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User Manual

Anybus® Communicator™

for EtherNet/IP™ / Modbus-TCP
(2-port version)

Doc. Id. HMSI-27-316
Rev. 1.00

Connecting Devices™

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Important User Information

This document contains a general introduction as well as a description of the technical features provided by the Anybus Communicator, including the PC-based configuration software.

The reader of this document is expected to be familiar with PLC and software design, as well as communication systems in general. The reader is also expected to be familiar with the Microsoft® Windows® operating system.

Liability

Every care has been taken in the preparation of this manual. Please inform HMS Industrial Networks AB of any inaccuracies or omissions. The data and illustrations found in this document are not binding. We, HMS Industrial Networks AB, reserve the right to modify our products in line with our policy of continuous product development. The information in this document is subject to change without notice and should not be considered as a commitment by HMS Industrial Networks AB. HMS Industrial Networks AB assumes no responsibility for any errors that may appear in this document.

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Warning:	This is a class A product. in a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.
ESD Note:	This product contains ESD (Electrostatic Discharge) sensitive parts that may be damaged if ESD control procedures are not followed. Static control precautions are required when handling the product. Failure to observe this may cause damage to the product.

Anybus Communicator EtherNet/IP/Modbus-TCP 2-port User Manual

Doc: HMSI-27-316

Table of Contents

Chapter 12 Nodes

Chapter 13 Transactions

Chapter 14 Frame Objects

Chapter 15 Commands

Chapter 22 CIP Object Implementation

P. About This Document

For more information, documentation etc., please visit the HMS website www.anybus.com.

P.1 Related Documents

Document name	Author
Anybus Communicator - EtherNet/IP Installation Sheet	HMS
DF1 Protocol and Command Set - Reference Manual, 1770-6.5.16, October 1996	Allen-Bradley
Open Modbus/TCP Specification, Release 1.0	Schneider Electric
RFC 821	Network Working Group
RFC 1918	Network Working Group
ENIP Specifications	ODVA

P.2 Document History

Summary of Recent Changes

This document (HMSI-27-316) succeeds HMSI-27-234 which has been revoked. The following list of changes refers to the final edition of that document (Rev. 4.20).

Change	Page(s)
Screenshots and descriptions of ABC Tool updated for Anybus Configuration Manager	Multiple
Changed “ABC” to “Communicator RS232/422/485”	Multiple
Amended description of “Update time” parameter	71, 72
Added description for Consume/Response to “Object Delimiter” parameter	79
Changed “Maximum Data Length” limit	79
Removed obsolete “Start Bits” parameter	88
Removed obsolete “ABCC ExtLink Wizard” entry	100
Added parameters to checksum object description	80
Added info about explicit messaging and the Run/Idle header parameter	22, 63
Updated screenshots in mailbox examples	120, 122
Minor text edits, typo corrections	Multiple

Revision List

Revision	Date	Author	Chapter	Description
1.00	March 2015	ThN	All	New document (succeeding HMSI-27-234)

P.3 Conventions & Terminology

The following conventions are used throughout this document:

- Numbered lists provide sequential steps
- Bulleted lists provide information, not procedural steps
- The term "user" refers to the person or persons responsible for installing the Anybus Communicator in a network.
- The term "ABC" refers to the Anybus Communicator.
- Hexadecimal values are written in the format 0xNNNN, where NNNN is the hexadecimal value.
- Decimal values are represented as NNNN where NNNN is the decimal value
- As in all communication systems, the terms "input" and "output" can be ambiguous, because their meaning depend on which end of the link is being referenced. The convention in this document is that "input" and "output" are always being referenced to the master/scanner end of the link.

P.3.1 Glossary

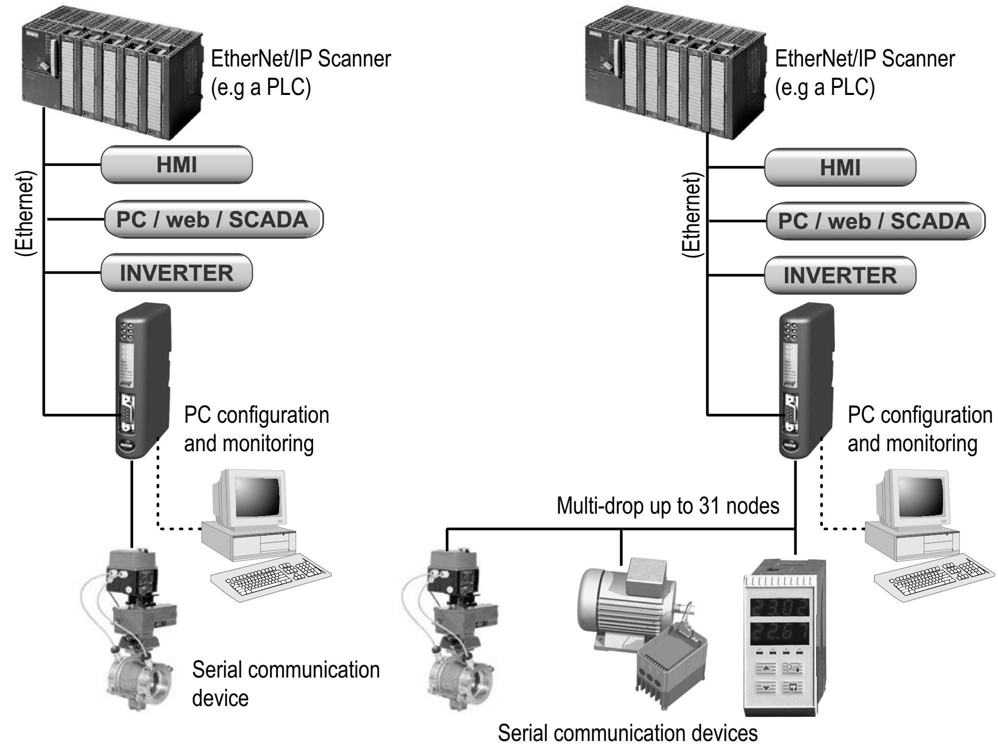
Term	Meaning
ABC	Anybus Communicator
ACM	Anybus Configuration Manager
EIP	EtherNet/IP
Broadcaster	A protocol specific node in the sub-network scan that hold transactions destined to all nodes
Command	A protocol specific transaction.
Configuration	List of configured nodes with transactions on the sub-network
Fieldbus	The network to which the communicator is connected.
Frame	Higher level series of bytes forming a complete telegram on the sub-network
Monitor	A tool for debugging the Anybus Communicator and the network connections
Node	A device in the scan-list that defines the communication with a slave on the sub-network
Scan list	List of configured slaves with transactions on the sub-network
Sub-network	The network that logically is located on a subsidiary level with respect to the fieldbus and to which the Anybus Communicator acts as a gateway
Transaction	A generic building block that is used in the sub-network scan-list and defines the data that is sent out the sub-network
Fieldbus Control System	Fieldbus master
Higher Level Network	In this case, Ethernet (including EtherNet/IP and Modbus-TCP)
Network	
Fieldbus	

P.4 Sales and Support

For general contact information and support, please refer to the contact and support pages at www.anybus.com

1. About the Anybus Communicator for EtherNet/IP

The Anybus Communicator for EtherNet/IP acts as a gateway between virtually any serial application protocol and an EtherNet/IP-based network. Integration of industrial devices is enabled with no loss of functionality, control and reliability, both when retro-fitting to existing equipment as well as when setting up new installations.



Single-Node Serial Sub Network **Multi-Node Serial Sub Network**

Sub-network

The Anybus Communicator can address up to 31 nodes, and supports the following physical standards:

- RS-232
- RS-422
- RS-485

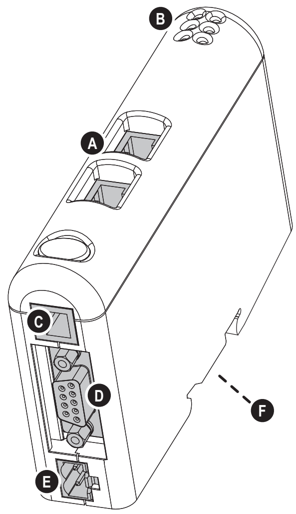
Ethernet Interface

Ethernet connectivity is provided through the patented Anybus technology; a proven industrial communication solution used all over the world by leading manufacturers of industrial automation products.

- EtherNet/IP group 2 and 3 server
- Modbus-TCP slave functionality
- Server Side Include (SSI) functionality
- Web server and E-mail client capabilities
- FTP & Telnet servers
- 10/100 Mbit/s, twisted pair

1.1 External View

For wiring and pin assignments, see "Connector Pin Assignments" on page 126.



A: Ethernet Connectors

These connectors are used to connect the Anybus Communicator to the network.

See also...

- "Ethernet Connector" on page 126

B: Status LEDs

See also...

- "Status LEDs" on page 13

C: PC-connector

This connector is used to connect the gateway to a PC for configuration and monitoring purposes.

See also...

- "PC Connector" on page 127

D: Sub-network Connector

This connector is used to connect the gateway to the serial sub-network.

See also...

- "Sub-network Interface" on page 128

E: Power Connector

This connector is used to apply power to the gateway.

See also...

- "Power Connector" on page 126

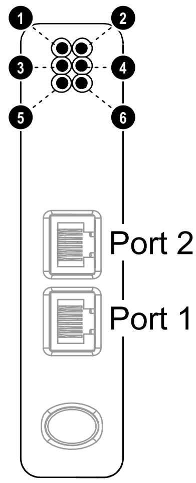
F: DIN-rail Connector

The DIN-rail mechanism connects the gateway to PE (Protective Earth).

See also...

- "Hardware Installation" on page 14

1.2 Status LEDs



#	State	Status
1 - Module Status *(EtherNet/IP only)*	Off	No power
	Green	Controlled by a scanner in RUN state
	Green, flashing	Not configured, or scanner in IDLE state
	Red	Major fault (unrecoverable)
	Red, flashing	Minor fault (recoverable)
	Alternating Red/Green	Self-test
2 - Network Status *(EtherNet/IP only)*	Off	No IP address (or no power)
	Green	Online, EtherNet/IP connection(s) established
	Green, flashing	Online, no EtherNet/IP connections established
	Red	Duplicate IP address detected, fatal error
	Red, flashing	One or more connections timed out
	Alternating Red/Green	Self-test
3 - Link/Activity 1	Off	No link (or no power)
	Green, flashing	Receiving/transmitting Ethernet packets (100 Mbit)
	Red, flashing	Receiving/transmitting Ethernet packets (10 Mbit)
3 - Link/Activity 2	Off	No link (or no power)
	Green, flashing	Receiving/transmitting Ethernet packets (100 Mbit)
	Red, flashing	Receiving/transmitting Ethernet packets (10 Mbit)
5 - Subnet Status[a]	Off	(no power)
	Green, flashing	Running correctly, but one or more transaction error(s) have occurred
	Green	Running
	Red	Transaction error/timeout or subnet stopped
6 - Device Status	Off	(no power)
	Alternating Red/Green	Invalid or missing configuration
	Green	Initializing
	Green, flashing	Running
	Red	Bootloader mode[b]
	Red, flashing	If the Device Status LED is flashing in a sequence starting with one or more red flashes, please note the sequence pattern and contact HMS support.

a. This LED shows green when all transactions have been active at least once. This includes any transactions using “change of state” or “change of state on trigger”. If a time-out occurs on a transaction, this LED will show red.

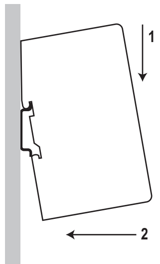
b. The gateway is in bootloader mode, and firmware must be restored in order for it to work properly. Start up the Anybus Configuration Manager and connect to the Anybus Communicator. Select **Tools/Options/Module**. Click **Factory Restore** to restore firmware. See “Tools” on page 60.

1.3 Hardware Installation

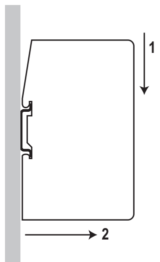
Perform the following steps to install the Anybus Communicator module:

1. Snap the gateway on to the DIN-rail.

The DIN-rail mechanism works as follows:



To snap the ABC *on*, first press it downwards (1) to compress the spring in the DIN-rail mechanism, then push it against the DIN-rail as to make it snap on (2)



To snap the ABC *off*, push it downwards (1) and pull it out from the DIN-rail (2), as to make it snap off from the DIN-rail

2. Connect the gateway to an Ethernet network.

3. Connect the gateway to the serial sub-network.

4. Connect the gateway to the PC via the configuration cable.

5. Connect the power cable and apply power.

6. Start the Anybus Configuration Manager program on the PC.

(The Anybus Configuration Manager software will automatically attempt to detect the serial port. If unsuccessful, select the correct port manually in the “Port”-menu)

7. Configure the gateway using the Anybus Configuration Manager and download the configuration.

8. Set up the EtherNet/IP communication according to the gateway configuration.

1.4 Software Installation

1.4.1 Anybus Configuration Manager

System requirements

- Pentium 133 MHz or higher
- 650 MB of free space on the hard drive
- 32 MB RAM
- Screen resolution 800 x 600 (16 bit color) or higher
- Microsoft Windows® 2000 / XP / Vista / 7 (32- or 64-bit)
- Internet Explorer 4.01 SP1 or newer (or any equivalent browser)

Installation

- **Anybus Communicator resource CD**
  - Insert the CD and follow the on-screen instructions.
  - If the installation does not start automatically: right-click on the CD drive icon and select "Explore" to show the contents of the CD. Locate the installation executable and double-click on it to start the installation, then follow the on-screen instructions.

- **From HMS website**
  - Download the latest version of Anybus Configuration Manager from www.anybus.com.
  - Unzip the archive on your computer and double-click on the installation executable.

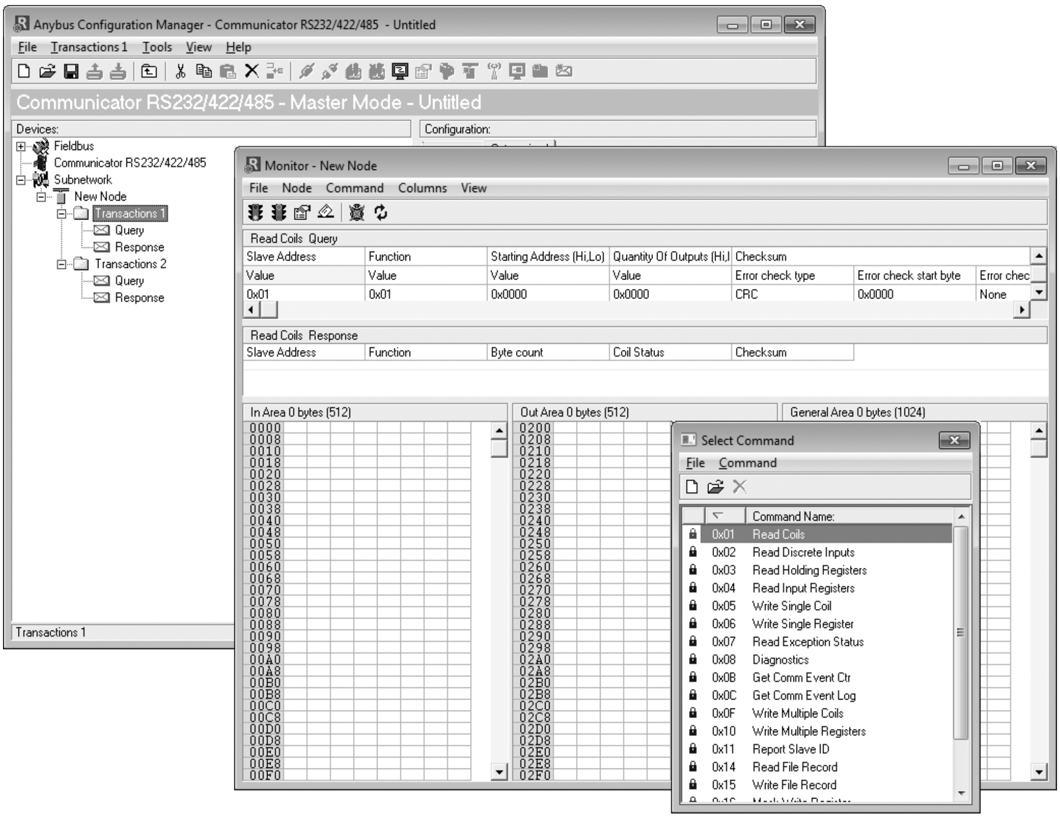
2. Basic Operation

2.1 General

The Anybus Communicator is designed to exchange data between a serial sub-network and a higher level network. Unlike most other similar devices, the Anybus Communicator has no fixed protocol for the sub-network, and consequently can be configured to handle almost any form of serial communication.

The gateway can issue serial telegrams cyclically, on change of state, or based on trigger events issued by the control system in the higher level network (i.e. the fieldbus master or PLC). It can also monitor certain aspects of the sub-network communication and notify the higher level network when data has changed.

An essential part of the Anybus Communicator package is Anybus Configuration Manager (ACM), a Windows-based application used to supply the gateway with a description of the sub-network protocol. No programming skills are required; instead, a visual protocol description-system is used to specify the different parts of the serial communication.

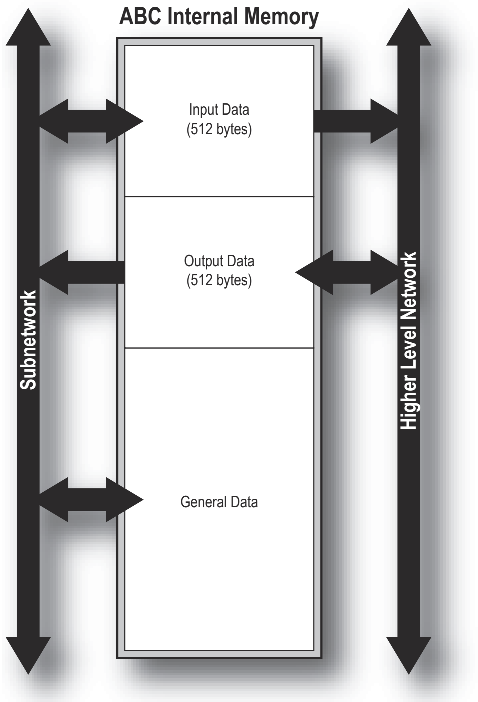


2.2 Data Exchange Model

Internally, data exchanged on the sub-network and on the higher level network all resides in the same memory.

This means that in order to exchange data with the sub-network, the higher level network simply reads and writes data to the memory locations specified using the Anybus Configuration Manager. The very same memory locations can then be exchanged on the sub-network.

The internal memory buffer is divided into three areas, based on function:



- **Input Data (512 bytes)**

  This area can be read by the higher level network, the web server and the E-mail client.

  (Data representation on the higher level network is described later in this chapter).

- **Output Data (512 bytes)**

  This area can be read/written to by the higher level network, the web server and the E-mail client.

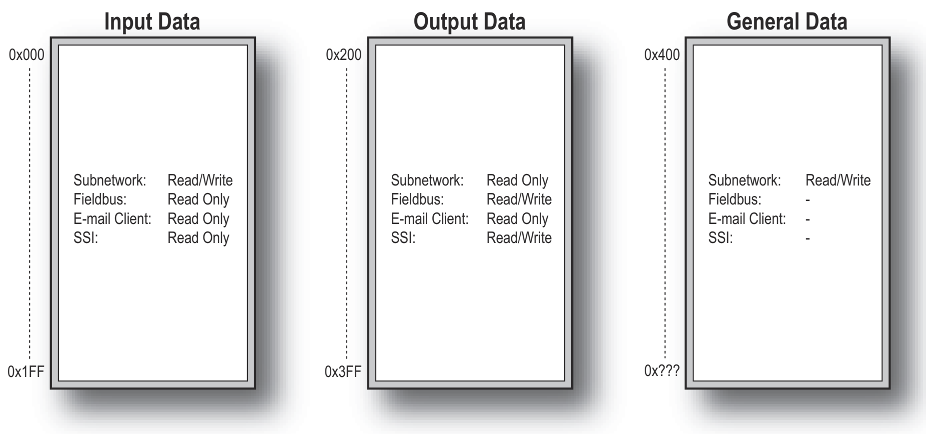
  (Data representation on the higher level network is described later in this chapter).

- **General Data (up to 1024 bytes)**

  This area cannot be accessed from the higher level network, but can be used for transfers between individual nodes on the sub-network, or as a general "scratch pad" for data. The actual size of this area depends on the amount of data that is exchanged on the sub-network. The gateway can handle up to 1024 bytes of general data.

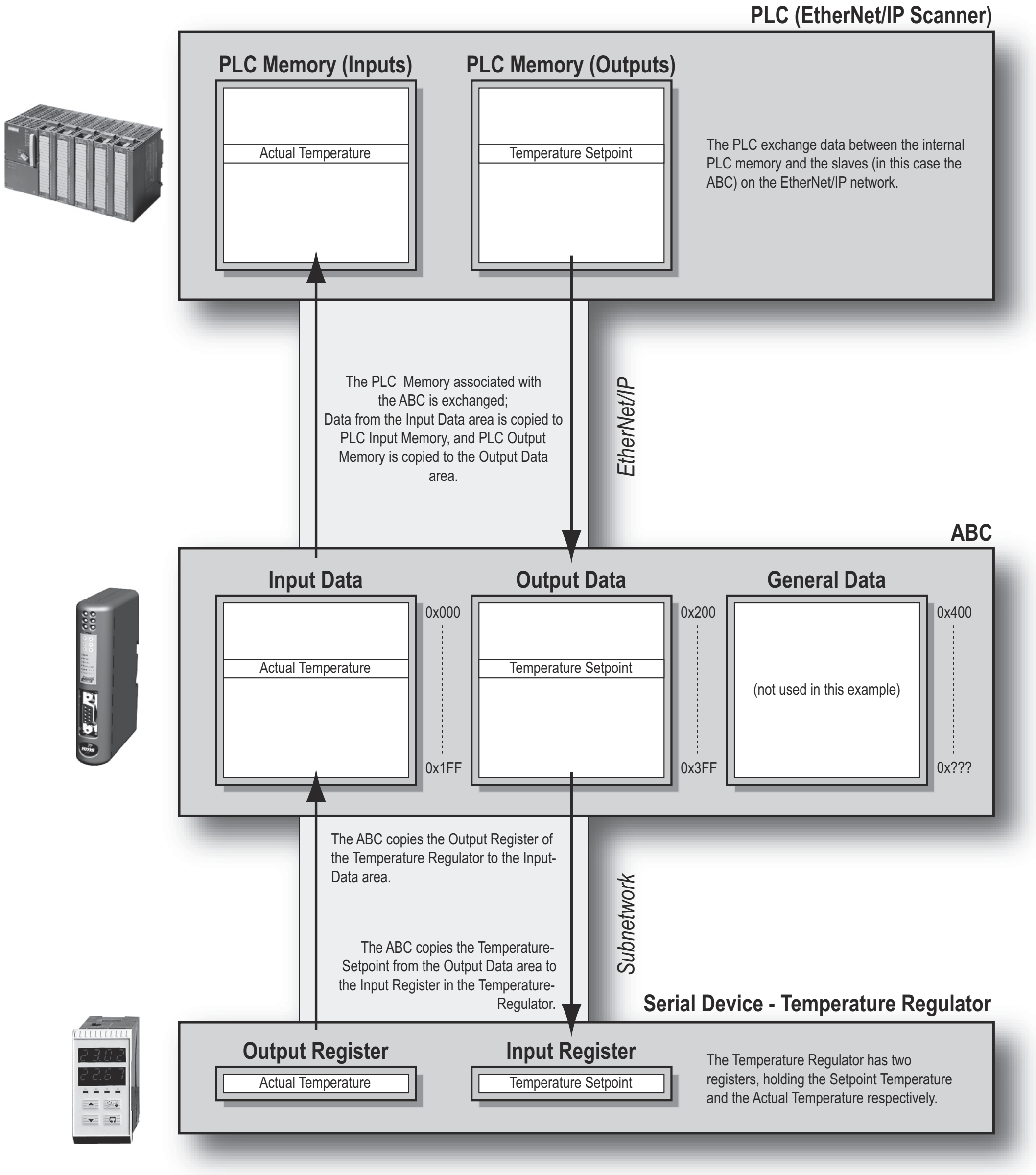
2.2.1 Memory Map

When building the sub-network configuration using the Anybus Configuration Manager, the different areas described above are mapped to the memory locations (addresses) specified below.



2.2.2 Data Exchange Example

In the following example, a temperature regulator on the sub-network exchanges information with a PLC on the higher level network, via the internal memory buffers in the Anybus Communicator.



2.3 Sub-network Protocol

2.3.1 Protocol Modes

The Anybus Communicator features three distinct operating modes for sub-network communication: 'Master Mode', 'DF1 Master Mode' and 'Generic Data Mode'. Note that the protocol mode only specifies the basic communication model, not the actual sub-network protocol.

- **Master Mode**

  In this mode, the gateway acts as a master on the sub-network, and the serial communication is query-response based. The nodes on the network are not permitted to issue messages unless first addressed by the gateway .

  For more information about this mode, see "Master Mode" on page 20.

- **DF1 Master Mode**

  In this mode, the gateway acts as a master on the sub-network, using the DF1 protocol. The serial communication is query-response based. For more information about this mode, see "DF1 Protocol Mode" on page 86.

- **Generic Data Mode**

  In this mode, there is no master-slave relationship between the sub-network nodes and the gateway; any node on the sub-network, including the gateway, may spontaneously produce or consume messages.

  For more information about this mode, see "Generic Data Mode" on page 21.

2.3.2 Protocol Building Blocks

The following building blocks are used in Anybus Configuration Manager to describe the sub-network communication. How these blocks apply to the three protocol modes is described later in this document.

- **Node**

  A 'node' represents a single device on the sub-network. Each node can be associated with a number of transactions, see below.

- **Transaction**

  A 'transaction' represents a complete serial telegram, and consists of a number of frame objects (see below). Each transaction is associated with a set of parameters controlling how and when to use it on the sub-network.

- **Commands**

  A 'command' is simply a predefined transaction stored in a list in the Anybus Configuration Manager. This simplifies common operations by allowing transactions to be stored and reused.

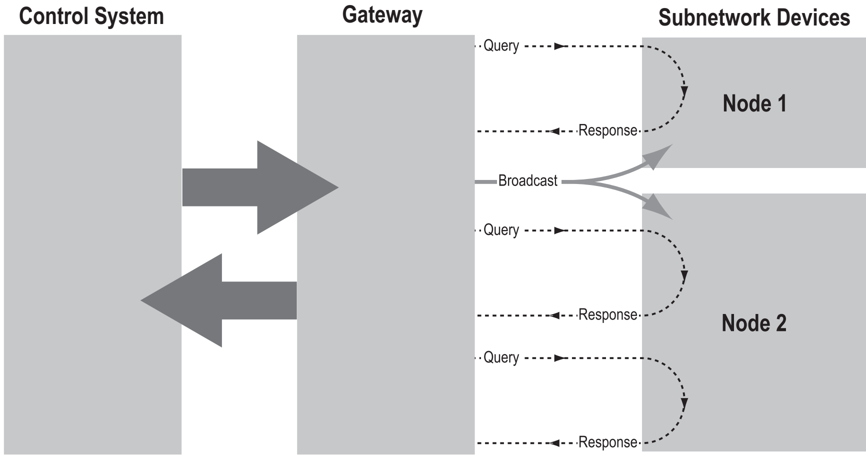
- **Frame Object**

  'Frame objects' are low level entities used to compose a transaction (see above). A frame object can represent a fixed value (a constant), a range of values (limit objects), a block of data or a calculated checksum.

2.3.3 Master Mode

In this mode, the communication is based on a query-response scheme; when the gateway issues a query on the sub-network, the addressed node is expected to issue a response. Nodes are not permitted to issue responses/messages spontaneously, i.e. without first receiving a query.

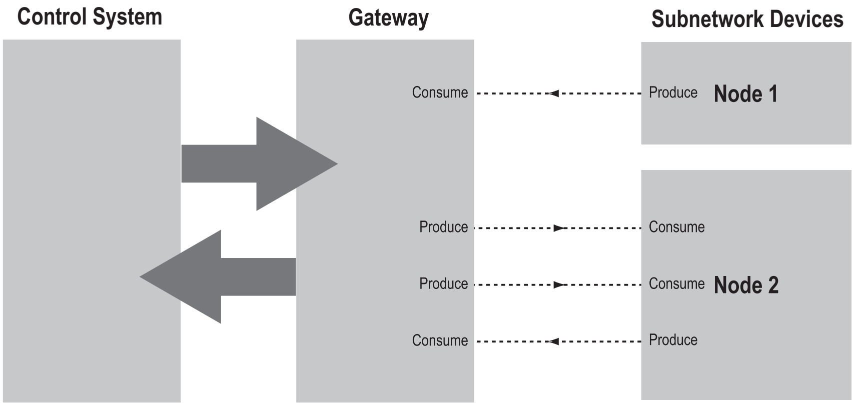
There is, however, one exception to this rule; the broadcaster. Most protocols offer some way of broadcasting messages to all nodes on the network, without expecting them to respond to the broadcasted message. This is also reflected in the gateway, which features a dedicated broadcaster node.



In Master Mode, Anybus Configuration Manager comes pre-loaded with the most commonly used Modbus RTU commands, which can be conveniently reached by right-clicking on a node in the Anybus Configuration Manager and selecting 'Insert New Command'. Note, however, that this in no way prevents other protocols based on the same query-response message-scheme from also being implemented.

2.3.4 Generic Data Mode

In this mode, there is no master-slave relationship between the nodes on the sub-network and the gateway. Any node (including the gateway) may spontaneously produce or consume a message. Nodes are not obliged to respond to messages, nor do they need to wait for a query in order to send a message.



In the figure above, the Anybus Communicator 'consumes' data 'produced' by a node on the sub-network. This 'consumed' data can then be accessed from the higher level network. This also works the other way around; the data received from the higher level network is used to 'produce' a message on the sub-network, for 'consumtion' by a node.

2.3.5 DF1 Master Mode

Please refer to "DF1 Protocol Mode" on page 86.

2.4 EtherNet/IP

2.4.1 General

EtherNet/IP is based on the Control and Information Protocol (CIP), which is also the application layer for DeviceNet and ControlNet. The Anybus Communicator acts as a Group 2 or 3 server on the EtherNet/IP network.

Input and output data is accessed using I/O connections or explicit messages towards the assembly object and the parameter input/output mapping objects.

Note: The EtherNet/IP Run/Idle header function must be disabled in the Anybus Configuration Manager if explicit messaging is used.

See also...

- “CIP Object Implementation” on page 107
- “Fieldbus Settings” on page 63

2.4.2 Data Types

The input and output data hold two types of data; I/O data and parameter data. I/O data is exchanged on change of value, and can be accessed using I/O connections towards the assembly object.

Parameter data can be accessed acyclically via the parameter input and output mapping objects. Note, however, that each instance attribute within these objects must be created manually using the Anybus Configuration Manager.

For more information see “Parameter Data Initialization (Explicit Data)” on page 121.

See also...

- “Assembly Object, Class 04h” on page 109
- “Parameter Data Input Mapping Object, Class B0h” on page 114
- “Parameter Data Output Mapping Object, Class B1h” on page 115
- “Fieldbus Settings” on page 63

2.4.3 Memory Layout

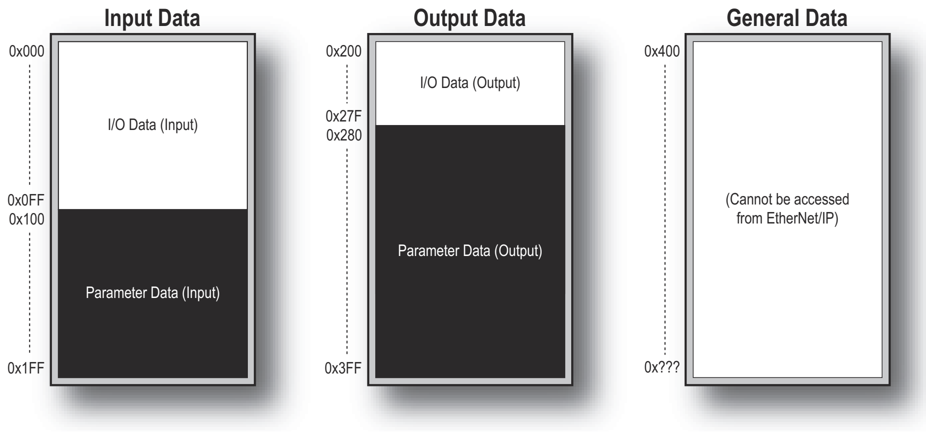
I/O sizes are specified using the Anybus Configuration Manager and correlate to the Anybus Communicator memory as follows:

Example:

I/O Sizes for the gateway set to the following values:

IO Size In= 256 bytes (0x0100)
IO Size Out= 128 bytes (0x0080)

Resulting memory layout:



2.5 Modbus-TCP

2.5.1 General

The Modbus-TCP protocol is an implementation of the standard Modbus protocol running on top of TCP/IP. The built-in Modbus-TCP server provides access to the input and output data areas via a subset of the functions defined in the Modbus-TCP specification.

The server supports up to 8 simultaneous connections and communicates over TCP port 502. For detailed information regarding the Modbus-TCP protocol, consult the Open Modbus Specification.

2.5.2 Addressing Modes

The Anybus Communicator features two different modes of operation regarding the Modbus communication:

- **Modbus Addressing Mode (Default)**

  In this mode, the input and output data areas are mapped to different function codes.

  Note that coil addressing is not possible in this mode.

  See also...

  - "Modbus Addressing Mode" on page 25

- **Anybus Addressing Mode**

  Compared to Modbus Addressing Mode, this mode allows data to be addressed in a more flexible way. Note however that several function codes can be used to access the same data in the gateway. While this may appear confusing at first, it allows data to be manipulated in ways not possible in Modbus Addressing Mode (e.g. it is possible to manipulate individual bits of a register by accessing coils associated with the same memory location).

  See also...

  - "Anybus Addressing Mode" on page 26

2.5.3 Supported Exception Codes

Code	Name	Description
0x01	Illegal function	The function code in the query is not supported
0x02	Illegal data address	The data address received in the query is outside the initialized memory area
0x03	Illegal data value	The data in the request is illegal

2.5.4 Modbus Addressing Mode

Supported Function Codes

The following function codes can be used in this mode:

Modbus Function	Function Code	Associated with Area	No. of I/Os or Data Points per Command
Read Holding Registers	3	Output Data area (0x200...0x3FF)	1 - 125 registers
Read Input Registers	4	Input Data area (0x000....0x1FF)	1 - 125 registers
Write Single Register	6	Output Data area (0x200...0x3FF)	1 register
Force Multiple Registers	16		1 - 800 registers
Mask Write Register	22		1 register
Read/Write Registers	23		125 registers read / 100 registers write

Input Register Map

The input data area is mapped to input registers as follows:

Register #	Memory Location in the gateway	Comments
1	0x000... 0x001	Each register corresponds to two bytes in the input data area.
2	0x002... 0x003	
3	0x004... 0x005	
4	0x006... 0x007	
5	0x008... 0x009	
6	0x00A... 0x00B	
...	...	
255	0x1FC... 0x1FD	
256	0x1FE... 0x1FF	

Holding Register Map

The output data area is mapped to holding registers as follows:

Register #	Memory Location in the gateway	Comments
1	0x200... 0x201	Each register corresponds to two bytes in the output data area.
2	0x202... 0x203	
3	0x204... 0x205	
4	0x206... 0x207	
5	0x208... 0x209	
6	0x20A... 0x20B	
...	...	
255	0x3FC... 0x3FD	
256	0x3FE... 0x3FF	