

**STANDARD
SAE J1201**

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**Piston Rings and Grooves
(Metric) — SAE J1201**

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1. General—These metric specifications have been established for piston rings used in spark ignition engines, compression ignition engines, and compressors in a diameter range of 25–200 mm. It is intended to serve as a guide for the application of new ring designs. Information on piston rings and pistons having inch dimensions is contained in SAE J929a (July, 1977).

2. Cylinder Diameter—It is recommended that cylinder diameter tolerance be specified as plus above the nominal diameter. For standardization, engine cylinder bore sizes and piston ring diameters should be in even increments of 0.5 mm. For example: 101.5 mm, 102.0 mm, 102.5 mm, etc. It is recommended that service oversizes be 0.5 mm, 1.0 mm, and 1.5 mm.

3. Materials—Piston rings are generally made of high grade cast iron type materials because of their inherent wear resistance and compatibility with cylinder materials. However, some rings are also made from steel. The cast irons for piston rings are statically or centrifugally cast depending on the properties to be achieved. Statically cast rings are made from individual castings or from pot type castings. Rings made from individual castings have higher strengths due in part to a faster cooling rate than rings cut from pot castings. For maximum mechanical properties, the centrifugal casting process is generally used. Heat treatment is also used to produce the desired structure and strength properties. The following types of materials are used depending upon operating requirements.

3.1 Cast Irons

3.1.1 CLASS 1—These cast irons are generally individually or pot cast and are used in a wide variety of engine, compressor, and seal applications. They contain large amounts of free graphite in the form of random flakes in a pearlitic matrix. The flake graphite together with the pearlitic matrix accounts for good wear resistance and compatibility with a wide variety of cylinder materials. These irons are of moderate strength. Typical properties for reference purposes are:

Tensile Strength	140 MPa Min
Transverse Strength	200–380 MPa
Modulus of Elasticity	60–110 GPa
Equivalent Brinell Hardness,	
Individually Cast	160–275
Pot Cast	150–225

The chemical element ranges shown represent typical chemical compositions for this class of cast iron.

3.1.1.1 Element

Total Carbon	3.50–3.95
Silicon	2.20–3.10
Manganese	0.40–0.80
Phosphorus	0.30–0.80
Sulfur	0.13 Max

Alloying elements such as chromium, copper, molybdenum, vanadium, tin, etc. may be added to enhance the material properties or improve the material.

3.1.1.2 Microstructure—The matrix is essentially completely pearlitic or sorbitic with a minimum of free ferrite and massive cementite. The phosphorus constituent, steadite, is uniformly distributed in non-massive particles. The graphite will consist principally of randomly oriented flakes that are described as AFS-ASTM Type A or A-B combination. The graphite particles will normally be of AFS-ASTM Sizes 4–8.

3.1.2 CLASS 2—These cast irons are a low alloy type which may or may not be heat treated depending upon desired properties. They also contain flake type graphite, and the matrix may be predominantly pearlitic or tempered martensite type structure. They are very similar in chemistry and have slightly higher properties than Class 1 irons. Typical properties for reference purposes are:

Tensile Strength	240 MPa Min
Transverse Strength	350–420 MPa
Modulus of Elasticity	90–130 GPa
Equivalent Brinell Hardness	190–320

3.1.3 CLASS 3—These cast irons are the malleable type which are typically centrifugally cast and heat treated for maximum strength. The graphite is in the form of flocculent nodules rather than the usual flake type. Due to the large amount of free graphite, these materials have good wear resistance when compared to steel. The wear compatibility is somewhat less than the Class 1 and Class 2 irons and for this reason the ring generally has a hard facing.

Typical properties for reference purposes are:

Tensile Strength	480 MPa Min
Transverse Strength	480–620 MPa
Modulus of Elasticity	140–170 GPa
Equivalent Brinell Hardness,	
Pearlitic Type	230–285
Martensitic Type	250–285

3.1.4 CLASS 4—The high strength of these cast irons is due in part to the graphite being in the form of spheroids. These materials are statically or centrifugally cast and offer high strength and maximum fatigue resistance. Typical properties for reference purposes are:

Tensile Strength	550 MPa Min
Transverse Strength	480–1040 MPa
Modulus of Elasticity	140–180 GPa
Equivalent Brinell Hardness,	
Pearlitic Type	240–300
Martensitic Type	250–440
Ferritic Type	180–300

3.2 Steels—There are various types of steel used for piston rings and expanders. Because of their lower wear resistance and reduced compatibility, various wear resistant surface platings or coatings may be required.

3.3 Ring Facings—Piston rings may be given a hard facing on the outside diameter surface to improve wear and scuff resistance. Flash chromium plate is available in thickness of 0.01 mm minimum. Electroplated chromium or thermally sprayed coatings are typically specified in 0.05 mm thickness increments. The thickness is dependent upon manufacturing processes, materials, piston ring applications, and design.

4. End Clearance—Piston ring end clearance must be determined for the nominal diameter. Normal end clearances for rings are given in Table 1.

5. Piston Ring Radial Wall and Groove Root Diameter—Recommended ring radial walls are shown in Tables 2 and 3. Standard walls (Table 2) are used for both light and heavy duty compression rings and also for single piece oil rings up to 80 mm. Low walls (Table 3) are used for single piece oil rings 80 mm and above and large diameter compression rings.

Ring radial walls and groove root diameters were calculated from the following formulae which allows for normal piston land clearances, 0.25 mm maximum radii at the root of the grooves and 0.13 T.I.R. eccentricity of the groove root.

Maximum Ring Radial Wall

$$\text{Standard Wall } \frac{D}{22} + 0.13 \quad 25\text{--}140 \text{ mm Dia}$$

$$\text{Low Wall } \frac{D}{32} + 1.25 \quad 80\text{--}200 \text{ mm Dia}$$

Maximum Compression Ring Groove Root Dia

$$A = D - (2T + 0.007D + 0.6)$$

$$\text{Maximum Oil Ring Groove Root Dia} \\ (\text{Single piece or spring expanded})$$

$$A = D - (2T + 0.006D + 1.5)$$

For all ring grooves: $B = A - 0.25$

where A = High limit for groove root dia

B = Low limit for groove root dia

D = Nominal dia

T = Maximum ring radial wall thickness

Groove root diameters are shown in Tables 2 and 3.

TABLE 1—RING END CLEARANCES

Cylinder Dia (mm)	End Clearances (mm)
25–49.9 incl.	0.15–0.35
50–74.9 incl.	0.20–0.45
75–99.9 incl.	0.25–0.50
100–124.9 incl.	0.30–0.60
125–149.9 incl.	0.40–0.75
150–174.9 incl.	0.50–0.90
175–199.9 incl.	0.60–1.05



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