

Autonomous connection / reconnection and admissible rate of change of active power

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

Revised clean version | 12 April 2021

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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 [1]):

- Article 13 (7) - automatic connection
- Article 14 (4) - reconnection after incidental disconnection

Introduction

This document addresses the issue of autonomous connection/reconnection of power generating modules of type A, B and C. Autonomous connection/reconnection is not allowed for type D power generating modules. Automatic within the context of article 13.7 shall be understood as autonomous. Art 13.7 defines in general the capabilities automatic, i.e. autonomous connection/reconnection, regardless whether it applies to initial connection or reconnection after disconnection.

The motivation for allowing autonomous 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. Autonomous 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

Art 14.4. introduces the right of the relevant TSO to define additional conditions for reconnection after disconnection.

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 is provided on the preferred values of voltage and frequency intervals for autonomous reconnection as well as a minimum observation time and maximum gradient of active power increase after reconnection is based on current practice [2] and for Continental Europe (CE) on the ENTSO-E report on Dispersed generation impact on CE region security [3].

Key definitions:

- Autonomous connection/reconnection: connection/reconnection initiated by the power generating module's control system based on real-time observation of system parameters/conditions after an incidental disconnection or at start-up
- Connection: Normal connection and synchronization of a power generating module for active power infeed after standstill
- Reconnection: Connection and synchronization of a power generating module after an incidental disconnection

NC frame

COMMISSION REGULATION (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators (NC RfG [4]):

- Articles 13(7) and 14(4)

COMMISSION REGULATION (EU) 2016/1388 of 17 August 2016 establishing a Network Code on Demand Connection (NC DC [4]):

- Articles 19(4)

Interdependencies

Between the CNCs

NC RfG Article 13.7 and 14.4, and NC DC Article 19.4 and Annex II

With other NCs

EU regulation SO GL 2017/1485, Article 25(1), 27(1), 27(5), 29(7)

Technology characteristics

The principle for the autonomous reconnection after an incidental disconnection is as depicted on figure 1.

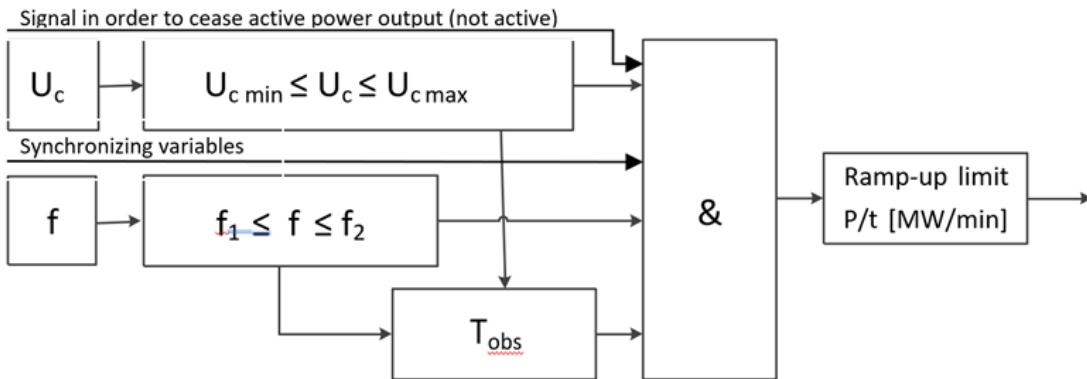


Figure 1. Principle for the autonomous reconnection

Synchronizing variables:

1. The voltage at the point of connection shall be within a specified range during an observation time T_{obs}
2. The frequency shall be stable within a specified range during an observation time T_{obs}
3. The observation time T_{obs} shall have been obtained before injection of active power
4. The active power increase shall not exceed the maximum admissible gradient
5. Synchronizing variables (voltage magnitude difference, frequency difference, voltage phase angle difference) are within prescribed ranges

Collaboration

TSO-TSO

Frequency range for autonomous reconnection shall be coordinated between the TSO's in each synchronous area.

TSO-DSO

According to NC DC the relevant TSO and the transmission-connected distribution system operator shall agree on the settings of synchronization devices prior to connection of a transmission-connected distribution system, including voltage, frequency, phase angle range and deviation of voltage and frequency.

RSO – Grid User

According to NC DC the relevant TSO and the transmission-connected demand facility owner shall agree on the settings of synchronization devices prior to connection of a transmission-connected demand facility, including voltage, frequency, phase angle range and deviation of voltage and frequency.

Methodology

The technical capability of power generating modules to connect to the network shall be as follows:

- Voltage range at the grid connection point: $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$; and
- Frequency range: $47.5 \text{ Hz} \leq f \leq 51.0 \text{ Hz}$; and
- Adjustable observation time: from 0 to 300 s
- Adjustable limitation of the gradient of active power increase $\leq 20\% \text{ of Pmax/min}$
- Synchronizing condition

If no settings are specified by the relevant TSO or relevant DSO (in coordination with the relevant TSO), the default settings for an autonomous reconnection for power generating modules after an incidental disconnection could be recommended as follows:

- Voltage range: $0.9 \text{ pu} \leq U \leq 1.1 \text{ pu}$; and
- Frequency range:
 - Continental Europe: $49.9 \text{ Hz} \leq f \leq 50.1 \text{ Hz}$
 - Other synchronous areas $49.0 \text{ Hz} \leq f \leq 51.0 \text{ Hz}$; and
- Minimum observation time: 60 s;
- Maximum gradient of active power increase $\leq 20\% \text{ of Pmax/min}$
- Condition on voltage phase angle difference: $\Delta\theta < 10^\circ$
- Voltage magnitude difference: $\Delta U < 4\% U$
- Frequency difference: $\Delta f < 0,2 \text{ Hz}$

Autonomous 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.

Some TSOs may distinguish between reconnection after a network disturbance and autonomous connection at start-up. On both cases the relevant TSO shall specify the conditions.

Some TSOs use a time delay to deactivate autonomous reconnection depending on substation and network's configuration.

References

The latest NCs and further information are available here:

- [1] Network Code for RfG, EU regulation 2016/631
- [2] Monitoring report on connection network codes implementation, 16 December 2019,
https://eepublicdownloads.entsoe.eu/clean-documents/Network%20codes%20documents/CNC/Monitoring_report_on_connection_network_codesImplementation_191216.pdf
- [3] ENTSO-E report on Dispersed generation impact on CE region security - 11.12.2014
- [4] Network Code for Demand Connection NC DC; EU regulation 2016/1388