Smart Substation Control and Protection

SSC600

Protocol Implementation Extra Information for Testing (PIXIT) for the IEC 61850 interface in SSC600

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1 About this manual

1.1 Read it first!

Before attempting any operation with SSC600 Smart Substation Control and Protection device, read carefully the device documentation.

This document is addressed to anyone who needs to interact with SSC600 and its IEC 61850 features in more detail.

1.2 Document information

Revision History

Revision	Date	Note
A	16 Jan 2019	SSC600 v1.0
B	26 March 2020	FP1 added
C	5 Dec 2022	FP4 added

Applicability

This manual is applicable to all SSC600 Smart Substation Control and Protection device versions mentioned in document Revision History above or newer versions if document update is not required.

1.3 Safety Information

There are safety warnings and notes in the following text. They are in a different format to distinguish them from normal text.

Safety warning

The safety warnings should always be observed. Non-observance can result in death, personal injury or substantial damages to property. Guarantee claims might not be accepted when safety warnings are not respected. They look like below:

Do not make any changes to the SSC600 configuration unless you are familiar with the SSC600 and its configuration tool. This might result in disoperation and loss of warranty.

Note

A note contains additional information worth noting in the specific context, and looks like below:

The selection of this control mode requires caution, because operations are allowed both from the HMI and remotely.

2 Abbreviations and Definitions

2.1 Abbreviations

FTP	**F**ile **T**ransfer **P**rotocol
GOOSE	**G**eneric **O**bject **O**riented **S**ubstation **E**vent
GPS	**G**lobal **P**ositioning **S**ystem
GSE	**G**eneric **S**ubstation **E**vent
GSSE	**G**eneric **S**ubstation **S**tatus **E**vent
HMI	**H**uman **M**achine **I**nterface
IED	**I**ntelligent **E**lectronic **D**evice
LED	**L**ight **E**mitting **D**iode
MAC	**M**edia **A**ccess **C**ontrol
MICS	**M**odel **I**mplementation **C**onformance **S**tatement
MMS	**M**anufacturing **M**essage **S**pecification
M/O	**M**andatory/**O**ptional
N	**N**o
PICS	**P**rotocol **I**mplementation **C**onformance **S**tatement
PIXIT	**P**rotocol **I**mplementation e**X**tra **I**nformation for **T**esting
RCB	**R**eport **C**ontrol **B**lock
SCADA	**S**upervision, **C**ontrol **a**nd **D**ata **A**cquisition
SLD	**S**ingle **L**ine **D**iagram
XML	e**X**tensible **M**arkup **L**anguage
Y	**Y**es

2.2 Definitions

Operational State	The unit is active and it is protecting and controlling the switchgear.
Stand-alone	The unit is not connected to a SCADA system.

3 References

[1] IEC: IEC 61850 (1-10), Communication networks and systems in substations, Part 1-10; 1st Edition

[2] IEC: IEC 61850 (1-10), Communication networks and systems for power utility automation, Part 1-10; Edition 2

4 Introduction

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in SSC600.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10. The PIXIT entries contain information which is not available in the PICS, MICS, TICS document or SCL file.

Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10. The “Ed” column indicates if the entry is applicable for IEC 61850 Edition 1 [1] and/or Edition 2 [2].

5 PIXIT for Association Model

ID	Ed	Description	Value/ Clarification
As1	1,2	Maximum number of clients that can set-up an association simultaneously	5
As2	1,2	TCP_KEEPALIVE value	15s
As3	1,2	Lost connection detection time range.	1-20s
As4	1,2	Is authentication supported	Y
As5	1,2	What association parameters are necessary for successful association	Y Transport selector Y Session selector Y Presentation selector N AP Title N AE Qualifier
As6	1,2	Association parameters	Transport selector 0001 Session selector 0001 Presentation selector 00000001

As7	1,2	What is the maximum and minimum MMS PDU size	Max MMS PDU size: 262144bytes Min MMS PDU size: -
As8	1,2	What is the typical startup time after a power supply interrupt	150 seconds.

Table 1 PIXIT for Association Model

6 PIXIT for Server Model

ID	Ed	Description	Value / Clarification
Sr1	1,2	Which analogue value (MX) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, Y Questionable N Overflow Y OutofRange N BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate Source: Y Process N Substituted Y Test N OperatorBlocked
Sr2	1,2	Which status value (ST) quality bits are supported (can be set by server)	Validity: Y Good, Y Invalid, N Reserved, Y Questionable N BadReference Y Oscillatory Y Failure N OldData N Inconsistent N Inaccurate Source: Y Process N Substituted Y Test N OperatorBlocked
Sr3	1,2	What is the maximum number of data values in one GetDataValues request	Stack does not limit the amount of the data values. MMS PDU is the limit.

Sr4	1,2	What is the maximum number of data values in one SetDataValues request	Stack does not limit the amount of the data values. MMS PDU is the limit.
Sr5	1,2	Which Mode / Behaviour values are supported	On Y Blocked Y Test Y Test/Blocked Y Off Y
Sr6	1,2	Quality attribute use cases	INVALID + OSCILLATORY: - Binary input failure TEST: - When data change occurs under test mode QUESTIONABLE + OLDDATA: - Default when data not updated or not used by configuration QUESTIONABLE + OUTOFRANGE: - According the limit supervision of the measurement blocks FAILURE + INVALID: - Device data in internal relay fault

Table 2 PIXIT for Server Model

7 PIXIT for Data Set Model

ID	Ed	Description	Value / Clarification
Ds1	1,2	What is the maximum number of data elements in one data set	256
Ds2	1,2	How many persistent data sets can be created by one or more clients	Not supported service, 140 pre-defined supported
Ds3	1,2	How many non-persistent data sets can be created by one or more clients	Not supported service

Table 3 PIXIT for Data Set Model

8 PIXIT for Setting Group Control Model

ID	Ed	Description	Value / Clarification
Sg1	1,2	What is the number of supported setting groups for each logical device?	Setting Group Control Block (SGCB) resides always in LD0.LLN0 and number of setting groups is 6.
Sg2	1,2	What is the effect of when and how the non-volatile storage is updated? (compare IEC 61850-8-1 $16.2.4)	Configuration resides in non-volatile memory. It is used when IED is restarted and configuration is changed. Changed settings are stored when settings editing is confirmed. Active setting group change will also be stored. Storing will take some to complete and is typically between 10-20s. CnfEdit attribute will go back to FALSE after storing is complete.
Sg3	1,2	Can multiple clients edit the same setting group?	N
Sg4	1,2	Multiple clients activating setting group editing	If Client1 has activated setting group editing Client2 sees EditSG with value 0. If Client2 tries also to activate setting group editing Request results to Response-.
Sg5	1,2	What happens if the association is lost while editing a setting group?	When client has activated editing setting groups by writing a valid value to EditSG attribute in SGCB the setting group editing is only active the when connection between client and server is active. If association is lost setting group editing is cancelled by server.
Sg6	1,2	Is EditSG value 0 allowed?	Y
Sg7	1,2	Canceling of setting group editing	Canceling of setting group editing is done by writing value FALSE to CnfEdit attribute in SGCB.
Sg8	1,2	Changing active setting group	When changing the active setting group the CnfEdit is automatically set to TRUE. After storing is complete, the CnfEdit value is automatically set back to FALSE
Sg9	1,2	Timeout for setting group editing	60 minutes

Table 4 PIXIT for Setting Group Control Model

9 PIXIT for Reporting Model

ID	Ed	Description	Value / Clarification
Rp1	1,2	The supported trigger conditions are	Integrity Y Data change Y Quality change Y Data update N General interrogation Y
Rp2	1,2	The supported optional fields are	Sequence-number Y Report-time-stamp Y Reason-for-inclusion Y Data-set-name Y Data-reference Y EntryID Y Conf-rev Y
Rp3	1,2	Can the server send segmented reports	Y
Rp4	1,2	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	1,2	Multi-client URCB approach (compare IEC 61850-7-2 $14.2.1)	URCBs are visible and shared by all Clients.
Rp6	1,2	What is the format of EntryID	Octet string 8, four MSB bytes are used as counter.
Rp7	1,2	What is the buffer size for each BRCB or how many reports can be buffered	26 events buffer for each BRCB instance.
Rp8	1,2	Pre-configured RCB attributes that cannot be changed online	<data set name> <configuration revision>
Rp9	1,2	May the reported data set contain: - structured data objects? - data attributes?	 Y N
Rp10	1,2	What is the scan cycle for binary events?	1ms. Not configurable.
Rp11	1,2	Does the device support to pre-assign a RCB to a specific client in the SCL	N

Rp12	1,2	Report time stamps	Most of the data object time stamps are defaulted in the startup. Timestamp is the time when IED gets the time synchronization first time during start-up. If time synchronization is not received a default time value is used with time invalid flag set. Time stamp value is updated when first real event occurs in the application.
Rp13	1,2	What is the integrity period minimum value?	1000ms. If client tries to set integrity period smaller than 1000ms, period of one second is used and Response+ is sent to client.
Rp14	1,2	Amount of datasets	IED configuration can have at most 140 datasets and 100 of those are dedicated for event reporting.

Table 5 PIXIT for Reporting Model

10 PIXIT for GOOSE publish model

ID	Ed	Description	Value / Clarification
Gp1	1,2	Can the test flag in the published GOOSE be turned on/off?	Yes in Ed.1 configuration by switching the test mode. No in Ed.2 configuration. GOOSE Simulation not supported.
Gp2	1,2	What is the behavior when the GOOSE publish configuration is incorrect.	IED will set ndsCOM=TRUE to GOCBs which exceed the limit defined by services(GOOSE max) otherwise IED keeps GoEna=FALSE when GOCB has incorrect configuration.
Gp3	1,2	Published Supported FCDA elements in dataset	Exchanged data in GOOSE can be any type of data, functional constraint been either ST or MX.
Gp4	1,2	What is the slow retransmission time?	60 seconds, configurable
Gp5	1,2	What is the fastest retransmission time?	2ms, fixed.
Gp6	1,2	Can the GOOSE publish be turned on/off by using SetGoCBValues(GoEna)	Y
Gp7	1,2	What is the initial GOOSE sqNum after restart	sqNum = 1
Gp8	1,2	May the GOOSE data set contain: - structured data object(FCD)? - timestamp data attributes?	Y Y
Gp9		Does the IED accept a configuration with a GOOSE control with empty data set or too large data set?	With Dataset which is empty, the GoCB is removed and warning event is activated. When dataset is too large, GoCB is created but warning event is activated and dataset has dropped attributes which exceed the limit of max attributes.
Gp10	1,2	Amount of GOOSE datasets and dataset limits.	40 datasets can be used for GOOSE with limitation of 20 data attributes in each dataset.

Table 6 PIXIT for GOOSE publish model

11 PIXIT for GOOSE subscribe model

ID	Ed	Description	Value / Clarification
Gs1	1,2	What elements of a subscribed GOOSE header are checked to decide the message is valid and the all data values are accepted? If yes, describe the conditions. Note: the VLAN tag may be removed by a ethernet switch and should not be checked	N source MAC address Y destination MAC address Y Ethertype = 0x88B8 N gocbRef N timeAllowedtoLive N datSet N goID N t Y stNum Y sqNum Y test Y confRev Y ndsCom Y numDatSetEntries Y APPID
Gs2	1,2	When is a subscribed GOOSE marked as lost? (TAL = time allowed to live value from the last received GOOSE message)	Message does not arrive in 2xTAL + 30ms. When TAL = 0, GOOSE is marked lost after 2x1000ms + 30ms
Gs3	1,2	What is the behavior when one subscribed GOOSE message isn't received or syntactically incorrect	Syntactically incorrect: A separate error counter is increased, subscribed dataset is defaulted and a warning is activated. Alarm event is also generated for client application. Message loss: Behaviour is the same as above if more than one message is lost. One message loss only increments error counter.

Gs4	1,2	What is the behavior when a subscribed GOOSE message is out-of-order?	A separate error counter is increased, subscribed dataset is defaulted and a warning is activated. Alarm event is also generated for client application. Message is not processed further. If frames are in wrong order(e.g. sqNum= 1,0,3,2), and stNum does not change, only first frame is processed and other frames are ignored.
Gs5	1,2	What is the behavior when a subscribed GOOSE message is duplicated?	Message with same stNum is not processed further.
Gs6	1,2	Does the device subscribe to GOOSE messages with/without the VLAN tag?	Y, with the tag. Y, without the tag.
Gs7	1,2	May the GOOSE data set contain: - structured data object(FCD)? - timestamp data attributes?	 Y Y
Gs8	1,2	Supported FCD/FCDA elements in dataset	Exchanged data in GOOSE can be any type of data, functional constraint been either ST(FCD/FCDA) or MX(FCDA).
Gs9	1,2	Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted?	Ed.1: Yes, processed if IED is in Test mode. Ed.2: Yes, processed if IED is in Allow simulation mode.
Gs10	1,2	Messages with Needs Commissioning bit set.	A separate error counter is increased, subscribed dataset is defaulted and a warning is activated. Alarm event is also generated for client application.
Gs11	1,2	Messages with wrong ConfRev.	A separate error counter is increased, subscribed dataset is defaulted and a warning is activated. Alarm event is also generated for client application.

Gs12	1,2	What is the behavior when subscribed dataset has quality attribute(s)?	GOOSE Input is set to defaulted state when the received quality attribute differs from GOOD. Default value is always false (0). Quality propagates to application. Received bad quality defaults the input value and in application logic the value is treated as false (0), regardless of the original status value.
Gs13	1,2	GOOSE Alarm	If any of the subscribed GOOSE data is in timeout an alarm is activated in LD0.GSELPRT1.Alm. In this case Data Object gets value TRUE.

Table 7 PIXIT for GOOSE subscribe model

12 PIXIT for GOOSE performance

ID	Ed	Description	Value / Clarification
Gf1	1,2	Performance class	P1
Gf2	1,2	GOOSE ping-pong processing method	Scan cycle based
Gf3	1,2	Application logic scan cycle(ms)	1ms
Gf4	1,2	Maximum number of data attributes in GOOSE dataset (value and quality has to be counted as separate attributes)	20
Gf5	1,2	Maximum number of GOOSE to be published	800 attributes
Gf6	1,2	Maximum number of GOOSE to be subscribed	3520 attributes

Table 8 PIXIT for GOOSE performance

13 PIXIT for Control Model

ID	Ed	Description	Value / Clarification
Ct1	1,2	What control modes are supported	Y Status-only Y Direct-with-normal-security N Sbo-with-normal-security N Direct-with-enhanced-security Y Sbo-with-enhanced-security
Ct2	1,2	Is the control model fixed, configurable and/or online changeable?	Configurable for logical node instances of CBCSWI, DCCSWI and ESCSWI in logical device CTRL. All other objects are fixed.
Ct3	1,2	Is Time activated operate (operTm) supported	N

Ct4	1,2	Is “operate-many” supported	N
Ct5	1,2	What is the behavior when the test attribute is set in the SelectWithValue and/or Operate request	If IED is in Test mode, control operation is accepted. Otherwise server responds as follows: DOns: Response- is returned SBOes: Response- is returned with additional cause “Select Failed”
Ct6	1,2	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Not used by application
Ct7	1,2	Is pulse configuration supported	Y
Ct8	1,2	What check conditions are supported? Is this behaviour fixed, configurable, online changeable?	N Synchrocheck N Interlock-check IED ignores the check value and always performs the check. Fixed.
Ct9	1,2	What service error types are supported?	N Instance-not-available N Instance-in-use Y Access-violation N Access-not-allowed-in-current-state N Parameter-value-inappropriate N Parameter-value-inconsistent N Class-not-supported N Instance-locked-by-other-client N Control-must-be-selected Y Type-conflict N Failed-due-to-communications N Constraint failed-due-to-server-constraint

Ct10	1,2	What additional cause diagnosis are supported?	N Unknown Y Blocked-by-switching-hierarchy Y Select-failed Y Invalid-position Y Position-reached Y Parameter-change-in-execution N Step-limit Y Blocked-by-Mode N Blocked-by-process Y Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution Y Blocked-by-health Y 1-of-n-control Y Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected Edition 2 specific values: Y Object-already-selected N No-access-authority N Endedn-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client
Ct11	1,2	How to force a “test-not-ok” respond with SelectWithValue request?	By using orCat value which is out of range (e.g. 9).
Ct12	1,2	How to force a “test-not-ok” respond with Operate request?	By using orCat value which is out of range (e.g. 9). SBOes: By using different parameters in Select and Operate (e.g. Test).

Ct13	1,2	Which origin categories are supported?	For primary apparatus control DPC and BSC (ATCC.TapChg) according “Station authority” setting (CTRL.LLN0.StaLevSet): “Station authority” 1 (L,R), 2(L,S,R) and 3(L,R,L+R): Y not-supported Y bay-control Y station-control Y remote-control Y automatic-bay Y automatic-station Y automatic-remote Y maintenance Y process “Station authority” and 4(L,S,S+R,L+S,L+S+R): N not-supported N bay-control Y station-control Y remote-control N automatic-bay N automatic-station N automatic-remote N maintenance N process For LLN0 Mod control INC according “Remote test mode” setting (LD0.LDEV1.ModRemCtl) “Remote test mode” 2(Maintenance): N not-supported N bay-control N station-control N remote-control N automatic-bay N automatic-station N automatic-remote Y maintenance N process “Remote test mode” 3 (All levels): Y not-supported Y bay-control Y station-control Y remote-control Y automatic-bay Y automatic-station Y automatic-remote Y maintenance Y process

Ct14	1,2	What happens if the orCat value is not supported?	DOns: Response- is returned SBOes: Response- is returned with additional cause blocked-by-switching hierarchy. Out of range orCat value will return response- with additional cause select-failed.
Ct15	1,2	Does the IED accept a SelectWithValue/Operate with the same ctlVal as the current status value? Is behaviour configurable?	DOns: Y SBOes: Y Operation for Open is always accepted. However operation for close will return response- with additional cause position-reached. DOns: N
Ct16	1,2	Does the IED accept a select/operate on the same control object from 2 different clients at the same time?	DOns: N SBOes: N
Ct17	1,2	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (tissue 334)?	SBOes: N
Ct18	1,2	Is for SBOes the internal validation performed during the SelectWithValue and/or Operate step?	SelectWithValue and Operate
Ct19	1,2	Can a control operation be blocked by Mod=Off or Blocked?	Y
Ct20	1,2	Does the IED support local / remote operation?	Y
Ct21	1,2	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security?	DOns N
Ct22	1,2	How to force a “parameter-change-in-execution”?	SBOes: By using different parameters in Select and Operate (e.g. Test).

Ct23	1,2	LLN0.Mod operation	LLN0.Mod uses direct control mode. Controlling this object is allowed only during manufactory tests. Otherwise the result of control operation is always Response-.
Ct24	1,2	Selection of objects	One object at time can be selected.
Ct25	1,2	Command checking	- Command checking based on client identification - Other commands control structure attributes are stored and used for response.
Ct26	1,2	Command timeout	Configurable data for both Select and Operate. Operation Timeout is at minimum 3s even when the set value is smaller. The selection is active configurable time, default is 30s. During this time the operate command should be given. When the operation is given additional configurable time is reserved for the command termination.

Table 9 PIXIT for Control Model

14 PIXIT for Time and Time Synchronization Model

ID	Ed	Description	Value / Clarification
Tm1	1,2	What quality bits are supported?	Y LeapSecondsKnown N ClockFailure Y ClockNotSynchronized
Tm2	1,2	What is the behavior when the time synchronization signal/messages are lost?	Device will go to unsynchronized state and tries to synchronize from another available source. Synchronization lost is indicated. Generated data timestamps indicate unsynchronized status.

Tm3	1,2	Time tagging of events	Overall time synchronization accuracy is T1 for computed events. Time tagged process events have a hardware delay up to 3 ms.
Tm4	1,2	When is the time quality bit "Clock not synchronized" set?	After 25 seconds with no available time server.
Tm5	1,2	Is the timestamp of a binary event adjusted to the scan cycle?	Y
Tm6	1,2	Does the device support time zone and daylight saving?	Y
Tm7	1,2	Time synchronization behavior	Startup: IED will read the absolute time and will set its internal clock accordingly. Looking for an time server: During this phase no time data are produced. Synchronized to an time server: Accurate time is resolved. The time server in use is lost: Meaning one of the following: - It stops responding. – It is not synchronized. – It is not the highest quality time server available.
Tm8	1,2	Do the COMTRADE files have local or UTC time and is this configurable?	Local time, not configurable.

Table 10 PIXIT for Time and Time Synchronization Model

15 PIXIT for File Transfer Model

ID	Ed	Description	Value / Clarification
Ft1	1,2	What is structure of files and directories?	Configuration Files are stored in the root directory. The Disturbance Recorder files are stored in COMTRADE directory. COMTRADE files are not zipped.
Ft2	1,2	Is the IETF FTP protocol also implemented?	Y
Ft3	1,2	Directory names are separated from the file name by	“\”
Ft4	1,2	The maximum file name size including path (recommended 64 chars)	256 characters.
Ft5	1,2	Are directory/file name case sensitive	N
Ft6	1,2	Is the wild char supported in MMS fileDirectory request?	Yes, wild card = *
Ft7	1,2	Directory listing	When client requests a directory contents the request must be following format; “COMTRADE”, “COMTRADE\”, or “COMTRADE*”. Response listing has whole path(including file name).
Ft8	1,2	Maximum file size	Maximum file size is not defined. Free space varies and size depends on configuration.
Ft9	1,2	Is it allowed that 2 clients get the same file at the same time?	Y
Ft10		Which files can be deleted?	Disturbance record files in COMTRADE directory.

Table 11 PIXIT for File Transfer Mode

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