET DEVICE FAILED TO RESPOND
  Specialized use in conjunction with Modbus Plus gateways, indicates that no response was obtained from the target device. Usually means that the device is not present on the network.

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8 Address table of the Modbus/TCP-Interfaces

The address map is designed to enable a Modbus/TCP master to connect to the AS-i/ Ethernet gateway as if it was a Modicon Momentum Ethernet Adapter. It follows the Open Modbus/TCP specification 1.0.

The references 0 to 33 and 61440 to 64521 correspond to the address map of the Modicon Momentum Ethernet Adapter. The other references are extensions to provide full access to the AS-i master according to the M1 AS-i master profile.

The AS-i/Ethernet gateway meets the Modbus/TCP conformance class 0, that is, modbus functions 3 (read multiple registers) and 16 (write multiple registers) are implemented only.

cyclic data exchange similar to the Momentum Ethernet Adapter		
address	access	data
0	r/-	AS-i circuit 1: Execution Control Flags
1 ... 16	r/-	AS-i circuit 1: Input Data Image IDI
17	r/-	AS-i circuit 2: Execution Control Flags
18 ... 33	r/-	AS-i circuit 2: Input Data Image IDI
0	-/w	AS-i circuit 1: Host Interface flags
1 ... 16	-/w	AS-i circuit 1: Output Data Image ODI
17	-/w	AS-i circuit 2: Host Interface flags
18 ... 33	-/w	AS-i circuit 2: Output Data Image ODI

The bits within the words of this block are arranged appropriate for the BLKM (Block Move) function in Modicon's 984 Ladder Language (as proposed in the Open Modbus/TCP Specification, Release 1.0). That is, the bits are numbered from most signicant bit to least signicant bit:

reference 0			
bit	bit value	writing	reading
1	8000_h	Data_Exchange_Active	Config_OK
2	4000_h	Off-Line	LDS.0
3	2000_h	Auto_Address_Enable	Auto_Address_Assign
4	1000_h	Conguration Mode on	Auto_Address_Available
5	800_h	Conguration Mode off	Conguration_Active
6	400_h		Normal_Operation_Active
7	200_h		APF/not APO
8	100_h		Offline_Ready
9	80_h		Periphery_OK

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Data_Exchange_Active: If this output is set, no data transmisson between the AS-i/ Modbus Gateway and the AS-i slaves is possible.
0: Data exchange is active
1: Data exchange is not active

Off-line: This output sets the master to off-line phase

Auto_Address_Enable: This output blocks automatic slave-address programming.
0: Auto-address is enabled
1: Auto-address is disabled

Configuration_Mode_on: Configuration mode is on

Configuration_Mode_off: Configuration mode is off

Config_OK: Configuration error:
0: no error
1: error

LDS.0: An AS-i slave with address zero is existing

Auto_Address_Assign: Automatic programming is allowed

Auto_Address_Available: Automatic programming is possible
0: Auto-address is possible
1: Auto-address is not possible

Configuration_Active: The configuration-mode is active

Normal_Operation_Active: The normal operation mode is active
0: normal operation is active
1: normal operation is not active

APF/not APO: An AS-i power fail occured

Offline_Ready: The off-line phase is active

Periphery_OK: Periphery is OK
0: Periphery is OK
1: Periphery is not OK

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reference 1			
bit	bit value	writing	reading
1	8000_h	ODI slave 0, D0	IDI slave 0, D0
2	4000_h	ODI slave 0, D1	IDI slave 0, D1
3	2000_h	ODI slave 0, D2	IDI slave 0, D2
4	1000_h	ODI slave 0, D3	IDI slave 0, D3
5	800_h	ODI slave 1, D0	IDI slave 1, D0
6	400_h	ODI slave 1, D1	IDI slave 1, D1
7	200_h	ODI slave 1, D2	IDI slave 1, D2
8	100_h	ODI slave 1, D3	IDI slave 1, D3
9	80_h	ODI slave 2, D0	IDI slave 2, D0
10	40_h	ODI slave 2, D1	IDI slave 2, D1
...	...	...	...

Some of the ags are inverted in order to have zero values in protected mode during normal operation without any conguration errors.

Configuration Mode may be swiched on or off with a rising edge in reference 0, bit 4 or 5, respectively.

device related references		
address	access	data
2048 ... 2063	r/-	device
2064 ... 2071	r/-	device version
2072 ... 2079	r/-	firmware features (without host interface flags
2080 ... 2083	r/-	firmware date code
2084	r/w	Front_Panel_Operation (0 enabled, else disabled)
2085	r/-	return value of most recently called Execution Control function: 0: success 1: failure 2: slave with 1st addr not detected 3: slave with zero addr detected 4: slave with 2nd addr detected 5: delete error 6: set error 7: address stored temporarily 8: extended ID1 stored temporarily 9: error reading extended ID1

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Register 2085 holds the return value of the Execution Control function most recently called by the reading Modbus/TCP connection.

Execution Control functions are called for the following writing accesses to each AS-i circuit:

- registers 4128 to 4143: sending Parameter AS-i circuit 1
- registers 4384 to 4399: writing Permanent Parameter (PP) AS-i circuit 1
- registers 4400 to 4463: writing Permanent Configuration Data (PCD) AS-i circuit 1
- registers 4464 to 4467: writing List of Projected Slaves (LPS) AS-i circuit 1
- register 4864: function invocation AS-i circuit 1
- registers 8224 to 8233: sending Parameter AS-i circuit 2
- registers 8480 to 8495: writing PP AS-i circuit 2
- registers 8496 to 8559: writing PCD AS-i circuit 2
- registers 8560 to 8563: writing LPS AS-i circuit 2
- register 8960: function invocation AS-i circuit 2

Note, they are not called for access to references 0 to 33.

AS-i circuit 1 process data and actual configuration data		
address	access	data
4096 ... 4111	r/-	Input Data Image IDI
4112 ... 4127	r/w	Output Data Image ODI
4128 ... 4143	r/w	Parameter Image PI[a]
4144 ... 4207	r/-	Configuration Data Image CDI
4208 ... 4211	r/-	List of Activated Slaves LAS
4212 ... 4215	r/-	List of Detected Slaves LDS
4216 ... 4219	r/-	List of Periphery Faults LPF
4224	r/-	ec-flags
4225	r/w	hi-flags

a. Writing to the refercences 4128 to 4143 invokes the Execution Control function Write_Parameter() rather than writing the PI.

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reference 4224	
bit value	Execution Control flag
1_h	Config_OK!
2_h	LDS.0
4	Auto_Address_Assign
8_h	Auto_Address_Available!
10_h	Configuration_Active
20_h	Normal_Operation_Active!
40_h	APF/not APO
80_h	Offline_Ready
100_h	Periphery_OK!

Config_OK!: Configuration error:
0: error
1: no error

LDS.0: An AS-i slave with address zero is existing

*Auto_Address_Assign:*Automatic programming is allowed

*Auto_Address_Available!:*Automatic programming is possible
0: Auto-address is not possible
1: Auto-address is possible

*Configuration_Active:*The configuration-mode is active

*Normal_Operation_Active!:*The normal operation mode is active
0: normal operation is not active
1: normal operation is active

APF/not APO: An AS-i power fail occured

Offline_Ready: The off-line phase is active

Periphery_OK!: Periphery is OK
0: Periphery is not OK
1: Periphery is OK

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reference 4225	
bit value	Host Interface flag
1	Data_Exchange_Active!
2	Off_Line
4	Auto_Address_Enable!

Data_Exchange_Active!: If this output is set, no data transmisson between the AS-i/ Modbus Gateway and the AS-i slaves is possible.
0: Data exchange is not active
1: Data exchange is active

Off-line: This output sets the master to off-line phase

Auto_Address_Enable!: This output blocks automatic slave-address programming.
0: Auto-address is disabled
1: Auto-address is enabled

references 4144 to 4207	
bit mask	data
$000F_h$	IO-Configuration
$00F0_h$	ID-Code
$0F00_h$	extended ID 1
$F000_h$	extended ID 2

AS-i circuit 1 permanent configuration data		
address	access	data
4384 ... 4399	r/w	Permanent Parameter PP
4400 ... 4463	r/w	Permanent Configuration Data PCD
4464 ... 4467	r/w	List of Projected Slaves LPS

AS-i circuit 1 extended diagnosis		
address	access	data
4608 ... 4671	r/-	Transmisson Error Counters[a]
4672 ... 4675	r/-	List of Corrupted Slaves LCS[a]
4676 ... 4679	r/w	List of Offline Slaves LOS

a. The Transmission Error Counters and the LCS are reset each time they are read.

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AS-i circuit 1 function invocation		
address	access	data
4864	-/w	function: opcode 1: Set_Operation_Mode 2: Change_Slave_Address 3: Store_Actual_Parameters 4: Store_Actual_Configuration 5: Execute_Command 6: Send_Parameter
4864	r/-	function: result 0: success 32769: failure 32770: slave with 1st addr not detected 32771: slave with zero addr detected 32772: slave with 2nd addr detected 32773: delete error 32774: set error 32775: address stored temporarily 32776: extended ID1 stored temporarily 32777: error reading extended ID1 32778: parameter out of range 32779: invalid opcode
4865	r/w	function: parameter 1
4866	r/w	function: parameter 2

*Set_Operation_Mode:*A zero in address 4864 activates the protected mode. All other values switch on the configuration mode.

*Change_Slave_Address:*This function will be executed, if the value 2 is written to address 4864. The value written in address 4866 is the new address of the slave. The old address must be written to address 4865 before.

*Store_Actual_Parameters:*If the value 3 is written to address 4864, the actual parameters (*PI*) will be stored as parameters projected (*PP*).

*Store_Actual_Configuration:*If the value 4 is written to address 4864, the actual AS-i configuration will be stored as projected parameters (*PCD, LPS*).

*Execute_command:*If the value 5 is written to address 4864, this function will be executed. The value written in address 4866 will be sent as information-part to a slave, which address has been written before to address 4865.

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The return-values of the functions are accessible in address 4864.

AS-i circuit 1 16-bit data of AS-i slaves according to slave profile 7.3 or 7.4		
address	access	data
5120 ... 5123	r/w	slave at address 0 (not used)
5124 ... 5127	r/w	slave at address 1
...		...
5244 ... 5247	r/w	slave at address 31

AS-i circuit 2 process data and actual configuration data		
address	access	data
8196 ... 8207	r/-	Input Data Image IDI
8208 ... 8223	r/w	Output Data Image ODI
8224 ... 8233	r/w	Parameter Image PI[a]
8240 ... 8303	r/-	Conguration Data Image CDI
8304 ... 8307	r/-	List of Activated Slaves LAS
8308 ... 8311	r/-	List of Detected Slaves LDS
8312 ... 8315	r/-	List of Periphery Faults LPF
8320	r/-	ec-flags
8321	r/w	hi-flags

a. Writing to the refercences 8224 to 8233 invokes the Execution Control function Write_Parameter() rather than writing the PI.

AS-i circuit 2 permanent configuration data		
address	access	data
8480 ... 8495	r/w	Permanent Parameter PP
8496 ... 8559	r/w	Permanent Configuration Data PCD
8560 ... 8563	r/w	List of Projected Slaves LPS

AS-i circuit 2 extended diagnosis		
address	access	data
8704 ... 8767	r/-	Transmisson Error Counters[a]
8768 ... 8771	r/-	List of Corrupted Slaves LCS[a]
8772 ... 8775	r/w	List of Offline Slaves LOS

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a. The Transmission Error Counters and the LCS are reset each time they are read.

AS-i circuit 2 function invocation		
address	access	data
8960	-/w	function: opcode 1: Set_Operation_Mode 2: Change_Slave_Address 3: Store_Actual_Parameters 4: Store_Actual_Configuration 5: Execute_Command 6: Send_Parameter
8960	r/-	function: result 0: success 32769: failure 32770: slave with 1st addr not detected 32771: slave with zero addr detected 32772: slave with 2nd addr detected 32773: delete error 32774: set error 32775: address stored temporarily 32776: extended ID1 stored temporarily 32777: error reading extended ID1 32778: parameter out of range 32779: invalid opcode
8961	r/w	function: parameter 1
8962	r/w	function: parameter 2

AS-i circuit 2 16-bit data of AS-i slaves according to slave profile 7.3 or 7.4		
address	access	data
9216 ... 9219	r/w	slave at address 0 (not used)
9220 ... 9223	r/w	slave at address 1
...		...
9340 ... 9343	r/w	slave at address 31

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device related references similar to the Momentum Ethernet Adapter		
address	access	data
61440	r/w	timeout in 10 msec units default 100 (≡ 1 sec) range 3 to 6000
62464 ... 62475	r/w	"allowed master" list (not used)
62480	-/w	authorize IP address record Set to 1 allow IP address assignment to be retained in FLASH. Default of 0 to require BOOTP.
63488	r/-	size of status block (63488 ... 63500)
63489	r/-	number of word of input (in cyclic data block, 34)
63490	r/-	number of word of output (in cyclic data block, 34)
63491	r/-	module ID code
63492	r/-	module revision number
63493	r/-	ASCII header size in words. ASCII header is (largely!) printable and starts at 64512
63494	r/-	internal diagnostic (not used)
63495	r/-	reservation time remaining (not used)
63496	r/-	watchdog holdup time remaining (resets to value in reference 61440 at each output operation)
63497	r/-	module health (32768 is good health)
63498 ... 63500	r/-	internal diagnostic (not used)
64512 ... 64521	r/-	ASCII text description of device e.g. "`AS-i/Ethernet GW`"

"run light" flash codes	
1 flash	Not used
2 flashes	Not used
3 flashes	No valid Ethernet signal seen. Check hub connection + cables
4 flashes	No MAC address assigned Return unit to factory!
5 flashes	Waiting for BOOTP reponse message. This will be a normal condition for a short period if the units have been preconfigured to operate without a BOOTP server and the units have recently gone through power-up.

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"run light" flash codes	
6 flashes	Failed to initialize the I/O base does not apply to the AS-i/Ethernet Gateway
7 flashes	This station does not have a valid EXEC. This will only happen if a download of a new version of the firmware is abandoned before it is complete. Reload the firmware using the appropriate tools.
8 flashes	Unexpected entry to Kernel mode. Unit has "crashed"
steady	Device OK, IP assigned

issue date 14.12.2000

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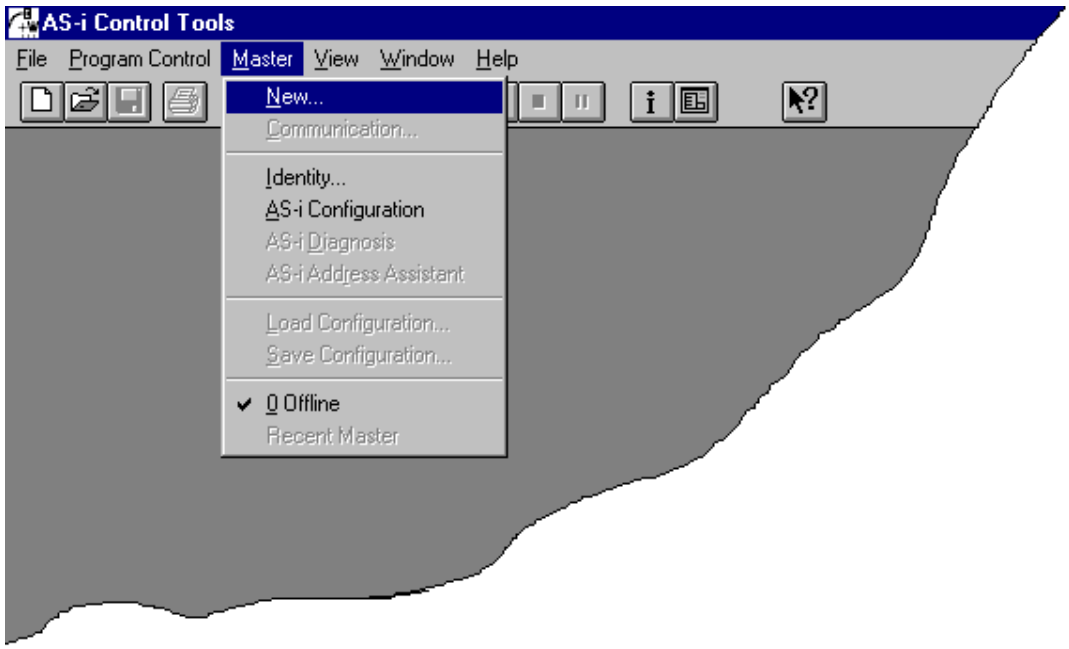
9 Accessories for putting AS-i into Operation and Test Tools

The AS-i circuit on the AS-i Master can be put into operation with the comfortable Windows software AS-i Control Tools.

9.1 Windows Software AS-i Control Tools

The Windows software AS-i Control Tools enables you to configure the AS-i circuit in a very comfortable manner.

1. For that purpose plug in the device to the RJ-45 connector and connect the device with an Ethernet TCP/IP cable to the network card of your PC.
2. Start the AS-i Control Tools.
3. Call the command Master | New.



4. Choose Ethernet as protocol.
5. Do the appropriate settings.

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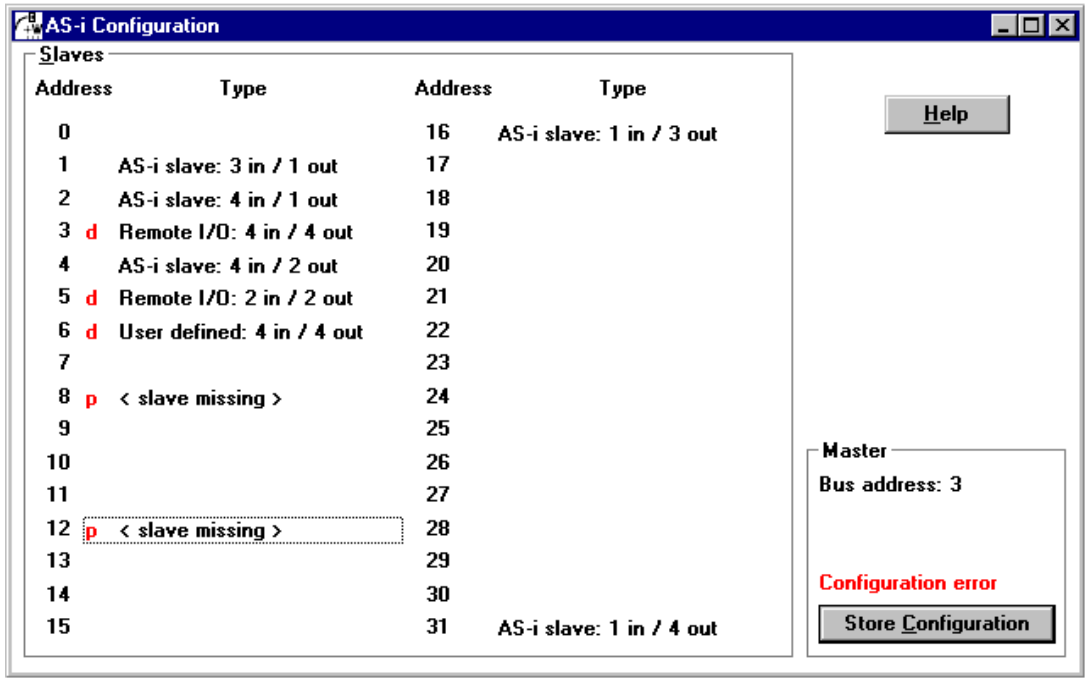
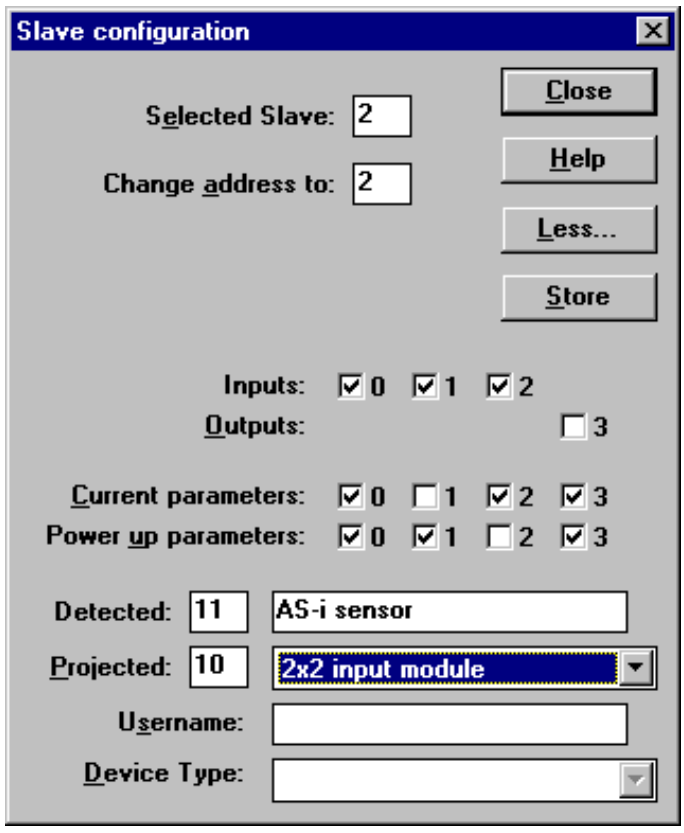
6. Call the command Master | AS-i configuration.
   The AS-i configuration editor will be started. All detected and projected AS-i slaves are displayed in this window.



7. Click on a slave entry to open the dialogbox slave configuration.



This dialog box is for changing a slave address, setting AS-i parameters or AS-i configuration data. Additionally you can test inputs and outputs.

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A very easy approach to configure the AS-i circuit is connecting each AS-i slave to the line and setting the AS-i slave address one after the other. After that press the button “Store configuration” to adopt the detected AS-i circuit to the AS-i master as projected data.

Moreover you can use the **AS-i Address Assistant**. This tool changes automatically the address of an AS-i slave to the desired address after plugging the slave to the AS-i line. The desired AS-i configuration can be created off-line before and stored to a file. When you build up the plant you only have to plug the AS-i slaves to the AS-i line one after the other.

Further descriptions to all features of the software can be obtained from the integrated help.

issue date 14.12.2000

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10 Appendix: Displays of the Figure Display

In the basic state of the configuration mode, the display shows one after the other the addresses of all detected slaves at a rate of two per second. A blank display means that the *LDS* is empty, i.e. no slaves were detected.

In the basic state of the protected operating mode, the display is either blank or displays the address of a faulty assignment (see chapter 6.4.2).

During manual address programming, the slave address display has a different meaning (see chapter 6.5 and 6.6).

All displayed numbers that are bigger than 31 and therefore can not be interpreted as a slave address are status or error messages of the master. They have the following meanings:

39	Advanced AS-i diagnostics: If a 39 appears on the display after pressing the 'set'-button a short-time AS-i power failure occured.
40	The AS-i master is in off-line phase.
41	The AS-i master is in detection phase.
42	The AS-i master is in activation phase.
43	The AS-i master starts the normal operating mode.
70	Hardware error: The AS-i master's EEPROM cannot be written to.
72	Hardware error: The PIC processor does not respond.
73	Hardware error: The PIC processor does not respond.
74	Checksum error in the EEPROM.
75	Error in the external RAM.
76	Error in the external RAM.
80	Error while attempting to exit the configuration mode: A slave with address zero exists.
81	General error while changing a slave address.
82	The front panel operation is blocked. Until the next power-up of the AS-i master the accessing to the device only from the host via the interface.
83	Program reset of the AS-i Control programm: The AS-i Control programm is just read out of EEPROM and copied into the RAM.
88	Display test while starting up the AS-i master
90	Error while changing a slave address in protected operating mode: No slave with address 0 existing.
91	Error while changing slave address: Target address is already occupied.
92	Error while changing slave address: New address could not be set.
93	Error while changing slave address: New address could only be stored volatile in the slave.
94	Error while changing slave address in protected operating mode: Slave has wrong configuration data.
95	Error while changing slave address in protected operating mode: The configuration error was caused by one slave too many (instead of one missing slave).

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11 Appendix: The First Commissioning of AS-i

Note

In this chapter an example is given of how to put an AS-i network into operation quickly and easily and without the need for external devices. The addressing of the components connected to the AS-i network can be performed directly on the AS-i master. It is of course more comfortable to do the addressing with a hand-held programming device or with the Windows software AS-i Control Tools. However, it is possible to configure even complex networks using only the AS-i master.

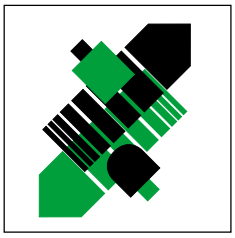
What to do ?	**How to go about it?**
See to it that the AS-i master is properly supplied with power.	Connect the AS-i power supply unit to the terminals AS-i + and AS-i - of the master, connect the ground terminal. Turn on the power supply.
After the self-test: the LEDs “power”, “config err”, ”U ASI” and “prj mode” are on. The figure display shows “40”: the AS-i master is in the off-line phase. Shortly after that a “41” will be displayed: the AS-i master stays in the detection phase.	
Switch the device to the projecting mode, if the yellow LED does not light up.	Press the “modeMODE”-button for approx. five seconds.
The yellow LED “prj mode” lights up. The device is now in projecting mode.	
Add a slave with the address 0 to the AS-i line.	Connect the slave's terminals with the terminals AS-i +/- of the master.
The green LED “ASI active” lights up. The figure display shows “0”. This means the AS-i master has detected the slave.	
Change the slave address to address 1.	Select address 1 by pressing the “set” button shortly, if necessary repeatedly. When a “1” appears on the display press the “set” button for approx. five seconds until the display blinks. Press again shortly the “set” button to assign the new address to the slave.
The AS-i master detects the slave with address 1 and displays “1”.	
Connect another slave with address 0 to the AS-i line and allocate the address 2 to it.	Connect the slave to the AS-i line. The addressing is the same as for the previous slave.
The addresses of all slaves detected are now displayed sequentially.	
Change to the protected operating mode and store the AS-i configuration.	Leave the configuration mode by pressing the “mode” button for at least five seconds until the “prj mode” LED goes out.

issue date 14.12.2000

What to do ?	How to go about it?
The configuration of the AS-i master is now finished. Now the hierarchically higher fieldbus system can be put into operation. **The gateway stays in the off-line phase (the display shows “40”, the LED “config err” lights up), until the hierarchically higher fieldbus system operates properly.**	

issue date 14.12.2000

Ein Kern, zwei Profile.



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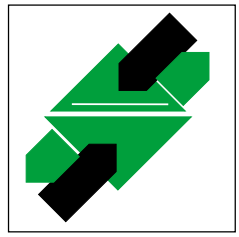

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