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1. INTRODUCTION

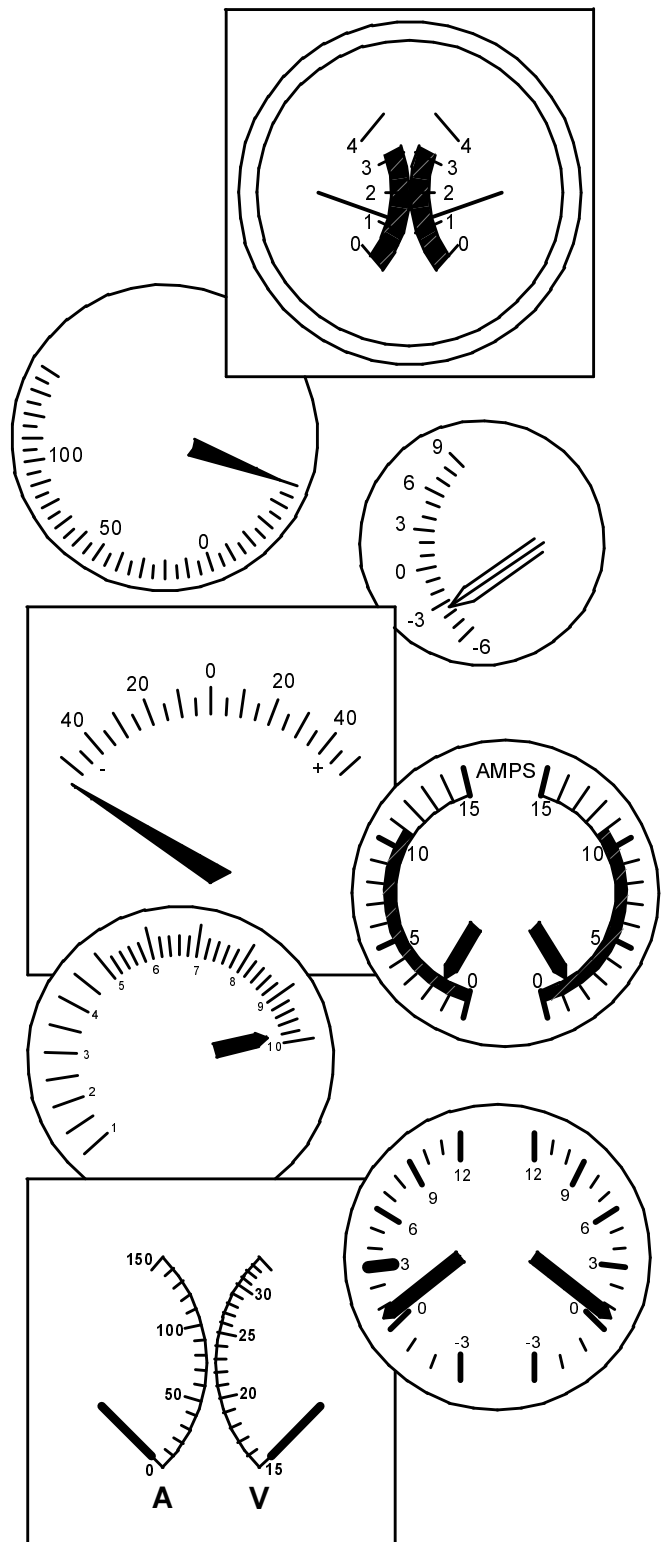
It is only possible to manufacture high-grade measurement instruments efficiently and according to given specifications, if precise components are available.

As part of its product line of movements, PREFAG also offers models for 250° moving coil instruments. They have been developed to allow the efficient manufacture of reliable movements for various applications.

Our modular system allows our meter movements to meet a wide variety of demands, i.e. high sensitivity, high accuracy class, high shock or vibration stress.

The dimensions of the KSI 150 series are especially suited for installation in the increasingly small cases found in aviation instrumentation and similar applications. The systems are especially designed for the high demands of this application so that instruments with these movements have passed the most difficult approval tests on the first approach.

It is easy to select the desired components for your meter movement by using the descriptions and dimension tables found in Chapter 10. Pivots, jewel bearings and coil formers etc. may be chosen as required by the particular application.



2. APPLICATIONS

The models of the KSI 150 series mentioned here are suited for all industrial applications, especially though for the high demands of aviation instrumentation and similar applications. Instruments with these systems have no difficulty passing tests in the following areas:

- vibrations
- shock exposure
- temperature exposure

as well as other difficult environmental conditions.

The concept of our KSI 150 series is designed to allow the efficient manufacture of components even in those numbers typical of the applications mentioned above, that is, in smaller or medium size lots. The large and modern CNC-tool-machine facilities in our production area and the long years of experience we have in this field allow us to achieve a very high degree of efficiency and the high quality standards typical of PREFAG components.

As a basis for your layout, you will find a summary of mechanical and electrical specifications for instruments in Chapter 11. These specifications can and should be used only as a basis for the calculation and design of your individual movement.

The correct selection of pivot and bearing criteria is decisive in achieving the optimal implementation of electrical measurement instruments. PREFAG has suitable calculation methods at its disposal and has gained decades of world wide, systematic experience. We would be happy to make proposals for your particular applications.

3. GENERAL CONCEPT

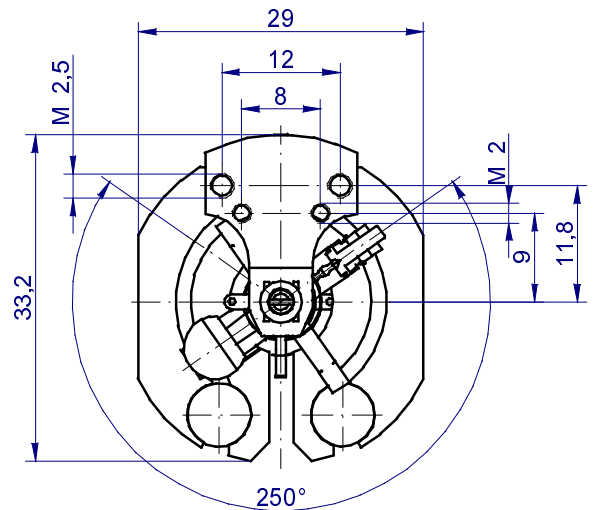
The KSI 150 series was designed to incorporate the principles of maximum standardization as well as the production potential of modern CNC controlled tool machines. As many design characteristics as possible of the other PREFAG systems were retained.

- The most important functional characteristics are as follows:
- self-centering pivot holder system
- damping to be optimized by means of different coil former material characteristics
- high sensitivity
- high precision
- A good linearity even without calibration
- play-free adjustment of the jewel bearings
- high degree of indifference to external magnetic field influence
- especially great rigidity of the movement support and of the fixing elements for respective areas of application.

Because these movements are usually used in small lot sizes, we have not developed any specific assembly equipment for the market; as for most of our customers it would not be economical to buy such equipment. We therefore suggest that you request our quotation for assembled meter movements.

4. DESIGN

Great care was taken in the development of the KSI 150 series to ensure a CNC machine adapted design for those components which could not be taken from the standard program. Nevertheless, several functions were integrated into one single component to ensure as uncomplicated a design as possible, which also increases the reliability so important in this sector. The meter movement support is milled as a CNC machine part that provides the basic frame for an axially aligned mounting of the moving element and for the best possible concentric placement of the magnet circuit. The design is, however, still flexible enough to allow the change-over to a different technology assuring efficient production as well in case of larger lot sizes.



Centering the coil former on the spindle is done by the time-tested PREFAG system for self-centering and clamped pivot holders.

Furthermore, the design principle guarantees the best possible concentricity of the pole rings and of the centre of rotation of the moving element, so that superior linearity with an accuracy deviation of at most 1.5% is ensured.

The design of the magnetic circuit guarantees effective shielding, so that external magnetic field influence is kept low.

These meter movements are nearly always used under extreme physical conditions. The position of the magnets, which are secured by a light press-fit, is therefore fixed by gluing. We use Loctite No. 493, a very liquid anaerobic glue.

5. MATERIALS

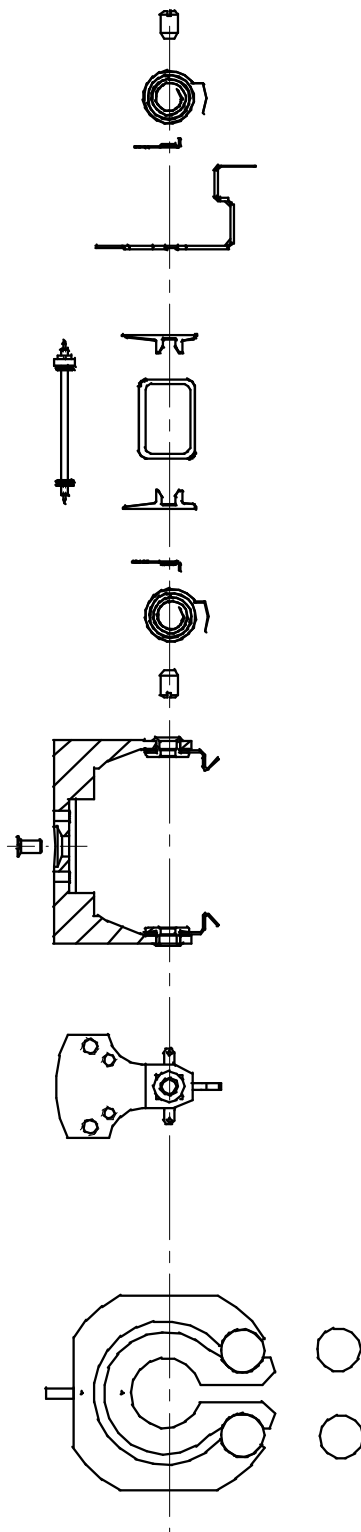
The choice of materials is based on our long years of experience in the field of components for electrical measurement instruments, including the field of aviation instrumentation.

The materials have been carefully selected for their particular uses and support the technological lead of our movements.

- Spindle: Al
- Coil Former: Al anodized
Various alloys
- Coil Former Support: Al
- Zero-Adjustors: Nickel-silver
- Pre-assembled in the movement support with plastic-bushing
- Counter-sunk screws: Brass
- Movement Support: Brass
integrated zero-adjustment
- Outside Pole-Ring: soft iron
- Inside Pole-Ring: soft iron
- Magnet: SECo
- Spring-loaded jewel screws: Brass

6. SURVEY OF MODELS

6.1 Series KSI 150

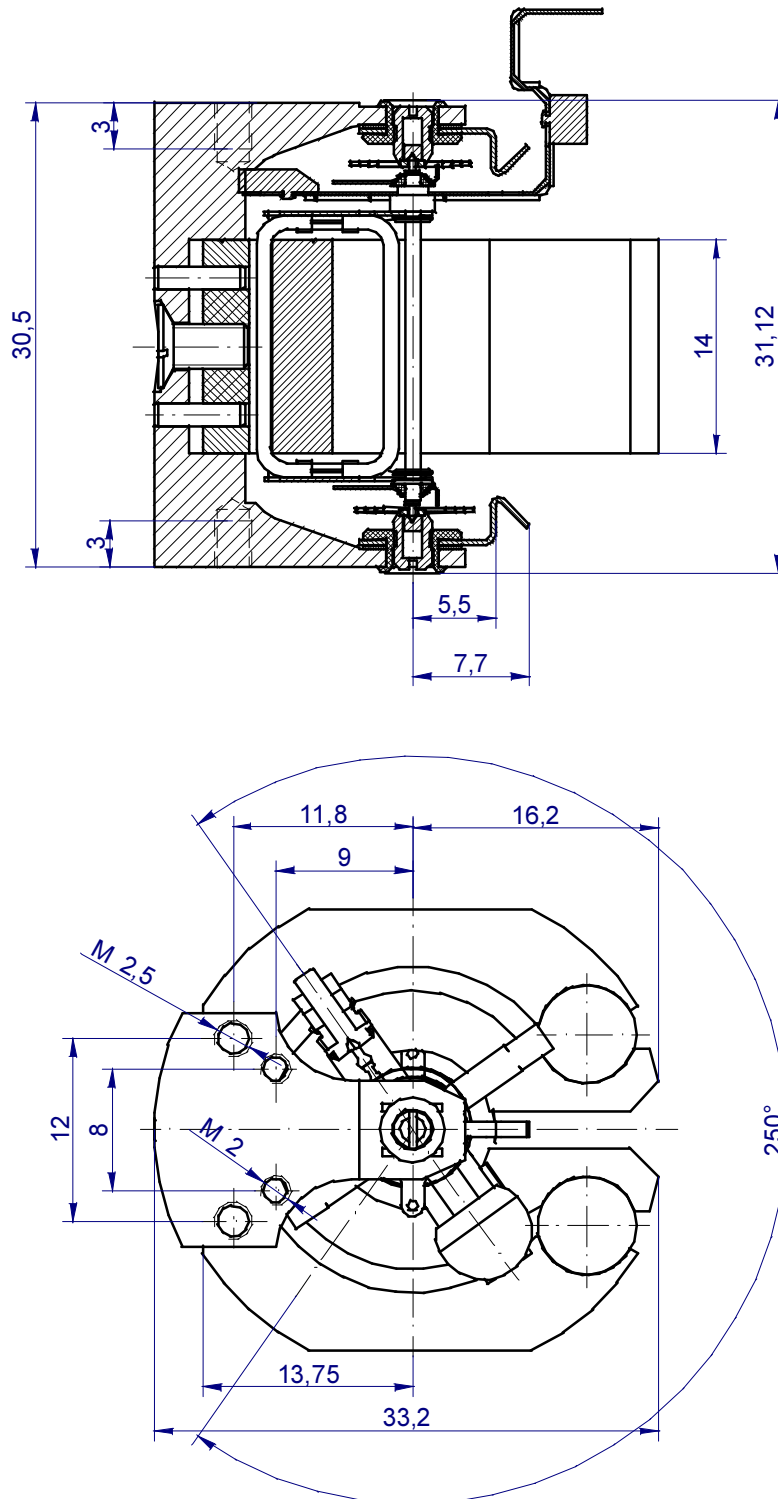


Bezeichnung designation		KSI 100/103
2	Körnerlager gefed. spring loaded jewel screw	← M 2,5 x 0,35 x 4 →
2	Spirale spring	FN 1219-1223
2	Spiralhalter, isoliert spring holder, insulated	IN 14
1	Zeigerträger pointer cross	ZTN 6122-ZTN6522 andere auf Anfrage
2	Rahmenträger Coilformer support	RTN 251
1	Rahmen coil- former	RN 221...
2	Nullstellung zero adjustment	NUN 7
1	Träger support	MTN 150
1	Schraube screw	SRN 20
1	Außenring outside pole- ring	ARN 150
1	Innenring inside pole-ring	IRN 150
2	Magnet magnet	MGN 150

KSI 150 MOVEMENT SERIES FOR 250° MOVING COIL INSTRUMENTS

7. DIMENSIONS

7.1 KSI 150



8. TECHNICAL SPECIFICATIONS

	KSI 150
Air-gap induction B_L	0,175 T
Pointer deflection, effective	250°
Linearity	1,5%
Operating temperature range *	-20°/+60°
Storage temperature range *	-30°/+80°C

* The indications of the temperature ranges only refer to a failure of components by exceeding the given temperature limits. Additional effects (for example measuring errors) are not considered.

9. DELIVERY DETAILS / SAMPLE ORDER

In order to avoid errors and mix-ups in defining particular movements and in ordering, we do ask that orders be set up according to the sample (opposite). The following components from the data sheets in Chap.10 are to be specified, corresponding to the particular instrument description:

- movement support Pos. 1
- coil former Pos. 5
- spindle Pos. 7
- jewel bearings Pos. 11

All the other components are dependent on the respective model and should be varied only after consulting our technical staff.

In addition to the above we require all relevant electrical data like sensitivity, resistance, torque etc.

You will find technical descriptions and specification pages for the individual components in Chapter 10 of this data book.

item - list for KSI 100 moving-coil-instrument 230°			
Pos.	Pcs.	Description	Part-No.
1	1	support with zero adjustment	MTM 1042
2	1	inside pole-ring	IRN 150
3	1	outside pole-ring	ARN 150
4	2	magnet	MGN 150
5	1	coil former	RN 221.34
6	2	coil former support	RTN 251
7	1	spindle	A 2014
7	1	pointer cross	ZTN 6122
8	2	spring holder insul.	IN 15
9	1	spring top	FN 1221
10	1	spring bottom	FN 1219
11	2	spring load. jewel-screw	LN 511
12	1	screw	SRN 20

**10. TECHNICAL DESCRIPTIONS AND
DATASHEETS OF THE INDIVIDUAL
COMPONENTS**

10.1 Jewel Bearings

In our KSI 150 series, we supply for both bearing positions our time-tested spring loaded jewel bearings M 2.5 x 0.35 x 4 according to the PREFAG standard.

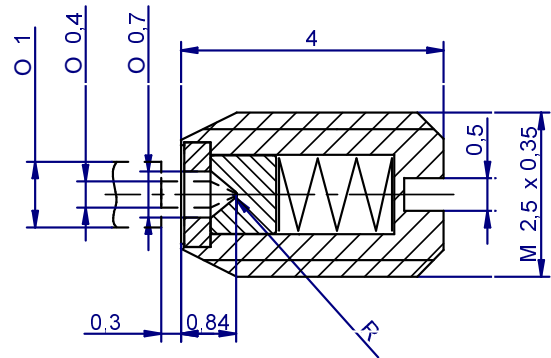
They feature the following superior characteristics:

- very high precision of jewels' return positioning
- minimal lateral play of jewels
- smooth jewel movement
- exactly maintained spring specifications
- excellent jewel bore surface
- high degree of cleanliness
- best, tested jewel quality according to PREFAG standards.

PREFAG jewel bearings are in use in the entire measurement instrument industry and related sectors. PREFAG jewel bearings have a world-wide reputation and guarantee a high degree of functional reliability.

We would be pleased to be of assistance in specifying suitable bearings and pivots in order to optimize your measuring instruments. For this, we would need the following data:

- type of instrument
- pointer deflection
- functional position of shaft (horizontal, vertical)
- pointer length and pointer weight
- desired sensitivity
- required vibration parameters



Steinmaterial jewel material		R μm	F1 cN
Keramik ceramic	Saphir sapphire		
L 50 402	LN 402	40 - 70	10
L 50 677	LN 677		15
L 50 678	LN 678		20
L 50 404	LN 404	50 - 80	10
L 50 680	LN 680		15
L 50 681	LN 681		20
L 50 405	LN 405	60 - 100	10
L 50 406 ←	LN 406		15
L 50 684	LN 684		20
L 50 407	LN 407	80 - 120	10
L 50 408 ←	LN 408		15
L 50 810	LN 810		20
L 50 409	LN 409	100 - 150	15
L 50 410	LN 410		20

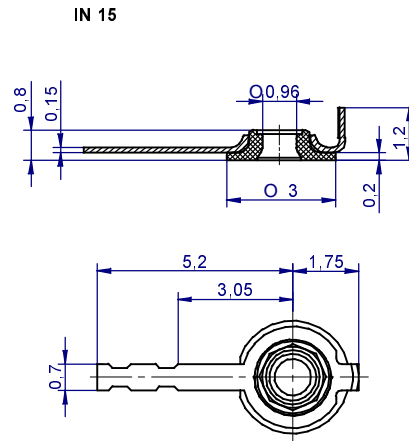
← Am häufigsten angewandte Teile
most applied parts

- required shock parameters

Please do not hesitate to consult our experienced technical staff to help you in the optimal design of your measuring instrument.

10.2 Spring Holders

Both spring holders top and bottom are insulated. The plastic parts will not suffer from the soldering temperature. The insulation value is 19.3 kV/mm.



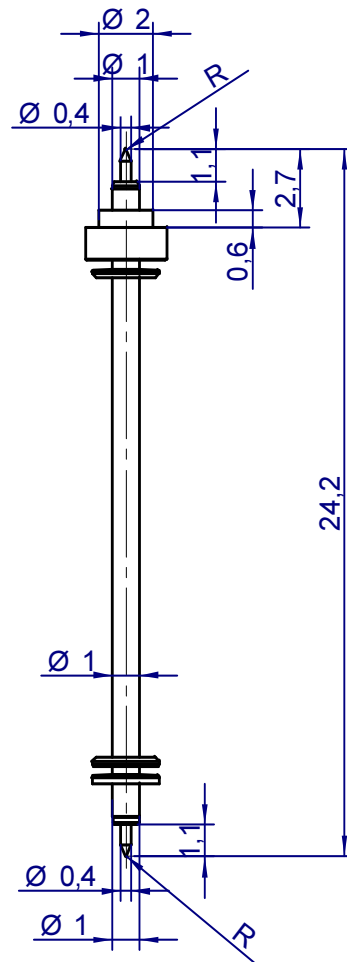
10.3 Spindles

Our spindles are available according to our PREFAG standard riveting assembly. They include our time-tested PREFAG bearing pivots. The pivot radii and the pivot material should be specified according to the table as follows for use in moving coil instruments in our KSI series.

PREFAG moving coil spindles for KSI meter movements have been designed for ease of assembly of the pointer cross, hair spring and coil former support

The spindle is to be used for rivetting assembly of the coil former support for this purpose, PREFAG has developed flexible, semi-automatic assembly devices which guarantee consistently high instrument quality.

Our spindles are manufactured according to the principle of inserted pivots. Special manufacturing processes guarantee exact straightness. All the attachment elements for the core support, spring holders and the pointer cross have been included in the lathing process.



Teile-Nr. part no.	R μm	Mat.
A 2025	9 - 11	HM
AN 1273	10 - 14	St
AN 1274	11 - 13	Inox
AN 1275	14 - 18	At
AN 1276	15 - 17	Inox
AN 1277	17 - 23	St
AN 1278	18 - 22	Inox
A 2014	18 - 22	HM ←

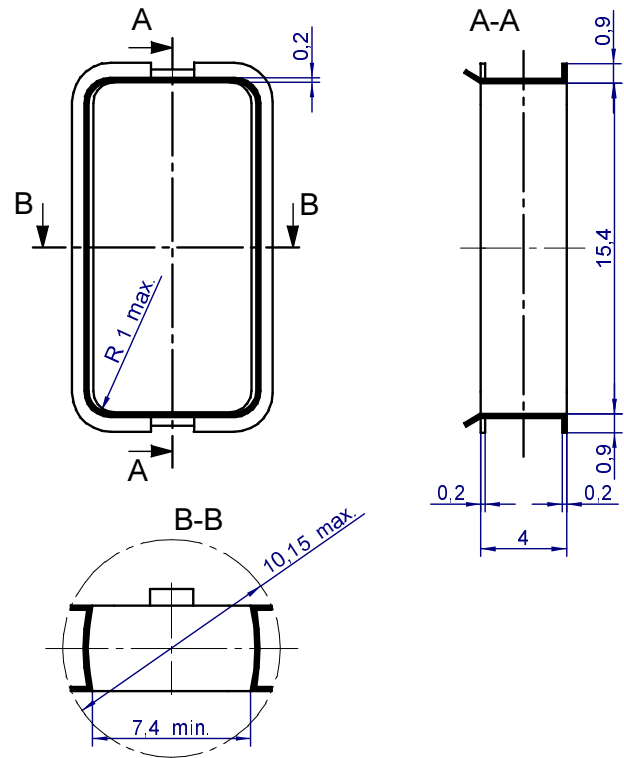
← am häufigsten angewandte Teile
most applied parts

10.4 Coil Former

Our coil formers offer you all the advantages of a carefully thought through large series production. Careful selection of materials, superior production methods and a dependable system of quality control ensure components of uniformly high quality. For the user, this means consistent instrument quality.

Our special manufacturing methods produce components of high quality exactly according to drawings

- without jagged edges and corners
- with sharp inner edges so that the entire
- winding space can be used
- with lightly rounded rims to ensure coil
- winding with unharmed insulation.



During the entire manufacturing process our coil formers are subjected to quality control.

Depending on your application, you may select your coil former from various aluminum alloys to achieve optimal damping. This usually makes a complicated and expensive reduction of damping through such measures as holes in the coil former unnecessary.

Teile-Nr. part no.	Material material	elektr.Leitfähigkeit conductivity	Farbe colour
RN 221.34	Al 34	34 S	Blau / blue
RN 221.26	Al 26	26 S	Gelb / yellow
RN 221.21	Al 21	21 S	Grün / green
RN 221.17	Al 17	17 S	Rot / red
RN 221.57 *	E-Cu	57 S	---

1 S = 1 / Ω

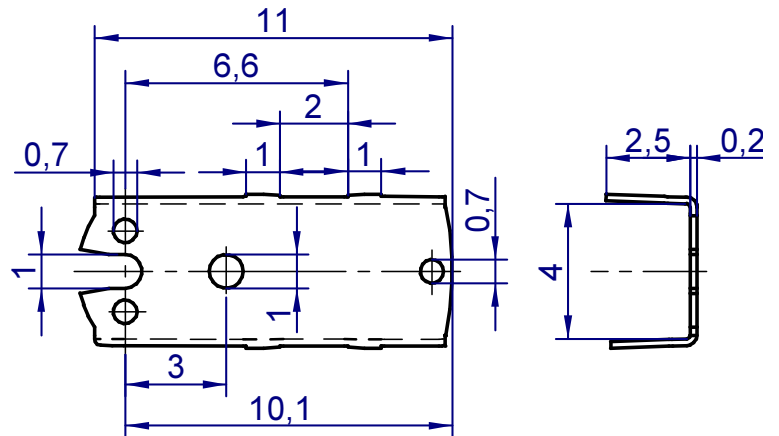
* nicht isoliert
not insulated

10.5 Coil Former Support

The coil former supports have been developed especially for the KSI 150/200 modular assembly kit series and ensure reliable and axially aligned mounting of the coil former onto the spindle.

The rivetting assembly process using our MTV 2000 assembly device and the related MTV 2056 jig guarantees absolutely rigid and torsion-free attachment of the coil former supports to the spindle.

In addition to this rivetting assembly process, the pointer cross and the spring holder can be mounted onto the spindle the very same operation.



10.6 Zero-Adjustors

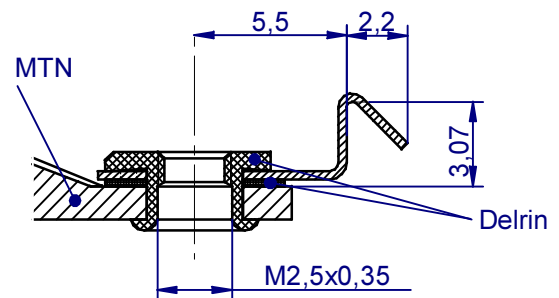
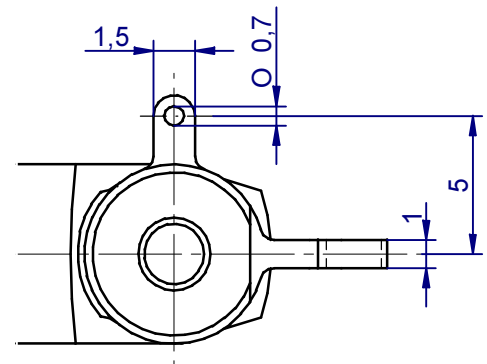
The zero-adjustors are used in the KSI 150 on both sides of the movement support.

Generally it is not possible to have a zero-adjustment from the outside on these meter movement, because it's usually in sealed housings, and therefore no provision for such an adjustment has been made.

PREFAG zero-adjustors feature a variety of outstanding characteristics:

- no backlash of threads during adjustment of pivot end play
- self-locking thread, so that no counter-nut or laquer is required
- safe fit by ultrasonic welding
- controlled torque of jewel bearing.

NUN 7



10.7 Movement Support

The movement supports include the proven PREFAG zero-adjustors.

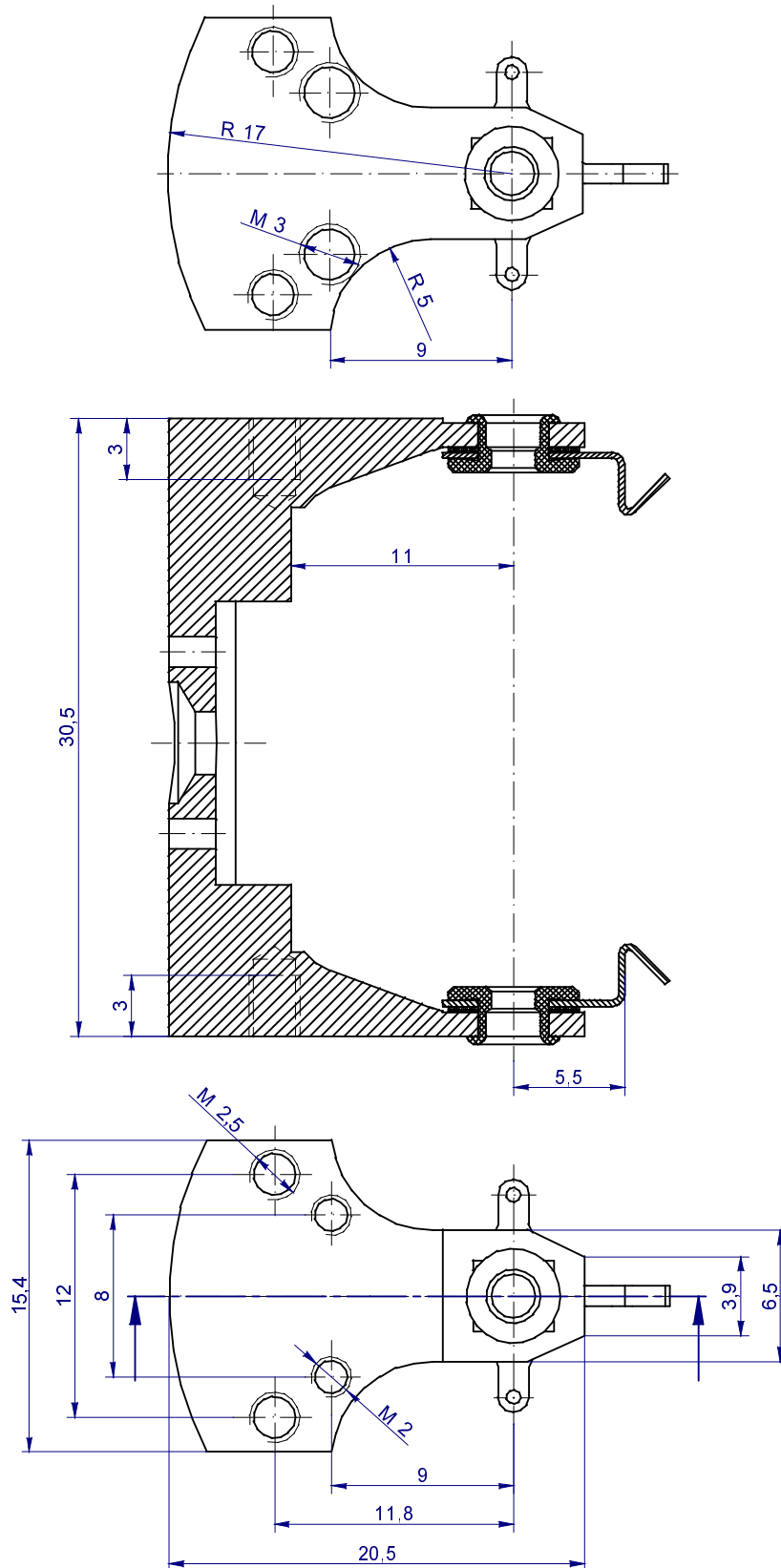
To ensure the necessary accuracy, these precision parts are manufactured completely on corresponding CNC controlled machines.

A sure and aligned fit of the mounted zero-adjustments is obtained by ultrasonic welding done by automated equipment.

Our movement supports are corrosion-resistant and mechanically stable even under extreme environmental influences such as temperature, humidity and so on.

10.7 Movement support

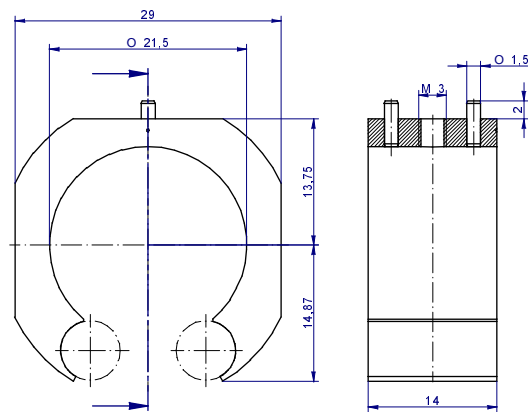
MTN 150 + NUN 7



10.8 Outside Pole-Ring

The outside pole-rings of the magnetic circuit are manufactured of soft iron in a lathing process on suitable CNC tool machines.

Carefully controlled steps during the manufacturing process tools result in series parts with exceedingly narrow tolerances.



10.9 Inside Pole-Ring

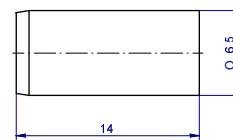
The inside pole-rings of the magnetic circuit are manufactured of soft iron in a lathing process on suitable CNC tool machines.

Carefully controlled steps during the manufacturing process tools result in series parts with exceedingly narrow tolerances.

10.10 Magnet

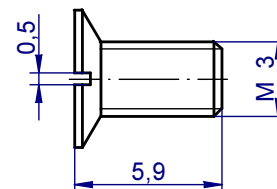
In order to obtain high sensitivity, we have chosen magnets made of samarium cobalt. The calibration for samarium cobalt magnets must be done however by adapting the electrical circuit accordingly.

In the movement KSI 150 the magnets MGN 150 are used.



10.11 Screws

The movement support is screwed to the magnetic circuit with a counter sunk screw. Two drift pins in the outer pole ring ensure rigidity and exact positioning. This guarantees that the moving element can move centrally in the magnetic circuit. This screw is additionally secured with Loctite 493.



10.12 Pointer Cross

for KSI 150

250° deflection angle

- Tin balance-
- Reinforced -

General Description

In the production Programm for pointer crosses PREFAG also offers a pointer cross for the case KSI 150 series.

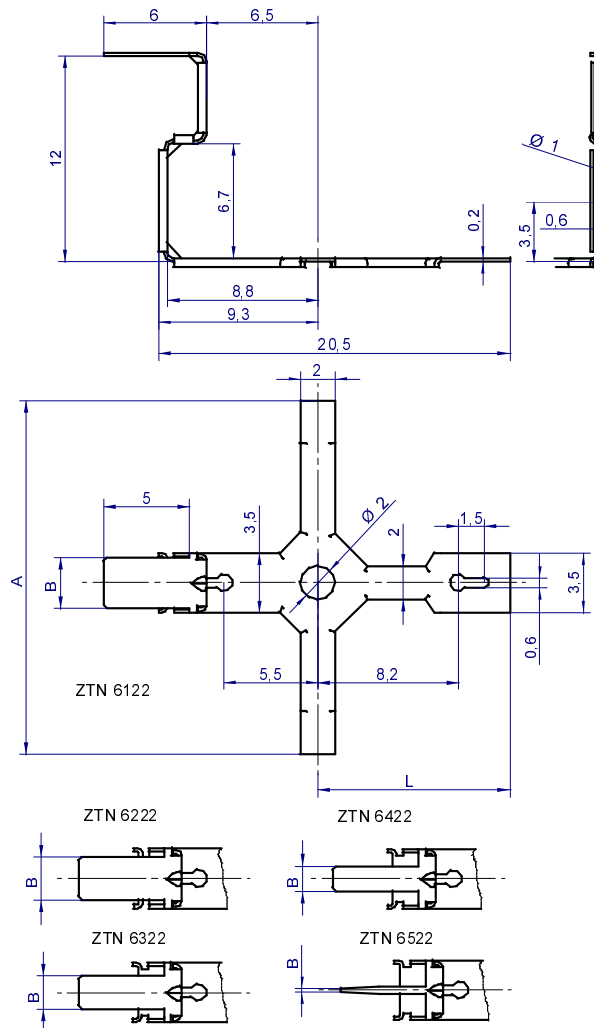
On ist critical points the pointer cross is reinforced by cramping, resulting in a higher mechanical stability.

For a more flexible assembly of the movements there are on 3 positions key hole openings for balance weight to be hooked in. This way it is possible to attach the balance weights on the finished movements, when the corresponding pointer is known.

The weights are in different sizes available. For the final fixing of the balance weights we recommend solder or adhesive.

These pointer crosses are available for DIN resp. shaft pointers as well as tupe pointers. The standard height is 12 mm. The manufacturing tool has been designed to allow certain flexibility in respect to height and pointer adapter configuration incurring only relatively low tooling cost.

Due to the mechanical stability we picked nickel silver as material for this pointer cross. The good solderability of this material helps the fine balancing which is still required.



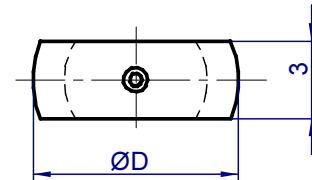
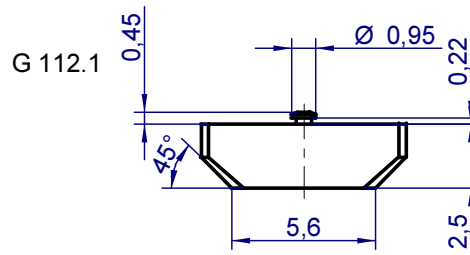
Teile-Nr. / part-no.	Meßwerk/ movement	Maße / dimensions		
		A mm	L mm	B mm
ZTN 6122	KSI 264, KSI 266, KSI 150	20	11,2	3
ZTN 6222				2,5
ZTN 6322				2
ZTN 6422				1,5
ZTN 6522				0,4

**10.13 Balance weight
for pointer crosses ZTN 6122 - 6522**

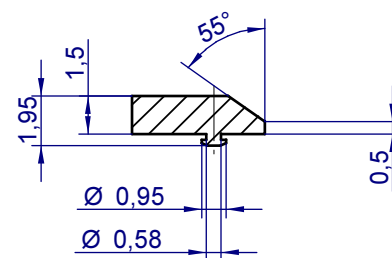
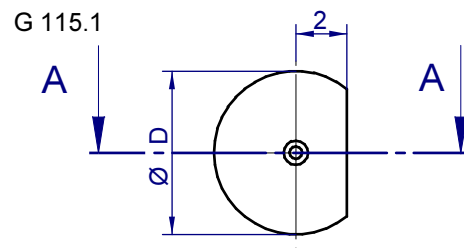
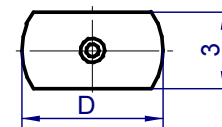
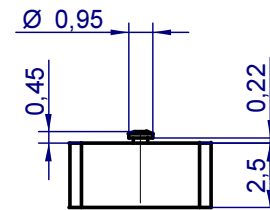
General description

In parallel to the pointer cross production program PREFAG offers for the pointer cross ZTN 6122 - 6522) hook-in balance weights to be assembled to the finished movements.

For rationalisation in balancing of the moving element there are on this new pointer cross on three positions key hole receivers for hook-in balance weights for the pre-balancing of the system. The assembly of these weights is fairly simple. They are hooked into the pointer cross with a little fixing button and fixed with solder or adhesive. They are in various sizes (weights) available. For further details please see chapter 10.12 for pointer crosses. The material for these weights is iron-free brass. For other executions please feel free to ask.

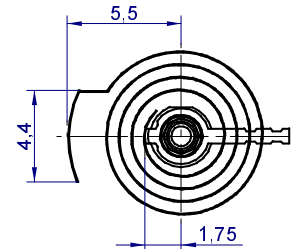
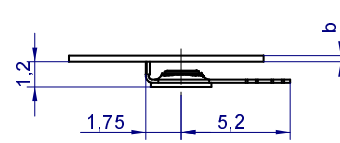


G113.



Teile-Nr. / part-no.	Maß D / dimensions D mm	Gewicht / weight mg
G 112.1	8	456
G 112.2	6,9	411
G 112.3	6,1	368
G 113.1	5,5	330
G 113.2	4,8	283
G 113.3	4,2	242
G 113.4	3,6	198
G 113.5	3,2	167
G 113.6	2,8	131
G113.7	2,4	97
G 115.1	6,4	321
G 115.2	6	288
G 115.3	5,4	242
G 115.4	4,8	199
G 115.5	4,3	165
G 115.6	3,8	113
G 115.7	3,2	97

**10.14 Spring weldet
with spring holder**



Spiralen geschweißt mit IN 15 spring welded with IN 15	Spirale spring	Drehmoment torque $\mu\text{Ncm} / 90^\circ$	Widerstand resistance Ohm +/- 20 %	Spiralbreite b mm +/- 10 %	Drehmoment-Abstufungen torque combinations		
					gesamt total	oben top	unten bottom
FNM 6915	FN 1416	60	2,10	0,24	120	60	60
FNM 6515	FN 1461	70	1,90	0,27	140	70	70
FNM 6615	FN 1462	80	1,80	0,26	160	80	80
FNM 7015	FN 1219	100	1,50	0,28	180	100	80
					200	100	100
FNM 6715	FN 1463	125	1,40	0,30	185	125	60
					195	125	70
					205	125	80
					225	125	100
FNM 7115	FN 1220	160	1,20	0,31	250	125	125
					220	160	60
					240	160	80
					260	160	100
FNM 6815	FN 1464	200	1,15	0,33	320	160	160
					280	200	80
					300	200	100
					325	200	125
					360	200	160
FNM 7215	FN 1221	250	0,97	0,34	400	200	200
					350	250	100
					375	250	125
					410	250	160
					450	250	200
FNM 7315	FN 1222	400	0,86	0,41	500	250	250
					525	400	125
					560	400	160
					600	400	200
					650	400	250
FNM 7415	FN 1223	630	0,75	0,48	800	400	400
					880	630	250
					1030	630	400
					1260	630	630

10.15 Pointers

After verification of the corresponding specification movements equipped with pointers also painted to aviation standards and tin balanced can be supplied.

In order to maintain a higher flexibility and to simplify handling we prefer to procure these components ourselves.

10.16 Balancing

For industrial as well as aviation instruments tin balancing of movements has become standard procedure in Europe. Therefore also the movements of the KSI 150 series are designed for tin balancing.

Balancing with corresponding riveting weights is performed where required.

In case other methods of balancing are requested resp. required, detailed verification is necessary.

10.17 Scales

In various cases movements with pointers and balanced are requested, however due to the design of the system, the pointer only can be fixed after the assembly of the scale. PREFAG therefore has meanwhile established together with selected capable partners the possibility to provide for the aviation industrie corresponding movements completely assembled with scales. Detailed verification of the specification is required prior to preparing the quotation.

10.18 Calibration

In order to obtain a powerful movement requiring the smallest possible space (for 1 inch round cases), the movements of the KSI 150 series use samarium cobalt magnets. Under normal conditions these movements can therefore not be calibrated magnetically.

It is therefore recommended to prepare for a calibration possibility in the electrical circuit by a potentiometer.

In case this is not possible, PREFAG offers a calibration system through weakening the magnetic circuit by adding a magnetical shunt.

11. GUIDELINES FOR THE ELECTRICAL AND MECHANICAL DESIGN

It has been proven useful to have a set of various standard versions for the layout of the movement which serve as guidelines for the individual design of the customers measurement instruments. For this reason the following data sheets have been set up for the PREFAG KSI 150 series. All the technical data that could interest the engineer is shown. Using these data, it is easier to design a particular instrument by extrapolation.

Our technical staff is always available to assist you in selecting and combining components for your movement.

11.1 KSI 150 /250°

11.1.1 Coil Data

		KSI 150 Ampermeter		
Measurement range*	mA	0,5	1	2,5
Sensitivity	KOhm/Volt	2	1	0,4
Number of windings		1.170	780	312
Cu- wire nominal diameter	mm	0,036	0,04	0,071
Resistance Ri(20°)	Ohm	988	535	70
Torque	µNcm/90°	600	800	800

For the layout of your particular application, you will find below the formula typical for the meter movements KSI 100 and KSI 103.

$$M(90^\circ) = \frac{B_L \times I \times N \times 1,5102}{\text{Angle of deflection of movement}}$$

(Torque)

For the induction in the air gap B_L we recommend that you assume a value of $B_L = 175 \text{ mT}$ / for the type KSI 150, for our magnets made of samarium cobalt.

* Designed for 90% of the current of the upper end scale value.
Calibration through electrical circuitry or magnetic shunting.

**11.1.2 Maximum number of windings for KSI 150
Coil former RN 221**

Average winding length 35.18 mm

Cu wire (mm)		Max. number of windings	Resistance of max. windings (Ohm calculated 20°C)
nominal Ø without insulation mm	nominal Ø with insulation * mm		
0,020	0,023	4690	12921
0,025	0,029	2980	5254
0,030	0,036	1900	2326
0,032	0,038	1690	1819
0,036	0,043	1330	1131
0,040	0,047	1060	730
0,045	0,053	870	473
0,050	0,059	670	295
0,056	0,066	540	190
0,060	0,070	510	156
0,063	0,073	440	122
0,071	0,082	340	74,3
0,080	0,093	260	44,8
0,090	0,104	200	27,2
0,100	0,115	180	19,84
0,106	0,121	145	14,22
0,112	0,128	140	12,30
0,118	0,135	130	10,29
0,125	0,142	100	7,05
0,132	0,150	98	6,20

* Average values as per DIN / IEC 317

12. Technical Changes

This documentation and the products described in it are subject to change without notice.

Design studies, based on samples of PREFAG movement kits or PREFAG data sheets and drawings, should not be released for production, unless the customer has thoroughly checked by himself that he is using the latest up-dated versions of PREFAG documentation and components.

Please see the cover sheet for the date of issue of this documentation.

13. Patent Rights

Our components are protected either by patents or patents pending. We kindly request that of none of our products drawings shall be passed on to third parties, even in altered form.

14. Guarantee / Capability Tests

PREFAG offers years of experience regarding the mechanical and electrical lay-out of the movements thus making the use of these movements possible under various environmental conditions. Suitable case design as well as the fitting of the movement in the case are also decisive factors ensuring that the instrument can fulfill its requirements.

The customer is therefore responsible for the type testing (capability tests) concerning the respective application. PREFAG only guarantees to deliver according to the agreed upon execution with the guarantee being limited to the value of the goods supplied.

The proposals of applications made by PREFAG are only examples.

They do not in any case represent a guarantee of characteristics according to the legislation.

15. PROGRAMME SURVEY

Meter Movements

Type of Movement	Angle range effective	Assembly kit series (Documentation)	Assembly kit
Moving iron movement	90°	DRI 400	DRI 407/402
Moving coil movement	250°	KSI 150	KSI 150 ¹⁾
Moving coil movement	240°	KSI 200	KSI 264-266
Moving coil movement	230°	KSI 100	KSI 100
Moving coil movement	170°	KSI 100	KSI 101
Moving coil movement	2x 170°	KSI 100	KSI 101 double
Moving coil movement	240°	KSI 100	KSI 103
Moving coil movement	240°	KSI 400	KSI 420/422
Moving coil movement	90°	KM 001 - 008	KM 001 to 008
Moving coil movement	90°	KM 400	KM 407/404/402
Moving coil movement	60°	SWI 60	SWI 60

¹⁾ = under preparation