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Title	Studio preliminare sulla resistenza strutturale del Gregorian Feed Rotator di SRT
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Studio preliminare sulla resistenza strutturale del Gregorian Feed Rotator di SRT

Appendice

Alessandro Attoli, Pasqualino Marongiu
INAF - Osservatorio Astronomico di Cagliari

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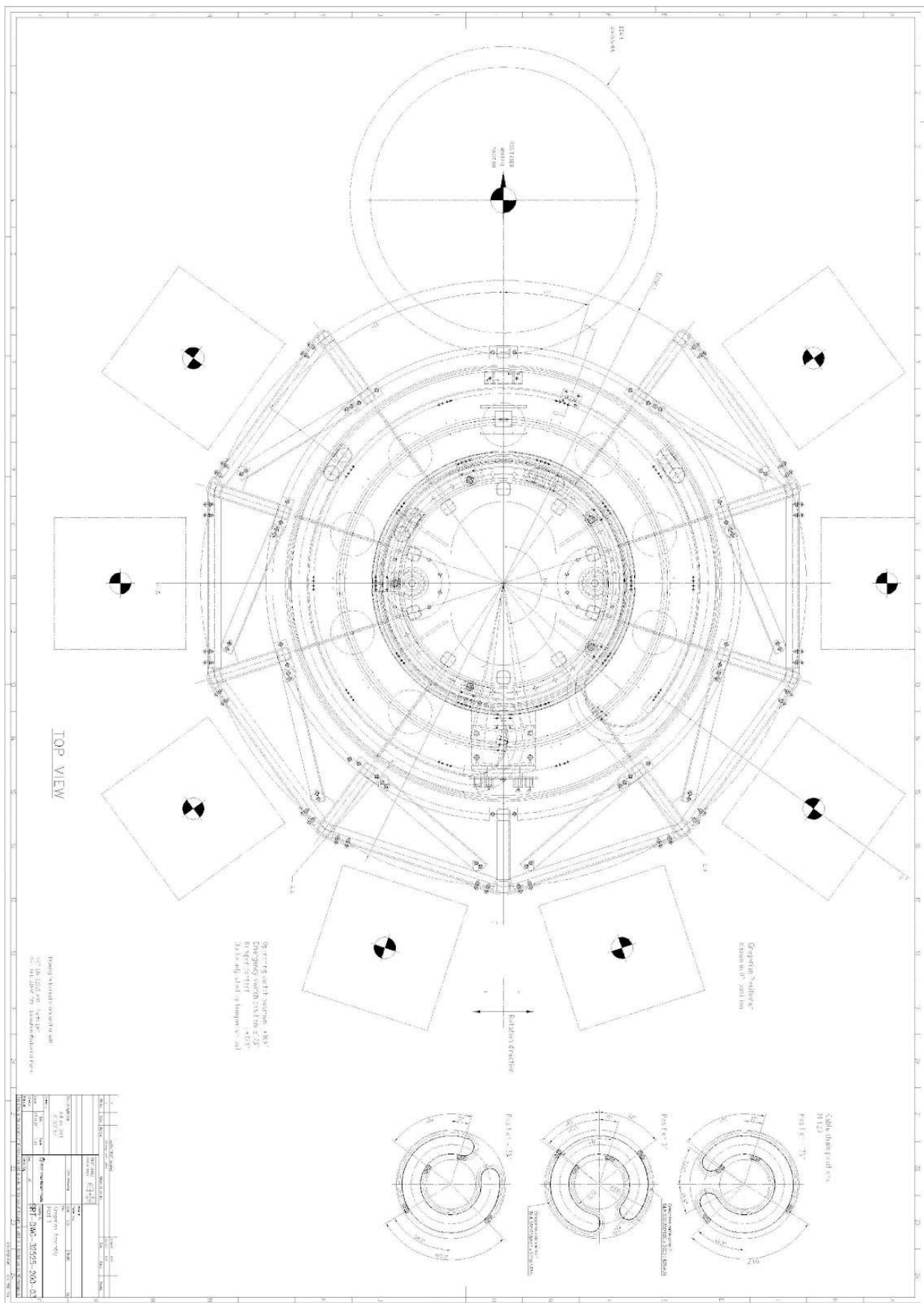
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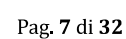
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9. Documento SRT-ANA-32525-003-01 Gregorian Positioner Bearing Analysis

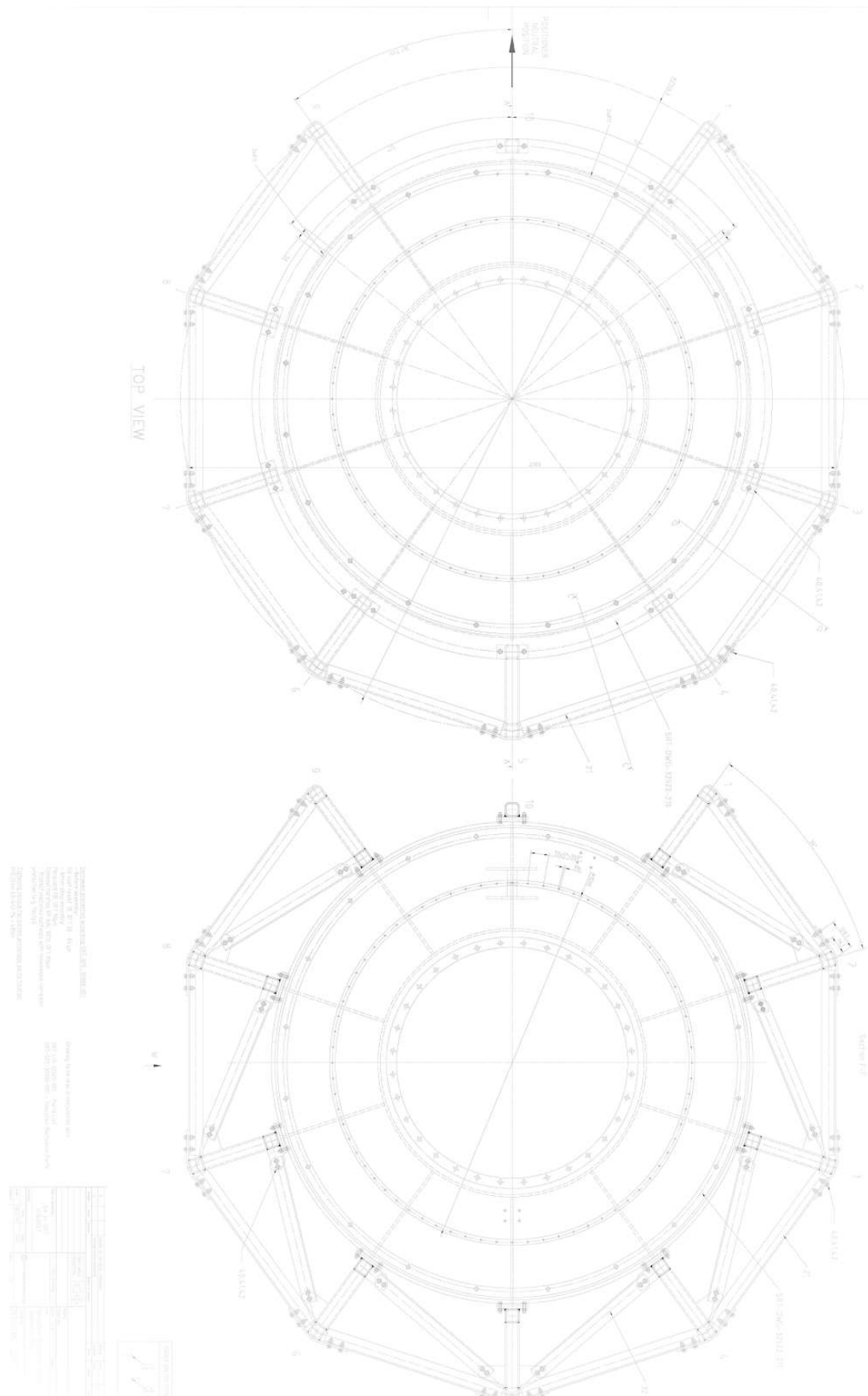
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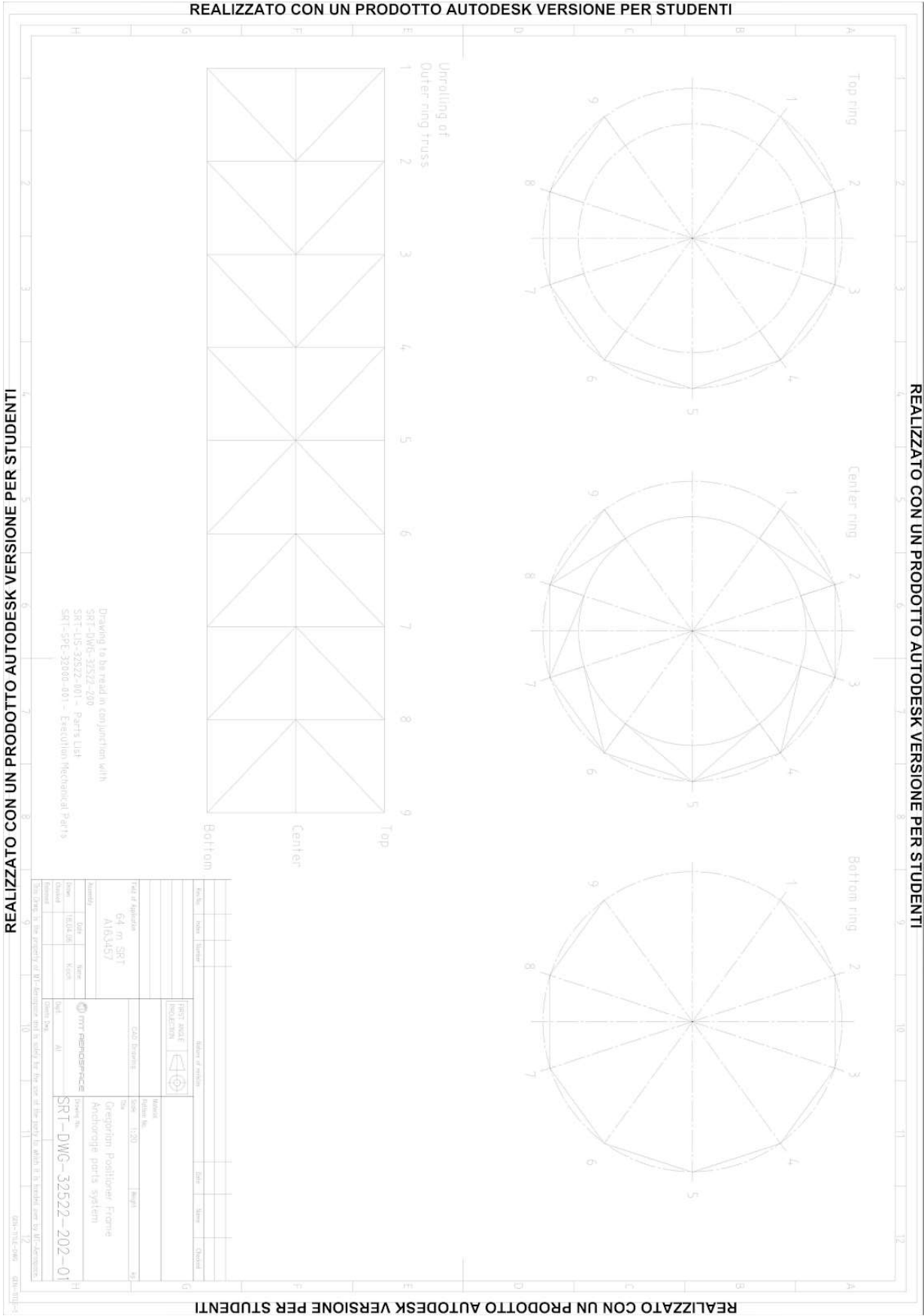


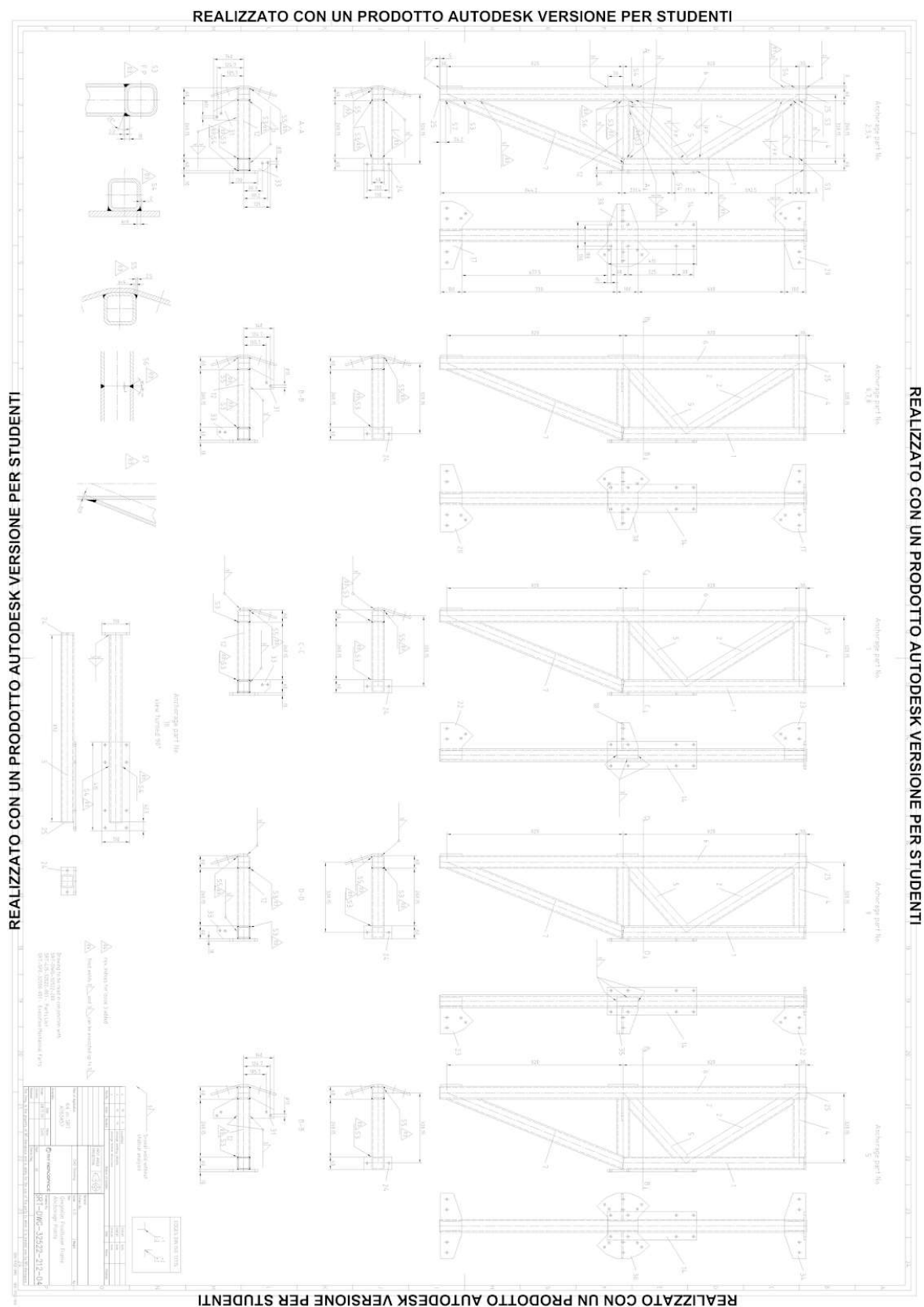
Allegato 2: SRT-DWG-32525-200-09-200



Allegato 3: SRT-DWG-32522-200-08-200







Allegato 7: SRT-LIS-32522-001-05

 MT AEROSPACE		Doc. No.: SRT-LIS-32522-001-05				Title PARTS LIST			
WP- / ASSEMBLY Title				DRAWING NO.			WP -No.		
Gergorian Positioner Frame				SRT-DWG-32522-200			32522		
Date of first issue / name		01.03.06 / Doth				Date of last issue / Name		20.08.07 / Doth	
DESCRIPTION	QUANTITY	DIMENSIONS CROSS SECTION x LENGTH (mm)	STANDARD DWG NO	Item	MATERIAL	Weight for 1 part(kg)	Weight- Total(kg)	REMARKS	
Sq. Tupe	9	60x60x6x845,7	SRT-DWG-32522-301	1	S355K2G3 (1.0595)	7,950	72		
L-Profile	9	L60x5x559,3	SRT-DWG-32522-302	2	S355K2G3 (1.0595)	2,320	21		
Sq. Tupe	1	60x60x6x872		3	S355K2G3 (1.0595)	8,230	8		
Sq. Tupe	9	60x60x6x268,15	SRT-DWG-32522-304	4	S355K2G3 (1.0595)	2,533	23		
L-Profile	9	L60x5x378,6	SRT-DWG-32522-305	5	S355K2G3 (1.0595)	1,618	15		
Sq. Tupe	9	60x60x6x1700		6	S355K2G3 (1.0595)	16,058	145		
Sq. Tupe	9	60x60x6x873	SRT-DWG-32522-307	7	S355K2G3 (1.0595)	7,579	68		
Plate	1	15x Dia 2010	SRT-DWG-32522-308	8	S235J2G3	206,360	206		
Plate	1	15x Dia 2010	SRT-DWG-32522-309	9	S235J2G3	271,670	272		
Plate	1	25x Dia1140	SRT-DWG-32522-310	10	S235J2G3	56,780	57		
Plate	10	10x300x445	SRT-DWG-32522-311	11	S235J2G3	10,362	104		
Sq. Tupe	9	60x60x6x268,15	SRT-DWG-32522-312	12	S355K2G3 (1.0595)	2,500	23		
Plate	1	10x298x3487,2	SRT-DWG-32522-313	13	S235J2G3	81,580	82		
Plate	20	10x130x415		14	S235J2G3	4,235	85		
Plate	1	10x105x6187		15	S235J2G3	51,000	51		
Plate	4	10x100x300		16	S235J2G3	1,570	6		
Plate	6	8x152x313,6	SRT-DWG-32522-317	17	S235J2G3	1,971	12		
Plate	1	8x100x174,6	SRT-DWG-32522-318	18	S235J2G3	0,946	1		
Plate	1	8x Dia2170		19	S235J2G3	38,890	39		
Plate	6	8x152x313,6	SRT-DWG-32522-317	20	S235J2G3	1,971	12		
L-Profile	24	L60x6x857,8	SRT-DWG-32522-321	21	S355K2G3 (1.0595)	4,645	111		
Plate	2	8x152x174,6	SRT-DWG-32522-322	22	S235J2G3	1,241	2		
Plate	2	8x152x174,6	SRT-DWG-32522-322	23	S235J2G3	1,241	2		
Plate	10	8x60x130		24	S235J2G3	0,490	5		
Plate	19	5x54x54	SRT-DWG-32522-325	25	S235J2G3	0,110	2		
Plate	1	10x92x99,82		26	S235J2G3	0,721	1		

 MT AEROSPACE		Doc. No.: SRT-LIS-32522-001-05				Title PARTS LIST		
WP- / ASSEMBLY Title			DRAWING NO.			WP -No.		
Gergorian Positioner Frame			SRT-DWG-32522-200			32522		
Date of first issue / name		01.03.06 / Doth		Date of last issue / Name		20.08.07 / Doth		
DESCRIPTION	QUANT ITY	DIMENSIONS CROSS SECTION x LENGTH (mm)	STAN- DARD DWG NO	Item	MATERIAL	Weight for 1 part(kg)	Weight- Total(kg)	REMARKS
Plate	1	40x105x110	SRT-DWG-32522-327	27	S235J2G3	3,356	3	
Plate	1	10x84,94x92		28	S235J2G3	0,613	1	
Plate	1	10x90x6187		29	S235J2G3	43,722	44	
Plate	1	10x Dia 1990		30	S235J2G3	26,250	26	
Plate	8	8x100x120	SRT-DWG-32522-331	31	S235J2G3	0,480	4	
L-Profile	8	L60x5x600	SRT-DWG-32522-332	32	S355K2G3 (1.0595)	2,742	22	
Plate	8	8x60x85	SRT-DWG-32522-333	33	S235J2G3	0,330	3	
Plate	2	8x100x315,4	SRT-DWG-32522-334	34	S235J2G3	1,679	3	
Plate	1	8x100x174,6	SRT-DWG-32522-318	35	S235J2G3	0,946	1	
Plate	1	8x244,1x313,6	SRT-DWG-32522-336	36	S235J2G3	3,320	3	
L-Profile	16	L60x5x1024,5	SRT-DWG-32522-337	37	S355K2G3 (1.0595)	4,682	75	
Plate	6	8x244,1x313,6	SRT-DWG-32522-338	38	S235J2G3	2,760	17	
				39				
Hexagon Bolt	212	M10x35	ISO 4017	40	8.8 zinc plated		0	
Washer	624	10	ISO 7094	41	200HV zinc plated		0	
Hexagon nut	312	M10	ISO 4032	42	8 zinc plated	0,003	1	
Hexagon Bolt	20	M10x45	ISO 4017	43	8.8 zinc plated		0	
Hexagon Bolt	80	M10x40	ISO 4017	44	8.8 zinc plated			
Total	1						1625	
Total	1						1625	
Material certificate EN 10204-3.1B from plates item 1 - 38 Beside drawing mentioned above SRT-DWG-32522-210 is valid in regard Pos. 15,19 Beside drawing mentioned above SRT-DWG-32522-211 is valid in regard Pos. 29,30 Beside drawing mentioned above SRT-DWG-32522-212 is valid in regard Pos. 1,5 - 7,12,14,18,22 - 25,31,33 - 36,38 Beside drawing mentioned above SRT-DWG-32522-213 is valid in regard Pos. 8 - 11,13,14,16,26 - 28 Dimensional check and record of the tolerance dimensions specified in the tables "fit"								
The items listed as follows will be supplied by MT at FMC shop:								

		Doc. No.: SRT-LIS-32522-001-05				Title PARTS LIST	
WP- / ASSEMBLY Title Gergorian Positioner Frame			DRAWING NO. SRT-DWG-32522-200			WP -No. 32522	
Date of first issue / name 01.03.06 / Doth				Date of last issue / Name 20.08.07 / Doth			
DESCRIPTION	QUANTITY	DIMENSIONS CROSS SECTION x LENGTH (mm)	STANDARD DWG NO	Item	MATERIAL	Weight for 1 part(kg)	Weight-Total(kg)
DESCRIPTION	QUANTITY	DIMENSIONS CROSS SECTION x LENGTH (mm)	STANDARD DWG NO	Item	MT Order Number		
The items listed as follows will be supplied by MT at site:							
DESCRIPTION	QUANTITY	DIMENSIONS CROSS SECTION x LENGTH (mm)	STANDARD DWG NO	Item	MT Order Number		

DOCUMENT CHANGE RECORD

Issue No. / Issue Date	Items changed,	Description of Change	Name
2	1,7,12,17,18,20,22,23,31 34,35,36,37,38,44 40,41,42	change dimension and quantity new items change quantity	Doth
3	11, 32	quantity changed	Koch
4	11	change dimension, new drawing	Doth
5	34	quantity changed	Doth

	Name	Date	Sign
Approved by			
Released by	Dreyer	03.12.09	

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Doc. No.:	SRT-SPE-32525-002-01	Issue No.:	01
		Issue Date:	08.04.04
Title:	Techn. Specification for Gregorian Pos. Bearing	Page:	1 of 10

	Name	Date	Sign
Prepared by	H. Merz	09.07.12	<i>H. Merz</i>
Approved by	Dr. H. Kärcher		
Released by	H. Dreger <i>Dr. D. Dreger</i>	09.07.12	<i>H. Dreger</i>

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		1

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		Issue Date:	08.04.04
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Issue No.	Issue date	No. Of pages	Pages changed, added, deleted	Description of Change
01	08.04.04	10		Issue 01

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1 Scope

The present specification describes the requirements to be met by the bearing of the Gregorian Positioner assembly.

The Gregorian Positioner bearing is part of the 64m Radio Telescope Sardinia to be built at 600 m altitude.

2 Description

The bearing is a ball bearing type with an internal gear, operating in any positions with axial loads, radial loads and overturning moments.

The inner and the outer rings of the bearing are supported by strong flanges that are welded to the stationary tower and to the rotating frame of the Positioner, see figure 1.

The bearing is lubricated with grease and supplied with seals, grease fittings and lifting eye-bolts for installation and maintenance purpose.

The Gregorian Positioner is driven by two identical pinions. Backlash of the toothing and the pinions itself will be eliminated by the servo system which produces a torque and a counter torque.

3 Environmental Conditions

Site:	Italy – Island of Sardinia appr. 50 km from the city of Cagliari
Ambient temperature	
maximum	+ 50 °C (operation)
minimum	- 15 °C (operation) - 30 °C (survival, no motion, stow position)
Relative atmospheric humidity	100 % with condensation
Atmosphere:	Dusty

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4 Kinematic Requirements

Maximum velocity:	3,5 °/second (0,58 rpm)
Duty cycle:	360 degree rotation, at 3,5 degree/second four times an hour
Lifetime:	20 years

5 Load Requirements

The bearing is designed to meet the following load requirements:

Mode	Radial Load	Axial Load	Moment	Torque	Time	Remark
Unit	N	N	Nm	Nm	%	(-)
Slewing	50.000	50.000	25.000	15.000	100	

6 Interface and Teeth Requirements

The bearing is designed to meet the requirements in figure 2.

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Parameter	Unit	Data	
		Bearing	Pinion
Quantity	--	1	2
Module	m	6	
Number of teeth	z	158	19
Pitch circle diameter	d _o	948	114
Pressure angle	α	20	
Basic rack design	--	DIN 867	
Quality ISO	--	9	8
Addendum modification	xm ₂	0.000	3.000
Addendum reduction	km ₂	0.000	0.000
Tip Relief	mm	none	none
Intentional backlash	--	none	none
Outside diameter.	d _k	TBD	TBD
Root circle diameter	d _f	105.000	963.000
Face Width	b	60	60
Load modification	mm	0	0
Theor. Centre distance	a	413,911	
Material	--	46Cr4V	20MnCrS5
Yield limit	σ_s	530	TBD
Tooth surface hardness		280 HB	55-62 RC
Internal backlash	--	none	none
Drawing Number	--	SRT-DWG-32525-301	SRT-DWG-32525-303

7 Compliance Requirements

Repeatable wobble	10 arc-second
Non-repeatable wobble	5 arc second
Radial stiffness	standard, TBD
Axial stiffness	standard, TBD
Friction torque	standard, TBD

8 Lubrication

Lubricant	TBD
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9 Quality Assurance and Documentation

The supplier shall have certification according to ISO 9001.

All documentation has to be prepared in English language and shall at least contain.

- Detailed design calculations
- Evidence of quality conformity of the materials in use, according to EN 10204-3.1B
- Dimension data sheets concerning works manufacture
- In-plant test report

The following documentation shall be submitted to the customer on the appropriate dates:

- Tooth geometry data for the pinion
Date: 2 weeks after award of contract
- Mechanical analysis summary showing life and survival margin, axial and radial stiffness and friction torque
Date: 1 month after award of contract
- Bearing drawing showing all main and interface dimensions
Date: 1 month after award of contract
- Operation and maintenance instructions, installation instructions
Date: 1 month before delivery of the bearing
- Material certificates and dimension data sheets concerning works manufacture
Date: at in-plant test
- In-plant test record
Date: 2 weeks after in-plant test

10 Tests

Vendor shall prepare for delivery, FOB shop, acceptance test procedure including test description and measurement data sheets to verify compliance with the technical requirements of this specification.

Test and acceptance will be performed at Vendor shop with MAN and customer representative.

Measured values / inspection results:

- Measurement of interface dimensions
- Measurement of runout
- Friction torque
- Hardness test measurement of tooth surface

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11 Protection against Corrosion

The centering, the contact surfaces and the teeth: treated with a temporary coat easily to remove, e.g. Tectyl

The rest of the outer surfaces: painted (*)

(*) Application of one coat 50 μ m of PERMATEx 73082 PVB-EP-Primer

12 Packing and transport

The bearing shall be properly packed suitable for the transport at shop (in Egypt) in order to prevent transport damages (unloading from truck, etc.)

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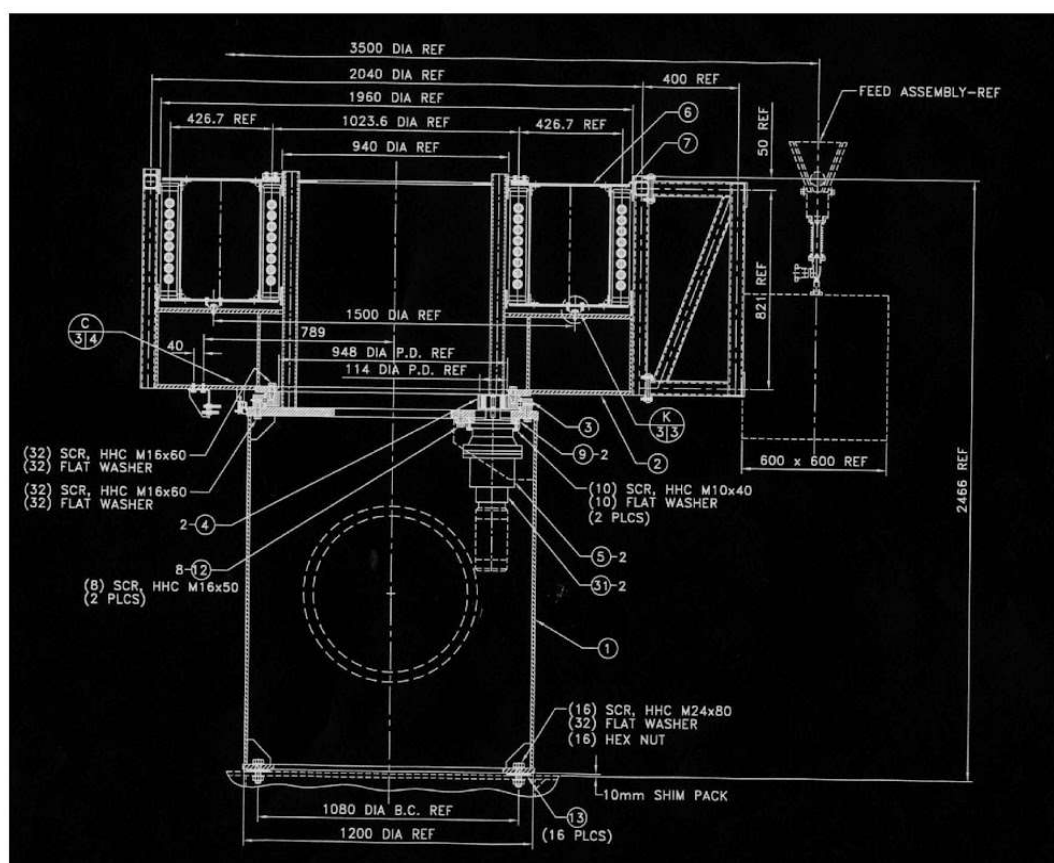


Figure 1 – Gregorian Positioner Assembly

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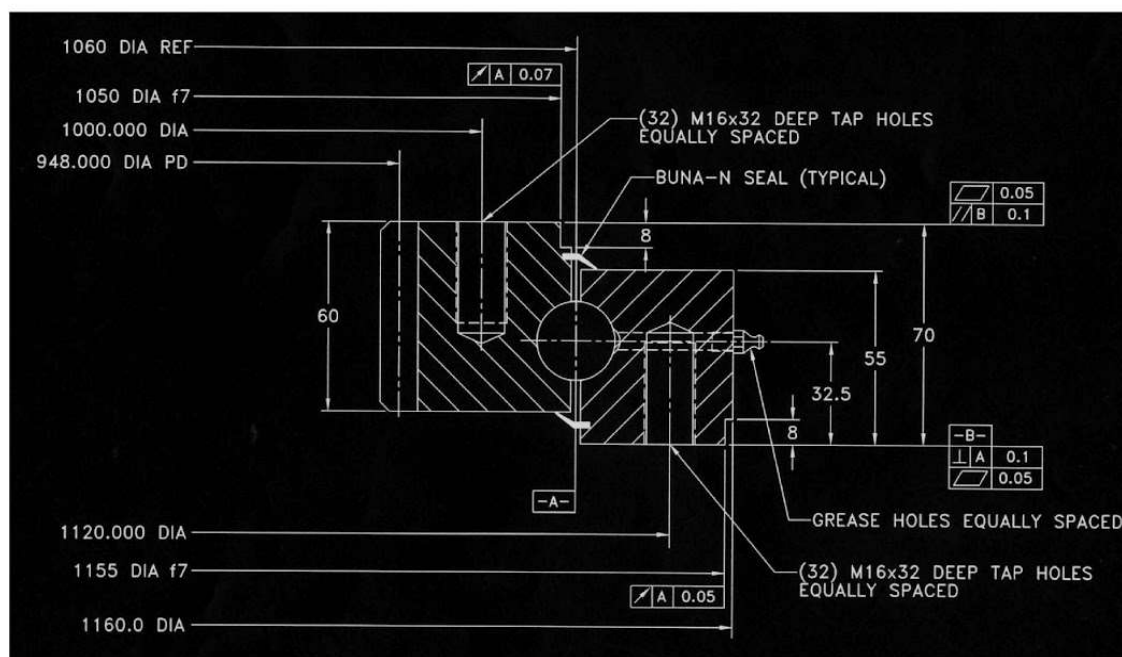


Figure 2 – Bearing Interface Requirements

SRT



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		Issue Date:	02.06.04
Title:	Gregorian Positioner Bearing Analysis	Page:	1 of 7

	Name	Date	Sign
Prepared by	Bernd Voß (Bearing Supplier Rothe Erde)	02.06.2004	
Approved by	Ulrich Krug (Bearing Supplier Rothe Erde)	02.06.2004	
Released by	Hartmut Dreger <i>Dr. H. Dreger</i>	09.07.12	<i>[Signature]</i>

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Issue No.	Issue date	No. Of pages	Pages changed, added, deleted	Description of Change
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ROTHE ERDE DRWG.-NR.: 062.22.1060.000.41.1123
ROTHE ERDE ORDER NO.: 63.2.30264

GEAR CALCULATION
PROGRAM STATUS 03.02.2000 GEOMETRY WITH NOMINAL VALUES
=====

WHEEL-2 : INTERNAL GEAR

HELIX ANGLE AT REFERENCE DIAMETER.....BETA : .000 DEG
NORMAL PRESSURE ANGLE.....ALFA-0 : 20.000 DEG
NORMAL MODULE.....MN : 6.000 MM
TRANSVERSE MODULE.....MT : 6.000 MM
WORKING TRANSVERSE PRESSURE ANGLE.....ALFA-WT : 18.790 DEG
WORKING NORMAL PRESSURE ANGLE.....ALFA-WN : 18.790 DEG
CALCULATED ADD. REDUCTION FROM X1+X2.....*MN : .089 MM

GEAR RATIO Z2/Z1.....U : -8.316
TRANSVERSE CONTACT RATIO.....EPS-A : 1.595
OVERLAP RATIO.....EPS-B : .000
TOTAL CONTACT RATIO (EPS-A) + (EPS-B).....EPS : 1.595
OPERATING CENTER DISTANCE.....A : -413.911 MM

	WHEEL-1	WHEEL-2
PROVIDED CUTTING TOOL.....: HOB	/	
	: RACK CUTTER	PINION CUT.
TOOL ADDENDUM COEFFICIENT.....HAO/MN:	1.250	1.250
TOOL TOOTH TIP RADIUS COEFFICIENT...R/MN:	.250	.000
NO. OF TEETH (PINION CUTTER).....Z0:	.000	25.000
ADDENDUM MODIFIC.COEFF. (PINION CUT.) X0:	.000	.000
FACTOR FOR REMAIN. PROTUBERANCE...PRO/MN:	.000	.000
FACEWIDTH.....B:	63.000	59.000 MM
NO. OF TEETH.....Z:	19.000	-158.000
ADDENDUM MODIFICATION.....XM:	3.000	.000 MM
CONSIDERED ADDENDUM REDUCTION.....KM:	.000	.000 MM
REFERENCE DIAMETER.....D:	114.000	-948.000 MM
WORKING PITCH DIAMETER.....DW:	113.156	-940.978 MM
TIP DIAMETER.....DA:	132.000	-936.000 MM
TIP DIAMETER UTILIZABLE.....DNA:	132.000	-936.000 MM
BASE DIAMETER.....DB:	107.125	-890.829 MM
ROOT DIAMETER UTILIZABLE.....DNF:	109.091	-954.857 MM
FORM DIA. OF DEPENDUM.....DFF:	108.702	-960.336 MM
ROOT DIAMETER.....DF:	105.000	-963.000 MM
NORMAL TOOTH THICKNESS AT TIP.....SAN:	2.742	5.209 MM

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TRANSV.TOOTH THICKNESS AT TIP.....SAT:	2.742	5.209 MM
NORMAL SPACEWIDTH AT ROOT DIA.....EFN:	5.208	3.714 MM
TRANSV.SPACEWIDTH AT ROOT DIA.....EFT:	5.208	3.714 MM
SLIDING FACTORS AT TOOTH TIP.....:	.316	.123
SPECIFIC SLIDING AT TIP.....:	.464	.403
SPECIFIC SLIDING AT ROOT.....:	-.675	-.866

G E A R S T R E S S A N A L Y S I S , B A S E D O N N I E M A N N B O O K N O . 2 / 1 9 6 0

=====

WHEEL-2 : I N T E R N A L G E A R

GENERAL DATA AND MATERIAL DATA

KEY (O.U.K=1, OTHERWISE=0)	:	0
KEY (MATING ST/ST=0, ST/ALU=1)	:	0
KEY (MATING W. HARDENED PINION=1, OTHERW.=0)	:	1
SEATING COEFF.GK=0 PINION SUPP.EACH SIDE GK:	:	.30
GK=0.3 PINION OVERHUNG		
CONSIDERED FACE WIDTH AT BENDING (MM)	:	59.00
CONSIDERED FACE WIDTH AT PITTING (MM)	:	59.00

		WHEEL-1	WHEEL-2
GEAR QUALITY AS PER DIN	:	8	9
KEY, CROSS SECTION OF RING (1,2,3)	:	1	1
	:	20MNCR5E	42CRMO4V
HARDENING METHOD	:	CASE HARDENED	
FLANK STRENGTH (N/MM2)	K0:	49.00	10.60
ROOT STRENGTH (N/MM2)	SIGMA-0:	461.00	310.00
STATIC STRENGTH (N/MM2)	SIGMA-OB:	1570.00	1080.00
AVAILABLE FLANK HARDNESS	HBV:	650.00	280.00
COMPARISON HARDNESS FOR FLANK	HBT:	650.00	280.00
YIELD STRENGTH (N/MM2)	SIGMA-0,2:	635.00	635.00

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Issue Date: 02.06.04

Title: Gregorian Positioner Bearing Analysis

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LOADS AND SAFETY FACTORS

WHEEL -1 WHEEL-2

```

-----
NO. OF DRIVING PINIONS          : 1
DRIVE TORQUE (N*M) MD: 1803.80 15000.00
ROTATIONAL SPEED (1/MIN) DREHZ: 4.82 .58
TANGENTIAL FORCE AT PCD OF ENGAGEM. (KN) FU: 31.88
SHOCK COEFFICIENT CS: 1.00
LUBRICATION COEFFICIENT YS: 1.00
FACTOR : .70
    DIRECTION OF ROTATING CHANGING= 0.7
    UNIDIRECTIONAL ROTATING = 1
SAFETY AGAINST FATIGUE FRACTURE SB: 1.86 1.45
FULL LOAD LIFE AT SB<1 LHB:***** *****
SAFETY AGAINST PITTINGS SG: 2.02 .48
FULL LOAD LIFE AT SG<1 LHG:***** 49641.96
SAFETY AGAINST FORCED RUPTURE SBR: 8.84 5.35
HERTZIAN-PRESS. AT PITCH POINT (N/MM2) PHC: 1058.034
STRIECK-PRESS. AT PITCH POINT (N/MM2) KC: 15.542
    
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RACEWAY CALCULATION

GENERAL RACEWAY DATA

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RACEWAY-Ø (MM) :1060
BALL-DIAMETER (MM) :22
NOMINELL NO. OF BALLS :122
    
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LOAD CASE

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FA= AXIAL LOAD = 50 KN
FR= RADIAL LOAD = 50 KN
MK= TILTING MOMENT = 25 KNM
    
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PEAK LOAD ON MAX. LOADED BALL = 2,53 KN

STATIC SAFETY CALCULATION

$$S_{st} = \frac{Q_{03}}{Q_{ges}} = \frac{16,11KN}{2,53KN} = 6,37 \text{ fold}$$

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BOLT CALCULATION

RACEWAY DIA OF UPLIFTING RACEWAY DL : 1060.00 MM
FACTOR FOR CALCULATION OF FK-ERF-REIB SMALL K : 4.37

DESCRIPTION	I DIMEN-I I SION I	I SYMBOL I	I I OUTER I	I I INNER
BOLT CIRCLE DIA	I MM	I LA/LI	I 1120.00I	I 1000.00
TIGHTENING FACTOR (FMMAX/FMMIN)	I	I ALPHA-A	I 1.60I	I 1.60
NO. OF BOLTS	I	I SMALL N	I 32.00I	I 32.00
BOLT DIA	I MM	I SMALL D	I 16.00I	I 16.00
NOMINAL CROSS SECTION	I MM2	I AN	I 201.06I	I 201.06
STRESS CROSS SECTION	I MM2	I AS	I 156.67I	I 156.67
CROSS SECTION AT MINOR DIA	I MM2	I AD3	I 144.12I	I 144.12
BOLT STRENGTH GRADE ISO 898	I	I	I 10.90I	I 10.90
0,2-PROOF STRESS	I N/MM2	I RP0,2	I 940.00I	I 940.00
FORCE AT 0,2-PROOF STRESS	I N	I F0,2	I 147266.I	I 147266.
NOMINAL PRELOAD (% RP0,2)	I %	I	I IABT. 70.00I	I IABT. 70.00
DEGREE OF EXPLOITATION OF	I	I NUE	I .90I	I .90
YIELD LOAD DURING TIGHTENG.	I	I	I	I
FRICITION COEFF. IN THREAD	I	I MUE-G	I .140I	I .140
INITIAL CLAMPING FORCE OF THE SELECTED BOLT	I N	I FM	I 106582.I	I 106582.
STRESS AMPLITUDE FOR ENDURANCE LIMIT	I N/MM2	I SIGMA-A	I 47.44I	I 47.44
DIA OF AREA UNDER BOLT HEAD OR NUT (1.5*D)	I MM	I ISMALL DW	I 24.00I	I 24.00
HOLE DIA (1.155*D)	I MM	I ISMALL DH	I 18.48I	I 18.48
DIA FOR CALCULATION OF AERS (DA = 1.6*DW)	I MM	I DA	I 38.40I	I 38.40
CLAMPING LENGTH I STEEL	I MM	I ISMALL LK1	I 80.00I	I 80.00
SHARE OF PARTS I KUNSTST.	I MM	I ISMALL LK2	I .00I	I .00
BOLTED TOGETHER I ALUMIN.	I MM	I ISMALL LK3	I .00I	I .00
ASSOCIATED YOUNG'S MODULUS OF PARTS BOLTED TOGETHER	I N/MM2	I EP1	I 205000.00I	I 205000.00
	I N/MM2	I EP2	I .00I	I .00
	I N/MM2	I EP3	I .00I	I .00

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YOUNG'S MODULUS	I N/MM2 I	ES I	205000.00I	205000.00
OF BOLT MATERIAL	I I	I	I	I
	I I	I	I	I
FRICITION COEFFICIENT BETW.	I I	MUE I	.15I	.15
CONTACT SURFACES	I I	I	I	I
	I I	I	I	I
RING SEGMENTED (0=NO/1=YES)	I I	I	.00I	.00

LOAD CASE

FA= AXIAL LOAD = 50 KN
 FR= RADIAL LOAD = 50 KN
 MK= TILTING MOMENT = 25 KNM

DESCRIPTION	I DIMEN-I I SION I	SYMBOL I	I I OUTER I	I I INNER
AXIAL WORKING FORCE OF BOLT (CALCULATED ITERATIVELY FROM THE RACEWAY LOADS)	I N I	FA I	3973.69I	3973.69
	I I	I	I	I
	I I	I	I	I
SUBSTITUTIONAL AREA	I MM2 I	A-ERS I	642.40I	642.40
	I I	I	I	I
	I I	I	I	I
ELASTIC RESILIENCE OF BOLTED PARTS	IMUE*M/NI	DELTA-P I	.0006075I	.0006075
	I I	I	I	I
	I I	I	I	I
ELASTIC RESILIENCE OF BOLT	IMUE*M/NI	DELTA-S I	.0025222I	.0025222
	I I	I	I	I
	I I	I	I	I
LOAD RATIO	I I	PHI-K I	.1941I	.1941
	I I	I	I	I
	I I	I	I	I
EMBEDDING	I MUE*M	ISMAIL FZ I	5.69I	5.69
	I I	I	I	I
	I I	I	I	I
LOSS OF PRELOAD DUE TO EMBEDDING	I N I	FZ I	1816.94I	1816.94
	I I	I	I	I
	I I	I	I	I
REQUIRED CLAMPING FORCE (TERM: SMALL FE*FA)	I N I	FK-ERF I	952.I	952.
	I I	I	I	I
	I I	I	I	I
FACTOR (RELATIVE TO BRG.- TYPE AND LOAD COMBINATION)	I I	ISMAIL FE I	.2396I	.2396
	I I	I	I	I
	I I	I	I	I
CALCULATED CLAMPING FORCE FOR BOLT SELECTION	I N I	FMMAX I	9986.I	9986.
	I I	I	I	I

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ALTERNATING STRESS	I	I	I	I		
OF BOLT	I	N/MM2	I	SIGMA--	I	3.48I
	I		I	SMALL A	I	3.48
	I		I		I	
PART OF WORKING FORCE FA	I	N	I	FSA	I	501.I
WHICH LOADS THE BOLT ADD.	I		I		I	501.
	I		I		I	
RESIDUAL CLAMPING FORCE	I	N	I	FKR	I	61324.I
	I		I		I	61324.
CLAMPING FORCE REQUIRED	I	N	I	FK-ERF	I	45521.I
FOR FRICTIONAL ENGAGEMENT	I		I	REIB	I	45521.

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