Detents ARRES
Presynchronisation of transmissions

SCHAEFFLER

Foreword

As a development partner to the automotive industry, Schaeffler Group Automotive develops and manufactures components and systems that take account of requirements for increased performance density and the reduction of factors such as mounting work and overall costs.

Higher performance engines, increased torque loads on transmissions and the demand for reduced design envelope are just a few of the defining conditions.

In this TPI, we aim to show the advantages that our detents ARRES make possible for the design of manual transmissions in this environment. The performance capacity of the various types and the specific advantages of the relevant designs are explained in detail.

In addition to the points mentioned above, we also consider the subject of gearshift comfort and present appropriate solutions.

Further information

Detents are components from our comprehensive product range. The function of a synchronisation system is described, the components required are presented and their interaction is explained in detail in TPI 125, INA Selector Hub Assemblies.

Safety guidelines and symbols

High product safety

Our products correspond to the current level of research and technology. If the bearing arrangement is designed correctly, the products are handled and fitted correctly and as agreed and if they are maintained as instructed, they do not give rise to any direct hazards.

Follow instructions

This publication describes standard products.
Since these are used in numerous applications, we cannot make a judgement as to whether any malfunctions will cause harm to persons or property.

It is always and fundamentally the responsibility of the designer and user to ensure that all specifications are observed and that all necessary safety information is communicated to the end user. This applies in particular to applications in which product failure and malfunction may constitute a hazard to human beings.

Definition of guidelines and symbols

The warning and hazard symbols are defined along the lines of ANSI Z535.6–2006.

The meaning of the guidelines and symbols is as follows:

! In case of non-compliance, damage or malfunctions in the product or the adjacent construction will occur.

Note! There follows additional or more detailed information that must be observed.

① Numbers within a circle are item numbers.

Detents ARRES

Product overview   Detents ARRES

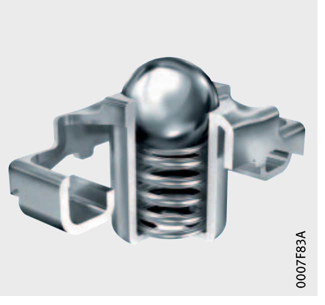
ARRES

Standard

ARRES-B

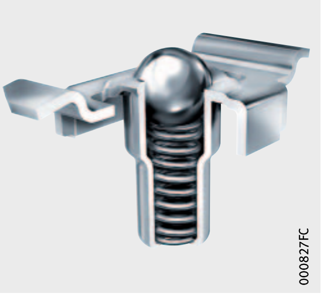
Stepped

ARRES-B..-S



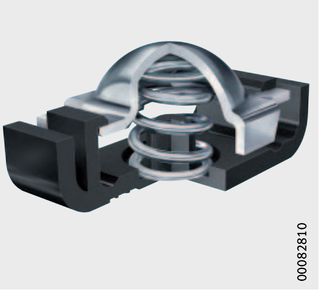
With wings

ARRES-W



Flat

ARRES-BL



Detents ARRES

Features

Axially movable detents are used for the presynchronisation system. The detents are located in recesses around the circumference of the selector hub, *Figure 1*. The detent element is preloaded by a spring against a recess in the selector sleeve.

For further information on the subject of synchronisation, see TPI 125, INA Selector Hub Assembly.

① Selector hub
② Detent
③ Selector sleeve
④ Synchro ring

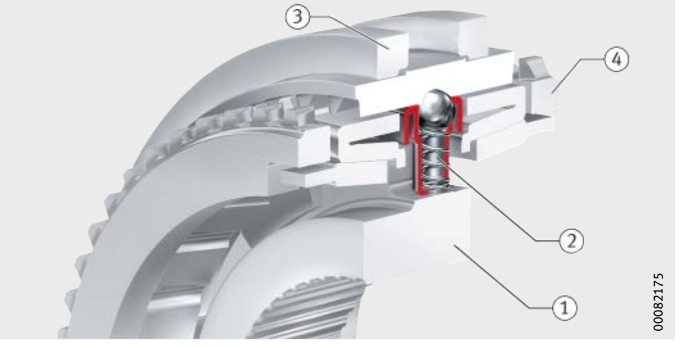


Figure 1
Synchronisation system

Designs

Detents exist in both multi-piece and single-piece designs. The multi-piece design is being increasingly replaced by the single-piece design.

Multi-piece design

These detents comprise at least two individual parts. During mounting, the detent elements must in this case be mounted under spring tension, *Figure 2*.

This mounting work is not required when using ARRES, a development of the Schaeffler Group.

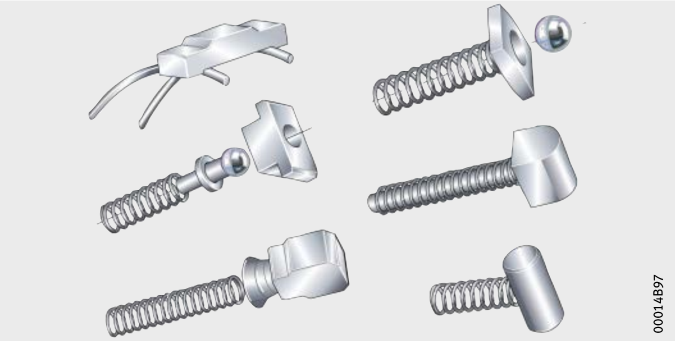


Figure 2
Conventional detents

Detents ARRES

Single-piece design

An ARRES consists of three components, *Figure 3*. The components are rigidly connected to each other during production. Due to the single-piece design, less work is involved during assembly of the transmission. Furthermore, there is no need for holes in the selector hub and stockholding costs are reduced.

① Drawn cup
② Compression spring
③ Locking element
④ Base

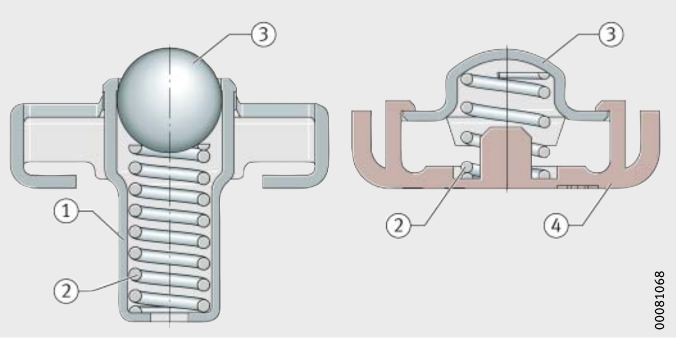


Figure 3
Single-piece detent

Materials

Detents ARRES are made from high quality materials. The steel parts can be black oxide coated and the plastic bases can be produced in any colour.

Wear

Wear of the guide surfaces leads to a deterioration in synchronisation behaviour. The materials and surfaces developed for the synchronisation system keep wear to a low level. This allows consistent function over the whole life of the transmission.

Quality

All the components are manufactured by Schaeffler Group Automotive and are thus subject, from individual part production through to assembly, to continuous and complete quality control.

Gearshift feel

The displacement force curve that is decisive for gearshift feel is determined by the compression spring. In an ARRES, the spring force can be set at any point over a wide range. The desired gearshift feel can thus be set even shortly before the start of volume production.

ARRES-B

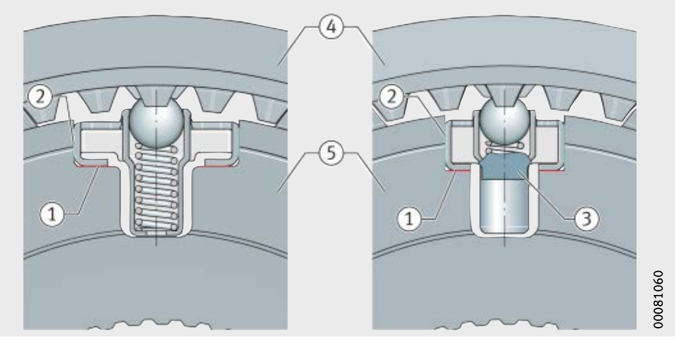
These easy-to-fit detents have proved themselves millions of times in practice.

Guidance

Good guidance in the selector hub is achieved by means of the large guidance surfaces, *Figure 4*.

Mounting retainer

A mounting retainer can be integrated in order to ensure that almost rectangular detents are mounted quickly and in the correct position, *Figure 4*.

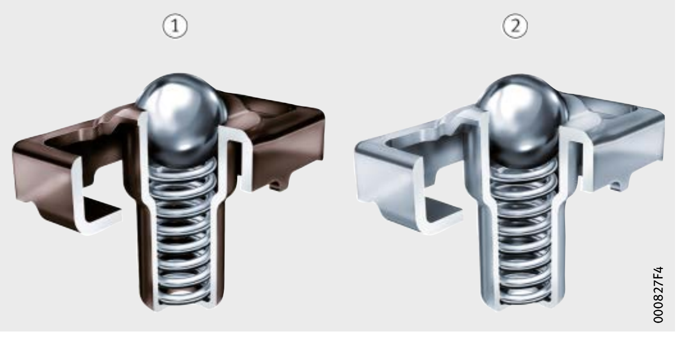


① Contact surfaces
② Guidance surfaces
③ Mounting retainer
④ Selector sleeve
⑤ Selector hub

Figure 4
Guidance surfaces, retainers

Colour differentiation

Two ARRES of identical dimensions are mounted in one transmission. The only difference is in the compression springs fitted in each case. Optical differentiation is thus advisable. Black oxide coating of one variant is a proven method here, *Figure 5*.



① With black oxide coating
② Without black oxide coating

Figure 5
Black oxide coating

Detents ARRES

ARRES-B..-S

The design of this ARRES is based on ARRES-B. The ARRES-B..-S is used in preference at high speeds.

Anti-lift device

In engines running at high speeds, very high speeds often also occur in the transmission. These cause considerable centrifugal forces and then lifting of the detents. Lifting can often lead to tilting and catching, in which case secure functioning is no longer ensured.

The ARRES-B..-S is designed such that the anti-lift device can be integrated in the selector hub, *Figure 6*.

① Selector hub with anti-lift device
② Selector sleeve

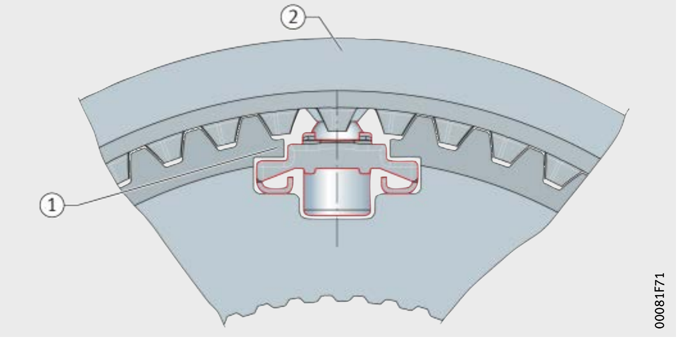


Figure 6
Anti-lift device

ARRES-W

This variant was derived from the basic ARRES design and incorporates the fundamental features of ARRES-B.

Wings

The special design feature is the two wings, *Figure 7*.

① Wings
② Selector hub
③ Selector sleeve

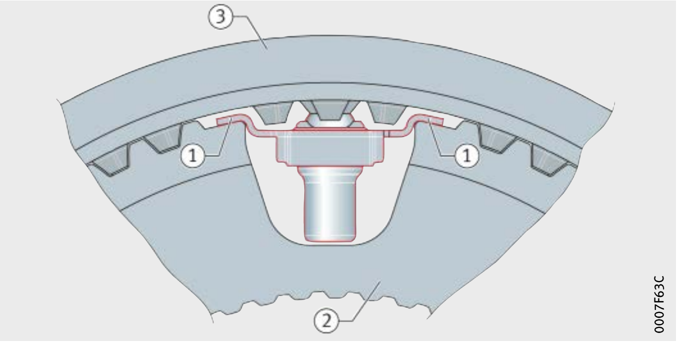


Figure 7
Mounting situation

Anti-lift device

The wings prevent lifting from the contact and guidance surfaces, thus avoiding the resultant tilting. The components remain in their specified position even under high centrifugal forces.

Guidance surfaces

Selector hubs have large contact and guidance surfaces for the wings in ARRES-W. The contact and guidance surfaces are significantly longer in comparison with ARRES-B, *Figure 8*.

In the case of ARRES-W, tilting under long gearshift travel is prevented by the significantly longer contact and guidance surfaces.

① Contact surface of ARRES-B
② Contact surface of ARRES-W
③ Selector hub

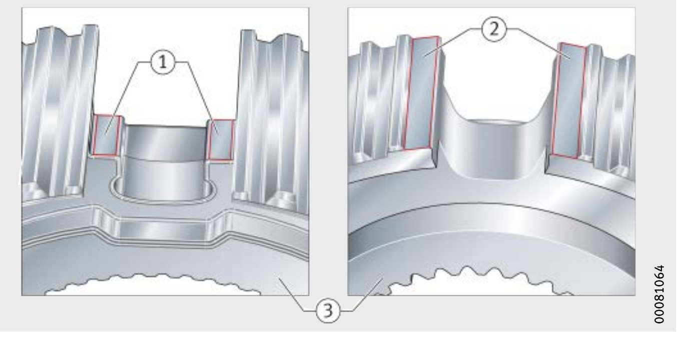


Figure 8
Guidance surface

ARRES-BL

These detents with a cap profile have the same functionality as our detents with a ball.

Section height

A significantly smaller section height is achieved since the volume under the cap can be used for the compression springs. The recess in the selector hub can thus be significantly smaller, *Figure 9*.

① Recess in ARRES-B, ARRES-B..-S and ARRES-W
② Recess in ARRES-BL
③ Critical cross-section

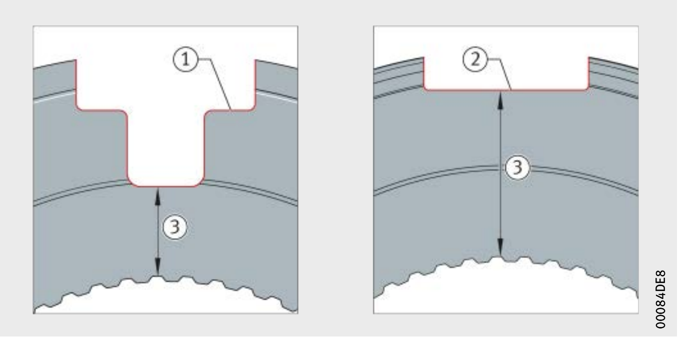


Figure 9
Recess, comparison

Flat recesses reduce the stresses in the critical cross-section by up to 25% and, with an otherwise unchanged transmission geometry, allow the selector hub to transmit greater torque. In new designs, the reduced dimensions allow transmission designs with compact dimensions and optimised mass.

Narrow design

With this design, the length of the transmission can be further reduced. The design envelope width from freewheel to freewheel can, in an ideal case, be reduced from 40 mm to 30 mm. This can be achieved since the minimum width is determined from the total spring width and twice the sheet metal thickness.

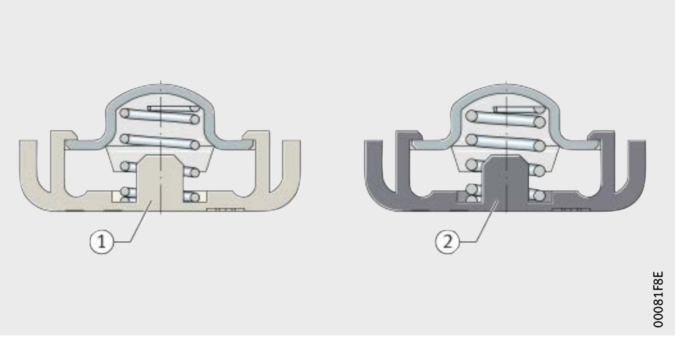
Plastic base Only the ARRES-BL has a plastic base.

Mass

A plastic base weighs significantly less than a steel base. This reduces the centrifugal forces and allows higher speeds in the transmission.

Colour

If ARRES-BL of the same dimensions but with different springs are used, we recommend that the plastic bases should be of different colours. Almost any colour can be selected for the plastic base, *Figure 10*.



① Plastic base, light
② Plastic base, dark

Figure 10
Colour of plastic base

Operating temperature

ARRES-BL can be used at operating temperatures from –40 °C to +140 °C.

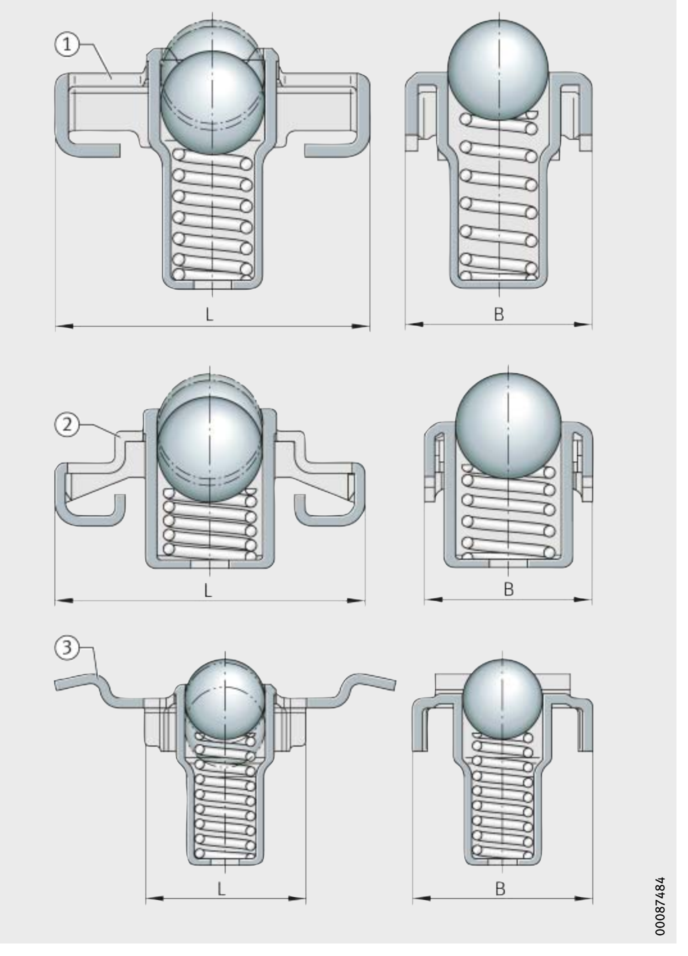
Lubricants

The plastic base has long term resistance to normal mineral and synthetic oils.

! Before using any special lubricants, please contact us for advice.

Economical variants

Where detents are made completely from steel and only the dimensions L and B (see dimension tables) are changed, this can be accommodated by only a partial change to the tooling.



L = length
B = width

① ARRES-B
② ARRES-B-..S
③ ARRES-W

Figure 11
Economical variants

Design

In the assessment of detents, the decisive factors are not only the design envelope but also the minimum and maximum value as well as the curve of the displacement force.

On the basis of geometrical data such as the diameter, the depth of the locking notch and the ramp angle as well as the specified speed and spring forces, it is determined whether the detents should be secured against lifting. Furthermore, the magnitude and curve of the displacement force are determined by the software, *Figure 12*.

However, the inverted route is also possible. If the displacement force is specified, the spring forces can be determined.

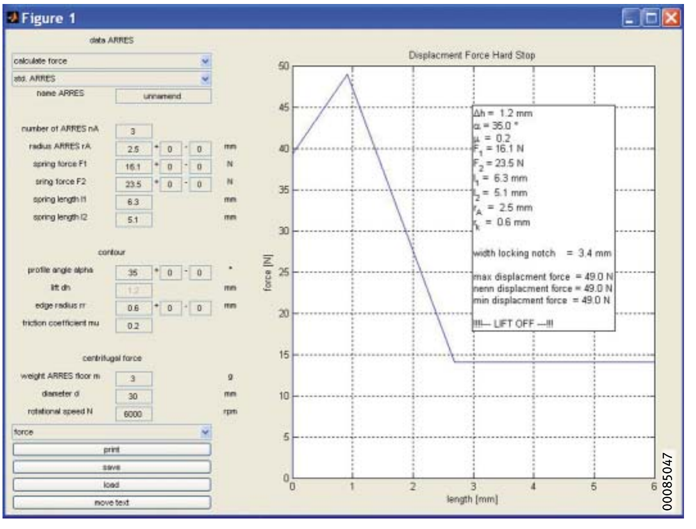


Figure 12
Design, applied software

Analysis of customer data

Upon request, we can carry out a design analysis. For this purpose, the customer sends us a completed enquiry form, see page 23. Alternatively, the 3D data records can be sent, *Figure 13*. We can check the application and then provide the required information.

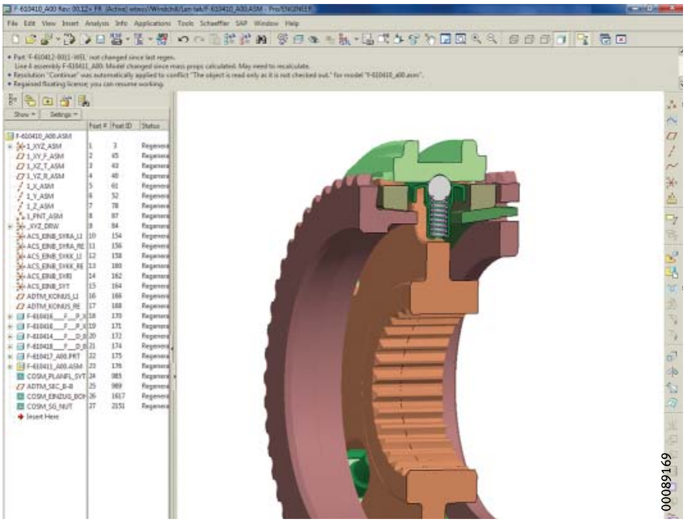
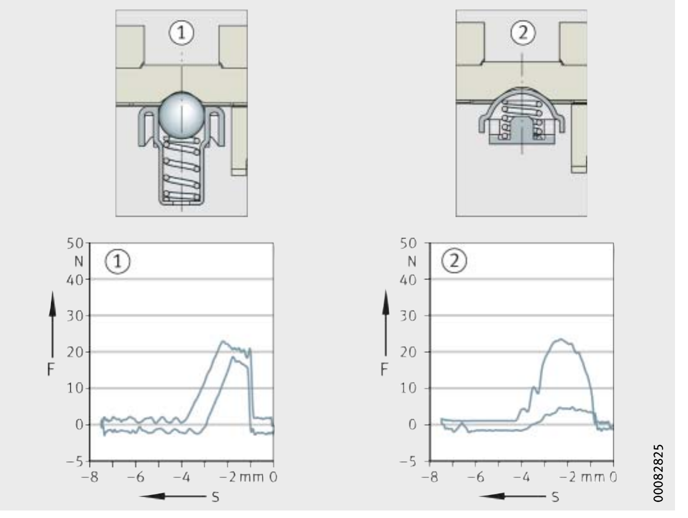


Figure 13
Analysis of customer data

Simulation Before samples are produced, the behaviour of the components is checked using simulation software, *Figure 14*.



F = displacement force
s = displacement travel

① ARRES-B, ARRES-B..-S and ARRES-W
② ARRES-BL

Figure 14
Displacement force, simulation

Quality assurance

An integral part of new developments is quality assurance in the design of components. The calculated characteristics are subsequently checked in tests. Upon customer request, all or only some of the measures described are implemented in the case of standard components.

FEM calculation

If the components fulfil the requirements relating to function, the service life is investigated. The stresses present in the model are checked, *Figure 15*.

The strength analysis uncovers weaknesses. The model is modified accordingly until the required strength is achieved in calculation.

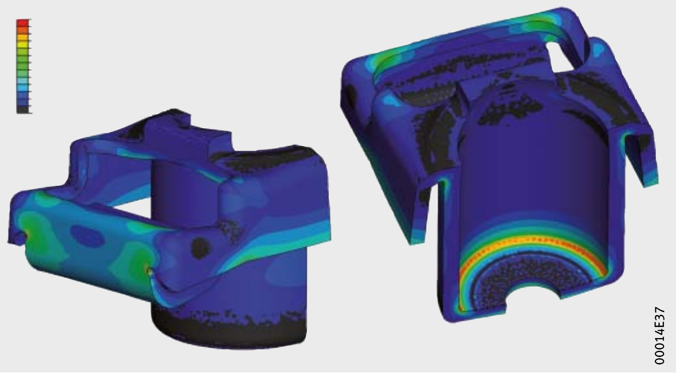


Figure 15
Strength analysis

Tests Sample parts and later production parts can be investigated on appropriate test rigs. Once the sample parts have passed the short term tests, this is followed by the system test.

Gearshift feel A final test would be an investigation of the sensory quality. Objective data can be fulfilled according to specifications.
The requirements in terms of subjective data such as gearshift feel can also be checked on a test rig representative of practical conditions, *Figure 16*.

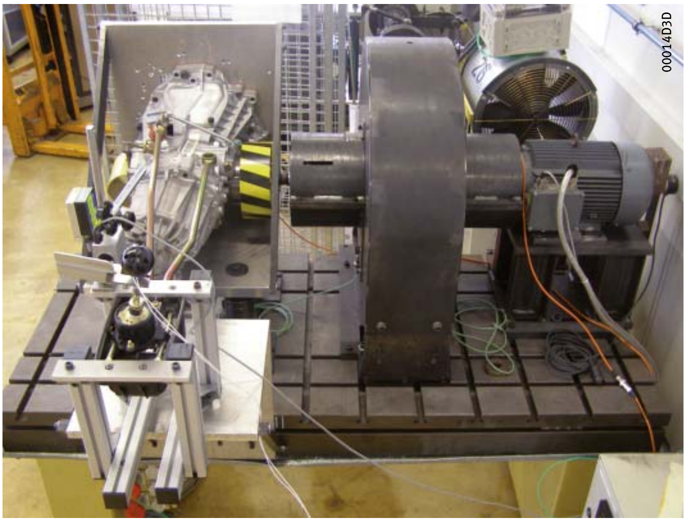
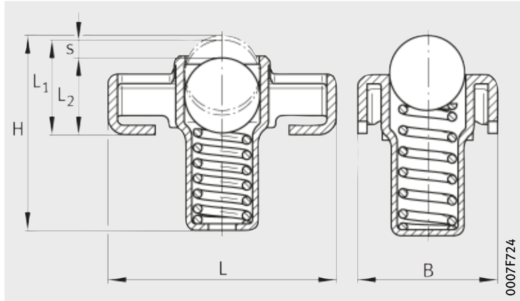


Figure 16
Transmission test rig (dyno test)

Test specification The tests are carried out in accordance with customer requirements or defined test specifications of the Schaeffler Group.
These specifications have been developed on the basis of many years of experience and are continuously adapted to take account of new findings.

Detents ARRES

Standard design

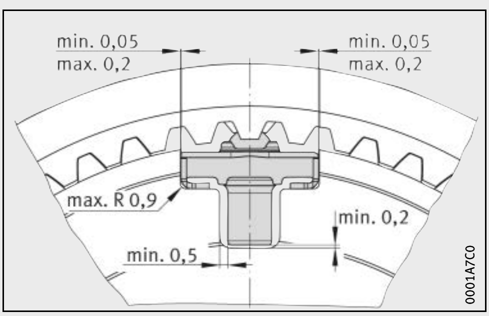


ARRES-B

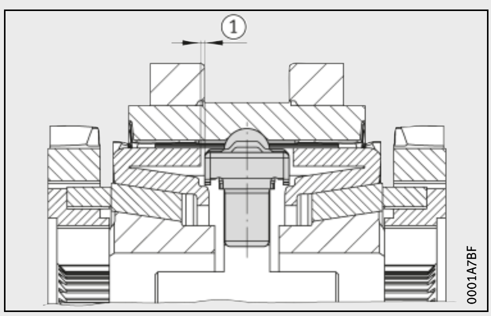
Dimension table · Dimensions in mm

Designation	Mass	Dimension					Forces				Stroke length
	m	L	H	B	L_1	L_2	F_1[1]		F_2[2]		s
							min.	max.	min.	max.	
	≈g						N	N	N	N	
ARRES-B1	2,4	15	12,9	9,2	6,3	4,8	10	23	16	46	1,5
ARRES-B2[3]	2,5	15	12,9	9,2	6,3	4,8	10	23	16	46	1,5
ARRES-B3	2,8	15	12,9	12,3	6,3	4,8	10	10	16	16	1,5
ARRES-B4	3	13,95	12,9	11,45	6,3	4,8	12	12,5	15,6	20	1,5
ARRES-B5	2,5	13,95	12,9	11,45	6,3	4,8	10	12,5	16	20	1,5
ARRES-B6	2,4	14,95	10,9	9,65	6,6	5,4	7,1	16	11,2	29	1,2
ARRES-B7	3	11,8	13,8	10,35	7,25	5,56	7,5	13	15	22	1,69
ARRES-B8[3]	3	11,8	13,8	10,35	7,25	5,56	7,5	13	15	22	1,69
ARRES-B9	3	13,95	12,9	18,75	6,3	4,8	10	13,5	16	21	1,5
ARRES-B10[3]	2,5	15	11,7	9,9	7,21	5,84	12	12	22	22	1,37
ARRES-B11	3	13,95	12,5	21,35	5,9	4,65	15	15	22,5	22,5	1,25
ARRES-B14	2,9	15	13,2	18,51	5,1	3,6	15,5	15,5	23,5	23,5	1,5
ARRES-B15	2,4	15	12,9	11,45	6,3	4,8	16,5	16,5	28	28	1,5

[1] F_1 = force at L_1, as a function of the springs used.
[2] F_2 = force at L_2, as a function of the springs used.
[3] With black oxide coating.



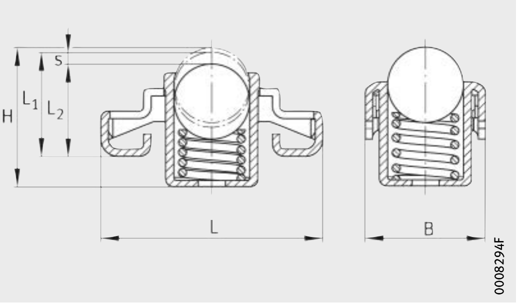
Design envelope proposal for ARRES-B, lateral view



① Application-specific gap dimension

Detents ARRES

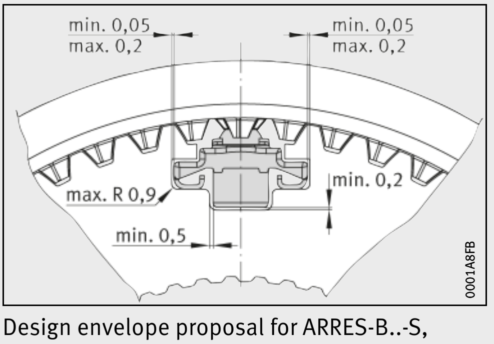
Stepped design



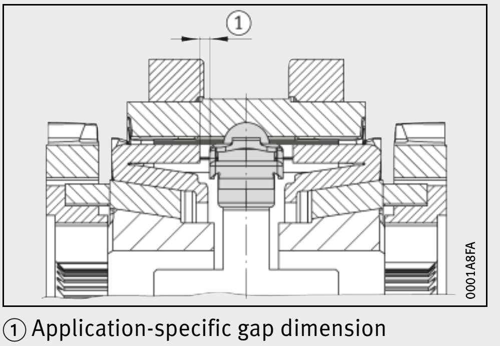
ARRES-B..-S

Dimension table · Dimensions in mm											
Designation	Mass	Dimension					Forces				Stroke length
	m	L	H	B	L_1	L_2	F_1 [1]		F_2 [2]		s
							min.	max.	min.	max.	
	≈g						N	N	N	N	
ARRES-B12-S	2,5	17,4	13,1	11,2	6,3	4,8	12	12	20	20	1,5
ARRES-B13-S	1,8	14,65	9,2	7,95	7	6,05	12	14,8	15,6	22,5	0,95

[1] F_1 = force at L_1, as a function of the springs used.
[2] F_2 = force at L_2, as a function of the springs used.



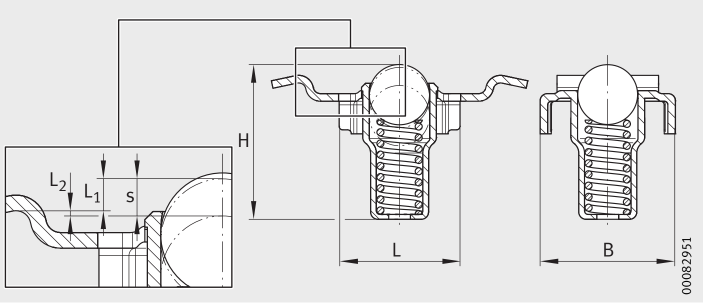
Design envelope proposal for ARRES-B..-S, lateral view



① Application-specific gap dimension

Detents ARRES

Design with wings

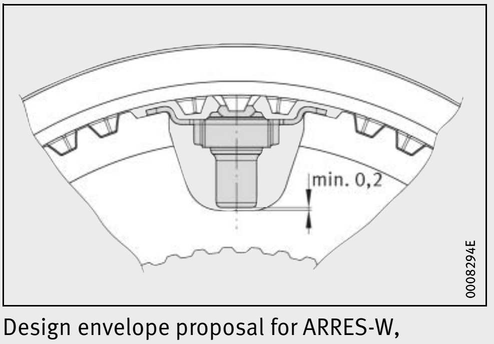


ARRES-W

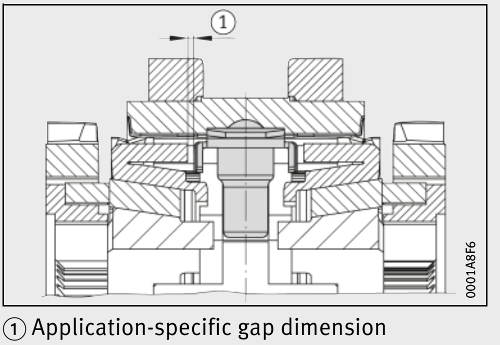
Dimension table · Dimensions in mm											
Designation	Mass	Dimension					Forces				Stroke length
	m	L	H	B	L_1	L_2	F_1 [1]		F_2 [2]		s
							min.	max.	min.	max.	
	≈g						N	N	N	N	
ARRES-W1	2,5	18,5	12,82	11,2	1,26	0,24	14	14	26	26	1,5
ARRES-W2	3	18,5	12,85	20	1,26	0,24	10	14	18	26	1,5

[1] F_1 = force at L_1, as a function of the springs used.

[2] F_2 = force at L_2, as a function of the springs used.



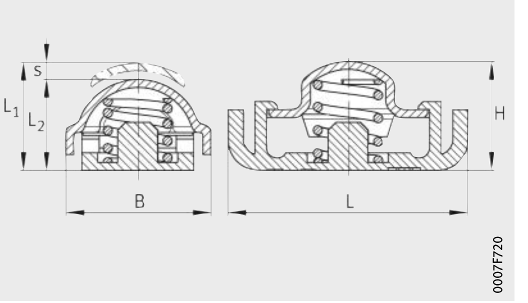
Design envelope proposal for ARRES-W, lateral view



① Application-specific gap dimension

Detents ARRES

Flat design, cap profile

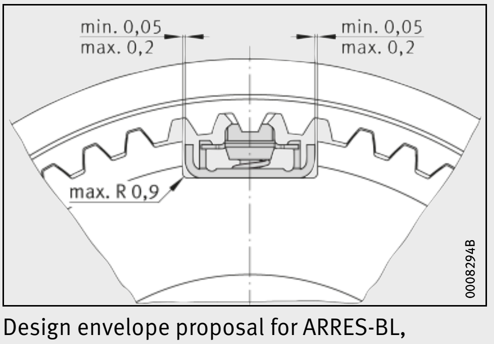


ARRES-BL

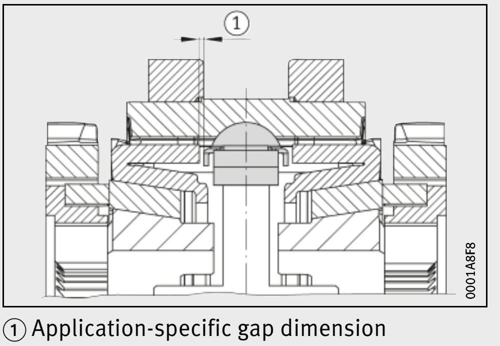
Dimension table · Dimensions in mm

Designation	Mass	Dimension						Forces				Stroke length
	m	L	H	B	R	L_1	L_2	F_1 [1]		F_2 [2]		s
								min.	max.	min.	max.	
	≈g							N	N	N	N	
ARRES-BL1	0,8	14,95	6,8	9,12	4	6,3	5,1	10	13	18	23	1,2

[1] F_1 = force at L_1, as a function of the springs used.
[2] F_2 = force at L_2, as a function of the springs used.



Design envelope proposal for ARRES-BL, lateral view



① Application-specific gap dimension

Check list for ARRES

Basic Information

Transmission name: ____________________

Transmission type: ____________________

Gears: ____________________

Engine torque: ____________________

Characteristic	Gear	/		/		/		/	
Gear ratio									
Shift force	N								
Shift time	ms								
Maximum speed	min^{-1}								
Differential speed	min^{-1}								

Background

❑ New development

❑ Cost reduction

❑ Optimization

❑ Other

Considered solution

Synchronization type:

❑ Single cone synchronization in gear: ____________________

❑ Double cone synchronization in gear: ____________________

❑ Triple cone synchronization in gear: ____________________

❑ Other system in gear:

Previous solution

Pre-synchronization:

❑ ARRES

❑ Other system

Environmental conditions

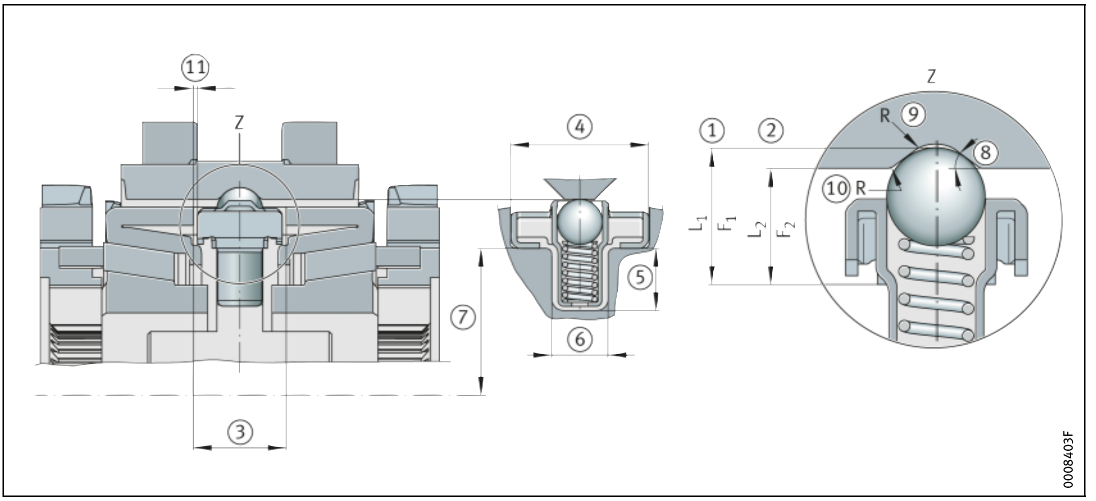
Transmission oil: ____________________

Cleanliness specification: ____________________

Working temperature: ____________________

Check list for ARRES

Dimensions and values



	Number of ARRES	______		______
①	Spring force F_1	______	N	______ N
①	Spring length L_1	______	mm	______ mm
②	Spring force F_2	______	N	______ N
②	Spring length L_2	______	mm	______ mm
③	Spacing between synchro outer rings	______	mm	______ mm
④	ARRES groove width max.	______	mm	______ mm
⑤	ARRES groove height	______	mm	______ mm
⑥	ARRES groove width min.	______	mm	______ mm
⑦	Hub support surface for ARRES height	______	mm	______ mm
⑧	Sleeve ARRES groove ramp angle	______	°	______ °
⑨	Sleeve ARRES groove radius	______	mm	______ mm
⑩	Sleeve ARRES corner edge radius	______	mm	______ mm
⑪	Clearance between outer ring and ARRES	______		______ mm
	Friction coefficient (ARRES/Sleeve)	______		______

Notes

MATNR 036815740-0000 / TPI 178 / 02 / GB-D / 201507 / pdf only

Schaeffler Technologies AG & Co. KG

Industriestraße 1 – 3
91074 Herzogenaurach
Germany
Internet www.ina.com
E-mail info.de@schaeffler.com

In Germany:
Phone 0180 5003872
Fax 0180 5003873

From other countries:
Phone +49 9132 82-0
Fax +49 9132 82-4950

TPI 178 GB-D