IEC 60255-181

Edition 1.0 2019-02

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Measuring relays and protection equipment –
Part 181: Functional requirements for frequency protection

Relais de mesure et dispositifs de protection –
Partie 181: Exigences fonctionnelles relatives aux protections de fréquence

IEC 60255-181:2019-02(en-fr)

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FOREWORD

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The text of this International Standard is based on the following documents:

FDIS	Report on voting
95/402/FDIS	95/409/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60255 series, published under the general title *Measuring relays and protection equipment*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,
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MEASURING RELAYS AND PROTECTION EQUIPMENT –

Part 181: Functional requirements for frequency protection

1 Scope

This part of IEC 60255 specifies the minimum requirements for functional and performance evaluation of frequency protection. This document also defines how to document and publish performance test results.

This document covers the functions based on frequency measurement or rate of change of frequency measurements. This document also covers frequency protection where additional blocking elements are used.

This document defines the influencing factors that affect the accuracy under steady state conditions and performance characteristics during dynamic conditions. The test methodologies for verifying performance characteristics and accuracy are also included in this document.

The frequency functions covered by this document are shown in Table 1:

Table 1 – Frequency protection designation

	IEEE/ANSI C37.2 function numbers	IEC 61850-7-4 logical nodes
Underfrequency protection	81U	PTUF
Overfrequency protection	81O	PTOF
Rate of change of frequency protection (ROCOF)	81R	PFRC

This functional document is applicable to frequency functions embedded in a protection relay but also to other physical devices which include frequency protection in their functionality (for example, trip units in a low-voltage circuit breaker or inverters associated with photovoltaic or storage systems).

This document does not cover synchronizing or synchronism-check functions.

This document does not specify the functional description of additional features often associated with frequency functions such as undervoltage blocking, df/dt or $\Delta f/\Delta t$ supervision, current supervision or power supervision (f/P function). Only their influence on the frequency protection function is covered in this document.

Frequency and rate of change of frequency measurement outputs provided by protection devices are not in the scope of this document.

Additionally, this document does not explicitly cover the frequency relays based on current as the input energizing quantity but the principles covered by this document can be extended to provide guidance for these applications.

The general requirements for measuring relays and protection equipment are defined in IEC 60255-1.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60255-1, *Measuring relays and protection equipment – Part 1: Common requirements*

IEC 60050-103, *International Electrotechnical Vocabulary – Part 103: Mathematics – Functions*

IEC 60050-447, *International Electrotechnical Vocabulary – Part 447: Measuring relays*

IEC 60050-601, *International Electrotechnical Vocabulary – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 61869 (all parts), *Instrument transformers*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-103, IEC 60050-447, IEC 60050-601, and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
input energizing quantity
energizing quantity which either by itself constitutes the characteristic quantity or helps to constitute it

Note 1 to entry: For the frequency protection function, the input characteristic quantity could be voltage.

[SOURCE: IEC 60050-447:2010, 447-03-02, modified – The note to entry has been replaced by a new note.]

3.2
characteristic quantity
electric quantity, or one of its parameters, the name of which characterizes a measuring relay or protection equipment and the values of which are the subject of accuracy requirements

Note 1 to entry: For underfrequency protection and overfrequency protection, the characteristic quantity is frequency; for rate of change of frequency protection (ROCOF), the characteristic quantity is rate of change of frequency.

[SOURCE: IEC 60050-447:2010, 447-07-01, modified – The examples have been replaced by a new note to entry.]

3.3
characteristic curve
curve which represents the relationship between the theoretical specified operate time and the characteristic quantity

3.4
setting value of the characteristic quantity
G_S
value of the characteristic quantity used as the reference for the definition of the characteristic curve

3.5
start value
value of the characteristic quantity at which a measuring relay or protection equipment starts (picks up)

Note 1 to entry: Start value is also called "pick-up value".

3.6
reset value
value of the characteristic quantity at which a measuring relay or protection equipment resets

3.7
start time
time interval between the instant a specified change is made in the value(s) of the input energizing quantity(ies) which will cause the measuring relay or protection equipment in initial condition or reset condition to start and the instant it starts

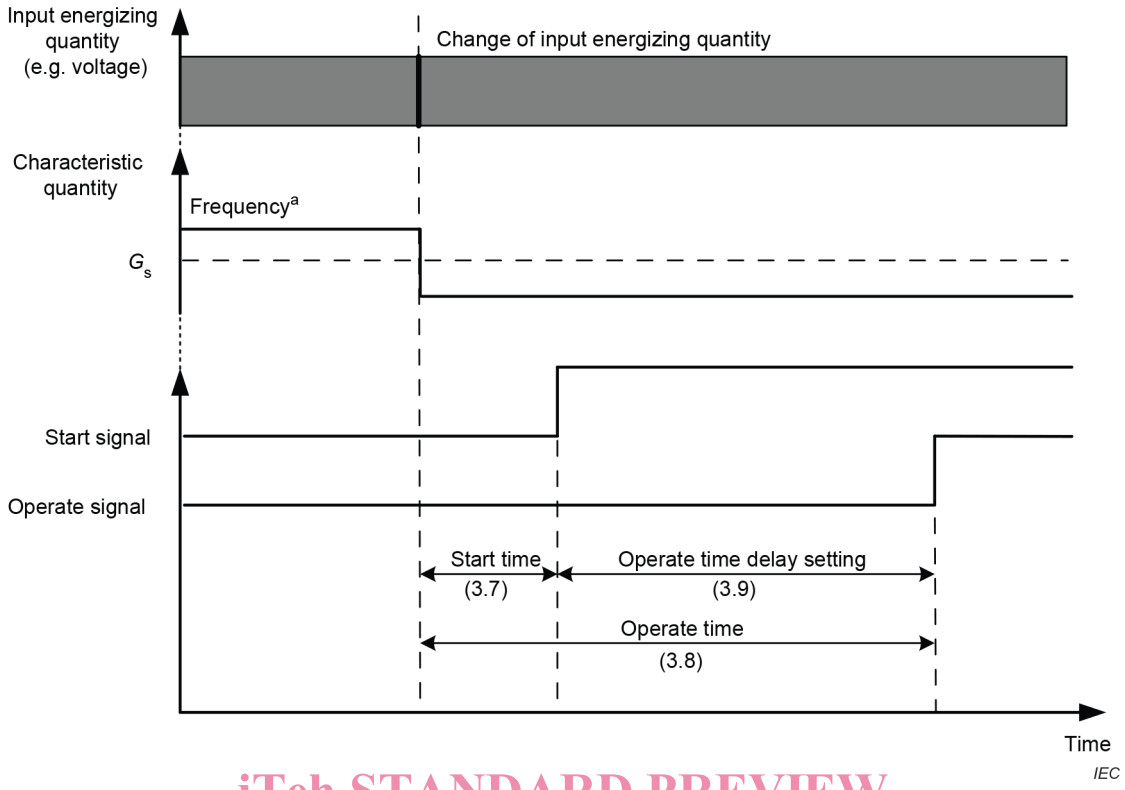
Note 1 to entry: Start time is also called "pick-up time".

3.8
operate time
time interval between the instant a specified change is made in the value(s) of the input energizing quantity(ies) which will cause the measuring relay or protection equipment in initial condition or reset condition to operate and the instant it operates

Note 1 to entry: The operate time of the protection function is the sum of the start time and the operate time delay setting.

3.9
operate time delay setting
intentional time delay defined by a user setting which is activated by the start signal to assert the operate signal

Note 1 to entry: The operate time of the frequency protection function is the sum of the start time (pick-up time) and the operate time delay setting. The difference between operate time and operate time delay setting is specified in Figure 1. Figure 1 is based on a sudden frequency change only to simplify the definition of start time initialization.



[a] Take underfrequency protection as an example.

Figure 1 – Operate time and operate time delay setting

3.10
disengaging time
time interval between the instant a specified change is made in the value(s) of the input energizing quantity(ies) which will cause the measuring relay or protection equipment in operate condition to disengage and the instant it disengages

3.11
reset time
duration between the instant a specified change is made in the value(s) of the input energizing quantity(ies) which will cause the measuring relay or protection equipment to reset and the instant it resets

[SOURCE: IEC 60050-447:2010, 447-05-06, modified. See figure 6.]

3.12
reset hysteresis
absolute value of the difference between the reset value and the start value of the protection function

3.13
reset ratio
ratio between the reset value and the start value of the protection function

Note 1 to entry: Reset ratio is used for rate of change of frequency, as defined in 4.4.2 and 5.8.

3.14
operating range
range for which the measuring relay under specified conditions is able to perform its intended function(s) according to the specified requirements

Note 1 to entry: When accuracy requirements have to be met, see effective range (IEC 60050-447:2010, 447-07-08).

Note 2 to entry: A minimum level of input energizing quantity, such as voltage, is required in order to calculate the power frequency correctly.

[SOURCE: IEC 60050-447:2010, 447-03-16, modified – Note 2 to entry has been added.]

3.15
effective range
part of the operating range of an input energizing quantity or characteristic quantity within which the accuracy requirements are met

Note 1 to entry: This note applies to the French language only.

[SOURCE: IEC 60050-447:2010, 447-07-08]

3.16
rate of change of frequency protection
ROCOF
protection function intended to operate when frequency changes by a given amount per unit of time

Note 1 to entry: This note applies to the French language only.

3.17
period
T

smallest positive difference between two values of the independent variable at which the values of a periodic quantity are identically repeated

Note 1 to entry: If $f(t)$ denotes a periodic quantity, then $f(t+T)=f(t)$.

Note 2 to entry: The term "period duration" is sometimes used in the case of a function of time.

Note 3 to entry: The symbol *T* is mainly used for the period when the independent variable is time.

[SOURCE: IEC 60050-103:2009, 103-06-01]

3.18
frequency
f
reciprocal of the period

Note 1 to entry: The symbol *f* is mainly used when the period is a time. The symbol ν (nu) is mainly used in optics.

Note 2 to entry: For a sinusoidal waveform, frequency is the first derivative of the phase angle (see IEC/IEEE 60255-118-1: 2018). A detailed description can be found in Annex D.

[SOURCE: IEC 60050-103:2017, 103-06-02, modified – Note 2 to entry has been replaced by a new note.]

3.19
power frequency
conventionally, the values of frequency used in the electricity supply systems

[SOURCE: IEC 60050-601:1985, 601-01-05]

4 Specification of the function

4.1 General

An example of the protection function with its inputs, outputs, measuring element, time delay characteristics and functional logic is shown in Figure 2. The manufacturer shall provide the functional block diagram of the specific implementation.

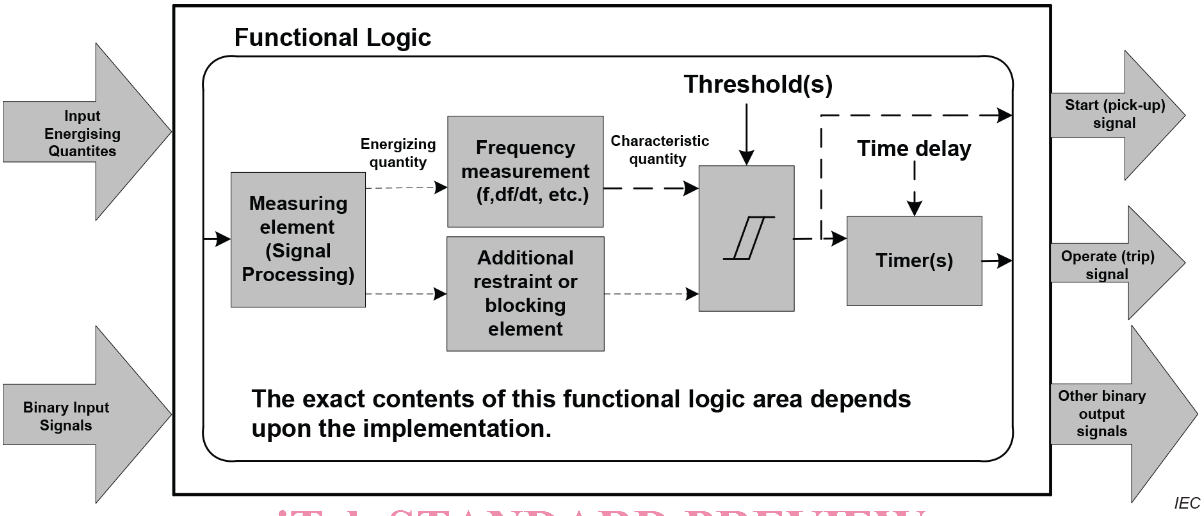


Figure 2 – Simplified protection function block diagram

4.2 Input energizing quantities / energizing quantities

The input energizing quantities are the measuring signals, for example, voltages. In the case of analogue entries, their ratings and relevant standards are specified in IEC 60255-1. Input energizing quantities can be acquired via direct connection with primary conductors (for example, low-voltage busbars) or from instrument transformers – for example, voltage transformer, VTs, according to IEC 61869 (all parts) – or as a data packet over a communication port using an appropriate communication protocol (such as that of IEC 61850-9-2 and, more specifically, IEC 61869-9).

The protection function documentation shall state the type of input energizing quantities used by the protection function. Examples are:

- single or multi phase-to-earth or phase-to-neutral voltage measurement;
- single or multi phase-to-phase voltage measurement;
- phase (line) currents.

The manufacturer shall specify which energizing quantities are used for the operation of the frequency protection. As illustrated in Figure 2, the energizing quantities can differ to that of the input energizing quantities, for example:

- use of phase-to-earth or phase-to-phase voltage;
- use of two different voltage sources;
- use of derived signals from phase quantities, for example, positive sequence voltage or calculated phase-to-phase voltages, etc.;
- use of current, such as phase current or positive sequence current, etc.

The manufacturer shall specify which characteristic quantity is used for the operation of frequency protections. Examples are:

- power frequency measurement;
- rate of change of frequency (*df/dt*) measurement (ROCOF).