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Gasoline engines with direct fuel injection (GDI engines) — Installation of the injectors to the engine

Moteurs à essence à injection directe de carburant (moteurs à injection directe d'essence) — Installation des injecteurs sur le moteur

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Foreword

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 34, *Propulsion, powertrain and powertrain fluids.*

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

Introduction

The motor vehicle industry is increasingly being pressured by the world's regulators to improve fuel consumption thus reducing exhaust CO_2 emissions. The challenge for automotive engineers is to balance the trade-offs between the technology to improve fuel consumption and to reduce any other regulated emissions (such as NO_X, HC and particulates).

The most promising new engine technology of late is the direct injection spark ignition engine [also known as the gasoline direct injection (GDI) engine]. Listed amongst the advantages of GDI are a significantly improved fuel economy and corresponding lower CO_2 emissions than on contemporary gasoline engines.

With this technology comes new fuel system components and updates to their interfaces with the engine. One component of the GDI fuel system is the injectors, which inject the fuel directly into the combustion chambers using fuel which is supplied at high pressure from the fuel rail.

This document provides design engineers with standard dimensions for the mounting of the GDI injectors in the cylinder head and for their connection to the fuel rail.

NOTE Gasoline direct injection systems typically operate at a pressure range of up to about 35 MPa. For gasoline systems this is considered as high pressure, thus the pump is called high pressure pump. If this pressure range is regarded in the view of all injection systems, diesel and gasoline, it is considered as medium pressure, as diesel injection operates at much higher pressures. So, even if the terms differ (high pressure connector in this document, medium pressure liquid fuel supply connections in ISO 18418-1 and ISO 18418-2), they mean the same pressure range and are designed for the same purpose.

Gasoline engines with direct fuel injection (GDI engines) — Installation of the injectors to the engine

1 Scope

This document specifies the dimensions required for the installation and integration of the fuel injectors in gasoline (GDI) engines. It also describes the interface of the fuel injector cup within the fuel rail to the individual injector.

NOTE When the word "fuel" is used in the terms listed, it can be omitted, provided there is no misunderstanding.

2 Normative references

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

ISO 2974, *Diesel engines — 60° female cones for high-pressure fuel injection components*

ISO 18418-1, *Gasoline engines — Medium pressure liquid fuel supply connections — Part 1: 60° female cone connectors*

3 Terms and definitions

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

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

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

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

3.1
fuel injector
device energized by an electrical signal that opens an internal valve via a solenoid or a piezo-electric actuator and injects fuel directly into the combustion chamber

3.2
fuel rail
pipe that serves as a reservoir for the pressurized fuel and as an adapter to provide the fuel to the inlets of the injectors

Note 1 to entry: The rail also serves to apply the necessary force to the injectors in order to position them in their locations in the cylinder head such that they can withstand the combustion pressure.

3.3
fuel injector cup
location in the *fuel rail* (3.2), which is placed over the inlet feed of the injector and transfers the fuel into the injector and applies a hydraulic force on the injector

4 Symbols and abbreviated terms

4.1 Injector dimensions

d_1 = injector nozzle diameter

d_2 = injector body outside diameter

L_1 = distance of nozzle tip to injector body seating face (support surface)

L_2 = distance of injector clamping surface to injector body seating face (support surface)

L_3 = distance of seal ring groove to injector body seating face (support surface)

L_4 = length of seal ring groove

NOTE Uppercase letter "D" denotes diameters of bores, lowercase letter "d" denotes diameters of shafts.

4.2 Rail assembly and injector cup bore dimensions

A_1 = coaxiality of the rail cup (D_1) to the nozzle bore (D_2)

A_2 = parallelism of the rail cup (D_1) to the nozzle bore (D_2)

A_3 = perpendicularity of rail lower cup surface to nozzle bore (D_2)

D_1 = rail cup bore diameter

L_5 = distance of rail cup to injector body seating face (support surface)

L_6 = complete depth of rail cup

L_7 = depth of finished section within rail cup bore (surface roughness)

L_8 = depth of insertion taper of rail cup

R_1 = radius between insertion taper and lower cup surface

R_2 = radius between rail cup bore and insertion taper

W_1 = angle of insertion taper of rail cup

Z_1 = surface roughness within rail cup bore and insertion taper

NOTE Uppercase letter "D" denotes diameters of bores, lowercase letter "d" denotes diameters of shafts.

4.3 Cylinder head bore dimensions

A_4 = perpendicularity of injector seat (support surface) to nozzle bore (D_2)

A_5 = flatness of injector seat (support surface)

A_6 = coaxiality of injector guide (D_4) to nozzle bore (D_2)

A_7 = cylindricity of injector guide bore (D_4)

D_2 = nozzle bore diameter

D_3 = diameter of injector lower guide bore

D_4 = diameter of injector upper guide bore

D_5 = diameter of injector bore upper section

L_9 = depth of injector lower guide bore

L_{10} = depth of lower end of insertion taper for injector sealing

L_{11} = height of injector guide bore

L_{12} = distance of injector seat (support surface) to combustion chamber

R_3 = radius between injector lower guide bore and injector seat (support surface)

R_4 = radius between injector seat (support surface) and injector lower guide bore

R_5 = radius at lower end of injector lower guide diameter

R_6 = radius at upper end of insertion taper for injector sealing

R_7 = radius at lower end of insertion taper for injector sealing

W_2 = angle of insertion taper for injector sealing

Z_2 = roughness within nozzle bore diameter and within insertion taper

Z_3 = roughness at injector seat

NOTE Uppercase letter "*D*" denotes diameters of bores, lowercase letter "*d*" denotes diameters of shafts.

5 General requirements

5.1 Injector description

The injectors are divided in 2 types for d_1 diameter:

— type A with a 6 mm nozzle diameter,

— type B with a 7,5 mm nozzle diameter.

The injectors include a seal ring at the nozzle to seal against the combustion pressure and also an O-ring at the fuel inlet feed to the injector for fuel sealing. A device shall be provided for the angular positioning of the injector, e.g. a pin at the injector and a corresponding location on the rail.

Figure 1 shows the dimensions of the injector, which are important for its installation within the cylinder head.

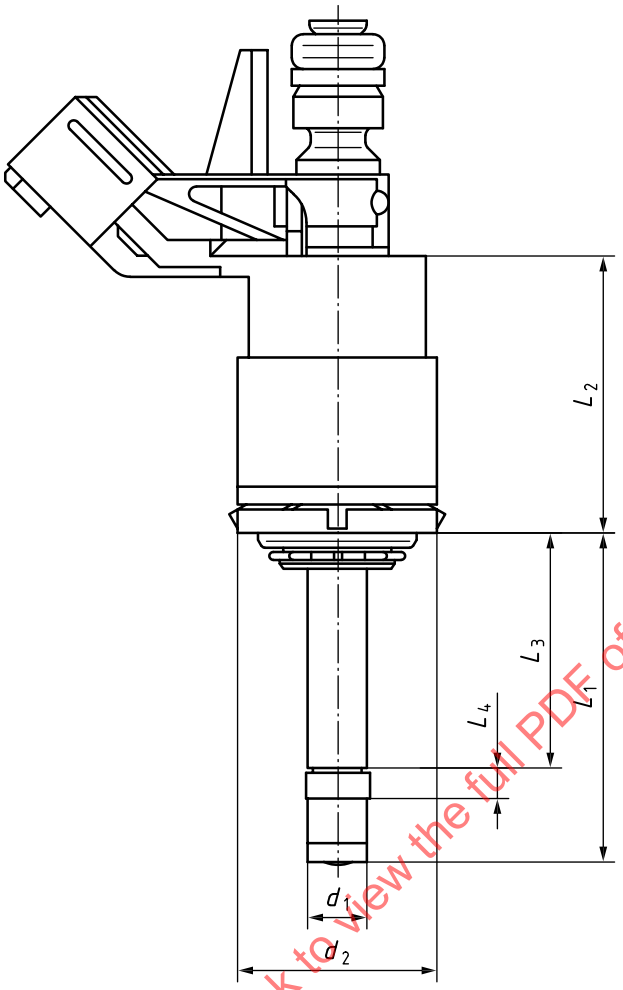
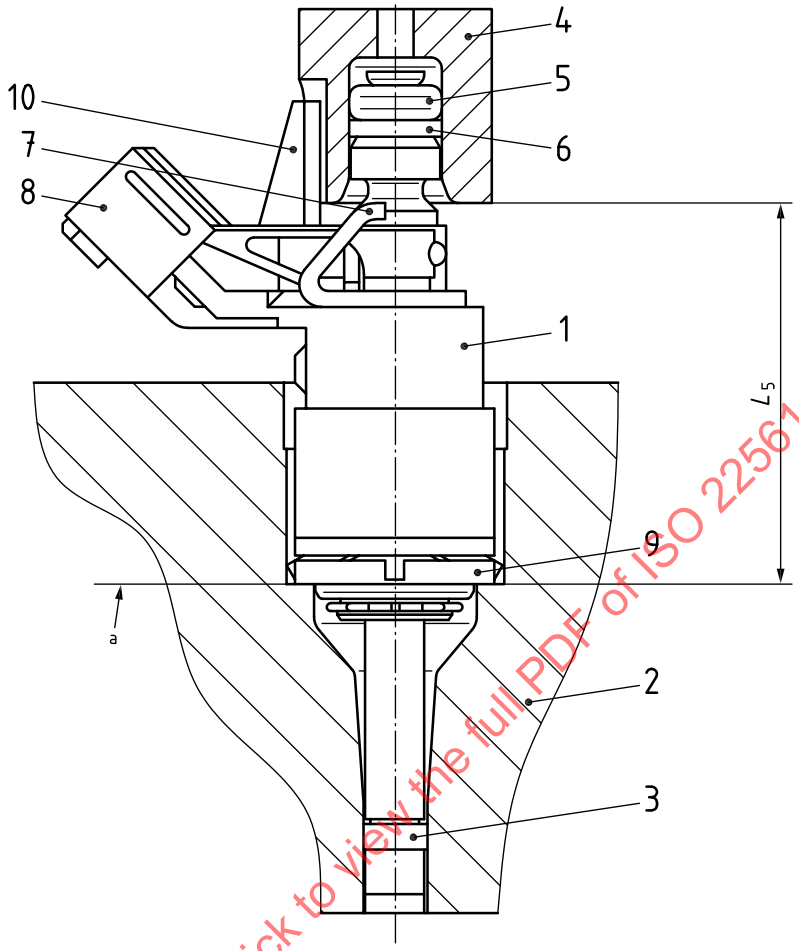


Figure 1 — Injector dimensions

Dimensions are indicated for explanatory purposes only, not for standardization.

5.2 Injector mounting arrangement



Key

1 injector
2 cylinder head
3 seal ring
4 rail with injector cup
5 O-ring
6 supporting disc(s)
7 spring for the fixation of the injector
8 electrical connector
9 adaptor between injector and cylinder head
10 pin for angular positioning of the injector
[a] Injector seat (support surface), reference position.

Figure 2 — Principle of installation

The injectors are not directly fastened to the cylinder head but are pressed down into their location by the fuel rail with the help of the spring force (Figure 2, key 7) and of the fuel rail pressure force. This design allows a certain misalignment of the injectors in order to align the adjacent cups in the rail, which will have positional tolerances relative to the injector bores in the cylinder head.

In order to ensure the sealing performance under misalignment, typically an adaptor (Figure 2, key 9) between the injector and the cylinder head is implemented. This adaptor may have additional benefits

such as insulation against noise and vibration. The design of this adaptor is dependent on the individual application and shall be agreed upon between the injector and engine manufacturers.

6 Dimensions and tolerances

6.1 General

The injectors are positioned by two sealing portions [seal ring (Figure 2, key 3) and O-ring (Figure 2, key 5)] and are supported by the adaptor (Figure 2, key 9). It is important for the sealing performance, that the required geometric accuracy (cylindricity, coaxiality, parallelism and perpendicularity) of the injector location in the cylinder head and fuel rail are valid at the final assembly and under all thermal and pressure conditions. Consideration shall also be made for any potential interference between the injector body and the cylinder head in the case of any assembly misalignment. For each specific application, individual conditions shall be checked in order to assure the correct function of the injector.

Dimensions, indicated in the figures but not specified in Tables 1 and 2, are important with respect to the assembly process and shall be agreed between all parties concerned in order to ensure reliable injector operation.

6.2 Injector cup

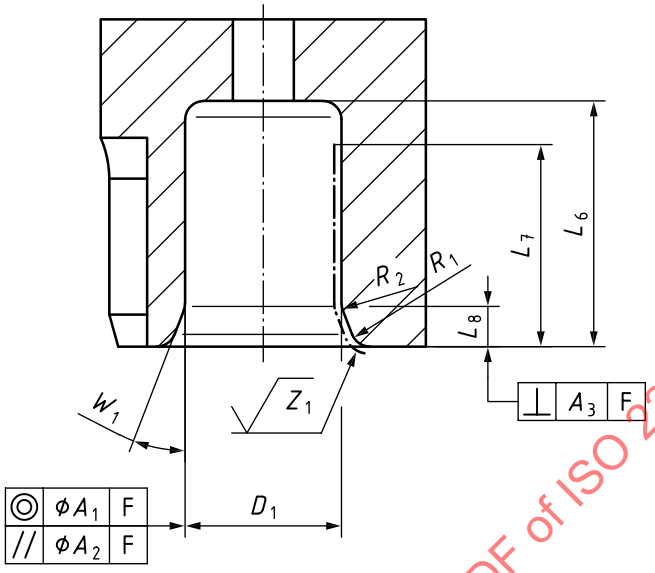


Figure 3 — Injector cup bore

Figure 3 shows the relevant dimensions of the injector cup section within the rail.

Table 1 — Dimensions of injector cup bore

Dimensions in millimetres

Dimension	Option 1	Option 2
D_1	9,4 ± 0,025	10,7 ± 0,025
L_5 (see Figure 2)	Dimension and accuracy to be agreed among related parties.	
L_7	= L_6 – max 2	
L_8	2,4	
W_1	20° ± 3°	
R_1	1	
R_2	1	
Z_1	Rzmax 6,3	Rz 3,2
A_1[a]	Coaxiality 1,2	To suit injector design
A_2	Parallelism 0,3	To suit injector design
[a] To be considered under all operating (temperature, pressure) conditions.		

6.3 Cylinder head bore

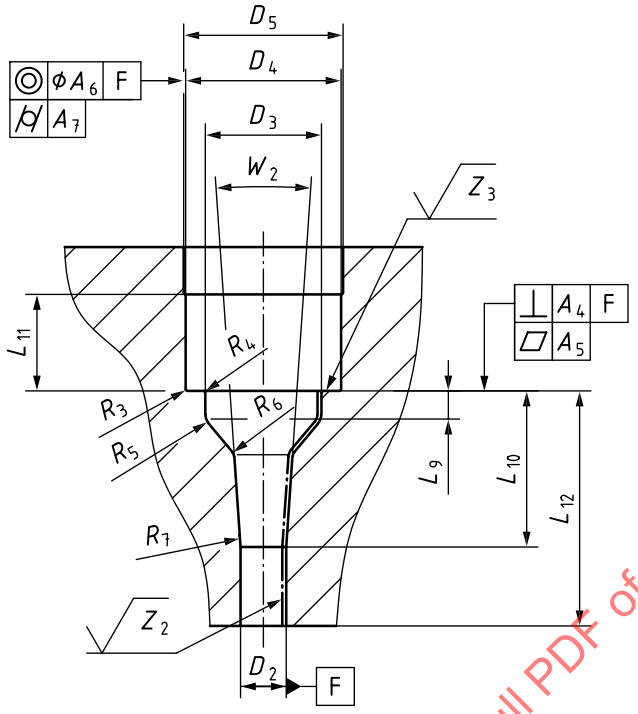


Figure 4 — Cylinder head bore

Figure 4 shows the dimensions of the bore for the injector within the cylinder head.

Table 2 — Dimensions of cylinder head bore

Dimensions in millimetres

Dimension	Option 1	Option 2
D_2	6,25 H8	7,75 H8
D_3	To suit injector design	
D_4	22,5 min	To suit injector design
L_{10}	20 min	
L_{12}	Engine specific with regard to the maximum temperature of the nozzle tip	
W_2	6°...12°	
R_3	0,4 max	To suit injector design
R_4	0,25 max	To suit injector design
R_6	1	
R_7	3	
Z_2	Rzmax 6,3	Rz 3,2
Z_3	Rzmax 6,3	
A_4	0,05 Perpendicularity	To suit injector design
A_5	< 0,02 Flatness	To suit injector design
A_6	0,1 Coaxiality	To suit injector design
A_7	0,03 Cylindricity	To suit injector design