

BS EN 62282-6-300:2009



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Fuel cell technologies

Part 6-300: Micro fuel cell power systems —
Fuel cartridge interchangeability

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National foreword

This British Standard is the UK implementation of EN 62282-6-300:2009. It is identical to IEC 62282-6-300:2009.

The UK participation in its preparation was entrusted to Technical Committee GEL/105, Fuel cell technologies.

A list of organizations represented on this committee can be obtained on request to its secretary.

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EN 62282-6-300

November 2009

ICS 27.070

English version

**Fuel cell technologies -
Part 6-300: Micro fuel cell power systems -
Fuel cartridge interchangeability
(IEC 62282-6-300:2009)**

Technologies des piles à combustible -
Partie 6-300: Systèmes à micro-piles
à combustible -
Interchangeabilité de la cartouche
de combustible
(CEI 62282-6-300:2009)

Brennstoffzellentechnologie -
Teil 6-300: Mikrobrennstoffzellen-
Energiesysteme -
Austauschbarkeit der Brennstoffkartusche
(IEC 62282-6-300:2009)

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

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Foreword

The text of document 105/214/FDIS, future edition 1 of IEC 62282-6-300, prepared by IEC TC 105, Fuel cell technologies, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62282-6-300 on 2009-09-01.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2012-09-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62282-6-300:2009 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60950-1 (mod)	2005	Information technology equipment - Safety - Part 1: General requirements	EN 60950-1 + A11	2006 2009
IEC/PAS 62282-6-1	2006	Fuel cell technologies - Part 6-1: Micro fuel cell power systems - Safety	-	-
IEC 62282-6-200	2007	Fuel cell technologies - Part 6-200: Micro fuel cell power systems - Performance test methods	EN 62282-6-200	2008
ISO 1302	2002	Geometrical Product Specifications (GPS) - Indication of surface texture in technical product documentation	EN ISO 1302	2002

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INTRODUCTION

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning fuel connectors given in 4.3.1, 4.3.2, 4.3.3 and 4.3.4, patents concerning mechanical keys given in 4.2.3, and patents concerning fuel quality in 5.5.

IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

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- Toyo Seikan Kaisha, Ltd., 3-1 Uchisaiwaicho 1-chome, Tokyo 100-8522 Japan
- Toshiba Corporation, 1-1, Shibaura 1-chome, Tokyo 1005-8001 Japan
- Tokai Corporation, 3-4, Shimohara, Subashiri, Oyama-cho, Sunto-Gun, Shizuoka, 410-1431 Japan
- NEC Corporation, 7-1, Shiba 5-chome, Tokyo 108-8001 Japan
- Samsung SDI Co., Ltd., 575 Shin-dong, Yeongtong-gu, Suwan-si, Gyeonggi-do, 443-731, Korea.

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

FUEL CELL TECHNOLOGIES –

Part 6-300: Micro fuel cell power systems – Fuel cartridge interchangeability

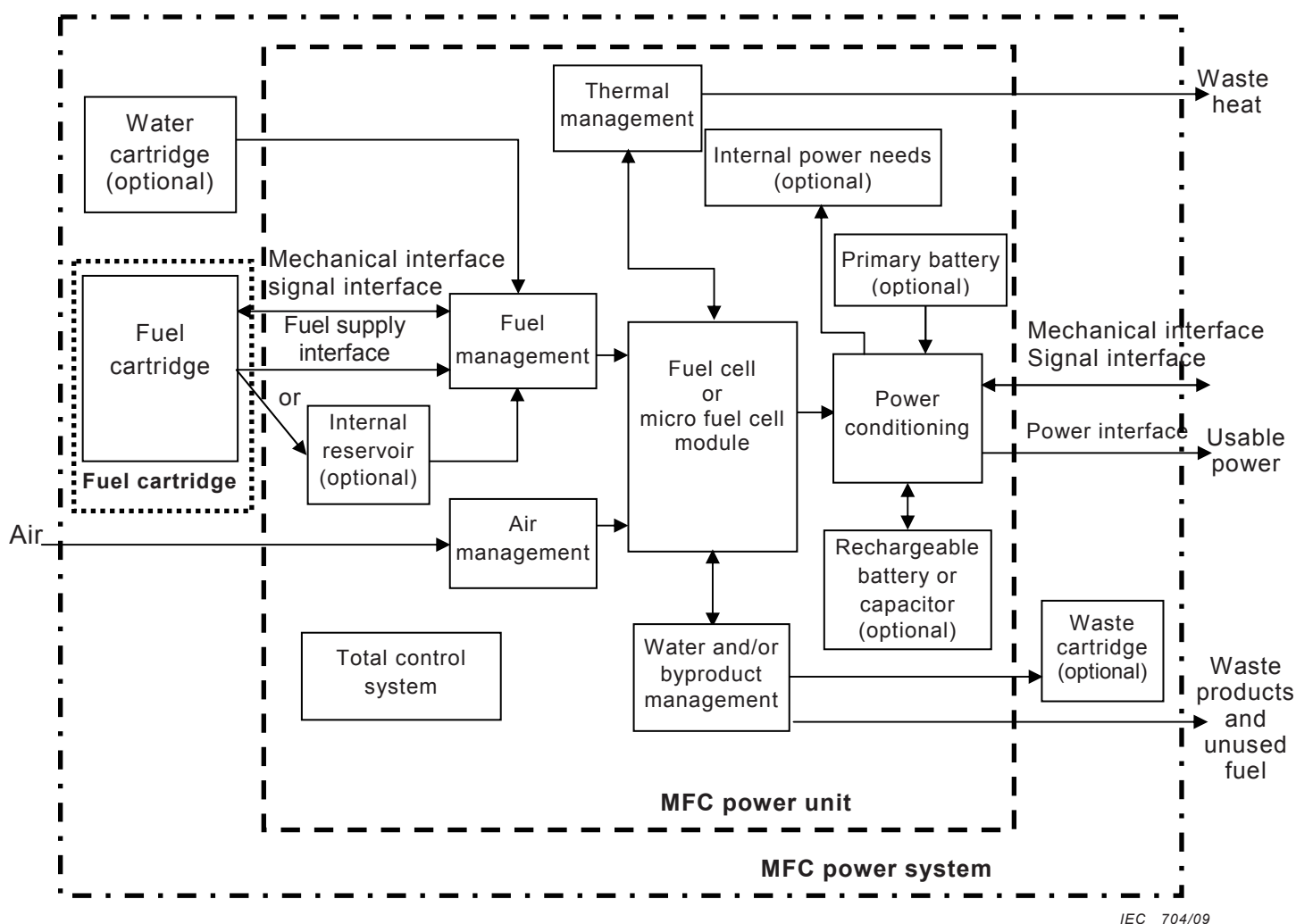
1 Scope

This International Standard covers interchangeability of micro fuel cell (MFC) fuel cartridges to provide the cartridge compatibility for a variety of MFC power units while maintaining the safety and performance of MFC power systems. For this purpose, the standard covers fuel cartridges and their connector designs. Fuel type, fuel concentration and fuel quality are also covered. This standard also provides for the means to avoid the miss-connection of an improper fuel cartridge. Test methods for verifying the compliance with the interchangeability requirements for fuel and fuel cartridges are also provided in this standard.

IEC/PAS 62282-6-1 and IEC 62282-6-200 do not cover fuel cartridge or fuel from the cartridge. IEC 62282-6-300 describes the performance test methods of fuel cartridges, the fuel from the cartridge, and markings to realize the interchangeability of fuel cartridges. These include performance effect of fuel cartridges, such as fuel quality which may affect the performance of MFC power units and usable fuel volume from fuel cartridges.

A MFC power system block diagram is shown in Figure 1. MFC power systems and MFC power units are defined as those wearable or easily carried by hand, providing d.c. outputs that do not exceed 60 V d.c. and power outputs that do not exceed 240 VA. This standard covers the fuel cartridge for MFC power units and the mechanical interface of connectors between fuel cartridges and MFC power units. The main body of this standard includes methanol liquid fuel cartridges, including methanol and water solution. Annex A shows the background used to determine the forces expected in normal operation and in foreseeable misuse. Annex B shows the example design for test fixtures for the fuel connector and fuel cartridge type tests.

NOTE Liquid fuel means fuel transported from a cartridge to a MFC power unit in the liquid state, and gas fuel means fuel transported from a cartridge to a power unit in the gaseous state.



IEC 704/09

Figure 1 – MFC power system block diagram

2 Normative references

The following referenced documents are indispensable for the application 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 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*

IEC/PAS 62282-6-1:2006, *Fuel cell technologies – Part 6-1: Micro fuel cell power systems safety*

NOTE IEC/PAS 62282-6-1 will be replaced with IEC 62282-6-100 when it is published as an International Standard. References to IEC/PAS 62282-6-1 will be updated accordingly in subsequent editions of the present standard.

IEC 62282-6-200:2007, *Fuel cell technologies – Part 6-200: Micro fuel cell power systems – Performance test methods*

ISO 1302:2002, *Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation*

3 Terms and definitions

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

3.1

base level

reference plane on the MFC power unit side connector

All dimensions as shown in the connector figures (see 4.3) are relative to this reference plane.

See Figures 3, 4, and 5 in 4.3.2.2, Figures 13 and 14 in 4.3.3.2, Figures 22 and 23 in 4.3.4.2 and Figures 29 and 30 in 4.3.5.2.

3.2

base plane

surface of the power unit to which the cartridge mates

See Figures 6 and 7 in 4.3.2.3, Figure 15 in 4.3.3.3, Figures 24 in 4.3.4.3 and Figure 31 in 4.3.5.3.

3.3

connector retainer

mechanical means that secures the connection between the fuel cartridge side connector and the MFC power unit connector

3.4

connector seal position

point where seal is established after the sealing section of the MFC power unit makes contact with the sealing section of the cartridge (seal complete position)

3.5

distance to open valve

distance between the base level of the MFC power unit side connector and the point where the valve starts to open during valve opening sequence

NOTE The distance to open valve is the same as the point where fluid stops flowing during the closing sequence.

3.6

distance to stop valve

distance between the base level of the MFC power unit side connector and the final position of the end of the valve actuator during the valve opening sequence

The valve actuator is a component responsible for opening of the valve.

See Figures 3, 4, and 5 in 4.3.2.2, Figures 13 and 14 in 4.3.3.2, Figures 22 and 23 in 4.3.4.2 and Figures 29 and 30 in 4.3.5.2.

3.7

electronic device

any of such electronic devices as cellular phone, music player, digital camera, camcorder, personal digital assistant (PDA), mobile game machine and mobile PC, which uses a MFC power unit/system

3.8

force to open valve

force required to push the MFC power unit valve to the stop position (distance to stop valve)

3.9**fractures**

visually-detectable cracks or breaks in the exterior of the fuel connector, valve and all the casings around the connector

3.10**fuel**

liquid or gas substance, which is supplied from fuel cartridge to the MFC power unit and is used to produce electricity in a MFC power system; liquid fuels of methanol and methanol/water solutions are considered fuels in the main body of this standard

NOTE Liquid fuels such as ethanol, ethanol/water solution, formic acid and formic-acid/water solution will be covered as per the supplement to this standard. Gaseous fuel, which shall use different types of fuel connectors, will be covered as per the supplement to this standard.

3.11**fuel cartridge**

removable article that contains and supplies fuel to the MFC power unit or internal reservoir, not to be refilled by user. See Figure 2 for cartridge types:

– insert cartridge:

fuel cartridge which has its own enclosure and is installed within the enclosure of the electronic device powered by the MFC power system

– exterior cartridge:

fuel cartridge which has its own enclosure that forms a portion of the enclosure of the electronic device powered by the MFC power system

– attached cartridge:

fuel cartridge, which has its own enclosure that connects to the electronic device powered by the MFC power system

– satellite cartridge:

fuel cartridge that is intended to be connected to and removed from the MFC power unit to transfer fuel to the internal reservoir inside the MFC power unit

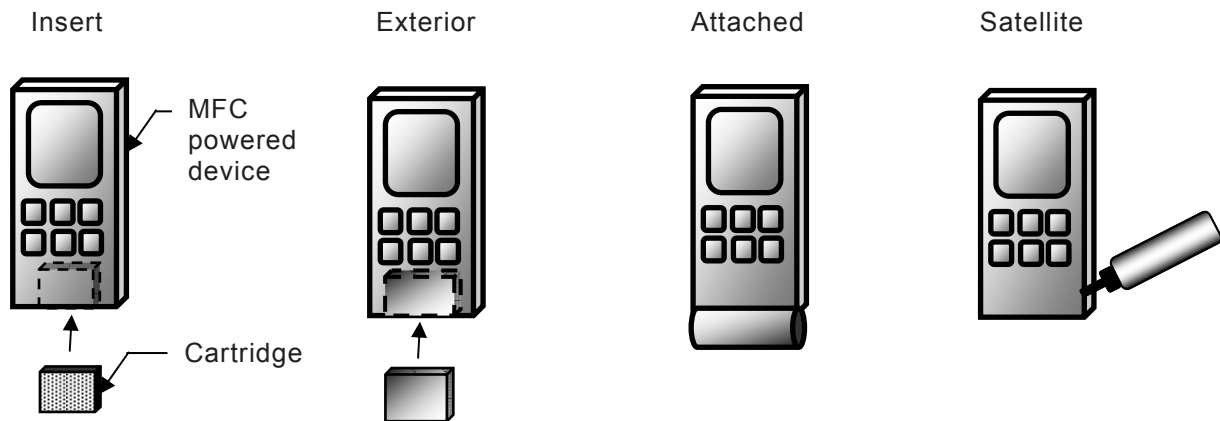


Figure 2 – Fuel cartridge types

3.12

fuel cartridge, pressurized

fuel supply unit in which the internal pressure exceeds a gauge pressure of 34,5 kPa measured at 24 °C without external forces

3.13

fuel cartridge, non-pressurized

fuel supply unit in which the internal pressure does not exceed a gauge pressure of 34,5 kPa measured at 24 °C without external forces

3.14

fuel connector

attachment means between the fuel cartridge and MFC power unit that allows for the passage of fuel from the cartridge to the power unit

3.15

internal reservoir

structure in a MFC power unit that stores fuel and cannot be removed

3.16

impurity

materials in any form of metal, inorganic material, organic material, molecule, ion, complex, polymer and oligomer, which are contained in the fuel and may disturb the power generation performance of MFC power unit

3.17

leakage

accessible hazardous liquid fuel outside the MFC power system or fuel cartridge

3.18

mechanical key

structure, installed around the fuel connector, that prevents the MFC power unit from being connected to cartridges with improper properties (e.g. fuel type, fuel concentration, internal pressure and connector strength)

3.19**MFC power unit**

electric generator as defined in Figure 1, providing direct current output that does not exceed 60 V d.c. and power output that does not exceed 240 VA

The MFC power unit does not include a fuel cartridge.

3.20**MFC power system**

MFC power unit with associated cartridges that is wearable or easily carried by hand

3.21**no fuel vapour loss**

fuel vapour escaping from the fuel cartridge or MFC power system or unit that is less than or equal to 0,08 g/h

4 Fuel connectors**4.1 Basic requirements****4.1.1 Safety**

Fuel connectors shall comply with the safety requirements in Subclause 4.10.3, Fuel valves, Subclause 4.17, Fuel supply construction, and pass type tests described in Clause 7 in IEC/PAS 62282-6-1.

4.1.2 No leakage and no fuel vapour loss

4.1.2.1 No leakage and no fuel vapour loss shall occur at fuel connectors in the process of connecting, using and removing of cartridge. Requirements listed under 4.1.2.2 through 4.1.2.5 shall be applied to all fuel cartridge types.

4.1.2.2 The cartridge side connector shall have an orientation feature(s) and/or mechanical feature(s) to ensure that the cartridge can only be connected in the proper orientation and that a wrong cartridge is prevented from being connected to the MFC power unit. These features ensure that the following conditions are met.

- a) Improper connection of the cartridge by the user to the MFC power unit shall not damage the cartridge side connector or MFC power unit side connector in any way that will result in leakage or fuel vapour loss when they are subsequently connected together properly, when the cartridge is subsequently connected properly to another MFC power unit, or when the MFC power unit is subsequently connected properly to another fuel cartridge.
- b) Attempting to connect the cartridge to a wrong MFC power unit shall not damage the cartridge side connector or MFC power unit side connector in any way that will result in leakage or fuel vapour loss when a correct cartridge is subsequently connected properly to the MFC power unit or when the cartridge is subsequently connected properly to a correct MFC unit.
- c) Attempting to connect the cartridge to the MFC power unit with a force expected in normal operation or foreseeable misuse shall not result in leakage or fuel vapour loss, or otherwise result in subsequent leakage or fuel vapour loss if used properly in the future.

4.1.2.3 If a force expected in normal operation or foreseeable misuse is applied to the cartridge and/or MFC power unit while the cartridge is connected to the MFC power unit, there shall be no leakage and no fuel vapour loss under the following conditions.

- a) If a cartridge is connected to a MFC power unit and loading is applied to the cartridge or MFC power unit, there shall be no leakage and no fuel vapour loss.
- b) If the cartridge can be connected to the MFC power unit after unintentional loading, there shall be no leakage and no fuel vapour loss. If another cartridge cannot be connected to the MFC power unit, there shall be no leakage and no fuel vapour loss.

4.1.2.4 If a force expected in normal operation or foreseeable misuse is applied to the cartridge side connector and/or MFC power unit side connector while the cartridge is being removed from the MFC power unit, there shall be no leakage and no fuel vapour loss under the following conditions.

- a) Attempting to remove the cartridge from the MFC power unit with a force expected in normal use shall not result in leakage or fuel vapour loss or otherwise result in subsequent leakage or fuel vapour loss if used properly in the future.
- b) Improper removal of the cartridge by the user from the MFC power unit shall not damage the cartridge side connector or MFC power unit side connector such that: when another cartridge is connected properly to the MFC power unit or when another MFC power unit is connected properly to the cartridge, there shall be no leakage and no fuel vapour loss. If the cartridge cannot be removed from the MFC power unit, there shall be no leakage and no fuel vapour loss.

4.1.2.5 If the cartridge side connector is damaged while the cartridge is being connected, used or removed by a force expected in foreseeable misuse, the following requirements shall be met.

- a) Leakage or fuel vapour loss shall not be detected even if the cartridge side fuel connector is damaged.
- b) When the cartridge side connector is damaged at its coupling part, no leakage and no fuel vapour loss shall be caused if the MFC power unit side connector is connected, used, or removed. This is not intended to include any damage to the MFC power unit caused by a user with an obviously damaged cartridge.
- c) If the cartridge side connector is damaged, it shall be easy for the user to remove the damaged cartridge and/or any broken parts of the cartridge from the MFC power unit side connector. The connection of a new cartridge to the MFC power unit shall not be affected.
- d) The MFC power unit side connector shall not be damaged. The cartridge side connector shall be designed with suitable connector material so as to cause the MFC power unit side connector no damage.

4.2 Construction and actuation requirements

4.2.1 General

Fuel connectors of cartridges and MFC power units shall comply with the compatibility requirements for construction and actuation as follows. The following requirements shall be applied to all types of cartridges such as insert, exterior, attached and satellite types.

4.2.2 Connector sealing

For MFC power unit side connectors, the connection cycling durability test for connect/disconnect (IEC/PAS 62282-6-1 requires 1 000 times) is required.

4.2.3 Connector sequence

The indicated sequence shall be followed for connection of a cartridge with an MFC power unit: first, the sealing is secured between the cartridge side connector and the MFC power unit side connector; second, the MFC power unit valve is opened; and finally the cartridge valve is opened.

When the cartridge side connector is removed, the cartridge valve is closed first, then the MFC power unit valve is closed, and finally the seal is opened.

4.2.4 Mechanical keys

Connectors between the cartridge and the MFC power unit shall have a mechanical key structure which permits only the connection of the proper combination of fuel cartridges and MFC power units in order to prevent wrong connections in fuel and/or internal pressure of the cartridge.

4.2.5 Material requirement

The connector material shall be chosen to maintain the integrity of connection and withstand methanol and aqueous methanol solution of pH 2,5. See 4.5 of IEC/PAS 62282-6-1 for material selection.

4.3 Interchangeable fuel connectors

4.3.1 General

The compatibility of fuel connectors is achieved by standardizing the dimensions of the MFC power unit side connector. Subclauses 4.3.2.7 to 4.3.2.9, 4.3.3.8 to 4.3.3.10, 4.3.4.7 to 4.3.4.9 and 4.3.5.7 to 4.3.5.9 provide additional requirements for the cartridge side.

The interchangeable connectors are defined in 4.3.2, 4.3.3, 4.3.4 and 4.3.5.

NOTE Designs that are not prescribed in this standard but that meet or exceed the performance requirements of this standard will be considered as covered by this standard.

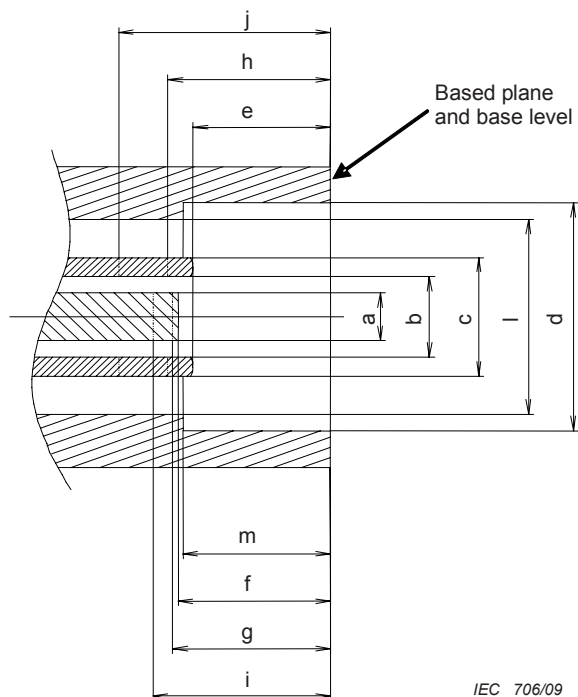
4.3.2 Type A

4.3.2.1 Basic information

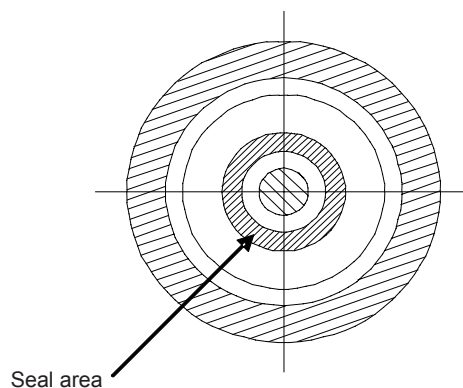
a. Fuel type	Methanol and aqueous methanol solutions, pressurized and non-pressurized
b. Cartridge category	All types of cartridges: insert, exterior, attached and satellite types
c. Connector category	All classifications of connector strength from I through IV
d. Cartridge size	No limitations regarding dimension and design (shape) in particular for insert, exterior, attached and satellite types

4.3.2.2 MFC power unit side connector design

The MFC power unit side connector design for Type A is shown in Figures 3, 4, and 5 with dimensions and tolerances in Table 1.



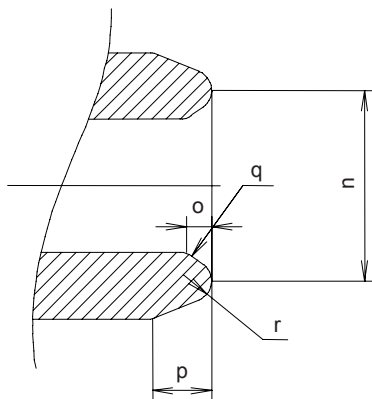
IEC 706/09



IEC 707/09

Figure 3 – MFC power unit side connector design (cross-sectional view)

Figure 4 – MFC power unit side connector design (front-elevational view)



IEC 708/09

Figure 5 – Seal surface area design for MFC power unit side connector (cross-sectional view)

Table 1 – Dimension with tolerance for MFC power unit side connector

Item	Value	Tolerance
a Valve diameter	1,2 mm	$\pm 0,02$ mm
b Inner diameter for seal	1,3 mm	$\pm 0,05$ mm
c Outer diameter for seal	2,6 mm	$\pm 0,05$ mm
d Hole diameter	4,8 mm	$+0,05/-0,0$ mm
e Initial seal surface position	2,8 mm	$+0,2/-0,1$ mm

Table 1 (continued)

Item	Value	Tolerance
f Initial valve rod position	3,1 mm	$\pm 0,05$ mm
g Distance to open valve	3,2 mm	$\pm 0,05$ mm
h Connector seal position	3,3 mm	$\pm 0,05$ mm
i Distance to stop valve	3,4 mm	$\pm 0,05$ mm
j Compressing limit for seal	4,5 mm	+0,0/–0,05 mm
k Force to open valve	2,95 N	$\pm 0,3$ N
l Inner ring diameter	4,1 mm	+0,0/–0,05 mm
m Distance to inner ring	3,0 mm	$\pm 0,05$ mm
n Seal top diameter	1,85 mm	$\pm 0,05$ mm
o Length for inside seal slope	0,25 mm	$\pm 0,05$ mm
p Length for outside seal slope	0,6 mm	$\pm 0,05$ mm
q Inside seal radius	R0,2 mm	$\pm 0,05$ mm
r Seal top radius	R0,2 mm	$\pm 0,05$ mm

4.3.2.3 Space not in conflict with the cartridge connected to the MFC power unit

The space to accommodate the cartridge when a cartridge is connected to the MFC power unit through Type A connectors is shown in Figures 6 and 7 with dimensions in Tables 2 and 3.

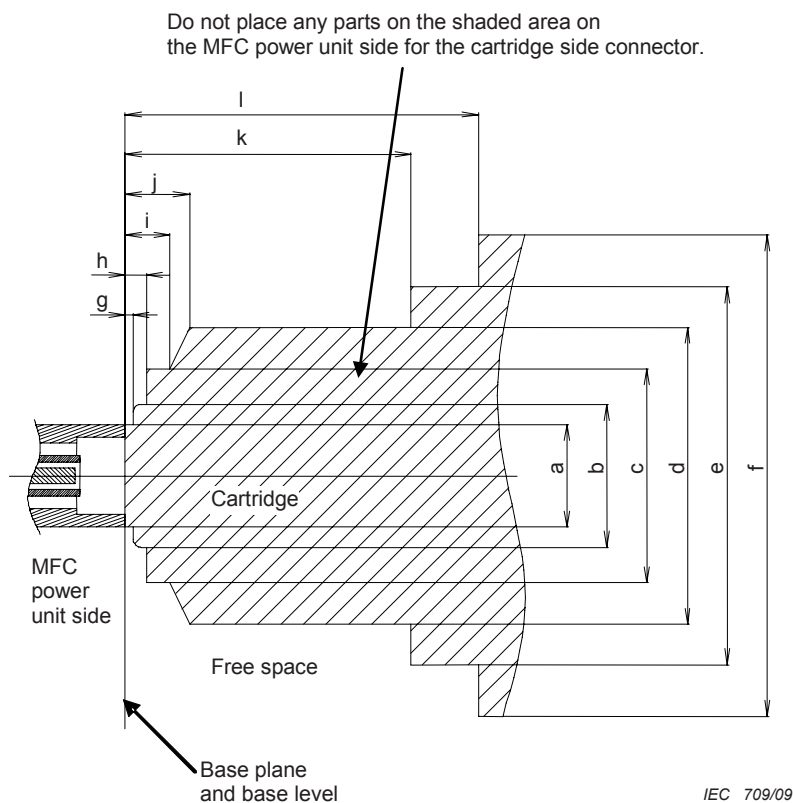


**Figure 6 – Cartridge space for satellite cartridge
(cross-sectional view)**

Table 2 – Dimension of space for satellite cartridge in MFC power unit

Mark	Value
a	Φ6,0 mm
b	Φ8,9 mm
c	Φ13,4 mm
d	Φ18,7 mm
e	Φ23,7 mm
f	Cartridge body size
g	0,3 mm
h	1,3 mm
i	2,8 mm
j	3,8 mm
k	17,6 mm
l	22,0 mm

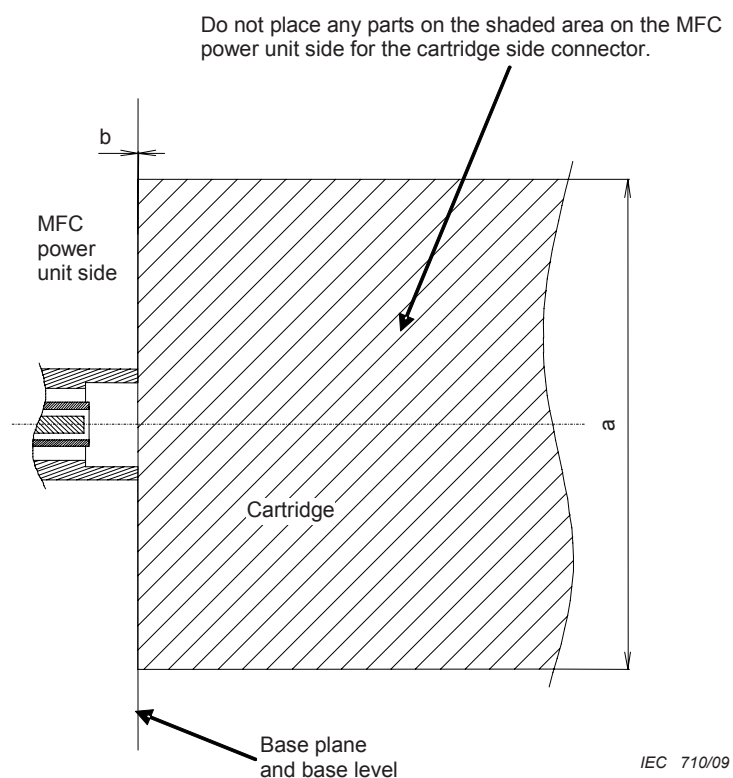


Figure 7 – Cartridge space for insert cartridge (cross-sectional view)

Table 3 – Dimension for insert cartridge space in MFC power unit

Mark	Value
a	Cartridge body size
b	0

4.3.2.4 MFC power unit side mechanical key

The mechanical keys on the MFC power unit side for Type A connectors are shown in Figures 8, 9, and 10 with the key locations, dimensions and tolerances in Table 4.

Dimensions in millimetres

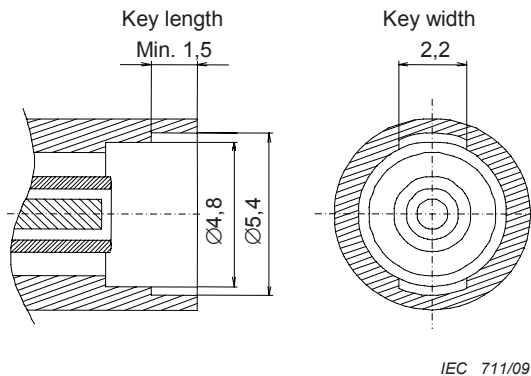


**Figure 8 – Mechanical key
(cross-sectional view)**

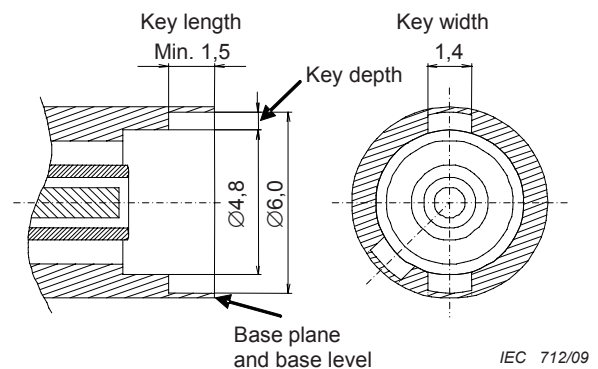


**Figure 9 – Mechanical key
(front-elevational view)**

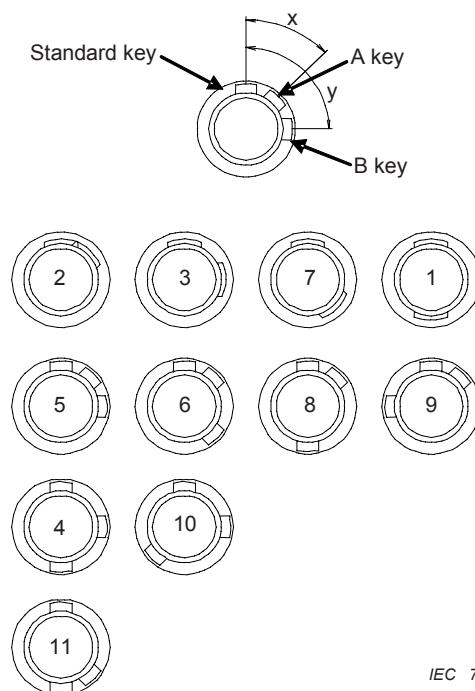


**Figure 10 – Mechanical key variation with key number
(front-elevational view)**

There are eleven keys in Type A connectors. Mechanical key number 1 is for non-pressurized cartridges of 98,0 mass % $\pm$ 1,5 mass % methanol, key number 2 for 64,0 mass % $\pm$ 1,5 mass % methanol and key number 3 for 61,8 mass % $\pm$ 1,5 mass % methanol. Mechanical key number 4 is for pressurized cartridges of 98,0 mass % $\pm$ 1,5 mass % methanol, number 5 for

64,0 mass % $\pm$ 1,5 mass % methanol and number 6 for 61,8 mass % $\pm$ 1,5 mass % methanol.
And the rest are for future applications.

Table 4 – Key location and dimension with tolerance for mechanical key

Key no.	Key category	Angle of A key against standard key: x	Angle of B key against standard key: y	Width of key tolerance	Depth of key tolerance	Length of key	Key assignment for fuel
1	Wide and 2-key type	180°	no key	2,2 mm $\pm$ 0,05 mm	0,3 mm +0,03/–0,0 mm	min. 1,5 mm	98,0 mass % $\pm$ 1,5 mass %, non-pressurized
2	Wide and 2-key type	45°	no key	2,2 mm $\pm$ 0,05 mm	0,3 mm +0,03/–0,0 mm	min. 1,5 mm	64,0 mass % $\pm$ 1,5 mass %, non-pressurized
3	Wide and 2-key type	90°	no key	2,2 mm $\pm$ 0,05 mm	0,3 mm +0,03/–0,0 mm	min. 1,5 mm	61,8 mass % $\pm$ 1,5 mass %, non-pressurized
4	Narrow and 3-key type	90°	180°	1,4 mm $\pm$ 0,05 mm	0,6 mm +0,03/–0,0 mm	min. 1,5 mm	98,0 mass % $\pm$ 1,5 mass %, pressurized
5	Narrow and 3-key type	45°	90°	1,4 mm $\pm$ 0,05 mm	0,6 mm +0,03/–0,0 mm	min. 1,5 mm	64,0 mass % $\pm$ 1,5 mass %, pressurized
6	Narrow and 3-key type	45°	135°	1,4 mm $\pm$ 0,05 mm	0,6 mm +0,03/–0,0 mm	min. 1,5 mm	61,8 mass % $\pm$ 1,5 mass %, pressurized
7	Wide and 2-key type	135°	no key	2,2 mm $\pm$ 0,05 mm	0,3 mm +0,03/–0,0 mm	min. 1,5 mm	
8	Narrow and 3-key type	45°	180°	1,4 mm $\pm$ 0,05 mm	0,6 mm +0,03/–0,0 mm	min. 1,5 mm	
9	Narrow and 3-key type	45°	270°	1,4 mm $\pm$ 0,05 mm	0,6 mm +0,03/–0,0 mm	min. 1,5 mm	
10	Narrow and 3-key type	90°	225°	1,4 mm $\pm$ 0,05 mm	0,6 mm +0,03/–0,0 mm	min. 1,5 mm	
11	Narrow and 3-key type	135°	180°	1,4 mm $\pm$ 0,05 mm	0,6 mm +0,03/–0,0 mm	min. 1,5 mm	

4.3.2.5 Requirements for MFC power unit side connector

- | | | |
|-----|--|--|
| a | Sealing | Elastic material for sealing shall be located on the MFC power unit side connector |
| b-1 | Dimension change from 22 °C down to –20 °C | –0,05 mm or less |
| b-2 | Dimension change from 22 °C up to 55 °C | +0,05 mm or less |
| c | Chemical resistance | Withstand fuel |
| d | Surface roughness | APA 0,008-2,5/Rz 12,5
[ISO 1302:2002] |
| e | Other requirement | Maintain the material characteristics such as impact resilience and abrasion resistance appropriate for the lifetime of the MFC power unit |

4.3.2.6 Requirements for connector retainer of coupling on the MFC power unit side

A connector retainer is required on the MFC power unit side as shown in Figures 11 and 12 with the dimensions and tolerances in Table 5.

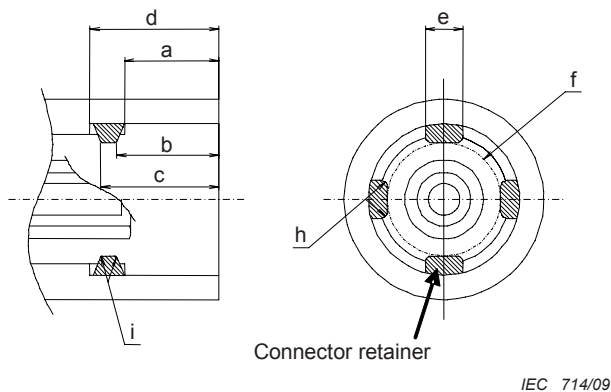


**Figure 11 – Connector retainer
(cross-sectional view)**

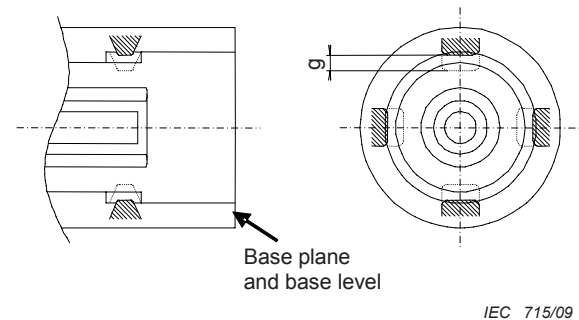


**Figure 12 – Connector retainer
(front-elevational view)**

**Table 5 – Dimension and tolerance for connector retainer
on the MFC power unit side**

Mark	Value	Tolerance
a	3,0 mm	± 0,05 mm
b	3,25 mm	± 0,05 mm
c	3,75 mm	± 0,05 mm
d	4,0 mm	± 0,05 mm
e	1,2 mm	± 0,05 mm
f	3,6 mm	± 0,05 mm
g	0,5 mm	± 0,05 mm
h	R0,25 mm	± 0,05 mm
i	R0,2 mm	± 0,05 mm

4.3.2.7 Requirements for cartridge side connector

a	Material	Withstand fuel
b-1	Dimension change from 22 °C down to –20 °C	–0,05 mm or less
b-2	Dimension change from 22 °C up to 55 °C	+0,05 mm or less
c	Surface roughness: Sealing area	APA 0,0025-0,8/Rz 6,3 [ISO 1302:2002]
	Others	APA 0,008-2,5/Rz 25 [ISO 1302:2002]

4.3.2.8 Requirements for cartridge side mechanical key

a	Dimension change from 22 °C down to –20 °C	–0,05 mm or less
b	Dimension change from 22 °C up to 55 °C	+0,05 mm or less

4.3.2.9 Requirements for cartridge body

Not applicable.

4.3.2.10 Valve sequence

Opening sequence

a	Completion of sealing	The seal is completed at the connector seal position of 3,3 mm.
b	MFC power unit side valve opening	After the completion of seal, the MFC power unit side valve starts to open at the distance to open valve of 3,2 mm and is completely open at the distance to stop valve of 3,4 mm.
c	Cartridge valve opening	The cartridge side valve starts to open after the MFC power unit side valve opens.

Closing sequence

d	Cartridge valve closing	The cartridge valve is closed first in the valve closing process.
e	MFC power unit side valve closing	After the cartridge side valve closes completely, the MFC power unit side valve starts to close at the distance to open valve of 3,2 mm and is completely closed at the initial valve rod position of 3,1 mm.
f	Seal open	After the MFC power unit side valve closes completely, the seal open occurs between the connector seal position at 3,3 mm and the initial seal surface position at 2,8 mm.

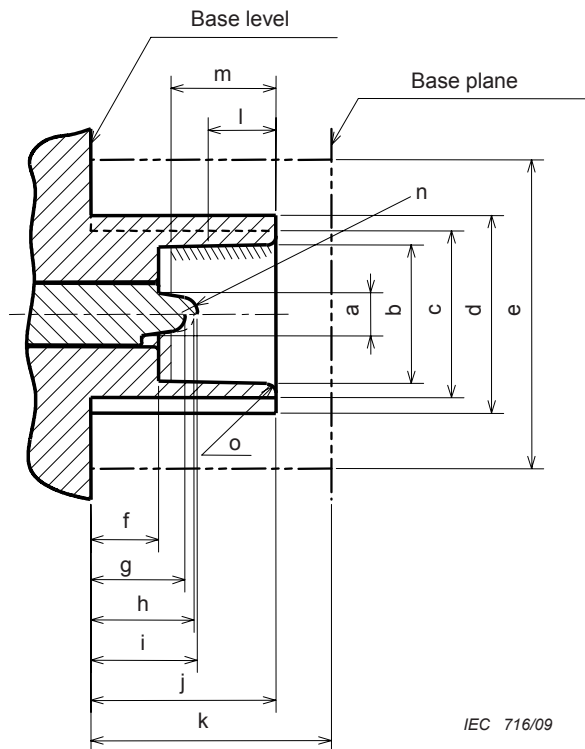
4.3.3 Type B

4.3.3.1 Basic information

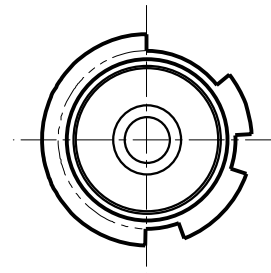
a Fuel type	Methanol and aqueous methanol solutions, pressurized and non-pressurized
b Cartridge category	All types of cartridges: insert, exterior, attached and satellite types
c Connector category	All classifications of cartridge strength from I through III
d Cartridge size	No limitations regarding dimension and design (shape) in particular for insert, exterior, attached and satellite types

4.3.3.2 MFC power unit side connector design

The MFC power unit side connector design for Type B is shown in Figures 13 and 14 with dimensions and tolerances in Table 6.



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Figure 13 – MFC power unit side connector design
(cross-sectional view)

Figure 14 – MFC power unit side
connector design
(front-elevational view)

Table 6 – Dimension with tolerance for MFC power unit side connector

Item	Value	Tolerance
a Valve rod diameter	1,4 mm	$\pm 0,05$ mm
b Hole diameter (entrance)	4,5 mm	$\pm 0,05$ mm
(bottom)	4,35 mm	$\pm 0,05$ mm
c Inner diameter for mechanical key	5,4 mm	$\pm 0,05$ mm
d Outer diameter for mechanical key	6,4 mm	$\pm 0,05$ mm
e Connector area diameter	10,6 mm	Min.
f Hole bottom	2,2 mm	$\pm 0,05$ mm
g Distance to stop valve	3,05 mm	$\pm 0,06$ mm
h Distance to open valve	3,35 mm	$\pm 0,1$ mm
i Initial valve rod position	3,45 mm	$\pm 0,1$ mm
j Connector height	6,0 mm	$\pm 0,03$ mm
k Distance of base level and base plane	7,8 mm	$\pm 0,05$ mm
l Connector seal position (center)	2,5 mm	$\pm 0,2$ mm
m Surface finish area	3,1 mm	$\pm 0,2$ mm
n Tip radius of the valve rod	0,5 mm	$\pm 0,1$ mm
o Radius of the whole entrance	0,5 mm	$\pm 0,05$ mm
p Force to open valve	1,5 N	$\pm 0,3$ N

4.3.3.3 Space not in conflict with the cartridge connected to the MFC power unit

The space to accommodate the cartridge when a cartridge is connected to the MFC power unit through Type B connectors is shown in Figure 15 with the dimensions and tolerances in Table 7.

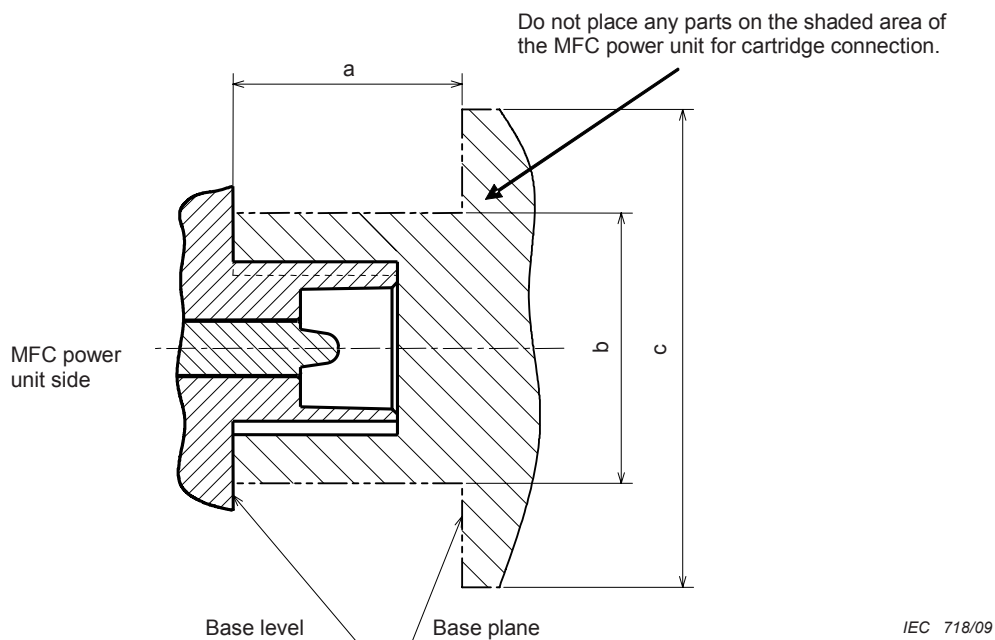


**Figure 15 – Cartridge space
(cross-sectional view)**

Table 7 – Dimension and tolerance

Mark	Value	Tolerance
a	7,8 mm	$\pm 0,05$ mm
b	$\varnothing 10,6$ mm	Min.
c	Cartridge body size	

4.3.3.4 MFC power unit side mechanical keys

The mechanical keys on the MFC power unit side for Type B connector are shown in Figure 16.

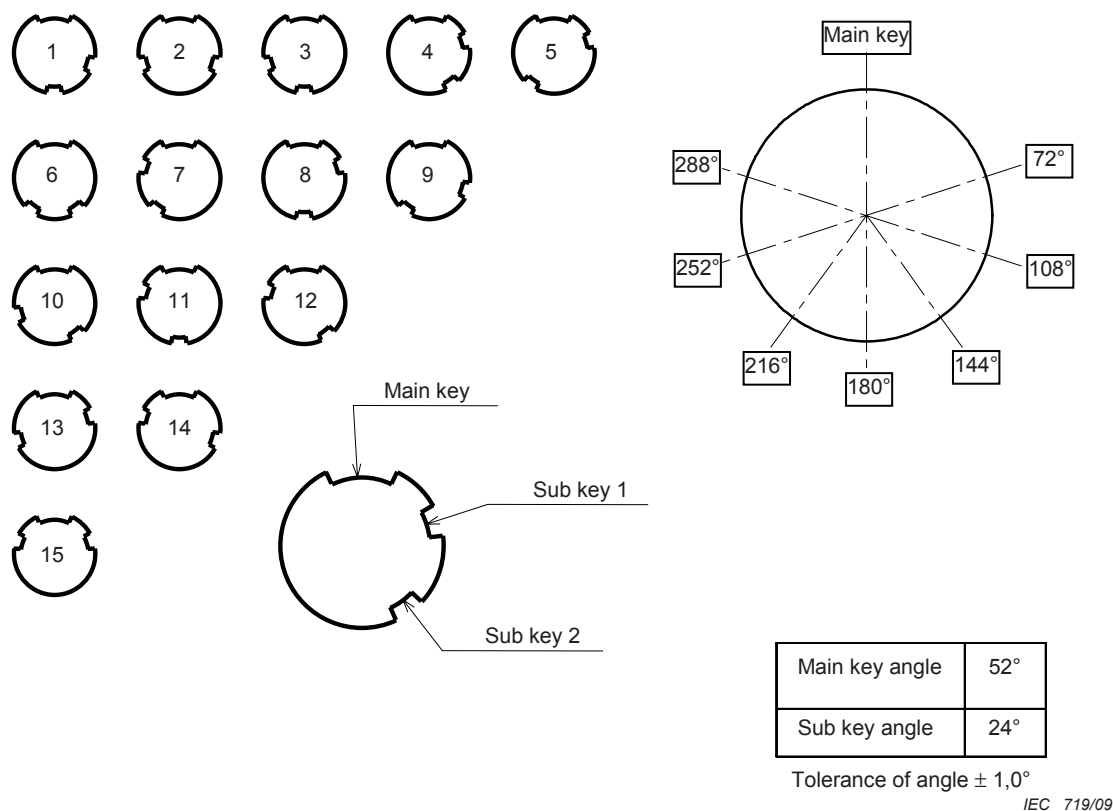


Figure 16 – Mechanical keys

There are fifteen keys in Type B connectors. Mechanical key number 1 is for non-pressurized cartridges of 98,0 mass % $\pm 1,5$ mass % methanol, number 2 for 64,0 mass % $\pm 1,5$ mass % methanol, and number 3 for 61,8 mass % $\pm 1,5$ mass % methanol. Mechanical key number 4 is for pressurized cartridges of 98,0 mass % $\pm 1,5$ mass % methanol, number 5 for 64,0 mass % $\pm 1,5$ mass % methanol, and number 6 for 61,8 mass % $\pm 1,5$ mass % methanol. And the rest are for future applications.

4.3.3.5 Key location and dimension with tolerance for mechanical key

No	Angle between main key and sub key 1	Angle between main key and sub key 2	Assignment of the key to methanol solution
1	108°	180°	98,0 mass % ± 1,5 mass %, non-pressurized
2	108°	252°	64,0 mass % ± 1,5 mass %, non-pressurized
3	180°	252°	61,8 mass % ± 1,5 mass %, non-pressurized
4	72°	144°	98,0 mass % ± 1,5 mass %, pressurized
5	72°	216°	64,0 mass % ± 1,5 mass %, pressurized
6	144°	216°	61,8 mass % ± 1,5 mass %, pressurized
7	216°	288°	
8	72°	180°	
9	108°	216°	
10	144°	252°	
11	180°	288°	
12	144°	288°	
13	72°	252°	
14	108°	288°	
15	72°	288°	

4.3.3.6 Requirements for MFC power unit side connector

- | | | |
|-----|--|---------------------------------------|
| a-1 | Dimension change from 22 °C down to –20 °C | –0,05 mm or less |
| a-2 | Dimension change from 22 °C up to 55 °C | +0,05 mm or less |
| b | Chemical resistance | Withstand fuel |
| c | Surface roughness: | |
| | Finished area | APA 0,0025-0,8/Rz 6,3 [ISO 1302:2002] |
| | Others | APA 0,008-2,5/Rz 25 [ISO 1302:2002] |

4.3.3.7 Requirements for connector retainer of coupling on the MFC power unit side

The connector retainer of ratchet-type is required for the coupling on the MFC power unit side as shown in Figures 17, 18, 19, 20 and 21 with the dimensions and tolerances in Table 8.

Position before connection

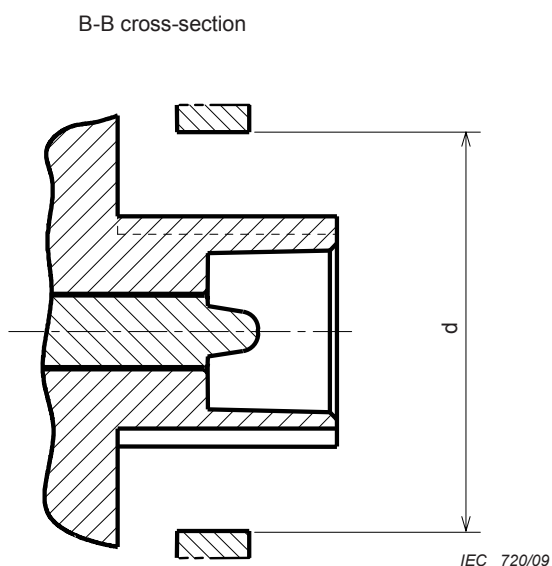


Figure 17 – Connector retainer (cross-sectional view before connection)

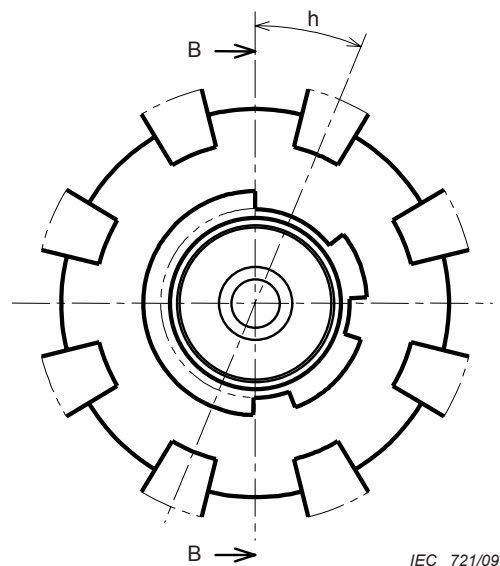
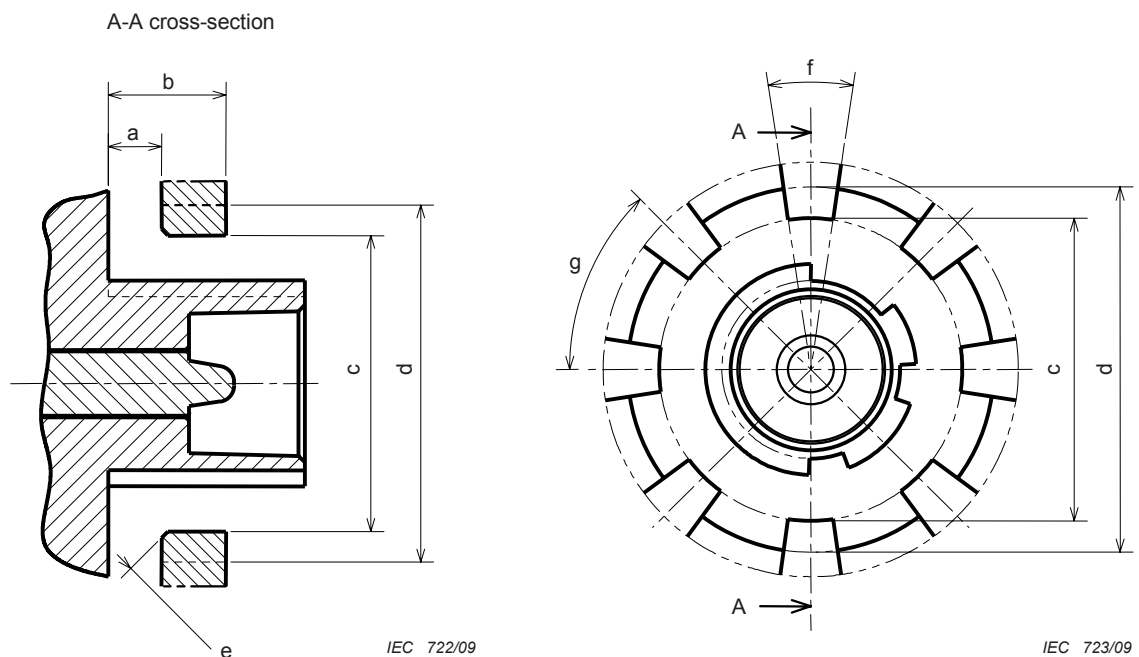


Figure 18 – Connector retainer (front-elevational view before connection)

Position when the cartridge is retained



NOTE Retainer rotated 22,5° from Figure 18

**Figure 19 – Connector retainer
(cross-sectional view when retained)**

**Figure 20 – Connector retainer
(front-elevational view when retained)**

Connected with mechanical retainer (reference drawing)

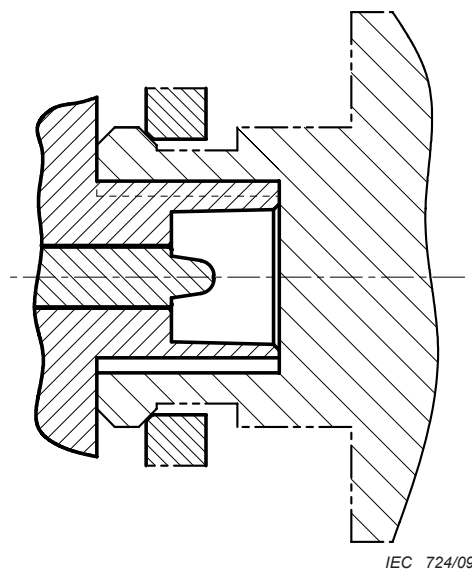


Figure 21 – Connector retainer engaged (cross-sectional view)