INTERNATIONAL STANDARD

ISO 8528-5

Fourth edition
2018-10

Reciprocating internal combustion engine driven alternating current generating sets —

Part 5: Generating sets

Groupes électrogènes à courant alternatif entraînés par moteurs alternatifs à combustion interne —

Partie 5: Groupes électrogènes

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

Reference number
ISO 8528-5:2018(E)

© ISO 2018

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

COPYRIGHT PROTECTED DOCUMENT

© ISO 2018

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8227a1859e8b/iso-8528-5-2018

© ISO 2018 – All rights reserved

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 8528-5:2018

This document was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This fourth edition cancels and replaces the third edition (ISO 8528-5:2013), which has been technically revised. The main changes compared to the previous edition are as follows:

— Clause 3 has been updated to take into account the minimum and maximum safety frequency;

— new Subclause 14.2 has been added;

— new Annex A has been created.

A list of all parts in ISO 8528 series can be found on the ISO website.

© ISO 2018 – All rights reserved

Reciprocating internal combustion engine driven alternating current generating sets —

Part 5: Generating sets

1 Scope

This document specifies design and performance criteria arising out of the combination of a reciprocating internal combustion (RIC) engine and an alternating current (a.c.) generator when operating as a unit. This unit can run paralleling or not to the grid.

It applies to a.c. generating sets driven by RIC engines for land and marine use, excluding generating sets used on aircraft or to propel land vehicles and locomotives.

For some specific applications (e.g. essential hospital supplies and high-rise buildings), supplementary requirements can be necessary. The provisions of this document are a basis for establishing any supplementary requirements.

For generating sets driven by other reciprocating-type prime movers (e.g. steam engines), the provisions of this document can be used as a basis for establishing these requirements.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8527a1859c8b/iso-8528-5-2018

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.

ISO 3046-5, *Reciprocating internal combustion engines — Performance — Part 5: Torsional vibrations*

ISO 8528-1:2018, *Reciprocating internal combustion engine driven alternating current generating sets — Part 1: Application, ratings and performance*

ISO 8528-3:2005, *Reciprocating internal combustion engine driven alternating current generating sets — Part 3: Alternating current generators for generating sets*

IEC 60034-1, *Rotating electrical machines — Part 1: Rating and performance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
frequency
f
reciprocal of the period

Note 1 to entry: The symbol f is mainly used when the period is a time.

© ISO 2018 – All rights reserved

3.2
maximum transient frequency rise frequency
overshoot frequency
$f_{d,max}$
maximum frequency which occurs on sudden change from a higher to a lower power

Note 1 to entry: The symbol is different from that given in ISO 3046-4:2009.

3.3
maximum transient frequency drop frequency
undershoot frequency
$f_{d,min}$
minimum frequency which occurs on sudden change from a lower to a higher power

Note 1 to entry: The symbol is different from that given in ISO 3046-4:2009.

3.4
operating frequency of over frequency limiting device
f_{do}[a]
frequency at which, for a given setting frequency, the over frequency limiting device starts to operate

3.5
setting frequency of over frequency limiting device
f_{ds}
frequency of the generating set, the exceeding of which activates the over frequency limiting device

Note 1 to entry: In practice, instead of the value for the setting frequency, the value for the permissible over frequency is stated (also see ISO 8528-2:2005, Table 1).

iTeh STANDARD PREVIEW
(standards.iteh.ai)
ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

3.6
no-load frequency
f_i
frequency at which the generating set is operating without load

3.7
rated no-load frequency
$f_{i,r}$
frequency at which the generating set is designed to operate without load

3.8
maximum permissible frequency
f_{max}[b]
frequency specified by the generating set manufacturer which lays a safe amount below maximum safety frequency

Note 1 to entry: See ISO 8528-2:2005, Table 1.

3.9
declared frequency
rated frequency
f_r
frequency at which the generating set is designed to operate

3.10
maximum no-load frequency
$f_{i,max}$
maximum frequency at which the generating set is operating without load

 © ISO 2018 – All rights reserved

3.11
minimum no-load frequency
$f_{i,\mathrm{min}}$
minimum frequency at which the generating set is operating without load

3.12
frequency at actual power
f_{arb}
frequency at which the generating set is actually operating

3.13
maximum safety frequency
f_{maxs}
frequency which causes a stop of production

3.14
minimum safety frequency
f_{mins}
frequency which causes a stop of production

3.15
envelope width oscillation of generating set
$\overset{\wedge}{\underset{\vee}{f}}$
envelope width oscillation of generating set frequency at constant power around a mean value

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.16
steady short-circuit current
I_{k}
steady-state current in the armature winding when after short-circuited, the speed being maintained at its nominal value

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

3.17
duration
t
range of a time interval

Note 1 to entry: The duration of a time interval is a non-negative quantity equal to the difference between the dates of the final instant and the initial instant of the time interval, when the dates are quantitative marks. Different time intervals may have the same duration, e.g. the period of a time-dependent periodic quantity is a duration that is independent of the choice of the initial instant.

Note 2 to entry: The duration is one of the base quantities in the International System of Quantities (ISQ) on which the International System of Units (SI) is based. The term "time" instead of "duration" is often used in this context and also for an infinitesimal duration.

Note 3 to entry: The coherent SI unit of duration and time is second, s (see IEC 60050-112). The units minute (1 min = 60 s), hour (1 h = 60 min = 3 600 s), and day (1 d = 24 h = 86 400 s) are accepted for use with the SI.

Note 4 to entry: "Time" is used as a synonym for continuous time scales.

3.18
total stopping time
t_{a}
time interval from the stop command until the generating set has come to a complete stop

Note 1 to entry: $t_{\mathrm{a}} = t_{\mathrm{i}} + t_{\mathrm{c}} + t_{\mathrm{d}}$.

© ISO 2018 – All rights reserved

3.19
load pick-up readiness time
t_b
time interval from the start command until ready for supplying an agreed power, taking into account a given frequency and voltage tolerance

Note 1 to entry: $t_b = t_p + t_g$.

3.20
off-load run-on time
cooling run-on time
t_c
time interval from the removal of the load until generating set off signal is given to the generating set

3.21
run-down time
t_d
time from the generating set off signal to when the time when generating set has come to a complete stop

3.22
load pick-up time
t_e
time interval from start command until the agreed load is connected

Note 1 to entry: $t_e = t_p + t_g + t_s$.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.23
frequency recovery time after load decrease
$t_{f,de}$
time interval between the departure from the steady-state frequency band after a sudden specified load decrease and the permanent re-entry of the frequency into the specified steady-state frequency tolerance band

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

Note 1 to entry: See Figure 4.

3.24
frequency recovery time after load increase
$t_{f,in}$
time interval between the departure from the steady-state frequency band after a sudden specified load increase and the permanent re-entry of the frequency into the specified steady-state frequency tolerance band

Note 1 to entry: See Figure 4.

3.25
total run-up time
t_g
time interval from the beginning of cranking until ready for supplying an agreed power, taking into account a given frequency and voltage tolerance

3.26
time of coupling to the grid
t_{cg}
time interval between the starting order and the moment when the generating set is coupled to the grid

3.27
run-up time
t_h
time interval from the beginning of cranking until the declared speed is reached for the first time

© ISO 2018 – All rights reserved

3.28
on-load run-on time
t_i
time interval from a stop command being given until the load is disconnected (automatic sets)

3.29
start preparation time
t_p
time interval from the start command until the beginning of cranking

3.30
load switching time
t_s
time from readiness to take up an agreed load until this load is connected

3.31
interruption time
t_u
time interval from the appearance of the criteria initiating a start until the agreed load is connected

Note 1 to entry: $t_u = t_v + t_p + t_g + t_s$.

$= t_v + t_e$.

Note 2 to entry: Recovery time (ISO 8528-12) is a particular case of interruption time.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.32
voltage recovery time after load decrease
$t_{U,de}$
time interval from the point at which a load decrease is initiated until the point when the voltage returns to and remains within the specified steady-state voltage tolerance band

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

Note 1 to entry: See Figure 5.

3.33
voltage recovery time after load increase
$t_{u,in}$
time interval from the point at which a load increase is initiated until the point when the voltage returns to and remains within the specified steady-state voltage tolerance band

Note 1 to entry: See Figure 5.

3.34
start delay time
t_v
time interval from the appearance of the criteria initiating a start to the starting command (particularly for automatically started generating units)

Note 1 to entry: This time does not depend on the applied generating set. The exact value of this time is the responsibility of and is determined by the customer or by special requirements of legislative authorities. For example, this time is provided to avoid starting in case of a very short mains failure.

3.35
cranking time
t_z
time interval from the beginning of cranking until the firing speed of the engine is reached

© ISO 2018 – All rights reserved

3.36
pre-lubricating time
t_0
time required for some engines to ensure that oil pressure is established before the beginning of cranking

Note 1 to entry: This time is usually zero for small generating sets, which normally do not require pre-lubrication.

3.37
rate of change of frequency setting
v_f
rate of change of frequency setting under remote control

Note 1 to entry: $v_f = \frac{(f_{i,max} - f_{i,min}) / f_r}{t} \times 100$.

Note 2 to entry: Expressed as a percentage of related range of frequency setting per second.

3.38
rate of change of voltage setting
v_u
rate of change of voltage setting under remote control

Note 1 to entry: $v_U = \frac{(U_{s,up} - U_{s,do}) / U_r}{t} \times 100$.

Note 2 to entry: Expressed as a percentage of the related range of voltage setting per second.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.39
downward adjustment of voltage
$U_{s,do}$
lower limit of adjustment of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

3.40
upward adjustment of voltage
$U_{s,up}$
upper limit of adjustment of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

3.41
rated voltage
U_r
line-to-line voltage at the terminals of the generator at rated frequency and at rated output

3.42
recovery voltage
U_{rec}
maximum obtainable steady-state voltage for a specified load condition

Note 1 to entry: Recovery voltage is normally expressed as a percentage of the rated voltage.

Note 2 to entry: It normally lies within the steady-state voltage tolerance band (ΔU). For loads in excess of the rated load, recovery voltage is limited by saturation and exciter/regulator field forcing capability.

Note 3 to entry: See Figure 5.

3.43
set voltage
U_s
maximum obtainable steady-state voltage for a specified load condition or line-to-line voltage for defined operation selected by adjustment

© ISO 2018 – All rights reserved

3.44
maximum steady-state voltage
$U_{st,max}$
maximum voltage under steady-state conditions at rated frequency for all powers between no-load and rated output and at specified power factor, taking into account the influence of temperature rise

3.45
minimum steady-state voltage
$U_{st,min}$
minimum voltage under steady-state conditions at rated frequency for all powers between no-load and rated output and at specified power factor, taking into account the influence of temperature rise

3.46
no-load voltage
U_0
line-to-line voltage at the terminals of the generator at rated frequency and no-load

3.47
maximum upward transient voltage on load decrease
$U_{dyn,max}$
maximum voltage which occurs on a sudden change from a higher load to a lower load

3.48
minimum downward transient voltage on load increase
$U_{dyn,min}$
minimum voltage which occurs on a sudden change from a lower load to a higher load

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.49
maximum value of set voltage
$\hat{U}_{max, s}$
maximum obtainable voltage for a specified load condition or line-to-line voltage for defined operation selected by adjustment

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

3.50
minimum value of set voltage
$\hat{U}_{mini, s}$
miminum obtainable voltage for a specified load condition or line-to-line voltage for defined operation selected by adjustment

3.51
mean value of set voltage
$\hat{U}_{mean, s}$
mean obtainable voltage for a specified load condition or line-to-line voltage for defined operation selected by adjustment

3.52
voltage modulation
$\hat{U}_{mod, s}$
quasi-periodic voltage variation (peak-to-peak) about a steady-state voltage having typical frequencies below the fundamental generation frequency

Note 1 to entry: Expressed as a percentage of average peak voltage at rated frequency and constant speed.

Note 2 to entry: $\hat{U}_{mod,s} = 2 \times \frac{\hat{U}_{mod,s,max} - \hat{U}_{mod,s,min}}{\hat{U}_{mod,s,max} + \hat{U}_{mod,s,min}} \times 100$.

Note 3 to entry: This is a cyclic or random disturbance which can be caused by regulators, cyclic irregularity or intermittent loads. Flickering lights are a special case of voltage modulation (see Figures 8 and 9).

© ISO 2018 – All rights reserved

3.53
maximum peak of voltage modulation
$\hat{U}_{mod, s, max}$
quasi-periodic maximum voltage variation (peak-to-peak) about a steady-state voltage

3.54
minimum peak of voltage modulation
$\hat{U}_{mod, s, min}$
quasi-periodic minimum voltage variation (peak-to-peak) about a steady-state voltage

3.55
width of voltage oscillation
$\overset{\wedge}{\underset{\vee}{U}}$
envelope width oscillation of generating set voltage at constant power around a mean value

3.56
steady-state frequency tolerance band
Δf
agreed frequency band about the steady-state frequency which the frequency reaches within a given governing period after increase or decrease of the load

3.57
negative deviation from a linear curve
Δf_{neg}
negative deviation from a linear curve that occurs between no load and rated load

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Note 1 to entry: See Figure 2.

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3755-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

3.58
positive deviation from a linear curve
Δf_{pos}
positive deviation from a linear curve that occurs between no load and rated load

Note 1 to entry: See Figure 2.

3.59
maximum frequency deviation from a linear curve
Δf_c
larger value of Δf_{neg} and Δf_{pos} that occurs between no load and rated load

Note 1 to entry: See Figure 2.

3.60
range of frequency setting
Δf_s
range between the highest and lowest adjustable no-load frequencies

Note 1 to entry: See Figure 1.

Note 2 to entry: $\Delta f_s = f_{i,max} - f_{i,min}$.

3.61
downward range of frequency setting
$\Delta f_{s,do}$
range between the declared no-load frequency and the lowest adjustable no-load

Note 1 to entry: See Figure 1.

Note 2 to entry: $\Delta f_{s,do} = f_{i,r} - f_{i,min}$.

 © ISO 2018 – All rights reserved

3.62
upward range of frequency setting
$\Delta f_{s,up}$
range between the highest adjustable no-load frequency and the declared no-load frequency

Note 1 to entry: See Figure 1.

Note 2 to entry: $\Delta f_{s,up} = f_{i,max} - f_{i,r}$.

3.63
steady-state voltage tolerance band
ΔU
agreed voltage band about the steady-state voltage that the voltage reaches within a given regulating period after a specified sudden increase or decrease of load

Note 1 to entry: $\Delta U = 2\delta U_{st} \times \frac{U_r}{100}$.

3.64
range of voltage setting
ΔU_s
range of maximum possible upward and downward adjustments of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

Note 1 to entry: $\Delta U_s = \Delta U_{s,up} + \Delta U_{s,do}$.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

3.65
downward range of voltage setting
$\Delta U_{s,do}$
range between the rated voltage and downward adjustment of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

ISO 8528-5:2018
https://standards.iteh.ai/catalog/standards/sist/91ec3795-18ed-4be7-85ea-8327af859c8b/iso-8528-5-2018

Note 1 to entry: $\Delta U_{s,do} = \Delta U_r + \Delta U_{s,do}$.

3.66
upward range of voltage setting
$\Delta U_{s,up}$
range between the rated voltage and upward adjustment of voltage at the generator terminals at rated frequency, for all loads between no-load and rated output and within the agreed range of power factor

Note 1 to entry: $\Delta U_{s,up} = \Delta U_{s,up} + \Delta U_r$.

3.67
frequency/power characteristic deviation
$\Delta \delta f_{st}$
maximum deviation from a linear frequency/power characteristic curve in the power range between no-load and declared power

Note 1 to entry: Expressed as a percentage of rated frequency.

Note 2 to entry: See Figure 2.

Note 3 to entry: $\Delta \delta f_{st} = \frac{\Delta f_c}{f_r} \times 100$.

3.68
frequency/power characteristic curve
curve of steady-state frequencies in power range between no-load and declared power, plotted against active power of generating set

Note 1 to entry: See Figure 2.

© ISO 2018 – All rights reserved