



TEST 11 - Broche / Spindle - Triplex + 3 + 2 roulements / 3 + 2 Bearings

Date: 23/07/2010

Designation	Units					
General						
Solving started : 15:37:26 End of solving: 15:37:47 Solving duration 00 h00 m 21 s Number of iterations : 9 Maximum authorized error : 0.1						
Calculation mode : Taking into account the mounting parameters	-					
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Bearing part number	-	220@15	220@15	220@15	220@15	220@15
Bearing location	<i>mm</i>	131.997	165.997	238.000	554.000	588.000
Bore diameter	<i>mm</i>	100.000	100.000	100.000	100.000	100.000
Outside diameter	<i>mm</i>	180.000	180.000	180.000	180.000	180.000
Inner ring width	<i>mm</i>	34.000	34.000	34.000	34.000	34.000
Outer ring width	<i>mm</i>	34.000	34.000	34.000	34.000	34.000
Number of balls	<i>mm</i>	14	14	14	14	14
Ball diameter	<i>mm</i>	25.400	25.400	25.400	25.400	25.400
Free Contact angle	<i>deg</i>	15.000	15.000	15.000	15.000	15.000
Operating axial clearance obtained from the mounting parameters (Reset to 0 in case of a set with an elastic preload)	<i>mm</i>	-0.0147	-0.0147	-0.0147	-0.0026	-0.0026
The operating temperatures are obtained from the mounting parameters	-					
Inner ring operating temperature	-	70.00	70.00	70.00	70.00	70.00
Outer ring operating temperature	-	60.00	60.00	60.00	60.00	60.00
Rolling element operating temperature	-	65.00	65.00	65.00	65.00	65.00
Inner ring status	-	Fixed	Fixed	Fixed	Fixed	Fixed
Outer ring status	-	Floating	Floating	Fixed	Floating	Floating
Static rating (catalog)	<i>N</i>	126800	126800	126800	126800	126800
Dynamic rating (catalog)	<i>N</i>	169000	169000	169000	169000	169000
Bearing mounting parameters						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Ring offset	-	0.0450	0.0450	0.0450	0.0350	0.0350
Inner ring fit	-	-0.0120	-0.0120	-0.0120	-0.0200	-0.0200
Outer ring fit	-	0.0050	0.0050	0.0050	0.0050	0.0050
Shaft inner diameter at bearing location	<i>mm</i>	53.000	53.000	53.000	47.089	47.089
Housing outer diameter at bearing location	<i>mm</i>	9999.000	9999.000	9999.000	9999.000	9999.000
Loss of interference shaft / Inner ring due to centrifugal effect (speed = 8000 rpm)	<i>mm</i>	0.0065	0.0065	0.0065	0.0073	0.0068
Increase of the shaft outside diameter due to centrifugal force (speed = 8000 rpm)	<i>mm</i>	0.0027	0.0027	0.0027	0.0018	0.0024



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Increase of the inner ring bore diameter due to centrifugal force (speed = 8000 rpm)	mm	0.0092	0.0092	0.0092	0.0092	0.0092
Increase of the inner ring outside diameter due to centrifugal force (speed = 8000 rpm)	mm	0.0086	0.0086	0.0086	0.0086	0.0086
Manual correction of the axial endplay (user value) - Set #1	mm	-0.0500				
Manual correction of the axial endplay (user value) - Set #2	mm	-0.0050				
Loads						
Applied external force definition	-	System				
The weight of the shaft is taken into account for the calculation The shaft axis is horizontal	-					
Location of the center of gravity	mm	357.879				
Direction	deg	0.000				
Magnitude	N	446.10				
Axial load						
Location	mm	0.000				
Lever arm	mm	0.000				
Direction	deg	0.000				
Magnitude	N	10000				
>>						
Radial load						
Location	mm	0.000				
Direction	deg	0.000				
Magnitude	N	20000				
Reactions, Deformations, Stresses, Stiffnesses						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Axial reaction	N	7618.25	5403.78	-3022.03	2969.20	-2969.20
Radial reaction according to Y	N	-16181.21	-9218.85	-288.38	2464.13	2778.21
Radial reaction according to Z	N					
Moment according to Y	N.m					
Moment according to Z	N.m	307.60	179.98	-1.22	-45.43	52.35
Max contact force (inner ring / rolling element)	N	5293.15	3097.12	557.92	1007.82	1086.79
Max contact force (outer ring / rolling element)	N	5833.01	3638.17	1124.58	1559.58	1637.37
Max contact pressure (inner ring / rolling element)	MPa	2058	1722	973	1185	1215
Max contact pressure (outer ring / rolling element)	MPa	1969	1682	1138	1269	1290
Maximum 1/2 length of the contact ellipse - (rolling element / inner ring)	μm	3348	2800	1577	1924	1973
Maximum 1/2 width of the contact ellipse - (rolling element / inner ring)	μm	367	307	173	211	216



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Risk of truncation of the ellipse of contact on inner ring : (1/2 ellipse length/ available race length based on contact angle)	-	Not detected (31.72 %)	Not detected (26.93 %)	Not detected (16.92 %)	Not detected (19.07 %)	Not detected (19.47 %)
Maximum 1/2 length of the contact ellipse - (rolling element / outer ring)	μm	2867	2449	1654	1845	1875
Maximum 1/2 width of the contact ellipse - (rolling element / outer ring)	μm	493	422	285	318	323
Risk of truncation of the ellipse of contact on outer ring : (1/2 ellipse length/ available race length based on contact angle)	-	Not detected (29.43 %)	Not detected (24.78 %)	Not detected (14.94 %)	Not detected (17.31 %)	Not detected (17.68 %)
Relative axial displacement	μm	17.1689	17.1758	-11.6712	3.4638	-1.7031
Relative radial displacement	μm	37.8019	24.5013	5.8535	15.2056	15.9025
Axial displacement	μm	2.9883	2.9190	3.1223	3.1223	3.2176
Axial stiffness	$N/\mu m$	443.7	314.6	258.9	857.2	1743.4
Radial stiffness	$N/\mu m$	428.1	376.3	49.3	162.1	174.7
Radial displacement according to Y	μm	-37.8019	-24.5013	-5.8535	15.2056	15.9025
Radial displacement according to Z	μm	-0.0000	-0.0000	0.0000	0.0000	0.0000
Tilting according to Y	$mRad$	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
Tilting according to Z	$mRad$	0.4267	0.3419	0.1734	0.0272	0.0226
Kinematic						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Inner ring rotation speed	rpm	8000	8000	8000	8000	8000
Outer ring rotation speed	rpm	0	0	0	0	0
Cage rotation speed	rpm	3401	3381	3347	3365	3367
Spin to Roll ratio For the most heavily loaded rolling element	-	0.1218	0.1433	0.2919	0.2136	0.2065
Spin to Roll ratio Maximum value verified over all the rolling element complement	-	0.6437	0.5416	0.3459	0.4536	0.4674
Contact angle ratio For the most heavily loaded rolling element	-	1.139	1.239	2.402	1.750	1.694
Contact angle ratio Maximum value verified over all the rolling element complement	-	16.002	7.528	2.681	4.483	4.941
Life Lundberg - Palmgren						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Dynamic rating of the bearing assembly (Assumed material : Steel)	N	110911	110911	110911	110911	110911
Outer ring life	10^6 $rev.$	858	3216	29454	23286	21872
Inner ring life	10^6 $rev.$	355	1689	70892	35616	30629



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L10 Bearing life	10^6 rev.	267	1180	22087	15054	13655
L10 Bearing life	Hours	555	2459	46016	31362	28448
Life Based on manufacturer ratings						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Dynamic rating of the bearing assembly	N	169000	169000	169000	169000	169000
Outer ring life	10^6 rev.	3036	11377	104201	82381	77380
Inner ring life	10^6 rev.	1256	5974	250800	126000	108360
L10 Bearing life	10^6 rev.	943	4175	78141	53258	48308
L10 Bearing life	Hours	1964	8699	162793	110953	100642
Periodic frequencies						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Frequencies : Retainer	Hz	61.39	59.65	56.91	58.30	58.50
Frequencies : Inner ring	Hz	1094.23	1093.04	1078.52	1088.04	1088.72
Frequencies : Outer ring	Hz	859.41	835.11	796.77	816.27	819.03
Frequencies : Ball (Hypothesis : 2 impacts per rotation of the ball)	Hz	799.40	776.60	739.84	758.71	761.38
Torque / Heat generated						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Lubricant name	-	ISO VG 15	ISO VG 15	ISO VG 15	ISO VG 15	ISO VG 15
Lubricant viscosity at a temperature of 40°C	cSt	15.00	15.00	15.00	15.00	15.00
Lubricant viscosity at a temperature of 100°C	cSt	3.35	3.35	3.35	3.35	3.35
Friction torque due to ball spinning	N.m	7.704	4.154	1.268	1.403	1.442
Heat generated due to ball spinning	W	2115.5	1442.5	790.2	770.5	769.3
Estimated operating temperature (Ambient temperature = 20°C)	°C	70.7	58.2	46.6	46.3	46.2
Operating temperature is imposed	°C	65.0	65.0	65.0	65.0	65.0
Viscosity at imposed operating temperature	cSt	7.08	7.08	7.08	7.08	7.08
Torque due to rolling	N.m	1.208	1.208	1.208	1.208	1.208
Heat generated due to rolling	W	1011.7	1011.7	1011.7	1011.7	1011.7
Total heat generated (spinning + rolling) Total of all the rows : 10946.5 W	W	3127.2	2454.2	1801.9	1782.2	1781.0
Lubrication / Film thickness						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Lubricant film thickness at inner ring contact	μm	0.49	0.51	0.58	0.56	0.55
Lubricant film thickness at outer ring contact	μm	0.57	0.59	0.66	0.64	0.63
Rolling element surface roughness	μm	0.06	0.06	0.06	0.06	0.06
Ring race surface roughness	μm	0.18	0.18	0.18	0.18	0.18



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Lambda factor at inner ring contact	-	2.66	2.77	3.13	3.00	2.99
Lambda factor at outer ring contact	-	3.07	3.19	3.55	3.43	3.41
Life adjustment factor (lubrication)	-	2.36	2.39	2.48	2.45	2.45
Adjusted bearing lives						
		Bearing 1	Bearing 2	Bearing 3	Bearing 4	Bearing 5
Based on Lundberg Palmgren Adjusted L10 bearing life (lubrication factor) (Assumed material : Steel)	<i>Hours</i>	1308	5868	114190	76847	69588
Based on manufacturer rating Adjusted L10 bearing life (lubrication factor)	<i>Hours</i>	4627	20761	403978	271869	246188
Important : In case of grease lubrication, it is advised to check the life of the grease against the life of the bearings.						
Warning - in case of grease lubrication Operating speed is excessive.		Bearing not suitable for a speed of 8000 RPM	Bearing not suitable for a speed of 8000 RPM	Bearing not suitable for a speed of 8000 RPM	Bearing not suitable for a speed of 8000 RPM	Bearing not suitable for a speed of 8000 RPM