PROCUREMENT SPECIFICATION OF HIGH PRECISION R4 SIZE BALL BEARINGS

Contents

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1. Type

Angular contact, inner ring separable, flanged ball bearing with non-ball retaining cages

2. Application

Bearings shall be suitable for stable operation at 6000 rpm (inner race revolving) under an axial preload of 11.12 ± 2.22 N (2.5 lbf ± 0.5 lbf) in back to back (DB) mounting. Operating temperature is +5°C to +70°C and is under vacuum of 3 torr. They are to be compatible for high grade gyroscopes for long life application (more than 15 years) without degradation in performance.

3. Dimensions

Bore diameter	:	6.35 mm (0.250 inch)
Outer diameter	:	15.875 mm (0.625 inch)
Flange diameter	:	17.526 mm (0.690 inch)
Total width	:	4.978 mm (0.196 inch)
Ball complement	:	2.381 mm (3/32 inch) dia ; 8 Nos.
Flange width	:	1.067 mm (0.0420 inch)

4. Engineering Data

Static radial load rating	:	191 N (43 lbf) min.
Static thrust load rating	:	307 N (69 lbf) min.
Basic dynamic capacity	:	667 N (150 lbf) min.

5. Material

a. Rings and balls

AISI 440C steel, Consumable Electrode Vacuum Melt (CEVM/VAR)

b. Cage

Very fine Cotton fabric based phenolic; VonRoll make, CANEVASIT VRI BAT T or similar (Typical properties of cage material in Annexure I)

6. Hardness

Rings : 60 ± 2 HRC

Balls : 62 ± 2 HRC

7. Passivation

The surfaces of bearing steels shall be passivated after final machining.

8. Tolerances

The ring tolerance shall confirm to ABEC-7P or better (ANSI/ABMA 12.1:1992)

The ball tolerance shall confirm to Grade 3 ABMA Standard (ANSI/ABMA/ISO 3290-1:2014)

Race surface finish:

Raceway (Outer and inner)	:	<0.025 microns (gyro grade)
Outer race cage riding land	:	<0.1 microns
General surface finish for ground surfaces	:	< 0.2 microns
Radial run out	:	Radial run out of the assembled bearing under 11.12 N (2.5 lbf) axial load shall be within 1.27 microns (50 microinches)

Cage dimensions and tolerances as per attached drawing (Annexure 1)

9. Contact angle

22 +/-2 deg. at 11.12 N (2.5 lbf) preload

10. Lubrication

Lubricant: Krytox 143 AC Fluorinated Oil

Process: By vacuum impregnation of the cage with Krytox 143AC Fluorinated oil.

Lubrication of bearings shall be carried out in a Class 100 environment to prevent

particulate contamination.

11. Visual Inspection of bearings

The cleanliness of the bearing rings and balls shall be such that when visually examined under optical microscopes (x30 magnification) immediately after cleaning, all surfaces shall have no detectable:

- Variation in coloration or reflectivity, with absence of any drying stain left behind from the last solvent rinse
- Defects like pits, dents, grinding Brinell marks, scratches, burrs, foreign particles, poorly bonded particles etc.
- Dust, fibers, particulates, etc. on , or embedded within the surface
- Spots or localized dull areas resulting from grinding particles
- Fingerprints and corrosion

Selection of bearing rings based on inspection shall subject to the following criteria given in the table 10-1

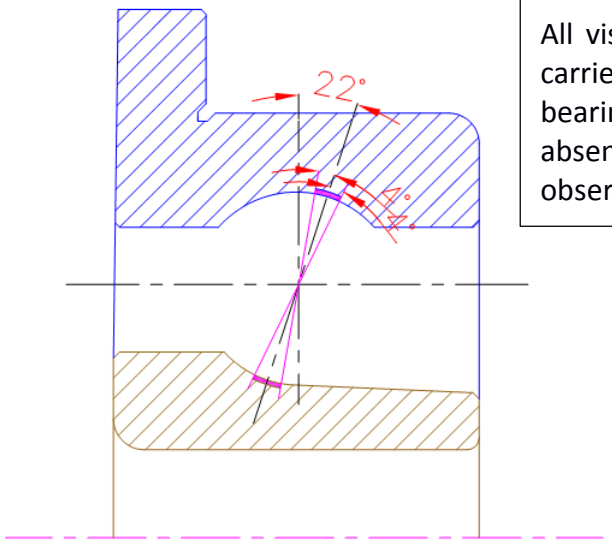
Defect	Contact (critical*) area of raceway	Non-contact area of the raceway and other surfaces	Remarks
Magnification	30 x	30 x	
Pits and inclusions	Nil	0.020 mm	Not more than one defect
Raised portion	Nil	None	
Transverse or circumferential scratches	Nil	0.010 mm wide	
Flats, ball dents, brinnell marks	Nil	Nil	
Burns	Nil	Nil	

Table 10-1 Bearing races acceptance criteria

Note: *Critical area of bearing raceway

Outer race: $22^0 \pm 4^0$ (as shown in figure 10-1)

Inner race: $22^0 \pm 4^0$ (as shown in figure 10-1)



Note
All visual inspection has to be carried out prior to final bearing assembly to ensure the absence of any of the observation mentioned above.

Figure 10-1 Bearing race critical area for inspection

Defect	Remarks
Pits, inclusions, flats, dents, scant finish	None allowed
Scratches	None allowed
Stains (Major dimensions not to exceed)	0.005
Rust marks	None allowed
Raised material	None allowed
Cracks and seams	None allowed

Table 10-2 Bearing balls acceptance criteria

12.Bearing Raceway Wettability

Bearing rings are to be checked for wettability. It should be ensured that the rings are 100% wettable by maintaining proper chemical cleanliness.

13. Torque measurement

a. Low speed torque

Bearing configuration: Single bearing with 4 N axial load

Speed: 2 to 5 rpm, CW and CCW

Duration: For minimum 2 complete revolutions

Sample volume: 5% of total quantity selected at random

14. Marking of bearings

Each bearing races shall bear the individual bearing number on the outer surfaces of both inner and outer rings on the thrust faces so that inner and outer ring of an assembly shall be identifiable from the marking.

Vibro-etch marking shall be strictly avoided.

Note
There shall be no raised portions on the butting faces after the marking. This has to be verified.

Figure 12-1 Marking on thrust faces

15. Handling, Packaging and Transportation

15.1. After final machining, appropriate handling and tooling shall be used to avoid scratching and abrasion, or continued contamination, of the bearing surfaces.

15.2. During the time lag between cleaning and packaging, exposure of the clean metal surfaces to ambient air must be minimized, wherever possible the components shall be stored at less than 50% RH or protected by desiccant in sealed, temporary packaging.

15.3. Bearings must only be exposed to controlled temperature and humidity environments to prevent contamination and other deviation.

15.4. The bearings shall be adequately cleaned and dried before lubrication and final packaging

15.5. Packaging shall be carried out in clean room conditions, minimum class 100 (for the lubricated bearings)

15.6. Each bearing shall be individually packed in sealed envelope with excess lubricant (Krytox 143 AC). Package shall be suitable for long term storage.

15.7. Packaged bearings must be securely boxed, and suitably restrained to prevent vibration of assembled components in transit, which could lead to “False Brinelling” at raceway contacts.

16. Documentation

16.1. Maximum and minimum values of the following parameters shall be recorded and supplied to the nearest value indicated for 10 bearings per assembly batch:

		(to the nearest)
a. Bearing O.D	:	0.0005mm
b. Bearing bore	:	0.0005mm
c. Contact angle under preload	:	0.5^0

16.2. On minimum 5 numbers of inner rings and outer rings randomly picked up from the lot, following parameters are to be measured and documented:

I. Raceway surface finish (Ra & Rz)

II. Hardness (RC)

The bearing components for which the above measurements are carried out shall be packed and labeled separately

16.3. Torque plots for low speed torque test as per the specification described in section 13

16.4. Batch reference and typical properties of lubricant and cage material

16.5. Material Conformity Certificates*

a. Bearing Races

Certificate of conformity from the steel manufacturer with lot reference number shall be provided. Material test certificate including the material description, chemical analysis, microcleanliness, hardness, decarburization, macroetch, grain size, microstructure, heat treat response, carbide size and frequency severity heat avg. shall be provided.

b. Bearing Balls

Certificate of conformity from the steel manufacturer with lot reference number shall be provided. Material test certificate including the material description, chemical analysis, microcleanliness, hardness, decarburization, macroetch,

grain size, microstructure, heat treat response, carbide size and frequency severity heat avg. shall be provided.

c. Lubricating Oil

Certificate of conformity from the manufacturer with lot reference number shall be provided.

d. Cage material

Certificate of conformity from the cage material manufacturer shall be provided.

16.6. Bearing ball conformity certificate[#]

Certificate or conformity of the bearing balls to Grade 3 (ANSI/ABMA/ISO 3290-1:2014) from the ball manufacturer

16.7. Bearing conformity certificate

The party/ manufacturer shall provide Certificate of conformance to the specification for the bearings.

[*] Copy of the conformity / test certificate received by the party from the respective material manufacturer is sufficient

[#] Copy of the conformity certificate received by the party from the ball manufacturer is sufficient

17. Other conditions

a. Party shall submit their drawing with detailed dimensioning of the bearings and the cage with the offer.
b. Party shall submit a detailed compliance sheet for all the requirements
c. If the party doesn't comply with any of the requirement and has their own alternate method/solution, they may clearly specify that in the compliance sheet.
d. **Terms of Warranty** –The item is a consumable. Functional defects, if any, will be informed to the party after receipt of the item and the same has to be rectified/ replaced by the party. Once the items and documents are received at IISU and are found to be devoid of any functional defects, the warranty shall deemed to be fulfilled.
e. The party shall have a supply history of similar Gyro grade bearings to any government organisation for at least 10 years. Proof of the same shall be submitted with the offer
f. The party shall submit documentary evidence of at least 10 years of operational life for similar bearings in any space gyro application

Annexure I

Cages for R4 size Precision Angular Contact Ball Bearing

Typical Properties of material

- Phenolic resin with a reinforcement of cotton batist fabric.
- Cotton fabric shall be of very fine weave (min 45 X 45 fibres/cm^2) suitable for machining of finest details.
- Density : 1.25 – 1.35 gm/cm^3.
- Water absorption 24h ,23 deg C : 3.5 mg/cm^2 max
- Linear coefficient of thermal expansion : 20 X 10^{-6} /K.
- Modulus of elasticity : 7.0 MPa min.
- Compressive strength, axial : 190 MPa min.
- Compressive strength, radial : 250 MPa min.
- Cohesion between layers : 160 MPa min.
- Flexural strength : 130 MPa min.
- Thermal conductivity : 0.2 W/m.K min.
- Material shall be free from voids, cracks and inclusions.
- Material Grade: Canevasite, VRI-BAT Make: VonRoll, Germany or equivalent

Inspection and documentation

All the cages are to be visually inspected at 25x magnification for any projecting lint or unwanted cuts. Cages with any of the above defects shall not be included in the delivery.

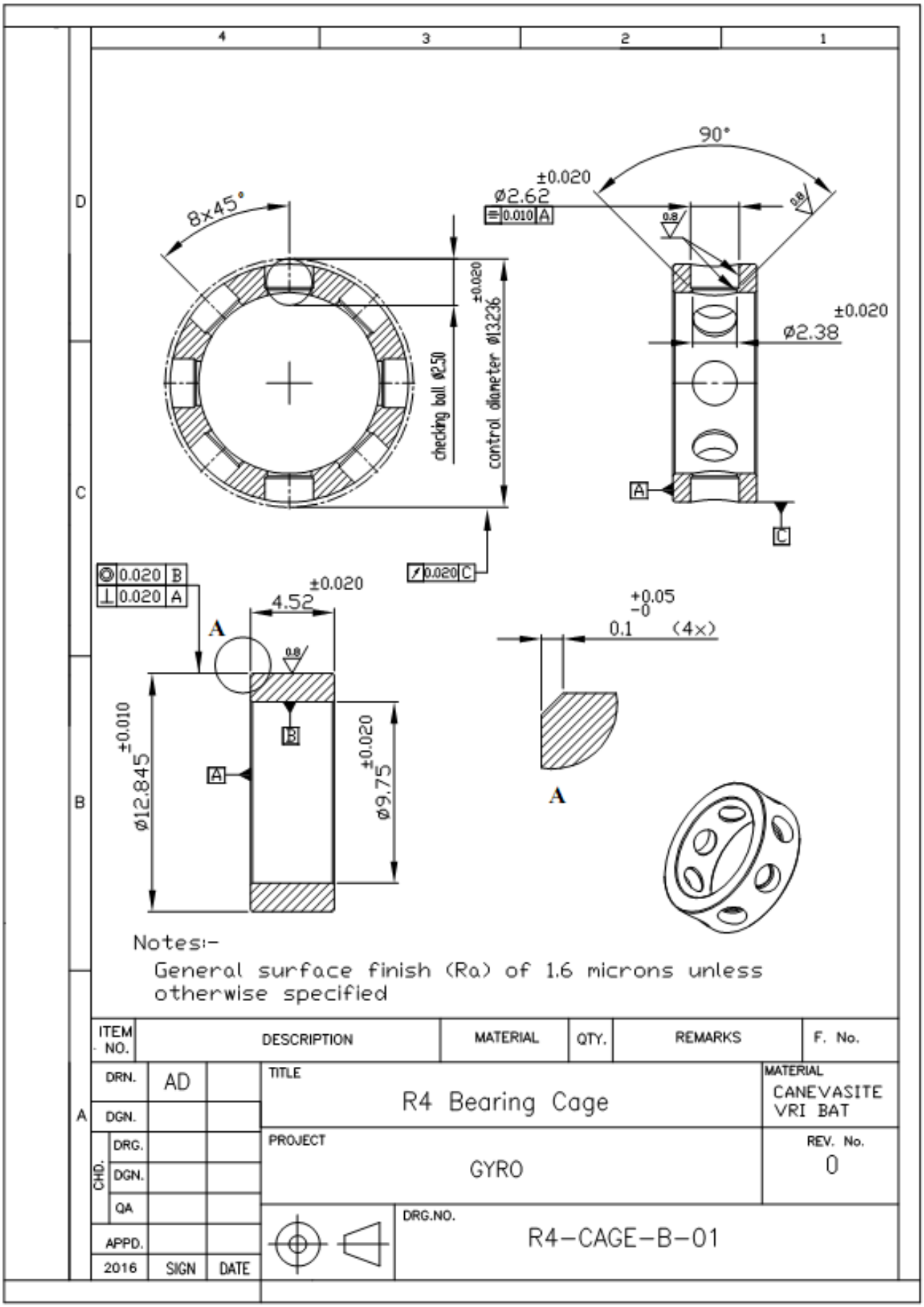
The following inspection shall be carried out on 5 % of the order quantity and corresponding documentation shall be supplied with the order. If any of the cages during inspection is found out of tolerance specification, the entire lot shall be subjected to inspection and the cages which are not meeting the tolerance shall be removed from the supply.

1. OD (Outer diameter)
2. Outer diameter radial run-out
3. Pocket diameter
4. Pocket depth / pocket control dimension
5. Dry weight

(Item number 1 and 2 shall be measured to the nearest 1 micron and item number 5 shall be measured to the nearest 1 milligram)

Other conditions

1. The machining of cages shall be dry machining and shall not include any coolant fluids.
2. Material conformity certificate from the material supplier shall be provided with the item.



Notes:-

General surface finish (Ra) of 1.6 microns unless otherwise specified

ITEM NO.	DESCRIPTION	MATERIAL	QTY.	REMARKS	F. No.

DRN.	AD		TITLE: R4 Bearing Cage	MATERIAL: CANEVASITE VRI BAT
DGN.				
CHD. DRG.			PROJECT: GYRO	REV. No.: 0
CHD. DGN.				
CHD. QA				
APPD.			DRG.NO.: R4-CAGE-B-01	
2016	SIGN	DATE		