THE POWER OF **CONNECTED**

Flow Computer
Device Series enCore FC

Manual
IEC60870 AFB

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Contents

1 About these Instructions

The enCore FC manual has a modular structure. An overview of the enCore/enSuite concept and the structure of the FC manual as well as the text labeling can be found in the volume "Configuration of the device software".

> **Safety information**
>
> All safety information is contained in the "Operating Instructions" volume of the FC manual. The documentation on hand does not include any safety information.
>
> Read the Operating Instructions carefully before starting all work on and with the enCore device, especially before commissioning! The manufacturer accepts no liability for damage and malfunctions resulting from non-observance of these instructions.

The present volume describes the basic functionality and operation of the IEC60870 AFB.

> **AFB IEC60870 in the FC device series**
>
> The IEC60870 AFB is available for selected devices of the enCore series. Which functions a device supports depends on the individual device type. Details can be found in the online help.
>
> Please contact Honeywell, if you want to use the IEC-870-5-104 protocol in device types where IEC60870 AFB is not included in the delivery state.

The parameterization of the device is explained in this document only by way of example as the meaning of individual parameters is documented in detail in the online help of enSuite.

> 📖 **Online help**
>
> In enSuite, you can call up the general help via the menu item
> **Help –** ❓ **Show online help**. Open the context-sensitive help
> directly from the desired branch in the parameterization window
> with **[F1]**.

This part of documentation is intended for specialist personnel who are
responsible for the service activities of the following tasks after the successful
assembly of the device and installation of the latest enSuite version on PC:

- customizing of device parameterization to the measuring task
- test of all data points and commissioning
- other service activities

The illustrations in this manual serve to depict the facts that are being
explained, and therefore may differ from the actual design depending on the
configuration of the device and enSuite.

2 Functional Description

IEC60870 AFB is an Application Function Block (AFB). The AFB enables enCore devices to operate as TCP servers in a telecontrol system using standard transport profiles according to the international standard IEC 60870-5-104[1].

The collective term *telecontrol* refers to the remote monitoring and control of remote objects (e.g. gas measuring plants) from one or more central locations. The data protocols used (e.g. the 60870-5) are tailored to transmit the process data securely, reliably and promptly via wide-range communication networks, even if they have a low bandwidth and/or transmission quality, either partially or temporarily.

The IEC 60870-5-104 telecontrol protocol describes the control and monitoring of intelligent subcomponents and substations by a higher-level control station. This is an open protocol that was approved by the International Electrotechnical Commission (IEC) in 2000.

Communication between control station(s) and controlled stations takes place via a standard TCP/IP network (LAN/WAN). Here, control stations take over the function of the TCP client, while monitored substations those of the TCP server.

The IEC protocol uses 5 layers, whereby the IEC standard itself only describes the application layer, since all layers below it are implemented according to the model of the TCP/IP layer model.

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[1] The IEC 60870-5 standard consists of several parts, whereby the AFB only implements IEC 60870-5-104 (⇨ chapter 5 References , p. 27).
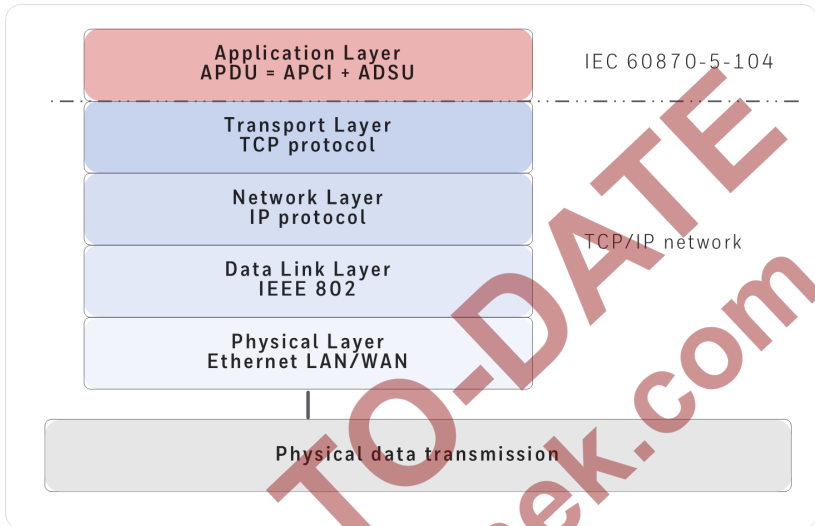
Fig. 2-1: The 5 layers of the IEC 608705-104 protocol

In IEC 60870-5-104, the telegram at application level is referred to as Application Protocol Data Unit (APDUs).

These consist of two parts: APDU = APCI + ASDU

- Application Protocol Control Information (APCI)

    This part is the header with the protocol control information.

    (The header must be present.)

- Application Service Data Unit (ASDU)

    This part consists of one or more information objects that contain the actual user data.

    (The ASDU may be present.)

    Refer to the separate document ⇨ "IEC6060870 AFB – Compatibility List" to check which ADSUs the AFB supports.

2.1   The IEC60870 AFB in an overview

The IEC60870 AFB is supported by selected enCore device types. Within such an enCore device, up to 3 instances of the IEC60870 AFB are possible. Each AFB instance has a unique address (station address) in a remote control system.

The communication takes place via the LAN interface of the CPU (ETH0) or an ESER4 (ETH1, ETH2). Addressing takes place via the IP address of the interface used. The APDUs are transmitted as TCP/IP packets. The number of the TCP port that the (local) TCP server uses in order to establish connection to the remote client is set by parameterization. By default, TCP port 2404 is reserved for the IEC 60870-5-104 protocol.

Each AFB instance can establish 4 connections simultaneously, so that each IEC60870 AFB can be queried by up to 4 control stations. During parameterization you determine which IP addresses the AFB allows as IP partner(s).

During parameterization, you also specify the transmission formats for the various export object types. The AFB supports transmission codes for measurements, counters, bitstrings and messages.

Example Scenario

The following example shows the addressing in a TCP/IP network. The prerequisite for data exchange between control stations and substations is that each subscriber has a unique IP address and that the control stations are stored as IP partners in the IEC60870 AFB. In this example, the control stations are realized with components from the Siemens PCS7 series of process computers:
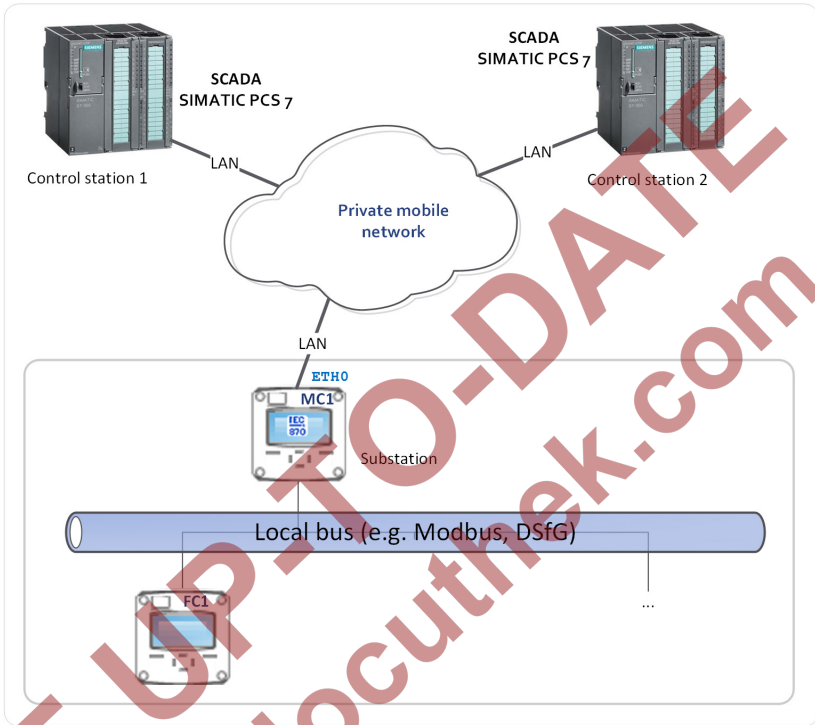
Fig. 2-1: Data communication via IEC protocol – example

2.1.1 Commands and responses

The objects that can be transferred via IEC60870-5-104 protocol between IEC60870 AFB and the control station(s) are classified into four different data types:

- Measurement (export and import objects)
- Counter (export objects only)
- Bitstring (export and import objects)
- Message (export and import objects)

An *export* object is transferred from the enCore device to the control station(s) whereas *import* objects are sent from the control station(s) to the enCore device. For more information about object types and available transmission formats ⇨ refer to chapter 3 Objects and Object Types (p. 15).

The conditions under which an *export object* is sent to the control station(s) are defined in the parameterization of each export object.

The data of *import objects*, on the other hand, is always updated when the IEC60870 AFB receives an information transfer command (I format) of a special type. The supported types of I commands depend on the data type:

Import object type	I format command	
Measurement	Type Identification 48	Set-point command of normalized value
	Type Identification 50	Set-point command of short floating point value
	Type Identification 61	Set-point command of normalized value with time tag CP56Time2a
	Type Identification 63	Set-point command of short floating point number with time tag CP56Time2a
Bitstring	Type Identification 51	Bitstring of 32-bit
	Type Identification 64	Bitstring of 32-bit with time tag CP56Time2a
Message	Type Identification 45	Single command
	Type Identification 46	Double command
	Type Identification 58	Single command with time tag CP56Time2a
	Type Identification 59	Double command with time tag CP56Time2a

Table 2-1: I format command types for updating import objects

The IEC60870 AFB also responds to following interrogation, read, test and reset commands sent by the control station(s):

Identification	Command type
Type Identification 100	Interrogation command: Information of all export measurement, bitstring and event message shall be send to the control station(s)
Type Identification 101	Counter interrogation command: Information of all export counter shall be send to the control station(s)
Type Identification 102	Read command: Information of any export object with object address defined in command shall be send to the control station(s)
Type Identification 105	Reset process command: Reset TCP connection and sequence number
Type Identification 107	Test command with time tag CP56Time2a: Incrementing sequence number is included in the response

Table 2-2: Interrogation, read, test and reset command types

Time synchronization

Actually, the IEC60870-5-104 specification provides a clock synchronization command (Type identification 103). However, a time synchronization of the enCore device via IEC60870-5-104 is not recommended and therefore not supported, because time synchronization via NTP (offered by the enCore **Time Service**) is much more accurate.[2]

For that reason, the IEC60870 AFB does not execute a time synchronization when a clock synchronization command arrives from a control station. However, a confirmation telegram is sent to avoid an error reaction in the sending control station.

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[2] The NTP time synchronization is parameterized in enSuite's parameter branch **Basic System – Time Service – NTP**. Refer to the online help for further information.

2.1.2   IP filtering – CIDR standard

The IP address range for IP partners that can establish a connection to the enCore device can be limited by parameterization. For that, the CIDR nota-tion is used: `<IPv4 address>[/<CIDR suffix>]`.

> **Classless Inter-Domain Routing (CIDR) in short**
>
> CIDR was introduced in 1993 to make more effective use of the existing 32-bit IP address space (IPv4). The CIDR notation, in contrast to the decimal point notation of IPv4, allows shorter expressions and is also unique. Thus, the CIDR notation `192.168.0.0/10` corresponds to the decimal point notation `192.168.0.0/255.192.0.0`. In the example, the `10` is the so-called CIDR suffix. To calculate a CIDR suffix, the leading bits of a net mask are added together and attached to the IP address with a slash.
> In our example the decimal point notation `255.192.0.0` corresponds to the bit pattern
> `1111'1111.1100'0000.0000'0000.0000'0000`, which results in a CIDR suffix of `10`.

Examples

- `192.168.0.10/24`
  IP partners from the IP address range `192.168.1.0` to `192.168.1.255` are accepted.
  (≡ `192.168.0.10/255.255.255.0`)

- `192.168.0.10/32`
  Only the IP partner with the IP address `192.168.0.10` is accepted. (≡ `192.168.0.10/255.255.255.255`)

- `192.168.0.10`
  (special case): In this case, only the configured IP address is allowed as an IP partner. No subnetwork is allowed. (≡ to the CIDR notation `<IPv4 address>/32`)

2.1.3   Communication monitoring

The IEC60870 AFB provides some options for monitoring the IEC60870-5-104 protocol communication and the TCP connection. The influencing parameters are located in the parameter branch **IEC60870 – Parameters – General**. The following paragraphs give an overview about the functioning; refer to the context-sensitive online help of enSuite for detailed information about how to parameterize the settings.

Under the following circumstances during the information transfer (I format) data transferring session, the IEC60870 AFB sends a supervisory function acknowledge telegram (S format) to the control station(s) immediately in order to prevent that a communication timeout is triggered in the stations:

- the number of outstanding unacknowledged received telegrams exceeds the parameterized **Telegram count to acknowledged (w)**
- any of the received telegram is not being acknowledged after the parameterized period of **Acknowledge delay (T2)**

If there is no communication between the IEC60870 AFB and the control station for a certain period of time, the connection shall be tested. To achieve this, the IEC60870 AFB sends a test telegram to the control station if the communication is idle for a longer time than the parameterized **Test frame timeout (T3)**. Once this test telegram is sent, a confirmation telegram is expected to be received from the control station.

Under the following circumstances, the IEC60870 AFB closes the currently established TCP connection and automatically tries to reconnect:

- The IEC60870 AFB has sent a telegram for testing the connection, but the control station does not acknowledge the reception within the parameterized timeout (**Acknowledge timeout (T1)**).
- The IEC60870 AFB has sent data (information transfer, I format), but the control station does not acknowledge the reception within the parameterized timeout (**Acknowledge timeout (T1)**).

- The number of outstanding unacknowledged telegrams sent by the `IEC60870 AFB` exceeds the parameterized **Max. unacknowledged telegrams (k)**.

- The `IEC60870 AFB` receives a "Reset process command" (Type Identification 105) from a control station.

3 Objects and Object Types

3.1 A summary of object types

Up to 500 import and export objects can be created within an IEC60870 AFB parameterization. An IEC60870-5-104 *export object* is transferred from the enCore device to the control station(s) whereas *import objects* are sent from the control station(s) to the enCore device.

The following object types are available in IEC60870 AFB parameterization:

- Import measurement
- Export measurement
- Export counter
- Import message
- Export message
- Import bitstring
- Export bitstring

You can specify the transmission format for all export objects of a specific object type by parameterization (parameter branch **IEC60870 – Parameters**).

Export object type	Available transmission codes/formats	
Measurement	9.Normalised value	16 bit integer value[3]
	13.Short floating point	32-bit IEEE754 floating point value
	34.Normalised value with time	as ⇨ 9.Normalised value plus time tag `CP56Time2a`
	36.Short floating point with time (default)	as ⇨ 13.Short floating point plus time tag `CP56Time2a`
Counter	15.Integrated value	32-bit integer with a range[4] `0..999999999`
	37.Integrated value with time (default)	as ⇨ 15.Integrated value plus time tag `CP56Time2a`
Bitstring	7.Bitstring of 32 bit	32-bit integer
	33.Bitstring of 32 bit with time (default)	as ⇨ 7.Bitstring of 32 bit plus time tag `CP56Time2a`
Message	1.Single point info	
	3.Double point info	
	30.Single point info with time (default)	as ⇨ 1.Single point info. plus time tag `CP56Time2a`
	32.Double point info with time	as ⇨ 3.Double point info. plus time tag `CP56Time2a`

Table 3-3: Export object types and available transmission codes/formats

For each single export object of whatever type, a cyclic transmission to the control station can be parameterized by assigning a cyclic time event of the Time service.

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[3] The input value is clipped to the 'lower range' (≡0) or 'upper range' (≡645535) accordingly.

[4] Counters are rounded to integer format and clipped to 9 digits.

As additional option, the AFB can send *measurement* exports to a controlling station whenever the currently measured value differs from the last transmitted value by more than the parameterized threshold value (**Send on deviation** parameter for the respective export object). For measurement export objects, it is also possible to parameterize a clipping of the value: If the measurement value is smaller than the parameterized **Lower cut-off** value, the lower cut-off value is transmitted instead. In case that the measurement value exceeds the parameterized **Upper cut-off** value, the upper cut-off value is transmitted.

For *message* and *bitstring* exports, you can choose the option **Send on change** in order to achieve that the export object is sent to the controlling station every time its value changes.

3.2   Defining objects in parameterization

IEC 60870-5-104 import and export objects vs. enCore import and export values

The expressions "import" and "export" are used both in IEC 60870-5-104 and in enCore terminology.

An IEC60870-5-104 *export object* is transferred by the IEC60870 AFB to the control station(s) whereas *import objects* are sent in the opposite direction, from the control station(s) to the enCore device.

In the context of enCore device parameterizations, an *export value* is a resulting value that is provided by a functionality of the device. You can see the export values in the **Export values** window of enSuite, grouped per functionalities. Export values can be used as *import values* by subsequent functionalities – just assign them in the parameterization per drag&drop from the **Export values** window to the respective import parameter. Actually, the IEC60870 AFB export objects that are transferred via IEC 60870-5-104 protocol contain export values that are provided by other functionalities/AFBs of the enCore device. In this

context, an export value is assigned as import value for the IEC export data object.

Example

Let's assume that a pressure transmitter is connected to the first current input channel of an MFE7 board. The I/O function block of the Basic System provides the pressure measurement as enCore export value in the **Export values** window of enSuite: **Basic System – I/O – Board <x> – A1+ A1- – Measured value**.

If this pressure measurement shall be transmitted via IEC-60870-5-104 protocol to a control station, you have to jump in parameterization to the IEC60870 AFB. There, you create an export object for the I/O export value **I/O. Board <x> – A1+ A1- – Measured value** (how this is done is explained in the next paragraph). In enCore way of speaking, the I/O export value serves as import value for the export object's definition within IEC60870 AFB.

Object addr	Name	Reference	Trigger	Import/Export
1	pressure 1	I/O.Board 3.A1+ A1-.Measured value		ExpMeas

On the other hand, the IEC60870 AFB provides an enCore export value for each of its *import objects*. These export values can be processed as import values by subsequent functionalities.

Procedure in enSuite (short instruction)

Prerequisites

- The communication settings and the transmission codes (formats) for export data objects are parameterized appropriately in parameter branch **IEC60870 <x>** – **General**.

  ⇨ All communication parameters and further settings are described in detail in enSuite's context-sensitive online help.

- The current state of the parameterization already provides the export values that are intended to be transferred via IEC60870-5-104 protocol.

In order to define import or export objects, to parameterize their settings and to manage the ordering of the list ...

► … switch to the **Object list** tab[5].

Each instance of the `IEC60870 AFB` can manage up to 500 objects. On the **Object list** tab, you can conveniently manage the object list, you can add, move or delete export and import objects as well as change object addresses.

The table lists the already defined objects in ascending order of the object addresses. As soon as you select an object in the table, the object-specific details are displayed in the lower window area.

To add a new ⬅ import object...

► … click on the symbol ⬅ on the right side of the table.
✓ An import object is inserted directly in front of the currently selected line.
► Select the new line and enter a name for the new object in the **Name** cell.
► If necessary, change the **Object address** that has been automatically assigned by enSuite. When doing so, note that all object addresses within an `IEC60870 AFB` have to be unique. Otherwise, the parameterization is not valid and cannot be transferred into the device.
► Edit the object-specific parameters being displayed in the **Details** area below.

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[5] The parameter branch **IEC60870 – Objects** also shows all defined data objects with their parameters, but in a more generic way without comfortable sorting and editing options. It is therefore recommended to work with the **Object list** tab instead.

To add a new ➡ export object...

► … select in the **Export values** window an export value that you want to transfer via IEC870-5-104 protocol.
► By using drag-and-drop, you can insert the selected export value at the desired position in the object list.
✓ A line for the new object is inserted at the selected position. The new object gets an object address automatically; the object addresses of the following objects (if existing) are automatically re-numbered, in ascending order.
► If necessary, change the **Object address** that has been automatically assigned by enSuite. When doing so, note that all object addresses within an IEC60870 AFB have to be unique. Otherwise, the parameterization is not valid and cannot be transferred into the device.

To delete an existing object...

► … select the object that you want to delete.
► Click on the symbol ✖.
✓ The selected object will be deleted without request for confirmation. The object addresses of the following data objects (if existing) are automatically re-numbered, in ascending order.

> **Tips & tricks for parameterizing**
>
> enSuite offers some comfortable tricks for editing and restructuring the object list, especially to ensure an unambiguous assignment of the object addresses. Refer to the context-sensitive online help for further information.

3.3   Protocol test function

By means of the Protocol test function, you can test the IEC60870-5-104 protocol directly via the device's display. The test function can only be activated if you are logged in to the device; an additional prerequisite is, that you are authorized to **Change general system settings**.

When the test function is activated, you can enter for one particular export object at a time a simulation value that you would like to transfer via IEC60870-5-104 protocol. Once the value is changed, the data is sent to the connected control station(s).

The test mode ends automatically if you navigate to another display page or to another object, in case of a log-out and after power failure/restart of the device.

4   Display and Operation

4.1   Displays at a glance

The following figure sketches the hierarchical order and the navigation though the displays of the IEC60870 AFB:
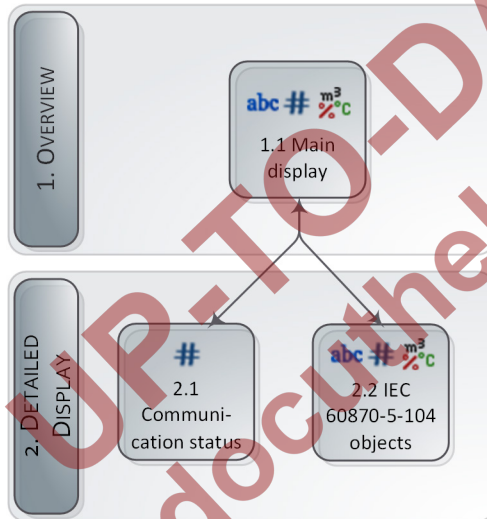

Fig. 4-1: Displays – hierarchical structure

4.2   Displays in detail

The first display of an IEC60870 AFB shows an overview of all defined objects, in ascending order of object addresses. The current value of the object is indicated additionally. The object addresses are designed as hyperlinks, with which you can switch to a detailed view for each object.
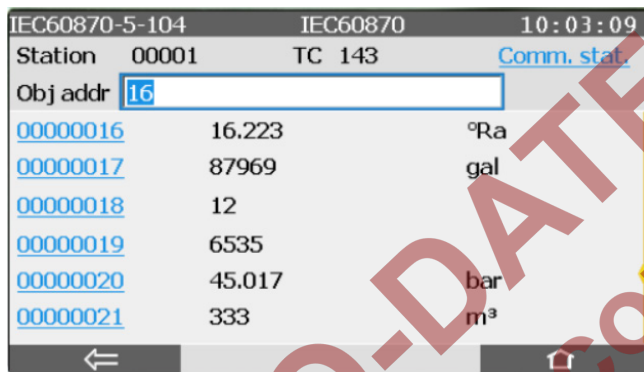
Fig. 4-2: IEC60870 **Main display** – example

In the example, the station address of the `IEC60870 AFB` is `0001` (shown on the left side in the first line). **TC** stands for **T**elegram **C**ounter and indicates the number of valid IEC 60870-5-104 telegrams that have been exchanged since the last startup of the device.

If you want to jump to another position in the object list, enter a start value in the **Obj. addr.** field.in line 2.

Main display and target displays

[1.1 Main display]	
Station **TC: <Counter>**	**Station address** (as parameterized)
	(Abbreviation **T**elegram **C**ounter): Counter for valid telegrams. This value is reset on restart after power failure.
Comm. stat.	⇨ **2.1 Communication statistics**
Obj. addr, <no.>	Input field for jumping to another position in the object list
List of **<Object addresses>**, in ascending order	Object address (hyperlink to detailed view), current value, physical unit (if applicable) ⇨ **2.2 IEC-60870 objects**

[2.1 Communication statistics]	
Connected stations	Total number of connected control stations
Data reception OK	Total number of received error-free telegrams
Data transmission OK	Total number of sent telegrams that have been acknowledged
Test frame	Total number of received test frames
Length error	Total number of received telegrams whose length is not matching the standard defined in IEC60870-5-104
Unknown type	Total number of received telegrams containing an unsupported type identification
Unknown object	Total number of received telegrams containing object addresses that are not configured in this I E C 6 0 8 7 0 A F B
Unknown station	Total number of received telegrams that are directed at a station address different from the **Station address** parameterized for this I E C 6 0 8 7 0 A F B
Incorrect cause of transmission	Total number of received telegrams containing an invalid "cause of transmission"
Send error	Total number of transmitted telegrams that have been rejected by the control station(s)
Receive error	Total number of received invalid telegrams
Command code error	Total occurrence of errors when writing the import objects
Acknowledgement error	Total occurrence of acknowledge errors
Timeout T1	Total occurrence of acknowledge timeouts
Clear statistics	Action for clearing the statistics (activation sets all statistical data to zero (0)). No login is necessary for executing this action.

[2.2 IEC-60870 objects]	
Test	For export objects only: Activation the test function. The test function can only be activated if you are logged in to the device; an additional prerequisite is, that you are authorized to **Change general system settings**.
	To activate the test function, choose **On** in the **Test** selection list. Then a field appears in the **Object content** line in which you can enter a simulation value instead of the current value, which is transferred to the control station(s). If you switch back to **Test = Off** again, the test mode is ended; the **Object content** field displays the actual value of the export object again.
	The test mode also ends automatically, if you navigate to another display page or to another object, in case of a log-out and after power failure/restart of the device.
Object name	Name of the currently displayed object (parameter **Name**)
Object type	Type of the object (**Import measurement**, **Export measurement**, **Export counter**, **Import message**, **Export message**, **Import bitstring**, or **Export bitstring**)
Object address	Object address as parameterized, format as defined in **Address display format** parameter
Object content (hex)	Value of the object in hexadecimal notation, displayed in case of an active TCP client only
Object content	If not in test mode: Current value of the object with physical unit (if applicable)
	In case of an export message, the **Object content** shows a counter that increases each time the status of the message changes. Via IEC60870-5-104 protocol, not this counter value, but simply a (1) for "message pending" or a (0) for "message not pending" is transmitted.
	In case that the test mode is activated, you can enter here a simulation value (see above).

[2.2 IEC-60870 objects]	
Quality labels	The **Quality labels** indicate following status information (all for export objects only): **IV** : The object's value is marked with an enCore error code (INT,OOO, OOS or OOU). **OV**: Out of range; the object's value is greater than the parameterized **Upper cut off** or lower than the parameterized **Lower cut off** value. **CA** (for counter objects only): The counter has been set. This label is shown until the next telegram is sent. **CY** (for counter objects only): the object's counter value had a decimal overflow (rollover).This label is shown until the next telegram is sent.
Last refresh	time stamp **<date> <time>** For an export object, the time stamp of the last transmission to the control station is displayed here. For import objects, it shows the latest time stamp being updated by the telegram. If the telegram is tagged with CP56Time2a (⇨ Table 3-3: Export object types and available transmission codes/formats, p. 16), the corresponding time is taken as **Last refresh time**.

Table 4-1: The main display and its target displays

5   References

[1] IEC 60870-5-104 Transmission protocols – Network access for IEC
    60870-5-101 using standard transport profiles. Second edition 2006-06
    Reference No.: IEC 60870-5-104:2006(E)
    Published by: International Electrotechnical Commission, 3, rue de
    Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
    www.iec.ch

[2] Manual „Flow Computer, Device series enCore FC – Operating
    Instructions"
    included in scope of FC1 delivery, additionally available for download at
    www.docuthek.com

[3] Manual „Flow Computer, Device series enCore FC – Configuration of
    Device Software"
    available for download at **www.docuthek.com**

[4] Manual „Flow Computer, Device series enCore FC – Basic System with
    SFBs"
    available for download at **www.docuthek.com**

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