swissgrid

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Test for secondary control capability

Revisions:

Version	Date	Section
1.0	20.10.2008	Document finalised
2.0	10.02.2012	Document revised in accordance with consultation
2.1	22.04.2013	Generalisation for generating units
3.0	30.11.20	Extension tests for SRL+, SRL-, technology prequalification

Contents

1. Introduction

All generating units that contribute to the market-based tenders of secondary control must be checked to ensure they meet the necessary technical conditions. This document describes the appropriate test for checking secondary control capability. This test assesses the reaction of the generating unit to the test signal provided by Swissgrid. A generating unit can be tested either for positive and negative secondary control or for only one supply direction (positive or negative secondary control).
This document is valid as of 1 June 2018.

1.1. Organization of the tests

The tests may not interfere with or jeopardise grid operations:

- The operators are responsible for carrying out the test. For partner plants, the tests are coordinated by the office responsible for operation along with the managing partner.
- The test must be structured in such a way that at no time is there a risk of damage to the components of a generating unit and the protection and control mechanisms do not trigger any shutdowns during the test. No protection equipment may be taken out of service for this purpose.
- The detailed sequence is agreed with Swissgrid in advance. Measurements (results) are evaluated by Swissgrid or – with the consent of the power plant operator – by an independent third party appointed by Swissgrid and form the basis for a binding prequalification.

1.2. Prequalification of technologies

Generating units (conventional and virtual) that do not feature a power band of at least 1 MW must be prequalified in a pool of at least 1 MW power band made up of generating units with the same technology and the same technical characteristics. The power band is defined as the difference between the minimum and maximum potential power

Upon successful prequalification of the technology, the pool can be expanded as needed with additional comparable generating units. Exceptions to this rule are at Swissgrid's discretion, in particular the demarcation between various technologies, and whether comparable systems can be integrated into the pool without a separate test. Because the test of the pool is identical to the test of an individual generating unit with a power band of at least 1 MW, «generating unit» is used in the following in reference to the pool.

2. Transmission of a test signal with power request

A generating unit that is intended to be used for the supply of negative and positive secondary control power must undergo the test in accordance with Chap. 2.1. A generating unit that is intended to be used solely for the supply of negative or solely for the supply of positive secondary power control must undergo the test in accordance with Chap. 2.2 and/or 2.3
The operating plan (road map) of the entire generating unit may not change throughout the test.

If a generating unit has justifiable difficulties with the power flow, then another scaling may be permitted in exceptional cases. The temporal sequence and duration remain unchanged.

2.1. Test for simultaneous prequalification for positive and negative power control

The test signal follows the course shown in figure 1 and is made available to the provider by Swissgrid as a MW request. The difference P_{sek} between the maximum (test signal 100%) and the minimum (test signal –100%) power should be at least 60 % of the maximum available secondary control power band, must be greater than 1 MW and should be aligned with the secondary control power subsequently offered. An operating point at approx. 50 % nominal output can be selected as the start value. The operating point that corresponds to a test signal of 0% should be based on typical operating points of the generating unit with secondary control power supply.

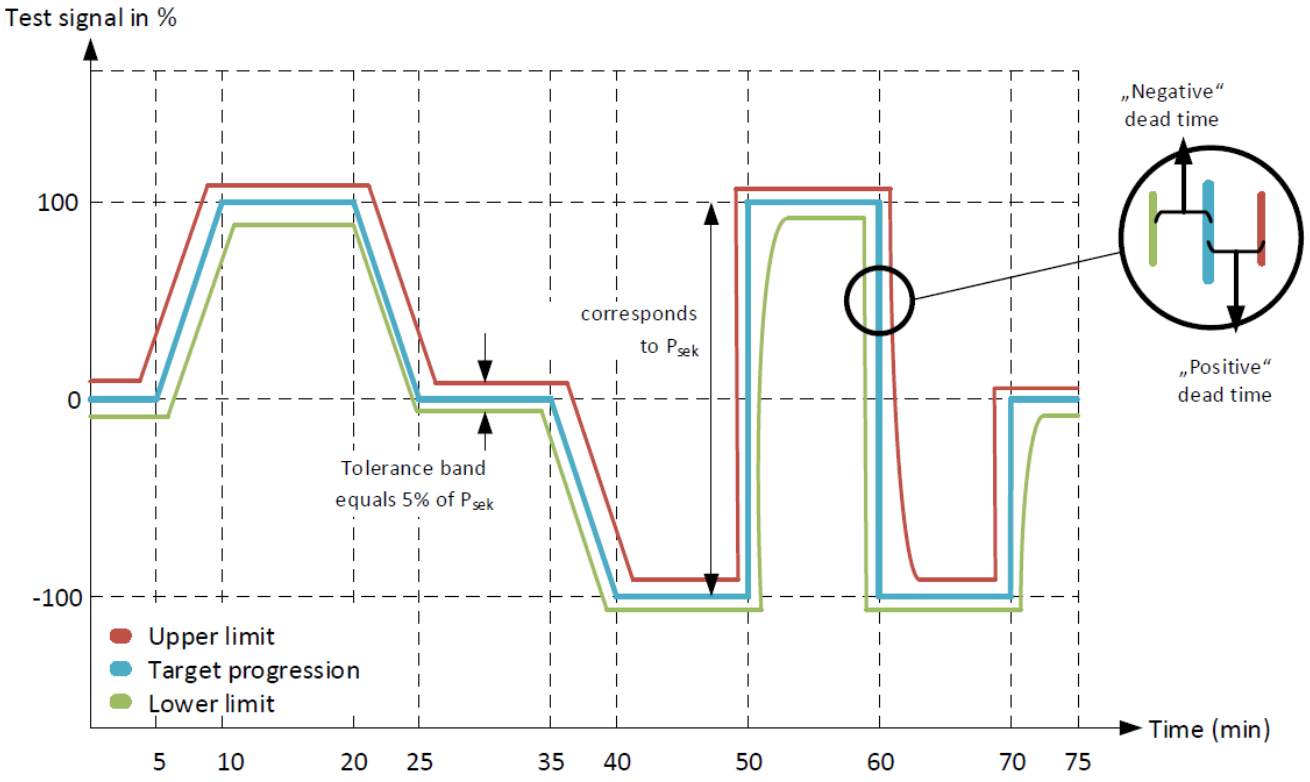

Figure 1: Test signal with tolerance bands

2.2. Test for prequalification for the supply of control power in a negative direction

The test signal follows the course depicted in Figure 2 and is made available to the provider by Swissgrid as a MW requirement. The difference P_{sek} between maximum (test signal 0%) and minimum power (test signal –100%) should constitute as least 60% of the maximum negative secondary control power that can be offered, must be greater than 1 MW and should be oriented to the secondary control power that is to be offered later. The operating point that corresponds to a test signal of 0% should be oriented to typical operating points of the generating unit with secondary control power.

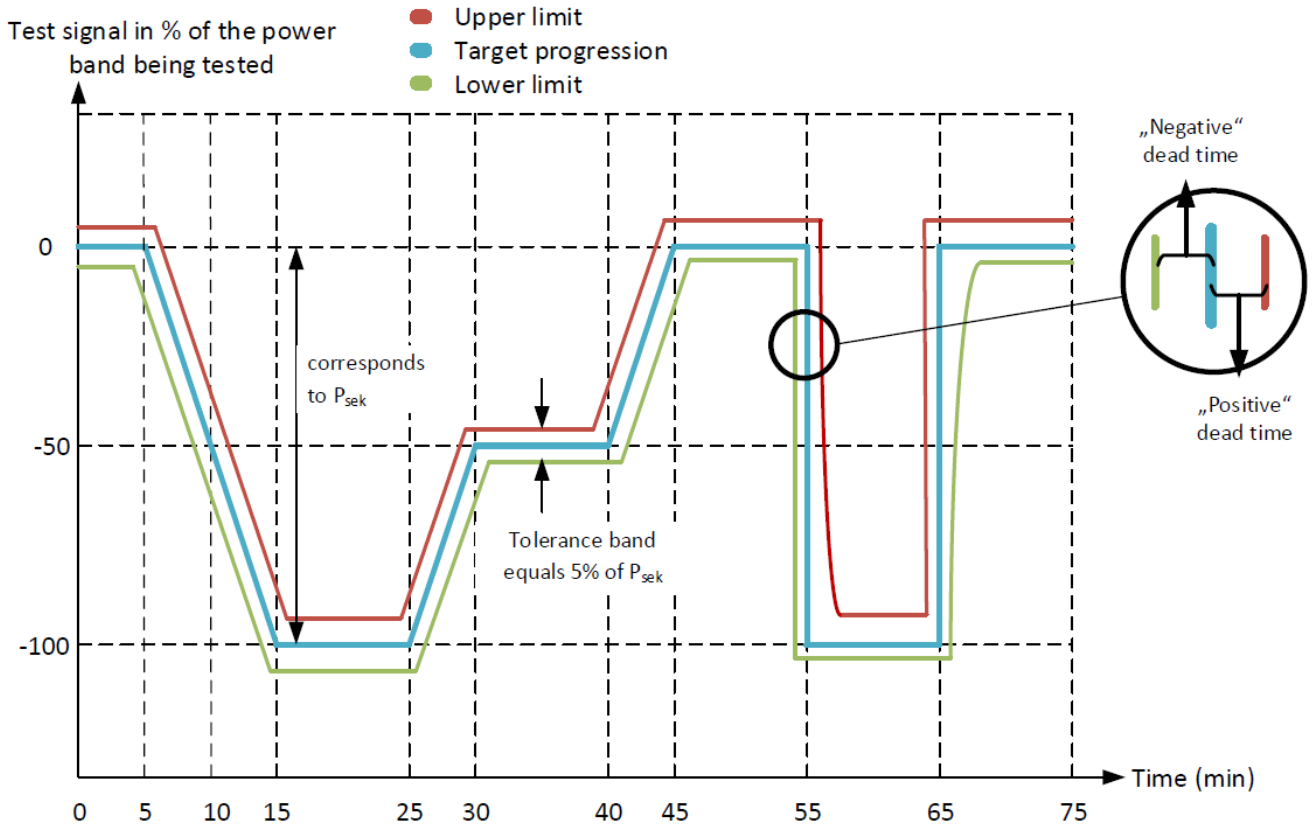

Figure 2 1: Test signal with tolerance bands for secondary control power

2.3. Test for prequalification for the supply of control power in a positive direction

The test signal follows the course depicted in Figure 3 and is made available to the provider by Swissgrid as a MW requirement. The difference P_{sek} between maximum (test signal 100%) and minimum power (test signal 0%) should constitute as least 60% of the maximum positive secondary control power that can be offered, must be greater than 1 MW and should be oriented to the secondary control power that is to be offered later. The operating point that corresponds to a test signal of 0% should be oriented to typical operating points of the generating unit with secondary control power.

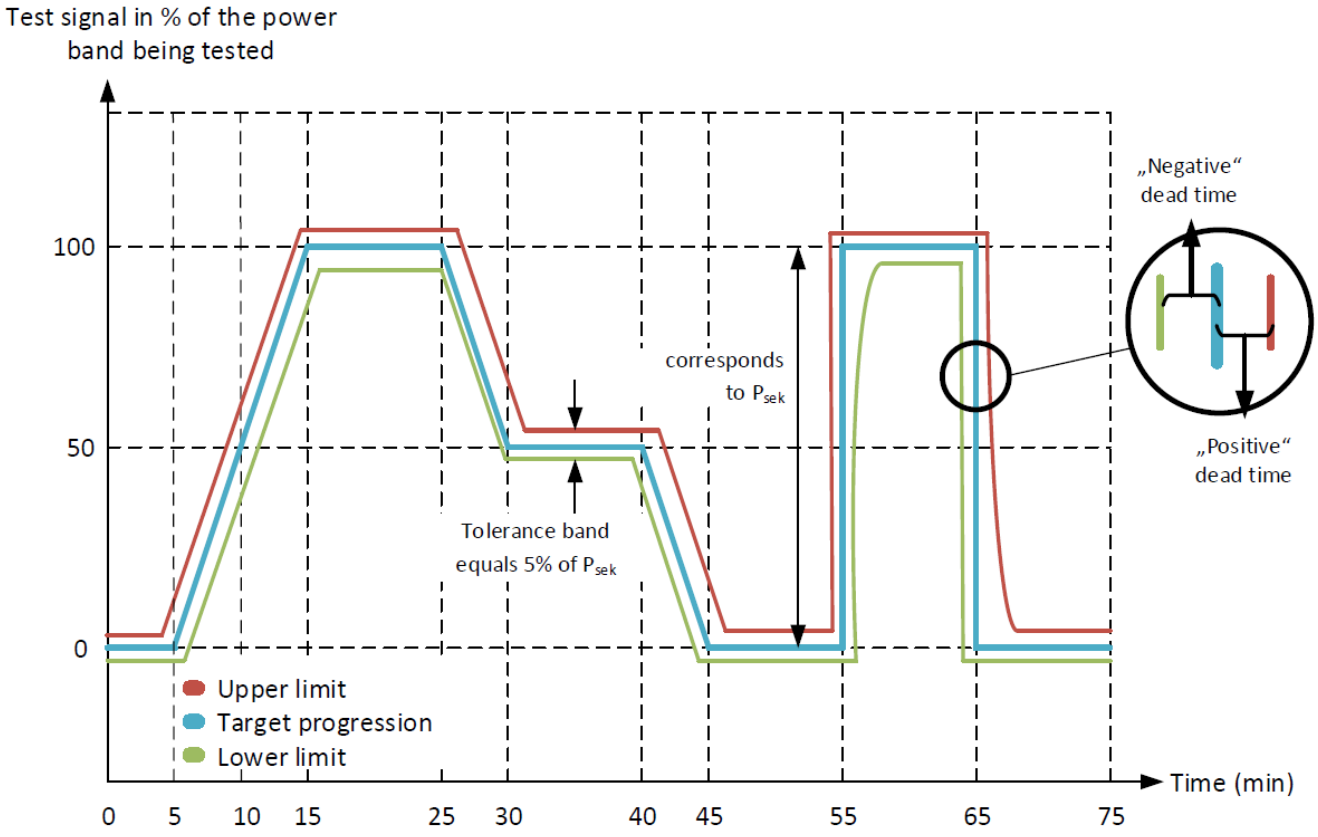

Figure 3: Test signal with tolerance bands for positive secondary control power

2.4. Evaluation procedure

The actual power of the generating unit must be within tolerance bands superimposed on the test signal sent by Swissgrid in accordance with figures 1-3.
At each increase in power, the nominal minimum control power is calculated with the help of a PT_1 element. The PT_1 element is detailed in the Annex.
In addition, an amplitude band is applied around the target sequence and the following parameters defined:

- «Negative» dead time: 10 s
- «Positive» dead time: 20 s
- Amplitude band: 5 % of the secondary control power to be provided P_{sek}

All values in excess of the band are added together and applied across the entire test signal. They must be no more than 1 % of the total surface from the length of the pre-qualification test multiplied with the pre-qualified power. Formula (1) illustrates this process.

$$t_t \cdot \sum_{i=0}^{i=t_d/t_t} \left| P_{diff}(i) \right| \leq 0.01\, P_{sek}\, t_d \qquad (1)$$

Where:

- P_{sek} Difference between maximum and minimum secondary control power
- $P_{diff}(i)$ Values in excess of the band i
- t_d Test duration
- t_t Sampling rate

2.5. Recording during the test

During the test, the following data from the generating unit must be recorded at a time resolution of at least 10 s, although Swissgrid recommends a time resolution of 2s:

- Grid frequency for subsequent synchronisation of the time sequences
- Test signal received at generating unit for evaluating the transmission quality
- Active feed-in of the generators participating in the test in chronological sequence
- Operating point of all plants in the generating unit

The data recorded must be made available to Swissgrid in electronic form.
Primary control must be switched off during the pre-qualification test. This ensures that the generating unit can be measured accurately.

2.6. Reporting and evaluation

The test is evaluated according to the evaluation criterion. If it is met, the attestation required for prequalification is issued. The result of the evaluation is provided in writing by Swissgrid. If a generating unit fails to meet the criterion, the test can be repeated.

3. Coordination and implementation

The sequence and the implementation of the test are coordinated with those persons responsible for prequalification at Swissgrid. In order to avoid major frequency fluctuations and the associated use of primary control as much as possible, the test should be carried out at a non-critical time. The suggested time period is between 13:30 and 15:45.

3.1. Comments on the test

- The «negative» dead time is primarily relevant for synchronisation of the time stamp. Since the time resolution of the meter data is usually 10 s, a different time stamp can only be offset with an accuracy of 10 s based on the frequency. If the time stamp were to deviate forwards by 7 s, for example, and assuming no delay over the signal path, the generating unit would always react 7 s before the test signal. This offsets the «positive» dead time.
- The test signal received at the generating unit is requested to investigate the influence of timing on the transmission path. This can explain whether a delay in transmitting the test signal was the reason the test was not passed
- The «positive» dead time allows for a certain delay of the generating unit over the signal path. The «negative» dead time shifts the sequence of the tolerance bands backwards by the specified time.
- The behaviour of the PT_1 element is defined by the time constant T_1. Higher values of this time constant generate a slower rise in the progression curve. Since the time constant is directly dependent on the ratio P_{sek} / P_n, where P_n is the nominal output, a slower rise in the tolerance bands can be achieved here by testing a larger amount of secondary control power (see Annex). It is therefore advantageous for the generating unit if they are tested with secondary control power that is close to their nominal output.
- To avoid too large power deviations yet at the same time take advantage of the positive effect of large time constants, it is advisable to test the entire secondary control area of the individual generators. At the same time, an «overlapping effect» can occur in identical generator types and an entire series of identical types can be prequalified on the basis of a single tested generator.
- As the amplitude bands are dependent in percentage terms on the tested secondary control power, a larger secondary control power ensures a larger band, in absolute terms.
- When selecting the secondary control band to be tested, it must be ensured that the generating unit is not run at too close to its maximum power order to be able to map any overshooting.

4. Annex

The time constant of the PT1 element is calculate in accordance with formula (2). For every generating unit, the initial gradient must be at least 0.5 % of the nominal output per second.

$$T_1 = \frac{P_{sek}}{P_n} \frac{1}{0.005} \quad (2)$$

The time-discrete progression of the PT1 element is described by formula (3).

$$L_i = \frac{1}{1+\frac{T_1}{t_t}} \left(\frac{T_1}{t_t} L_{i-1} + S_i \right) \quad (3)$$

Where:

- Li Limit at time point i
- Si Signal from Swissgrid at time point I, delayed by the respective dead time from the respective target progression
- t_t Sampling interval