DYNAMIC SYSTEM MONITORING (DSM)

This document is for internal and contract specific use only.

Disclaimer
NGG and NGET or their agents, servants or contractors do not accept any liability for any losses arising under or in connection with this information. This limit on liability applies to all and any claims in contract, tort (including negligence), misrepresentation (excluding fraudulent misrepresentation), breach of statutory duty or otherwise. This limit on liability does not exclude or restrict liability where prohibited by the law nor does it supersede the express terms of any related agreements.”

PURPOSE AND SCOPE

This document describes the technical requirements for User’s equipment directly connected to the England and Wales Transmission system and located within NGET’s busbar protection zone operating at nominal voltages of 400 kV, 275 kV, 132 kV and 66 kV unless otherwise agreed with the user as defined in the Bilateral agreement. The principles of this document applies to equipment connected at other voltages”.

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 supplier to meet the overall functional and performance requirement specified herein.

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 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.

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 (±).

   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
1.5 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.

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

Table 1: Accuracy, Resolution and Measurement Range.

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 / √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. Contract specified options:

None

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

<table>
<thead>
<tr>
<th>Issue</th>
<th>Date</th>
<th>Summary of Changes / Reasons</th>
<th>Author(s)</th>
<th>Approved By (Inc. Job Title)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>October 2014</td>
<td>First Issue</td>
<td>Richard Poole</td>
<td>GCRP</td>
</tr>
</tbody>
</table>

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 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

© National Grid 2014

© 2014 Copyright owned by National Grid Electricity Transmission plc, all rights reserved.

No part of this publication may be reproduced in any material form (including photocopying and restoring in any medium or electronic means and whether or not transiently or incidentally) without the written permission of National Grid Electricity Transmission plc, except:

1. To the extent that any party who is required to comply (or is exempt from complying) with the provisions under the Electricity Act 1989 reasonably needs to reproduce this publication to undertake its licence or statutory duties within Great Britain (or any agent appointed so as to act on that party’s behalf); and

2. In accordance with the provisions of the Copyright, Design’s and Patents Act 1988.