

INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

**Technologies des piles à combustible –
Partie 6-300: Systèmes à micro-piles à combustible – Interchangeabilité de la
cartouche de combustible**



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FUEL CELL TECHNOLOGIES –**Part 6-300: Micro fuel cell power systems –
Fuel cartridge interchangeability**

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International Standard IEC 62282-6-300 has been prepared by IEC technical committee 105: Fuel cell technologies.

This second edition cancels and replaces the first edition, published in 2009, and constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

- a) The status of designs yet to be included in the standard is clarified.
- b) Type A to D interchangeable connectors are updated, and Type E is added.
- c) The procedures, criteria and figures of the type tests for interchangeable connectors are updated to ensure they produce accurate and consistent results.
- d) The fuel quality requirements are updated including the test procedures for residue and impurities.

The text of this standard is based on the following documents:

CDV	Report on voting
105/370/CDV	105/409/RVC

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

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

A list of all parts of the IEC 62282 series, under the general title: *Fuel cell technologies*, can be found on the IEC website.

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

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- withdrawn,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

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.

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FUEL CELL TECHNOLOGIES –

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

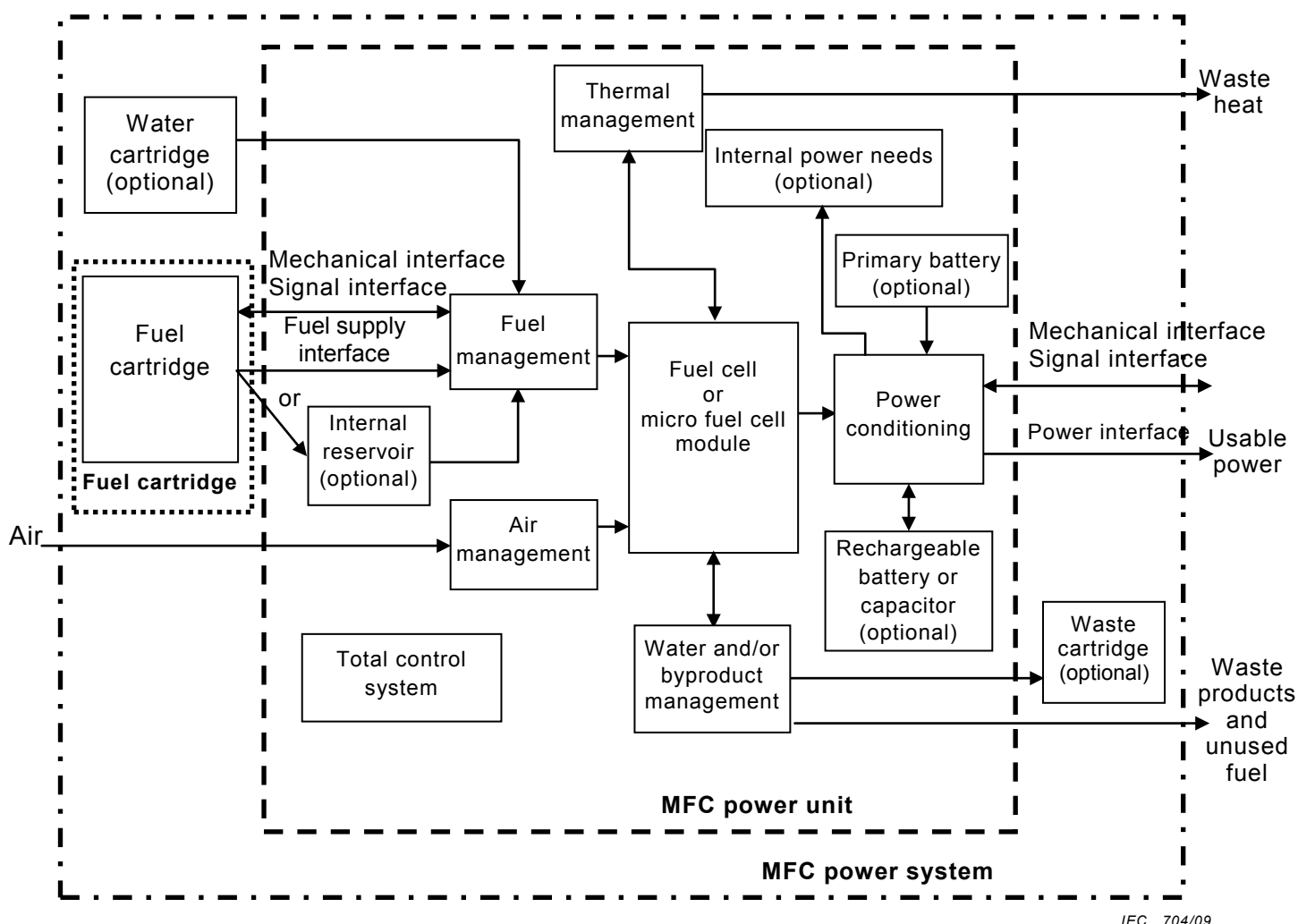
1 Scope

This part of IEC 62282 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 62282-6-100 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 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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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, *Information technology equipment – Safety – Part 1: General requirements*

IEC 62282-6-100:2010, *Fuel cell technologies – Part 6-100: Micro fuel cell power systems – Safety*

IEC 62282-6-200, *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

Note 1 to entry: All dimensions as shown in the connector figures (see 4.3) are relative to this reference plane.

Note 2 to entry: See Figures 3, 6 and 7 in 4.3.2.2 and 4.3.2.3; Figures 13 and 15 in 4.3.3.2 and 4.3.3.3; Figures 22 and 24 in 4.3.4.2 and 4.3.4.3; Figures 29 and 31 in 4.3.5.2 and 4.3.5.3; and Figures 37, 39 and 40 in 4.3.6.2 and 4.3.6.3.

3.2

base plane

surface of the power unit to which the cartridge mates

Note 1 to entry: See Figures 3, 6 and 7 in 4.3.2.2 and 4.3.2.3; Figures 13 and 15 in 4.3.3.2 and 4.3.3.3; Figures 22 and 24 in 4.3.4.2 and 4.3.4.3; Figure 29 and 31 in 4.3.5.2 and 4.3.5.3; and Figures 37, 39 and 40 in 4.3.6.2 and 4.3.6.3.

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

Note 2 to entry: See Figure 3 and Table 1 in 4.3.2.2; Figure 13 and Table 6 in 4.3.3.2; Figure 22 and Table 10 in 4.3.4.2; and, Figure 29, Table 14, Figure 37 and Table 19 in 4.3.6.2.

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

Note 1 to entry: The valve actuator is a component responsible for opening of the valve.

Note 2 to entry: See Figure 3 and Table 1 in 4.3.2.2; Figure 13 and Table 6 in 4.3.3.2; Figure 22 and Table 10 in 4.3.4.2; and Figure 29, Table 14, Figure 37 and Table 19 in 4.3.6.2.

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

Note 1 to entry: Liquid fuels of methanol and methanol/water solutions are considered fuels in the main body of this standard.

Note 2 to entry: 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 have to 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

Note 1 to entry: See Figure 2 for cartridge types.

3.11.1

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

3.11.2

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

3.11.3

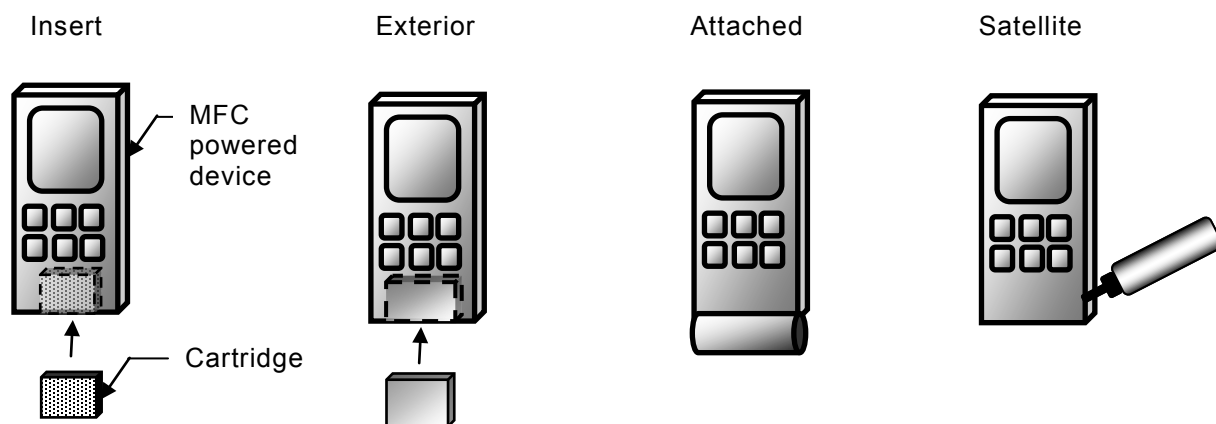
attached cartridge

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

3.11.4

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



IEC 705/09

Figure 2 – Fuel cartridge types

3.12

pressurized fuel cartridge

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**non-pressurized fuel cartridge**

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

Note 1 to entry: 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 IEC 62282-6-100:2010, 4.6 (fuel valves) and 4.12 (fuel supply construction), and shall pass type tests described Clause 7 of that standard.

4.1.2 Safety of connectors during connecting, fueling and removing

4.1.2.1 General

No leakage and no fuel vapour loss shall occur at fuel connectors in the process of connecting, fueling 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 Connecting

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 Fueling

If a force, expected under conditions of 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 Removing

If a force, expected under conditions of 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 Damaged connector

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 62282-6-100 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 seal 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 IEC 62282-6-100:2010, 4.4 (selection of materials).

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, 4.3.3.7 to 4.3.3.9, 4.3.4.7 to 4.3.4.9

and 4.3.5.7 to 4.3.5.9, and 4.3.6.6 to 4.3.6.7 provide additional requirements for the cartridge side.

The interchangeable connectors are defined in 4.3.2, 4.3.3, 4.3.4, 4.3.5 and 4.3.6.

NOTE Designs that are not prescribed in this standard but that meet or exceed the performance requirements of this standard are considered to be in conformance with this standard, even though the designs may not be physically compatible with any designs in this standard. Any alternative design not already included in this standard should be interchangeable and prevent misconnection that could compromise safety.

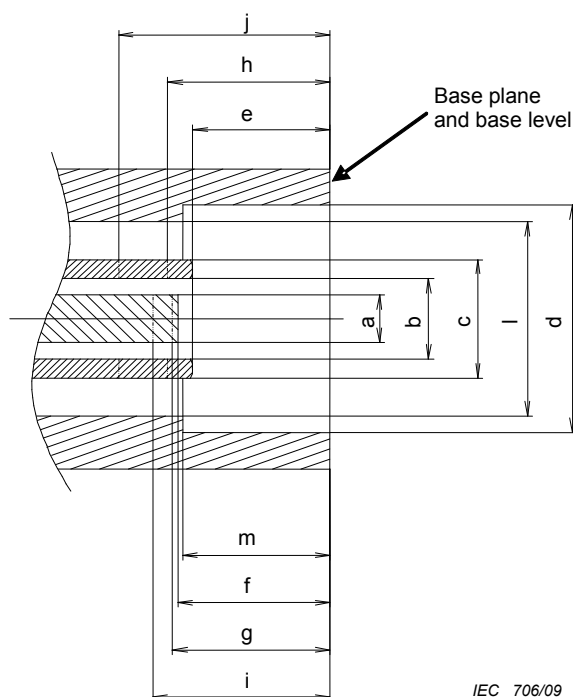
4.3.2 Type A

4.3.2.1 Basic information

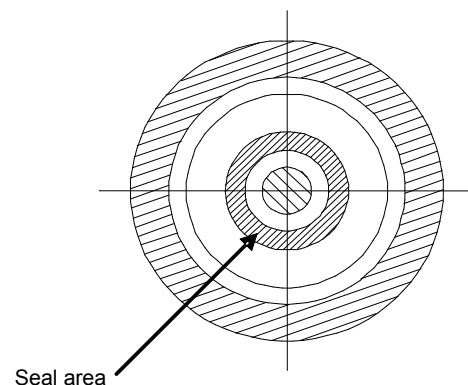
- | | |
|-----------------------|---|
| a. Fuel type | Methanol and aqueous methanol solutions, pressurized and non-pressurized. |
| b. Cartridge category | All types of cartridges: insert, exterior, attached and satellite. |
| c. Connector category | All classifications of connector strength from I 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.



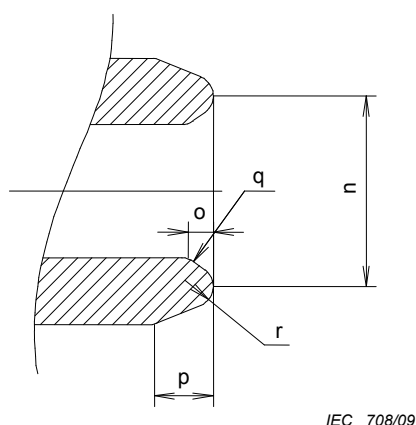
IEC 706/09



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 and tolerance for MFC power unit side connector

Item	Value	Tolerance
a Valve diameter	1,2 mm	± 0,02 mm
b Inner diameter for seal	1,3 mm	± 0,05 mm
c Outer diameter for seal□	2,6 mm	± 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
f Initial valve rod position	3,1 mm	± 0,05 mm
g Distance to open valve	3,2 mm	± 0,05 mm
h Connector seal position	3,3 mm	± 0,05 mm
i Distance to stop valve	3,4 mm	± 0,05 mm
j Compressing limit for seal□	4,5 mm	+0,0 -0,5 mm
k Force to open valve□	2,95 N	± 0,3 N
l Inner ring diameter	4,1 mm	+0,0 -0,05 mm
m Distance to inner ring□	3,0 mm	± 0,05 mm
n Seal top diameter	1,85 mm	± 0,05 mm
o Length for inside seal slope	0,25 mm	± 0,05 mm
p Length for outside seal slope	0,6 mm	± 0,05 mm
q Inside seal radius	R0,2 mm	± 0,05 mm
r Seal top radius	R0,2 mm	± 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.

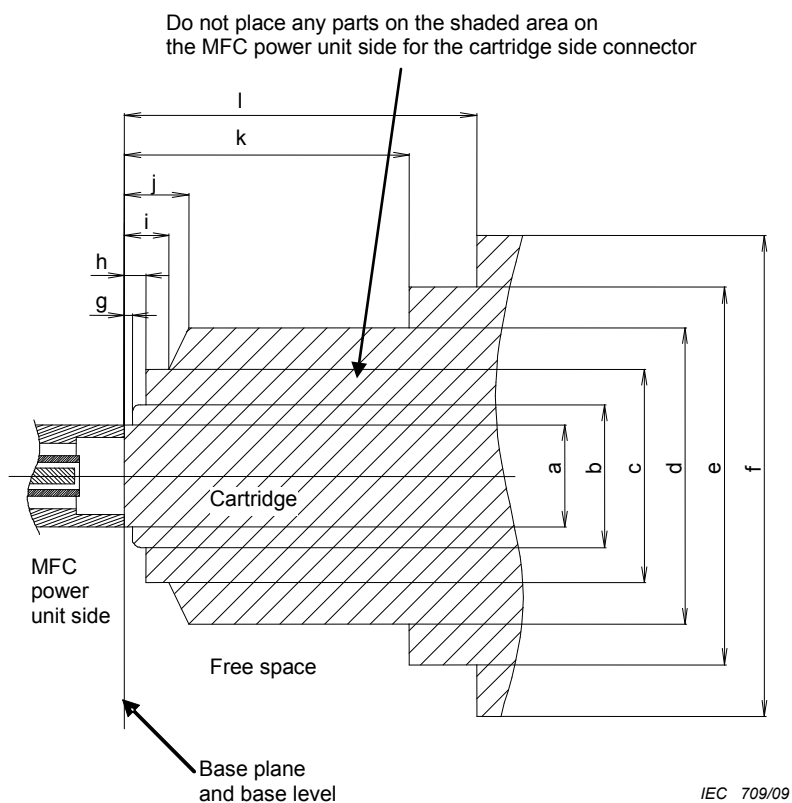


Figure 6 – Cartridge space for satellite cartridge (cross-sectional view)

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

Mark	Value mm
a	Ø6,0
b	Ø8,9
c	Ø13,4
d	Ø18,7
e	Ø23,7
f	Cartridge body size
g	0,3
h	1,3
i	2,8
j	3,8
k	17,6
l	22,0

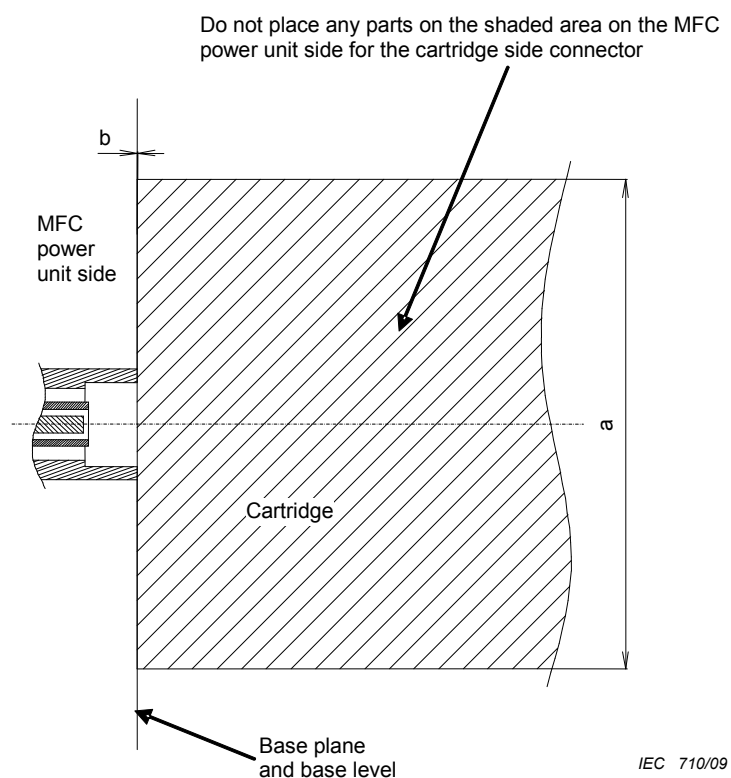


**Figure 7 – Cartridge space for insert cartridge
(cross-sectional view)**

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

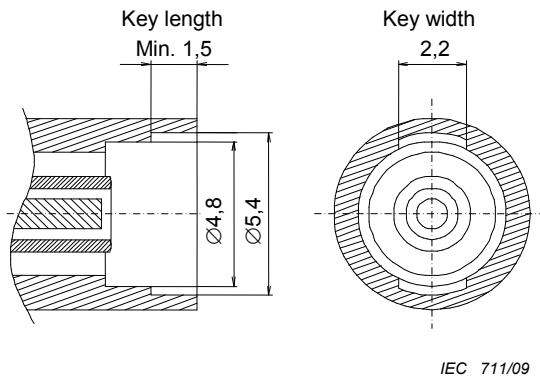


**Figure 8 – Mechanical key
(wide and 2-key type)**

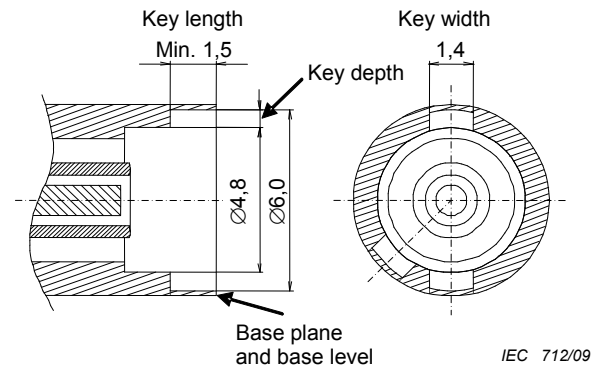


**Figure 9 – Mechanical key
(narrow and 3-key type)**

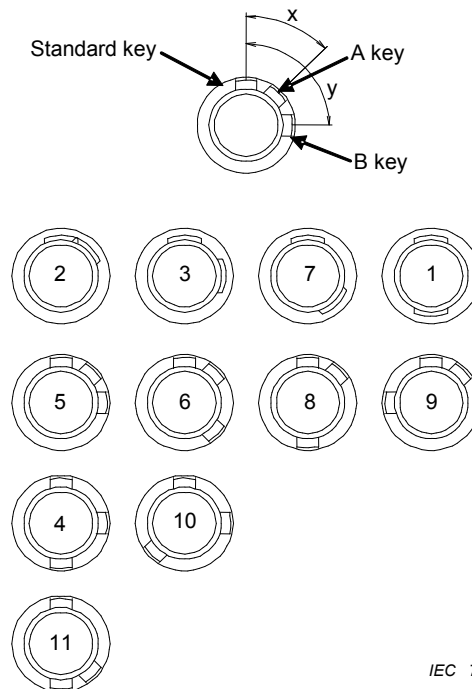


Figure 10 – Mechanical key variation with key number (front-elevational view)

There are eleven keys in Type A connectors. Mechanical key number 1 is for non-pressurized fuel 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 fuel 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 mm	Depth of key tolerance mm	Length of key mm	Key assignment for fuel
1	Wide and 2-key type	180	No key	$2,2 \pm 0,05$	$0,3 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	98,0 % mass $\pm 1,5$ % mass, non-pressurized
2	Wide and 2-key type	45	No key	$2,2 \pm 0,05$	$0,3 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	64,0 % mass $\pm 1,5$ % mass, non-pressurized
3	Wide and 2-key type	90	No key	$2,2 \pm 0,05$	$0,3 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	61,8 % mass $\pm 1,5$ % mass, non-pressurized
4	Narrow and 3-key type	90	180	$1,4 \pm 0,05$	$0,6 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	98,0 % mass $\pm 1,5$ % mass, pressurized
5	Narrow and 3-key type	45	90	$1,4 \pm 0,05$	$0,6 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	64,0 % mass $\pm 1,5$ % mass, pressurized
6	Narrow and 3-key type	45	135	$1,4 \pm 0,05$	$0,6 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	61,8 % mass $\pm 1,5$ % mass, pressurized
7	Wide and 2-key type	135	No key	$2,2 \pm 0,05$	$0,3 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	
8	Narrow and 3-key type	45	180	$1,4 \pm 0,05$	$0,6 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	
9	Narrow and 3-key type	45	270	$1,4 \pm 0,05$	$0,6 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	
10	Narrow and 3-key type	90	225	$1,4 \pm 0,05$	$0,6 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	
11	Narrow and 3-key type	135	180	$1,4 \pm 0,05$	$0,6 \begin{smallmatrix} +0,03 \\ 0,0 \end{smallmatrix}$	Min. 1,5	

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 $\square$ | 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.

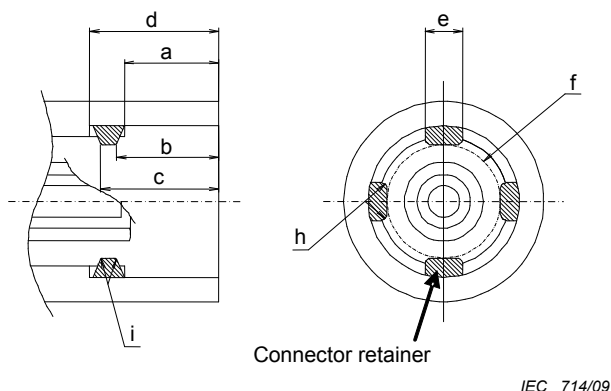


Figure 11 – Connector retainer (unlocked)

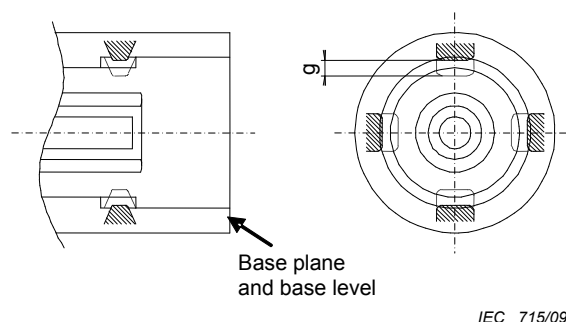


Figure 12 – Connector retainer (maximum set-back: locked)

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

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

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

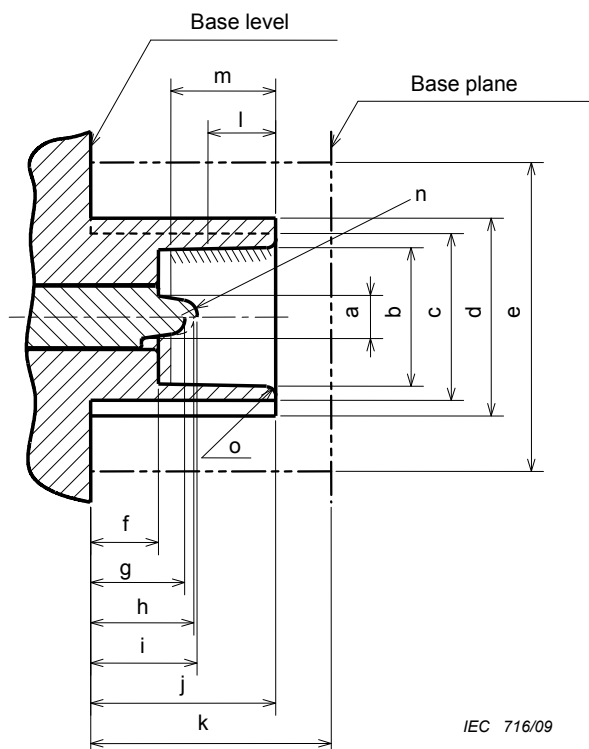
- | | | |
|---|-----------------------------------|---|
| d | Cartridge valve closing | The cartridge valve is closed first in the valve closing process. |
| e | MFC power unit side valve closing | After the cartridge side valve closes completely, the MFC power unit side valve starts to close at the 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**

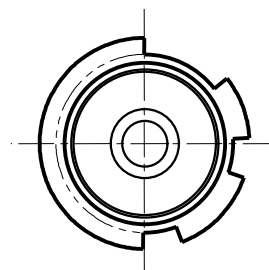
- | | | |
|---|--------------------|---|
| a | Fuel type | Methanol and aqueous methanol solutions, pressurized and non-pressurized. |
| b | Cartridge category | All types of cartridges: insert, exterior, attached and satellite. |
| c | Connector category | Classifications of cartridge strength from 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 and tolerance for MFC power unit side connector

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

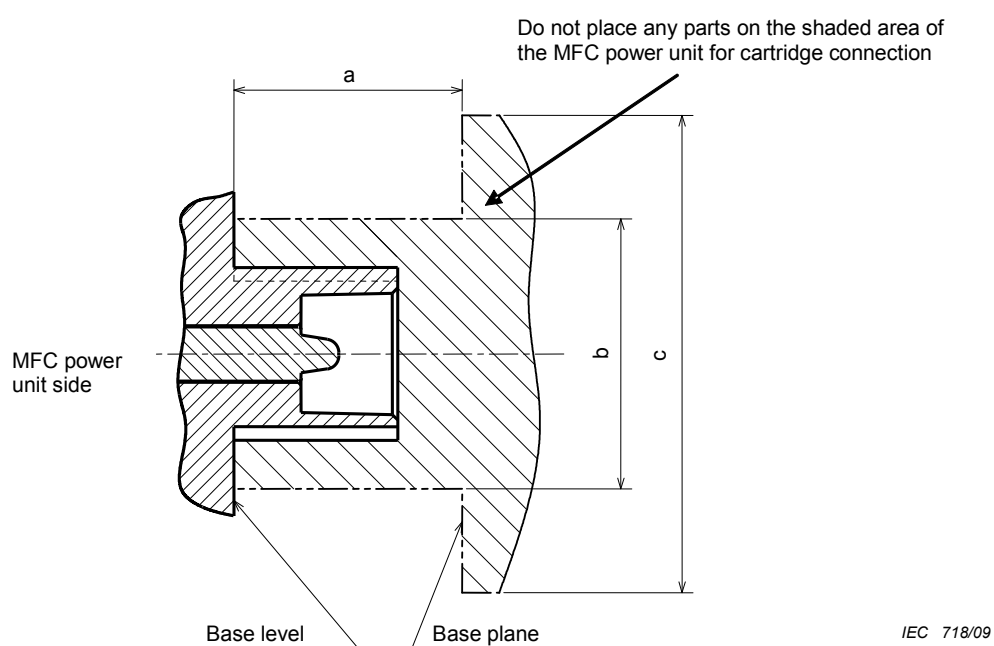


Figure 15 – Cartridge space (cross-sectional view)

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.

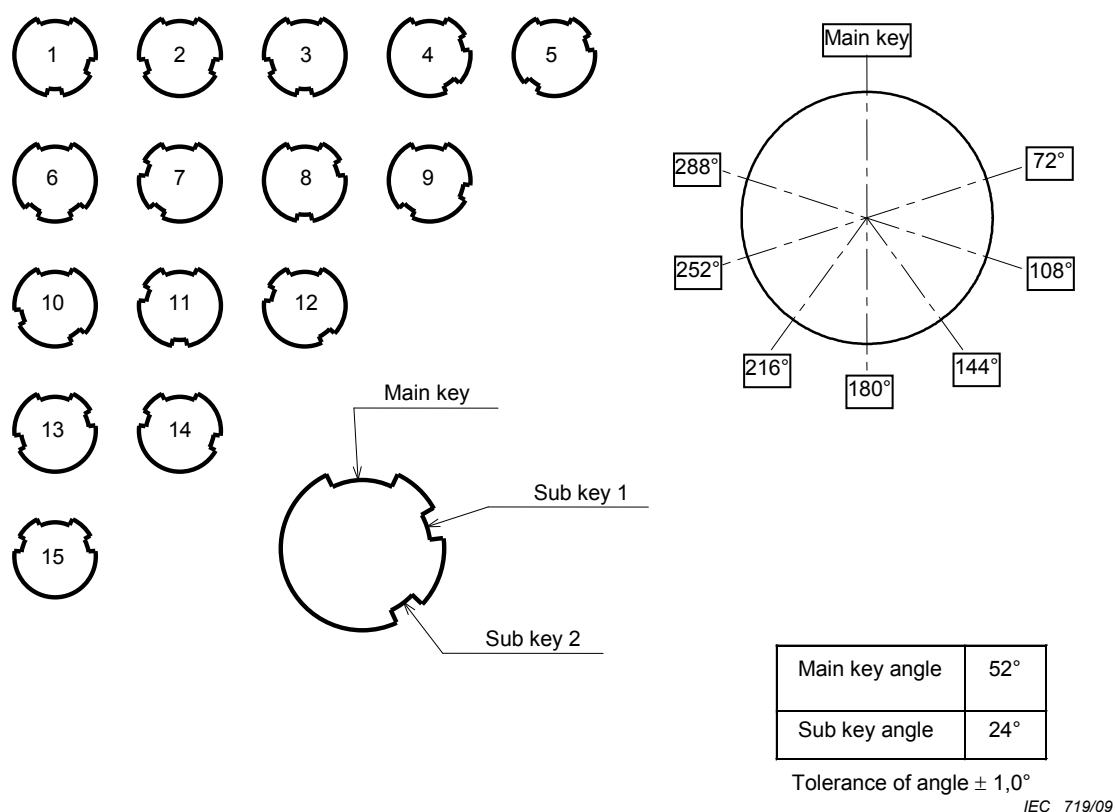


Figure 16 – Mechanical keys

There are fifteen keys in Type B connectors. Mechanical key number 1 is for non-pressurized fuel 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 fuel 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 8 – 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 $\pm 1,5$ % mass, non-pressurized
2	108	252	64,0 % mass $\pm 1,5$ % mass, non-pressurized
3	180	252	61,8 % mass $\pm 1,5$ % mass, non-pressurized
4	72	144	98,0 % mass $\pm 1,5$ % mass, pressurized
5	72	216	64,0 % mass $\pm 1,5$ % mass, pressurized
6	144	216	61,8 % mass $\pm 1,5$ % mass, pressurized
7	216	288	
8	72	180	
9	108	216	
10	144	252	
11	180	288	
12	144	288	
13	72	252	

No.	Angle between main key and sub key 1	Angle between main key and sub key 2	Assignment of the key to methanol solution
14	108	288	
15	72	288	

4.3.3.5 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)

4.3.3.6 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 9.

Position before connection

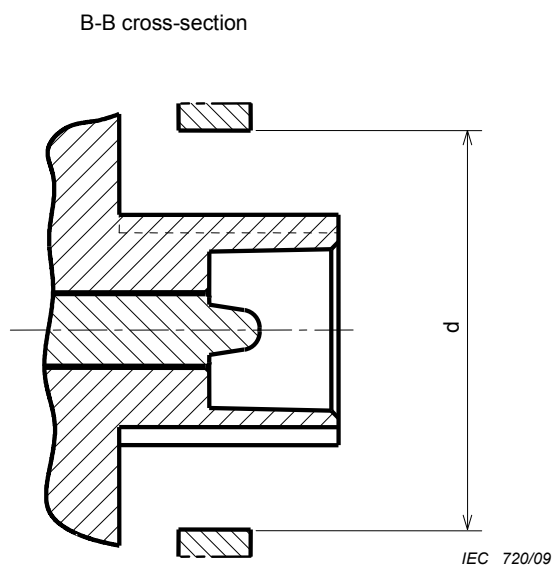


**Figure 17 – Connector retainer
(cross-sectional view before connection)**

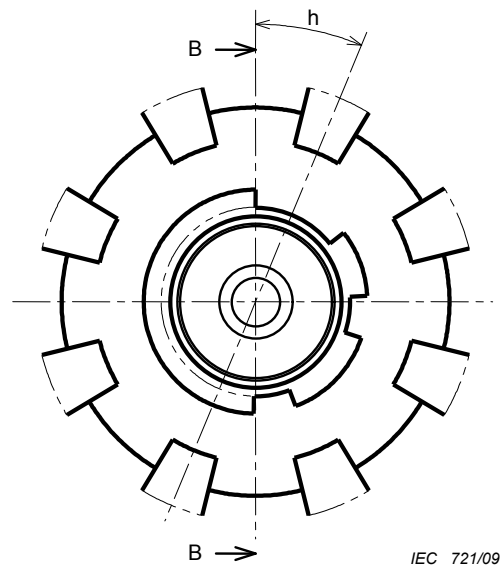


**Figure 18 – Connector retainer (front-
elevational view before connection)**

Position when the cartridge is retained

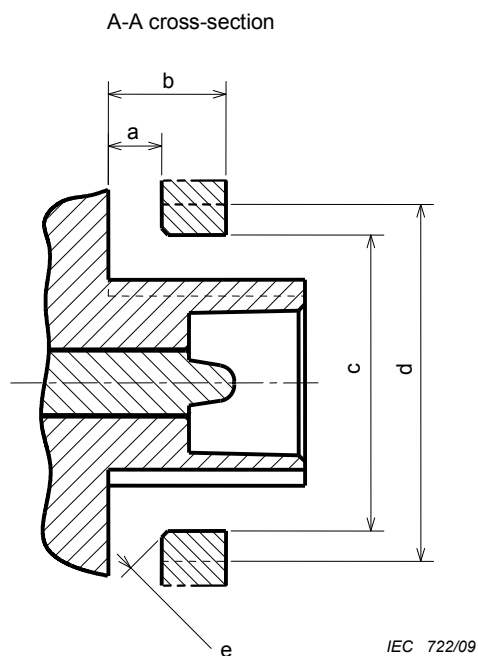


**Figure 19 – Connector retainer
(cross-sectional view when retained)**

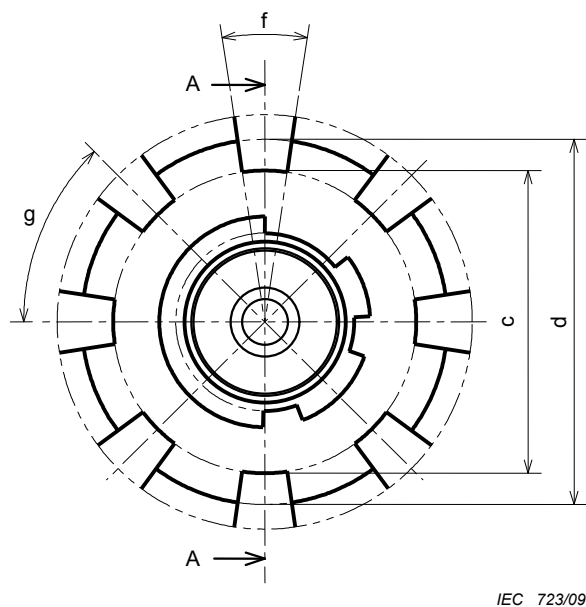


**Figure 20 – Connector retainer
(front-elevational view when retained)**

NOTE Retainer rotated 22,5° from Figure 18.

Connected with mechanical retainer (reference drawing)

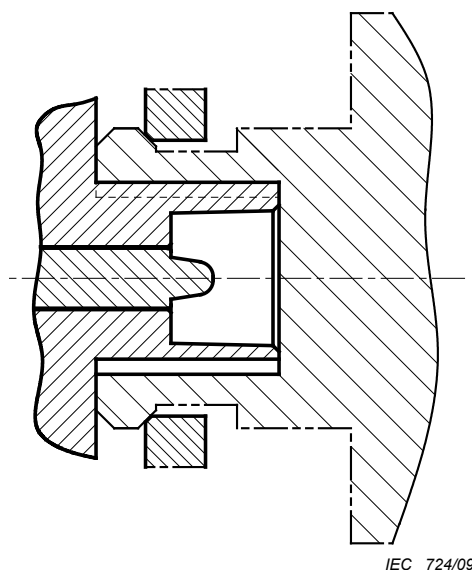


Figure 21 – Connector retainer engaged (cross-sectional view)

Table 9 – Dimension and tolerance for connector retainer on the MFC power unit

Mark	Value	Tolerance
a	1,65 mm	$\pm 0,1$ mm
b	3,65 mm	Max.
c	$\varnothing$ 9,2 mm	$\pm 0,03$ mm
d	$\varnothing$ 11,1 mm	$\pm 0,05$ mm
e	C0,2 mm (C:Chamfer)	$\pm 0,03$ mm
f	17,0°	$\pm 0,5^\circ$
g	45,0°	$\pm 0,5^\circ$
h	22,5°	$\pm 0,5^\circ$

4.3.3.7 Requirements for cartridge side connector

a	Sealing	Elastic material for sealing shall be located on the cartridge 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:	
	Sealing area	APA 0,0025-0,8/Rz 6,3 (ISO 1302:2002)
	Others	APA 0,008-2,5/Rz 25 (ISO 1302:2002)

4.3.3.8 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 |

4.3.3.9 Requirements for cartridge body

Not applicable.

4.3.3.10 Valve sequence

Opening sequence

- | | | |
|---|------------------------------|---|
| a | Completion of seal | When the elastic material on the cartridge side connector touches the MFC power unit side connector hole, the seal is complete. It is completed before the initial valve rod position of 3,45 mm. |
| b | MFC power unit valve opening | After the completion of seal, the MFC power unit side valve starts to open at the distance to open valve of 3,35 mm and completely open at the distance to stop valve of 3,05 mm. |
| c | Cartridge valve opening | The cartridge side valve starts to open after the opening of the MFC power unit side valve. |

Closing sequence

- | | | |
|---|------------------------------|--|
| d | Cartridge valve closing | The cartridge valve is closed first in the valve closing process. |
| e | MFC power unit 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 3,35 mm and completely closes at the initial valve rod position of 3,45 mm. |
| f | Seal open | After the MFC power unit side valve closes completely, the seal open occurs. |

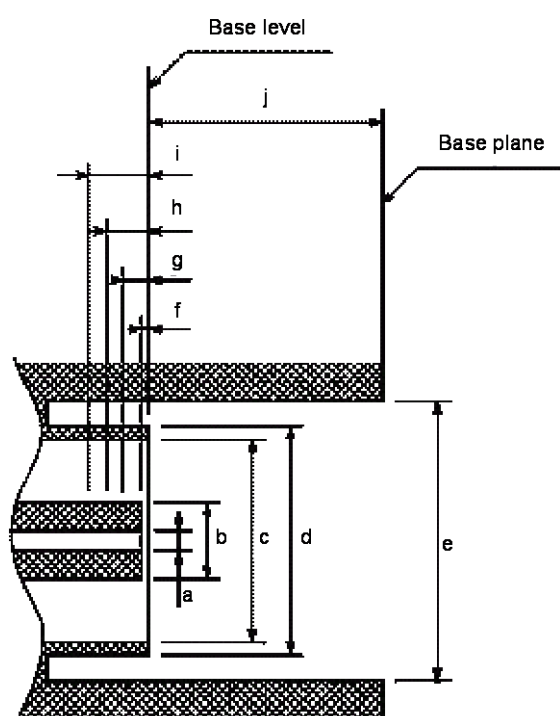
4.3.4 Type C

4.3.4.1 Basic information

- | | | |
|---|--------------------|--|
| a | Fuel type | Methanol and aqueous methanol solutions, 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 III. |
| d | Cartridge size | No limitation regarding dimension and design (shape) in particular for insert, exterior, attached and satellite types. |

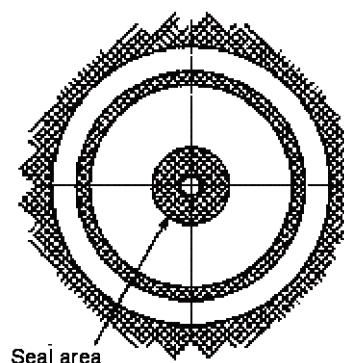
4.3.4.2 MFC power unit side connector design

The MFC power unit side connector design for Type C is shown in Figures 22 and 23 with the dimensions and tolerances in Table 10.



IEC 725/09

Figure 22 – MFC power unit side connector design (cross-sectional view)



IEC 726/09

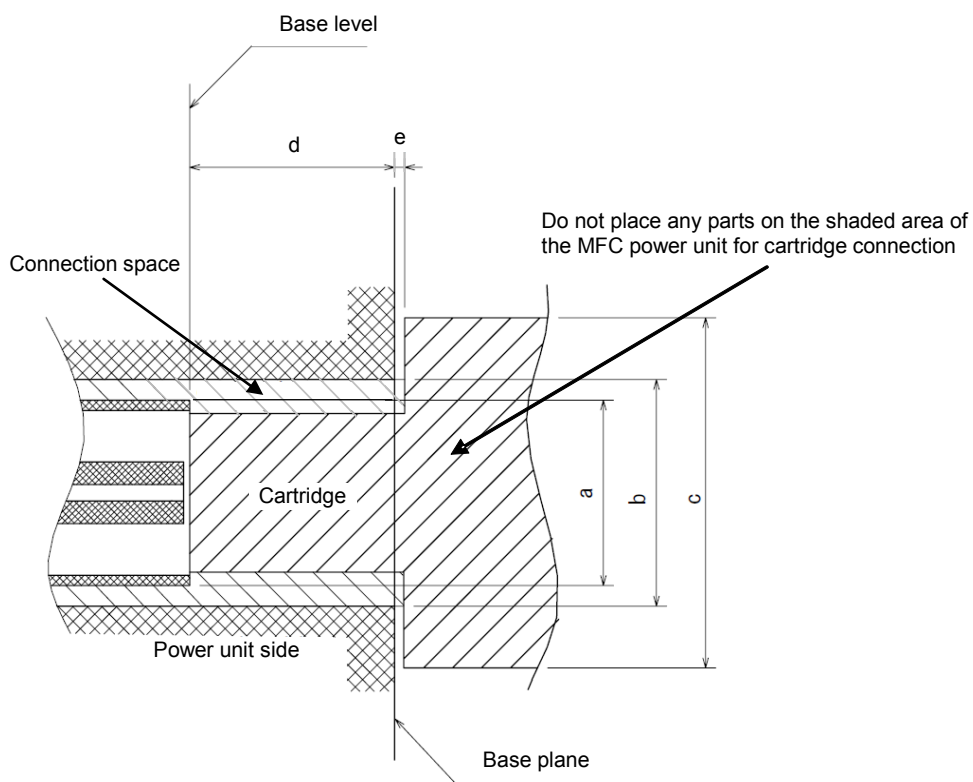
Figure 23 – MFC power unit side connector design (front-elevational view)

Table 10 – Dimension and tolerance for MFC power unit side connector

Item	Value	Tolerance
a Fuel hole diameter	0,8 mm	$\pm 0,1$ mm
b Seal area outer diameter	3,0 mm	$\pm 0,1$ mm
c Hole diameter	8,0 mm	$\pm 0,1$ mm
d Outer diameter	9,0 mm	$\pm 0,1$ mm
e Outer hole diameter	10,0 mm	$\begin{smallmatrix} 0,0 \\ -0,2 \end{smallmatrix}$ mm
f Initial seal surface position	0,8 mm	$\pm 0,05$ mm
g Connector seal position	0,95 mm	$\pm 0,05$ mm
h Distance to open valve	0,95 mm	$\pm 0,05$ mm
i Distance to stop valve	1,55 mm	$\pm 0,05$ mm
j Distance to top of outer hole	11,0 mm	$\begin{smallmatrix} +0,2 \\ 0,0 \end{smallmatrix}$ mm
k Force to open valve	2,4 N	$\pm 0,2$ N

4.3.4.3 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 C connectors is shown in Figure 24 with the dimensions and tolerances in Table 11.



IEC 727/09

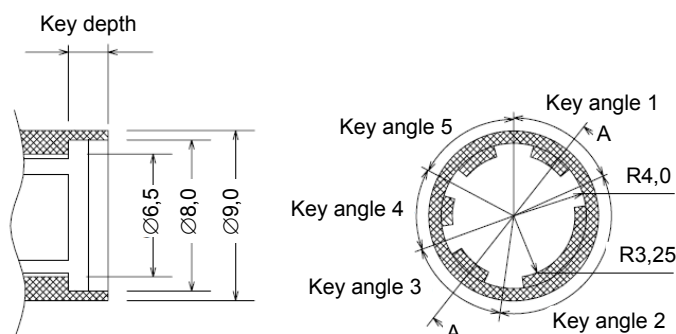
Figure 24 – Cartridge space (cross-sectional view)

Table 11 – Dimension and tolerance for cartridge space within MFC power unit

Mark	Value mm	Tolerance mm
a	Ø9,0	
b	Ø10,0	0,0 –0,2
c	Cartridge body size	
d	11,0	+0,2 0,0
e	0,5	

4.3.4.4 MFC power unit side mechanical key

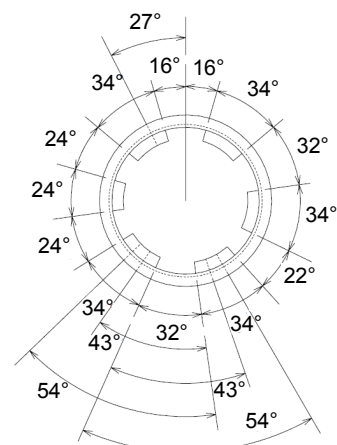
The mechanical keys on the MFC power unit side for Type C connectors are shown in Figures 25, 26, and 27 with the key locations, dimensions and tolerances in Table 12.



IEC 728/09

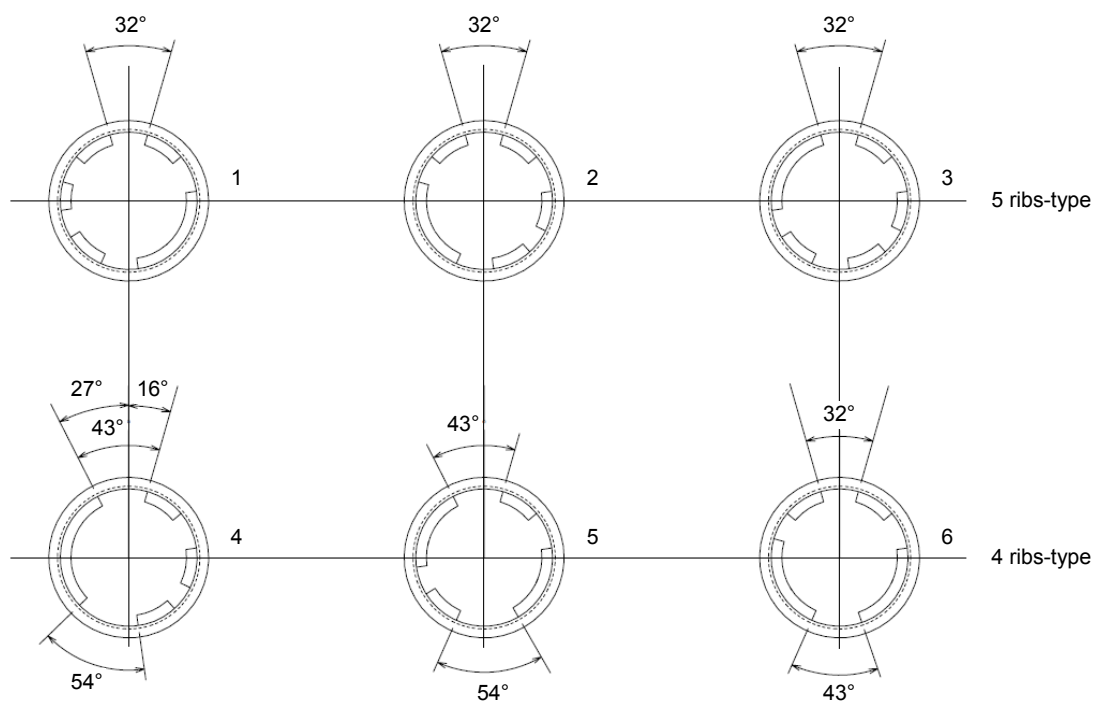
**Figure 25 – Mechanical key
(cross-sectional view)**

Dimensions in millimetres



IEC 729/09

**Figure 26 – Mechanical key
(front-elevational view)**



IEC 730/09

Figure 27 – Mechanical key variation with key number

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

Table 12 – Key location and dimension with tolerance for mechanical key

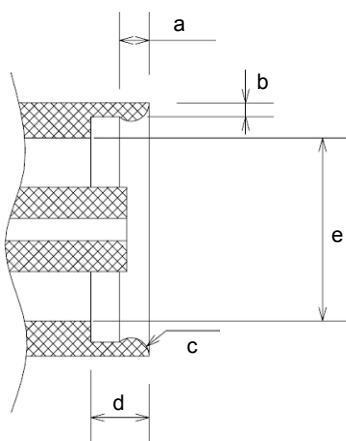
Key no.	Key depth mm	Key angle 1 °	Key angle 2 °	Key angle 3 °	Key angle 4 °	Key angle 5 °	Assignment of the key to methanol solution
1	2,1	66	122	62	48	62	98,0 % mass ± 1,5 % mass, non-pressurized
2	2,1	66	61	61	110	62	64,0 % mass ± 1,5 % mass, non-pressurized
3	2,1	66	61	61	62	110	61,8 % mass ± 1,5 % mass, non-pressurized
4	2,1	71,5	61	72	155,5	–	
5	2,1	71,5	111	73	104,5	–	
6	2,1	66	127,5	104,5	62	–	

4.3.4.5 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 methanol |
| d | Surface roughness | APA 0,008-2,5/Rz 6,3
(ISO 1302:2002) |
| e | Other requirement | The MFC power unit side connector is to be placed at 11 mm ± 0,05 mm in depth of a hole of Ø10 mm as shown in Figure 22. |

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

The connector retainer of a snap hook mechanism is required on the MFC power unit side as shown in Figure 28 with the dimensions and tolerances in Table 13.



IEC 731/09

Figure 28 – Connector retainer (cross-sectional view)

Table 13 – Dimension and tolerance for the MFC power unit side connector retainer

Mark	Value mm	Tolerance mm
a	1,06	±0,05
b	0,5	±0,05
c	R0,65	±0,05
d	2,1	±0,05
e	Ø6,5	±0,1

4.3.4.7 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 | APA 0,008-2,5/Rz 6,3
(ISO 1302:2002) |

4.3.4.8 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 |

4.3.4.9 Requirements for cartridge body

Not applicable.

4.3.4.10 Valve sequence**Opening sequence**

- | | | |
|---|------------------------------|--|
| a | Completion of sealing | The seal is completed at the seal position of 0,95 mm. |
| b | MFC power unit valve opening | After the completion of seal, the MFC power unit valve starts to open and completely opens at the distance to open of 1,15 mm. |
| c | Cartridge valve opening | The cartridge valve starts to open after the opening of the MFC power unit valve. |

Closing sequence

- | | | |
|---|------------------------------|---|
| d | Cartridge valve closing | The cartridge valve is closed first in the valve closing process. |
| e | MFC power unit valve closing | After the cartridge valve closes completely, the MFC power unit valve starts to close at the distance to open valve of 1,15 mm and completely closes at the seal position of 0,95 mm. |
| f | Seal open | After the MFC power unit side valve closes completely, the seal open occurs at the seal position of 0,95 mm. |

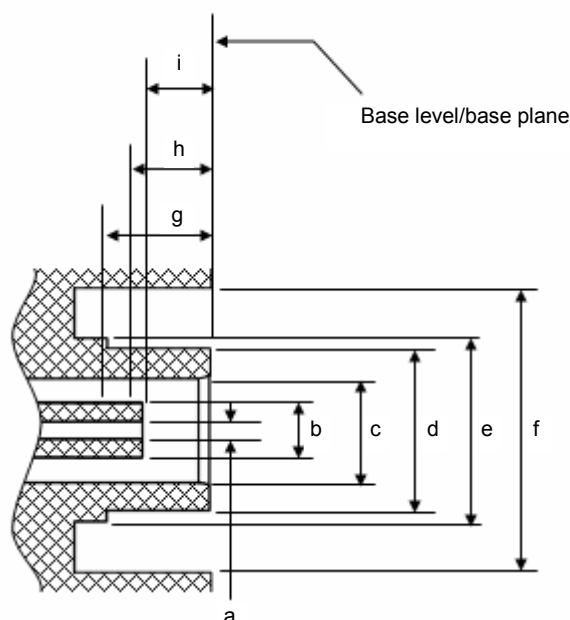
4.3.5 Type D

4.3.5.1 Basic information

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

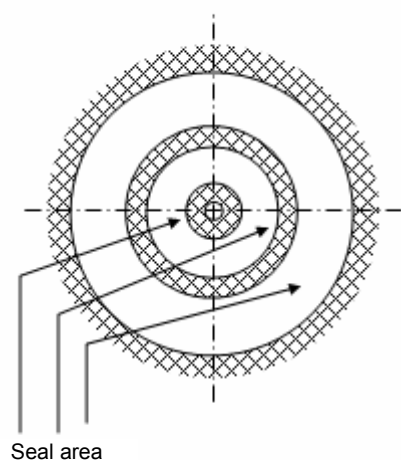
4.3.5.2 MFC power unit side connector design

The MFC power unit side connector design for Type D is shown in Figures 29 and 30 with the dimensions and tolerance in Table 14.



IEC 732/09

Figure 29 – MFC power unit side connector design (cross-sectional view)



IEC 733/09

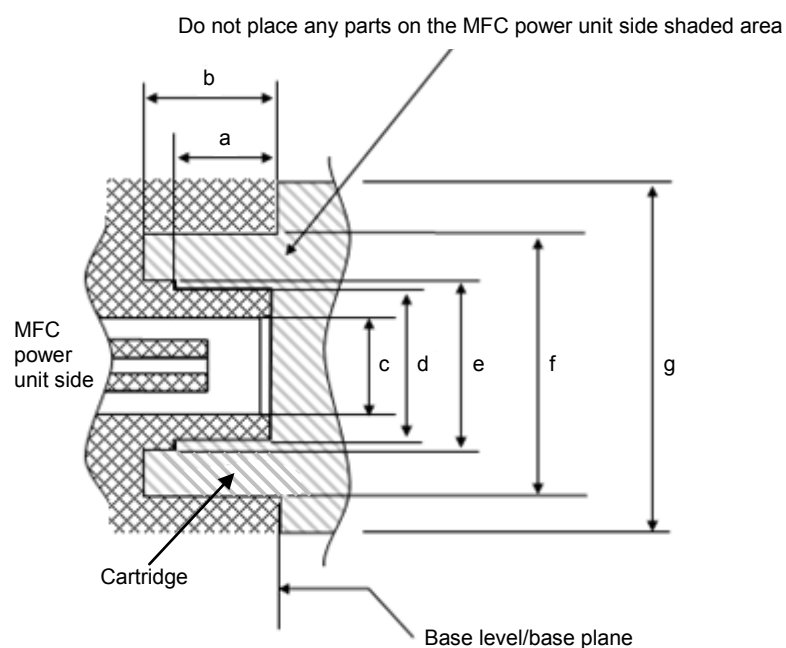
Figure 30 – MFC power unit side connector design (front-elevational view)

Table 14 – Dimension and tolerance for MFC power unit side connector

Item	Value	Tolerance
a Fuel hole diameter	0,8 mm	±0,01 mm
b Rod outer diameter	2,5 mm	±0,01 mm
c Inner seal diameter	4,8 mm	±0,01 mm
d Outer seal diameter	7,4 mm	±0,01 mm
e Outer diameter with key	8,4 mm	±0,01 mm
f Outer diameter	13,0 mm	±0,02 mm
g Distance to stop valve	4,6 mm	±0,01 mm
h Distance to open valve	3,6 mm	±0,01 mm
i Distance to top of outer hole	3,1 mm	±0,05 mm
j Force to open valve	2,0 N	±0,3 N

4.3.5.3 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 D connectors is shown in Figure 31 with the dimensions and tolerances in Table 15.



IEC 734/09

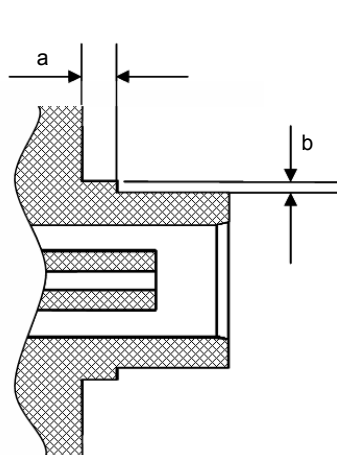
Figure 31 – Cartridge space for insert cartridge (cross-sectional view)

Table 15 – Dimension and tolerance for the cartridge space in MFC power unit

Mark	Value mm	Tolerance mm
a	4,9	$\pm 0,01$
b	6,4	$\pm 0,01$
c	4,8	$\pm 0,01$
d	7,4	$\pm 0,01$
e	8,4	$\pm 0,01$
f	13,0	$\pm 0,02$
g	Cartridge	

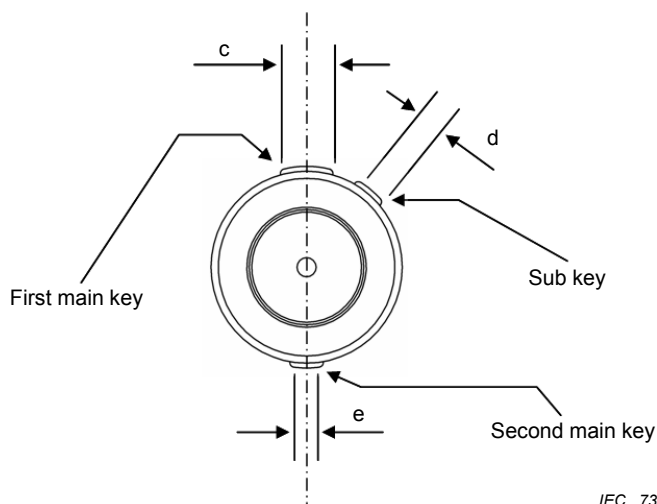
4.3.5.4 MFC power unit side mechanical key

The mechanical keys on the MFC power unit side for Type D connectors are shown in Figures 32, 33 and 34 with the key locations, dimensions and tolerances in Tables 16 and 17.



IEC 735/09

**Figure 32 – Mechanical key
(cross-sectional view)**

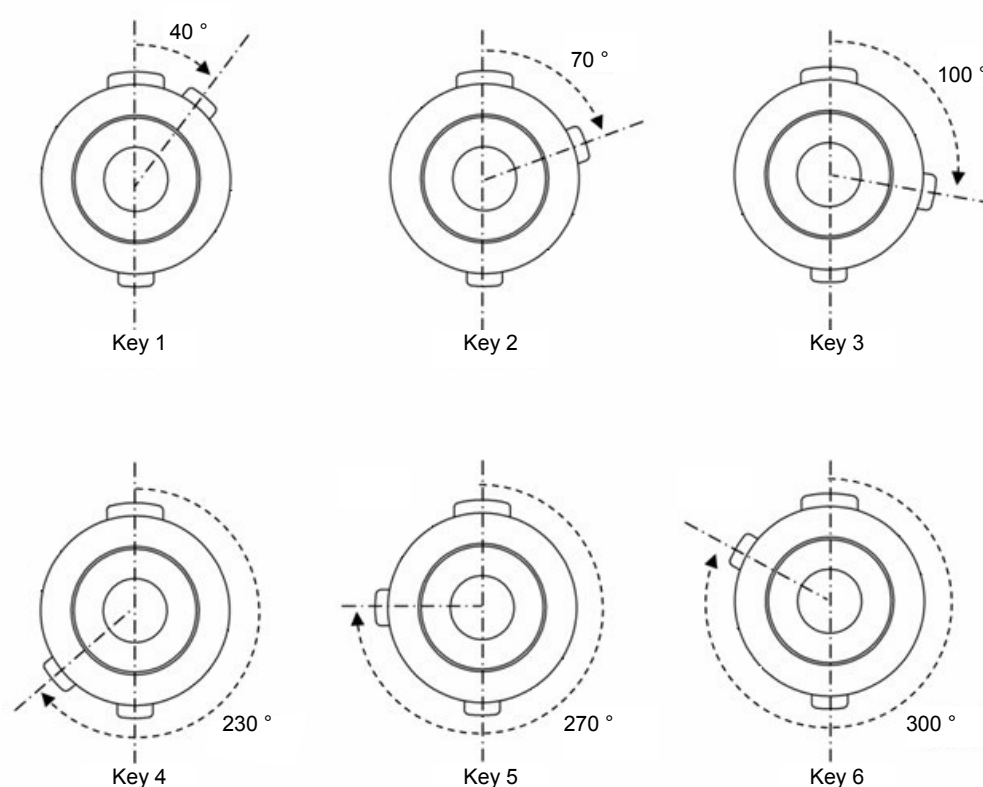


IEC 736/09

**Figure 33 – Mechanical key
(front-elevational view)**

Table 16 – Dimension and tolerance for mechanical key

Mark	Value mm	Tolerance mm
a	1,5	$\pm 0,01$
b	0,5	$\pm 0,01$
c	2,2	$\pm 0,01$
d	1,4	$\pm 0,01$
e	1,4	$\pm 0,01$



IEC 737/09

Figure 34 – Mechanical key variation with key number

There are six keys in Type D connectors. Mechanical key number 1 is for non-pressurized fuel 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 fuel 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.

Table 17 – Key location for mechanical key

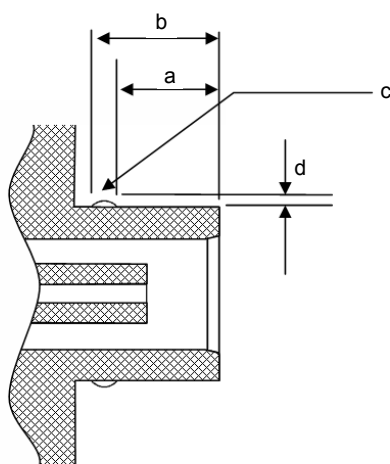
Key no.	Angle between first main key and sub key in clockwise direction	Assignment of the key
1	40	98,0 % mass $\pm 1,5$ % mass, non-pressurized
2	70	64,0 % mass $\pm 1,5$ % mass, non-pressurized
3	100	61,8 % mass $\pm 1,5$ % mass, non-pressurized
4	230	98,0 % mass $\pm 1,5$ % mass, pressurized
5	270	64,0 % mass $\pm 1,5$ % mass, pressurized
6	300	61,8 % mass $\pm 1,5$ % mass, pressurized

4.3.5.5 Requirements for MFC power unit side connector

a	Sealing	Elastic material 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 methanol
d	Surface roughness	Finished area
		Others
		APA 0,0025 – 0,8/Rz 6,3 (ISO 1302:2002)
		APA 0,008 – 2,5/Rz 25 (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.

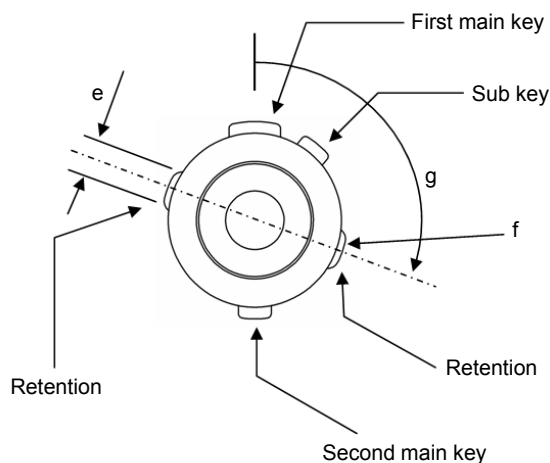
4.3.5.6 Requirements for connector retainer of coupling on the MFC power unit side

A connector retainer is required on the MFC power unit side as shown in Figures 35 and 36 with the dimensions and tolerances in Table 18.



IEC 738/09

**Figure 35 – Connector retainer
(cross-sectional view)**



IEC 739/09

**Figure 36 – Connector retainer
(front-elevational view)**

Table 18 – Dimension and tolerance for the MFC power unit side retainer

Mark	Value	Tolerance
a	4,35 mm	±0,01 mm
b	5,45 mm	±0,01 mm
c	Ø 0,70 mm	±0,01 mm
d	0,27 mm	±0,01 mm
e	1,76 mm	±0,01 mm
f	Ø 3,97 mm	±0,01 mm
g	150°	±0,2 °

4.3.5.7 Requirements for cartridge side connector

a	Materials	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 Finished area	APA 0,0025 – 0,8/Rz 6,3 (ISO 1302:2002)
	Others	APA 0,008 – 2,5/Rz 25 (ISO 1302:2002)

4.3.5.8 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

4.3.5.9 Requirements for cartridge body

Not applicable.

4.3.5.10 Valve sequence**Opening sequence**

a	Completion of sealing	The seal is completed at the seal position of 3,1 mm.
b	MFC power unit valve opening	After the completion of seal, the MFC power unit valve starts to open at the distance to open valve of 3,6 mm and is completely open at the distance to stop valve of 4,6 mm.
c	Cartridge valve opening	The cartridge valve starts to open after the opening of the MFC power unit valve.

Closing sequence

d	Cartridge valve closing	The cartridge valve is closed first in the valve closing process.
e	MFC power unit valve closing	After the cartridge valve closes completely, the MFC power unit valve starts to close at the distance to open valve of 3,6 mm and completely closes at the distance to stop valve of 4,6 mm.

valve rod position of 3,1 mm.

f Seal open

After the MFC power unit valve closes completely, the seal open occurs at the seal position of 3,1 mm.

4.3.6 Type E

4.3.6.1 Basic information

- | | |
|----------------------|---|
| a Fuel type | 98,0 mass % $\pm$ 1,5 mass % methanol aqueous solutions, non-pressurized. |
| b Cartridge category | All types of cartridges: insert, exterior, attached and satellite. |
| c Connector category | Classifications of connector strength from I through III. |
| d Cartridge size | No limitations regarding dimension and design (shape). |

4.3.6.2 MFC power unit side connector design

The MFC power unit side connector design for Type E is shown in Figures 37 and 38 with dimensions and tolerances in Table 19.

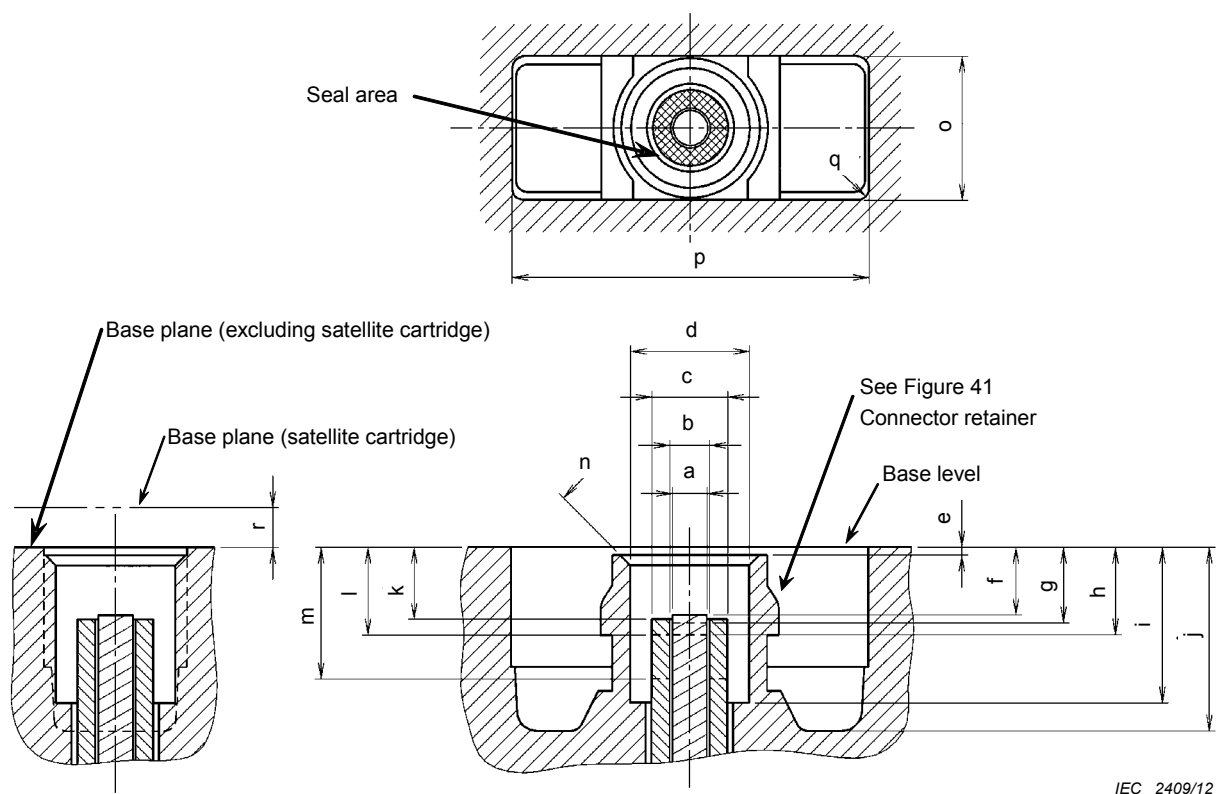


Figure 37 – MFC power unit side connector design

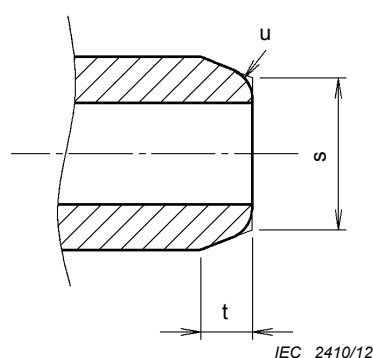


Figure 38 – Seal surface area design for MFC power unit side connector (cross-sectional view)

Table 19 – Dimension and tolerance for MFC power unit side connector

Item	Value	Tolerance
a Valve diameter	Ø 0,91 mm	+0,02 mm 0
b Inner diameter for seal	Ø 1,0 mm	±0,05 mm
c Outer diameter for seal	Ø 1,9 mm	±0,05 mm
d Nozzle hole diameter	Ø 3,0 mm	±0,03 mm
e Distance to nozzle hole	0,2 mm	±0,05 mm
f Initial valve rod position	1,7 mm	±0,05 mm
g Distance to open valve	1,9 mm	±0,05 mm
h Distance to stop valve	2,2 mm	±0,05 mm
i Bottom of nozzle hole	3,9 mm	±0,05 mm
j Bottom of cartridge retainer hole	4,6 mm	±0,1 mm
k Initial seal surface position	1,8 mm	±0,1 mm
l Connector seal position	2,2 mm	±0,05 mm
m Compressing limit for seal	3,4 mm	±0,05 mm
n Chamfer for nozzle hole entrance	0,25 mm	±0,03 mm
o Rectangular narrow side	3,6 mm	±0,05 mm
p Rectangular long side	9,0 mm	±0,05 mm
q Corner radius for entrance hole	R0,3 mm	±0,05 mm
r Distance to base plane for satellite cartridge	1,0 mm	±0,05 mm
s Seal top diameter	Ø 1,5 mm	±0,05 mm
t Length for outside seal slope	0,5 mm	±0,05 mm
u Seal top outside radius	R0,3 mm	±0,05 mm
v Force to open valve	2,93 N	±0,3 N

4.3.6.3 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 E connectors is shown in Figures 39 and 40 with dimensions in Tables 20 and 21.

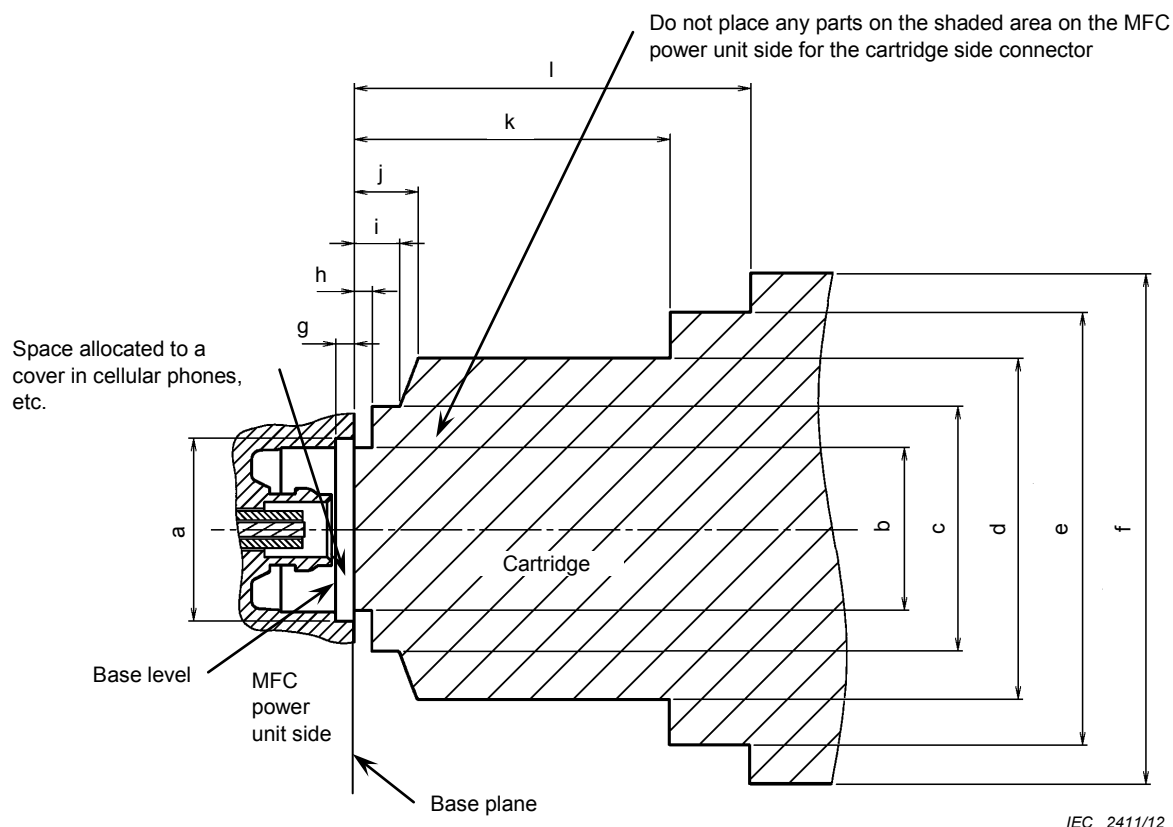


**Figure 39 – Cartridge space for satellite cartridge
(cross-sectional view)**

Table 20 – Dimension of space for satellite cartridge in MFC power unit

Mark	Value
a (rectangular long side)	Over 9,0 mm
a (rectangular narrow side)	From 3,6 mm to 5,0 mm
b	Ø9,5 mm
c	Ø13,4 mm
d	Ø18,7 mm
e	Ø23,7 mm
f	Cartridge body size
g	1,0 mm
h	1,0 mm
i	2,5 mm
j	3,5 mm
k	17,3 mm
l	21,7 mm

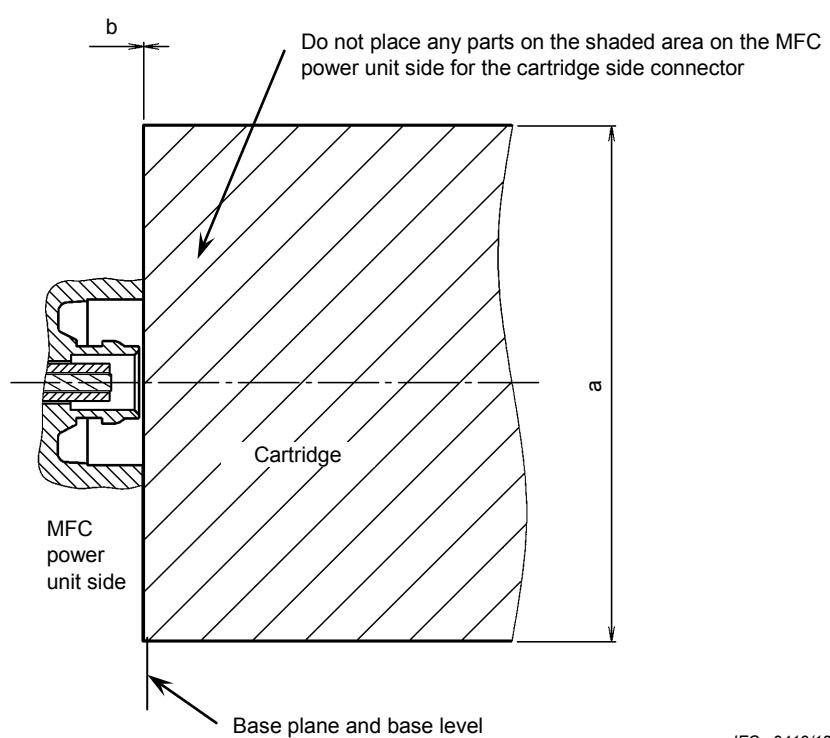


Figure 40 – Cartridge space for insert cartridge (cross-sectional view)

Table 21 – Dimensions for insert cartridge space in MFC power unit

Mark	Value
a	Cartridge body size
b	0 mm

4.3.6.4 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

4.3.6.5 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 Figure 41 with the dimensions and tolerances in Table 22.

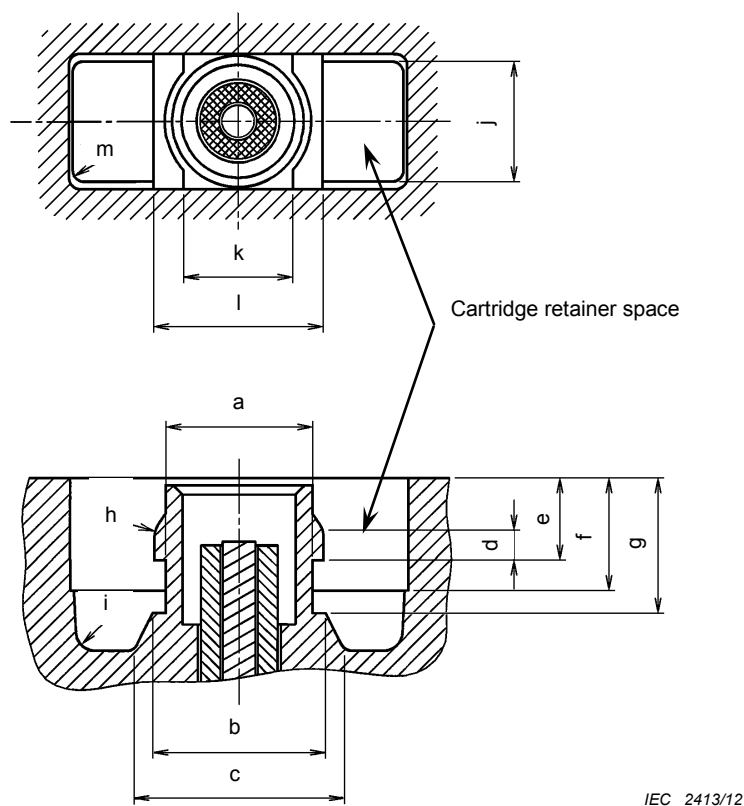


Figure 41 – Connector retainer

Table 22 – Dimension and tolerance for connector retainer on the MFC power unit side

Mark	Value mm	Tolerance mm
a	Ø 3,9	±0,05
b	4,6	±0,05
c	5,6	±0,05
d	0,8	±0,05
e	2,2	±0,05
f	3,0	±0,05
g	3,6	±0,05
h	R 0,6	±0,1
i	R 0,5	±0,1
j	3,2	±0,05
k	2,9	±0,05
l	4,5	±0,05
m	R 0,3	±0,05

4.3.6.6 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)

4.3.6.7 Requirements for cartridge body

Not applicable.

4.3.6.8 Valve sequence

Opening sequence

a	Completion of sealing	The seal is completed at the connector seal position of 2,2 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 1,9 mm and is completely open at the distance to stop valve of 2,2 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 1,9 mm and is completely closed at the initial valve rod position of 1,7 mm.
f	Seal open	After the MFC power unit side valve closes completely, the seal open occurs between the connector seal position at 2,2 mm and the initial seal surface position at 1,8 mm.

4.4 Type tests for interchangeable fuel connectors

4.4.1 Test types

The interchangeable connectors shall be subject to the following type tests.

a) Interchangeable connector connection test with a fuel cartridge

Set up the connectors with a manufacturer's fuel cartridge and a device test fixture, and then proceed to conduct the tests as specified in Table 23. Prior to conducting the tests in Table 23, determine the strength category of the connector from connector strength classes I to IV as defined in Table 24. Also, use Table 27 for determining the external forces that are applicable to the tests in Table 23.

b) Interchangeable connector connection test with an end use MFC device

Set up the connectors with a cartridge test fixture and a manufacturer's device, and then proceed to conduct the tests as specified in Table 23. Prior to conducting the tests in Table 23, determine the strength category of the connector from connector strength class I to IV as defined in Table 24. Also, use Table 27 for determining the external forces that are applicable to the tests in Table 23.

4.4.2 Mechanical strength requirement for interchangeable fuel connectors

Interchangeable fuel connectors shall have the following mechanical properties.

- a) No leakage, no fuel vapour loss, and no fractures that may lead to leakage or fuel vapour loss shall occur when a force is applied in the process of connecting, fueling as connected, or disconnecting of a MFC power unit and a cartridge as long as the force is within a range reasonably expected in the proper usage (f_1 : forces in normal operation).
- b) The interchangeable fuel connector shall be constructed, such that:
 - 1) in normal operation, the interchangeable fuel connector shall withstand a force (f_1) as shown in Table 27 without damage to the power unit or cartridge. Disconnection of the cartridge is permissible, and
 - 2) in foreseeable misuse, the interchangeable cartridge side connector shall not damage the interchangeable MFC power unit side connector at a force up to f_2 as shown in Table 27. The cartridge may sustain damage, but no leakage shall occur (see Figures 44, 46, 48, 50, 52 and 53). This is not applicable to compression tests.
- c) When the cartridge side connector is designed as described in the foregoing b) 2), it shall comply with the safety requirements provided in IEC 62282-6-100; it shall not cause leakage, fuel vapour loss, fire, or explosion.

Compliance with this interchangeability standard shall be verified by interchangeable fuel connector type tests.

Interchangeable fuel connector type tests shall be performed on each connector classification by the combination of the test samples shown in Tables 25 and 26. The type test results will show to which classification the tested connector belongs.

NOTE This standard does not cover those cases where the MFC power unit is damaged when the cartridge side connector is coupled with the MFC power unit connector by a force larger than f_2 , the force specified as the maximum for the protection of the MFC power unit.

4.4.3 Test parameters

Type tests as described in Table 23 shall be conducted on the coupling part of connectors based on the connecting action, usage as connected and disconnecting action. Every test from 4.4.9.2 to 4.4.9.9 except 4.4.9.8 shall be performed using the normal operation as provided in 4.4.2 a). For foreseeable misuse as provided in 4.4.2 b) and c), six tests from 4.4.9.3 to 4.4.9.8 shall be conducted.