Network Interface Appendix

Anybus® CompactCom CANopen

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HMS Industrial Networks AB

	☎	✉
Germany	+49 - 721 - 96472 - 0	ge-sales@hms-networks.com
Japan	+81 - 45 - 478 -5340	jp-sales@hms-networks.com
Sweden	+46 - 35 - 17 29 20	sales@hms-networks.com
U.S.A.	+1 - 312 - 829 - 0601	us-sales@hms-networks.com
France	+33 - 3 89 32 76 76	fr-sales@hms-networks.com
Italy	+39 - 347 - 00894 - 70	it-sales@hms-networks.com
China	+86 - 10 - 8532 - 3183	cn-sales@hms-networks.com

Important User Information

This document is intended to provide a good understanding of the functionality offered by CANopen. The document only describes the features that are specific to the Anybus CompactCom CANopen. For general information regarding the Anybus CompactCom, consult the Anybus CompactCom design guides.

The reader of this document is expected to be familiar with high level software design, and communication systems in general. The use of advanced CANopen-specific functionality may require in-depth knowledge in CANopen networking internals and/or information from the official CANopen specifications. In such cases, the people responsible for the implementation of this product should either obtain the CANopen specification to gain sufficient knowledge or limit their implementation in such a way that this is not necessary.

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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.

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Table of Contents

P. About This Document

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

P.1 Related Documents

Document	Author
Anybus-CompactCom Software Design Guide	HMS
Anybus-CompactCom Hardware Design Guide	HMS
Anybus-CompactCom Software Driver User Guide	HMS
IEC 61158-6	IEC
CiA Draft Standard 301 v4.02	CAN in Automation

P.2 Document History

Summary of Recent Changes (2.02 ... 3.01)

Change	Page(s)
Clarified description of CANopen object	25
Updated support information	3
Corrected default value of attribute 7 of CANopen object, instance #1	26

Revision List

Revision	Date	Author(s)	Chapter(s)	Description
2.00	2007-05-30	PeP	-	First official version
2.01	2007-07-09	PeP	2	Minor update
2.02	2008-06-30	PeP	5	Minor update
3.00	2010-04-14	KeL	All	Change of concept, updates
3.01	2011-02-10	KeL	P, 6	Minor updates

P.3 Conventions & Terminology

The following conventions are used throughout this manual:

- Numbered lists provide sequential steps
- Bulleted lists provide information, not procedural steps
- The terms 'Anybus' or 'module' refers to the Anybus CompactCom module.
- The terms 'host' or 'host application' refers to the device that hosts the Anybus module.
- Hexadecimal values are written in the format NNNNh or 0xNNNN, where NNNN is the hexadecimal value.
- A byte always consists of 8 bits.

P.4 Support

HMS Sweden (Head Office)

E-mail:support@hms-networks.com
Phone: +46 (0) 35 - 17 29 20
Fax: +46 (0) 35 - 17 29 09
Online:www.anybus.com

HMS North America

E-mail:us-support@hms-networks.com
Phone: +1-312-829-0601
Toll Free:+1-888-8-Anybus
Fax: +1-312-629-2869
Online:www.anybus.com

HMS Germany

E-mail:ge-support@hms-networks.com
Phone: +49-721-96472-0
Fax: +49-721-964-7210
Online:www.anybus.com

HMS Japan

E-mail:jp-support@hms-networks.com
Phone: +81-45-478-5340
Fax: +81-45-476-0315
Online:www.anybus.com

HMS China

E-mail:cn-support@hms-networks.com
Phone: +86 10 8532 3023
Online:www.anybus.com

HMS Italy

E-mail:it-support@hms-networks.com
Phone: +39 039 59662 27
Fax: +39 039 59662 31
Online:www.anybus.com

HMS France

E-mail:fr-support@hms-networks.com
Phone: +33 (0) 3 89 32 76 41
Fax: +33 (0) 3 89 32 76 31
Online:www.anybus.com

1. About the Anybus CompactCom CANopen

1.1 General

The Anybus CompactCom CANopen communication module provides instant CANopen connectivity via the patented Anybus CompactCom host interface. Any device that supports this standard can take advantage of the features provided by the module, allowing seamless network integration regardless of network type.

This product conforms to all aspects of the host interface for Active modules defined in the Anybus-CompactCom Hardware- and Software Design Guides, making it fully interchangeable with any other device following that specification. Generally, no additional network related software support is needed, however in order to take advantage of advanced network specific functionality, a certain degree of dedicated software support may be necessary.

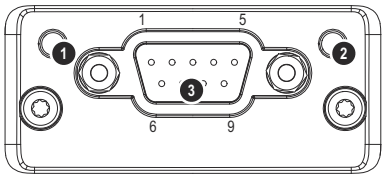
The functionality of the module is described in three categories: Basic, Extended and Advanced, see "Categorization of Functionality" on page 27.

1.2 Features

- DS301 v4.02 compliant
- Galvanically isolated bus electronics
- Supports all standard baud rates
- Automatic baudrate detection
- Supports LSS
- Customizable Identity Information
- Up to 32 TPDO's & 32 RPDO's (Corresponds to a total of 256 bytes of Process Data)
- PDO mapping can be customized via network configuration tool
- Up to 16383 ADI's can be accessed from the network as Manufacturer Specific Objects.
- Diagnostic support
- Supports Expedited- and Segmented SDO Transfer (Block Transfer not supported)

1.3 Front View

#	Item
1	RUN LED[a]
2	ERROR LED[a]
3	CANopen Interface



a. The flash sequences for these LEDs are defined in DR303-3 (CiA).

RUN LED

LED State	Indication	Description
Off	-	No power.
Green	OPERATIONAL	The module is in the 'operational' state.
Green, blinking	PRE-OPERATIONAL	The module is in the 'pre-operational' state.
Green, single flash	STOPPED	The module is in the 'stopped' state.
Green, flickering	Autobaud	Baudrate detection in progress.
Red[a]	EXCEPTON state (Fatal Event)	The module has shifted into the EXCEPTION state.

a. If both LEDs turns red, this indicates a fatal event; the bus interface is shifted into a physically passive state.

ERROR LED

LED State	Indication	Description
Off	-	No power - *or* - device is in working condition.
Red, single flash	Warning limit reached	A bus error counter reached or exceeded its warning level.
Red, flickering	LSS	LSS services in progress.
Red, double flash	Error Control Event	A guard- (NMT-Slave or NMT-master) or heartbeat event (Heartbeat consumer) has occurred.
Red[a]	Bus off (Fatal Event)	Bus off.

a. If both LEDs turns red, this indicates a fatal event; the bus interface is shifted into a physically passive state.

CANopen Interface

Pin	Signal	Comments
1	-	-
2	CAN_L	-
3	CAN_GND	-
4	-	-
5	CAN_SHLD	-
6	-	-
7	CAN_H	-
8	-	-
9	-	-
Housing	CAN_SHIELD	-

2. Tutorial

2.1 Introduction

This chapter is a complement to the Anybus CompactCom Implementation Tutorial. The ABCC tutorial describes and explains a simple example of an implementation with Anybus CompactCom. This chapter includes network specific settings that are needed for a host application to be up and running and possible to certify for use on CANopen networks.

2.2 Fieldbus Conformance Notes

- This product is pre-certified for network compliance. While this is done to ensure that the final product *can* be certified, it does not necessarily mean that the final product will not require recertification. Contact HMS for further information.
- The .EDS-file associated with this product must be altered to match the final implementation. See also "Electronic Data Sheet (EDS)" on page 9.
- HMS recommends that the device identity information is customized to ensure interoperability. CiA (CAN in Automation) members should apply for a unique Vendor ID; non-members may contact HMS to obtain a custom Product ID. Note however that a unique Vendor ID is required when certifying the final product.
- The module supports CAN Standard Frames with 11-bit Identifier Field, see 'CiA Draft Standard 301 v4.02'. 29-bit Identifier Fields are not allowed.

2.3 Certification

The following steps are necessary to perform to obtain a certification:

1. **Change Vendor ID:**

   Replace the HMS Vendor ID with a unique Vendor ID, obtained from CiA (CAN in Automation). This is done by implementing the CANopen object (FBh), instance1, attribute 1 and returning the Vendor ID when receiving a Get_Attribute request.

2. **Change Product Code:**

   Replace the HMS Product Code in the CANopen object (FBh) with a product code of your own. If you do not have a Vendor ID of your own, please contact HMS for a specific product code. Implement the CANopen object (FBh), instance 1, attribute 2 and return the Product Code when receiving a Get_Attribute request.

3. **Change Revision Number:**

   Replace the HMS Revision Number in the CANopen object (FBh), Instance 1, Attributes 3 and 4. Implement the CANopen object (FBh), instance 1, attributes 3 and 4, and return the Revision Number when receiving a Get_Attribute request.

4. **Change Manufacture Device Name:**

   Replace the "Manufacture Device Name" in the CANopen object (FBh), Instance 1, Attribute 6. Implement the CANopen object (FBh), instance 1, attribute 6, and return the Manufacture Device Name when receiving a Get_Attribute request

5. **Modify the EDS-file:**

   Modify the CANopen ABCC EDS file so that it corresponds to the vendor product (e.g. Vendor ID, Product Name and Product Number along with ADI object names, that correspond to descriptive names in the application). Run the EDS-file checker program from www.can-cia.org. See also "Electronic Data Sheet (EDS)" on page 9.

3. Basic Operation

3.1 General Information

3.1.1 Software Requirements

No additional network support code needs to be written in order to support the Anybus-CompactCom CANopen, however due to the nature of the CANopen networking system certain restrictions must be taken into account:

- An ADI cannot be mapped as both Write- and Read Process Data simultaneously. Any attempt to do so will result in an error.
- An ADI cannot be mapped more than once. Any attempt to do so will result in an error.
- Only ADI's with instance numbers less than 16384 can be accessed from the network.
- Only ADI elements 0...253 can be accessed from the network.
- To be able to initialize the Read Process Data properly during the NW-INIT state, ADIs mapped as Read Process Data must have both 'Set' and 'Get' access. If not, the startup value for their data will be zero.
- Requests towards instances in the Application Data Object shall be handled within 3.5 seconds, or the module will generate an error on the bus.
- When using the default PDO mapping scheme, only the first element of an array will be represented cyclically. There is however no such limitation if creating a custom PDO mapping scheme through the bus configuration tool.
- For data consistency reasons, the module will not accept SDO downloads to ADIs mapped as Read Process Data during the NMT Operational State.

For further information about the Anybus-CompactCom software interface, consult the general Anybus-CompactCom Software Design Guide.

3.1.2 Electronic Data Sheet (EDS)

Each device on CANopen is associated with an Electronic Data Sheet (a.k.a. .EDS-file), which holds a description of the device and its functions. Most importantly, the file describes the object dictionary implementation in the module.

HMS supplies a generic .EDS-file which can serve as a basis for new implementations; however this file must be altered to match the end product (i.e. the ADI and process data configuration, identity settings etc.). All ABCC ADIs must be described as specified in the CANopen standard "DS306 Electronic data sheet specification for CANopen" (can be requested from the CiA home page, www.can-cia.org). All application specific objects start from index 2001h, but all ADIs should have a descriptive name in the EDS-file, that corresponds to the name in the application.

To verify the EDS-file, download and run the EDS-file checker program from www.can-cia.org.

See also...

- "Fieldbus Conformance Notes" on page 6

3.1.3 Device Identity

Generic Implementation

In a generic implementation (i.e. no network specific support is implemented) the module will appear as a generic HMS device with the following identity information:

Object Entry	Value
Vendor ID	0000 001Bh (HMS Industrial Networks)
Product Code	0000 000Ah (Anybus-CompactCom)
Manufacturer Device Name	'Anybus-CC CANopen'
Manufacturer Hardware Revision	-
Manufacturer Software Revision	(Anybus software revision)

Vendor Specific Implementation

By implementing support for the CANopen Object (FBh), the module can be customized to appear as a vendor specific implementation rather than a generic Anybus device.

See also...

- "CANopen Object (FBh)" on page 25

3.2 Data Exchange

3.2.1 Application Data (ADI)

Application Data Instances (ADIs) can be accessed from the network via dedicated object entries in the Manufacturer Specific range (2001h - 5FFFh), see 4-15 “Manufacturer Specific Objects”.

Note: The .EDS-file must match the actual ADI implementation in the host application.

3.2.2 Process Data

On CANopen, ADIs mapped as Process Data can be exchanged cyclically as Process Data Objects (PDOs) on the bus. Which ADIs that are actually exchanged this way is in the end determined by the network configuration tool.

For natural reasons, only object entries which correspond to Process Data-mapped ADIs may be mapped as PDOs; any attempt to map an object entry which does not fit this criteria will result in an error.

The module supports up to 32 RPDOs and 32 TPDOs, each capable of carrying up to 8 bytes of data.

Note: The .EDS-file must match the actual Process Data implementation in the host application.

Default PDO Mapping Scheme

If no PDO-mapping is specified in the network configuration tool, the module will fall back on a simple default mapping scheme with 4 TPDOs and 4 RPDOs, with one ADI in each PDO.

- **RPDO Default COB ID’s**

RPDO no.	Default COB ID	Default Transmission Type	Description
1	200h + Node ID	254	Default enabled according to DS301
2	300h + Node ID		
3	400h + Node ID		
4	500h + Node ID		
5...32	8000 06E0h		Default Disabled

- **TPDO Default COB ID’s**

TPDO no.	Default COB ID	Default Transmission Type	Description
1	180h + Node ID	254	Default enabled according to DS301
2	280h + Node ID		
3	380h + Node ID		
4	480h + Node ID		
5...32	8000 06E0h		Default Disabled

Note 1: If no ADIs have been mapped to Process Data, the RPDOs will be mapped to a dummy object entry (0005h) and the TPDOs will be mapped to object 1001h (Error Register).

Note 2: When using the default PDO mapping scheme, only the first element of an array will be represented cyclically. There is however no such limitation if creating a custom PDO mapping scheme through the bus configuration tool.

PDO Triggering Modes

The module supports two triggering modes:

- **Event Driven**

  Message transmission is triggered by:

Transmission Type	Description	Notes
254/255	COS	When Process data have been changed. (The performance will be dependent on the number of PDO's using COS)
1...240	Cyclic Synchronous	For synchronous this is the expiration of the specified transmission period, synchronized by the reception of the SYNC object. The data will be synchronized only to the module (current process data in buffer) and not all the way down to the application.
0	Acyclic Synchronous	A transmission type of zero means that the message shall be transmitted synchronously with the SYNC object but not periodically. Only on when COS is fulfilled (SYNC & COS).

- **Timer Driven**

  Message transmission is either triggered by the occurrence of a device-specific event (COS) or if a specified has elapsed without the occurrence of the event.

Transmission Type	Description	Notes
254/255	COS/Timer	Message transmission is either triggered by the occurrence of a device-specific event (COS) or if a specified time has elapsed without occurrence of the event.

3.3 Device Address & Baudrate Configuration

3.3.1 General

The CANopen baud rate and device address can be set by the host application using Network Configuration Object (04h). Note that in order to ensure network compliance, the recommendations stated for this object in the Anybus-CompactCom Software Design Guide must be followed at all times.

The module supports automatic baud rate detection, i.e. if no valid baud rate is set, the module will measure the bus traffic at different speeds until the correct baud rate has been established. Under normal conditions, i.e. with cyclic bus traffic above 2Hz, the baud rate should be detected within 5 seconds. Note that the automatic baud rate detection will not work if there is no traffic on the network.

3.3.2 Layer Setting Service (LSS)

The module supports the Layer Setting Service (LSS). This service can be used to set the Baud Rate and Device Address via the network, and may address the module by it's Vendor-ID, Product Code, Revision number and serial number.

It is possible to enforce LSS during startup by setting the 'Device Address' instance (01h) to 255, see "Instance Attributes (Instance #1, 'Device Address')" on page 23

3.4 Network Reset Handling

3.4.1 Reset Node

Upon receiving a 'Reset Node' request from the network, the module will issue a reset command to the Application Object (FFh) with CmdExt[1] set to 00h ('Power-on reset') and shift to Anybus state 'EXCEPTION'. The bus interface is shifted into a physically passive state.

3.4.2 Reset Communication

Upon receiving a 'Reset Communication' request from the network, the module will reset all Communication object entries to their default values, and shift to the CANopen state 'Reset Communication'. No reset command will be issued to the host application.

3.4.3 Restore Manufacturer Parameters to Default

Upon receiving a 'Restore Manufacturer Parameters to Default' request from the network, the module will issue a reset command to the Application Object (FFh) with CmdExt[1] set to 01h ('Factory default reset').

See also "Standard Objects" on page 13, entry 1011h ('Restore Parameters')

4. Object Dictionary (CANopen)

4.1 Standard Objects

4.1.1 General

The standard object dictionary is implemented according to the DS302 specification (v4.02) from CiA (CAN in Automation). Note that certain object entries correspond to settings in the CANopen Object (FBh), and the Diagnostic Object (02h).

4.1.2 Object Entries

Index	Object Name	Sub-Index	Description	Type	Access	Notes
0005h	Dummy Object	00h	Dummy Object	U8	WO	-
0006h	Dummy Object	00h	Dummy Object	U16	WO	-
0007h	Dummy Object	00h	Dummy Object	U32	WO	-
1000h	Device Type	00h	Device Type	U32	RO	0000 0000h (No profile)
1001h	Error register	00h	Error register	U8	RO	This information is handled through the Diagnostic Object, see "Diagnostic Object (02h)" on page 20.
1003h	Pre-defined error field	00h	Number of errors	U8	RW	
		01h...06h	Error field[a]	U32	RO	
1005h	COB-ID Sync	00h	COB-ID Sync	U32	RW	Default value is 0000 0080h
1008h	Manufacturer device name	00h	Manufacturer device name	Visible string	RO	This information is determined by the CANopen Object, which can optionally be implemented in the host application. See "CANopen Object (FBh)" on page 25.
1009h[b]	Manufacturer hardware version	00h	Manufacturer hardware version	Visible string	RO	
100Ah	Manufacturer software version	00h	Manufacturer software version	Visible string	RO	
100Ch	Guard time	00h	Guard time	U16	RW	-
100Dh	Life time factor	00h	Life time factor	U8	RW	-
1010h	Store Parameters[c]	00h	Largest sub index supported	U8	RO	02h
		01h	Store all parameters	U32	RW	Baud rate and Node ID cannot be stored using this command.
		02h	Store Communication parameters	U32	RW	
1011h	Restore parameters	00h	Largest sub index supported	U8	RO	04h
		01h	Restore all default parameters	U32	RW	-
		02h	Restore communication default parameters	U32	RW	-
		04h	Restore manufacturer parameters to Default.	U32	RW	See "Network Reset Handling" on page 12
1014h	COB ID EMCY	00h	COB ID EMCY	U32	RO	-
1015h	Inhibit Time EMCY	00h	Inhibit Time EMCY	U16	RW	Default value is 0000h

Index	Object Name	Sub-Index	Description	Type	Access	Notes
1016h	Consumer Heartbeat Time	00h	Number of entries	U8	RO	01h
		01h	Consumer Heartbeat Time	U32	RW	Node ID + Heartbeat Time. Value must be a multiple of 1ms.
1017h	Producer Heartbeat Time	00h	Producer Heartbeat Time	U16	RW	-
1018h	Identity object	00h	Number of entries	U8	RO	04h
		01h	Vendor ID	U32	RO	This information is determined by the CANopen Object, which can optionally be implemented in the host application. See "CANopen Object (FBh)" on page 25.
		02h	Product Code	U32	RO	
		03h	Revision Number	U32	RO	
		04h	Serial Number	U32	RO	
1400h ... 141Fh	Receive PDO parameter	00h	Largest sub-index supported	U8	RO	02h
		01h	COB ID used by PDO	U32	RW	-
		02h	Transmission type.	U8	RW	-
1600h ... 161Fh	Receive PDO mapping	00h	No. of mapped application objects in PDO	U8	RW	-
		01h	Mapped object #1	U32	RW	-
		02h	Mapped object #2	U32	RW	-
		03h	Mapped object #3	U32	RW	-
		04h	Mapped object #4	U32	RW	-
		05h	Mapped object #5	U32	RW	-
		06h	Mapped object #6	U32	RW	-
		07h	Mapped object #7	U32	RW	-
		08h	Mapped object #8	U32	RW	-
1800h ... 181Fh	Transmit PDO parameter	00h	Largest sub-index supported	U8	RO	05h
		01h	COB ID used by PDO	U32	RW	-
		02h	Transmission type	U8	RW	-
		03h	Inhibit time	U16	RW	-
		05h	Event Timer (ms)	U16	RW	-
1A00h ... 1A1Fh	Transmit PDO mapping	00h	No. of mapped application objects in PDO	U8	RW	-
		01h	Mapped object #1	U32	RW	-
		02h	Mapped object #2	U32	RW	-
		03h	Mapped object #3	U32	RW	-
		04h	Mapped object #4	U32	RW	-
		05h	Mapped object #5	U32	RW	-
		06h	Mapped object #6	U32	RW	-
		07h	Mapped object #7	U32	RW	-
		08h	Mapped object #8	U32	RW	-

a. The Anybus diagnostic object allows up to 5 diagnostic events to be reported. However, an extra event is reserved for internal errors etc.

b. This object must be enabled, see "CANopen Object (FBh)" on page 25 (If not enabled, any access to this object will generate an error).

c. Relevant only for communication parameters

4.2 Manufacturer Specific Objects

4.2.1 General

Each object entry in the manufacturer specific range (2001h...5FFFh) corresponds to an instance (a.k.a. ADI) within the Application Data Object (FEh), i.e. network accesses to these objects results in object requests towards the host application. In case of an error, the status (or error) code returned in the response from the host application will be translated into the corresponding CANopen abort code.

Important: As any access to these object entries will result in an object access towards the host application, the time spent communicating on the host interface must be taken into account when calculating the SDO timeout value.

4.2.2 Translation of Status Codes

Status (or error codes) are translated to CANopen abort codes as follows:

ABCC Status Code	CANopen Abort Code #[a]	CANopen Code Description
Reserved	N.A.	-
Fragmentation error (serial mode)	N.A.	-
Invalid message format	N.A.	-
Unsupported object	0602 0000h	Object does not exist in the object dictionary.
Unsupported instance	0602 0000h	Object does not exist in the object dictionary.
Unsupported Command	0604 0043h	General parameter incompatibility reason.
Invalid CmdExt[0]	0602 0000h	Object does not exist in the object dictionary. (ADI access).
Invalid CmdExt[1]	0609 0011H	Sub-index does not exist. (ADI access).
Attribute not settable	0601 0002h	Attempt to write a read only object
Attribute not gettable	0601 0001h	Attempt to read a write only object
Too Much Data	0607 0012h	Data type does not match, length of service parameter too high
Not Enough Data	0607 0013h	Data type does not match, length of service parameter too low
Out of range	0609 0030h	Value range of parameter exceeded (only for write access)
Invalid state	0800 0022h	Data cannot be transferred or stored to the application because of the present device state.
Out of resources	0504 0005h	Out of memory. (Can be generated if a message is outstanding to the application and during this time an abort is done, and then a new Request on an ADI is made)
Object Specific Error	0800 0000h	General error

a. The default error code will be the 'General error' code (0800 0000h) if no corresponding error meets the error definition.

4.2.3 Network Data Format

Data is translated between the native network format and the Anybus data format as follows:

Anybus Data Type	Native CANopen Data Type
BOOL	UNSIGNED8
SINT8	INTEGER8
SINT16	INTEGER16
SINT32	INTEGER32
UINT8	UNSIGNED8
UINT16	UNSIGNED16

Anybus Data Type	Native CANopen Data Type
UINT32	UNSIGNED32
CHAR	VISIBLE STRING
ENUM	UNSIGNED8
SINT64	INTEGER64
UINT64	UNSIGNED64
FLOAT	REAL32

Note 1: ADIs with multiple elements are represented as arrays, with the exception of 'CHAR', which will always be represented as VISIBLE STRING.

Note 2: Single element ADIs are represented as a simple variable, with the exception of 'CHAR', which will always be represented as VISIBLE STRING.

4.2.4 Object Entries

The exact representation of an ADI depends on its number of elements. In the following example, ADIs no. 0002h and 0004h only contain 1 element each, causing them to be represented as simple variables rather than arrays. The other ADIs have more than 1 element, causing them to be represented as arrays.

Index	Object Name	Sub-Index	Description	Type	Access	Notes
2001h	ADI 0001h	00h	Number of entries (NNh)	U8	RO	(Sub-Index FFh excluded)
		01h	ADI value(s) (Attribute #5) ADI's with multiple elements (i.e. arrays) are represented as multiple sub-indexes.	-	-	The data type and access rights of the ADI values are determined by the ADI itself.
		02h				
		...				
		...				
		NNh				
		FFh	ADI data type[a]	U32	RO	
2002h	ADI 0002h	00h	ADI value (Attribute #5)	-	-	Data type and Access rights depends on the ADI itself.
		FFh	ADI data type[a]	U32	RO	
2003h	ADI 0003h	00h	Number of entries (NNh)	U8	RO	(Sub-Index FFh excluded)
		01h	ADI value(s) (Attribute #5) ADI's with multiple elements (i.e. arrays) are represented as multiple sub-indexes.	-	-	Data type and Access rights depends on the ADI itself.
		02h				
		...				
		...				
		NNh				
		FFh	ADI data type[a]	U32	RO	
2004h	ADI 0004h	00h	ADI value (Attribute #5)	-	-	Data type and Access rights depends on the ADI itself.
		FFh	ADI data type[a]	U32	RO	
2005h	ADI 0005h	00h	Number of entries (NNh)	U8	RO	(Sub-Index FFh excluded)
		01h	ADI value(s) (Attribute #5) ADI's with multiple elements (i.e. arrays) are represented as multiple sub-indexes.	-	-	Data type and Access rights depends on the ADI itself.
		02h				
		...				
		...				
		NNh				
		FFh	ADI data type[a]	U32	RO	
...	...	...	...	...	...	...
5FFFh	ADI 3FFFh	00h	Number of entries (NNh)	U8	RO	(Sub-Index FFh excluded)
		01h	ADI value(s) (Attribute #5) ADI's with multiple elements (i.e. arrays) are represented as multiple sub-indexes.	-	-	Data type and Access rights depends on the ADI itself.
		02h				
		...				
		...				
		NNh				
		FFh	ADI data type[a]	U32	RO	

a. Data type according to DS302 (v4.02)

5. Anybus Module Objects

5.1 General Information

This chapter specifies how the standard Anybus Module Objects have been implemented and how they correspond to CANopen specific functions.

5.2 Anybus Object (01h)

Category

Basic

Object Description

This object assembles all common Anybus data, and is described thoroughly in the general Anybus-CompactCom Software Design Guide.

Supported Commands

Object: Get_Attribute

Instance: Get_Attribute
Set_Attribute
Get_Enum_String

Object Attributes (Instance #0)

(Consult the general Anybus-CompactCom Software Design Guide for further information.)

Instance Attributes (Instance #1)

Basic

#	Name	Access	Type	Value
1	Module type	Get	UINT16	0401h (Standard Anybus-CompactCom)
2... 11	-	-	-	Consult the general Anybus-CompactCom Software Design Guide for further information.
12	LED colors	Get	struct of: UINT8(LED1A) UINT8(LED1B) UINT8(LED2A) UINT8(LED2B)	Value:Color: 01h Green 02h Red 01h Green 02h Red
13... 15	-	-	-	Consult the general Anybus-CompactCom Software Design Guide for further information.

5.3 Diagnostic Object (02h)

Category

Basic, extended

Description

This object provides a standardised way of handling host application events & diagnostics, and is thoroughly described in the general Anybus-CompactCom Software Design Guide.

Object Attributes (Instance #0)

#	Name	Access	Data Type	Value
1	Name	Get	Array of CHAR	"Diagnostic"
2	Revision	Get	UINT8	01h
3	Number of instances	Get	UINT16	See general Anybus-CompactCom Software Design Guide
4	Highest instance no.	Get	UINT16	
11	Max no. of instances	Get	UINT16	0005h (0006h) (See Note 2 below)

Instance Attributes (Instance #1)

Basic

#	Name	Access	Type	Value
1	Severity	Get	UINT8	(below)
2	Event Code	Get	UINT8	

Extended

#	Name	Access	Type	Value
3	NW specific extension	Get	Array of UINT8	CANopen specific EMCY code (2 bytes)

When an instance is created (i.e. a diagnostic event is entered), the following actions are performed:

1. A new entry will be created in object entry 1003h (Pre-defined error field) as follows:

High byte (UINT32)		Low byte
(Not used)	Event Code	00h

2. The Error Register (object entry 1001h) is set with the corresponding bit information
3. The EMCY Object is sent to the network with the following information:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
00h	Event Code	Error Register (1001h)	Manufacturer Specific Field (Not used)				

Note 1: When creating a Major-severity, this will not end up as an EMCY-message on the bus, since this effectively forces the Anybus module to enter the EXCEPTION state.

Note 2: An internal 6th instance is reserved for internal CANopen diagnostics. This includes the following EMCY error codes:

EMCY Error Code	Description
8110h	CAN controller signalled a lost message
8120h	CAN controller reached the warning limit due to error frames.
8210h	A received PDO was smaller than specified by the valid mapping table
8220h	The DLC of a received PDO exceeded the length specified by the valid mapping table.
8130h	An error control event has occurred (either a life guarding event or a heartbeat event).
8140h	Can controller has recovered from a BUS OFF state.
8150h	COB-ID collision detected.
FF01h	The saved PDO configuration has no corresponding process data map.

5.4 Network Object (03h)

Category

Basic

Description

For more information regarding this object, consult the general Anybus-CompactCom Software Design Guide.

Object Attributes (Instance #0)

#	Name	Access	Data Type	Value
1	Name	Get	Array of CHAR	“Network”
2	Revision	Get	UINT8	02h
3	Number of instances	Get	UINT16	0001h
4	Highest instance no.	Get	UINT16	0001h

Instance Attributes (Instance #1)

Basic

#	Name	Access	Type	Value
1	Network type	Get	UINT16	0020h
2	Network type string	Get	Array of CHAR	‘CANopen’
3	Data format	Get	ENUM	00h (LSB first)
4	Parameter data support	Get	BOOL	True
5	Write process data size	Get	UINT16	Current write process data size (in bytes) Updated on every successful Map_ADI_Write_Area[a]
6	Read process data size	Get	UINT16	Current read process data size (in bytes) Updated on every successful Map_ADI_Read_Area[a]
7	Exception Information	Get	UINT8	Additional information is provided here when the module has entered the EXCEPTION state. Value:Meaning: 00h (no additional information available) 01h Invalid data type reported by the application
8... 10	(reserved)	-	-	(not used)
11-255	Network specific	-	-	

a. Consult the general Anybus-CompactCom Software Design Guide for further information.

5.5 Network Configuration Object (04h)

Category

Basic

Description

This object contains network specific configuration parameters that may be configured by the end user.

Supported Commands

Object: Get_Attribute (01h)
Reset (Factory Default) (05h)

Instance: Get_Attribute (01h)
Set_Attribute (02h)

Object Attributes (Instance #0)

#	Name	Access	Data Type	Value
1	Name	Get	Array of CHAR	'Network configuration'
2	Revision	Get	UINT8	01h
3	Number of instances	Get	UINT16	0002h
4	Highest instance no.	Get	UINT16	0002h

Instance Attributes (Instance #1, 'Device Address')

Basic

#	Name	Access	Type	Description
1	Name	Get	Array of CHAR	'Node address'
2	Data type	Get	UINT8	04h (= UINT8)
3	Number of elements	Get	UINT8	01h (one element)
4	Descriptor	Get	UINT8	07h (read/write/shared access)
5	Value[a]	Get/Set	UINT8	1...127:CANopen device address value 255:Enforce LSS at startup[b]

a. Note that this value may be updated by the LSS service, see "Layer Setting Service (LSS)" on page 12
b. See "Layer Setting Service (LSS)" on page 12

Baud Rate Configuration (Instance #2, ‘Baud rate’)

Basic

#	Name	Access	Type	Description
1	Name	Get	Array of CHAR	‘Data rate’
2	Data type	Get	UINT8	08h (= ENUM)
3	Number of elements	Get	UINT8	01h (one element)
4	Descriptor	Get	UINT8	07h (read/write/shared access)
5	Value[a]	Get/Set	ENUM	Value and ENUM string: 0: ‘10 kbps’ 1: ‘20 kbps’ 2: ‘50 kbps’ 3: ‘100 kbps’ 4: ‘125 kbps’ 5: ‘250 kbps’ 6: ‘500 kbps’ 7: ‘800 kbps’ 8: ‘1 Mbps’ 9: ‘Auto’ 10: ‘LSS’ (default)

a. Note that this value may be updated by the LSS service, see “Layer Setting Service (LSS)” on page 12

Command Details: Reset

Details

Command code: 05h

Valid for: Object instance

Description

Resets Baud Rate and Device Address values to default

- **Command Details**

Field	Contents
CmdExt[0]	reserved
CmdExt[1]	01h = Factory Default Reset

6. Host Application Objects

6.1 CANopen Object (FBh)

Category

Basic, extended

Object Description

This object implements CANopen specific settings in the host application.

The implementation of this object is optional; the host application can support none, some, or all of the attributes specified below. The module will attempt to retrieve the values of these attributes during start-up; if an attribute is not implemented in the host application, simply respond with an error message (06h, "Invalid CmdExt[0]"). In such case, the module will use its default value.

If the module attempts to retrieve a value of an attribute not listed below, respond with an error message (06h, "Invalid CmdExt[0]").

Note: Support for this object is optional, but in order to certify the product a new Vendor ID should be assigned. The CAN in Automation group recommends requesting a Vendor ID. It is also highly recommended to support all attributes listed below, if the object is implemented, since this has a very high impact on CANopen-specific functionality.

Supported Commands

Object:	Get Attribute
Instance:	Get Attribute

Object Attributes (Instance #0)

#	Name	Access	Data Type	Value
1	Name	Get	Array of CHAR	‘CANopen’
2	Revision	Get	UINT8	01h
3	Number of instances	Get	UINT16	0001h
4	Highest instance no.	Get	UINT16	0001h

Instance Attributes (Instance #1)

Basic

#	Name	Access	Type	Default Value	Comment
1	Vendor ID[a]	Get	UINT32	0000 001Bh	These values replace the settings in object entry 1018h. (Identity Object)
2	Product Code	Get	UINT32	0000 000Ah	
3	Major revision	Get	UINT16	Major revision	
4	Minor revision	Get	UINT16	Minor revision	
5	Serial Number	Get	UINT32	Unique number	

a. A unique Vendor ID has to be requested and assigned if the product is to be certified and/or if LSS services are used in the network.

Extended

#	Name	Access	Type	Default Value	Comment
6	Manufacturer Device Name	Get	Array of CHAR (Max. 24 bytes)	‘Anybus-CC CANopen’	Replaces object entry 1008h (Manufacturer Device Name)
7	Manufacturer Hardware Version	Get	Array of CHAR (Max. 24 bytes)	Object entry 1009h not implemented	Specifies the value of object entry 1009h (Manufacturer Hardware Version)
8	Manufacturer Software Version	Get	Array of CHAR (Max. 24 bytes)	x.yy	Replaces object entry 100Ah (Manufacturer Software Version)

A. Categorization of Functionality

The objects, including attributes and services, of the Anybus CompactCom and the application are divided into three categories: basic, advanced and extended.

A.1 Basic

This category includes objects, attributes and services that are mandatory to implement or to use. They will be enough for starting up the Anybus CompactCom and sending/receiving data with the chosen network protocol. The basic functions of the industrial network are used.

Additional objects etc, that will make it possible to certify the product also belong to this category.

A.2 Extended

Use of the objects in this category extends the functionality of the application. Access is given to the more specific characteristics of the industrial network, not only the basic moving of data to and from the network. Extra value is given to the application.

A.3 Advanced

The objects, attributes and services that belong to this group offer specialized and/or seldom used functionality. Most of the available network functionality is enabled and accessible. Access to the specification of the industrial network is normally required.

B. Implementation Details

B.1 SUP-Bit Definition

The supervised bit (SUP) indicates that the network participation is supervised by another network device. CANopen specific interpretation:

SUP-bit	Interpretation
0	[LSS active] - *or* - [No error control mechanism is enabled]
1	[Heartbeat consumer - *and* - Heartbeat producer is enabled & error free] *- or -* [Node guarding is enabled & error free] - *and* - [LSS not active]

B.2 Anybus State Machine

The table below describes how the Anybus State Machine relates to the CANopen network status.

Anybus State	Corresponding CANopen State
WAIT_PROCESS	PRE-OPERATIONAL state
ERROR	BUS OFF state
PROCESS_ACTIVE	OPERATIONAL state
IDLE	STOP state
EXCEPTION	-

B.3 Application Watchdog Timeout Handling

At the time of writing, no Application Watchdog functionality is supported by the module.

C. Technical Specification

C.1 Protective Earth (PE) Requirements

In order to ensure proper EMC behaviour, the module must be properly connected to protective earth via the PE pad / PE mechanism described in the general Anybus-CompactCom Hardware Design Guide.

HMS Industrial Networks does not guarantee proper EMC behaviour unless these PE requirements are fulfilled.

C.2 Power Supply

Supply Voltage

The module requires a regulated 3.3V power source as specified in the general Anybus-CompactCom Hardware Design Guide.

Power Consumption

The Anybus-CompactCom CANopen is designed to fulfil the requirements of a Class A module. For more information about the power consumption classification used on the Anybus-CompactCom platform, consult the general Anybus-CompactCom Hardware Design Guide.

The current hardware design consumes up to 180mA[1].

Note: It is strongly advised to design the power supply in the host application based on the power consumption classifications described in the general Anybus-CompactCom Hardware Design Guide, and not on the exact power requirements of a single product.

C.3 Environmental Specification

Consult the Anybus-CompactCom Hardware Design Guide for further information.

C.4 EMC Compliance

Consult the Anybus-CompactCom Hardware Design Guide for further information.

1. Note that in line with HMS policy of continuous product development, we reserve the right to change the exact power requirements of this product without prior notification. Note however that in any case, the Anybus-CompactCom CANopen will remain as a Class A module.

D. Timing & Performance

D.1 General Information

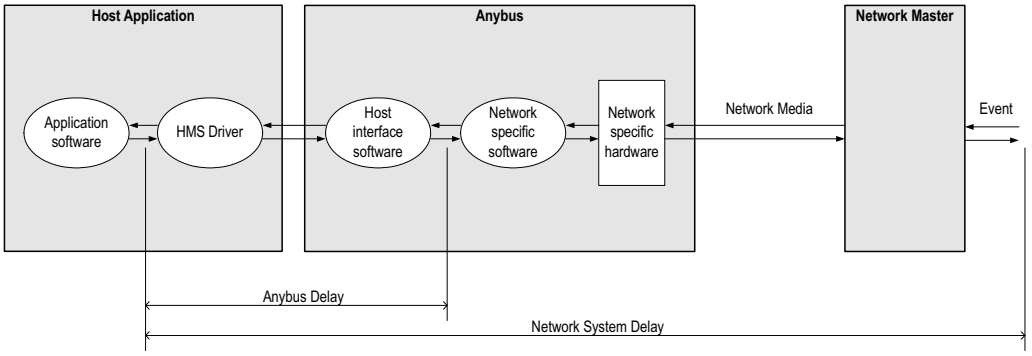
This chapter specifies timing and performance parameters that are verified and documented for the Anybus CompactCom CANopen.

The following timing aspects are measured:

Category	Parameters	Page
Startup Delay	T1, T2	Please consult the Anybus CompactCom Software Design Guide, App. B.
NW_INIT Delay	T3	
Telegram Delay	T4	
Command Delay	T5	
Anybus Read Process Data Delay (Anybus Delay)	T6, T7, T8	
Anybus Write Process Data Delay (Anybus Delay)	T12, T13, T14	
Network System Read Process Data Delay (Network System Delay)	T9, T10, T11	32
Network System Write Process Data Delay (Network System Delay)	T15, T16, T17	32

D.2 Process Data

D.2.1 Overview



D.2.2 Anybus Read Process Data Delay (Anybus Delay)

The Read Process Data Delay (labelled 'Anybus delay' in the figure above) is defined as the time measured from just before new data is buffered and available to the Anybus host interface software, to when the data is available to the host application (just after the new data has been read from the driver).

Please consult the Anybus CompactCom Software Design Guide, Appendix B, for more information.

D.2.3 Anybus Write Process Data Delay (Anybus Delay)

The Write Process Data Delay (labelled 'Anybus delay' in the figure) is defined as the time measured from the point the data is available from the host application (just before the data is written from the host application to the driver), to the point where the new data has been forwarded to the network buffer by the Anybus host interface software.

Please consult the Anybus CompactCom Software Design Guide, Appendix B, for more information.

D.2.4 Network System Read Process Data Delay (Network System Delay)

The Network System Read Process Data Delay (labelled 'Network System Delay in the figure), is defined as the time measured from the point where an event is generated at the network master to when the corresponding data is available to the host application (just after the corresponding data has been read from the driver).

Parameter	Description	Typ.	Max.	Unit.
T9	Network System Read Process Data delay, 8 ADIs (single UINT8)	1.3	1.9	ms
T10	Network System Read Process Data delay, 16 ADIs (single UINT8)	1.1	1.8	ms
T11	Network System Read Process Data delay, 32 ADIs (single UINT8)	1.3	1.8	ms

Conditions:

Parameter	Conditions
Application CPU	-
Timer system call interval	1 ms
Driver call interval	0.2... 0.3 ms
No.of ADIs (single UINT8) mapped to Process Data in each direction.	8, 16 and 32
Communication	Parallel
Telegram types during measurement period	Process Data only
Bus load, no. of nodes, baud rate etc.	Normal

D.2.5 Network System Write Process Data Delay (Network System Delay)

The Network System Write Process Data Delay (labelled 'Network System Delay in the figure), is defined as the time measured from the time after the new data is available from the host application (just before the data is written to the driver) to when this data generates a corresponding event at the network master.

Parameter	Description	Min.	Max.	Unit.
T15	Network System Write Process Data delay, 8 ADIs (single UINT8)	0.4	1.5	ms
T16	Network System Write Process Data delay, 16 ADIs (single UINT8)	0.4	1.4	ms
T17	Network System Write Process Data delay, 32 ADIs (single UINT8)	0.5	1.7	ms

Conditions: as in "Network System Read Process Data Delay (Network System Delay)", p. 32.