

GPS SUBSTATION CLOCK

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PURPOSE AND SCOPE

This specification defines the functional requirements for substation clocks that use the Global Positioning Satellite (GPS) system as a time reference source. It is to be used for all new and replacement substation clock applications. The functional requirement detailed in this specification can be provided by a substation control system or as separate stand-alone device. The GPS clock function provided by this specification may not be suitable for high accuracy requirements such as Unit Protection systems.

PART 1 – GENERAL REQUIREMENTS

1 FUNCTIONAL REQUIREMENTS

1.1 General

1.1.1 GPS shall be used as the time reference throughout National Grid on all new installations and where there is a need to replace existing equipment.

1.1.2 The time standard used shall be UTC.

Informative: Time distribution is in UTC format. There may be an operational need to display local time by adding one hour during British Summer Time; this shall be performed by the user system for display purposes only. All time data should be logged and stored in UTC format.

1.1.3 The clock shall have at least an eight-channel parallel C/A code receiver operating in the L1 band.

Informative: This requirement will enable the receiver to process signals from eight or more satellites, in view, at any one time. Where possible, the receiver should also be capable of receiving signals in the L2C band.

1.1.4 In addition to the C/A code, the receiver shall be capable of receiving and processing the Navigation Message, in particular the satellite health and status information. The clock shall ignore time signals from any satellite that has the health or status flags set to abnormal.

1.1.5 The clock shall be capable of distributing time via a 100BASE-TX (100 Mbit/s) Ethernet Port using Network Timing Protocol (NTP).

Informative: The clock can also support the earlier 10BASE-T (10 Mbit/s) Ethernet ports for backward compatibility.

1.1.6 The network timing protocol shall be UDP/IP on port 123.

1.1.7 An information interface shall be provided through the Ethernet port to allow for remote setting of date and time, remote configuration, diagnostics and alarms.

- 1.1.8 The software for remote operations shall be provided together with the appropriate documentation.
- 1.1.9 Simple Network Management Protocol Version 3 (SNMPv3) shall be supported on the information interface.
Informative: In terms of protocol of SNMPv3, there is no change in comparison of SNMPv1 & SNMPv2. However, additional cryptographic security is considered in SNMPv3.
- 1.1.10 After power up the clock shall establish its location to enable the time of day to be determined accurately. Once the clock has established its location it shall be capable of determining the time of day within 100 ns of UTC by receiving the GPS signal from one or more satellites.
- 1.1.11 The clock operating system shall be able to detect and ignore erroneous time data either correctly or incorrectly formatted by using RAIM (Receiver Autonomous Integrity Monitoring) or other suitable algorithms.
Informative: As an example a satellite fault may result in correctly formatted time data being transmitted with an incorrect time of day. The clock system shall be able to detect the error by comparing its own time or that from other satellites and ignore the errored data.
- 1.1.12 Where specified in the supply contract, the clock system shall have a receiver and processing system which is GNSS (Global Navigation Satellite System) compatible. If alternative signal source is required for additional reliability, suitable solution(s) shall be agreed by National Grid.
Informative: The receiver may need to be capable of receiving and processing signals from different satellite systems such as the GLONASS, Galileo, the ELORAN terrestrial based service or the EGNOS system which gives a significant increase in availability and dependability of time and location transmissions.
- 1.1.13 The clock shall be provided with an internal back-up reference source so that a time output is available in the event the clock does not receive a GPS signal, an alarm shall be raised and transmitted on the information interface when this condition exists.
- 1.1.14 A display shall be provided on the front panel of the clock with showing the time of day HH:MM:SS, the date DD/MM/YYYY, the clock status and any alarm conditions that exists.
- 1.1.15 A time setting facility shall be provided via the information interface to enable the setting of the time of day and the date to enable the clock to be put into operation if the GPS signal cannot be received for whatever reason.
- 1.1.16 The clock shall automatically adjust itself to the correct time and date after a period of free running when the GPS signal becomes available.
- 1.1.17 The clock shall be self-monitoring and produce an alarm output on volt-free change-over contacts should there be a failure of the clock system or its power supply.
- 1.1.18 An alarm indicating the loss of reception of the GPS signal shall be provided, the alarm shall be displayed on the front display and transmitted over the information interface.
- 1.1.19 When called for in the supply contract an additional interface is required, as described in Appendix A, for interfacing to legacy equipment.
- 1.2 Output Ports**
- 1.2.1 There shall be an output port to provide time data in IRIG B format with an analogue output of ± 6 Vpp into 75 Ω modulated at 1 kHz.

1.2.2 Where an IRIG B signal is to be distributed across site this shall be via a fibre optic converter system that converts the IRIG B electrical signal at the transmitter into optical format and vice versa at the receiver. The supply contract will state if this requirement is to be supplied.

1.2.3 There shall be an optional standard serial communication port such as RS 422 or RS 485, to provide 1 pulse per second.

1.3 GPS Signal Reception

1.3.1 The clock shall be provided with a matched aerial or other device to receive the GPS transmissions. Where the aerial requires a power supply this shall be provided from the clock.

1.3.2 The aerial shall be installed in a location with an unrestricted visibility of the southern hemisphere from east to west.

1.3.3 The aerial shall be capable of suppressing or rejecting multipath or other unwanted interference in certain circumstances where there are structures that can reflect the signal into the aerial.

1.3.4 Where necessary and appropriate, extremely low loss cables or signal amplifiers shall be provided to achieve the required connection between the aerial and the receiver.

1.3.5 The aerial cable shall be part of the clock supply.

2 ELECTRICAL HARDWARE REQUIREMENTS

2.1 General

2.1.1 The clock shall be suitable for cubicle mounting with terminations on the rear panel.

2.1.2 Dimensions of the clock unit shall be in accordance with IEC 60297-3-100; a maximum height of 2U is preferred.

2.1.3 The receiver and the aerial shall operate in a physical environment as specified in TS 1 and provide the performance as required under TS 1.

2.1.4 The requirements of TS 3.24.4 shall apply.

2.1.5 The requirements of TS 3.24.15 shall apply.

2.1.6 Where the equipment is to be installed in a Grid Control Centre, port test levels shall be applied as defined in Table 7 of TS 3.24.15.

2.1.7 Where the equipment is to be installed in a substation, port test levels shall be as defined in Table 5 and Table 8 of TS 3.24.15.

2.1.8 The GPS receiver shall be powered by the standard substation DC supply system as per TS 3.12.4.

3 PERFORMANCE REQUIREMENTS

3.1 With the reception of a valid time signal

3.1.1 After the initialisation period the internal clock time shall be within 1 μ s of UTC.

3.1.2 The NTP output shall provide accuracy of 1 to 10 ms of UTC depending on the network configuration.

- 3.1.3 The IRIG B output shall provide accuracy within 10 μ s of UTC.
- 3.1.4 The 1 pulse per second output shall be synchronised to within 1 μ s of UTC.
- 3.2 The long-term time drift from UTC of the clock when not receiving the GPS signal shall be $\leq \pm 10$ ms per week within a temperature range of +5 to +40°C.

4 TYPE REGISTRATION

- 4.1 National Grid Type Registration shall be in accordance with TP 183.
- 4.2 The supplier shall perform a series of tests to demonstrate that the product meets the requirements of this specification.
- Informative: Manufacturers test reports confirming performance to the requirements of this NGTS may be acceptable in lieu of specific tests.*

5 CONTRACT SPECIFIC OPTIONS

- 5.1 The requirements for GNSS capability (see 1.1.1)
- 5.2 The requirements for an optical IRIG B convertor (see 1.2.2)
- 5.3 Legacy interface requirements when specified (see Appendix A)

6 FORMS AND RECORDS

Not Applicable

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

7 DEFINITIONS

C/A code	Coarse/acquisition code; civilian code used for transmitting GPS data.
EGNOS	European Geostationary Navigation Overlay Service.
GNSS	Global Navigation Satellite System.
GPS	Global Positioning Satellite Navigation System.
IP	Internet Protocol (RFC 791).
NTP	Network Timing Protocol; defacto standard used for distributing time data over a LAN/WAN (RFC 5905).
RFC	Request for Comments; vehicle for publishing internal standards.
SNMP	Simple Network Management Protocol (RFC 2570).
UDP	User Datagram Protocol (RFC 768).
UTC	Universal Co-ordinated Time (International time of day standard).