DYNAMIC SYSTEM MONITORING (DSM)

This document is for internal and contract specific use only.

PURPOSE AND SCOPE

This document describes the technical requirements for User's equipment directly or indirectly connected to the National Electricity Transmission System who are required to provide Dynamic System Monitoring equipment pursuant to the terms of the Bilateral Connection Agreement.

This document details the functional and performance requirements for Dynamic System Monitoring (DSM).

Equipment topologies other than those proposed in this specification are acceptable where such solutions can be demonstrated by the User to meet the overall functional and performance requirement specified herein. In particular, different monitoring and fault recording functions can be integrated into the same hardware, provided that the required data can be recorded and retained in line with the requirements specified for each data type.

PART 1 – PROCEDURAL

1 FUNCTIONAL AND PERFORMANCE REQUIREMENTS

1.1 General

1.1.1 DSM is required to provide data on a substation and system wide basis of System Dynamic behaviour on a continuous time series basis.

1.1.2 Access to system data, parameter settings and the configuration of equipment shall be via a secure network connection.

1.1.3 The DSM system shall comprise:

a) A data acquisition unit providing both local and remote access capability.

b) A master server at substation level and software to interrogate and collect data from all bay level data acquisition units.

c) All appropriate user software to access and analyse data stored on the substation master servers.

1.1.1 All DSM equipment shall be dual rated for use on both 110 / 48V DC supplies.

1.1.2 The Data Acquisition Units shall have at least 2 x Ethernet ports and 1 x USB port

Each Ethernet port shall be capable of accepting individual TCP/IP address's and manage the data traffic independent of the other.

All cross site communications shall be conducted using fibre connections.

The USB port or a third Ethernet port shall be utilised to update the firmware locally and provide access to system configuration locally.

1.2 Time Keeping

1.2.1 Sampling of inputs and all derived data shall be time-tagged.

1.2.2 Inputs shall be sampled such that a 1 µs timing accuracy is achieved.

1.2.3 Storage of data shall maintain the timing accuracy specified in 1.2.2.

1.3 Continuous Time Series Data

1.3.1 All data acquired by the Data Acquisition Unit shall be continuously stored.

1.3.2 The storage rate shall be user selectable but capable of at least 256 samples per cycle (i.e. 12.8kHz)

1.3.3 Non-volatile static memory shall be provided for storage of a minimum of 28 days data, prior to overwriting on a first in first out basis.

1.3.4 In the event of a deviation from the minimum or maximum set thresholds, the Data Acquisition Unit will trigger a flag, attach it to the event and raise a notification to the substation master server. Each user shall be able to customise their individual profile to state which system parameter flags they will be notified of. Users shall be notified of event flags immediately via user defined means (email, sms).

1.3.5 The following flag types shall be provided as a minimum for the parameters given in Table 1.

a) Rate of change ($\pm$).

b) Level (over and/or under).

c) Oscillatory condition of active power values. Setting shall enable the detection of small oscillations to be made on the basis of the oscillation period, amplitude, and the number of oscillations within a given time window. The frequency of the oscillations will be in the range 0.01 to 5 Hz. Settings shall enable the detection of small oscillations to be made by configurable frequency bands.

d) Status inputs (change of state: open to closed, closed to open, or both).

1.4 Parameters to Measure for the Activation Flags

1.4.1 Parameters comprising derived values from CT and VT inputs and plant status inputs shall be determined on a real time basis as required below for the purpose of activation of flags:

a) For each 3-phase voltage and current vector group: 3-phase active and reactive PPS power values.

b) For each 3-phase voltage and current vector group the PPS and NPS sequence components (rms magnitude).

c) For each vector group having single-phase voltage input: the active and reactive power values, scaled as total 3-phase power (Based on PPS current).

d) For each voltage vector group having a single-phase input: rms magnitude.

e) For each voltage vector group the system frequency, derived from one of the 3 phase VT inputs.

f) Plant status inputs

1.4.2 For HVDC converter stations the following additional parameters shall be measured for the purpose of activating flags:

a) DC voltage

b) DC current

1.5 Accuracy, Resolution and Measurement Range for Time Series Data

1.5.1 Accuracy requirements shall be met over the power system frequency range of 45 – 55 Hz. The supplier shall provide data regarding the performance over the range 40 to 60 Hz.

Parameter	**Measurement Range**	**Accuracy (±)% of nominal input**	**Resolution (±)% of nominal input**	**Notes**
r.m.s voltage	0 – 1.5 Vn	0.1	0.01	Crest Factor ≤ 1.5
Phase sequence components (voltage)	0.8 – 1.5 Vn	0.1	0.01	Crest Factor ≤ 1.5
Phase sequence components (current)	0 – 5 In	0.1	0.02	Crest Factor ≤ 3.0
Active Power	0 – 5 Pn	0.5	0.01	Pn = nominal active power = Vn.In. Cos |. Accuracy to be maintained over the power system phase angle range unity to 60° Lag/Lead
Reactive Power	0 – 5 RPn	0.5	0.01	RPn = nominal reactive power = Vn.In. Sin |. Accuracy to be maintained over the power system phase angle range zero to 30 ° Lag/Lead
Frequency	45 – 55Hz	0.005	0.001	20 to 150% Vn.

Table 1: Accuracy, Resolution and Measurement Range.

Note: Measurement range, accuracy and resolution for DC voltage and current shall align with the corresponding quantities of the AC system as listed above.

2 DATA & USER REQUIREMENTS

2.1 Software and Firmware

2.1.1 DSM firmware shall be available to National Grid free of charge and on an as required basis to enable upgrade activities.

2.2 Client Software User Interface

2.2.1 The User Software shall allow up to 12 analogue and 12 status channels to be selectable for simultaneous display.

2.2.2 The channels required for display shall be selectable from any Data Acquisition Unit on the system.

2.2.3 All data selected for display shall be clearly identified by its source.

2.2.4 The display of time shall be selectable to relative, or real time.

2.2.5 The units of time shall be appropriate to the period selected for display.

2.2.6 Export of data should be in a range of common formats such as .CSV, .XLS, .MDB COMTRADE.

2.3 Communication Architecture

Each Data Acquisition shall have the capability to independently sense, acquire and store data and then to transfer the data via a LAN to the master substation server

2.3.1 The master substation server shall collect all the data from the remote Data Acquisition Units on a pre-determined regular interval, with the option to access the data on request.

2.3.2 The data should then be accessible to National Grid by web browser.

3 HARDWARE PLATFORMS

The following apply to all hardware items supplied, as appropriate to the equipment item.

3.1.1 A Real Time Multi-tasking Operating System should be used to maximise reliability

3.1.2 Hardware platforms used within a National Grid substation environment shall comply with the requirements of TS 3.24.15(RES).

3.2 Single Point Status Inputs

3.2.1 Single point status inputs shall be provided for the indication of main plant status.

3.3 Single Point Status Outputs

3.3.1 The following Status Outputs shall be provided

a) Equipment healthy.

b) Out of service mode selected.

3.4 CT and VT Inputs

3.4.1 Three VT and three CT inputs shall be provided.

3.4.2 The nominal value of CT inputs (In) shall be 1 amp.

3.4.3 The nominal value of VT inputs (Vn) shall be 110 V / $\sqrt{3}$.

3.4.4 CT and VT inputs shall be sampled at a frequency of 256 samples per cycle. Higher whole integer sampling frequency multiples may also be considered.

Anti-aliasing filters shall be incorporated, having a rollover characteristic of ≥ 3 dB per octave and a Nyquist frequency of ≥ 0.5 and ≤ 0.7 of that of the sampling frequency.

4 OTHER REQUIREMENTS

4.1.1 The calibration period over which performance requirements are met shall be defined. The equipment and software shall be supportable for a period not less than 15 years.

5 TEST REQUIREMENTS

5.1 General

5.1.1 The equipment shall be tested in accordance with the requirements of TS 3.24.15 (RES) - Environmental and Test Requirements for Electronic Equipment.

For the purposes of electrical environmental tests all equipment shall be classified as “substation equipment”.

During and after all environmental tests, all equipment shall meet with the requirements of this specification. No additional derogation is given for influence quantities.

Performance requirements are inclusive of the effects of all external accessories e.g. current shunts and current transformers.

5.1.2 The manufacturer of the electrical equipment shall declare conformance with the essential requirements (safety objectives) of the European Union Low Voltage Directive 2006/95/EC. A CE mark shall be affixed to all equipment to confirm that the equipment has been manufactured in accordance with the applicable technical standards and essential requirements as defined in the Directive.

6 FORMS AND RECORDS

Not applicable

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

7 DEFINITIONS

CT	Current Transformer
DAU	Data Acquisition Unit
DSM	Dynamic System Monitor
GPS	Global Positioning System
In	Nominal input current
LAN	Local Area Network
NPS	Negative Phase Sequence
PPS	Positive Phase Sequence
QoS	Quality of Supply
Vn	Nominal input voltage
VT	Voltage Transformer
WAN	Wide Area Network
PMU	Phasor Measurement Unit
MTBF	Mean Time between Failure

8 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
1	October 2014	First Issue	Richard Poole	GCRP
2	Februar y 2018	Alignment with EU codes	Thomas Charton	GCRP

8.1 Procedure Review Date

5 years from publication date.

PART 3 - GUIDANCE NOTES AND APPENDICES

9 REFERENCES

9.1 National/International Standards

IEEE C37.118-2005	Reporting synchronized phasor measurements in power systems.
IEC 61000-4-30	Electromagnetic Compatibility – Testing and Measurement Techniques – Power Quality Measurement Techniques
IEC 61850	Communication networks and systems in substations

9.2 National Grid Documents

TS 3.24.15 (RES)	Environmental and test requirements for the hardware units
TS 2.19 (RES)	Ancillary Light Current Equipment