SuperTAPP SG

Voltage Control & Monitoring Relay

User Documentation

Part 3 SCADA Communication Guide

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About this manual

The information contained in this document is subject to change without notice.

This document is one part (highlighted in bold below) of the complete user documentation set, which comprises three parts in total:

- Part 1 Installation, Operation and Maintenance Guide
- Part 2 Technical Reference
- **Part 3 SCADA Communication Guide**

This part of the user documentation, relating to SCADA communications, is written for the SCADA communications professional. It is largely technical in nature focussing on the communications function and how it interrelates with other SuperTAPP SG functionality. It does not provide any description of the AVC function, or any description of the meaning of the indications or commands; for this, and for a more general introduction into the SCADA communications function, reference should be made to the Technical Reference (Part 2).

Manufacturer and Publisher

SuperTAPP SG is manufactured by, and this manual is published by:

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Document Reference FP1034-U-12 v3.3

Scope

This document is applicable to all SuperTAPP SG relay types.

Version Information

Document Issue

Issue	Issue Date	Description of Main Changes	Applicable relay version
1.0	May 2018	First issue	h/w 04, 05 s/w v7.4
2.0	July 2019	IEC 61850 and IEC 60870-5-103 profiles added, Firmware upgrade procedure added and data points list is updated.	h/w 04, 05 s/w v8.2 mapping 3.6 comms image 23
2.1	Nov 2019	Milliamp inputs/outputs are added and other minor fixes are made in the DNP3 and 61850 data points list	h/w 04, 05 s/w v8.3.1 mapping 3.6 comms image 24
2.2	Nov 2020	Appendix A Analogue inputs and outputs ▲ Corrected data point names ▲ Adjusted inconsistent scalings from 1,0 to n/a	h/w 04, 05 s/w v8.3.1-8.4 mapping 3.6 comms image 24
3.0	Jan 2021	Milliamp inputs/outputs and PT100 inputs increased as 2 mA cards and 2 RTD cards can be supported. Addition of thermal management data points in DNP3 and 61850	h/w 04, 05 s/w v9.0 mapping 3.8 comms image 26
3.1	Feb 2021	Addition of thermal management and Network services data points in IEC60870-5-103	h/w 04, 05 s/w v9.1 mapping 3.9 comms image 27
3.2	Nov 2021	Addition of software update instructions Locations Added	h/w 04,05 s/w v9.3 mappping 3.9 comms image 28
3.3	May 2022	Changes to reflect new ICD file for conformance Remove statuses for 103 prepare for switch in Updated locations	h/w 04,05 s/w v9.4 mappping 4.0 comms image 29

Hardware Version

Version	Release Date	Description of Main Changes
00	April 2016	First release

01	September 2016	Module type P Tap position input connections changed Module type S Orientation of Ethernet ports changed Serial communication terminating resistor moved
02	January 2017	Module type D Frequency measurement response time reduced
03	May 2017	Module type G Ability to reject AC signals added (selectable in software)
04	June 2017	Case height marginally reduced to meet 4u cutout standard SFP removal warning added
05	June 2018	Real time clock lithium backup battery replaced with capacitor Module type A Voltage range of tapchanger interface extended

Note. The hardware version of the relay may be determined from the label in the bottom left-hand corner of the front panel. The relay type is printed in the form 'FP1034-XXXXXXXXXX-X**HH**', and the digits in the position 'HH' represent the hardware version.

Software Version

Version	Release Date	Description of Main Changes
v4.0	April 2016	First release
v5.0	December 2016	New features added: ▲ General voltage offset group B ▲ Load response ▲ Frequency response ▲ Tap stagger ▲ Frequency tripping
v6.0	March 2017	Some features (load response, frequency response, frequency tripping) moved to correct feature level (Ultimate)
v6.1	May 2017	New features added: ▲ 3-phase and 2-wattmeter power measurements ▲ Tap change impact calculations
v6.6	September 2017	New features added: ▲ Input/output timers ▲ CT Trim added Adjustments to behaviour of some features in non-availability or activation fail conditions (load response, frequency response, tap stagger, frequency tripping)
v6.7	October 2017	Fixes to the following issues: ▲ handling of transfer taps in step-by-step mode ▲ handling of Auto command from SCADA ▲ possibility of relay reboot when current is zero.
v6.8	November 2017	New features added: ▲ Configurable deadbands for reporting of analogues over SCADA communications Fixes to the following issues: ▲ Internal driver error which causes loss of event and command handling

Version	Release Date	Description of Main Changes
v7.3	February 2018	New features added: ▲ Addition of master-follower functionality ▲ Ability to upgrade SCADA communications software via Ethernet
v7.4	April 2018	Fixes to the following issues: ▲ A driver error which can cause lock up of the SD card which records measurement and event data, and also prevent comms event reporting
v 7.5	June 2018	New features added: ▲ "Automatic" option for inter-tap time delay setting ▲ Adjustable bandwidth hysteresis Fixes to the following issues: ▲ Possible incorrect tap position displayed during tap changer lockout
v 7.7	October 2018	New features added: ▲ Alarms information screen
v8.1	April 2019	New features added: ▲ Automatic busbar topology detection ▲ Measurement and control of voltages on either side of the transformer ▲ Pseudo-VT ▲ Real time clock monitoring ▲ Block SCADA control input ▲ Reset lockout by SCADA command
v8.2	July 2019	New features added: Support for IEC 60870-5-103 SCADA communications
v8.3.1	September 2019	New features added: ▲ Nominal transformer voltage settings default to be the same as nominal system voltages ▲ Inter tap time delay and tap pulse time settings now default to ‘automatic’ Fixes for the following issues: ▲ Feeder measurements were assigned to the wrong bus section when busbar grouping was controlled by CB statuses or was automatic
v9.0	September 2020	New features added: ▲ Thermal Management feature ▲ New RTD card support
v9.1	September 2020	New features added: ▲ Thermal management functions are available at advanced function level ▲ Hide Thermal management configuration options when Thermal functionality is not available
v9.2	June 2021	New features added: ▲ Tap position customisation
V9.3	November 2021	New feature added: ▲ Network circulating current factor setting can be set to “disabled”. Fixes for the following issues: ▲ Issue accessing settings over USB on v9.2 Basic relays.
V9.4	March 2022	Updates to IEC 61850 implementation

Note. The software version of the relay may be determined from within the menu structure in 'Instruments/Diagnostics/Relay Information (7/xx)'. The software version is the displayed on the first line of the display.

Table of Contents

Sections 1 to 12 can be found in part 1 of the user documentation, and sections 13 to 19 in part 2 of the user documentation.

Conventions and Definitions

Text Conventions

Important information in the text may be in the form of either Warnings or Notes:

WARNING

A Warning contains information about situations that could result in personal injury to yourself or other persons, or risk damaging the relay or associated equipment.

NOTE. A note gives significant additional information about the use of the product.

Glossary

Abbreviations

AVC	Automatic Voltage Control
IED	Intelligent Electronic Device – a device that monitors components of electrical power supplies and issues control commands based on the data received
PRP	Parallel Redundancy Protocol
RTU	Remote Terminal Unit – a communication end point remote from the control centre which interfaces communication signals to plant activity
SCADA	Supervisory Control and Data Acquisition
SFP	Small Form-factor Pluggable – refers to a communication transceiver standard for pluggable Ethernet communications modules

20 Introduction to SCADA Communication

SCADA communication in SuperTAPP SG allows all remote operator monitoring, and supervisory control activities to be applied to the relay through digital communications, rather than hardwiring as has historically been used. This has the benefit of significantly reducing panel wiring and associated equipment.

SCADA communication provides facilities to:

- Provide input to the SCADA system for indication of events such as tap change operations, alarms, setting changes;
- Provide input to the SCADA system of status such as relevant circuit breaker positions, operation modes (auto/manual etc.);
- Receive commands from the SCADA system such as manual tap, mode change;
- Provide input to the SCADA system of any of the measured voltages or currents, and many internally calculated values such as frequency, MW, MVAr, MVA;
- Provide input to the SCADA system of internal counters such as no. of taps;
- Provide input to the SCADA system of currently applied setpoint values
- Receive instruction from the SCADA system to change the active settings group; and
- Receive instruction from the SCADA system to change current setpoint values.

SuperTAPP SG can employ the following commonly used substation communication protocols:

- IEC 60870-5-103 (serial)
- DNP3 (serial or Ethernet)
- IEC 61850 (Ethernet)

SuperTAPP SG takes the role of RTU in communication models, and slave (for serial communications) or data server (for Ethernet communications).

20.1 Ordering Options and Product Codes

SCADA communication in SuperTAPP SG is an optional feature. Its presence or otherwise can be determined from the product code as described in Table 3-1, which decodes the subset of features relevant to SCADA communication.

The relevant characters are:

Option position 10

- R – indicates that the communication module carries out inter-relay communication only and **does not have SCADA communication hardware present**;
- S – indicates that the communication module includes SCADA communication hardware – this is required for SCADA communication to be present on the relay;

Option position 11

- 0 – indicates no protocols are present
- L – indicates that IEC 60870-5-103, DNP3 and IEC 61850 protocols are loaded onto the SCADA communication hardware

Option position 15

- The character in this position indicates the type and number of Ethernet connectors present. If serial communications are being used no Ethernet connectors are needed.

Option positions 16 and 17

- The product code does not always have characters present in these positions. Characters in these positions indicate a customer-specific or special configuration is fitted, which can include a non-standard communication profile. If there are no characters in this position, or if the characters are '00' then the standard communication profiles are fitted.

The product code as displayed is how the relay is ordered, and is what appears on delivery notes, invoices and product packaging. However, on the relay fascia only the options which require manufacturer fitting are displayed, that is the characters up to and including option position 13.

Table 3-1 Extract of SuperTAPP SG product code relevant to SCADA communications

	1	2	3	4	5	6	7	8	9	10		11	12 13		14	15		16 17
Product Code	FP1034	-							P	D		-		v v	-		-	c c
SCADA Communication																		
None										R		0						
IEC 61850, IEC 60870, DNP3										S		L						
Ethernet																		
None																0		
100base-T RJ45																A		
100base-SX (850nm MM) LC																B		
100base-T RJ45 x2																C		
100base-SX (850nm MM) LC x2																D		
100base-FX (1300nm MM) LC																E		
100base-FX (1300nm MM) LC x2																F		
100base-LX (1300nm SM) LC																G		
100base-LX (1300nm SM) LC x2																H		
Special Configuration																		
None																		
None																		00
Customer 1 special profile																		01
Customer 2 special profile																		02
etc																		

Note. ‘v v’ in the product code is a 2-digit number indicating the hardware version. This issue of the manual is applicable to the hardware versions indicated in the Version Information.

21 SCADA Communication Module Description

21.1 Hardware Features

SCADA communications in SuperTAPP SG is provided on a dedicated processor running an embedded Linux distribution.

Two data link/physical layer options are available:

- Serial RS485 over twisted-pair is available on all relays that are equipped with SCADA communications. The interface includes a terminating resistor for the end of the chain which may be wired in if required.
- TCP-IP over wired or fibre-optic Ethernet is provided through the use of Small Form-factor Pluggable (SFP) modules. SuperTAPP SG may be fitted with two of these modules to provide redundancy.

21.2 Connections to the Communication Module

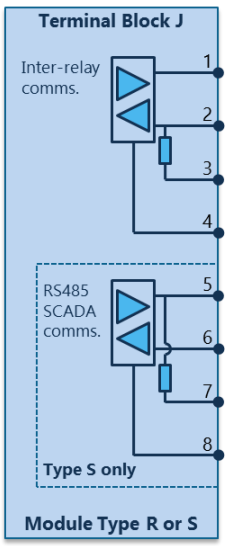
Serial communications

Serial communications is to RS485 and a shielded twisted-pair cable should be employed with characteristic impedance of 120Ω. This can be a multi-drop arrangement, however as is normal for RS485 the ends of the cable should be terminated with a resistor.

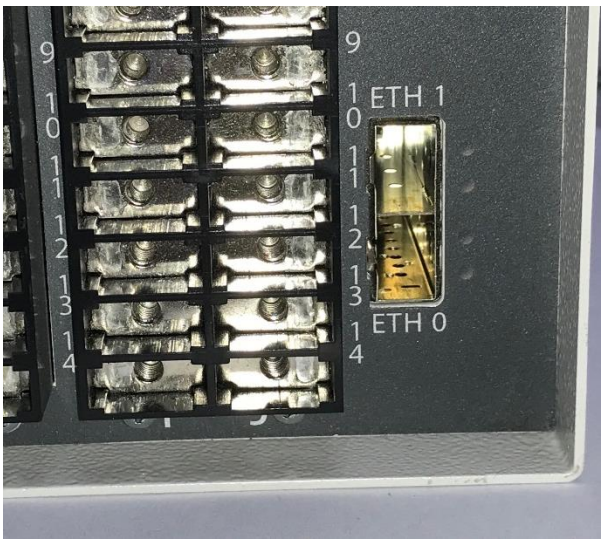
Terminals J5 and J6 are used for the twisted pair connection, with the screen connected to terminal J8 and earthed at one point only along its length. If the SuperTAPP SG is the last station on the cable a 120Ω terminating resistor can be included by connecting terminal J6 to J7. See Figure 3-1(a).

Figure 3-1 Connections to Communication Module

(a) Serial connections



(b) Ethernet connections



Ethernet communications

SFPs should be inserted appropriate to the media being used, as detailed in Table 3-1, and shown in Figure 3-1(b).

Ethernet 0 (ETH 0) is the main port for SCADA communications. Ethernet 1 (ETH 1) is used for communications firmware updates and manufacturer access, and for redundancy using PRP.

21.3 Communication Module Configuration

The settings associated with SCADA Communications are listed in Table 3-2. Unlike other settings in the relay the communication settings are not immediately applied on a setting change, since this requires an internal restart of the communications module. Rather the last item in the communication settings list is an 'APPLY' option and when this is selected the communications module is restarted and the settings are applied.

This section describes the various settings, and their purpose. For an explanation on how to navigate the menu system of SuperTAPP SG and apply the settings refer to Part 1 of the User Documentation.

IED name

A name, up to 20 characters in length, can be defined to identify the IED. Valid characters are "AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQqRrSsTtUuVvWwXxYyZz_-0123456789".

A space can also be entered and the first space occurrence signifies the end of the IED name string. This character and all subsequent characters are not included in the IED name.

Enabled protocol

Only one protocol can be active at any time. Available protocols are: IEC 61850, IEC 60870-5-103 and DNP3.

Station address, Destination address

The Station address setting is relevant for DNP3 and IEC 60870-5-103 protocols only. For DNP3 it is the address of the station which is communicating with the IED (e.g. the SCADA headend, or substation data concentrator) and for IEC 60870-5-103 it defines the link address or address of the IED (i.e. the SuperTAPP SG).

The Destination address which is only applicable to DNP3 defines the address of the Master station which is communicating with the IED.

Allow unsolicited messages

This setting is relevant for DNP3 protocol only. Some old RTUs which use serial as communicating medium do not support unsolicited messages so this setting enables/disables unsolicited reporting functionality of the IED.

Comms medium

Select as appropriate. Other settings are enabled/disabled dependent on whether serial or Ethernet is chosen.

Baud rate, Parity

These settings are only relevant for serial communications and should match the settings at the data concentrator.

PRP

PRP is a redundancy protocol only relevant to Ethernet communications. It makes use of two Ethernet ports so if it is to be used two SFPs are required.

Ethernet 0 IP address, Ethernet 0 netmask, Ethernet 0 gateway

These settings are only relevant for Ethernet communications, and are the standard IP settings required for any Ethernet device.

Ethernet 1 IP address, Ethernet 1 netmask

These settings are only relevant for Ethernet communications when PRP is not selected.

When PRP is used port 1 automatically takes on the IP settings of port 0 if port 0 communications are dropped, and therefore the settings are not used.

Port 1 is used for upgrading the communications firmware and manufacturer access (local only) and these settings are the standard IP settings required for any Ethernet device, which enable this port to be used.

Note. For security reasons, port 0 and 1 cannot be on the same subnet. So user will have to make sure that both ports are on different subnets otherwise relay will not communicate to any device on the network.

Time source, SNTP IP address, Sync interval

These settings are only relevant for Ethernet communication. If serial communications are used the time source is fixed at using the protocol master station.

For Ethernet protocols the time source for the relay can be selected between the protocol master and an SNTP server. At the time of writing PTP is not available as a time source for SuperTAPP SG although this is a planned feature.

If SNTP is selected as the source the IP address of the source must be specified.

The Sync interval specifies how frequently the IED will poll the time source for an update. This can be set to disabled, in which case it relies on having the time pushed to it by the source.

Voltage dead band, Current dead band, Power dead band, Frequency dead band

These settings specify a dead band window for each type of measurement. The measured value will only be updated to the communication protocol when it varies from the last update by more than the dead band value.

Table 3-2 Communications menu

This setting menu will not always be visible, depending on relay configuration

Setting	Range	Default
IED name	Standard set of ASCII values	SuperTAPP
Enabled protocol	DNP3 *, IEC 80870-5-103 *, IEC 61850	DNP3
Station address *	For DNP3 (0 – 65519), For IEC 80870-5-103 (1-254)	0
Destination address *	0 - 65519	1
Allow unsolicited msgs *	No,Yes	No
Comms medium *	Serial †, Ethernet ‡	Ethernet
Baud rate †	2400, 4800, 9600, 19200, 38400, 57600, 115200	9600
Parity †	None, Even, Odd	None
PRP ‡	Disabled ⌂, Enabled	Disabled
Ethernet 0 IP address ‡	0.0.0.0 – 255.255.255.255	192.168.1.228
Ethernet 0 netmask ‡	0.0.0.0 – 255.255.255.255	255.255.255.0
Ethernet 0 gateway ‡	0.0.0.0 – 255.255.255.255	192.168.1.1
Ethernet 1 IP address ‡ ⌂	0.0.0.0 – 255.255.255.255	192.168.2.229
Ethernet 1 netmask ‡ ⌂	0.0.0.0 – 255.255.255.255	255.255.255.0
Time source ‡	Master, SNTP	SNTP
SNTP IP address ‡	0.0.0.0 – 255.255.255.255	129.67.1.160
Sync interval ‡	0 – 10000 s	260 s
Voltage dead band	0.1 – 2.0 %	0.5 %
Current dead band	0.2 – 5.0 %	1.0 %
Power dead band	0.2 – 5.0 %	1.0 %
Frequency dead band	3 – 100 mHz	10 mHz

**, †, ‡, ⌂ setting identified by the symbol is only visible if the setting value identified by the same symbol is selected*

Note. The settings in this table are not applied until 'APPLY' is selected from the bottom of the settings menu. At this point the settings will be applied and the communications card restarted.

21.4 Monitoring Health of Communication Functions

SuperTAPP SG has two specific functions to ensure and confirm to the operator that the communication function is healthy.

A dedicated watchdog is provided which ensures that the communications functions are fully operable. If the watchdog fails to indicate to the main processor of SuperTAPP SG that the communication function is healthy, then the relay will be reset. The watchdog function can be disabled if the user prefers (Table 3-3).

A "dummy CB" is also provided which takes no physical action but allows a control desk operator to confirm a complete communication path from the control desk to the SuperTAPP SG, through the main

application function, and back again. The dummy CB data point is indicated in the communication profiles.

21.5 Upgrading the Communication Module Software

The ability to upgrade this software (also referred as comms image) requires that the relay be running at least v7.4 main software and v16 or later comms module software. If unsure, Fundamentals Ltd should be consulted to determine if a relay has been configured to accept Communications module updates in the field. If the user attempts this procedure on a relay that does not support it then there will be no harm or affect to the relay other than a brief interruption to communications while the procedure is attempted. Fundamentals Ltd maintain a database containing software versions installed on each relay in the field and will be able to advise customers on what actions customers will need to take in upgrading their installed relay base.

Upgrade files are placed in a TFTP server which relay can access using Ethernet Ports on the back. User can setup a TFTP server on their laptop/PC and carry out update following instruction in section 21.5.1. However, TFTP server needs access through the PC/laptop firewall which may not be possible for some users due to various security reasons. Therefore, an alternate method is provided which uses special Communication Subsystem Programming Modules supplied by Fundamentals as shown in section 21.5.2.

For both methods, the relay will need to be placed into “This Panel” and “Manual”. It also needs to be powered, throughout the whole process, via the Auxiliary and Control Supply.

21.5.1 Updating image using PC/laptop

21.5.1.1 Preparation

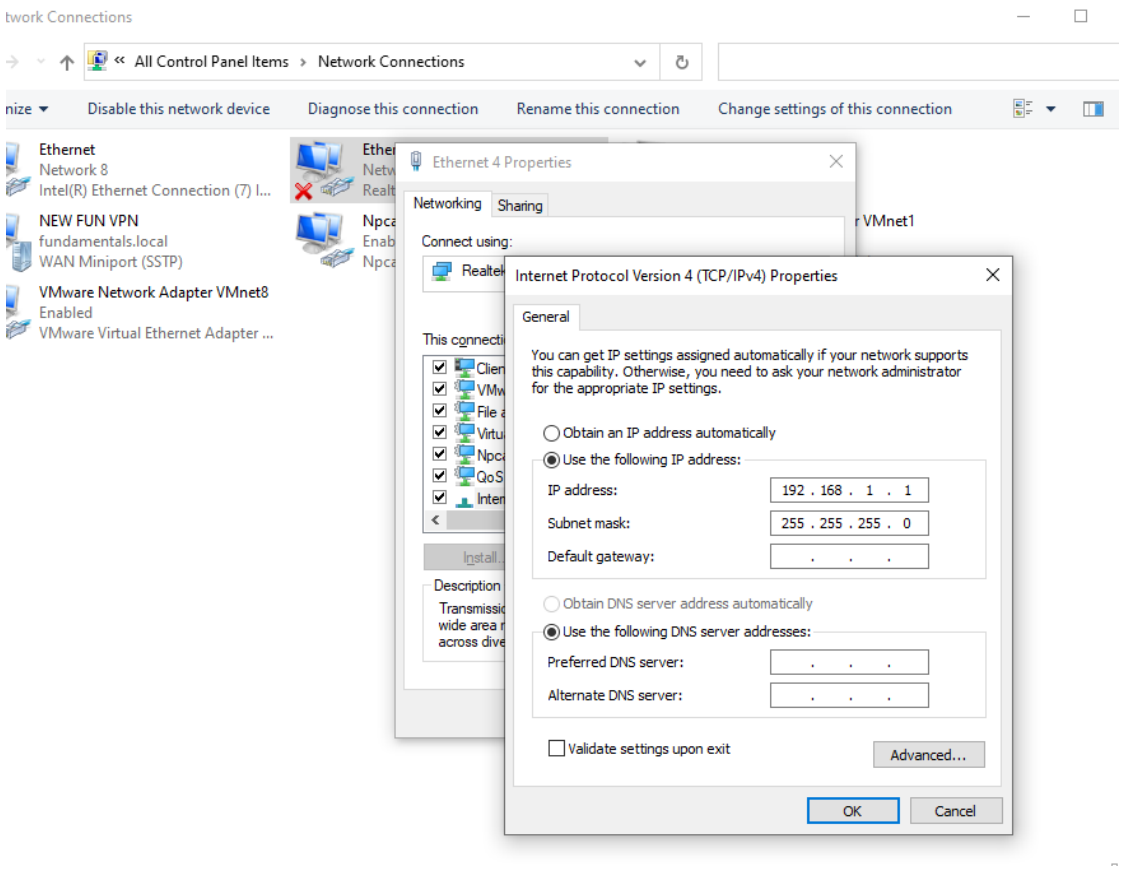
The user needs following Equipment: -

- PC/laptop running TFTP server
- Image/software update files
- SuperTAPP SG relay running, at least V7.4 main software.
- At least a Category 5 Ethernet patch lead.
- Copper Ethernet SFP (sourced from Fundamentals Ltd if relay is not using Ethernet communications).
- Fundamentals PC Settings management software running on a Windows laptop (V2.7.0.0 or later recommended). This is to save the settings from the SuperTAPP SG relay prior to the image update and restore the saved settings post image update.
- USB lead to connect laptop to relay.

Setting up TFTP server on PC/laptop

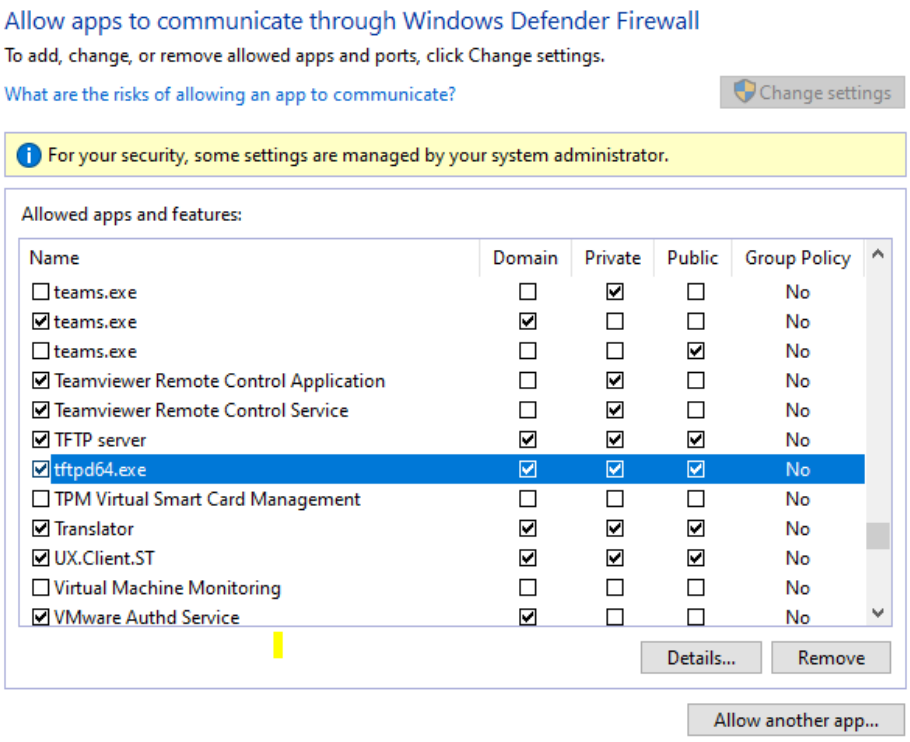
- First of all, set the IP address, for the Ethernet interface which connects to the relay, to **192.168.1.1** as shown in the figure below.

Figure 3.2 Configuring IP address on a windows laptop



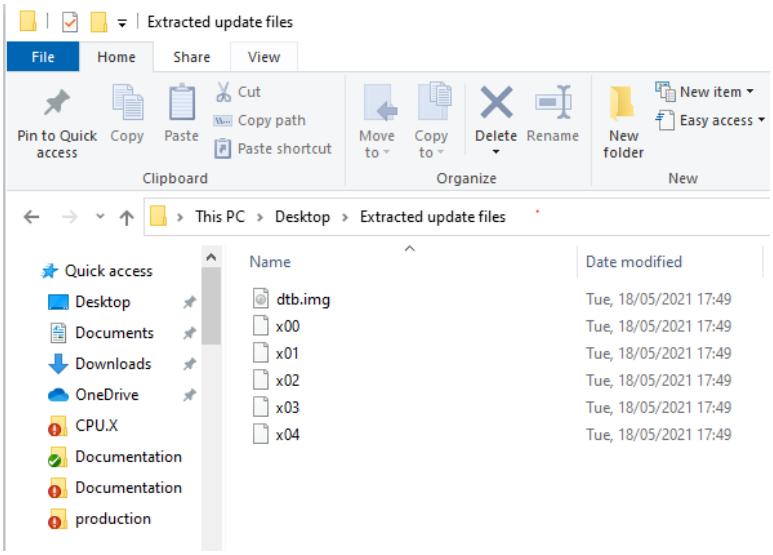
- Install your favourite TFTP server application. Fundamentals Ltd recommends ‘TFTPd by Ph. Jounin’ which can be downloaded from https://tftpd64.software.informer.com/4.6/.
- Allow the TFTP server app access through the computers firewall if required.

Figure 3.3 Allowing TFTP server access through the firewall



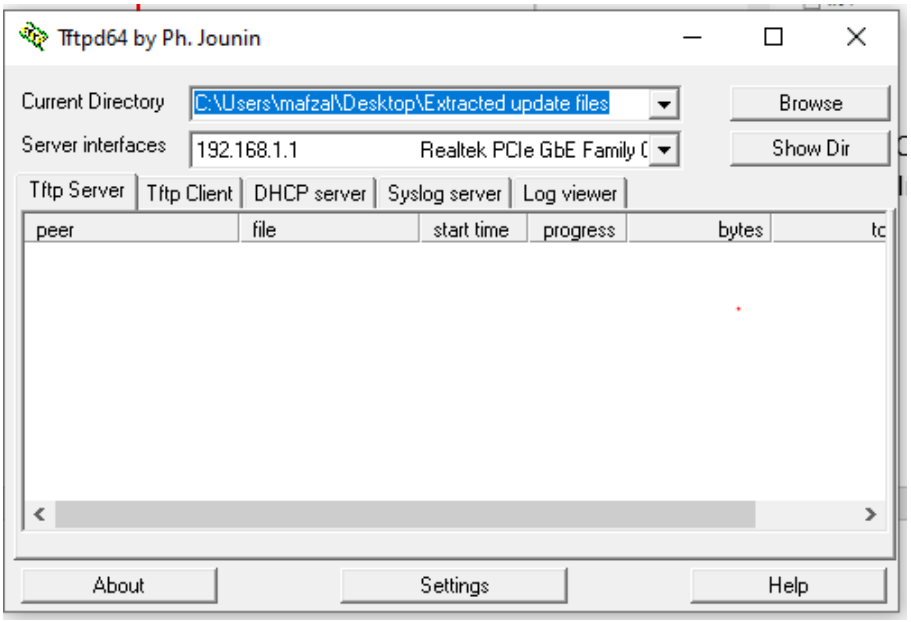
- The new image/software is usually supplied as compressed/zipped files by Fundamentals. Extract these files anywhere on your PC/laptop and verify that extracted directory contains following items.

Figure 3.4 Extracted update files



- Start the TFTP server app and set the 'Current Directory' to location where the extracted update files(0x00, 0x01 etc) are stored and set 'Server Interfaces' to 192.168.1.1.

Figure 3.4 Setting TFTP root directory



21.5.1.2 Update Procedure

- Place the relay in “This Panel” and “Manual”. This will suspend voltage control, and the response to commands over communications and from other connected relays.
- Use PC Settings management software to take a copy of setting from the relay to be upgraded.
- Hot unplug the Ethernet plugs from the rear of the SuperTAPP SG being upgraded.
- Connect the Ethernet patch lead between the Ethernet socket on PC/laptop and the ETH0 SFP port (bottom) on the rear of the SuperTAPP SG.
- Start software upgrade by selecting Settings→Relay configuration→ Upgrade communications software from the relay menu.
- Select “Yes” and note that, within a few seconds, the TFTPs server application starts showing update progress. This process takes around twenty minutes. The Auxiliary and Control supplies to the relay should be maintained throughout.
- Relay will restart on completion of update. Verify that the comms image version number in ‘Instruments->Measurements->Fitted Hardware’ screen is updated.
- Use the PC setting management tool to re-apply the previously recorded settings to the relay. This is important because the update process restores the communications settings to their default states.
- Reconnect the substation Ethernet connects to the correct ports on the back of the relay.
- Re-enable voltage control and communications by pressing “Auto” and “Remote” buttons on relay.

21.5.2 Updating image using Communication Subsystem Programming Module

21.5.2.1 Preparation

The user needs the following Equipment, supplied by Fundamentals Ltd: -

Note. The USB Flash drive containing Communication software is not required for some new SuperTAPP SG Communications Subsystem Programming Module so all the actions related to the USB Flash drive in the following sections are not applicable for such module.

- SuperTAPP SG Communications Subsystem Programming Module.
- PSU module for programming module (requires 230V 13A mains socket).
- USB Flash Drive containing Communications Subsystem Software.
- SuperTAPP SG relay running, at least V7.4 main software.
- At least a Category 5 Ethernet patch lead.
- Copper Ethernet SFP (sourced from Fundamentals Ltd if relay is not using Ethernet communications).
- Fundamentals PC Settings management software running on a Windows laptop (V2.7.0.0 or later recommended). This is to save the settings from the SuperTAPP SG relay prior to the image update and restore the saved settings post image update.
- USB lead to connect laptop to relay.

This procedure will need to be followed in conjunction with the user's standard operating procedures for making changes of this type.

21.5.3 Procedure

- Place the relay in "This Panel" and "Manual". This will suspend voltage control, and the response to commands over communications and from other connected relays.
- Use PC Settings management software to take a copy of setting from the relay to be upgraded.
- Hot unplug the Ethernet plugs from the rear of the SuperTAPP SG being upgraded.
- Ensure that the USB Flash drive is connected to the programming module.
- Connect the Ethernet patch lead between the programming module and the ETH0 SFP port (bottom) on the rear of the SuperTAPP SG.
- Connect live power to the Micro USB socket on the programming module.
- Wait for the Green LED to continuously illuminate. Failure of this happening within 2 minutes could be due to a connection problem or that the relay does not support the filed update mechanism. Check your connections and contact Fundamentals Ltd for assistance.
- On receiving the Green LED, Instruct the relay to begin the upgrade procedure by using the rotary control knob to perform the following (Table 3-3): -
    - Settings→Relay configuration→ Upgrade communications firmware
- Select "Yes" and note that, within a few seconds, the Red LED will illuminate to indicate that the procedure has commenced. This process takes around twenty minutes. The Auxiliary and Control supplies to the relay should be maintained throughout as should the supply to the programming module. Failure to display a Red LED may indicate that the relay does not support the upgrade process and Fundamentals Ltd should be consulted. Interruption of this procedure will render the communication subsystem inoperative until the procedure is repeated and allowed to complete.

- The Red LED will flash to indicate that the update procedure has completed.
- Disconnect power from the programming module and unplug Ethernet patch lead from the back of the relay.
- Use the PC setting management tool to re-apply the previously recorded settings to the relay. This is important because the update process restores the communications settings to their default states.
- Reconnect the substation Ethernet connects to the correct ports on the back of the relay.
- Re-enable voltage control and communications by pressing “Auto” and “Remote” buttons on relay.

Table 3-3 Relay configuration menu (subset)

Setting	Range	Default	Section
Communications watchdog	Enabled, Disabled	Enabled	
Upgrade communications firmware	No, Yes	No	

21.6 Communication Protocol Definitions and Configuration

The following appendices provide the full definitions of the communication protocol implementations available for SuperTAPP SG. The DNP3 protocol definition is also available as an XML file.

- Appendix A – A full list of all communication data points provided within SuperTAPP SG, and their associated mappings to the DNP3 and IEC 61850 protocols.
- Appendix B – List of data points mapped on the IEC 60870-5-103
- Appendix C – DNP3 device profile definition
- Appendix D – IEC 60870-5-103 interoperability profile

Fundamentals also provides eNode Designer tool which can be used to create/modify data mappings to all the protocols. IED configurator is another tool which can be used to create/modify IEC 61850 configurations. For more information about eNode and IED Configurator please contact Fundamentals.

Appendix A: Standard Data Point List and its mapping on to DNP3 and IEC 61850

The following pages contains data point list which is available for mapping on to all supported protocols. It also shows factory default mapping of all the available points on to the DNP3 and IEC 61850 protocols. This is the data point list applied in the factory to all relays with the latest software version, as specified in the version information for this document, and for which a special configuration has not been used. If a special configuration is assigned to the relay then this list may not be valid.

The list contains common information for the data points, and for each supported protocol the minimum information required to configure a master station for SuperTAPP SG. Reference also needs to be made to the relevant appendix containing the device profile for the protocol being used.

An explanation of the individual data points and what they represent is provided in Part 2 of the documentation (Technical Reference).

A.1 Binary and double point inputs and outputs/commands

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Auto/Manual	Manual / Auto	Manual / Auto	1	1,2	0	1	10,12	0	/ATCC1/Auto.stVal	/ATCC1/Auto.Oper.CtlVal
SCADA/This Panel	Local / SCADA		1	1,2	1				/ATCC1/Loc.stVal /AVCO1/Loc.stVAl	
Parallel operation	Independent operation / Parallel operation		1	1,2	2				/ATCC1/ParOp.stVal	
Tap raise	Idle / Tap raise initiated	Idle / Raise	1	1,2	3	1	10,12	3		/ATCC1/TapRaise.Oper.CtlVal
Tap lower	Idle / Tap lower initiated	Idle / Lower	1	1,2	4	1	10,12	4		/ATCC1/TapLower.Oper.CtlVal
Voltage offset A1	Inactive / Active	Deactivate / Activate	1	1,2	5	1	10,12	5	/AVCO1/VOfsA1.stVal	/AVCO1/VOfsA1.Oper.ctlVal
Voltage offset A2	Inactive / Active	Deactivate / Activate	1	1,2	6	1	10,12	6	/AVCO1/VOfsA2.stVal	/AVCO1/VOfsA2.Oper.ctlVal
Voltage offset A3	Inactive / Active	Deactivate / Activate	1	1,2	7	1	10,12	7	/AVCO1/VOfsA3.stVal	/AVCO1/VOfsA3.Oper.ctlVal

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Voltage offset A4	Inactive / Active	Deactivate / Activate	1	1,2	8	1	10,12	8	/AVCO1/VOfsA4.stVal	/AVCO1/VOfsA4.Oper.ctlVal
Voltage offset B1	Inactive / Active	Deactivate / Activate	1	1,2	9	1	10,12	9	/AVCO1/VOfsB1.stVal	/AVCO1/VOfsB1.Oper.ctlVal
Voltage offset B2	Inactive / Active	Deactivate / Activate	1	1,2	10	1	10,12	10	/AVCO1/VOfsB2.stVal	/AVCO1/VOfsB2.Oper.ctlVal
Voltage offset B3	Inactive / Active	Deactivate / Activate	1	1,2	11	1	10,12	11	/AVCO1/VOfsB3.stVal	/AVCO1/VOfsB3.Oper.ctlVal
Voltage offset B4	Inactive / Active	Deactivate / Activate	1	1,2	12	1	10,12	12	/AVCO1/VOfsB4.stVal	/AVCO1/VOfsB4.Oper.ctlVal
Voltage offsets B unavailable	Idle / Activation inhibited		1	1,2	13				/AVCO1/VOfsBUnAvl.stVal	
Voltage target increment/decrement		Incrment/Decrement				1	10,12	14	/AVCO1/TapChg.valWTr.posVal	/AVCO1/TapChg.Oper.ctlVal
Voltage target increment		Idle / Increment				1	10,12	15		/AVCO1/VIncr.Oper.CtlVal
Voltage target decrement		Idle / Decrement				1	10,12	16		/AVCO1/VDecr.Oper.CtlVal
Voltage inc/dec reset		Idle / Reset				1	10,12	17		/AVCO1/IncrDecrRst.Oper.CtlVal
Winding 1 prepare for switchout	Inactive / Active	Deactivate / Activate	1	1,2	18	1	10,12	18	/ATCC1/Wdg1PreSwOut.stVal	/ATCC1/Wdg1PreSwOut.Oper.CtlVal
Winding 2 prepare for switchout	Inactive / Active	Deactivate / Activate	1	1,2	19	1	10,12	19	/ATCC1/Wdg2PreSwOut.stVal	/ATCC1/Wdg2PreSwOut.Oper.CtlVal
Selected as master	Idle / Master	Idle/Activate	1	1,2	23	1	10,12	23	/ATCC1/Master.stVal	/ATCC1/Master.Oper.ctlVal
Tap raise/lower		Raise / Lower				1	10,12	24		/ATCC1/TapChg.Oper.ctlVal
Settings group 1	Inactive / Active	Idle / Activate	1	1,2	25	1	10,12	25	/ATCC1/ActiveSG1.stVal	/ATCC1/ActiveSG1.Oper.ctlVal
Settings group 2	Inactive / Active	Idle / Activate	1	1,2	26	1	10,12	26	/ATCC1/ActiveSG2.stVal	/ATCC1/ActiveSG2.Oper.ctlVal
Settings group 3	Inactive / Active	Idle / Activate	1	1,2	27	1	10,12	27	/ATCC1/ActiveSG3.stVal	/ATCC1/ActiveSG3.Oper.ctlVal

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Settings group 4	Inactive / Active	Idle / Activate	1	1,2	28	1	10,12	28	/ATCC1/ActiveSG4.stVal	/ATCC1/ActiveSG4.Oper.ctlVal
Settings group 5	Inactive / Active	Idle / Activate	1	1,2	29	1	10,12	29	/ATCC1/ActiveSG5.stVal	/ATCC1/ActiveSG5.Oper.ctlVal
Settings group 6	Inactive / Active	Idle / Activate	1	1,2	30	1	10,12	30	/ATCC1/ActiveSG6.stVal	/ATCC1/ActiveSG6.Oper.ctlVal
Settings group 7	Inactive / Active	Idle / Activate	1	1,2	31	1	10,12	31	/ATCC1/ActiveSG7.stVal	/ATCC1/ActiveSG7.Oper.ctlVal
Settings group 8	Inactive / Active	Idle / Activate	1	1,2	32	1	10,12	32	/ATCC1/ActiveSG8.stVal	/ATCC1/ActiveSG8.Oper.ctlVal
Digital output 1	Inactive / Active		1	1,2	33					
Digital output 2	Inactive / Active		1	1,2	34					
Digital output 3	Inactive / Active		1	1,2	35					
Digital output 4	Inactive / Active		1	1,2	36					
Digital output 5	Inactive / Active		1	1,2	37					
Digital output 6	Inactive / Active		1	1,2	38					
Digital output 7	Inactive / Active		1	1,2	39					
Digital output 8	Inactive / Active		1	1,2	40					
Digital output 9	Inactive / Active		1	1,2	41					
Digital output 10	Inactive / Active		1	1,2	42					
Digital output 11	Inactive / Active		1	1,2	43					

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Digital output 12	Inactive / Active		1	1,2	44					
Digital output 13	Inactive / Active		1	1,2	45					
Digital output 14	Inactive / Active		1	1,2	46					
Digital output 15	Inactive / Active		1	1,2	47					
Digital output 16	Inactive / Active		1	1,2	48					
Digital output 17	Inactive / Active		1	1,2	49					
Digital output 18	Inactive / Active		1	1,2	50					
Digital output 19	Inactive / Active		1	1,2	51					
Digital output 20	Inactive / Active		1	1,2	52					
Digital output 21	Inactive / Active		1	1,2	53					
Digital output 22	Inactive / Active		1	1,2	54					
Digital output 23	Inactive / Active		1	1,2	55					
Digital output 24	Inactive / Active		1	1,2	56					
Timer 1 output	Inactive / Active		1	1,2	81					
Timer 2 output	Inactive / Active		1	1,2	82					
Timer 3 output	Inactive / Active		1	1,2	83					

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
SCADA control blocked	Block/Unblock		1	1,2	87	1	10,12	87	ATCC1/RemCtlBlk.stVal	
Setting group inc/dec		Increment/Decrement				1	10,12	89		/ATCC1/ SetGrpIncDec.Oper.ctlVal
Dummy CB	Open / Closed	Open / Close	1	1,2	90					
TPI uncertain alarm	Idle / Active		1	1,2	91				/ATCC1/TapIndUncert.stVal	
Out of step alarm	Idle / Active		1	1,2	92				/ATCC1/Oostep.stVal	
Block tap lower	Idle / Active		1	1,2	93				/ATCC1/LTapBlk.stVal	
Block tap raise	Idle / Active		1	1,2	94				/ATCC1/RTapBlk.stVal	
Data logging alarm	Idle / Active		1	1,2	95					
Relay healthy	Relay unhealthy / Relay healthy		1	1,2	96					
Tap raise/lower block	Inactive / Active	Deactivate / Activate	1	1,2	97	1	10,12	97	/ATCC1/TapChgBlk.stVal	/ATCC1/TapChgBlk.Oper.ctlVal
Frequency trip enable	Disabled / Enabled	Disable / Enable	1	1,2	98	1	10,12	98	/AVCO1/HzTrEna.stVal	/AVCO1/ HzTrEna .Oper.ctlVal
Frequency trip active	Inactive / Active	Idle / Activate	1	1,2	99	1	10,12	99	/AVCO1/HzTrAct.stVal	/AVCO1/HzTrAct .Oper.ctlVal
Frequency trip unavailable	Idle / Unavailable		1	1,2	100				/AVCO1/HzTrUnAvail.stVal	
Frequency trip activation fail	Idle / Activation failed		1	1,2	101				/AVCO1/HzTrActFail.stVal	
Frequency trip activation inhibit	Idle / Activation inhibited		1	1,2	102				/AVCO1/HzTrActInh.stVal	
Frequency trip outside voltage limits	Idle / Outside voltage limits		1	1,2	103				/AVCO1/HzTrVOofLim.stVal	
Frequency offset F1 enable	Disabled / Enabled	Disable / Enable	1	1,2	104	1	10,12	104	/AVCO1/HzOfsEna.stVal	/AVCO1/HzOfsEna.Oper.ctlVal

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Frequency offset F1 active	Inactive / Active	Deactivate / Activate	1	1,2	108	1	10,12	108	/AVCO1/HzOfsAct.stVal	/AVCO1/HzOfsAct.Oper.ctlVal
Frequency offsets unavailable	Idle / Unavailable		1	1,2	112				/AVCO1/HzOfsUnAvail.stVal	
Frequency offsets activation fail	Idle / Activation failed		1	1,2	113				/AVCO1/HzOfsActFail.stVal	
Frequency offsets activation inhibit	Idle / Activation inhibited		1	1,2	114				/AVCO1/HzOfsActInh.stVal	
Frequency offsets outside voltage limits	Idle / Outside voltage limits		1	1,2	115				/AVCO1/HzOfsVOofLim.stVal	
Load offset L1 enable	Disabled / Enabled	Disable / Enable	1	1,2	116	1	10,12	116	/AVCO1/LodOfsEna.stVal	/AVCO1/LodOfsEna.Oper.ctlVal
Load offset L1 active		Deactivate / Activate				1	10,12	120		AVCO1/LodOfsAct.Oper.ctlVal
Load offsets unavailable	Idle / Unavailable		1	1,2	124				/AVCO1/LodOfsUnAvl.stVal	
Tap stagger S1 active	Inactive / Active	Deactivate / Activate	1	1,2	127	1	10,12	127	/AVCO1/TapStag1.stVal	/AVCO1/TapStag1.Oper.ctlVal
Tap stagger S2 active	Inactive / Active	Deactivate / Activate	1	1,2	128	1	10,12	128	/AVCO1/TapStag2.stVal	/AVCO1/TapStag2.Oper.ctlVal
Tap stagger S3 active	Inactive / Active	Deactivate / Activate	1	1,2	129	1	10,12	129	/AVCO1/TapStag3.stVal	/AVCO1/TapStag3.Oper.ctlVal
Tap stagger S4 active	Inactive / Active	Deactivate / Activate	1	1,2	130	1	10,12	130	/AVCO1/TapStag4.stVal	/AVCO1/TapStag4.Oper.ctlVal
Tap stagger unavailable	Idle / Unavailable		1	1,2	131				/AVCO1/TapStUnAvail.stVal	
Tap stagger activation fail	Idle / Activation failed		1	1,2	132				/AVCO1/TapStActFail.stVal	

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Tap stagger activation inhibited	Idle / Activation inhibited		1	1,2	133				/AVCO1/TapStActInh.stVal	
AVC enable	AVC disabled / AVC enabled		1	1,2	134				/ATCC1/LocKey.stVal	
Tap change in progress	Idle / Active		1	1,2	135				/ATCC1/TapChgInProg.stVal /ATCC1/ TapChg.valWTr.transInd	
Winding 1 ready for switch out	Idle / Active		1	1,2	136				/ATCC1/Wdg1SwOutRdy.stVal	
Winding 1 ready for switch in	Idle / Active		1	1,2	137				/ATCC1/Wdg1SwInRdy.stVal	
Winding 2 ready for switch out	Idle / Active		1	1,2	138				/ATCC1/Wdg2SwOutRdy.stVal	
Winding 2 ready for switch in	Idle / Active		1	1,2	139				/ATCC1/Wdg2SwInRdy.stVal	
Tap position indication failure	Idle / Active		1	1,2	151				/ATCC1/TapIndErr.stVal	
Maximum tap position reached	Idle / Active		1	1,2	152				/ATCC1/EndPosR.stVal	
Minimum tap position reached	Idle / Active		1	1,2	153				/ATCC1/EndPosL.stVal	
AVC alarm	Idle / Active		1	1,2	154				/ATCC1/AVCAlm.stVal	
T/C motor overloaded	Idle / Active		1	1,2	155				/ATCC1/MotDrvBlk.stVal	
Tap changer alarm	Idle / Active		1	1,2	156				/ATCC1/TapOpErr.stVal	
Tap changer lockout	Idle / Active	Idle/Clear	1	1,2	157	1	10,12	157	/ATCC1/TapChgLO.stVal	
VT fuse failure	Idle / Active		1	1,2	158				/ATCC1/VTFsFail.stVal	
End of tap range	Idle / Active		1	1,2	159				/ATCC1/EndOfTapRa.stVal	
Tap not achievable	Idle / Active			1,2	160				/ATCC1/TapNotAch.stVal	
CAN bus error	Idle / Active		1	1,2	161				/ATCC1/ErrPar.stVal	

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Transformer overload	Idle / Active		1	1,2	162				/ATCC1/TraOvLod.stVal	
Reverse current overload	Idle / Active		1	1,2	163				/ATCC1/RevIOvLod.stVal	
Voltage high	Idle / Voltage higher than limits		1	1,2	164				/AVCO1/HiVAlm.stVal	
Voltage low	Idle / Voltage lower than limits		1	1,2	165				/AVCO1/LoVAlm.stVal	
Loss of phase reference	Idle / Active		1	1,2	166				/ATCC1/PhRefLos.stVal	
Voltage out of band	Idle / Active		1	1,2	167				/ATCC1/VOutOfBand.stVal	
Tap changer runaway	Idle / Active		1	1,2	168				/ATCC1/TapChgRA.stVal	
Tap change incomplete	Idle / Active		1	1,2	169				/ATCC1/TapChgIncomp.stVal	
CB1	Open / Closed		1	1,2	170				/ATCC1/CB1Pos.stVal	
CB2	Open / Closed		1	1,2	171				/ATCC1/CB2Pos.stVal	
CB3	Open / Closed		1	1,2	172				/ATCC1/CB3Pos.stVal	
CB4	Open / Closed		1	1,2	173				/ATCC1/CB4Pos.stVal	
CB5	Open / Closed		1	1,2	174				/ATCC1/CB5Pos.stVal	
CB6	Open / Closed		1	1,2	175				/ATCC1/CB6Pos.stVal	
CB7	Open / Closed		1	1,2	176				/ATCC1/CB7Pos.stVal	

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
CB8	Open / Closed		1	1,2	177				/ATCC1/CB8Pos.stVal	
Blocking due to under voltage	Idle / Active		1	1,2	178				/ATCC1/LTCBlkVLo.stVal	
Blocking due to over voltage	Idle / Active		1	1,2	179				ATCC/LTCBlkVHi.stVal	
Blocking due to over current	Idle / Active		1	1,2	180				ATCC/LTCBlkAHi.stVal	
Transformer wdg1 CB	Open / Closed		1	1,2	182				/ATCC1/Wdg1CBPos.stVal	
Transformer wdg2 CB	Open / Closed		1	1,2	183				/ATCC1/Wdg2CBPos.stVal	
CB status invalid	Idle / Active		1	1,2	186				/ATCC1/CBStatusInv.stVal	
Digital input 1	Inactive / Active		1	1,2	187				/GGIO2/Ind1.stVal	
Digital input 2	Inactive / Active		1	1,2	188				/GGIO2/Ind2.stVal	
Digital input 3	Inactive / Active		1	1,2	189				/GGIO2/Ind3.stVal	
Digital input 4	Inactive / Active		1	1,2	190				/GGIO2/Ind4.stVal	
Digital input 5	Inactive / Active		1	1,2	191				/GGIO2/Ind5.stVal	
Digital input 6	Inactive / Active		1	1,2	192				/GGIO3/Ind1.stVal	
Digital input 7	Inactive / Active		1	1,2	193				/GGIO3/Ind2.stVal	
Digital input 8	Inactive / Active		1	1,2	194				/GGIO3/Ind3.stVal	
Digital input 9	Inactive / Active		1	1,2	195				/GGIO3/Ind4.stVal	

Data Point name	Input State	Command	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	0/1 (binary), 1/2 (dbl.pt.)	0 / 1	Class	Group	Point	Class	Group	Point	Status tag	Control tag
Digital input 10	Inactive / Active		1	1,2	196				/GGIO3/Ind5.stVal	
Digital input 11	Inactive / Active		1	1,2	197				/GGIO4/Ind1.stVal	
Digital input 12	Inactive / Active		1	1,2	198				/GGIO4/Ind3.stVal	
Digital input 13	Inactive / Active		1	1,2	199				/GGIO4/Ind4.stVal	
Digital input 14	Inactive / Active		1	1,2	200				/GGIO4/Ind5.stVal	
Digital input 15	Inactive / Active		1	1,2	201				/GGIO4/Ind6.stVal	
Digital input 16	Inactive / Active		1	1,2	202				/GGIO5/Ind1.stVal	
Digital input 17	Inactive / Active		1	1,2	203				/GGIO5/Ind2.stVal	
Digital input 18	Inactive / Active		1	1,2	204				/GGIO5/Ind3.stVal	
Digital input 19	Inactive / Active		1	1,2	205				/GGIO5/Ind4.stVal	
Digital input 20	Inactive / Active		1	1,2	206				/GGIO5/Ind5.stVal	
Digital input 21	Inactive / Active		1	1,2	207				/GGIO6/Ind1.stVal	
Digital input 22	Inactive / Active		1	1,2	208				/GGIO6/Ind2.stVal	
Digital input 23	Inactive / Active		1	1,2	209				/GGIO6/Ind3.stVal	
Digital input 24	Inactive / Active		1	1,2	210				/GGIO6/Ind4.stVal	
Digital input 25	Inactive / Active		1	1,2	211				/GGIO6/Ind5.stVal	

Data Point name	Input State 0/1 (binary), 1/2 (dbl.pt.)	Command 0 / 1	DNP3 Inputs Class	Group	Point	DNP3 Outputs Class	Group	Point	IEC 61850 Status tag	IEC 61850 Control tag
Digital input 26	Inactive / Active		1	1,2	212				/GGIO7/Ind1.stVal	
Digital input 27	Inactive / Active		1	1,2	213				/GGIO7/Ind2.stVal	
Digital input 28	Inactive / Active		1	1,2	214				/GGIO7/Ind3.stVal	
Digital input 29	Inactive / Active		1	1,2	215				/GGIO7/Ind4.stVal	
Digital input 30	Inactive / Active		1	1,2	216				/GGIO7/Ind5.stVal	
Invalid mA Pt100 inputs alarm	Inactive / Active		1	1,2	260				/GGIO1/PT100mAFlty.stVal	
Thermal managment functionality active	Inactive / Active		1	1,2	280				/SPTR0/Beh.stVal /CCGR0/Beh.stVal	
Cooling pump running	Inactive / Active		1	1,2	281				/CCGR0/PmpRunning.stVal	
Cooling fan running	Inactive / Active		1	1,2	282				/CCGR0/FanRunning.stVal	
Thermal alarm H1	Inactive / Active		1	1,2	283				/SPTR0/AlmThmSt1.stVal	
Thermal alarm H2	Inactive / Active		1	1,2	284				/SPTR0/AlmThmSt2.stVal	
Cooling C1	Inactive / Active		1	1,2	285				/CCGR0/CStg1.stVal	
Cooling C2	Inactive / Active		1	1,2	286				/CCGR0/CStg2.stVal	
Cooling C3	Inactive / Active		1	1,2	287				/CCGR0/CStg3.stVal	
Alarm Thermal	Inactive / Active		1	1,2	297				/SPTR0/AlmThm.stVal	
Cooling equipment fault alarm	Inactive / Active		1	1,2	302				/CCGR0/CEFaulty.stVal	

Counters

Data Point name	DNP3 Inputs			IEC 61850	IEC 61850
	Class	Group	Point	Status tag	Control tag
Number of taps	3	20	0	/ATCC1/OpCntRs.stVal	

A.2 Analogue inputs and outputs

* Minimum setting is interpreted as 'disabled'

† Maximum setting is interpreted as 'disabled'

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
Active settings group	1 – 8	n/a	n/a	2	40	0	2	41	0	/ATCC1/SetGrp.setMag	/ATCC1/SetGrp.setMag
Wdg 1 busbar group	1 – 8	n/a	n/a	2	40	11	2	41	11	/ATCC1/Win1GrpID.stVal	/ATCC1/Win1GrpID.Oper.ctlVal
Wdg 2 busbar group	1 – 8	n/a	n/a	2	40	12	2	41	12	/ATCC1/Win2GrpID.stVal	/ATCC1/Win2GrpID.Oper.ctlVal
Voltage high limit setpoint	900 – 1200	%	10, 0	2	40	16	2	41	16	/ATCC1/BlkRV.setMag	/ATCC1/BlkRV.setMag
Voltage low limit setpoint	800 – 1100	%	10, 0	2	40	17	2	41	17	/ATCC1/BlkLV.setMag	/ATCC1/BlkLV.setMag
LDC setpoint	0 – 200	%	10, 0	2	40	18	2	41	18	/ATCC1/LDCZ.setMag	/ATCC1/LDCZ.setMag
Reverse LDC setpoint	0 – 200	%	10, 0	2	40	19	2	41	19	/ATCC1/RevLDC.setMag	/ATCC1/RevLDC. setMag
Bandwidth setpoint	5 – 50	%	10, 0	2	40	20	2	41	20	/ATCC1/BndWid.setMag	/ATCC1/BndWid.setMag
Generator bias setpoint	0 – 100	%	10, 0	2	40	21	2	41	21	/ATCC1/GenBias.setMag	/ATCC1/GenBias.setMag
Voltage target setpoint	900 – 1100	%	10, 0	2	40	24	2	41	24	/AVCO1/VolSpt.mxVal	/AVCO1/VolSpt.Oper.ctVal
Initial tap time delay setpoint	10 – 120	secs	n/a	2	40	25	2	41	25	/ATCC1/CtlDlTmms.setMag	/ATCC1/CtlDlTmms.setMag
Voltage offset A1 setpoint	-100 – 100	%	100, 0	2	40	27	2	41	27	/AVCO1/VOfsA1Set.setMag	/AVCO1/VOfsA1Set.setMag
Voltage offset A2 setpoint	-100 – 100	%	100, 0	2	40	28	2	41	28	/AVCO1/VOfsA2Set.setMag	/AVCO1/VOfsA2Set.setMag
Voltage offset A3 setpoint	-100 – 100	%	100, 0	2	40	29	2	41	29	/AVCO1/VOfsA3Set.setMag	/AVCO1/VOfsA3Set.setMag
Voltage offset A4 setpoint	-100 – 100	%	100, 0	2	40	30	2	41	30	/AVCO1/VOfsA4Set.setMag	/AVCO1/VOfsA4Set.setMag
Voltage offset B1 setpoint	-100 – 100	%	100, 0	2	40	31	2	41	31	/AVCO1/VOfsB1Set.setMag	/AVCO1/VOfsB1Set.setMag
Voltage offset B2 setpoint	-100 – 100	%	100, 0	2	40	32	2	41	32	/AVCO1/VOfsB2Set. setMag	/AVCO1/VOfsB2Set. setMag

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
Voltage offset B3 setpoint	-100 – 100	%	100, 0	2	40	33	2	41	33	/AVCO1/VOfsB3Set. setMag	/AVCO1/VOfsB3Set. setMag
Voltage offset B4 setpoint	-100 – 100	%	100, 0	2	40	34	2	41	34	/AVCO1/VOfsB4Set. setMag	/AVCO1/VOfsB4Set. setMag
Maximum tap position setpoint	1 – 39	n/a	n/a	2	40	37	2	41	37	/ATCC1/TapBlkR.stVal	/ATCC1/TapBlkR.Oper.CtlVal
Minimum tap position setpoint	1 – 39	n/a	n/a	2	40	38	2	41	38	/ATCC1/TapBlkL.stVal	/ATCC1/TapBlkL.Oper.CtlVa
Transformer ID setpoint	1 – 8	n/a	n/a	2	40	39				/ATCC1/TrarID.setVal	
Load capacity setpoint	10 – 10000	MVA	10, 0	2	40	40	2	41	40		
Fast tap threshold setpoint	5 – 50	%	10, 0	2	40	42	2	41	42	/ATCC1/FastTapTH.setMag	/ATCC1/FastTapTH.setMag
Fast tap time delay setpoint	1 – 120	secs	n/a	2	40	43	2	41	43	/ATCC1/FastTapTmDl.setMag	/ATCC1/FastTapTmDl.setMag
Low voltage inhibit level setpoint	50 – 90	%	n/a	2	40	44	2	41	44	/ATCC1/LoVInhSet.setMag	/ATCC1/LoVInhSet.setMag
Inner Bandwidth setpoint	0 – 50	%	10, 0	2	40	45	2	41	44		
Tap position	1 – 39	n/a	n/a	2	30	49				/ATCC1/TapChg.valWTr.posVal	
VT 1 measured voltage	0 – 2^{16}-1	kV	100, 0	2	30	50				/MMXU2/VT1AvVolt.mag /MMXU0/PPV.phsAB.cVal.mag	
VT 2 measured voltage	0 – 2^{16}-1	kV	100, 0	2	30	51				/MMXU2/VT2AvVolt.mag /MMXU0/PPV.phsBC.cVal.mag	
VT 3 measured voltage	0 – 2^{16}-1	kV	100, 0	2	30	52				/MMXU2/VT3AvVolt.mag /MMXU1/PPV.phsAB.cVal.mag	
VT 4 measured voltage	0 – 2^{16}-1	kV	100, 0	2	30	53				/MMXU2/VT4AvVolt.mag /MMXU1/PPV.phsBC.cVal.mag	
Effective voltage target	0 – 2^{16}-1	kV	100,0	2	40	59				/AVCO1/EffVTarg.mag	
CT1 current	0 – 2^{16}-1	A	n/a	2	30	60				/MMXU2/CT1A.mag	

Data Point name	Range min – max	Units	Scaling – m, c Pt.val. = act. × m + c	DNP3 Inputs Class	Group	Point	DNP3 Outputs Class	Group	Point	IEC 61850 Status tag	IEC 61850 Control/Setpoint tag
										/MMXU0/A.phsA.cVal.mag	
CT1 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	61				/MMXU2/CT1W.mag	
CT1 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	62				/MMXU2/CT1VAr.mag	
CT1 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	63				/MMXU2/CT1VA.mag	
CT2 current	$0 – 2^{16}-1$	A	n/a	2	30	64				/MMXU2/CT2A.mag /MMXU1/A.phsA.cVal.mag	
CT2 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	65				/MMXU2/CT2W.mag	
CT2 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	66				/MMXU2/CT2VAr.mag	
CT2 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	67				/MMXU2/CT2VA.mag	
CT3 current	$0 – 2^{16}-1$	A	n/a	2	30	68				/MMXU2/CT3A.mag	
CT3 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	69				/MMXU2/CT3W.mag	
CT3 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	70				/MMXU2/CT3VAr.mag	
CT3 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	71				/MMXU2/CT3VA.mag	
CT4 current	$0 – 2^{16}-1$	A	n/a	2	30	72				/MMXU2/CT4A.mag	
CT4 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	73				/MMXU2/CT4W.mag	
CT4 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	74				/MMXU2/CT4VAr.mag	
CT4 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	75				/MMXU2/CT4VA.mag	
CT5 current	$0 – 2^{16}-1$	A	n/a	2	30	76				/MMXU2/CT5A.mag	
CT5 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	77				/MMXU2/CT5W.mag	
CT5 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	78				/MMXU2/CT5VAr.mag	
CT5 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	79				/MMXU2/CT5VA.mag	
CT6 current	$0 – 2^{16}-1$	A	n/a	2	30	80				/MMXU2/CT6A.mag	
CT6 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	81				/MMXU2/CT6W.mag	
CT6 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	82				/MMXU2/CT6VAr.mag	
CT6 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	83				/MMXU2/CT6VA.mag	
CT7 current	$0 – 2^{16}-1$	A	n/a	2	30	84				/MMXU2/CT7A.mag	
CT7 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	85				/MMXU2/CT7W.mag	

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
CT7 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	86				/MMXU2/CT7VAr.mag	
CT7 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	87				/MMXU2/CT7VA.mag	
CT8 current	$0 – 2^{16}-1$	A	n/a	2	30	88				/MMXU2/CT8A.mag	
CT8 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	89				/MMXU2/CT8W.mag	
CT8 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	90				/MMXU2/CT8VAr.mag	
CT8 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	91				/MMXU2/CT8VA.mag	
CT9 current	$0 – 2^{16}-1$	A	n/a	2	30	92				/MMXU2/CT9A.mag	
CT9 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	93				/MMXU2/CT9W.mag	
CT9 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	94				/MMXU2/CT9VAr.mag	
CT9 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	95				/MMXU2/CT9VA.mag	
CT10 current	$0 – 2^{16}-1$	A	n/a	2	30	96				/MMXU2/CT10A.mag	
CT10 real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	97				/MMXU2/CT10W.mag	
CT10 reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	98				/MMXU2/CT10VAr.mag	
CT10 apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	99				/MMXU2/CT10VA.mag	
Wdg1 group load current	$0 – 2^{16}-1$	A	n/a	2	30	120					
Wdg1 group load real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	121					
Wdg1 group load reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	122					
Wdg1 group load apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	123					
Wdg2 group load current	$0 – 2^{16}-1$	A	n/a	2	30	124					
Wdg2 group load real power	$-2^{15} – 2^{15}-1$	kW	n/a	2	30	125					
Wdg2 group load reactive power	$-2^{15} – 2^{15}-1$	kVAr	n/a	2	30	126					
Wdg2 group load apparent power	$0 – 2^{16}-1$	kVA	n/a	2	30	127					

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
Wdg1 site circulating current	$-2^{15} – 2^{15}-1$	A	n/a	2	30	140				/MMXU2/Wdg1SiteCirA.mag	
Wdg1 network circulating current	$-2^{15} – 2^{15}-1$	A	n/a	2	30	141				/MMXU2/Wdg1NetCirA.mag	
Wdg2 site circulating current	$-2^{15} – 2^{15}-1$	A	n/a	2	30	142				/MMXU2/Wdg2SiteCirA.mag	
Wdg2 network circulating current	$-2^{15} – 2^{15}-1$	A	n/a	2	30	143				/MMXU2/Wdg2NetCirA.mag	
Frequency	$0 – 2^{16}-1$	mHz	n/a	2	30	150				/MMXU0/Hz.mag /MMXU1/Hz.mag	
mA input 1	$-2^{15} – 2^{15}-1$	µA	n/a	2	30	151				/GGIO1/MAmpInput1.mag	
mA input 2	$-2^{15} – 2^{15}-1$	µA	n/a	2	30	151				/GGIO1/MAmpInput2.mag	
mA Input 3	$-2^{15} – 2^{15}-1$	µA	1,0	2	30	152				/GGIO1/MAmpInput3.mag	
mA Input 4	$-2^{15} – 2^{15}-1$	µA	1,0	2	30	153				/GGIO1/MAmpInput4.mag	
mA Input 5	$-2^{15} – 2^{15}-1$	µA	1,0	2	30	154				/GGIO1/MAmpInput5.mag	
mA Input 6	$-2^{15} – 2^{15}-1$	µA	1,0	2	30	155				/GGIO1/MAmpInput6.mag	
mA Input 7	$-2^{15} – 2^{15}-1$	µA	1,0	2	30	156				/GGIO1/MAmpInput7.mag	
mA Input 8	$-2^{15} – 2^{15}-1$	µA	1,0	2	30	157				/GGIO1/MAmpInput8.mag	
mA output 1	0 – 24000	µA	n/a	2	30	159				/GGIO1/MAmpOutput1.mag	
mA output 2	0 – 24000	µA	n/a	2	30	160				/GGIO1/MAmpOutput2.mag	
mA output 3	0 – 24000	µA	n/a	2	30	161				/GGIO1/MAmpOutput3.mag	
mA output 4	0 – 24000	µA	n/a	2	30	162				/GGIO1/MAmpOutput4.mag	
mA Output 5	0 – 24000	µA	1,0	2	30	163				/GGIO1/MAmpOutput5.mag	
mA Output 6	0 – 24000	µA	1,0	2	30	164				/GGIO1/MAmpOutput6.mag	
mA Output 7	0 – 24000	µA	1,0	2	30	165				/GGIO1/MAmpOutput7.mag	
mA Output 8	0 – 24000	µA	1,0	2	30	166				/GGIO1/MAmpOutput8.mag	
mA Output 9	0 – 24000	µA	1,0	2	30	167				/GGIO1/MAmpOutput9.mag	
Pt100 input 1	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	172				/GGIO1/MAPt100In1.mag	

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
Pt100 Input 2	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	173				/GGIO1/MAPt100In2.mag	
Pt100 Input 3	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	174				/GGIO1/MAPt100In3.mag	
Pt100 Input 4	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	175				/GGIO1/MAPt100In4.mag	
Pt100 Input 5	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	176				/GGIO1/MAPt100In5.mag	
Pt100 Input 6	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	177				/GGIO1/MAPt100In6.mag	
Pt100 Input 7	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	178				/GGIO1/MAPt100In7.mag	
Pt100 Input 8	$-2^{15} – 2^{15}-1$	°C	100,0	2	30	179				/GGIO1/MAPt100In8.mag	
Real power voltage exponent k_p	$0 – 2^{16}-1$			2	30	185				/AVCO1/WattVExp.mag	
Reactive power voltage exponent K_q	$0 – 2^{16}-1$			2	30	186				/AVCO1/VarVExp.mag	
Frequency trip T1 pickup setpoint	4499 – 6500 *	Hz	100, 0	2	40	187	2	41	187	/AVCO1/HzTr1Pickup.setMag	/AVCO1/HzTr1Pickup.setMag
Frequency trip T1 pickup delay setpoint	0 – 1800	secs	n/a	2	40	188	2	41	188	/AVCO1/HzTr1PuDl.setMag	/AVCO1/HzTr1PuDl.setMag
Frequency trip T2 pickup setpoint	4499 – 6500 *	Hz	100, 0	2	40	189	2	41	189	/AVCO1/HzTr2Pickup.setMag	/AVCO1/HzTr2Pickup.setMag
Frequency trip T2 pickup delay setpoint	0 – 1800	secs	n/a	2	40	190	2	41	190	/AVCO1/HzTr2PuDl.setMag	/AVCO1/HzTr2PuDl.setMag
Frequency trip T3 pickup setpoint	4499 – 6500 *	Hz	100, 0	2	40	191	2	41	191	/AVCO1/HzTr3Pickup.setMag	/AVCO1/HzTr3Pickup.setMag
Frequency trip T3 pickup delay setpoint	0 – 1800	secs	n/a	2	40	192	2	41	192	/AVCO1/HzTr3PuDl.setMag	/AVCO1/HzTr3PuDl.setMag
Frequency trip T4 pickup setpoint	4499 – 6500 *	Hz	100, 0	2	40	193	2	41	193	/AVCO1/HzTr4Pickup.setMag	/AVCO1/HzTr4Pickup.setMag
Frequency trip T4 pickup delay setpoint	0 – 1800	secs	n/a	2	40	194	2	41	194	/AVCO1/HzTr4PuDl.setMag	/AVCO1/HzTr4PuDl.setMag
Frequency trip reset time setpoint	0 – 1800	secs	n/a	2	40	195	2	41	195	/AVCO1/HzTrRstTm.setMag	/AVCO1/HzTrRstTm.setMag

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
Frequency offset F1 pickup setpoint	4500 – 6500	Hz	100, 0	2	40	196	2	41	196	/AVCO1/HzOfsPickup.setMag	/AVCO1/HzOfsPickup.setMag
Frequency offset F1 dropoff setpoint	4500 – 6501 †	Hz	100, 0	2	40	197	2	41	197	/AVCO1/HzOfsdropOf.setMag	/AVCO1/HzOfsdropOf.setMag
Frequency offset F1 pickup delay setpoint	0 – 7200	secs	n/a	2	40	198	2	41	198	/AVCO1/HzOfsPuDl.setMag	/AVCO1/HzOfsPuDl.setMag
Frequency offset F1 offset setpoint	-100 – 100	%	10, 0	2	40	199	2	41	199	/AVCO1/HzOfsOffset.setMag	/AVCO1/HzOfsOffset.setMag
Frequency offsets reset time setpoint	29 – 7200 *	secs	n/a	2	40	212	2	41	212	/AVCO1/HzOfsRstTm.setMag	/AVCO1/HzOfsRstTm.setMag
Tap stagger S1 setpoint	0 – 500	%	10, 0	2	40	213	2	41	213	/AVCO1/TapStag1set.setMag	/AVCO1/TapStag1set.setMag
Tap stagger S2 setpoint	0 – 500	%	10, 0	2	40	214	2	41	214	/AVCO1/TapStag2set.setMag	/AVCO1/TapStag2set.setMag
Tap stagger S3 setpoint	0 – 500	%	10, 0	2	40	215	2	41	215	/AVCO1/TapStag3set.setMag	/AVCO1/TapStag3set.setMag
Tap stagger S4 setpoint	0 – 500	%	10, 0	2	40	215	2	41	215	/AVCO1/TapStag4set.setMag	/AVCO1/TapStag4set.setMag
Load offset L1 pickup setpoint	500 – 2000	%	10, 0	2	40	217	2	41	217	/AVCO1/LoadOfsPu.setMag	/AVCO1/LoadOfsPu.setMag
Load offset L1 dropoff setpoint	500 – 2000	%	10, 0	2	40	218	2	41	218	/AVCO1/LoadOfsDOf.setMag	/AVCO1/LoadOfsDOf.setMag
Load offset L1 pickup delay setpoint	0 – 3600	secs	n/a	2	40	219	2	41	219	/AVCO1/LoadOfsRstTm.setMag	/AVCO1/LoadOfsRstTm.setMag
Load offset L1 offset setpoint	-100 – 100	%	10, 0	2	40	220	2	41	220	/AVCO1/LoadOfsOfset.setMag	/AVCO1/LoadOfsOfset.setMag
Wdg1 real power	-2^{15} – 2^{15}-1	kW	n/a	2	30	238				/MMXU0/TotW.mag	
Wdg1 reactive power	-2^{15} – 2^{15}-1	kVAr	n/a	2	30	239				/MMXU0/TotVAr.mag	
Wdg1 apparent power	0 – 2^{16}-1	kVA	n/a	2	30	240				/MMXU0/TotVA.mag	
Wdg2 real power	-2^{15} – 2^{15}-1	kW	n/a	2	30	241				/MMXU1/TotW.mag	
Wdg2 reactive power	-2^{15} – 2^{15}-1	kVAr	n/a	2	30	242				/MMXU1/TotVAr.mag	

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
Wdg2 apparent power	0 – 2^{16}-1	kVA	n/a	2	30	243				/MMXU1/TotVA.mag	
Controlled voltage	0 – 2^{16}-1	kV	100,0	2	30	253				/AVCO1/CtlV.mag	
Inc/Dec applied offset	-150 – 150	%	10,0	2	30	254					
Prepare to switch winding 1 in group	1 – 15	n/a	n/a	2	40	255	2	41	254	/ATCC1/ SwWdg1inGrp.mxVal	/ATCC1/ SwWdg1inGrp.Oper.ctlVal
Prepare to switch winding 2 in group	1 – 15	n/a	n/a	2	40	256	2	41	254	/ATCC1/ SwWdg2inGrp.mxVal	/ATCC1/ SwWdg2inGrp.Oper.ctlVal
Winding1 power factor	-1000 – +1000	n/a	1000, 0	2	40	257				/MMXU0/TotPF.mag	
Winding2 power factor	-1000 – +1000	n/a	1000, 0	2	40	258				/MMXU1/TotPF.mag	
Measured ambient temperature	-2^{15} – 2^{15}-1	°C	100,0	2	40	283				TTMP0/TmpSv.instMag	
Measured winding temperature	-2^{15} – 2^{15}-1	°C	100,0	2	40	284				TTMP2/TmpSv.instMag	
Measured top oil temperature	-2^{15} – 2^{15}-1	°C	100,0	2	40	285				TTMP1/TmpSv.instMag	
Measured t/c oil temperature	-2^{15} – 2^{15}-1	°C	100,0	2	40	286				TTMP3/TmpSv.instMag	
Life Lost	0 - 2^{32} -1	s	n/a	2	40	287				SPTR0/LifeLoss.mag	
Ageing rate	-1000000 - + 1000000	n/a	1000000,0	2	40	288				SPTR0/AgeRte.mag	
Runtime	0 - 2^{32} -1	s	n/a	2	40	289				SPTR0/RunTime.mag	
winding hotspot temperature	-2^{15} – 2^{15}-1	°C	100,0	2	40	290				SPTR0/HPTmpClc.mag	
top oil temperature	-2^{15} – 2^{15}-1	°C	100,0	2	40	291				SPTR0/TopOilTmpClc.mag	
winding hotspot temperature Final	-2^{15} – 2^{15}-1	°C	100,0	2	40	292				SPTR0/HPTmpFin.mag	

Data Point name	Range	Units	Scaling – m, c	DNP3 Inputs			DNP3 Outputs			IEC 61850	IEC 61850
	min – max		Pt.val. = act. × m + c	Class	Group	Point	Class	Group	Point	Status tag	Control/Setpoint tag
top oil temperature Final	-2^{15} – $2^{15}-1$	°C	100,0	2	40	293				SPTR0/TopOilTmpFin.mag	
winding hotspot temperature Forcast	-2^{15} – $2^{15}-1$	°C	100,0	2	40	294				SPTR0/HPTmpFC.mag	
top oil temperature Forcast	-2^{15} – $2^{15}-1$	°C	100,0	2	40	295				SPTR0/TopOilTmpFC.mag	
Current for thermal load model	0 – $2^{16}-1$	A	1, 0	2	40	296				SPTR0/Amp.mag	
Total Load current	0 – $2^{16}-1$	A	1, 0	2	40	296				/ATCC1/LodA.mag	
Load reserve to alarm	0 – $2^{16}-1$	A	1, 0	2	40	297				SPTR0/LodRsvAlm.mag	
Clock sync identity: SNTP: (1)										/LTMS0/TmSrc.stVal	
Clock sync active for SNTP: (1)										/LTMS0/TmChSt1.stVal	
Clock sync app id: SuperTAPP SG: (1)										/LTMS0/TmSrcTyp.stVal	

Appendix B: List of data points mapped on the IEC 60870-5-103 protocol

The following list shows factory default mapping of the data points from the standard list onto IEC 60870-5-103 protocol. Customers can change/modify this mapping using eNode tool.

The list contains common information for the data points, and for each supported protocol the minimum information required to configure a master station for SuperTAPP SG. Please refer to the Appendix D for more information about IEC 60870-5-103 capabilities of the SuperTAPP SG.

- Type ID Typically, the ASDU Type as defined in IEC 60870-5-103 sections 7.3.1 and 7.3.2
- Info Number Information Numbers as defined in IEC 60870-5-103 section 7.2.5.2
- GI Flag that the data point should appear in general interrogation responses. For time tagged messages and relative time tagged messages (type ids 1 and 2), this also means that the transition from 'ON' to 'OFF' will be reported. By default, only 'OFF' to 'ON' transitions cause events.
- Cyclic Flag that the data point should appear in cyclic transmissions. To comply fully with the standard, only measurand points should be marked cyclic.

B.1 Binary status inputs

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
Timer 1 output	Inactive / Active	1 Time tagged message	16	40	Yes	No
Timer 2 output	Inactive / Active	1 Time tagged message	17	40	Yes	No
Timer 3 output	Inactive / Active	1 Time tagged message	18	40	Yes	No
CB1 status	Open / Closed	1 Time tagged message	16	60	Yes	No
CB2 status	Open / Closed	1 Time tagged message	17	60	Yes	No
CB3 status	Open / Closed	1 Time tagged message	18	60	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
CB4 status	Open / Closed	1 Time tagged message	19	60	Yes	No
CB5 status	Open / Closed	1 Time tagged message	20	60	Yes	No
CB6 status	Open / Closed	1 Time tagged message	21	60	Yes	No
CB7 status	Open / Closed	1 Time tagged message	22	60	Yes	No
CB8 status	Open / Closed	1 Time tagged message	23	60	Yes	No
CB status invalid	Idle/Active	1 Time tagged message	24	60	Yes	No
Digital input 1	Inactive / Active	1 Time tagged message	5	70	Yes	No
Digital input 2	Inactive / Active	1 Time tagged message	6	70	Yes	No
Digital input 3	Inactive / Active	1 Time tagged message	7	70	Yes	No
Digital input 4	Inactive / Active	1 Time tagged message	8	70	Yes	No
Digital input 5	Inactive / Active	1 Time tagged message	9	70	Yes	No
Digital input 6	Inactive / Active	1 Time tagged message	10	70	Yes	No
Digital input 7	Inactive / Active	1 Time tagged message	11	70	Yes	No
Digital input 8	Inactive / Active	1 Time tagged message	12	70	Yes	No
Digital input 9	Inactive / Active	1 Time tagged message	13	70	Yes	No
Digital input 10	Inactive / Active	1 Time tagged message	14	70	Yes	No
Digital input 11	Inactive / Active	1 Time tagged message	15	70	Yes	No
Digital input 12	Inactive / Active	1 Time tagged message	16	70	Yes	No
Digital input 13	Inactive / Active	1 Time tagged message	17	70	Yes	No
Digital input 14	Inactive / Active	1 Time tagged message	18	70	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
Digital input 15	Inactive / Active	1 Time tagged message	19	70	Yes	No
Digital input 16	Inactive / Active	1 Time tagged message	20	70	Yes	No
Digital input 17	Inactive / Active	1 Time tagged message	21	70	Yes	No
Digital input 18	Inactive / Active	1 Time tagged message	22	70	Yes	No
Digital input 19	Inactive / Active	1 Time tagged message	23	70	Yes	No
Digital input 20	Inactive / Active	1 Time tagged message	24	70	Yes	No
Digital input 21	Inactive / Active	1 Time tagged message	25	70	Yes	No
Digital input 22	Inactive / Active	1 Time tagged message	26	70	Yes	No
Digital input 23	Inactive / Active	1 Time tagged message	27	70	Yes	No
Digital input 24	Inactive / Active	1 Time tagged message	28	70	Yes	No
Digital input 25	Inactive / Active	1 Time tagged message	29	70	Yes	No
Digital input 26	Inactive / Active	1 Time tagged message	30	70	Yes	No
Digital input 27	Inactive / Active	1 Time tagged message	95	70	Yes	No
Digital input 28	Inactive / Active	1 Time tagged message	96	70	Yes	No
Digital input 29	Inactive / Active	1 Time tagged message	97	70	Yes	No
Digital input 30	Inactive / Active	1 Time tagged message	98	70	Yes	No
Binary Output 1 status	Inactive / Active	1 Time tagged message	1	80	Yes	No
Binary Output 2 status	Inactive / Active	1 Time tagged message	2	80	Yes	No
Binary Output 3 status	Inactive / Active	1 Time tagged message	3	80	Yes	No
Binary Output 4 status	Inactive / Active	1 Time tagged message	4	80	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
Binary Output 5 status	Inactive / Active	1 Time tagged message	5	80	Yes	No
Binary Output 6 status	Inactive / Active	1 Time tagged message	6	80	Yes	No
Binary Output 7 status	Inactive / Active	1 Time tagged message	7	80	Yes	No
Binary Output 8 status	Inactive / Active	1 Time tagged message	8	80	Yes	No
Binary Output 9 status	Inactive / Active	1 Time tagged message	9	80	Yes	No
Binary Output 10 status	Inactive / Active	1 Time tagged message	10	80	Yes	No
Binary Output 11 status	Inactive / Active	1 Time tagged message	11	80	Yes	No
Binary Output 12 status	Inactive / Active	1 Time tagged message	12	80	Yes	No
Binary Output 13 status	Inactive / Active	1 Time tagged message	13	80	Yes	No
Binary Output 14 status	Inactive / Active	1 Time tagged message	14	80	Yes	No
Binary Output 15 status	Inactive / Active	1 Time tagged message	15	80	Yes	No
Binary Output 16 status	Inactive / Active	1 Time tagged message	16	80	Yes	No
Binary Output 17 status	Inactive / Active	1 Time tagged message	17	80	Yes	No
Binary Output 18 status	Inactive / Active	1 Time tagged message	18	80	Yes	No
Binary Output 19 status	Inactive / Active	1 Time tagged message	19	80	Yes	No
Binary Output 20 status	Inactive / Active	1 Time tagged message	20	80	Yes	No
Binary Output 21 status	Inactive / Active	1 Time tagged message	21	80	Yes	No
Binary Output 22 status	Inactive / Active	1 Time tagged message	22	80	Yes	No
Binary Output 23 status	Inactive / Active	1 Time tagged message	23	80	Yes	No
Binary Output 24 status	Inactive / Active	1 Time tagged message	24	80	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
Voltage offset A1 Indication	Inactive / Active	1 Time tagged message	23	179	Yes	No
Voltage offset A2 Indication	Inactive / Active	1 Time tagged message	24	179	Yes	No
Voltage offset A3 Indication	Inactive / Active	1 Time tagged message	25	179	Yes	No
Voltage offset A4 Indication	Inactive / Active	1 Time tagged message	26	179	Yes	No
Voltage offset B1 Indication	Inactive / Active	1 Time tagged message	27	179	Yes	No
Voltage offset B2 Indication	Inactive / Active	1 Time tagged message	28	179	Yes	No
Voltage offset B3 Indication	Inactive / Active	1 Time tagged message	29	179	Yes	No
Voltage offset B4 Indication	Inactive / Active	1 Time tagged message	30	179	Yes	No
Setting group 1 activation status	Inactive / Active	1 Time tagged message	31	179	Yes	No
Setting group 2 activation status	Inactive / Active	1 Time tagged message	32	179	Yes	No
Setting group 3 activation status	Inactive / Active	1 Time tagged message	33	179	Yes	No
Setting group 4 activation status	Inactive / Active	1 Time tagged message	34	179	Yes	No
Setting group 5 activation status	Inactive / Active	1 Time tagged message	35	179	Yes	No
Setting group 6 activation status	Inactive / Active	1 Time tagged message	36	179	Yes	No
Setting group 7 activation status	Inactive / Active	1 Time tagged message	37	179	Yes	No
Setting group 8 activation status	Inactive / Active	1 Time tagged message	38	179	Yes	No
Selected as master	Idle/Master	1 Time tagged message	79	179	Yes	No
Parallel operation Indication	Independent operation / Parallel operation	1 Time tagged message	80	179	Yes	No
Auto/Manual Indication	Manual / Auto	1 Time tagged message	81	179	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
SCADA/This Panel Indication	Local / SCADA	1 Time tagged message	82	179	Yes	No
AVC enable	AVC disabled / AVC enabled	1 Time tagged message	83	179	Yes	No
SCADA control blocked	Idle/Active	1 Time tagged message	84	179	Yes	No
Winding 1 prepare for switch out	Inactive / Active	1 Time tagged message	88	179	Yes	No
winding 1 ready for switch out	Idle/Active	1 Time tagged message	89	179	Yes	No
Winding 2 prepare for switch out	Inactive / Active	1 Time tagged message	91	179	Yes	No
winding 2 ready for switch out	Idle/Active	1 Time tagged message	93	179	Yes	No
Highest tap position reached	Idle / Active	1 Time tagged message	94	179	Yes	No
Lowest tap position reached	Idle / Active	1 Time tagged message	95	179	Yes	No
AVC alarm	Idle / Active	1 Time tagged message	96	179	Yes	No
Tap block indication	Idle / Active	1 Time tagged message	97	179	Yes	No
Tap raise block indication	Idle / Active	1 Time tagged message	98	179	Yes	No
Tap lower block indication	Idle / Active	1 Time tagged message	99	179	Yes	No
Out of step alarm	Idle / Active	1 Time tagged message	100	179	Yes	No
Tap pos mismatch	Idle/ Active	1 Time tagged message	101	179	Yes	No
TAP change in progress	Idle / Active	1 Time tagged message	102	179	Yes	No
Tap not achievable	Idle / Active	1 Time tagged message	103	179	Yes	No
tap change in complete	Idle / Active	1 Time tagged message	104	179	Yes	No
tap changer runaway alarm	Idle / Active	1 Time tagged message	105	179	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
Tap Changer lockout	Idle / Active	1 Time tagged message	106	179	Yes	No
T/C motor overloaded	Idle / Active	1 Time tagged message	107	179	Yes	No
Tap Changer Alarm	Idle / Active	1 Time tagged message	108	179	Yes	No
End of tap range	Idle / Active	1 Time tagged message	109	179	Yes	No
TPI failure	Idle/Active	1 Time tagged message	110	179	Yes	No
Phase reference alarm	Idle / Active	1 Time tagged message	116	179	Yes	No
Voltage low	Idle / Voltage lower than limits	1 Time tagged message	117	179	Yes	No
Voltage high	Idle / Voltage higher than limits	1 Time tagged message	118	179	Yes	No
Reverse current alarm	Idle / Active	1 Time tagged message	119	179	Yes	No
Overcurrent alarm	Idle / Active	1 Time tagged message	120	179	Yes	No
voltage out of band alarm	Idle / Active	1 Time tagged message	121	179	Yes	No
VT fuse failure	Idle / Active	1 Time tagged message	122	179	Yes	No
Dummy CB	Open / Closed	1 Time tagged message	128	179	Yes	No
Transformer wdg1 CB status	Open / Closed	1 Time tagged message	130	179	Yes	No
Transformer wdg2 CB status	Open / Closed	1 Time tagged message	131	179	Yes	No
Data logging error	Idle/Active	1 Time tagged message	160	179	Yes	No
CAN failure	Idle/Active	1 Time tagged message	164	179	Yes	No
Frequency trip enable	Disabled / Enabled	1 Time tagged message	16	180	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
Frequency trip active	Inactive / Active	1 Time tagged message	17	180	Yes	No
Frequency trip unavailable	Idle / Unavailable	1 Time tagged message	18	180	Yes	No
Frequency trip activation fail	Idle / Activation failed	1 Time tagged message	19	180	Yes	No
Frequency trip activation inhibit	Idle / Activation inhibited	1 Time tagged message	20	180	Yes	No
Frequency trip outside voltage limits	Idle / Outside voltage limits	1 Time tagged message	21	180	Yes	No
Frequency offset F1 enable	Disabled / Enabled	1 Time tagged message	16	181	Yes	No
Frequency offset F1 active	Inactive / Active	1 Time tagged message	17	181	Yes	No
Frequency offsets unavailable	Idle / Unavailable	1 Time tagged message	18	181	Yes	No
Frequency offsets activation fail	Idle / Activation failed	1 Time tagged message	19	181	Yes	No
Frequency offsets activation inhibit	Idle / Activation inhibited	1 Time tagged message	20	181	Yes	No
Frequency offsets outside voltage limits	Idle / Outside voltage limits	1 Time tagged message	21	181	Yes	No
Load offset L1 enable	Disabled / Enabled	1 Time tagged message	16	182	Yes	No
Load offset L1 active	Inactive / Active	1 Time tagged message	17	182	Yes	No
Load offsets unavailable	Idle / Unavailable	1 Time tagged message	18	182	Yes	No
Tap stagger S1 active	Inactive / Active	1 Time tagged message	16	183	Yes	No
Tap stagger S2 active	Inactive / Active	1 Time tagged message	17	183	Yes	No
Tap stagger S3 active	Inactive / Active	1 Time tagged message	18	183	Yes	No
Tap stagger S4 active	Inactive / Active	1 Time tagged message	19	183	Yes	No

Data Point Name	Input State 0/1	Type Id	Info Number	Function Type	GI	Cyclic
Tap stagger unavailable	Idle / Unavailable	1 Time tagged message	20	183	Yes	No
Tap stagger activation fail	Idle / Activation failed	1 Time tagged message	21	183	Yes	No
Tap stagger activation inhibited	Idle / Activation inhibited	1 Time tagged message	22	183	Yes	No
Thermal management functionality active	Inactive / Active	1 Time tagged message	16	194	Yes	No
Cooling pump running	Inactive / Active	1 Time tagged message	36	194	Yes	No
Cooling fan running	Inactive / Active	1 Time tagged message	38	194	Yes	No
Cooling C1	Inactive / Active	1 Time tagged message	50	194	Yes	No
Cooling C2	Inactive / Active	1 Time tagged message	51	194	Yes	No
Cooling C3	Inactive / Active	1 Time tagged message	52	194	Yes	No
Thermal alarm H1	Inactive / Active	1 Time tagged message	20	194	Yes	No
Thermal alarm H2	Inactive / Active	1 Time tagged message	21	194	Yes	No
Alarm Thermal	Inactive / Active	1 Time tagged message	30	194	Yes	No
Cooling equipment fault alarm	Inactive / Active	1 Time tagged message	40	194	Yes	No
Invalid mA Pt100 inputs alarm	Inactive / Active	1 Time tagged message	55	194	Yes	No

B.2 Analogue status inputs

All analogue values (i.e. Measurands) are reported as Measurand II – ASDU type 9. Each measurand is returned as two octets, low then high, that are combined to form the 16 bit word as shown below.

High Octet								Low Octet							
Sign	V12	V11	V10	V9	V8	V7	V6	V5	V4	V3	V2	V1	RES	ERR	OV

Bits V1 to V12 comprise the 12 bit normalised value, which uses 2's complement format, RES is reserved bit, ERR is an error bit and OV is the overflow bit. The maximum normalised value is 1.2x the rated value of the relay. If the value exceeds this maximum the overflow bit will be set and value will be the maximum that can be represented. The SuperTAPP SG calculates the Normalise value as follows

$$Normalised\ Value = \frac{Measured\ Value * 2^{12}}{Rated\ Value * 1.2}$$

Measurands are not included in general interrogation but they are sent periodically.

The table below shows all the factory default values mapped on IEC 60870-5-103.

Description	Type Id	Function Type	Info Number	Index	Rated Value
Line Voltage	9 Measurands II	179	201	0	Nominal system voltage
Effective Target Voltage	9 Measurands II	179	201	1	Nominal system voltage
Frequency	9 Measurands II	179	201	2	60 Hz
Tap position	9 Measurands II	179	201	3	Number of transformer taps
Transformer Winding1 Load magnitude	9 Measurands II	179	202	0	Transformer winding1 LDC rating
Transformer Winding1 Load angle	9 Measurands II	179	202	1	360 degree

Transformer Winding1 Group Load magnitude	9 Measurands II	179	202	2	Transformer winding1 LDC rating
Transformer Winding1 Group Load angle	9 Measurands II	179	202	3	360 degree
Transformer Winding2 Load magnitude	9 Measurands II	179	203	0	Transformer winding2 LDC rating
Transformer Winding2 Load angle	9 Measurands II	179	203	1	360 degree
Transformer Winding2 Group Load magnitude	9 Measurands II	179	203	2	Transformer winding2 LDC rating
Transformer Winding2 Group Load angle	9 Measurands II	179	203	3	360 degree

B.3 Binary Commands

Description	Command 0/1	Type Id	Info Number	Function Type
Voltage offset Group B reset	Idle / Activate	20 General command	22	179
Voltage offset A1	Deactivate / Activate	20 General command	23	179
Voltage offset A2	Deactivate / Activate	20 General command	24	179
Voltage offset A3	Deactivate / Activate	20 General command	25	179
Voltage offset A4	Deactivate / Activate	20 General command	26	179
Voltage offset B1	Deactivate / Activate	20 General command	27	179
Voltage offset B2	Deactivate / Activate	20 General command	28	179
Voltage offset B3	Deactivate / Activate	20 General command	29	179
Voltage offset B4	Deactivate / Activate	20 General command	30	179

Description	Command 0/1	Type Id	Info Number	Function Type
Setting group 1 Activate/Deactivate	Deactivate / Activate	20 General command	31	179
Setting group 2 Activate/Deactivate	Deactivate / Activate	20 General command	32	179
Setting group 3 Activate/Deactivate	Deactivate / Activate	20 General command	33	179
Setting group 4 Activate/Deactivate	Deactivate / Activate	20 General command	34	179
Setting group 5 Activate/Deactivate	Deactivate / Activate	20 General command	35	179
Setting group 6 Activate/Deactivate	Deactivate / Activate	20 General command	36	179
Setting group 7 Activate/Deactivate	Deactivate / Activate	20 General command	37	179
Setting group 8 Activate/Deactivate	Deactivate / Activate	20 General command	38	179
Settings Group Inc/Dec	Decrement/Increment	20 General command	40	179
Voltage target Increment	Idle/Increment	20 General command	42	179
Voltage target Decrement	Idle/Decrement	20 General command	43	179
Voltage target Inc/Dec	Decrement/Increment	20 General command	44	179
Voltage Increment/Decrement Reset	Idle/Reset Inc/Dec Offset	20 General command	45	179
Tap raise/lower	Raise/Lower	20 General command	70	179
Tap raise	Idle/ Raise tap	20 General command	72	179
Tap lower	Idle/ Lower tap	20 General command	75	179
Select Master	Idle/Activate	20 General command	79	179
Auto/Manual	Manual/Auto	20 General command	81	179
Winding 1 Prepare for Switch Out	Idle/Activate	20 General command	88	179
Winding 2 Prepare for Switch Out	Idle/Activate	20 General command	91	179

Description	Command 0/1	Type Id	Info Number	Function Type
TAP block command	Idle/Activate	20 General command	97	179
Reset Lockout	Idle/Activate	20 General command	106	179
Dummy Circuit Breaker	Idle/Activate	20 General command	128	179
Frequency trip enable	Disable / Enable	20 General command	16	180
Frequency trip activate	Deactivate/Activate	20 General command	17	180
Frequency Offset F1 enable	Disable / Enable	20 General command	16	181
Frequency offset F1 active	Deactivate/Activate	20 General command	17	181
Load offset L1 enable	Disable / Enable	20 General command	16	182
Tap Stagger S1 Activate/Deactivate	Deactivate/Activate	20 General command	16	183
Tap Stagger S2 Activate/Deactivate	Deactivate/Activate	20 General command	17	183
Tap Stagger S3 Activate/Deactivate	Deactivate/Activate	20 General command	18	183
Tap Stagger S4 Activate/Deactivate	Deactivate/Activate	20 General command	19	183

Appendix C: SuperTAPP SG DNP3 Device Profile

This profile is based on DNP XML Schema version 2.08.00

Where relevant, factory defaults are shown underlined.

C.1 Device Properties

1.1 Device Identification

Parameter		Device capabilities	Method of configuration
1.1.1	Device function	Outstation	
1.1.2	Vendor name	Fundamentals Limited	
1.1.3	Device name	SuperTAPP SG – Voltage Control and Monitoring Relay	
1.1.4	Device manufacturer's hardware version string	01	
1.1.5	Device manufacturer's software version string	5.0	
1.1.6	Device profile document version number	1	
1.1.7	DNP levels supported for	Level 1, Level 2, Level 3	
1.1.8	Supported function blocks	Self address support	
1.1.9	Notable additions	None	
1.1.10	Methods to set configurable parameters	Vendor software (SuperTAPP SG Tool) Proprietary file (loaded via other transport mechanism) Direct (keypad on device front panel) Factory (specified when device is ordered) Protocol (set via DNP3)	
1.1.11	DNP3 XML files available on-line	None	
1.1.12	External DNP3 XML files available off-line	Rd: complete device profile	
1.1.13	Connections supported	Serial, IP networking	Factory

1.2 Serial Connections

Parameter		Device capabilities	Method of configuration
1.2.1	Port name		
1.2.2	Serial connection parameters	Asynchronous	
1.2.3	Baud rate	2400, 4800, 9600, 19200, 38400, 57600, 115200	Vendor software Direct
1.2.4	Hardware flow control (handshaking)	None	
1.2.5	Interval to request link status	0 seconds	
1.2.6	Supports DNP3 collision avoidance	No	
1.2.7	Receive inter-character delay	Not checked	
1.2.8	Inter-character gaps in transmission	None	

1.3 IP Networking

Parameter		Device capabilities	Method of configuration
1.3.1	Port name		
1.3.2	Type of end point	TCP listening	
1.3.3	IP address of this device	0.0.0.0 – 255.255.255.255	Vendor software Direct
1.3.4	Subnet mask	0.0.0.0 – 255.255.255.255	Vendor software Direct
1.3.5	Gateway IP address	0.0.0.0 – 255.255.255.255	Vendor software Direct
1.3.6	Accepts TCP connections or UDP datagrams from	Allows all	
1.3.7	IP addresses from which TCP connections or UDP datagrams are accepted	*.*.*.*	
1.3.8	TCP listen port number	20000	
1.3.9	TCP listen port number	Not applicable (outstation w/o dual end point)	
1.3.10	TCP keep-alive timer	20000 ms	
1.3.11	Local UDP port	20000	
1.3.12	Destination UDP port for DNP3 requests (Masters only)	20000	
1.3.13	Destination UDP port for initial unsolicited null responses (UDP only outstations)	20000	
1.3.14	Destination UDP port for responses (UDP only outstations)	20000	
1.3.15	Multiple outstation connections (masters only)		
1.3.16	Multiple master connections (outstations only)	Method 1 (based on IP address)	
1.3.17	Time synchronisation support	DNP3 Write Time	

1.4 Link Layer

Parameter		Device capabilities	Method of configuration
1.4.1	Data link address	0	
1.4.2	DNP3 source address validation	Always, one address allowed	
1.4.3	DNP3 source address(es) expected when validation is enabled	0	
1.4.4	Self address support using address 0xFFFC	No	
1.4.5	Sends confirmed user data frames	Always	
1.4.6	Data link layer confirmation timeout	2000 ms	
1.4.7	Maximum data link retries	3	
1.4.8	Maximum number of octets transmitted in a data frame	292	

Parameter		Device capabilities	Method of configuration
1.4.9	Maximum number of octets that can be received in a data frame	292	

1.5 Application Layer

Parameter		Device capabilities	Method of configuration
1.5.1	Maximum number of octets transmitted in an application layer fragment other than file transfer	2048	
1.5.2	Maximum number of octets transmitted in an application layer fragment containing file transfer	2048	
1.5.3	Maximum number of octets that can be received in an application layer fragment	2048	
1.5.4	Timeout waiting for complete application layer fragment	1000 ms	
1.5.5	Maximum number of objects allowed in a single control request for CROB (group 12)	1	
1.5.6	Maximum number of objects allowed in a single control request for analogue outputs (group 41)	1	
1.5.7	Maximum number of objects allowed in a single control request for data sets (groups 85, 86, 87)	1	
1.5.8	Supports mixed object groups (AOBs, CROBs and data sets)	No	
1.5.9	User data		

1.6 Not used

1.7 Outstations only

Parameter		Device capabilities	Method of configuration
1.7.1	Timeout waiting for application confirm of solicited message	10000 ms	
1.7.2	How often is time synchronisation required from the master	Never	
1.7.3	Device trouble bit IIN1.6	Never used	
1.7.4	File handle timeout	Not applicable, files not supported	
1.7.5	Event buffer overflow behaviour	Discard the oldest event, Other – per object group	Factory
1.7.6	Event buffer organisation	Other – per object group	
1.7.7	Sends multi-fragment responses	Yes	
1.7.8	Last fragment confirmation	Sometimes – only when it contains events	
1.7.9	DNP command settings preserved through a device restart	Assign class	

1.8 Outstation Unsolicited Response Support

Parameter		Device capabilities	Method of configuration
1.8.1	Supports unsolicited resporting	Yes	
1.8.2	Master data link address	3	
1.8.3	Unsolicited response confirmation timeout	10000 ms	
1.8.4	Number of unsolicited retries	3	
1.8.5	User data		

1.9 Outstation Unsolicited Response Trigger Conditions

Parameter		Device capabilities	Method of configuration
1.9.1	Number of class 1 events	5	
1.9.2	Number of class 2 events	5	
1.9.3	Number of class 3 events	5	
1.9.4	Total number of events from any class	Total number of events not used to trigger unsolicited responses	
1.9.5	Hold time after class 1 event	5000 ms	
1.9.6	Hold time after class 2 event	5000 ms	
1.9.7	Hold time after class 3 event	5000 ms	
1.9.8	Hold time after event assigned to any class	5000 ms	
1.9.9	Retrigger hold time	Hold-time timer will not be retriggered for each new event detected	
1.9.10	Other unsolicited response trigger conditions		

1.10 Outstation Performance

Parameter		Device capabilities	Method of configuration
1.10.1	Maximum time base drift	0 ms/min	
1.10.2	When does outstation set IIN1.4	108000 seconds after last sync	
1.10.3	Maximum internal time reference error when set via DNP	0 ms	
1.10.4	Maximum delay measurement error	0 ms	
1.10.5	Maximum response time	0 ms	
1.10.6	Maximum time from start-up to IIN1.4 assertion	0 ms	
1.10.7	Maximum event time tag error for local binary and double bit I/O	0 ms	
1.10.8	Maximum event time-tag error for local I/O other than binary and double bit data types	0 ms	

1.11 Individual Field Outstation Performance

Parameter		Device capabilities	Method of configuration
1.11.1	User-assigned location name or code string		
1.11.2	User-assigned ID code/number string		
1.11.3	User-assigned name string for the outstation	20 characters from AaBbCcDdEeFfGgHhIiJjKkLlMmNnOoPpQq RrSsTtUuVvWwXxYyZz-0123456789	Vendor software Direct
1.11.4	Device serial number string		

1.12 Security Parameters

Parameter		Device capabilities	Method of configuration
1.12.1	DNP3 device support for secure authentication	Not supported	

1.13 Broadcast

Parameter		Device capabilities	Method of configuration
1.13.1	Support for broadcast functionality	Disabled	

C.2 Mapping between DNP3 and IEC 61850 Objects

C.3 Capabilities and Current Settings for Device Database

3.1 Single-bit Binary Input Points

- Static (steady-state) object number: 1
- Event object number: 2

Parameter		Device capabilities	Method of configuration
3.1.1	Static variation reported when variation 0 requested or in response to class polls	Variation 1 – single-bit packed format, Variation 2 – single-bit with flag, Based on point index	Factory
3.1.2	Event variation reported when variation 0 requested or in response to class polls	Variation 1 – without time, Variation 2 – with absolute time, Variation 3 – with relative time, Based on point index	Factory
3.1.3	Event reporting mode	Only most recent, All events	Factory
3.1.4	Binary inputs included in class 0 response	Always, Based on point index	Factory

3.2 Double-bit Input Points

- Static (steady-state) object number: 3
- Event object number: 4

Parameter		Device capabilities	Method of configuration
3.2.1	Static variation reported when variation 0 requested or in response to class polls	Variation 1 – single-bit packed format, Variation 2 – single-bit with flag, Based on point index	Factory
3.2.2	Event variation reported when variation 0 requested or in response to class polls	Variation 1 – without time, Variation 2 – with absolute time, Variation 3 – with relative time, Based on point index	Factory
3.2.3	Event reporting mode	Only most recent, All events	Factory
3.2.4	Double bit inputs included in class 0 response	Always, Based on point index	Factory

3.3 Binary Output Status and Control Relay Output Block

- Binary output status object number: 10
- Binary output event object number: 11
- CROB object number: 12
- Binary output command event object number: 13

Parameter		Device capabilities	Method of configuration
3.3.1	Minimum pulse time allowed with trip, close and pulse on commands	Fixed, Based on point index	Factory
3.3.2	Maximum pulse time allowed with trip, close and pulse on commands	Fixed, Based on point index	Factory
3.3.3	Biinary output status included in class 0 response	Always, Based on point index	Factory
3.3.4	Reprts output command event objects	Only upon a successful control	
3.3.5	Static variation reported when variation 0 requested or in response to class polls	Variation 1 – continuous control, Variation 2 – continuous control, binary output status	Factory
3.3.6	Event variation reported when variation 0 requested or in response to class polls	Variation 1 – without time	
3.3.7	Command event variation reported when variation 0 requested or in response to class polls	Variation 1 – without time	
3.3.8	Event reporting mode	Only most recent, All events	Factory
3.3.9	Command event reporting mode	Only most recent, All events	Factory
3.3.10	Maximum time between select and operate	5 seconds	

3.4 Counters / Frozen Counters

- Static counter object number: 20
- Static frozen counter object number: 21
- Counter event object number: 22
- Frozen counter event object number: 23

Parameter		Device capabilities	Method of configuration
3.4.1	Static counter variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 5 – 32-bit without flag, Variation 6 – 16-bit without flag, Based on point index	Factory
3.4.2	Counter event variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 5 – 32-bit with flag and time, Variation 6 – 16-bit with flag and time, Based on point index	Factory
3.4.3	Counters included in class 0 response	Always, Based on point index	Factory
3.4.4	Counter event reporting mode	A: only most recent (value at time of event) C: all events	Factory
3.4.5	Static frozen counter variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 5 – 32-bit with flag and time, Variation 6 – 16-bit with flag and time, Variation 9 – 32-bit without flag, Variation 10 – 16-bit without flag, Based on point index	Factory
3.4.6	Frozen counter event variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 5 – 32-bit without flag, Variation 6 – 16-bit without flag	Factory
3.4.7	Frozen counters inlcuded in class 0 response	Always, Based on point index	Factory
3.4.8	Frozen counter event reporting mode	Only most recent fozen value	
3.4.9	Counters roll over at	16 bits, Based on point index	Factory
3.4.10	Counters frozen by means of	Master request	

3.5 Analogue Input Points

- Static (steady-state) object number: 30
- Event object number: 32
- Deadband object number: 34

Parameter		Device capabilities	Method of configuration
3.5.1	Static variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 3 – 32-bit without flag, Variation 4 – 16-bit without flag, Variation 5 – sgl-prec flt. point with flag, Based on point index	Factory
3.5.2	Event variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 3 – 32-bit with flag and time, Variation 4 – 16-bit with flag and time, Variation 5 – sgl-prec flt. point w/o time, Variation 7 – sgl-prec flt. point with time, Based on point index	Factory
3.5.3	Event reporting mode	A: only most recent (value at time of event) C: all events, Based on point index	Factory

Parameter		Device capabilities	Method of configuration
3.5.4	Analogue inputs included in class 0 response	Always, based on point index	Factory
3.5.5	How deadbands are set	C. Configurable via other means (Vendor software, Direct), Based on point index	Factory
3.5.6	Analogue deadband algorithm	Simple	
3.5.7	Static frozen analogue input variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 3 – 32-bit with time-of-freeze, Variation 4 – 16-bit with time-of-freeze, Variation 5 – 32-bit without flag, Variation 6 – 16-bit without flag, Variation 7 – sgl-prec flt. point with flag	Factory
3.5.8	Frozen analogue input event variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit without time, Variation 2 – 16-bit without time, Variation 3 – 32-bit with time, Variation 4 – 16-bit with time, Variation 5 – sgl-prec flt. point w/o time, Variation 7 – sgl-prec flt. point with time	Factory
3.5.9	Frozen analogue inputs included in class 0 response	Always	
3.5.10	Frozen analogue input event reporting mode	Only most recent frozen value	

3.6 Analogue Output Status and Analogue Output Control Block

- Analogue output status object number: 40
- Analogue output control block object number: 41
- Analogue output event object number: 42
- Analogue output command event object number: 43

Parameter		Device capabilities	Method of configuration
3.6.1	Static analogue output status variation reported when variation 0 requested or in response to class polls	Variation 1 – 32-bit with flag, Variation 2 – 16-bit with flag, Variation 3 – sgl-prec flt. point with flag, Based on point index	Factory
3.6.2	Analogue output status included in class 0 response	Always, Based on point index	Factory
3.6.3	Reports output commandevent objects	Never	
3.6.4	Event variation reported when variation 0 requested or in response to class polls	Variation 4 – 16-bit with time	
3.6.5	Command event variation reported when variation 0 requested or in response to class polls	Variation 2 – 16-bit without time	
3.6.6	Event reporting mode	Only most recent, All events	Factory
3.6.7	Command event reporting mode	Only most recent, All events	Factory
3.6.8	Maximum time between select and operate	5 seconds	

3.7 Sequential File Transfer

- Object number: 70

Parameter		Device capabilities	Method of configuration
3.7.1	File transfer supported	No	
3.7.6	Max number of files open at one time	0	

3.8 Octet String Points

- Static (steady-state) object number: 110
- Event object number: 111

Parameter		Device capabilities	Method of configuration
3.8.1	Event reporting mode	Only most recent, All events	Factory
3.8.2	Octet strings included in class 0 response	Never	

3.9 Virtual Terminal Port Numbers (Points)

- Static (steady-state) object number: 112
- Event object number: 113

No requirement in this device profile. Reserved for future use.

3.10 Data Set Prototype

- Object number: 85
- Variation number: 1

No requirement in this device profile. Reserved for future use.

3.11 Data Set Descriptor Contents and Characteristics

- Object number: 86
- Variation numbers: 1 and 2

No requirement in this device profile. Reserved for future use.

C.4 Implementation Table

DNP object group and variation		Request (Outstation will parse)		Response (Outstation may issue)	
Object group	Variations	Function codes	Qualifier codes	Function codes	Qualifier codes
1 *binary input*	0 *any variation*	1 *read* 22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
1 *binary input*	1 *single-bit packed* 2 *single-bit with flag*	1 *read*	00, 01, 06, 07, 08, 17, 27, 28	129 *response*	00, 01, 17, 28
2 *binary input change event*	0 *any variation*	1 *read*	06, 07, 08		
2 *binary input change event*	1 *without time* 2 *with absolute time* 3 *with relative time*	1 *read*	06, 07, 08	129 *response*	17, 28

DNP object group and variation		Request (Outstation will parse)		Response (Outstation may issue)	
Object group	Variations	Function codes	Qualifier codes	Function codes	Qualifier codes
2 *binary input change event*	1 *without time* 2 *with absolute time* 3 *with relative time*			130 *unsol. rsp.*	17, 28
3 *double-bit input*	0 *any variation*	1 *read* 22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
3 *double-bit input*	1 *double-input packed* 2 *with flag*	1 *read*	00, 01, 06, 07, 08, 17, 27, 28	129 *response*	00, 01, 17, 28
4 *double-bit input change event*	0 *any variation*	1 *read*	06, 07, 08		
4 *double-bit input change event*	1 *without time* 2 *with absolute time* 3 *with relative time*	1 *read*	06, 07, 08	129 *response*	17, 28
4 *double-bit input change event*	1 *without time* 2 *with absolute time* 3 *with relative time*			130 *unsol. rsp.*	17, 28
10 *binary output*	0 *any variation*	1 *read*	00, 01, 06, 07, 08, 17, 28		
10 *binary output*	0 *any variation*	22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
10 *binary output*	1 *packed format* 2 *output status with flags*	1 *read*	00, 01, 06, 07, 08, 17, 28	129 *response*	00, 01, 17, 28
10 *binary output*	1 *packed format*	2 *write*	00, 01		
12 *binary output command (CROB)*	0 *any variation*	22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
12 *binary output command (CROB)*	1 *control relay output block*	3 *select* 4 *operate* 5 *direct op.* 6 *direct op. no ack.*	17, 27, 28	129 *response*	Echo of request
20 *counter*	0 *any variation*	1 *read* 22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
20 *counter*	0 *any variation*	7 *freeze* 8 *freeze, no ack.* 9 *freeze & clear* 10 *frz & clr, no ack.*	00, 01, 06, 07, 08		
20 *counter*	1 *32-bit with flag* 2 *16-bit with flag* 5 *32-bit without flag* 6 *16-bit without flag*	1 *read*	00, 01, 06, 07, 08, 17, 27, 28	129 *response*	00, 01, 17, 28
21 *frozen counter*	0 *any variation*	1 *read* 22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
21 *frozen counter*	1 *32-bit with flag* 2 *16-bit with flag*	1 *read*	00, 01, 06, 07, 08, 17, 27, 28	129 *response*	00, 01, 17, 28

DNP object group and variation		Request (Outstation will parse)		Response (Outstation may issue)	
Object group	Variations	Function codes	Qualifier codes	Function codes	Qualifier codes
	5 *32-bit with flag and time* 6 *16-bit with flag and time* 9 *32-bit without flag* 10 *16-bit without flag*				
22 *counter change event*	0 *any variation*	1 *read*	06, 07, 08		
22 *counter change event*	1 *32-bit with flag* 2 *16-bit with flag* 5 *32-bit with flag and time* 6 *16-bit with flag and time*	1 *read*	06, 07, 08	129 *response*	17, 28
22 *counter change event*	1 *32-bit with flag* 2 *16-bit with flag* 5 *32-bit with flag and time* 6 *16-bit with flag and time*			130 *unsol. rsp.*	17, 28
23 *frozen counter change event*	0 *any variation*	1 *read*	06, 07, 08		
23 *frozen counter change event*	1 *32-bit with flag* 2 *16-bit with flag* 5 *32-bit with flag and time* 6 *16-bit with flag and time*	1 *read*	06, 07, 08	129 *response*	17, 28
23 *frozen counter change event*	1 *32-bit with flag* 2 *16-bit with flag* 5 *32-bit with flag and time* 6 *16-bit with flag and time*			130 *unsol. rsp.*	17, 28
30 *analogue input*	0 *any variation*	1 *read*	00, 01, 06		
30 *analogue input*	0 *any variation*	22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
30 *analogue input*	1 *32-bit with flag* 2 *16-bit with flag* 3 *32-bit without flag* 4 *16-bit without flag* 5 *sgl.-prec. fl.-pt. with flag*	1 *read*	00, 01, 06, 07, 08, 17, 27, 28	129 *response*	00, 01, 17, 28
32 *analogue input change event*	0 *any variation*	1 *read*	06, 07, 08		
32 *analogue input change event*	1 *32-bit without time* 2 *16-bit without time* 3 *32-bit with time* 4 *16-bit with time* 5 *sgl.prec. fl.pt. without time* 7 *sgl.prec. fl.pt. with time*	1 *read*	06, 07, 08	129 *response*	17, 28
32 *analogue input change event*	1 *32-bit without time* 2 *16-bit without time* 3 *32-bit with time* 4 *16-bit with time* 5 *sgl.prec. fl.pt. without time*			130 *unsol. rsp.*	17, 28

DNP object group and variation		Request (Outstation will parse)		Response (Outstation may issue)	
Object group	Variations	Function codes	Qualifier codes	Function codes	Qualifier codes
	7 *sgl.prec. fl.pt. with time*				
40 *analogue output status*	0 *any variation*	1 *read* 22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
40 *analogue output status*	1 *32-bit with flag* 2 *16-bit with flag* 3 *sgl.-prec. fl.-pt. with flag*	1 *read*	00, 01, 06, 07, 08, 17, 27, 28	129 *response*	00, 01, 17, 28
41 *analogue output block*	0 *any variation*	22 *assign class*	00, 01, 06, 07, 08, 17, 27, 28		
41 *analogue output block*	1 *32-bit* 2 *16-bit* 3 *sgl.-prec. fl.-pt.*	3 *select* 4 *operate* 5 *direct op.* 6 *direct op. no ack.*	17, 27, 28	129 *response*	Echo of request
50 *analogue output status*	1 *absolute time*	1 *read*	07	129 *response*	07
50 *analogue output status*	1 *absolute time*	2 *write*	07		
60 *class objects*	1 *class 0 data*	1 *read* 22 *assign class*	06		
60 *class objects*	2 *class 1 data* 3 *class 2 data* 4 *class 3 data*	1 *read*	06, 07, 08		
60 *class objects*	2 *class 1 data* 3 *class 2 data* 4 *class 3 data*	20 *en. unsol.* 21 *dis. unsol.* 22 *assign class*	06		
80 *internal indications*	1 *packed format*	1 *read*	00, 01	129 *response*	00, 01
80 *internal indications*	1 *packed format*	2 *write*	00		

C.5 Data Points List

Parameter		Device capabilities	Method of configuration
5.1	Definition of binary input point list	Fixed	
5.2	Definition of double bit input point list	Fixed	
5.3	Definition of binary output status / control relay output block point list	Fixed	
5.4	Definition of counter / frozen counter point list	Fixed	
5.5	Definition of analogue input point list	Fixed	
5.6	Definition of analogue output status / analogue output block point list	Fixed	
5.7	Definition of filenames that may be read or written	Fixed	

	Parameter	Device capabilities	Method of configuration
5.8	Definition of octet string point list	Fixed	
5.9	Definition of virtual terminal port numbers	Fixed	
5.10	Definition of data set prototypes	Fixed	
5.11	Definition of data set descriptors	Fixed	
5.12	Definition of point index attributes	Fixed	

Refer to Appendix A for a combined standard data point list for all communication protocols.

Appendix D: IEC 60870-5-103 Interoperability profile

D.1 Physical Layer

1.1 Electrical Interface

- ☑ EIA RS-485
- ☑ Number of loads **0.125** for one protection equipment

1.2 Optical Interface

- ☑ Glass fibre
- ☑ Plastic fibre

1.3 Transmission speed

- ☑ 9600 bits/sec
- ☑ 19200 bits/sec

D.2 Link Layer

There are no choices for the link layer.

D.3 Application layer

3.1 Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this Companion standard.

3.2 COMMON ADDRESS of ASDU

- ☑ One COMMON ADDRESS OF ASDU (identical with station address)
- ☐ More than one COMMON ADDRESS OF ASDU

3.3 Transmission speed

- ☑ 9600 bits/sec
- ☑ 19200 bits/sec

D.4 Selection of standard information numbers in monitor direction

4.1 System functions in monitor direction

- ☑ <0> End of general interrogation
- ☑ <1> Time synchronisation
- ☑ <2> Reset FCB

- ☑ <3> Reset CU
- ☑ <4> Start/restart
- ☑ <5> Power on

4.2 Status indications, supervision indications, fault, earth fault indications and Measurands in monitor direction

Not applicable as SuperTAPP SG is not a protection device and it doesn't implement any standard functions defined in IEC 60870-5-103. Factory default Functions and information numbers are listed in Appendix C and also users can modify them or add/map new Functions/Information numbers using eNode designer tool.

4.3 Generic functions in monitor direction

- ☐ <240> Read headings of all defined groups
- ☐ <241> Read values or attributes of all entries of one group
- ☐ <243> Read directory of a single entry
- ☐ <244> Read value or attribute of a single entry
- ☐ <245> End of general interrogation of generic data
- ☐ <249> Write entry with confirmation
- ☐ <250> Write entry with execution
- ☐ <251> Write entry aborted

D.5 Selection of standard information numbers in control direction

5.1 System functions in control direction

- ☑ <0> Initiation of general interrogation
- ☑ <0> Time synchronisation

5.2 General commands in control direction

Not applicable as SuperTAPP SG is not a protection device and it doesn't implement any standard commands defined in IEC 60870-5-103. Factory default Functions and information numbers are listed in Appendix C and also users can modify them or add/map new Functions/Information numbers using eNode designer tool.

5.3 Generic functions in control direction

- ☐ <240> Read headings of all defined groups
- ☐ <241> Read values or attributes of all entries of one group
- ☐ <243> Read directory of a single entry
- ☐ <244> Read value or attribute of a single entry
- ☐ <245> General interrogation of generic data
- ☐ <248> Write entry
- ☐ <249> Write entry with confirmation
- ☐ <250> Write entry with execution
- ☐ <251> Write entry abort

D.6 Basic application functions

- ☐ Test mode
- ☐ Blocking of monitor direction
- ☐ Disturbance data
- ☐ Generic Services
- ☐ Private Data

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