

## Vibration Frequencies Of DODGE Anti-Friction Mounted Bearings

More and more manufacturing facilities are getting involved with plant-wide preventive maintenance programs. By monitoring vibration levels of motors, pumps, fans and compressors, maintenance supervisors can predict imminent failures. Knowing that a piece of equipment is showing signs of potential failure permits scheduling of maintenance at an appropriate time and avoids the consequences of catastrophic failures. Shown on Table 1 - Table 10 are vibration frequencies generated by bearing components defects. All frequencies are based on unity inner ring or cone rotation.

### Frequency

Cup Nick or Spall	1000 x 9.249 = 9249 RPM
Cone Nick or Spall	1000 x 11.751 = 11751 RPM
Roller Nick or Spall	1000 x 8.068 = 8068 RPM
Roll Size Variation	1000 x .440 = 440 RPM

Since all the values on Table 1 - Table 10 are based on unity inner ring or cone rotation, the vibration due to flaws will show up at the frequencies obtained by multiplying the RPM times the factors found on the appropriate table. The resulting product will have units of REV./MIN.

### How to Use the Tables

If a 2-7/16 Type E pillow block is rotating at 1000 RPM, the vibration due to a failed component will show up at the following frequencies: (Table 3 , Line 6)

**Table 1: All Setscrew, Eccentric & D-Lok Ball Bearing Parameters For Vibration Analysis (1-RPS)**

Series	SC Bore	SCM Bore	# Balls	Diameter of Balls	Pitch Diameter	Outer Ring Frequency Hz	Inner Ring Frequency Hz	Ball Spin Frequency Hz	Cage Frequency Hz
203	1/2 - 5/8		8	17/64	1.1506	3.076569	4.923431	2.050406	0.384571
204	1/2 - 3/4		8	5/16	1.3251	3.056675	4.943325	2.002244	0.382084
205	7/8 - 1		9	5/16	1.5325	3.582382	5.417618	2.350042	0.398042
206	1-1/6 - 1-1/4	1	9	3/8	1.823	3.574328	5.425672	2.327814	0.397148
207	1-1/4 - 1-7/16	1-3/16	9	7/16	2.136	3.578301	5.421699	2.338732	0.397589
208	1-1/2 - 1-5/8	1-7/16 - 1-1/2	9	1/2	2.387	3.557394	5.442606	2.282266	0.395266
209	1-11/16 - 1-3/4	1-1/2	9	13/25	2.5591	3.585616	5.414384	2.359075	0.398402
210	1-15/16 - 2	1-11/16 - 1-3/4	10	1/2	2.7645	4.095677	5.904323	2.674068	0.409568
211	2 2-1/4	1-15/16 - 2	10	9/16	3.092	4.090395	5.909605	2.657484	0.409039
212	2-1/4 - 2-7/16	2-3/16 - 2-1/4	10	5/8	3.385	4.076809	5.923191	2.615681	0.407681
214	2-11/16	2-7/16 - 2-1/2	10	11/16	3.775	4.089404	5.910596	2.654395	0.408940
215	2-15/16	2-11/16	11	11/16	4.085	4.574357	6.425643	2.886760	0.415851
216		2-15/16 - 3	11	3/4	4.33	4.547344	6.452656	2.800062	0.413395
218		3-7/16 - 3-1/2	11	27/32	4.9199	4.556764	6.443236	2.829748	0.414251

**Table 2: CC Ball Bearing Parameters For Vibration Analysis (1-RPS)**

Series	Shaft Size	# Balls	Diameter of Balls	Pitch Diameter	Outer Ring Frequency Hz	Inner Ring Frequency Hz	Ball Spin Frequency Hz	Cage Frequency Hz
205	15/16 - 1	9	5/16	1.516	3.572394	5.427606	2.322533	0.396933
206	1-1/8 - 1-3/16	9	3/8	1.811	3.568194	5.431806	2.311133	0.396466
207	1-1/4 - 1-7/16	9	7/16	2.106	3.565171	5.434829	2.302987	0.396130
209	1-11/16 - 1-3/4	9	1/2	2.362	3.547417	5.452583	2.256157	0.394157
210	1-15/16	10	1/2	2.756	4.092888	5.907112	2.665289	0.409289
211	2-3/16	10	9/16	3.051	4.078171	5.921829	2.619817	0.407817

**Table 3: Type E, K, DI, and TAF Tapered Roller Bearing Parameters For Vibration Analysis (1-RPS)**

Bore Size	# Rollers Per Row	Mean Diameter of Rollers	Pitch Diameter	Contact Angle	Cup Frequency Hz	Cone Frequency Hz	Roller Spin Frequency Hz	Cage Frequency Hz
1-3/16 - 1-1/4	19	0.23	1.774	17.533	8.325540	10.674460	3.797580	0.438186
1-3/8 - 1-7/16	20	0.29	2.084	16.5	8.665750	11.334250	3.529138	0.433287
1-1/2 - 1-11/16	18	0.35	2.411	16	7.744100	10.255900	3.377216	0.430228
1-3/4 - 2	17	0.41	2.709	12.033	7.241814	9.758186	3.231274	0.425989
2-3/16	19	0.41	3.014	13.283	8.242270	10.757730	3.611184	0.433804
2-1/4 - 2-1/2	21	0.41	3.337	14.5	9.251011	11.748989	4.011931	0.440524
2-11/16 - 3	24	0.41	3.9	16.733	10.791879	13.208121	4.707891	0.449662
3-3/16 - 3-1/2	26	0.46	4.78	18.167	11.811316	14.188684	5.152213	0.454281
3-15/16 - 4	26	0.51	5.12	17.567	11.765467	14.234533	4.974340	0.452518
4-7/16 - 4-1/2	25	0.59	5.727	18.983	11.282275	13.717725	4.807330	0.451291
4-15/16 - 5	25	0.68	6.568	17	11.262395	13.737605	4.782071	0.450496
5-7/16 - 6	32	0.67	8.444	17.75	14.790895	17.209105	6.265507	0.462215
6-7/16 - 7	27	0.93	9.791	19.167	12.288783	14.711217	5.221605	0.455140

Cup Frequency =  $N * RPM * (1 - (Bd * \cos a / Pd)) / 2$   
 Cone Frequency =  $N * RPM * (1 + (Bd * \cos a / Pd)) / 2$   
 Roller Spin Frequency =  $Pd * RPM * (1 - (Bd * \cos a / Pd)^2) / (2 * Bd)$   
 Cage Frequency =  $RPM * (1 - (Bd * \cos a / Pd)) / 2$

Pd = Pitch Diameter  
 N = Number of rollers  
 Bd = Roller Diameter  
 a = Cup Angle (contact angle)

**Table 4: Type C Tapered Roller Bearing Parameters For Vibration Analysis (1-RPS)**

Bore Size	# Rollers Per Row	Mean Diameter of Rollers	Pitch Diameter	Contact Angle	Cup Frequency Hz	Cone Frequency Hz	Roller Spin Frequency Hz	Cage Frequency Hz
1-3/16 - 1-7/16	19	0.31	2.251	14.92	8.235801	10.764199	3.566352	0.433463
1-1/2 - 1-3/4	21	0.32	2.604	11.50	9.235581	11.764419	4.009748	0.439790
1-15/16	22	0.33	2.848	15.00	9.768852	12.231148	4.261097	0.444039
2 - 2-1/4	21	0.40	3.335	16.83	9.294571	11.705429	4.113807	0.442599
2-3/16 - 2-7/16	25	0.35	3.533	18.00	11.322284	13.677716	5.002340	0.452891
2-1/2 - 2-11/16	23	0.43	3.827	16.50	10.261076	12.738924	4.398352	0.446134
2-7/16 - 2-15/16	26	0.42	4.22	16.50	11.759442	14.240558	4.978061	0.452286
3 - 3-3/16	22	0.55	4.612	16.50	9.742225	12.257775	4.137910	0.442828
3-1/4 - 3-7/16	24	0.51	4.761	16.42	10.766982	13.233018	4.618367	0.448624
3-1/2 - 4	25	0.59	5.727	18.98	11.282253	13.717747	4.807328	0.451290
4-7/16 - 4-1/2	33	0.46	3.109	11.50	14.107710	18.892290	3.308310	0.427506
4-15/16 - 5	26	0.68	6.983	18.00	11.796028	14.203972	5.090519	0.453693

Cup Frequency =  $N * RPM * (1 - (Bd * \cos a / Pd)) / 2$   
 Cone Frequency =  $N * RPM * (1 + (Bd * \cos a / Pd)) / 2$   
 Roller Spin Frequency =  $Pd * RPM * (1 - (Bd * \cos a / Pd)^2) / (2 * Bd)$   
 Cage Frequency =  $RPM * (1 - (Bd * \cos a / Pd)) / 2$

Pd = Pitch Diameter  
 N = Number of rollers  
 Bd = Roller Diameter  
 a = Cup Angle (contact angle)

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**Table 5: Special Duty Tapered Roller Bearing Parameters For Vibration Analysis (1-RPS)**

Bore Size	# Rollers Per Row	Mean Diameter of Rollers	Pitch Diameter	Contact Angle	Cup Frequency Hz	Cone Frequency Hz	Roller Spin Frequency Hz	Cage Frequency Hz
1-3/8 - 1-1/2	16	0.40	2.563	11.54	6.776702	9.223298	3.128839	0.423544
1-9/16 - 1-3/4	18	0.40	2.854	12.72	7.769570	10.230430	3.500820	0.431643
1-7/8 - 2	19	0.41	3.014	13.28	8.242255	10.757745	3.611183	0.433803
2-1/8 - 2-1/4	22	0.41	3.475	15	9.746381	12.253619	4.182764	0.443017
2-3/8 - 2-1/2	20	0.46	3.695	14.38	8.794078	11.205922	3.957897	0.439704
2-5/8 - 3	22	0.51	4.336	15.07	9.750677	12.249323	4.196146	0.443213
3-3/16 - 3-1/2	23	0.59	5.22	17.42	10.259806	12.740194	4.372280	0.446079
3-11/16 - 4	23	0.68	5.942	15.50	10.231809	12.768191	4.315984	0.444861
4-7/16 - 4-1/2	26	0.68	6.983	18	11.796028	14.203972	5.090519	0.453693
4-15/16 - 5	24	0.81	7.537	16.42	10.762960	13.237040	4.603028	0.448457
5-7/16 - 6	24	0.93	9.123	17.33	10.832249	13.167751	4.858391	0.451344
6-1/2 - 7	29	0.93	10.19	19.23	13.250482	15.749518	5.437812	0.456913
7-15/16 - 8	27	1.12	11.471	12.42	12.212741	14.787259	5.074422	0.452324
8-1/2 - 10	41	0.87	13.979	16.40	19.276067	21.723933	8.005271	0.470148
11 - 12	37	1.20	16.061	12.50	17.150534	19.849466	6.656476	0.463528

Cup Frequency =  $N * RPM * (1 - (Bd * \cos a / Pd)) / 120$

Cone Frequency =  $N * RPM * (1 + (Bd * \cos a / Pd)) / 120$

Roller Spin Frequency =  $Pd * RPM * (1 - (Bd * \cos a / Pd)^2) / (120 * Bd)$

Cage Frequency =  $RPM * (1 - (Bd * \cos a / Pd)) / 120$

Pd = Pitch Diameter

N = Number of rollers

Bd = Roller Diameter

a = Cup Angle (contact angle)

**Table 6: All Steel Tapered Roller Bearing Parameters For Vibration Analysis (1-RPS)**

Bore Size	# Rollers Per Row	Mean Diameter of Rollers	Pitch Diameter	Contact Angle	Cup Frequency Hz	Cone Frequency Hz	Roller Spin Frequency Hz	Cage Frequency Hz
2-11/16 - 3	27	0.36	4.114	15.50	12.361632	14.638368	5.673261	0.457838
3-1/4 - 3-1/2	26	0.51	5.120	17.57	11.765488	14.234512	4.974342	0.452519
3-15/16 - 4	33	0.48	5.814	12.50	15.170061	17.829939	6.016904	0.459699
4-7/16 - 4-1/2	29	0.60	6.503	12.92	13.196026	15.803974	5.375340	0.455035
4-15/16 - 5	32	0.61	7.355	12.50	14.704466	17.295534	5.989163	0.459515
5-7/16	27	0.84	8.272	12	12.159067	14.840933	4.875231	0.450336
5-15/16 - 6	26	0.85	8.323	12	11.701366	14.298634	4.847026	0.450053
6-7/16 - 7	32	0.81	9.748	12.50	14.702011	17.297989	5.977683	0.459438
7-1/2 - 8	27	1.12	11.471	12.42	12.212741	14.787259	5.074422	0.452324
9 - 10	32	1.28	14.026	12.03	14.571921	17.428079	5.435259	0.455373

Cup Frequency =  $N * RPM * (1 - (Bd * \cos a / Pd)) / 120$

Cone Frequency =  $N * RPM * (1 + (Bd * \cos a / Pd)) / 120$

Roller Spin Frequency =  $Pd * RPM * (1 - (Bd * \cos a / Pd)^2) / (120 * Bd)$

Cage Frequency =  $RPM * (1 - (Bd * \cos a / Pd)) / 120$

Pd = Pitch Diameter

N = Number of rollers

Bd = Roller Diameter

a = Cup Angle (contact angle)

**Table 7: Spherical Roller Bearing Parameters for Vibration Analysis (1-RPS)**

Basic Bearing Series	USAF/SAF-XT Bore Sizes (in)	S2000 Unisphere II Sizes (in)	Imperial Bore Sizes (in)	# Rollers Per Row	Diameter of Rollers	Pitch Diameter	Contact Angle	Outer Ring Frequency Hz	Inner Ring Frequency Hz	Spin Frequency Hz	Cage Frequency Hz
22207E1ASKM				15	0.3937	2.166	11.750	6.165339	8.834661	2.663713	0.411023
22208E1ASKM		1-3/8 - 1-1/2	1-1/8 - 1-1/2	15	0.4488	2.449	10.583	6.148942	8.851058	2.639849	0.409929
22209E1ASKM	1-7/16	1-11/16 - 1-3/4	1 5/8 - 1-3/4	17	0.4291	2.665	9.750	7.151157	9.848843	3.027139	0.420656
22210E1ASKM	1-11/16	1-15/16 - 2	1 7/8 - 2	18	0.4331	2.858	9.083	7.653247	10.346753	3.225588	0.425180
22211E1ASKM	1-15/16	2-3/16	2-3/16 - 2-1/4	19	0.4646	3.189	8.750	8.132069	10.867931	3.360826	0.428004
22213E1ASKM	2-3/16	2 -7/16	2-3/8 - 2-1/2	18	0.5827	3.795	9.083	7.635432	10.364568	3.181534	0.424191
22215E1ASKM	2 7/16 - 2-1/2	2-11/16 - 3	2-11/16 - 3	20	0.5748	4.197	8.250	8.644623	11.355377	3.583768	0.432231
22216E1ASKM	2-11/16 - 2-3/4			19	0.6535	4.48	8.167	8.128283	10.871717	3.356234	0.427804
22217E1ASKM	2-15/16 - 3			18	0.7323	4.764	8.417	7.631462	10.368538	3.177554	0.423970
22218E1ASKM	3-3/16	3-7/16	3-3/16 - 3-1/2	18	0.7795	5.079	8.833	7.635107	10.364893	3.182930	0.424173
22220E1ASKM	3-7/16 - 3-1/2	3-1 5/16 - 4	3-1 1/16 - 4	18	0.878	5.705	9.000	7.631952	10.368048	3.173794	0.423997
22222E1ASKM	3-1 5/16 - 4	4-7/16	4-7/16 - 4-1/2	17	1.0197	6.287	9.417	7.139947	9.860053	3.003844	0.419997
22224E1ASKM	4-3/16			18	1.0472	6.819	9.417	7.636487	10.363513	3.181095	0.424249
22226E1ASKM	4-7/16 - 4-1/2	4-15/16	4-15/16 - 5	18	1.1181	7.307	9.750	7.642733	10.357267	3.193282	0.424596
22228E1ASKM	4-15/16 - 5		5-7/16 - 5-1/2	18	1.2165	7.933	9.583	7.639139	10.360861	3.186035	0.424397
22230E1ASKM	5-3/16			18	1.315	8.559	9.500	7.636209	10.363791	3.179646	0.424234
22232E1ASKM	5-7/16 - 5-1/2		5-15/16 - 6	18	1.4094	9.189	9.667	7.639189	10.360811	3.185371	0.424399
22234E1ASKM	5-15/16 - 6			17	1.5827	9.74	9.833	7.139085	9.860915	2.998143	0.419946
22236E1ASKM	6-7/16 - 6-1/2		6-7/16 - 7	18	1.5591	10.157	9.417	7.637116	10.362884	3.182632	0.424284
22238E1ASKM	6-15/16 - 7			20	1.4961	10.669	10.667	8.621944	11.378056	3.497892	0.431097
22240E1ASKM	7-3/16			19	1.6142	11.021	10.833	8.133372	10.866628	3.343119	0.428072
22244E1ASKM	7-1/2 - 8			19	1.8504	12.48	10.833	8.116546	10.883454	3.300728	0.427187
23048KMB	8-7/16 - 9			29	1.1417	12.008	9.333	13.139616	15.860384	5.212536	0.453090
23052KMB	9-7/16 - 9-1/2			27	1.378	13.228	9.667	12.113633	14.886367	4.749092	0.448653
23056KMB	9-15/16 - 10-1/2			28	1.378	13.976	9.333	12.637908	15.362092	5.023115	0.451354

Outer Ring Frequency =  $N * RPM * (1 - (Bd * \cos a / Pd)) / 120$   
 Inner Ring Frequency =  $N * RPM * (1 + (Bd * \cos a / Pd)) / 120$   
 Roller Spin Frequency =  $Pd * RPM * (1 - (Bd * \cos a / Pd)^2) / (120 * Bd)$   
 Cage Frequency =  $RPM * (1 - (Bd * \cos a / Pd)) / 120$

Pd = Pitch Diameter  
 N = Number of rollers  
 Bd = Roller Diameter  
 a = Contact Angle

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**Table 8: DODGE USAF Air Handling Spherical Roller Bearing Parameters For Vibration Analysis (1-RPS)**

Bore Size	Basic Bearing Series	# Rollers Per Row	Diameter of Rollers	Pitch Diameter	Contact Angle	Outer Ring Frequency Hz	Inner Ring Frequency Hz	Roller Spin Frequency Hz	Cage Frequency Hz
1-7/16	22209E1K	17	0.3937	2.5976	10.0000	7.231287	9.768713	3.225462	0.425370
1-11/16	22210E1K	19	0.3937	2.7976	9.2500	8.180471	10.819529	3.484413	0.430551
1-15/16	22211E1K	18	0.4528	3.0921	8.9200	7.698000	10.302000	3.342963	0.427667
2-3/16	22213E1K	19	0.5315	3.7110	9.2500	8.157076	10.842924	3.421302	0.429320
2-7/16 - 2-1/2	22215E1K	21	0.5315	4.1098	8.3300	9.156413	11.843587	3.802922	0.436020
2-11/16 - 2-3/4	22216E1K	20	0.5709	4.3638	8.2500	8.705275	11.294725	3.757794	0.435264
2-15/16 - 3	22217E1K	20	0.6299	4.6811	8.5000	8.669157	11.330843	3.649937	0.433458
3-3/16	22218E1K	20	0.6693	4.9602	8.8300	8.666651	11.333349	3.639636	0.433333
3-7/16 - 3-1/2	22220E1K	19	0.7677	5.5606	9.0000	8.204572	10.795428	3.554256	0.431820
3-15/16 - 4	22222E1K	19	0.8661	6.1559	9.4200	8.181428	10.818572	3.485342	0.430601
4-3/16	22224E1K	19	0.9252	6.6382	9.5800	8.194401	10.805599	3.519683	0.431284
4-7/16 - 4-1/2	22226E1K	19	0.9843	7.1358	9.9200	8.209178	10.790822	3.557887	0.432062
4-15/16 - 5	22228E1K	19	1.0630	7.7232	9.6700	8.211024	10.788976	3.565861	0.432159

Outer Ring Frequency =  $N * \text{RPM} * (1 - (\text{Bd} * \cos a / \text{Pd})) / 120$

Inner Ring Frequency =  $N * \text{RPM} * (1 + (\text{Bd} * \cos a / \text{Pd})) / 120$

Roller Spin Frequency =  $\text{Pd} * \text{RPM} * (1 - (\text{Bd} * \cos a / \text{Pd})^2) / (120 * \text{Bd})$

Cage Frequency =  $\text{RPM} * (1 - (\text{Bd} * \cos a / \text{Pd})) / 120$

Pd = Pitch Diameter

N = Number of rollers

Bd = Roller Diameter

a = Contact Angle

**Table 9: Split-Spherical Roller Bearing Parameters For Vibration Analysis**

Bore Size	Basic Bearing Series	# Rollers Per Row	Diameter of Rollers	Pitch Diameter	Contact Angle	Outer Ring Frequency Hz	Inner Ring Frequency Hz	Roller Spin Frequency Hz	Cage Frequency Hz
2-3/16	22213SS	17	0.559	3.414	9.000	7.125120	9.874880	2.973241	0.419125
2-7/16	22215SS	18	0.551	3.748	9.083	7.693012	10.306988	3.328155	0.427390
2-11/16	22216SS	19	0.579	3.950	8.667	8.124082	10.875918	3.341232	0.427583
2-15/16	22217SS	20	0.575	4.153	8.250	8.630263	11.369737	3.544783	0.431513
3-3/16	22218SS	19	0.654	4.435	8.167	8.114365	10.885635	3.321078	0.427072
3-7/16	22220SS	18	0.780	5.079	8.833	7.635107	10.364893	3.182930	0.424173
3-15/16 - 4	22222SS	18	0.878	5.634	9.000	7.614712	10.385288	3.132415	0.423040
4-3/16	22224SS	17	1.110	6.203	9.417	6.999864	10.000136	2.707845	0.411757
4-7/16 - 4-1/2	22226SS	18	1.047	6.727	9.417	7.617839	10.382161	3.136146	0.423213
4-15/16	22228SS	18	1.118	7.202	9.750	7.622945	10.377055	3.145244	0.423497
5-3/16	22230SS	18	1.217	7.822	9.583	7.619828	10.380172	3.139355	0.423324
5-7/16	22232SS	18	1.315	8.442	9.500	7.617307	10.382693	3.134123	0.423184
5-15/16 - 6	22234SS	18	1.409	9.059	9.667	7.619661	10.380339	3.138182	0.423314
6-7/16 - 6-1/2	22236SS	18	1.409	9.059	9.667	7.619661	10.380339	3.138182	0.423314
6-15/16 - 7	22238SS	18	1.559	10.021	9.417	7.618619	10.381381	3.138004	0.423257
7-3/16	22240SS	16	1.579	10.716	9.417	6.837308	9.162692	3.322243	0.427332
7-1/2 - 8	22244SS	16	1.752	11.257	9.500	6.771984	9.228016	3.136916	0.423249
8-1/2 - 9	23048SS	20	1.307	11.189	8.083	8.843406	11.156594	4.222831	0.442170
9-1/2	23052SS	22	1.339	11.949	8.417	9.780985	12.219015	4.408432	0.444590
10	23056SS	20	1.539	13.175	8.667	8.844916	11.155084	4.222170	0.442246

Outer Ring Frequency =  $N * RPM * (1 - (Bd * \cos a / Pd)) / 12$   
 Inner Ring Frequency =  $N * RPM * (1 + (Bd * \cos a / Pd)) / 120$   
 Roller Spin Frequency =  $Pd * RPM * (1 - (Bd * \cos a / Pd)^2) / (120 * Bd)$   
 Cage Frequency =  $RPM * (1 - (Bd * \cos a / Pd)) / 120$

Pd = Pitch Diameter  
 N = Number of rollers  
 Bd = Roller Diameter  
 a = Contact Angle

# ENGINEERING


**Table 10: USDAF Spherical Roller Bearing Parameters For Vibration Analysis (1-RPS)**

Bore Size	Basic Bearing Series	# Rollers Per Row	Diameter of Rollers	Pitch Diameter	Contact Angle	Outer Ring Frequency Hz	Inner Ring Frequency Hz	Roller Spin Frequency Hz	Cage Frequency Hz
10-15/16 - 11	23060K	27	1.575	15.066	9.5	12.108065	14.891935	4.732011	0.448447
11-7/16 - 12	23064K	28	1.575	15.85	9.333	12.627248	15.372752	4.983368	0.450973
12-7/16 - 12-1/2	23068K	27	1.732	17.007	9.5	12.144010	14.855990	4.860109	0.449778
12-15/16 - 13-1/2	23072K	28	1.732	17.793	9.333	12.655257	15.344743	5.089157	0.451973
13-15/16 - 14	23076K	30	1.732	18.587	9	13.619458	16.380542	5.320311	0.453982
15	23080K	29	1.929	19.822	9.167	13.106938	15.893062	5.090472	0.451963
15-3/4	23084K	30	1.929	20.609	9	13.613287	16.386713	5.296232	0.453776
9-7/16 - 9-1/2	23152K	23	1.693	13.914	12.5	10.133894	12.866106	4.051285	0.440604
10-7/16 - 10-1/2	23156K	24	1.732	14.711	12	10.618053	13.381947	4.190502	0.442419
10-15/16 - 11	23160K	23	1.89	15.923	12.333	10.166494	12.833506	4.155793	0.442021
11-15/16 - 12	23164K	23	2.087	17.044	12.833	10.127024	12.872976	4.025170	0.440305
12-7/16 - 12-1/2	23168K	23	2.244	18.272	12.833	10.122953	12.877047	4.012925	0.440128
13-7/16 - 13-1/2	23172K	24	2.244	19.077	12.333	10.621032	13.378968	4.194537	0.442543
13-15/16 - 14	23176K	25	2.323	19.833	12	11.067894	13.932106	4.212801	0.442716
8-15/16 - 9	23248K	20	1.929	13.523	14	8.615913	11.384087	3.438035	0.430796
9-7/16 - 9-1/2	23252K	19	2.126	14.745	14	8.170935	10.829065	3.399907	0.430049
10-7/16 - 10-1/2	23256K	20	2.126	15.537	13.583	8.669925	11.330075	3.589401	0.433496
10-15/16 - 11	23260K	20	2.323	16.706	13.833	8.649811	11.350189	3.530230	0.432491
11-15/16 - 12	23264K	20	2.441	17.878	14	8.675192	11.324808	3.597751	0.433760
12-7/16 - 12-1/2	23268K	20	2.638	19.048	14.167	8.657198	11.342802	3.545213	0.432860

Outer Ring Frequency =  $N * RPM * (1 - (Bd * \cos a / Pd)) / 120$

Inner Ring Frequency =  $N * RPM * (1 + (Bd * \cos a / Pd)) / 120$

Roller Spin Frequency =  $Pd * RPM * (1 - (Bd * \cos a / Pd)^2) / (120 * Bd)$

Cage Frequency =  $RPM * (1 - (Bd * \cos a / Pd)) / 120$

Pd = Pitch Diameter

N = Number of rollers

Bd = Roller Diameter

a = Contact Angle