Using GOOSE with SPA-ZC 400 Ethernet Adapter and RE_541/3/5 Terminals

SPA-ZC 400, RE_541/3/5

Application Note

Contents

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1. Introduction

1.1. Purpose

This document describes the GOOSE capability of SPA-ZC 400 v2.1 Ethernet adapter.

The purpose of the document is to explain how to use the GOOSE capability of SPA-ZC 400 with protection and control feeder terminals REF541/3/5, transformer protection terminal RET543/5 and machine protection terminal REM543/5 in medium voltage networks and substations. In general, according the standard, GOOSE can be used in different applications depending on the performance requirements and the functionality of the devices. The document highlights applications where SPA-ZC 400 and the GOOSE functionality can be effectively used with RE541/3/5 series of IEDs.

1.2. Definitions

Table 1.2.-1 Terms and definitions

Term	Description
GOOSE	Generic Object Oriented Substation Event
IED	Intelligent Electronic Device, here mostly a protection and/or control relay
DPC	DoublePointControllable, Common Data Class acc. IEC 61850-7-3
CDC	Common Data Class, data type definitions defined in IEC 61850-7-3
CET	Communication Engineering Tool
SPS	SinglePointStatus, Common Data Class acc. IEC 61850-7-3
CSWI	Logical node acc. IEC 61850-7-4, switch controller
PTUV, PTUF, PTOC	Protection logical nodes acc. IEC 61850-7-4
XCBR, XSWI	Logical node acc. IEC 61850-7-4, breaker, disconnector
CID	Configured IED Description. Single IED configuration.
SCD	Substation Configuration Description. All configured IEDs in substation
SCL	Substation Configuration Language

1.3. Reference documents

Table 1.3.-1 Reference documents

Ref	Document ID	Rev	Document title
[1]	1VLD000015-en		Standardization of the secondary part of the UniGear switchboard, Topic: Automatic Change-Over
[2]	IEC 61850-7-3	Ed. 1	Published standard
[3]	1MRS755347		Ethernet Adapter SPA-ZC 400 SPA to IEC 61850 Gateway Installation and Commissioning Manual
[4]	1MRS755224 in 1MRS750889-MCD		RET541/543/545 documentation, function block documentation: COLTC Automatic or manual voltage control of transformers

2. Description of the application

2.1. GOOSE in general

2.1.1. Brief technical description

The glossary of the IEC 61850 standard defines GOOSE as follows:

On the occurrence of any change of state, an IED will multicast a high speed, Generic Object Oriented Substation Event (GOOSE) report by exception, typically containing the double command state of each of its status inputs, protection starts, output elements and relays, actual and virtual. This report is re-issued sequentially, typically after the first report, again at short interval. (The first repetition delay value is an open value it may be either shorter or longer). A GOOSE report enables high speed trip signals to be issued.

All the details about GOOSE messaging and services communication profiles can be found in the following parts of the IEC 61850 standard:

Table 2.1.1-1 IEC 61850 Standard

Part	Description
IEC 61850-6-1	Configuration description language, for communication in electrical substations related to IEDs
IEC 61850-7-1	Basic communication structure for substation and feeder equipment – Principles and models
IEC 61850 7-2	Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)
IEC 61850 7-3	Basic communication structure for substation and feeder equipment – Common data classes
IEC 61850-8-1	Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

2.1.2. Benefits

GOOSE messaging is one of the key benefits of IEC 61850 which in comparison with the traditional way of signal transfer between IEDs in a substation will bring added value to customers in all aspects. The Fig. 2.1.2.-1 shows the traditional protection architecture and way of transferring signals between IEDs. The Fig. 2.1.2.-2 shows the IEC 61850 protection architecture using GOOSE messaging for transferring signals between IEDs

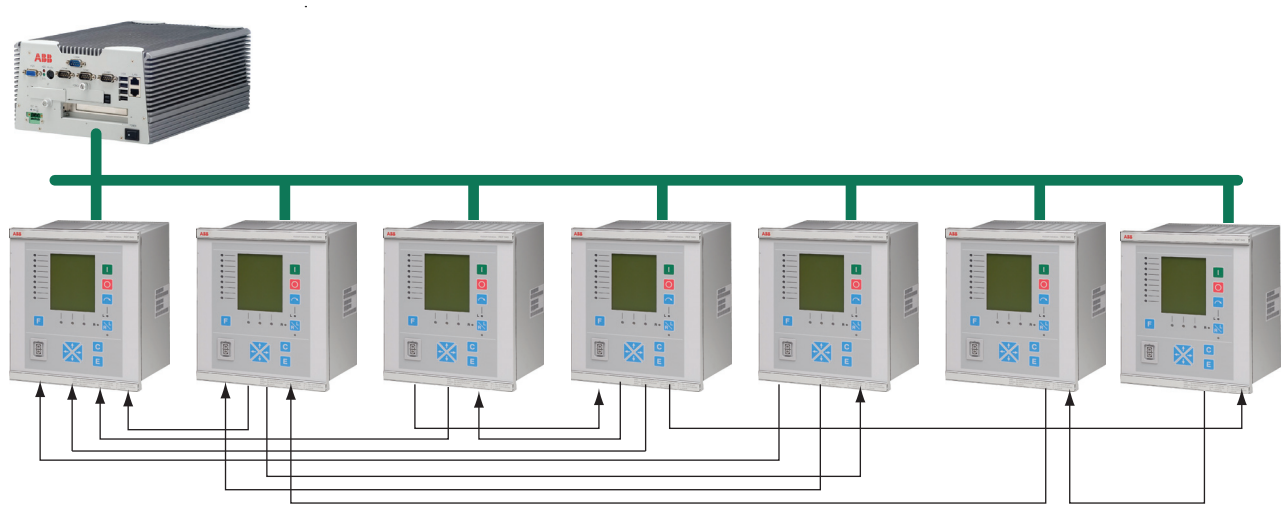

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Fig. 2.1.2.-1 Traditional approach

Here wiring between the relays must be done individually for each signal, from bay device to bay device. An output signal can be shared, but inputs have to be individually used.

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Fig. 2.1.2.-2 GOOSE approach

Here interbay signals can be easily shared between bays without additional physical wiring.

Table 2.1.2-1 shows a comparison of signal transfer between IEDs based on the traditional protection approach and on IEC 61850 (GOOSE).

Table 2.1.2-1 Comparison of signal transfer between IEDs

Traditional way		**IEC 61850 with GOOSE**	
-	Requires N*(N-1)/2 links for N relays.	+	Relays share common network making sophisticated protection schemes possible.
-	Requires filtering on links to prevent false trips.	+	Number of links for N relays is N.
-	Reprogramming can require rewiring.	+	Relays send their status to all other relays at once using GOOSE.

Table 2.1.2-1 Comparison of signal transfer between IEDs (Continued)

Traditional way		IEC 61850 with GOOSE	
-	Don't know if links are working until you use them.	+	Status exchanged continuously.
-	Performance of signal transfer is between 8-20 ms depending on IEDs binary input/ output capabilities	+	High performance (Transfer of signals between IEDs can be less than 10 ms)
+	Educated engineering, testing and commissioning personnel is not needed	+	Reduction of wiring costs
+	Accepted solution in every market	+	More flexible programming is independent of wiring
+	Wire will be always wire --> unlimited lifecycle	+	More flexible programming is independent of wiring
		+	Reliability: Link status known before use.
		+	Higher performance with more data.
		+	Higher performance with more data.
		-	Higher investment in network components is needed (not always true, since you often have the network anyway)
		-	Training of engineering, testing, and commissioning persons

As seen above, GOOSE offers indisputable benefits and added value for different users.

2.1.3. Implementation of GOOSE in SPA-ZC 400 with RE_541/3/5 terminals

The SPA-ZC 400 works as IEC 61850 Ethernet interface for the IED. GOOSE support is specifically designed for latest versions of RE_541/3/5 terminal and SPA-ZC 400 to guarantee best possible performance using fast communication speed in internal link. Following IED software versions supports peer-to-peer communication over IEC 61850:

- REF541/543/545 3.5 Software revision K
- RET541/543/545 3.0 SW Build 4.38
- REM543/545 2.5 SW Build 4.00

Configuration of GOOSE is done with the communication engineering tool CET for SPA-ZC 40x together with RE_541/3/5 terminal CAP 505 application.

Performance in terms of response time is a very important parameter, which defines the capability of the GOOSE messaging for a certain application. When using SPA-ZC 400 with RE_541/3/5 terminal you can refer to the performance class P1/ 1B for distribution, which defines a response time of 100 ms from application to application communication. This is the case when both sender and receiver are SPA-ZC 400 Ethernet Interfaces.

2.1.3.1. Sending data

GOOSE sending is based on GOOSE Control Block (GoCB) and to the specified dataset. The GOOSE addressing is done in GoCB properties and the edited GOOSE dataset specifies the data to be sent to station bus. GoCB must always reside under LD0.LLN0 logical node for SPA-ZC 400. When user creates GoCB, two COGGIO

Logical Nodes with 16 SPS Data Objects Ind1..16 are created. These two word groups of 16 bits of data can be programmed in RE_541/3/5 application using COMM_OUT31 and 32 function blocks.

GOOSE addressing is based on Multicast MAC address and APPID address. Multicast address can be shared by many IEDs but generally both addresses should be unique in the substation configuration for each GoCB.

SPA-ZC 400 can send any data from its IEC 61850 data model in GOOSE messages. Best and guaranteed performance is obtained for COGGIO single bit data connected internally to global horizontal communication variables on RE_541/3/5 application: COMM_OUT31 and 32.

For non-critical signals, event reporting based data, e.g. CSWI.Pos.stVal, or analogue data can be added to GOOSE dataset and sent to station bus. The response time of event based data is the same as for vertical communication, i.e. it depends on the load situation and can be in the range of hundreds of milliseconds. Only expection of named data is control selection stSeld attribute which is handled by Ethernet Interface control handler and it is the fastest method to send control object (e.g. circuit breaker) selection data over station bus.

2.1.3.2. Receiving data

To receive data, the user has to create the GOOSE Inputs using the CET. This is done creating CSEInput object under LD0.LLN0. At the same time the CET automatically creates 2 CIGGIO logical nodes for the received data with 16 SPS type of data objects Ind1…16. If double-point data is used, receiving data objects has to be created separately. In GSEInput, object data from other IEDs is mapped to receiving data in CIGGIO and in the end to RE_541/3/5 application COMM_IN input point.

There are limitations for receiving capabilities with SPA-ZC 400 and RE_541/3/5. The following type of data can be received from other IEDs using GOOSE:

- BOOLEAN type of data, 0 or 1 (stVal from SPS, SPC CDCs)
- CODED ENUM attributes from double point data (stVal from DPC, DPS CDCs)
  - intermediate-state | off | on | bad-state interpreted as consecutive decimals "0", "1", "2", "3”, in binary "00", "01", "10", "11"
- Quality attribute type of data (q from SPS, SPC, DPS, DPC CDCs)
  - good | invalid | reserved | questionable interpreted as "0", "1", "1", "1"

These data attribute types can be forwarded to RE_541/3/5 function blocks named COMM_IN31 and COMM_IN32. Therefore it is possible to receive 32 single bits for horizontal data. It should be noticed that double point data will occupy two consecutive bits.

For double-point data, two consecutive Ind data objects (SPS type) has to be deleted and replaced by a single DPCSO data object (DPC type), the index of which must refer to the first deleted one. For example, delete Ind2 and Ind3 and create DPCSO2 to utilize these two bits. In the IED application function block COMM_IN two input points are separated, and the application must handle the conversion from two bits to double binary information.

Additionally, to extend the GOOSE address space of 32bits, single binary signals can be multiplexed to receiving input point. When assigning several signals to the same input, logical OR operation is applied and any logical TRUE (1) on any incoming signal will turn the input to TRUE. The DefaultInput value must be used by all signals in this scheme. See the example in Fig. 2.1.3.2.-1:

Select	IEDNa	LDInst	Prefix	LNCla	LNInst	DOName	daName	SourceOrdinal	TargetDAPath	ConfigRev	DefaultInput
☑	tyrann	LD1	ESW	CSWI	127	Pos	stVal	11	LD0.CIGGIO31.Ind2.stVal	4	0
☑	tyrann	LD1	CB	CSWI	120	Pos	stSeld	4	LD0.CIGGIO31.Ind16.stVal	4	0
☑	tyrann	LD1	CB	CSWI	120	Pos	stVal	1		4	0
☑	comt2	LD0	CO	GGIO	31	Ind7	stVal	19	LD0.CIGGIO32.Ind8.stVal	8	0
☑	comt2	LD0	CO	GGIO	31	Ind6	stVal	16	LD0.CIGGIO32.Ind8.stVal	8	0
☑	comt2	LD0	CO	GGIO	31	Ind5	stVal	13	LD0.CIGGIO32.Ind8.stVal	8	0
☑	comt2	LD0	CO	GGIO	31	Ind4	stVal	10	LD0.CIGGIO32.Ind8.stVal	8	0

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Fig. 2.1.3.2.-1 GOOSE input tool

Correspondingly, if you define TRUE (1) as default value, any FALSE (0) in incoming signals will turn the input to FALSE, implementing a simple logical AND function. Assigning the DefaultInput value and combining multiple sources are only applicable for BOOLEAN attributes, not quality or double-point attributes.

List of details:

- BOOLEAN type of data, 0 or 1
  - default value is configurable
- CODED ENUM attributes from double point data
  - default value is always "11"
  - values of double-point data cannot be multiplexed
- q, quality attribute type of data
  - if the communication supervision has detected a failure, it will be indicated with the default value "1", bad status
  - values of q cannot be multiplexed

Refer to the SPA-ZC 400 documentation. [3]

2.1.3.3. GOOSE communication

When a data change happens in a configured GOOSE system, the frame is sent multiple times in a fast cycle to overcome the possible short, sporadic errors in the communication. GOOSE data is sent multiple times in short interval Tmin in Ethernet priority (802.1Q) multicast frames over the local network. The IEDs are able to monitor the connections due to the cyclic background transmission Tmax of the GOOSE messages. By this way, a high reliability of data transmission can be reached.

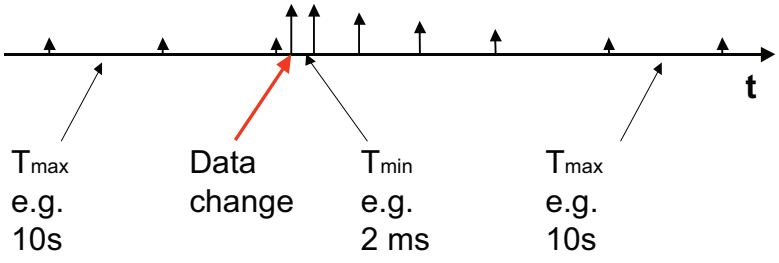

Fig. 2.1.3.3.-1 Data change in GOOSE system

2.1.3.4. GOOSE communication supervision

To secure the reliability and availability of the application, the GOOSE communication must be supervised and the application must be designed to handle loss of communication, e.g. bay not in service and IED not powered.

Every GOOSE frame has a Time Allowed to Live (TAL) field, which indicates how long the frame is valid until the next heartbeat frame should be received. This is set to 10 s in SPA-ZC 400 and cannot be changed. Other devices may have other TAL values, but TAL values under 1000 ms are rounded to 1000 ms on the receiving side.

If no frames are received during the time of 2xTAL on the receiving side, i.e. at least two consecutive frames are lost, the quality of the whole dataset received is set to “bad” and the input value is set to the default value stated in the ***DefaultInput*** field of the GSEInput object. This has to be taken into account when the application is designed. Communication losses are detected within 20 s.

DefaultInput value assignment is only applicable for BOOLEAN attributes, not quality or double point attributes, since these are predefined to “1” and “11”.

This means that for q attributes received, a communication fault will set the input to “1”, which means faulty. A communication fault for double point data will set the input to “11”. For Boolean data, on the other hand, the default value configured is used in the case of communication fault.

In worst case, finding a communication loss may take as much as 20 s.

More comprehensive supervision, if needed, say, cyclic transmission of “I’m alive” data, must be programmed for the application. One way to save the data and application work is to create a loop of IEDs with GOOSE. Then any failure in the loop will give all IEDs information about the problem. A drawback is that the system does not tolerate single failures or non-existing devices, e.g. in service situations.

Both the GOOSE input and output Logical Nodes can be monitored via any IEC 61850 client since these, as all the other LNs, are visible on the data model. From these objects, the user can monitor and diagnose the actual values of sent and received GOOSE data. When these data objects have valid quality, GOOSE data has been received or sent. Timestamp value indicates the last value change time.

The user can also diagnose the GOOSE communication from SPA-ZC 400 diagnostic web pages obtained behind its IP address with any web browser. From these pages, the user can check basic communication counter values and also IED specific counter values of received data.

See the SPA-ZC 400 documentation. [3]

2.1.3.5. Engineering principle using the bottom-up approach

Versions of the DA products and engineering tools to be used when programming GOOSE messaging:

- RE_541/3/5. See the firmware versions in Section 2.1.3.
- CAP505 2.4.0 supporting the firmware versions
- CET for SPA-ZC 40x 2.1

The engineering using CET is optimized in the 2.1 release for systems with horizontal communication only between SPA-ZC 400 devices. According to the IEC 61850 terminology, CET is not a fully-fledged system engineering tool.

If you need to engineer GOOSE between REF54_ and RE_670 or 3rd party IEDs, the CCT engineering tool must be used. This tool is supplied together with the PCM600 Pro. It is recommended always to use the latest IED connectivity package.

GOOSE signals available in other types of devices can be used with the mentioned limitations. In such a case, import a configured CID or SCD file, where GOOSE datasets and control blocks for 3rd party devices are defined.

In the same way, engineered GOOSE dataset of SPA-ZC 400 can be used by any 3rd party device, but their tools or system tools cannot be used to engineer SPA-ZC 400, i.e. define the information to be published.

To enable fast internal bi-directional communication link with Ethernet Interface, the protocol setting "Protocol 2" for RE_541/3/5 terminal must be set to IEC 61850, and correspondingly the bit rate in CET to 38400 bit/s.

To make the engineering of the IEC 61850 system more efficient, more Connectivity Packages are and will be available for ABB IEDs. Connectivity Package includes descriptions of data and signals available in the IED. These descriptions are used to automatically configure the communication in SPA-ZC 400 Ethernet Interface. Available connectivity packages can be downloaded from the ABB web pages.

After finalizing the RE_541/3/5 terminal application configuration, you must import the configuration file in the CET. All signal mappings from IED to IEC 61850 are automatically carried out if the corresponding connectivity package is present in your computer. Additionally, the CET allows the mapping to be deleted or changed and logical nodes and attributes to be altered, but this is not recommended since the consistency and standard compliance of the data model can be threatened, creating some unexceptional behavior of the communication to upper level station components.

From CET you can also export the CID type of the SCL file corresponding to the RE_541/3/5 terminal application configuration concerned. This file can then be used in station-level components, for example in COM600.

The detailed description of SPA-ZC 400 engineering using CET is provided in a separate document available in your computer after CET has been installed. [3]

2.1.3.6. Configuring GOOSE between RE_541/3/5 terminal and IED 670

GOOSE engineering between RE_541/3/5 terminal and IED 670 is done as follows after IED application engineering is ready. Configuration is done in CET for SPA-ZC 40x, CCT and PCM600. CCT tool comes along with PCM600 Engineering Pro.

1. Begin in CET for SPA-ZC 40x and create the GOOSE control block "GoCB", this will also create a GOOSE dataset. Define the GOOSE communication parameters under "GoCB" and define the data that should be sent in the GOOSE dataset to station bus. Refer to SPA-ZC 400 Installation and Commissioning Manual for details about GOOSE engineering.
2. Export the CID files to the hard drive.
3. As next we assume there is a CCT project where the basic IEC 61850 communication engineering has already been done for the IED 670s. Open this project and import all the SPA-ZC 400 CID files "import SCL file".

Now you will have access to the GOOSE configuration in the SPA-ZC and can configure the IED 670 inputs from it. Refer to CCT manual "Engineering quide IEC 61850 Station" for details about GOOSE engineering process with the IED 670.

4. When the communication engineering is done for all the IEDs in station import SCD from CCT back to PCM 600 and download the configuration to IEDs.
5. Return to CET tool for SPA-ZC 400.
6. Now you can create for all RE_541/3/5 terminals receiving GOOSE data from IED670s the GOOSE input "GSEInput" under LD0.LLN0. Open the Input Editor and select import and browse for the SCD file. Select the correct IED670 from the drop down list and mark the signals you want to import and press "apply". Repeat the import process for all IED 670 containing data you want. When you have all the inputs imported and mapped you press "Apply" and exit the Input Editor. Refer to SPA-ZC 400 Installation and Commissioning Manual for details about GOOSE engineering.
7. Now you can download the configuration to the SPA-ZC 400.

After this the GOOSE communication should work. If there are still problems it is recommended to check with an Ethernet protocol analyzer if the IEDs are sending the messages and also check if the messages contain the correct communication data. (Multicast MAC address, APPID). Good tool to use with GOOSE applications is ABB IEC 61850 Ethernet analyser tool, ITT-SA Explorer.

SPA-ZC 400 provides additional diagnostic information from its web-pages, which are available from any standard web-browser.

2.2. Applications

2.2.1. Ethernet network architecture and components supporting GOOSE messaging

Both star and loop based architectures of Ethernet networks can be used to transfer GOOSE messages. From the performance point of view, the star topology is able to transfer GOOSE messages faster, since every Ethernet component between the IEDs causes some delay. Performance is just one aspect to be considered. Other aspects, like availability and reliability of the whole Ethernet network, clearly indicate that the loop topology is to be preferred. Ethernet switches normally create a delay of about one microsecond, which, however, may increase at high communication loads. Based on this assumption, no more than 20 switches are recommended to be used in one loop. This limitation does not only apply to GOOSE, it is also applicable to the communication to upper level systems. When GOOSE messaging is required, the minimum and optimum transfer rate is 100 Mb/s, managed by an Ethernet switch with VLAN capability. RuggedCom or Westermo Ethernet switches are recommended. Both already have the mentioned features and fulfil the utility automation requirements (power supply, operating ambient temperature, IP degree of protection, etc.).

2.2.2. Applications in general

Both for utility and industry applications we must consider the performance level of SPA-ZC 400 when thinking about possible applications. As already mentioned, SPA-ZC 400 Ethernet Interface fulfils a 1P, 1B IEC 61850 performance class, which defines a 100 ms application to application response time. Based on this, GOOSE messaging of SPA-ZC 400 can be used for any application where a performance of 100 ms is sufficient. We recommend GOOSE messaging for the transfer of non-time critical binary data with information about interlocking and blocking.

As a general conclusion, if SPA-ZC 400 can be used for the application where the transfer of trip signal is required cannot be made, this should be evaluated case by case. Regarding these applications we must also consider the IEC 60834 standard, which says: “Trip command between protection functions need max. 20 ms.” IEC 61850 defines the performance class 1P, 1A, which is 10 ms, for trips. Both cannot be achieved using SPA-ZC 400 and therefore we do not recommend SPA-ZC 400 and its GOOSE messaging to be used where the transfer of trip signals between protection functions is required.

Additionally, when comparing the response time for interbay communications, traditional way and GOOSE, the traditional way also includes delays which GOOSE does not have, e.g. output relay operating time and binary input debouncing filter time, which also can be in the range of several tens of ms.

2.2.3. Classification of signals and applications for GOOSE

The signals transferred between feeders can be divided into six categories based on the application criteria, which usually also define the required response times.

1. Interlocking of commands

Any information from the process that is used for preventing a malfunction of an operation in order to achieve proper behavior of MV substation with maximum safety. (e.g. position of primary equipment). Normally the response time is not critical here, because the operation is controlled by humans.

2. Blocking of protection functions

Any information from the MV process that prevents unwanted trips in a MV substation for the purpose of increasing the reliability of the MV process. The response time is critical, but still the Start signal of the first protection relay is normally used to block the next function, which gives some extra time.

3. Automated functions

Functions, which increase the availability and reliability of the MV substation when an external failure could create unwanted disconnection of the MV substation from the network or the process (e.g. automatic busbar transfer). Response time requirements vary.

4. Trips of protection functions

Fast trips, which ensure safety by disconnecting the MV substation or parts of it from the process or the network, if the failure in question can cause significant damage to the processes or the MV substation (e.g. CBFP). Here the response time is critical; tripping should be carried out in the range of 20 ms as standard.

5. External signals

Information, which has to be transferred from the MV substation for a specific purpose outside the MV substation (e.g. group alarm which collects signals from several IEDs and/or bays). The requirements significantly depend on the use of the signal, but, for example, alarm indications are normally intended for humans, and the response time is not critical.

6. Distributed functions

Some functions may have to work in a distributed way, i.e. the functionality can be achieved by the interplay of several IEDs, for example, voltage control of parallel transformers). The required response time depends on the use, but e.g. for transformer control 500 ms is enough.According to the IEC 61850 standards all signals mentioned above can be transferred using GOOSE messaging with sufficient performance and high reliability. The GOOSE function of SPA-ZC 400 Ethernet Interface together with RE_541/3/5 terminal cannot be used for transmitting category 4 signals (Trip signals for protection functions) and 5 external signals. This is due to the limited performance (1P/1B) and amount of signals (32 bits) to be sent/received by one SPA-ZC 400 with RE_541/3/5 terminal.

RE_541/3/5 terminal with SPA-ZC 400 can be freely used in MV substations to transfer signals of category 1, 2 or 3 using GOOSE messaging.

2.2.4. Applications using interlocking signals for commands

The purpose of command interlocking is to block dangerous or unwanted control of switches based on information about the situation of other switches in the same substation.

The following interlocking and blocking signals are used for most interlocking and blocking logics in MV substations as inputs.

- Position of circuit breaker (Open/Closed)
- Position of busbar disconnectors (Open/Closed) / withdrawable truck (Service/Test)
- Position of earthing switch (Open/Closed)
- Position of busbar earthing switch (Open/Closed)
- Information about other ongoing command operations (*Selected* (Pos.stSeld)

These data are normally found in the Pos.stVal attributes in the IEC 61850 model either in the CSWI, XCBR, or XSWI logical nodes. The selected information is found from the Pos.stSeld attribute. Selection data is generated in Ethernet Interface Command Handler, and it is the fastest method to send selected information. CAP505 application programming is not required.

With SPA-ZC 400, the best response times are achieved if, instead of named data, internal horizontal communication signals from the application are used, see Implementation of GOOSE in SPA-ZC 400 with RE_541/3/5 terminal.

When the signals described above are transferred between different feeders as inputs to the logics configured in the IEDs, which create interlocking or blocking conditions based on the requirements in the specific MV substation. The traditional way is to wire the signals from a dedicated feeder to dedicated feeders or from dedicated feeders to a dedicated feeder. A change required in an interlocking or blocking scheme almost always leads to a change in the drawings, wiring, and configurations of the IEDs.

When RE_541/3/5 terminal is used with SPA-ZC 400, the above mentioned signals can always be configured to be transferred from each RE_541/3/5 terminal using GOOSE messaging. All possible signals needed for blocking or interlocking are available for processing by any RE_541/3/5 terminal connected to this network. For the interlocking or blocking scheme of a particular feeder you just have to define which of the possible signals available are needed as inputs to the interlocking or blocking logic configured in an IED. A change in the interlocking or blocking scheme will cause no change in the wiring and drawings of the LV part. The signals and the configuration for the particular feeder affected have to be redefined.

In the following, three typical examples are shown. For implementation details, contact our technical support.

2.2.4.1. 1-out-of-N[3]

In addition to the interlocking function another system is to ensure that only one primary switch at a time can operate, the so-called reservation or 1-of-n blocking. There are a number of safe solutions, but the following method is preferred:

- Reservation based upon the selected state. This means that all primary switches in a command scheme must check the selected state (Pos.stSeld) of all other primary switches of concern prior to operating.

The selection based reservation uses the stSeld attribute on the ‘other’ CSWIs to determine whether an operation is in progress or not. When a select request is received by a CSWI1, it checks that no other CSWIs in the reservation scheme are in a selected state prior to setting the stSeld in CSWI1.

If any other CSWI is in a selected state set by its stSeld, the select request is rejected. In SPA-ZC 400, no further details of a selection failure can be included, i.e. AddCause.

If another stSeld is received during the selected state, but before the Operate request has been received, then two select requests have been sent out at the same time and the selected state has to be cancelled everywhere with addCause = “1-of-n control”. As before, SPA-ZC 400 cannot send AddCause information.

The stSeld attributes are typically distributed via GOOSE services. The distributed dataset also contains the corresponding switch positions from the XCBR / XSWI for interlocking.

If the reservation shall be valid only for a specific part of the switchyard, e.g. a busbar zone or a voltage level, and then the receiving IED has to consider just the relevant stSeld signals from the incoming GOOSE messages.

2.2.4.2. 2-out-of-3

In a two-section busbar system there is a bus coupler and a bus riser between the separately supplied bus sections. Generally incomers from different supplies cannot be interconnected. The interconnection can be prevented by means of interlocking. The name of the scheme stems from the principle that only 2 out of 3 breakers (Q1, QC, Q25) in the scheme can be closed at the same time.

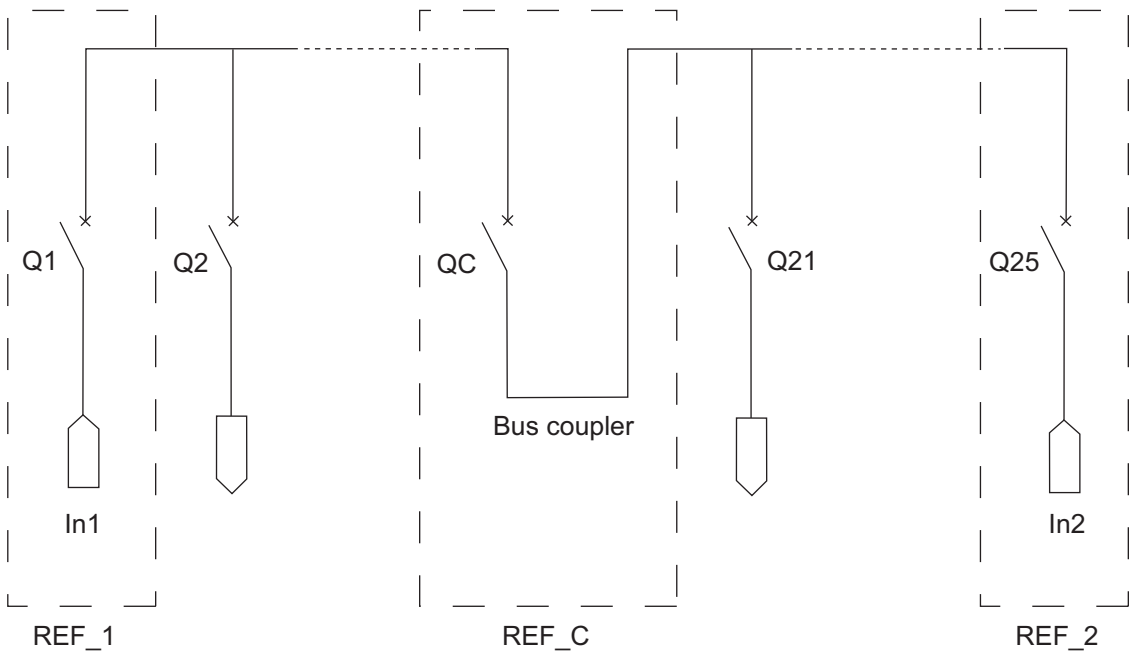

Fig. 2.2.4.2.-1 2-out-of-3 interlocking

Now if the status of the other breakers is known by the command logic of the controlled IED, illegal operations can be prohibited.

2.2.4.3. Busbar earthing

In UniGear switchgear configurations, a special busbar earthing device is installed. The earthing mechanism is a mechanical device, which can be interlocked by the RE_541/3/5 terminal handling the concerned bay. The busbar is not allowed to be earthed if any of the bays in this section are in service, i.e. the truck is in service position. Correspondingly, if the busbar is earthed, electromechanical interlocking systems prevents the CB trucks from being switched into service position.

GOOSE services can be used to transfer truck position and earth switch position information to all RE_541/3/5 terminals involved. (Pos.stVal attribute to be used, or alternatively, if considered time critical, COM_OUT in the IED application and corresponding COGGIO.Ind).

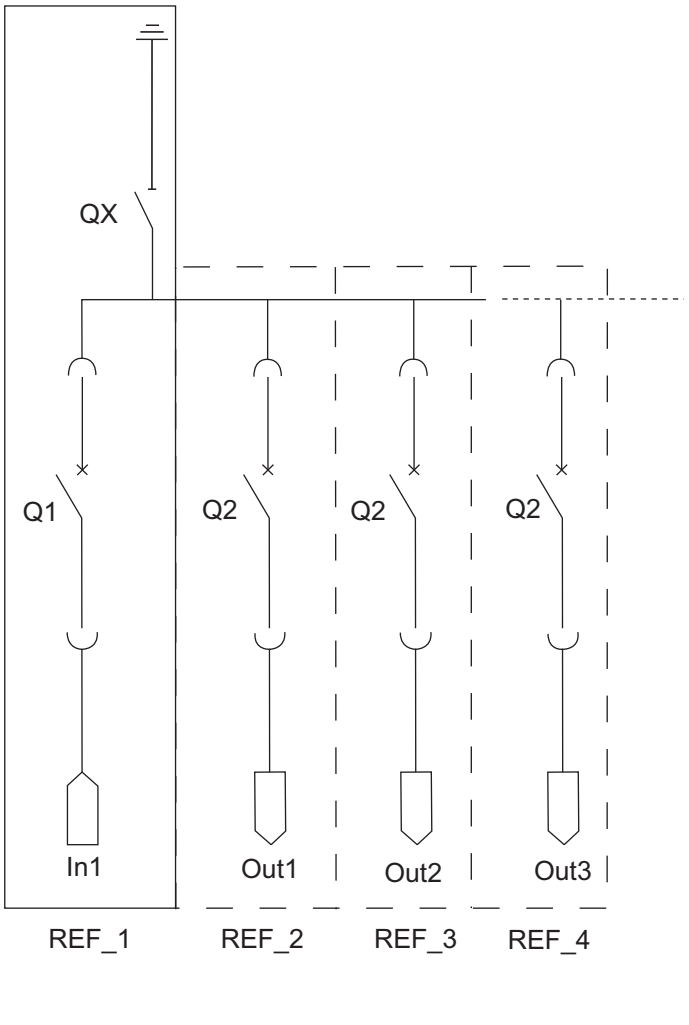

Fig. 2.2.4.3.-1 Interlocking based on busbar earthing, single line diagram

2.2.5. Applications using blocking signals for protection functions

GOOSE services can also be used with caution to block protection functions. One of the simplest applications is described here. It can also be found in the DA Supportline Knowledgebase. (http://abb.custhelp.com/)

If a fault occurs on the feeder, the overcurrent relay of the outgoing feeder sends a blocking signal to the overcurrent relay of the incoming feeder.

If the fault occurs on the busbar system, no blocking signal will be issued and the 3I>> stage of the overcurrent relay of the infeeder delivers a trip signal to the infeeder circuit breaker. If no auxiliary trip relay is used, it is therefore possible to use a minimum operate time of 100 ms, when a fault occurs on the busbar system.

The time, which must be permitted for a blocking signal between two relays, does not depend on the time setting of the downstream protection relay, because the blocking is usually obtained from the start signal (PTOC.Str.general).

The time setting for a blocked stage can always be 100 ms (or longer, if e.g. directional overcurrent relays are used), no matter how many consecutive relays/ substations there are. Nor does it matter what the time setting of the downstream relay is, because the blocking is usually received from the start signal. (PTOC.Str.general).

The blocking time includes the start time of the relay, the input delay of the relay to be blocked and a safety margin.

The blocking is usually done in a conventional manner by copper wiring, but the horizontal communication with GOOSE can be used as well.

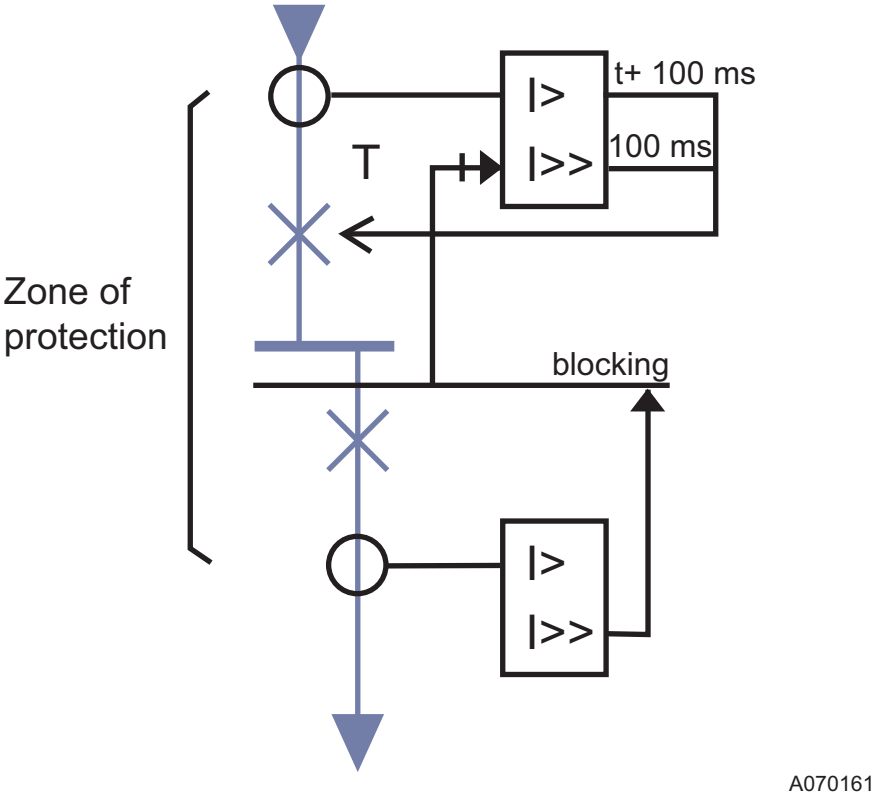

Fig. 2.2.5.-1 Protection blocking

2.2.6. Automation functions

2.2.6.1. Automatic busbar transfer

A reference document [1] available describes the function of various wiring diagrams for automatic change-over normally used and proven by practical experience gained when powering the busbars of the UniGear type switchgear. The solutions focus on typical applications encountered in normal service, i.e. the use of programmable REF54_ series terminals, in switching stations arranged as follows:

1. Switching station consisting of two busbar sections, separated by a bus coupler.

2. Switching station consisting of one busbar section with two separate inputs.

3. Switching station consisting of two busbar sections, separated by a bus coupler, and synchrocheck functionality.

These same applications can also be implemented with GOOSE. Notice that also in case 3), the performance is acceptable since the critical synchrocheck function is included in one RE_541/3/5 terminal.

An example drawing of case 1) is shown below. For more details, e.g. signals needed for the horizontal communication, see the referenced guideline document [1].

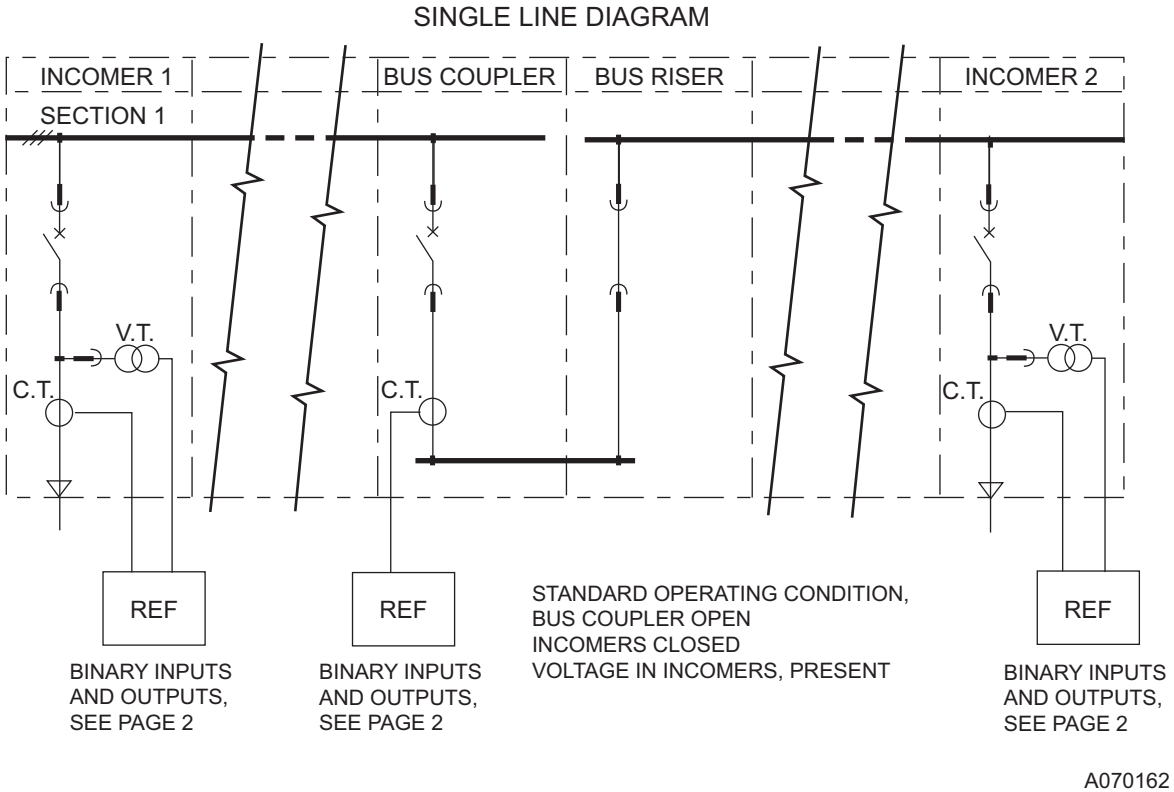

Fig. 2.2.6.1.-1 Busbar transfer example, 2 incoming feeders, 2 busbar sections + bus coupler

2.2.6.2. Frequency or voltage based load shedding

In heavy industry or in special utility applications, automatic load shedding may sometimes be required. The load shedding can be based either on the network frequency and/or voltage. The Start signal of the voltage or frequency protection relays is used to drop loads in a predefined order implemented with a delay scheme for the separate outgoing feeders. Restoring the supply is usually a manual operation, but it can also be automated.

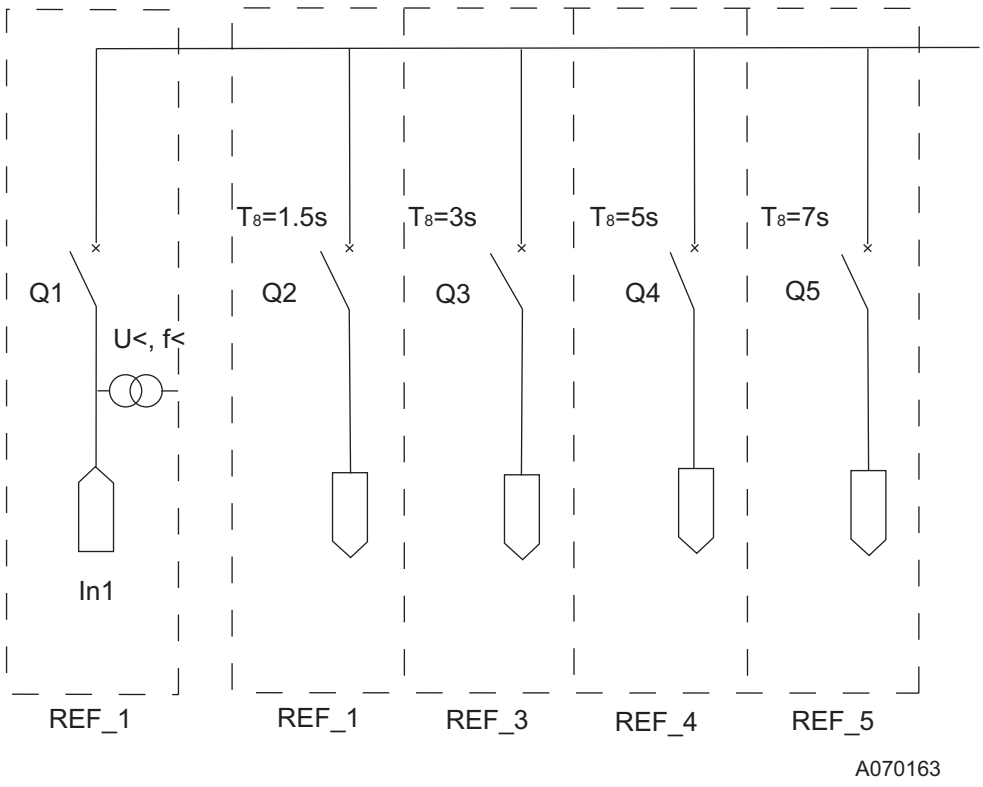

Fig. 2.2.6.2.-1 Simple load shedding system based on frequency measurement

In this case, the PTUF.Str.General attribute from REF_1 is communicated using GOOSE communication to the RE_541/3/5 terminals of the outgoing feeders, which trip after the preset time delay, if the underfrequency *Start* signal stays active.

In contrast with the individual timer scheme shown in the previous picture, the outgoing feeders are sometimes allocated to groups, which are shed at the same time. The allocation to a group can also be changed from the LHMI of IED.

2.2.7. Distributed functions

2.2.7.1. Voltage control of parallel transformers

This application is described in the RET541/543/545 documentation for the voltage control function, COLTC. [5]

Short description of the applications:

Minimizing Circulating Current

The MCC (Minimizing Circulating Current) principle is the optimal solution for controlling parallel power transformers of different ratings or step voltages in substations with varying reactive loads. Since this control scheme allows data to be exchanged between regulators, the circulating current can be calculated more exactly than with other schemes. The method uses phasor information from the other relays. Therefore, horizontal communication is needed between relays, when the MCC principle is used. The figure below shows the connection between two regulators.

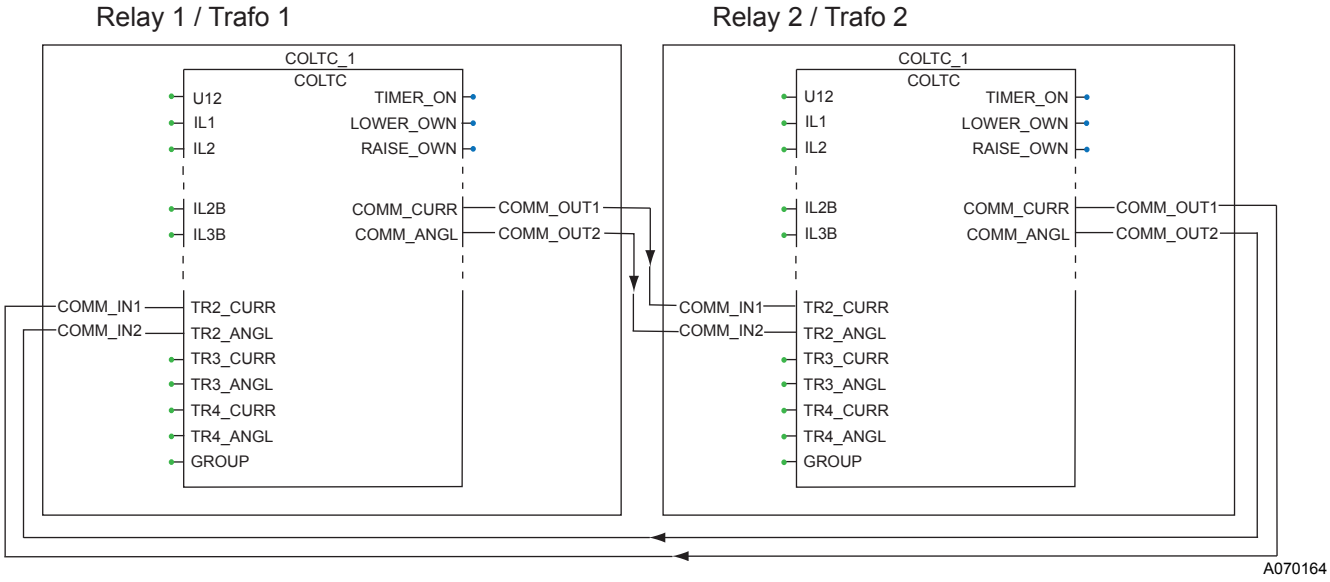

Fig. 2.2.7.1.-1 Two parallel transformers and the horizontal connection of the voltage regulators for the transfer of current and phase angle information when the MCC principle is used

The example in the figure above uses COM_IN1 global variables, and it must be noted that with GOOSE, specific COM_IN and COM_OUT variables must be used, see Section 2.1.3. Implementation of GOOSE in SPA-ZC 400 with RE_541/3/5 terminals.

Master/follower

Additionally, in the Master/follower mode the tap changer position information between the IEDs can be transferred using horizontal communication and GOOSE. For more details, see reference [5].

3. Revision history

Table 3.-1 Revision history

Revision	Description	Date
A	New document created	26.02.2007
B	Updated RE_541/3/5 terminal information	10.04.2009

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