

## Protection and Control Relay

# 615 GRID AUTOMATION SERIES

## Protocol Implementation extra Information for Testing (PIXIT) for the IEC 61850 interface in 615 GA series



**ABB**

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# 1 About this manual

## 1.1 Read it first!

Before attempting any operation with IED from 615 GA series, read carefully the IED documentation first.

This document is addressed to anyone who needs to interact with 615 GA series and its IEC 61850 features in more detail.

## 1.2 Document information

### Revision History

Revision	Date	Note
A	01 July 2013	615 GA series v1.0
B	06 March 2015	615 GA series v1.1
C	16 July 2018	615 GA series v2.0

### Applicability

This manual is applicable to all 615 GA series Protection and Control IED 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 615 GA series configuration unless you are familiar with the 615 GA series 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	<b>F</b> ile <b>T</b> ransfer <b>P</b> rotocol
GOOSE	<b>G</b> eneric <b>O</b> bject <b>O</b> riented <b>S</b> ubstation <b>E</b> vent
GPS	<b>G</b> lobal <b>P</b> ositioning <b>S</b> ystem
GSE	<b>G</b> eneric <b>S</b> ubstation <b>E</b> vent
GSSE	<b>G</b> eneric <b>S</b> ubstation <b>S</b> tatus <b>E</b> vent
HMI	<b>H</b> uman <b>M</b> achine <b>I</b> nterface
IED	<b>I</b> ntelligent <b>E</b> lectronic <b>D</b> evice
LED	<b>L</b> ight <b>E</b> mitting <b>D</b> iode
MAC	<b>M</b> edia <b>A</b> ccess <b>C</b> ontrol
MICS	<b>M</b> odel <b>I</b> mplementation <b>C</b> onformance <b>S</b> tatement
MMS	<b>M</b> anufacturing <b>M</b> essage <b>S</b> pecification
M/O	<b>M</b> andatory/ <b>O</b> ptional
N	<b>N</b> o
PICS	<b>P</b> rotocol <b>I</b> mplementation <b>C</b> onformance <b>S</b> tatement
PIXIT	<b>P</b> rotocol <b>I</b> mplementation <b>eX</b> tra <b>I</b> nformation for <b>T</b> esting
RCB	<b>R</b> eport <b>C</b> ontrol <b>B</b> lock
SCADA	<b>S</b> upervision, <b>C</b> ontrol and <b>D</b> ata <b>A</b> cquisition
SLD	<b>S</b> ingle <b>L</b> ine <b>D</b> iagram
XML	<b>eX</b> tensible <b>M</b> arkup <b>L</b> anguage
Y	<b>Y</b> 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; 1<sup>st</sup> Edition.

### 4 Introduction

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in 615 GA series with firmware version 1.0.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

### 5 PIXIT for Association Model

ID	Description	Value/ Clarification
As1	Maximum number of clients that can set-up an association simultaneously	5
As2	TCP_KEEPALIVE value	15s
As3	Lost connection detection time range.	1-20s
As4	Is authentication supported	Y
As5	What association parameters are necessary for successful association	Y Transport selector Y Session selector Y Presentation selector N AP Title N AE Qualifier
As6	Association parameters	Transport selector 0001 Session selector 0001 Presentation selector 00000001
As7	What is the maximum and minimum MMS PDU size	Max MMS PDU size: 16000bytes Min MMS PDU size: -
As8	What is the typical startup time after a power supply interrupt	10s for the vertical communication, exact value depends on application size. Horizontal communication (GOOSE) starts within 3s if configuration remains the same.

**Table 1 PIXIT for Association Model**

## 6 PIXIT for Server Model

ID	Description	Value / Clarification
Sr1	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	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	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	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	Which Mode / Behaviour values are supported	On Y Blocked Y Test Y Test/Blocked Y Off Y

Sr6	Quality attribute use cases	<p><b>INVALID + OSCILLATORY:</b> - Binary input failure</p> <p><b>TEST:</b> - When data change occurs under test mode</p> <p><b>QUESTIONABLE + OLDDATA:</b> - Default when data not updated or not used by configuration</p> <p><b>QUESTIONABLE + OUTFRANGE:</b> - According the limit supervision of the measurement blocks</p> <p><b>FAILURE + INVALID:</b> - Device data in internal relay fault</p>
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**Table 2 PIXIT for Server Model**

## 7 PIXIT for Data Set Model

ID	Description	Value / Clarification
Ds1	What is the maximum number of data elements in one data set	256 data attributes
Ds2	How many persistent data sets can be created by one or more clients	14
Ds3	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	Description	Value / Clarification
Sg1	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	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	Can multiple clients edit the same setting group?	N
Sg4	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	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	Is EditSG value 0 allowed?	Y
Sg7	Canceling of setting group editing	Canceling of setting group editing is done by writing value FALSE to CnfEdit attribute in SGCB.
Sg8	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	Timeout for setting group editing	60 minutes

**Table 4 PIXIT for Reporting Model**

## 9 PIXIT for Reporting Model

ID	Description	Value / Clarification
Rp1	The supported trigger conditions are	Integrity Y Data change Y Quality change Y Data update N General interrogation Y
Rp2	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	Can the server send segmented reports	Y
Rp4	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	Multi-client URCB approach (compare IEC 61850-7-2 §14.2.1)	Each client has its own set of URCB's
Rp6	What is the format of EntryID	Octet string 8, four MSB bytes are used as counter.
Rp7	What is the buffer size for each BRCB or how many reports can be buffered	25 events buffer for each BRCB instance.
Rp8	Pre-configured RCB attributes that cannot be changed online	<data set name> <configuration revision>
Rp9	May the reported data set contain: - structured data objects? - data attributes?	Y N
Rp10	What is the scan cycle for binary events?	2ms-2.5ms. Not configurable.
Rp11	Does the device support to pre-assign a RCB to a specific client in the SCL	N

Rp12	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	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	Amount of datasets	IED configuration can have at most 14 datasets and 10 of those are dedicated in standard configuration for event reporting. User is able to create and modify one additional dataset for a new RCB. The default setup may differ by IED variant.

**Table 5 PIXIT for Reporting Model**

## 10 PIXIT for Generic Substation Events Model

ID	Description	Value / Clarification
Go1	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
Go2	Can the test flag in the published GOOSE be turned on/off?	Yes, by switching the test mode.
Go3	What is the behavior when the GOOSE publish configuration is incorrect.	IED will send GOOSE with ndsCom=TRUE or IED keeps GoEna=FALSE.
Go4	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 + 10%.
Go5	What is the behavior when one subscribed GOOSE message isn't received or 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.
Go6	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.
Go7	What is the behavior when a subscribed GOOSE message is duplicated?	Message with same stNum is not processed further.

Go8	Does the device subscribe to GOOSE messages with/without the VLAN tag?	Y, with the tag. Y, without the tag.
Go9	Messages with Test bit set	Only processed if IED is in Test state.
Go10	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.
Go11	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.
Go12	May the GOOSE data set contain: - structured data object(FCD)? - timestamp data attributes?	Subscribed Published N N  N N
Go13	Supported FCDA elements in dataset	Exchanged data in GOOSE can be any type of data, functional constraint been either ST or MX.
Go14	What is the minimum retransmission time? What is the maximum retransmission time?	2ms, fixed.  60 seconds, configurable.
Go15	Can the GOOSE publish be turned on/off by using SetGoCBValues(GoEna)	Y
Go16	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.
Go17	GOOSE Alarm	If any of the subscribed GOOSE data is in timeout an alarm is activated in LD0.GSEGGIO1.Alm. In this case Data Object gets value TRUE.
Go18	Amount of GOOSE datasets and dataset limits.	4 datasets can be used for GOOSE with limitation of 20 data attributes in each dataset.

**Table 6 PIXIT for Reporting Model****11 PIXIT for Control Model**

<b>ID</b>	<b>Description</b>	<b>Value / Clarification</b>
Ct1	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	Is the control model fixed, configurable and/or online changeable?	Breaker object is configurable. All other objects are fixed.
Ct3	Is Time activated operate (operTm) supported	N
Ct4	Is "operate-many" supported	N
Ct5	What is the behavior when the test attribute is set in the SelectWithValue and/or Operate request	Server will reply with response-for Select if IED is not in Test mode. If IED is in Test mode, control is accepted.
Ct6	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Not used by application
Ct7	Is pulse configuration supported	Y
Ct8	What check conditions are supported?	N Synchrocheck N Interlock-check  IED ignores the check value and always performs the check.
Ct9	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	What additional cause diagnosis are supported?	N Unknown Y Blocked-by-switching-hierarchy Y Select-failed N 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 N 1-of-n-control Y Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected
Ct11	Selection of objects	One object at time can be selected.
Ct12	Command checking	- Command checking based on client identification - Other commands control structure attributes are stored and used for response.
Ct13	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.
Ct14	How to force a "test-not-ok" respond with SelectWithValue request?	By using orCat value which is out of range (e.g. 9).
Ct15	How to force a "test-not-ok" respond with Operate request?	SBOes: By using different parameters in Select and Operate (e.g. Test).

Ct16	Which origin categories are supported?	<p>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</p> <p>Above origin categories are supported only if CTRL.LLN0.StaAuth.setVal=2. Otherwise only range check is performed and IED will accept control operation.</p>
Ct17	What happens if the orCat value is not supported?	<p>DOns: Response- is returned</p> <p>SBOes: Response- is returned with additional cause blocked-by-switching hierarchy.</p> <p>Out of range orCat value will return response- with additional cause select-failed.</p>
Ct18	Does the IED accept a SelectWithValue/Operate with the same ctIVal as the current status value?	<p>DOns: Y  SBOes: Y</p> <p>Operation for Open is always accepted. However operation for close will return response- with additional cause position-reached.</p>
Ct19	Does the IED accept a select/operate on the same control object from 2 different clients at the same time?	<p>DOns: N  SBOes: N</p>
Ct20	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (tissue 334)?	SBOes: N
Ct21	Is for SBOes the internal validation performed during the SelectWithValue and/or Operate step?	SelectWithValue and Operate
Ct22	Can a control operation be blocked by Mod=Off or Blocked?	Y
Ct23	Does the IED support local / remote operation?	Y



Ct24	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security?	DOns N
Ct25	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-.

Table 7 PIXIT for Control Model

## 12 PIXIT for Time and Time Synchronization Model

ID	Description	Value / Clarification
Tm1	What quality bits are supported?	N LeapSecondsKnown N ClockFailure Y ClockNotSynchronized
Tm2	What is the behavior when the time synchronization signal/messages are lost?	Two SNTP Time Servers are supported. If primary server is not available, secondary server is taken into use. If both primary and secondary servers are not available, IED will go to unsynchronized state. For more behavior see Tm9.
Tm3	SNTP Request Interval	60 seconds
Tm4	Time tagging of events	T1 related to time tagged process events are supported with an hardware related delay of up to 3 ms.
Tm5	When is the time quality bit "Clock not synchronised" set?	After 3min timeout when SNTP server has not responded.
Tm6	Is the timestamp of a binary event adjusted to the scan cycle?	Y
Tm7	Does the device support time zone and daylight saving?	Y

Tm8	Which attributes of the SNTP response packet are validated?	Y Leap indicator not equal to 3? Y Mode is equal to SERVER Y Originate Timestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4
Tm9	SNTP Time synchronization behavior	<p><u>Startup:</u>                  IED will read the absolute time and will set its internal clock accordingly.</p> <p><u>Looking for an SNTP server:</u>                  During this phase no time data are produced.</p> <p><u>Synchronized to an SNTP server:</u>                  The accurate SNTP algorithm is acquiring the data needed to reach full accuracy.</p> <p><u>The SNTP server in use is lost:</u>                  Meaning one of the following:                  - It stops responding.                  - It sends a “kiss’o’death” message.                  – It is not synchronized.</p> <p><u>SNTP disabled by Configuration</u>                  (i.e. IRIG-B on the Main Unit is used)</p>

**Table 8 PIXIT for Time and Time Synchronization Model**

### 13 PIXIT for File Transfer Model

ID	Description	Value / Clarification
Ft1	What is structure of files and directories?	Configuration Files are stored in the root directory. The Disturbance Recorder files are stored in COMTRADE directory.
Ft2	Is the IETF FTP protocol also implemented?	Y

Ft3	Directory names are separated from the file name by	"\"
Ft4	The maximum file name size including path (recommended 64 chars)	256 characters.
Ft5	Are directory/file name case sensitive	N
Ft6	Is the wild char supported in MMS fileDirectory request?	Yes, wild card = *
Ft7	Directory listing	When client requests a directory contents the request must be following format; "\COMTRADE\"". Response listing has only file and subdirectories not whole paths.
Ft8	Maximum file size	Maximum file size is not defined. Free space varies and size depends on configuration.
Ft9	Is it allowed that 2 clients get the same file at the same time?	Y

**Table 9 PIXIT for File Transfer Model**

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