

---

# **Automatic connection/reconnection and admissible rate of change of active power**

ENTSO-E guidance document for national implementation of conditions for automatic connection / reconnection after incidental disconnection and admissible rate of change of active power

31 January 2018

---

**DESCRIPTION**

**Code(s) &  
Article(s)**

COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (NC RfG):

- Articles 13(7) and 14(4)

This document addresses the issue of **automatic** connection/reconnection of power generating modules of type A, B and C. Automatic connection/reconnection is not allowed for type D power generating modules.

The motivation for allowing automatic reconnection after an incidental disconnection or during system restoration is that neither the relevant TSO nor the relevant DSO can manage to respond to all individual start-up requests of power generating modules. In addition, communication with type A power generating modules for connection/reconnection is not required. Hence, they need to act autonomously according to a configured schedule in such cases.

Automatic reconnection of power generating units after an incidental disconnection includes, but is not limited to, the following fundamental conditions:

- Specifications of the voltage range, for which reconnection is allowed
- Specifications of the frequency range, for which reconnection is allowed
- Specification of a minimum observation time of voltage and frequency conditions
- Specification of a maximum gradient of active power increase after reconnection

**Introduction**

Uncoordinated/uncontrolled reconnection of a large amount of distributed generation after system disturbance could result in system stability problems and cause system split or islanding. Therefore, some basic rules/conditions for reconnection shall be specified.

In addition, coordination between frequency ranges for reconnection of power generating modules and disconnection/reconnection of demand facilities shall also be taken into account where relevant.

The document provides guidance on implementing the capability of power generating modules related to voltage and frequency ranges, observation time and gradient of active power increase for connection or reconnection.

Recommendation on the preferred values of voltage and frequency intervals for automatic reconnection as well as a minimum observation time and maximum gradient of active power increase after reconnection is given in the methodology section of this document and is based on current practice and for Continental Europe (CE) on the ENTSO-E report on Dispersed generation impact on CE region security [3].

**Key definitions:**

- Automatic reconnection: connection/reconnection initiated by the power generating

	<p>module's control system based on real-time observation of system parameters/conditions after an incidental disconnection or at start-up.</p> <ul style="list-style-type: none"> <li>• Connection: Normal connection and synchronisation of a power generating module for active power infeed after standstill</li> <li>• Reconnection: Connection and synchronisation of a power generating module after an incidental disconnection</li> </ul>
<b>NC frame</b>	<p>COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (NC RfG):</p> <ul style="list-style-type: none"> <li>• Articles 13(7) and 14(4)</li> </ul> <p>COMMISSION REGULATION (EU) 2016/1388 of 17 August 2016 establishing a Network Code on Demand Connection (NC DCC):</p> <ul style="list-style-type: none"> <li>• Articles 19(4)</li> </ul>
<b>Further info</b>	<p>The latest NCs and further information are available here:</p> <p>[1] Network Code for RfG, EU regulation 2016/631.          [2] Network Code for Demand Connection NC DCC; EU regulation 2016/1388          [3] ENTSO-E report on Dispersed generation impact on CE region security - 11.12.2014</p>

**INTERDEPENDENCIES**

<b>Between the CNCs</b>	NC RfG Article 13.7 and 14.4, and NC DCC Article 19.4 and Annex II
<b>With other NCs</b>	EU regulation SO GL 2017/1485, Article 25(1); 27(1); 27(5); 29(7).
<b>System characteristics</b>	N/A
<b>Technology characteristics</b>	<p>The principle for automatic reconnection after an incidental disconnection is as depicted on figure below.</p> <pre>             graph LR             Uc[Uc] --&gt; U_range[Uc min ≤ Uc ≤ Uc max]             f[f] --&gt; f_range[f1 ≤ f ≤ f2]             U_range --&gt; AND[&amp;]             f_range --&gt; AND             T_obs[T_obs] --&gt; AND             AND --&gt; Ramp[Ramp-up limit P/t [MW/min]]             </pre> <ol style="list-style-type: none"> <li>1. The voltage at the point of connection shall be within a specified range during an observation time <math>T_{obs}</math></li> <li>2. The frequency shall be stable within a specified range during an observation time <math>T_{obs}</math></li> <li>3. The observation time <math>T_{obs}</math> shall have been obtained before injection of active power</li> </ol>

	<p>4. The active power increase shall not exceed the maximum admissible gradient</p> <p>Condition 1 and 2 shall be fulfilled concurrently.</p>
<b>COLLABORATION</b>	
<b>TSO – TSO</b>	<p>Frequency range for automatic reconnection shall be coordinated between the TSO's in each synchronous area.</p>
<b>TSO – DSO</b>	<p>According to NC DCC the relevant TSO and the transmission-connected distribution system operator shall agree on the settings of synchronisation devices prior to connection of a transmission-connected distribution system, including voltage, frequency, phase angle range and deviation of voltage and frequency.</p>
<b>RSO – Grid User</b>	<p>According to NC DCC the relevant TSO and the transmission-connected demand facility owner shall agree on the settings of synchronisation devices prior to connection of a transmission-connected demand facility, including voltage, frequency, phase angle range and deviation of voltage and frequency.</p>
<b>Methodology</b>	<p>The technical capability of power generating modules to connect to the network shall be as follows:</p> <ul style="list-style-type: none"> <li>• Voltage range at the grid connection point: <math>0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}</math>; and</li> <li>• Frequency range: <math>47.5 \text{ Hz} \leq f \leq 51.0 \text{ Hz}</math>; and</li> <li>• Adjustable observation time: from 0 to 300 s;</li> <li>• Adjustable limitation of the gradient of active power increase <math>\leq 20 \%</math> of <math>P_{\text{max}}/\text{min}</math></li> </ul> <p>If no settings are specified by the relevant TSO or relevant DSO (in coordination with the relevant TSO), the default settings for an automatic reconnection for power generating units after an incidental disconnection could be recommended as follows:</p> <ul style="list-style-type: none"> <li>• Voltage range: <math>0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}</math>; and</li> <li>• Frequency range:             <ul style="list-style-type: none"> <li>○ Continental Europe: <math>49.9 \text{ Hz} \leq f \leq 50.1 \text{ Hz}</math></li> <li>○ Other synchronous areas <math>49.0 \text{ Hz} \leq f \leq 51.0 \text{ Hz}</math>; and</li> </ul> </li> <li>• Minimum observation time: 60 s;</li> <li>• Maximum gradient of active power increase <math>\leq 20 \%</math> of <math>P_{\text{max}}/\text{min}</math></li> </ul> <p>Automatic reconnection after incidental disconnection is allowed when the system frequency and the voltage at the grid connection point are within the specified range for the defined observation time, and any protection tripping has been cleared.</p> <p>Some TSOs may distinguish between reconnection after a frequency disturbance and automatic connection at start-up. The frequency range for automatic reconnection after a frequency disturbance could be limited.</p> <p>Some TSOs use a timeout to deactivate automatic reconnection depending on substation and network's configuration.</p>

Some examples of common practice in various countries are listed below:

**Examples from CE:**

- Country specific voltage ranges for the voltage at the grid connection point:
  - CZ:  $0.85 \text{ pu} \leq U \leq 1.1 \text{ pu}$
  - DK:  $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$
- Country specific frequency ranges:
  - BE: 47.5 Hz – 50.05 Hz
  - CZ: 47.5 Hz – 50.05 Hz
  - DK: 47.5 Hz – 50.05 Hz
  - IT: 49.9 Hz - 50.1 Hz
- Country specific values for observation time  $T_{\text{obs}}$  :
  - DK: 180 s
  - DE: 600 s
  - NL: 120 s
  - BE: 60 s
  - F: specified in the operational agreement, automatic connection disables, if voltage does not recover within 180 s
  - CZ: 300 s
  - IT: 300 s (after frequency disturbance), 30 s (for normal start-up)
- Country specific values for the maximum gradient of active power increase:
  - DK:  $10\% P_{\text{max}}/\text{min}$ ;
  - BE:  $10\% P_{\text{max}}/\text{min}$ ;
  - F: 4 MW/min;
  - CZ:  $10\% P_{\text{max}}/\text{min}$ ;
  - PL:  $10\% P_{\text{max}}/\text{min}$

**Examples from Nordic:**

- Country specific voltage ranges for the voltage at the grid connection point:
  - DK:  $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$
- Country specific frequency ranges:
  - DK: 47.5 Hz – 50.1 Hz
  - NO: 47.5 Hz – 50.1 Hz
- Country specific values for observation time  $T_{\text{obs}}$ :
  - DK: 180 s;
  - NO: 60 s
- Country specific values for the maximum gradient of active power increase:
  - DK:  $10\% P_{\text{max}}/\text{min}$ ;
  - NO:  $10\% P_{\text{max}}/\text{min}$

**Examples from IE/NL:**

Automatic connection / reconnection are not allowed.

**Examples from Baltic:**

- Values for all Baltic countries are the same.
  - Frequency range: 49.0 Hz - 50.1 Hz
  - $T_{\text{obs}}$ : 60 s
  - Maximum gradient of active power increase:  $10\% \text{ of } P_{\text{max}}/\text{min}$