

IEC 60870-5-101 COMMUNICATIONS PROTOCOL

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PURPOSE AND SCOPE

The Technical Specifications for all new plant, equipment, apparatus and services, for use on the National Grid UK Electricity Transmission system, are contained in a three level hierarchy of documents. Level 1 covers ratings and general requirements, Level 2 covers major plant categories and Level 3 covers specific related plant functions.

This document is a Level 3 specification, which describes the functional and performance requirements for the IEC 60870-5-101 communication protocol.

This protocol is designed for use in Supervisory Control and Data Acquisition (SCADA) applications and this document describes the requirements of the slave system when communicating with a master system.

An example slave system application is a National Grid Substation Automation System (SAS), which is polled by the Electricity National Control Centre (ENCC) master system (iEMS). See Figure 1

The protocol standard documents IEC 60870-5-1 to IEC 60870-5-6 and companion standard IEC 60870-5-101 Ed2 define the requirements of the communications protocol. Whilst the IEC 60870 series of standards define the requirements of the communications protocol, they do not describe how to use the protocol when implemented on particular systems.

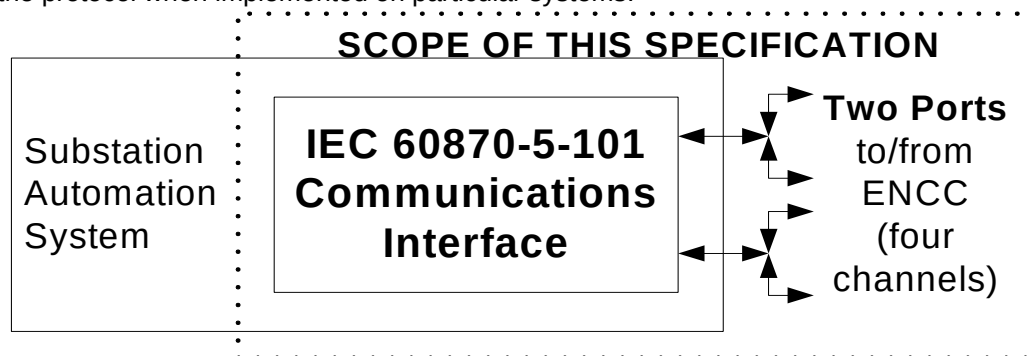


Figure 1 - Scope

This Protocol Implementation Document (PID) selects options from IEC 60870-5-101 standard for use in slave mode applications. In addition there are some issues outside of the companion standard, which are essential to the correct working of the protocol on National Grid's telecommunications networks. These include system specific parameters where the standards allow choice, higher level requirements such as backup communications and methods of performing sequences of communication functions.

The particular configuration requirements of IEC 60870-5-101 for an SAS for connection to the Integrated Energy Management System (iEMS) application are described in TGN(E)165.

PART 1 – PROCEDURAL

1 FUNCTIONAL REQUIREMENTS

1.1 Type Registration

The supplier shall provide a certificate of conformance to the IEC 60870 standard from an accredited third party test house.

The latest versions of the standards and any published amendments shall be used.

The conformance testing shall be in accordance with the principles of IEC 60870-5-6 and the test cases as defined in IEC 60870-5-601.

The supplier shall provide completed Type Registration and Self-Certification Statements inclusive of test report references, model numbers, software and firmware references etc, to clearly identify the version of the communication interface and functionality covered by the protocol implementation.

National Grid SCADA communication strategy includes future migration to IEC 60870-5-104 network routed protocol. Suppliers shall state the current level of support and compliance for this protocol standard on their protocol platform and how future upgrade and implementation can be achieved.

National Grid SCADA communication strategy is to adopt a protocol security layer in accordance with IEC 62351-5. Suppliers shall state the current level of support and compliance against this security standard and how future upgrade and implementation can be achieved.

1.2 Requirements for Data Acquisition

This section gives supplementary information to the Interoperability Statement, which can be found as Appendix A1 to this specification.

1.2.1 Station Initialisation

Informative: Station initialisation consists of a reset of the communications link, followed by a general interrogation (GI) of the slave station. On completion of the GI the master station will begin its normal scanning (for Class 2 data)

1.2.2 Normal Acquisition

Informative: At the master station the following parameters will be set: -

- a) *Frequency of General Interrogation requests: adjustable between 1 minute and 24 hours. Pre-set to 30 minutes.*

- b) *Frequency of Test Command: adjustable between 30 minutes and 24 hours or none (manual). Pre-set to 12 hours.*
- c) *Timeout interval for repeated frame transmission: adjustable between 50 ms and 5s. Pre-set to 500 ms.*
- d) *Number of repeat frame transmissions: adjustable between 0 and 10. Pre-set to 3.*
- e) *The maximum poll interval will be set to 2 seconds.*
- f) *The iEMS scanning regime will use the request for Class 1 data to acquire events from the slave station, if a response to a request for Class 2 data has the ACD bit set*

Informative: The master station scanning regime will use polling for Class 2 data.

- g) *If in the response to this request, the ACD bit is set, then the master station will subsequently request Class 1 data from the slave station.*
- h) *Deleted*
- i) *If the response to a scan for Class 2 data repeatedly indicates no data is available a General Interrogation scan will be scheduled.*
- j) *If the continued setting of the ACD bit means that a scan for Class 2 data has not been sent for more than the predefined time, a scan for Class 2 data shall be inserted as the next scan.*
- k) *The slave station may return Class 1 data in response to a Class 2 request if no Class 2 data is available and Class 1 data is awaiting transmission.*

At the slave station, if a request for Class 2 data is received and no data is available a negative response, data not available, shall be returned to the master station. The negative response may be a fixed length frame (FC=9) or the Single Control Character (E5), which in this case is treated as a NACK.

At the slave station, the processing delay for each frame shall be less than 50 milliseconds and the value to be stated with any statistical variance.

Class 1 data occurring at the slave station shall cause the ACD bit to be set in the next Class 1 or Class 2 data response. The master station shall respond to ACD set by inserting a scan for Class 1 data as the next scan.

The response to a Class 1 data request shall also have the ACD bit set if more Class 1 data is awaiting transmission. In this case a further scan for Class 1 data shall be scheduled by the master station.

At the slave station, if a request for Class 1 data is received and no data is available a negative response, data not available, returned to the master station. The negative response shall be a fixed length frame (FC=9) or the single Control Character (E5), which in this case is treated as a NACK.

The event buffer for each communication port shall be set to limit between 500 and 1500 events.

The event buffer shall not store repeated Class 2 analogue messages, only the latest and current value shall be stored in the event buffer for reporting

1.2.3 General Interrogation (GI)

Informative: General interrogation of each slave station shall be performed periodically by the master station. In the event of loss of communications to a slave station a GI will be performed as part of the re-connection procedure.

Informative: The master station should be aware of the following paragraph from IEC 60870-5-5: "The outstation interrogation procedure can be interrupted by events which may occur in the slave station."

The GI shall return the current status information directly from the slave station's database.

Time tags shall not be used for data items returned as part of the GI response.

If GI groups are supported these will be set up in the database and each of the (up to 16) groups shall be requested/reported individually.

1.2.4 Clock Synchronisation

Informative: Clock synchronisation via the telecommunications network is not required, since each substation has its own highly accurate GPS clock. This method is considered more accurate, due to variable delays on the communications network.

The slave station shall use the local GPS clock as its time synchronisation source.

The invalid bit in the time-stamp shall be set when the time source is not available.

The slave station shall report any time correction by sending a clock synchronisation message (ASDU 103) to the master station, as Class 1 data, with a cause of transmission spontaneous (COT = 3).

1.2.5 Command Transmission

All commands shall be Select before Execute.

Informative: The maximum time between the Select and Execute commands sent by the Master Station shall be 2s.

If the Execute command is not received within 2s of the Select command, the command process shall be terminated.

Activation termination (C_SE_ACTTERM) shall be returned to the master station to signal the end of a control sequence.

Informative: the master station requires certain responses to be received within specific time windows, else error messages are generated.

Positive ACTTERM is required to be sent to the master station, within 5s of the Execute command being received and actioned by the slave station. Note this may need to be before the appropriate indication changes state particularly from slow moving plant.

Informative: If the ACTERM is not received within 5s of the Execute command, then a Deactivation command will be sent by the master station.

Feedback from associated indications shall be sent within 60s of receiving the Execute Command for the associated control.

The QU field of the Qualifier of Command shall be set to zero (0), no additional definition, as there is no requirement for control of the duration of the output pulse.

1.2.6 Test Procedure

Informative: A test command may be issued by the master station at any time to ensure the availability of the communications link and the commands subsystem.

Test commands may be sent to the slave station on the active link. The slave station shall mirror the test command, on the link from which it was received, with a cause of transmission indicating activation confirmation.

An error response should be sent if the command is incorrect, with a cause of transmission indicating negative activation confirmation.

1.2.7 Communications Failure

Informative: Communications to the slave station shall be re-initialised where the frame repeat process has completed without successfully transmitting the frame (i.e. the frame time-out period times the number of repeats).

1.2.8 Slave Station Failure

The slave station shall indicate to the master station that it has initialised by sending a frame indicating End of Initialisation with a Cause of Initialisation (COI) field, which will identify the reason for the initialisation.

1.3 Requirements Specific to Protocol Layers

This section gives supplementary information to the Protocol Interoperability Document, which can be found as Appendix A1 to this specification.

1.3.1 Physical Layer

The physical layer interfaces for the four communication channels at the slave station, shall conform to the EIA RS232 DE-9 standard.

A separate interface panel/facility shall be provided for connection of the communication services. This shall be fixed within the cubicle to a suitable mounting rail.

Each communication channel interface shall be provided with a parallel connected EIA RS232 DE-9 connector for the “in service” connection and disconnection of communications line monitoring equipment. This shall be part of the interface panel facility.

The physical interfaces for communication services shall be a 9 pin D-SUB male plug.

The interface shall be an unbalanced interchange circuit conforming to ITU-T V.24 with signal levels to ITU-T V28.

The pin connections used shall be as a Data Terminating Equipment (DTE): –

Pin	Service	Slave Station Use
1	DCD	Not Used
2	RXD (104)	Data from Master Station
3	TXD (103)	Data to Master Station
4	DTR	Not Used
5	0V (102)	Signal Ground
6	DSR	Not Used
7	RTS	Not Used
8	CTS	Not Used
9	RI	Not Used

Any additional hardware communication handshaking signals required, shall be provided at the suppliers communications interface.

1.3.2 Link Layer

For any slave station, every communications link to that station will have a unique Link address.

1.3.3 Application Layer

The Common Address of ASDU shall be unique for each slave station.

For any slave station, each data item within that station shall have a unique Information Object Address (IOA).

The supplier to state which Quality descriptors are supported and how these are implemented.

1.4 User Processes

The following processes for the iEMS connections are required to be supported, but are not considered as part of the IEC 60870 standard.

1.4.1 Channel Switching

Informative: To provide backup and physical diversity the communications between the slave and master stations there is a requirement for the communications to be able to be directed to one of two physical channels out of each of the master stations (iEMS Main and DBU).

The slave station is required to have 2 physical channels to the iEMS Main and 2 physical channels to the DBU.