

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

Bränsleceller – Del 8-102: Energilagringssystem med bränslecellsmoduler för reversibel drift – Provning av PEM-celler och stackar med PEM-celler

Fuel cell technologies –

Part 8-102: Energy storage systems using fuel cell modules in reverse mode –

Test procedures for proton exchange membrane single cell and stack performance including reversing operation

Som svensk standard gäller europastandarden EN IEC 62282-8-102:2020. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 62282-8-102:2020.

Nationellt förord

Europastandarden EN IEC 62282-8-102:2020

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 62282-8-102, First edition, 2019 - Fuel cell technologies - Part 8-102: Energy storage systems using fuel cell modules in reverse mode - Test procedures for proton exchange membrane single cell and stack performance including reversing operation**

utarbetad inom International Electrotechnical Commission, IEC.

ICS 27.070.00

Denna standard är fastställd av SEK Svensk Elstandard, som också kan lämna upplysningar om **sakinnehållet** i standarden.
Postadress: Box 1284, 164 29 KISTA
Telefon: 08 - 444 14 00.
E-post: sek@elstandard.se. Internet: www.elstandard.se

Standarder underlättar utvecklingen och höjer elsäkerheten

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

SEK är Sveriges röst i standardiseringsarbetet inom elområdet

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

Stora delar av arbetet sker internationellt

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

SEK Svensk Elstandard

Box 1284
164 29 Kista
Tel 08-444 14 00
www.elstandard.se

English Version

Fuel cell technologies - Part 8-102: Energy storage systems
using fuel cell modules in reverse mode - Test procedures for
the performance of single cells and stacks with proton exchange
membranes, including reversible operation
(IEC 62282-8-102:2019)

Technologies des piles à combustible - Partie 8-102:
Systèmes de stockage de l'énergie utilisant des modules à
piles à combustible en mode inversé - Procédures d'essai
pour la performance des cellules élémentaires et des piles
à membrane échangeuse de protons, comprenant le
fonctionnement réversible
(IEC 62282-8-102:2019)

Brennstoffzellentechnologien - Teil 8-102:
Energiespeichersysteme mit Brennstoffzellenmodulen im
Umkehrbetrieb - Prüfverfahren zum Leistungsverhalten von
Einzelzellen und Stacks mit Protonen-Austausch-Membran
einschließlich Umkehrbetrieb
(IEC 62282-8-102:2019)

This European Standard was approved by CENELEC on 2020-01-17. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

European foreword

The text of document 105/763/FDIS, future edition 1 of IEC 62282-8-102, prepared by IEC/TC 105 "Fuel cell technologies" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62282-8-102:2020.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-10-17
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2023-01-17

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62282-8-102:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

- | | | |
|-----------------|------|---|
| IEC 62282-8-101 | NOTE | Harmonized as EN IEC 62282-8-101 ¹ |
| IEC 62282-8-201 | NOTE | Harmonized as EN IEC 62282-8-201 ² |

¹ To be published. Stage at the time of publication: FprEN IEC 62282-8-101:2019.

² To be published. Stage at the time of publication: FprEN IEC 62282-8-201:2019.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-485	2020	International Electrotechnical Vocabulary - Part 485: Fuel cell technologies	-	-
IEC/TS 62282-7-1	2017	Fuel cell technologies - Part 7-1: Test methods - Single cell performance tests for polymer electrolyte fuel cells (PEMFC)	-	-

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms, definitions and symbols	8
3.1 Terms and definitions.....	8
3.2 Symbols.....	13
3.3 Standard temperature and pressure (STP) values for gas temperature and pressure	15
4 General safety considerations	15
5 Test environment.....	16
5.1 General.....	16
5.2 Reversible PEM cell/stack assembly unit	17
5.3 Separated reversible PEM cell/stack assembly unit.....	17
5.4 Experimental set-up	17
5.4.1 General	17
5.4.2 Fluid flow control equipment	18
5.4.3 Load/power control equipment.....	18
5.4.4 Measurement and data acquisition equipment	18
5.4.5 Safety equipment.....	19
5.4.6 Mechanical load control equipment.....	19
5.4.7 Heat management equipment	19
5.4.8 Gas pressure control equipment	19
5.4.9 Test system control equipment	19
5.5 Parameter control and measurement	19
5.6 Measurement methods of TIPs and TOPs and control accuracy	20
6 Measurement instruments and measurement methods.....	20
6.1 Instrument uncertainty	20
6.2 Recommended measurement instruments and methods.....	21
6.2.1 General	21
6.2.2 Voltage.....	21
6.2.3 Current	21
6.2.4 Internal resistance (IR)	21
6.2.5 Electrode gas flow rates	22
6.2.6 Electrode gas temperature.....	22
6.2.7 Cell/stack temperature.....	23
6.2.8 Electrode gas pressures	23
6.2.9 Electrode gas humidity	23
6.2.10 Ambient conditions	23
6.3 Reference test conditions and manufacturer recommendations	24
6.3.1 Start-up and shut-down conditions.....	24
6.3.2 Range of test conditions	24
6.3.3 Stabilization, initialization conditions and stable state	24
6.4 Data acquisition method.....	24
7 Test procedures and computation of results	25
7.1 General.....	25

7.2	Current-voltage (<i>I-V</i>) characteristics test	25
7.2.1	Objective	25
7.2.2	Test method	25
7.2.3	Data post-processing	25
7.3	Steady-state test	26
7.3.1	Objective	26
7.3.2	Test methods	26
7.3.3	Data post-processing	26
7.4	Durability test	26
7.4.1	Objective	26
7.4.2	Test method	26
7.4.3	Data post-processing	26
7.5	Internal resistance (IR) measurement	27
7.5.1	Objective	27
7.5.2	Test methods	27
7.5.3	Data post processing	28
7.6	Current cycling durability test	28
7.6.1	Objective	28
7.6.2	Test method	28
7.6.3	Data post-processing	28
7.7	Pressurized test	29
7.7.1	Objective	29
7.7.2	Test method	29
7.7.3	Data post-processing	29
8	Test report	29
8.1	General	29
8.2	Report items	29
8.3	Test unit data description	30
8.4	Test condition description	30
8.5	Test data description	30
8.6	Uncertainty evaluation	30
Annex A	(normative) Test procedure guidelines	31
A.1	Test objective	31
A.2	Test set-up	31
A.3	Current-voltage characteristics test (7.2)	31
A.3.1	Test input parameters (TIPs)	31
A.3.2	Test output parameters (TOPs)	32
A.3.3	Derived quantities	32
A.4	Steady-state test (7.3)	33
A.4.1	Test input parameters (TIPs)	33
A.4.2	Test output parameters (TOPs)	34
A.4.3	Derived quantities	34
A.5	Durability test (7.4)	35
A.5.1	Test input parameters (TIPs)	35
A.5.2	Test output parameters (TOPs)	35
A.5.3	Derived quantities	36
A.5.4	Measurement of durability	36
A.6	Current cycling durability test	37
A.6.1	Test input parameters (TIPs)	37

A.6.2	Test output parameters (TOPs).....	37
A.6.3	Derived quantities.....	38
A.6.4	Measurement of current cycling durability.....	38
A.7	Pressurized test.....	39
A.7.1	Test input parameters (TIPs).....	39
A.7.2	Test output parameters (TOPs).....	39
A.7.3	Derived quantities.....	39
A.7.4	Measurement of pressurized test.....	40
Annex B (normative)	Formulary.....	41
	Bibliography.....	42
	Figure 1 – Schematic representation of a reversible PEM cell/stack assembly unit.....	17
	Figure 2 – Schematic representation of a separate reversible PEM cell/stack assembly unit.....	17
	Figure 3 – Schematic graph of a test environment for a PEM cell/stack assembly unit.....	18
	Figure 4 – Schematic diagram of PEM cell impedance.....	22
	Table 1 – Symbols.....	14
	Table 2 – Instrument uncertainty for each quantity to be measured.....	20
	Table A.1 – Test input parameters (TIPs) for current-voltage characteristics test.....	32
	Table A.2 – Test output parameters (TOPs) for current-voltage characteristics test.....	32
	Table A.3 – Derived quantities for current-voltage characteristics test.....	33
	Table A.4 – Test input parameters (TIPs) for steady state test.....	33
	Table A.5 – Test output parameters (TOPs) for steady state test.....	34
	Table A.6 – Derived quantities for steady state test.....	34
	Table A.7 – Test input parameters (TIPs) for durability test.....	35
	Table A.8 – Test output parameters (TOPs) for durability test.....	36
	Table A.9 – Derived quantities for constant load durability test.....	36
	Table A.10 – Test input parameters (TIPs) for current cycling durability test within a single operating mode (fuel cell or electrolysis).....	37
	Table A.11 – Test input parameters (TIPs) for current cycling durability test covering both operating modes (fuel cell and electrolysis).....	37
	Table A.12 – Test output parameters (TOPs) for current cycling durability test.....	38
	Table A.13 – Derived quantities for current cycling durability test.....	38
	Table A.14 – Test input parameters (TIPs) for pressurized testing.....	39
	Table A.15 – Test output parameters (TOPs) for pressurized testing.....	39
	Table A.16 – Derived quantities for pressurized test.....	39

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUEL CELL TECHNOLOGIES –

Part 8-102: Energy storage systems using fuel cell modules in reverse mode – Test procedures for the performance of single cells and stacks with proton exchange membranes, including reversible operation

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62282-8-102 has been prepared by IEC technical committee 105: Fuel cell technologies.

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

FDIS	Report on voting
105/763/FDIS	105/776/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 62282 series, published under the general title *Fuel cell technologies*, 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This part of IEC 62282 describes test methods for a single cell and stack (denoted as "cell/stack" hereafter) that are intended for use in energy storage systems that use proton exchange membrane fuel cells (PEMFC) in combination with proton exchange membrane water electrolyzers (PEMWE), or directly using proton exchange membrane cells (Re-PEM).

This document is intended to be used for data exchanges in commercial transactions between cell/stack manufacturers and system developers or for acquiring data on a cell or stack in order to estimate the performance of a system based on it. Users of this document can selectively execute test items suitable for their purposes from those described in this document.

PEMFCs, PEMWEs and Re-PEMs have a broad range of geometry and size. As such, in general, peripherals like current collectors and gas manifolds are unique to each cell or stack and are often incorporated into a cell or stack to form one integrated unit. In addition, they tend to have a significant effect on the power generation characteristics of the cell or stack. This document therefore introduces as its subject "cell/stack assembly unit", which are defined as those units containing not only a cell or a stack, but also peripherals.

IEC 62282-8 (all parts) aims to develop performance test methods for power storage and buffering systems based on electrochemical modules (combining electrolysis and fuel cells, in particular reversible fuel cells), taking into consideration both options of re-electrification and substance (and heat) production for sustainable integration of renewable energy sources.

Under the general title *Energy storage systems using fuel cell modules in reverse mode*, the IEC 62282-8 series consists of the following parts:

- IEC 62282-8-101: *Test procedures for the performance of solid oxide single cells and stacks, including reversible operation*
- IEC 62282-8-102: *Test procedures for the performance of single cells and stacks with proton exchange membranes, including reversible operation*
- IEC 62282-8-103¹: *Alkaline single cell and stack performance including reversible operation*
- IEC 62282-8-201: *Test procedures for the performance of power-to-power systems*
- IEC 62282-8-202²: *Power-to-power systems – Safety*
- IEC 62282-8-300 (all parts)³: *Power-to-substance systems*

As a priority dictated by the emerging needs for industry and opportunities for technological development, IEC 62282-8-101, IEC 62282-8-102 and IEC 62282-8-201 have been initiated jointly and as a priority. These parts are presented as a package to highlight the need for an integrated approach as regards the system application (i.e. a solution for energy storage) and its fundamental constituent components (i.e. fuel cells operated in reverse or reversing mode).

IEC 62282-8-103, IEC 62282-8-202 and IEC 62282-8-300 (all parts) are suggested but are left for initiation at a later stage.

¹ Under consideration.

² Under consideration.

³ Under consideration.

FUEL CELL TECHNOLOGIES –

Part 8-102: Energy storage systems using fuel cell modules in reverse mode – Test procedures for the performance of single cells and stacks with proton exchange membranes, including reversible operation

1 Scope

This part of IEC 62282 deals with PEM cell/stack assembly units, testing systems, instruments and measuring methods, and test methods to test the performance of PEM cells and stacks in fuel cell mode, electrolysis and/or reversible mode.

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 60050-485:—⁴, *International Electrotechnical Vocabulary – Part 485: Fuel cell technologies*

IEC TS 62282-7-1:2017, *Fuel cell technologies – Part 7-1: Test methods – Single cell performance tests for polymer electrolyte fuel cells (PEMFC)*

⁴ Under preparation. Stage at the time of preparation: IEC FDIS 60050-485:2019.