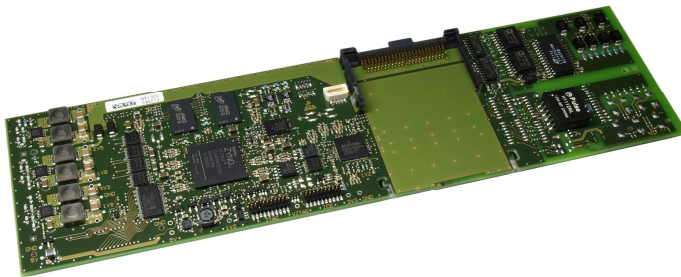


SIEMENS

SICAM AK SICAM TM

SM-2558/ETA5

Protocol element for Ethernet acc. IEC 61850 Edition 2



Protocol element for communication via LAN/WAN

- Standard according to IEC 61850 Edition 2 (Client)
 - Fast Ethernet 100 Mbit/s, IEEE 802.3, 100BaseTX, electrical
 - TCP/IP
 - Mapping from IEC 60870-5-101/104 to IEC 61850
 - Data formats according to IEC 61850
 - Time synchronization of client via network time protocol (NTP) and simple network time protocol (SNTP)
 - Time synchronization of server via network time protocol (NTP)

the protocol element can be attached to master control and communication elements of SICAM RTUs
Optionally it can be expanded with a serial interface by SM-0551/PROTOCOL

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Disclaimer of Liability

Although we have carefully checked the contents of this publication for conformity with the hardware and software described, we cannot guarantee complete conformity since errors cannot be excluded.

The information provided in this manual is checked at regular intervals and any corrections that might become necessary are included in the next releases. Any suggestions for improvement are welcome.

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Application

The protocol element described herein can be used in several automation units based on SICAM RTUs.

- SICAM AK
- SICAM TM

Protocol elements process specific communication protocols when SICAM RTUs communicate with each other oder with devices of third-party manufacturers, in the field of telecontrol, automation and protection.

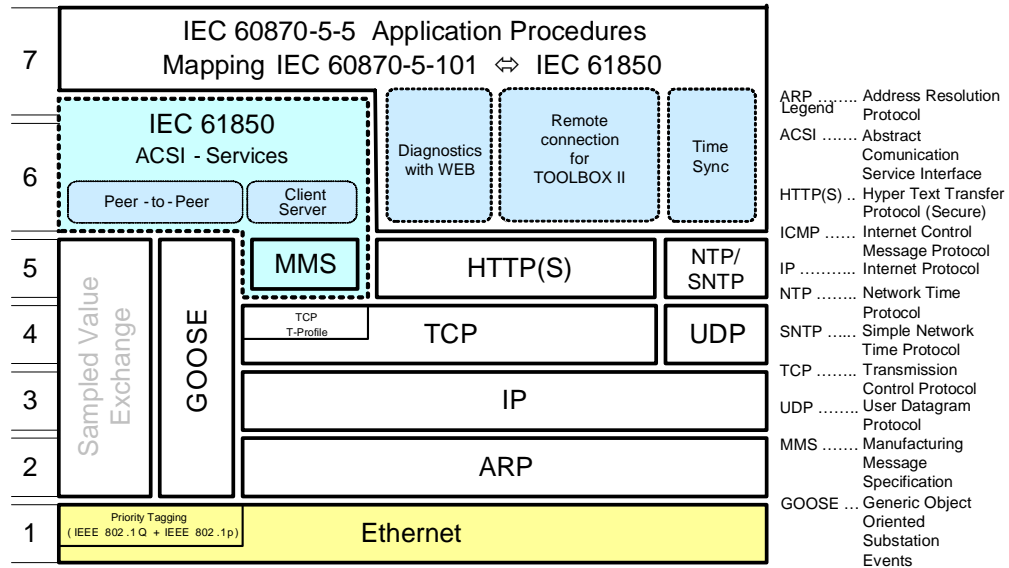
Due to its features, protocol element technology has a successful tradition for many years at SIEMENS. A fundamental characteristic is the separation of protocol-bound communication from application tasks of an automation unit.

- Each interface has its own protocol processor
 - communication has no impact on the application, and vice versa
 - each processor runs one communication protocol
 - various different protocols run on one and the same hardware
 - all protocols can be loaded with SICAM TOOLBOX II
- You can change the communication protocol without retroactive effect to the application tasks of an automation unit
- Each automation unit can be equipped with various protocols This allows easy implementation of data nodes and frontends.

Engineering is done using SICAM TOOLBOX II.

Features and Functions

Protocols according to the standard IEC 61850 are based on the OSI layer model.



Layer	Task	Functions, Characteristics, Comments
7 - Application	Application	<ul style="list-style-type: none"> • Transmission Handling • Reception Handling • Management of multiple connections
6 - Presentation	Data format	<ul style="list-style-type: none"> • IEC 61850 ACSI to Ax 1703 / SICAM RTUs and compatible systems In the "private range" according to IEC 60870-5-104, Ax 1703 / SICAM RTUs-specific system messages and some user data are implemented (i.e. transmission of fault records to SICAM DISTO)
5 - Session	Interface between data format and communication protocol	<ul style="list-style-type: none"> • GOOSE • MMS • HTTP/ HTTPS • NTP client and server according to RFC 1305 • SNTP client according to RFC 4330
4 - Transport 3 - Network	Communication protocol	<ul style="list-style-type: none"> • TCP/IP according to RFC 791 and RFC 793 • ICMP according to RFC 792; GOOSE according to IEC 61850-8-1
2 - Data Link 1 - Physical	LAN interface	<ul style="list-style-type: none"> • Ethernet 100 Mbps full duplex according to IEEE 802.3 • Connection technique (RJ45 on the master control or communication element) • ARP according to RFC 826 • IP Encapsulation according to RFC 894

General Functions IEC 61850 Client

• LAN/WAN Communication over Ethernet TCP/IP - General	
– 100 MBit (full duplex)	✓
• IEC 61850 Client	
– Edition 1	✓
– Edition 2	✓
– max. number of servers (max. connections)	100 ²⁾
– max. number of “logical devices” (for each connection)	✓ ³⁾
– max. number of “logical nodes” (for each connection) – not limited	✓ ³⁾
– max. number of data points	10000
– ACSI services	5)
– data classes	5)
– attributes	5)
– supported functionality according to:	
– PICS (Protocol Implementation Conformance Statement)	✓
– PIXIT (Protocol Implementation Extra Information)	✓
– Supported Logical Nodes and their Attributes	✓
• Acquisition of events (transmission of data ready to be sent)	
– Static Data Sets	✓
– Dynamic Data Sets	✓
– Buffered Reports	✓
– Unbuffered Reports	✓
• Transmission of files	
– Disturbance records to SICAM DISTO	✓
• Transmission of integrated totals	✓
• General interrogation	✓
• Command transmission	✓
– Set control location	✓
– Check control location	✓
– Command interlocking	✓
– Direct Control with normal security	✓
– Direct Control with enhanced security	✓
– SBO control with enhanced security	✓
• Clock synchronization according to NTP (Network Time Protocol)	
– NTP-Server	✓
– NTP-Client	✓
– SNTP-Client	✓
• Functions for the support of redundant communication routes	
– 1703 redundancy	✓

• Protocol Element Control and Return Information	
Protocol Element Control (PRE control message)	
– START connection to server ("Initiate")	✓
– STOP connection to server ("Initiate")	✓
– Send (general) interrogation command	✓
– Send (general) interrogation command to GI-group	✓
– Preset control location	✓
Protocol Element return information (PRE return information)	
• SICAM TOOLBOX II connection over LAN/WAN ("remote connection")	
– Remote connection based on http/https	✓
• Web Server	
– Integrated web server to display connection- statistic- and developer information	✓
– Access to the web server with standard web browser via HTTP (Hyper Text Transfer Protocol)	✓
• Special functions	
– Conversion of the time information (UTC; local time w/wo Summer-Wintertime)	✓
– Signaling / measured value disabling	✓
– Emulation of the going binary information	✓
– Emulation of the data on reception of the attribute Beh.stVal="OFF" and Beh.stVal = "BLOCKED"	✓
– Technological adaptation for measured values	✓
– Measured value change monitoring	✓
– Monitoring intermediate and faulty positions of double-point information	✓
– Remote parameterization/diagnostic of SICAM RTUs components via 61850	✓
2) recommendation: max. 50	
3) not limited (limited only by free memory)	
5) supported with restrictions	



Note

The features and functions are described in detail in the document *SICAM RTUs • Ax 1703 Common Functions Protocol Elements, section "LAN Communication (61850)"*.

Communication

For the stations to communicate with each other, suitable transmission facilities and/or network components may be needed in addition. An optical connection is possible via media converter or switch.

Client

System	System Element	Protocol Element	Note
SICAM AK	CP-2014/CPCX25 CP-2017/PCCX25	SM-2558/ETA5	
SICAM TM	CP-6014/CPCX65	SM-2558/ETA5	

Server

System	System Element	Protocol Element	Note
SICAM AK	CP-2014/CPCX25 CP-2017/PCCX25	SM-2558/ETA3 SM-2556/ET03	
SICAM TM	CP-6014/CPCX65	SM-2558/ETA3 SM-2556/ET03	
SICAM CMIC	CP-8000/CPC80	ET83	
Third-party system			IEC 61850 interoperability

Configurations

The following table lists supported configurations. In addition to one or two SM-2558, all parts (SIM, carriermodule, connection board, patch plug, etc.) listed for the chosen configuration are needed:

Configuration			Interfaces			
Carrier Module	Connection Board ¹⁾	Patch Plug ¹⁾	SIM0		SIM1	
			SI0	SI1	SI2	SI3
CP-2014	CM-2839	²⁾	✓ ⁴⁾	✓		
CP-2017	CM-2838	²⁾	✓ ⁴⁾	✓	✓ ⁴⁾	✓
CP-6014	---	²⁾	✓ ⁴⁾	✓	✓ ⁴⁾	✓

- ¹⁾ one connection board for each carrier module, one patch plug for each interface
²⁾ For patch plugs for standard protocols in standard configurations as supported see *Modes of Operation*.
⁴⁾ serial interface (V.24/V.28) – can be added optionally (SM--0551)



Hint

Details on assembly of SIMs and Patch Plugs can be found in the user manual of the respective SICAM RTUs, chapter *Setup of external Communication Connections*.

Modes of Operation

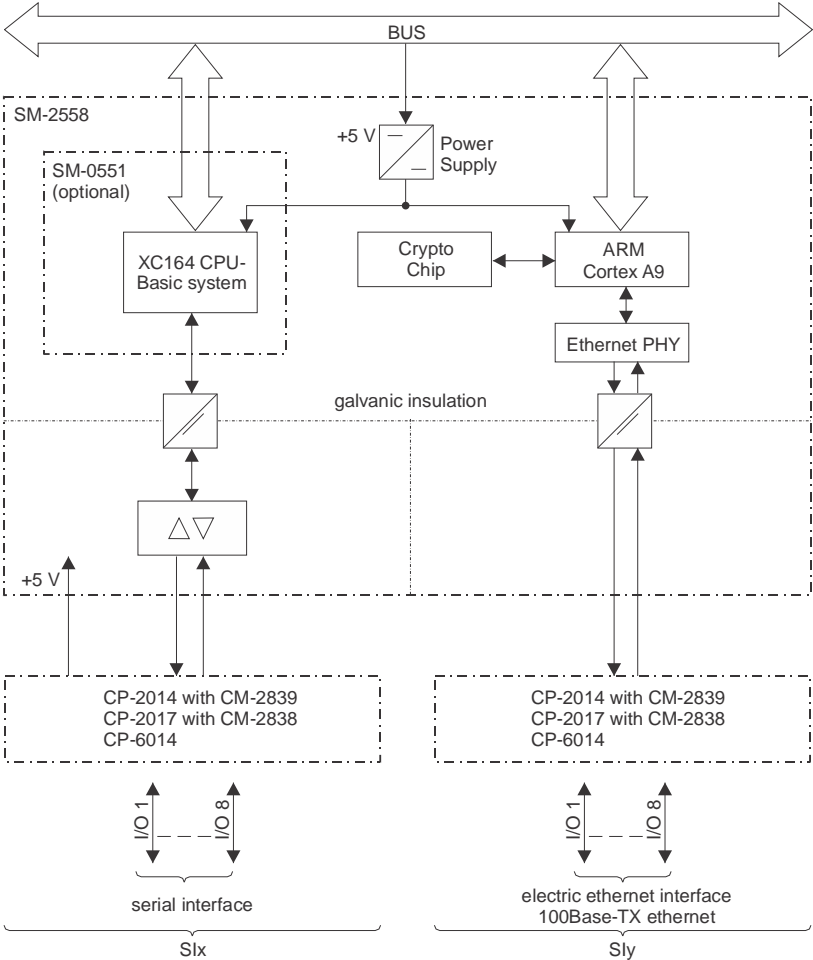
Operating mode	Patch Plug/Modul	Extras ¹⁾	Note
Electrical ethernet-interface (twisted pair)	CM-2860	–	<ul style="list-style-type: none"> • Fast Ethernet acc. IEEE 802.3, 100Base-TX • Transmission rate up to 100 Mbps • RJ45 connector 8-pin according to IEC 603.7
Optical ethernet interface (multimode fibre optic)	CM-2860	Media Converter or Switch	<ul style="list-style-type: none"> • Fast Ethernet acc. IEEE 802.3, 100Base-TX • Transmission rate up to 100 Mbps

¹⁾ Extras are optional equipments
 For details see *SICAM RTUs Platforms • Configuration Automation Units and Automation unit Networks*

Technical Specifications

Communication Circuits			
Electrical LAN interface (twisted pair)	Fast Ethernet acc. IEEE 802.3, 100Base-TX Data rate 100 Mbit/s Line lengths up to 100 m (using CAT 5e cables)		
1 serial interface (SM-0551 can be added optional)	Technical Specifications see data sheet <i>SM-x551/PROTOCOL (MC0-003-2.00)</i>		
Power Supply			
Operating voltage	4.75 .. 5.25 VDC,	typ. 400 mA,	max. 500 mA (without SM-0551)
	4.75 .. 5.25 VDC,	typ. 525 mA,	max. 770 mA (with SM-0551)
The voltage is supplied by the carrier module.			
Mechanics			
Dimensions	227.3 x 63.5 mm		
Weight	Approx. 90 g		

Block Diagram

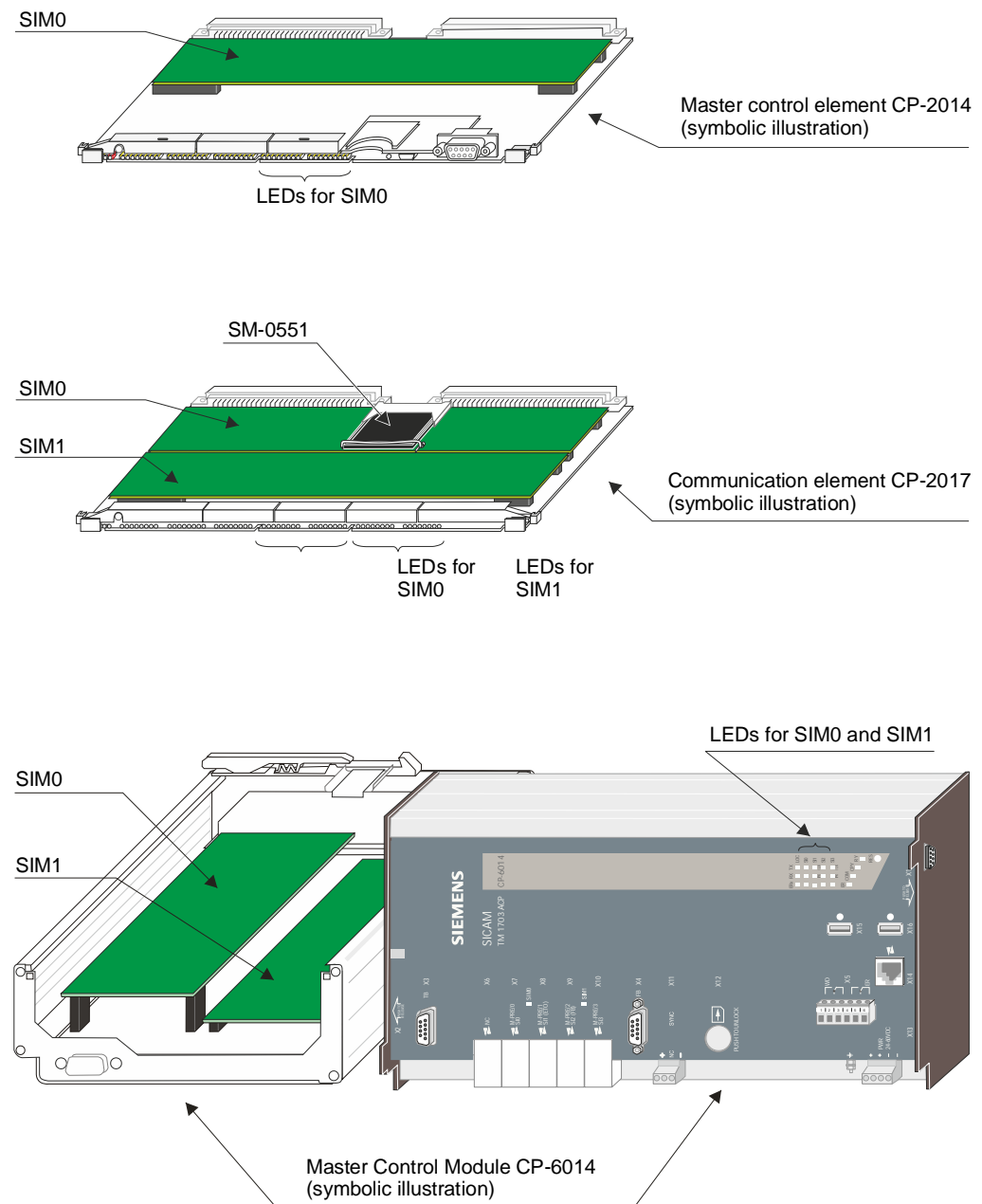


Status and Function display

The protocol element SM-2558/ETA5 itself has neither a front panel nor LEDs to display status and functions.

It uses the LEDs of the master control unit or communication elements. The meaning of these LED displays is described in the manual of the concerning system element.

Protocol elements – Mounting place and LED display SICAM AK/SICAM TM



Pin Assignment

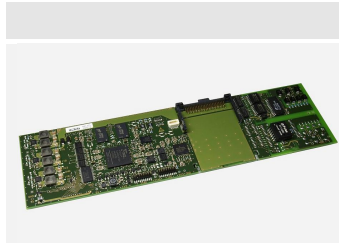
According to its application, the interfaces of a communication element (RJ45 socket connector) are on the connection board (SICAM AK) or on the housing (SICAM TM).

RJ45 socket connector	
SI1	on CM-2839 with CP-2014
SI1, SI3	on CM-2838 with CP-2017
SI1, SI3	on housing of CP-6014

Pin	Signal	Meaning
1	TxD+	Transmit Data +
2	TxD-	Transmit Data -
3	RxD+	Receive Data +
4	-	not used
5	-	not used
6	RxD-	Receive Data -
7	-	not used
8	-	not used

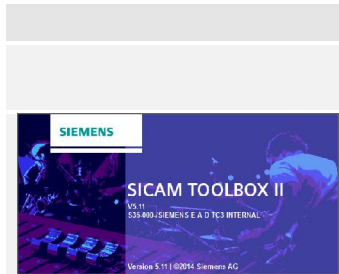
System Components

Hardware



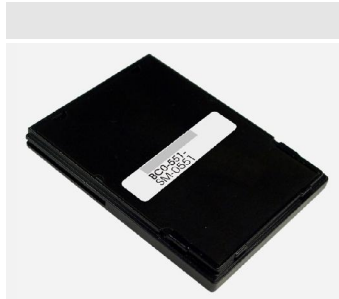
Designation	Item-Number/MLFB
SM-2558 Ethernet Interface 1x100Base-TX (+1 ser. Interface optional)	BC2-558 6MF10130CF580AA0

Firmware



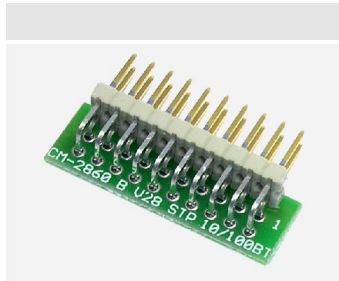
Designation	Item-Number/MLFB
ETA5 Ethernet Interface according to IEC 61850 Client Ed. 2	SC0-590-1
TU ETA5 TB II-Update	SC0-590-1.XX/53

Can be equipped optional



Designation	Item-Number/MLFB
SM-0551 Serial Interface Processor, 1 serial Interface	BC0-551 6MF10130AF510A00

Accessories



Designation	Item-Number/MLFB
CM-2860 Patch Plug Standard V28, ET, TR	CA2-860 6MF12110CJ600AA0

Placement into the Information Landscape

Document name	Item Number
SICAM RTUs • Ax 1703 Common Functions Protocol Elements	DC0-023-2
SICAM RTUs Platforms Configuration Automation Units and Automation Networks	DC0-021-2
SICAM RTUs SM-xx51/PROTOCOL	MC0-003-2

A. Protocol Implementation Conformance Statement (PICS)

A.1. PICS ETA5

The tables in the following sections correspond to the standard IEC 61850-8-1, chapter 24.

Here, the conformance statements that are described under the term "Protocol Implementation Conformance Statement" are clarified.

A.1.1. Profile Conformance

A-Profile Support

A-Profile	Profile Description	Client supported	Value/Comment
A1	Client/Server	✓	
A2	GOOSE/GSE Management		
A3	GSSE A		
A4	TimeSync	✓	

T-Profile Support

T-Profile	Profile Description	Client supported	Value/Comment
T1	TCP/IP	✓	
T2	OSI		
T3	GOOSE/GSE		
T4	GSSE		
T5	TimeSync	✓	

A.1.2. MMS Conformance

A.1.2.1. Environmental Services

A.1.2.1.1. Initiate Conformance

MMS Initiate Request General Parameters

InitiateRequest	Client-CR	
	supported	Value/ Range
InitiateRequest		
localDetailCalling	✓	
proposedMaxServOutstandingCalling	✓	6
proposedMaxServOustandingCalled	✓	6
initRequestDetail	✓	
InitiateRequestDetail		
proposedVersionNumber	✓	
proposedParameterCBB	✓	
servicesSupportedCalling	✓	
additionalSupportedCalling		
additionalCbbSupportedCalling		
privilegeClassIdentityCalling		

MMS Initiate Response General Parameters

InitiateResponse	Client-CR	
	supported	Value/ Range
InitiateResponse		
localDetailCalled	✓	
negotiatedMaxServOutstandingCalling	✓	
negotiatedMaxServOustandingCalled	✓	
initResponseDetail	✓	
InitiateResponseDetail		
negotiatedVersionNumber	✓	
negotiatedParameterCBB	✓	
servicesSupportedCalled	✓	
additionalSupportedCalled		
additionalCbbSupportedCalled		
privilegeClassIdentityCalled		

MMS Service Supported Conformance Table

MMS Service Supported CBB	Client-CR	
	supported	Value/Range
status	✓	
getNameList	✓	
identify	✓	
rename		
read	✓	
write	✓	
getVariableAccessAttributes	✓	
defineNamedVariable		
defineScatteredAccess		
getScatteredAccessAttributes		
deleteVariableAccess		
defineNamedVariableList	✓	
getNamedVariableListAttributes	✓	
deleteNamedVariableList	✓	
defineNamedType		
getNamedTypeAttributes		
deleteNamedType		
input		
output		
takeControl		
relinquishControl		
defineSemaphore		
deleteSemaphore		
reportPoolSemaphoreStatus		
reportSemaphoreStatus		
initiateDownloadSequence		
downloadSegment		
terminateDownloadSequence		
initiateUploadSequence		
uploadSegment		
terminateUploadSequence		
requestDomainDownload		
requestDomainUpload		
loadDomainContent		
storeDomainContent		
deleteDomain		
getDomainAttributes		
createProgramInvocation		
deleteProgramInvocation		
start		

MMS Service Supported CBB	Client-CR	
	supported	Value/Range
stop		
resume		
reset		
kill		
getProgramInvocationAttributes		
obtainFile		
defineEventCondition		
deleteEventCondition		
getEventConditionAttributes		
reportEventConditionStatus		
alterEventConditionMonitoring		
triggerEvent		
defineEventAction		
deleteEventAction		
alterEventEnrollment		
reportEventEnrollmentStatus		
getEventEnrollmentAttributes		
acknowledgeEventNotification		
getAlarmSummary		
getAlarmEnrollmentSummary		
readJournal		
writeJournal		
initializeJournal		
reportJournalStatus		
createJournal		
deleteJournal		
fileOpen	✓	
fileRead	✓	
fileClose	✓	
fileRename		
fileDelete		
fileDirectory	✓	
unsolicitedStatus		
informationReport	✓	
eventNotification		
attachToEventCondition		
attachToSemaphore		
conclude	✓	
cancel		
getDataExchangeAttributes		
exchangeData		

MMS Service Supported CBB	Client-CR	
	supported	Value/ Range
defineAccessControlList		
getAccessControlListAttributes		
reportAccessControlledObjects		
deleteAccessControlList		
alterAccessControl		
reconfigureProgramInvocation		

MMS Parameter Conformance Building Block (CBB)

MMS Parameter CBB	Client-CR	
	supported	Value/ Range
STR1	✓	
STR2	✓	
NEST	✓	5
VNAM	✓	
VADR		
VALT		
bit 5		
TPY		
VLIS	✓	
bit 8		
bit 9		
CEI		
ACO		
SEM		
CSR		
CSNC		
CSPLC		
CSPI		

A.1.2.1.2. GetNameList Conformance

GetNameList Conformance Statement

GetNameList	Client-CR	
	supported	Value/ Range
Request		
ObjectClass	✓	
ObjectScope	✓	
DomainName	✓	
ContinueAfter	✓	
Response		
List Of Identifier	✓	
MoreFollows	✓	
Response		
Error Type	✓	

A.1.2.2. Variable Access Conformance

A.1.2.2.1. Supporting Productions

AlternateAccessSelection Conformance Statement

AlternateAccessSelection	Client-CR	
	supported	Value/ Range
accessSelection		
component		
index		
indexRange		
allElements		
alternateAccess		
selectAccess		
component		
index		
indexRange		
allElements		

VariableAccessSpecification Conformance Statement

VariableAccessSpecification	Client-CR	
	supported	Value/Range
listOfVariable	✓	
variableSpecification	✓	
alternateAccess		
variableListName	✓	

VariableSpecification Conformance Statement

VariableSpecification	Client-CR	
	supported	Value/Range
name	✓	
address	✓	
variableDescription		
scatteredAccessDescription		
invalidated		

A.1.2.2.2. Read

Read Conformance Statement

Read	Client-CR	
	supported	Value/Range
Request		
specificationWithResult		
variableAccessSpecification	✓	
Response		
variableAccessSpecification	✓	
listOfAccessResult	✓	

A.1.2.2.3. Write

Write Conformance Statement

Write	Client-CR	
	supported	Value/ Range
Request		
variableAccessSpecification	✓	
listOfData	✓	
Response		
failure	✓	
success	✓	

A.1.2.2.4. InformationReport

InformationReport Conformance Statement

InformationReport	Client-CR	
	supported	Value/ Range
Request		
variableAccessSpecification	✓	
listOfAccessResult	✓	

A.1.2.2.5. GetVariableAccessAttributes

GetVariableAccessAttributes Conformance Statement

GetVariableAccessAttributes	Client-CR	
	supported	Value/ Range
Request		
name	✓	
address		
Response		
mmsDeletable		
address	✓	
typeSpecification	✓	

A.1.2.2.6. DefineNamedVariableList

DefineNamedVariableList Conformance Statement

DefineNamedVariableList	Client-CR	
	supported	Value/Range
Request		
variableListName	✓	
listOfVariable	✓	
variableSpecification	✓	
alternateAccess		
Response	✓	

A.1.2.2.7. GetNamedVariableListAttributes

GetNamedVariableListAttributes Conformance Statement

GetNamedVariableListAttributes	Client-CR	
	supported	Value/Range
Request		
ObjectName	✓	
Response		
mmsDeletable		
listOfVariable	✓	
variableSpecification	✓	
alternateAccess		

A.1.2.2.8. DeleteNamedVariableList

DeleteNamedVariableList Conformance Statement

DeleteNamedVariableList	Client-CR	
	supported	Value/Range
Request		
Scope	✓	
listOfVariableListName	✓	
domainName		
Response		
numberMatched	✓	
numberDeleted	✓	
DeleteNamedVariableList-Error	✓	

A.1.2.3. Journal management services

A.1.2.3.1. ReadJournal

ReadJournal Conformance Statement

ReadJournal	Client-CR	
	supported	Value/ Range
Request		
invokelD		
journalName		
rangeStartSpecification		
startingTime		
EntrytoStartAfter		
rangeStopSpecification		
endingTime		
numberOfEntries		
EntryToStartAfter		
TimeSpecification		
EntrySpecification		
Response		
invokelD		
listOfJournalEntry		
entryIdentifier		
originatingApplication		
entryContent		
moreFollows		

JournalEntry Conformance Statement

Ref	Parameter	Client-CR	
		supported	Value/ Range
1	occurenceTime		
2	additionalDetail		
3	entryForm		
4	data		
5	event		
6	currentState		
7	listofVariable		
8	variableTag		
9	valueSpecification		
10	annotation		

A.1.2.3.2. InitializeJournal

InitializeJournal Conformance Statement

InitializeJournal	Client-CR	
	supported	Value/ Range
Request		
journalName		
limitSpecification		
limitingTime		
limitingEntry		
Response+		
entriesDeleted		

A.1.2.4. File Management Services

A.1.2.4.1. FileDirectory

FileDirectory Conformance Statement

FileDirectory	Client-CR	
	supported	Value/ Range
Request		
filespecification	✓	
continueAfter	✓	
Response+		
listOfDirectoryEntry	✓	
moreFollows	✓	

A.1.2.4.2. FileOpen

FileOpen Conformance Statement

FileOpen	Client-CR	
	supported	Value/ Range
Request		
filename	✓	
initialPosition		
Response+		
frsmID	✓	
fileAttributes	✓	

A.1.2.4.3. FileRead

FileRead Conformance Statement

FileRead	Client-CR	
	supported	Value/ Range
Request		
frsmID	✓	
Response+		
fileData	✓	
moreFollows	✓	

A.1.2.4.4. FileClose

FileClose Conformance Statement

FileClose	Client-CR	
	supported	Value/ Range
Request		
frsmID	✓	
Response+	✓	

A.2. PICS Statement

A.2.1. Logical Device

A.2.1.1. GOOSE Services

GOOSE Conformance Statement

GOOSE	Subscriber	Value/ Range
GOOSE Services		
SendGOOSEMessage		
GetGoReference		
GetGOOSEElementNumber		
GetGoCBValues		
SetGoCBValues		
GSENotSupported		
GOOSE Control Block (GoCB)		

*) only IEC 61850 Server

GSSE Conformance Statement

GSSE	Subscriber	Value/ Range
GSSE Services		
SendGSSEMessage		
GetGsReference		
GetGSSEDataOffset		
GetGsCBValues		
SetGsCBValues		
GSENotSupported		
GSSE Control Block (GsCB)		

B. Protocol Implementation Extra Information for Testing (PIXIT)

B.1. PIXIT ETA5 Client

The tables in the following sections contain statements about special informations for tests corresponding to the standard IEC 61850-10.

Here, the statements that are described under the term "Protocol Implementation Extra Information for Testing" are clarified. The definition of the single informations is device-specific and not in the scope of the standard.

B.1.1. Association Model

Description	Value/Range	Remarks
Max. number of connected servers	100	
Connection failure recognition (TCP KEEPALIVE)	1...255 s	
Authentication	NO	
Maximum MMS PDU size	8000	

B.1.2. Dataset Model

Description	Value/Range	Remarks
Number of "data elements" per dataset	Not limited	
Number of datasets	Not limited	

B.1.3. Setting Group Control Model

Description	Value/Range	Remarks
Change of a setting group	NO	
Edit a setting group	NO	

B.1.4. Reporting Model

Description	Value/Range	Remarks
Trigger conditions		
integrity	NO	
data change	YES	
quality change	YES	
data updated	YES	
GI	YES	
Optional fields		
sequence number	YES	
report time stamp	YES	
reason for inclusion	YES	
dataset	YES	
buffer overflow	NO	
entry id	YES	
conf rev	NO	
segmentation	YES	

B.1.5. Control Model

Description	Value/Range	Remarks
Control model		
status only	YES	
direct with normal security	YES	
SBO with normal security	NO	
direct with enhanced security	YES	
SBO with enhanced security	YES	
Time activated operate	NO	
Number of simultaneous commands	50	
Check attribute		
synchrocheck	YES	
interlockcheck	YES	
Service errors	All	conversion to ACTCON neg. resp. ACTTERM neg.
Additional causes diagnosis	All	conversion to ACTCON neg. resp. ACTTERM neg.
Cancel request		Only for a currently running command
Format control time stamp T	Time stamp	

B.1.6. Time and Time Synchronization Model

Description	Value/Range	Remarks
Quality bits		
Leap seconds known	NO	
Clock failure	YES	
Clock not synchronized	YES only for Attributes from Server -> Client	
Time accuracy	Not evaluated	

B.1.7. File Transfer Model

Description	Value/Range	Remarks
Directory indication	"/" or "\"	
Length of filename (incl. directory)	40 ASCII characters	
Maximum file size	1 MB	
Interrogation simultaneously to several servers	NO	