RegalRexnord™

Sprag Retainer Assemblies

FORMSPRAG CLUTCH™

PRODUCT CATALOG

Formsprag Clutch

For more than 50 years Formsprag Clutch has been known as the world's leading authority for the design and manufacture of long-life overrunning clutches, backstops, bi-directional clutches and clutch couplings. Formsprag offers the broadest range of both sprag and ramp & roller type overrunning clutches and backstops available globally.

Exceptionally reliable Formsprag solutions are hard at work in many key markets including mining, aerospace & defense, packaging equipment, food processing, material handling and paper converting machinery on applications such as conveyors, rotary & fixed wing aircraft, pumps, hoists & cranes and machine tools.

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Formsprag's Quality Management System is certified to AS 9100 Rev. D and ISO 9001: 2015

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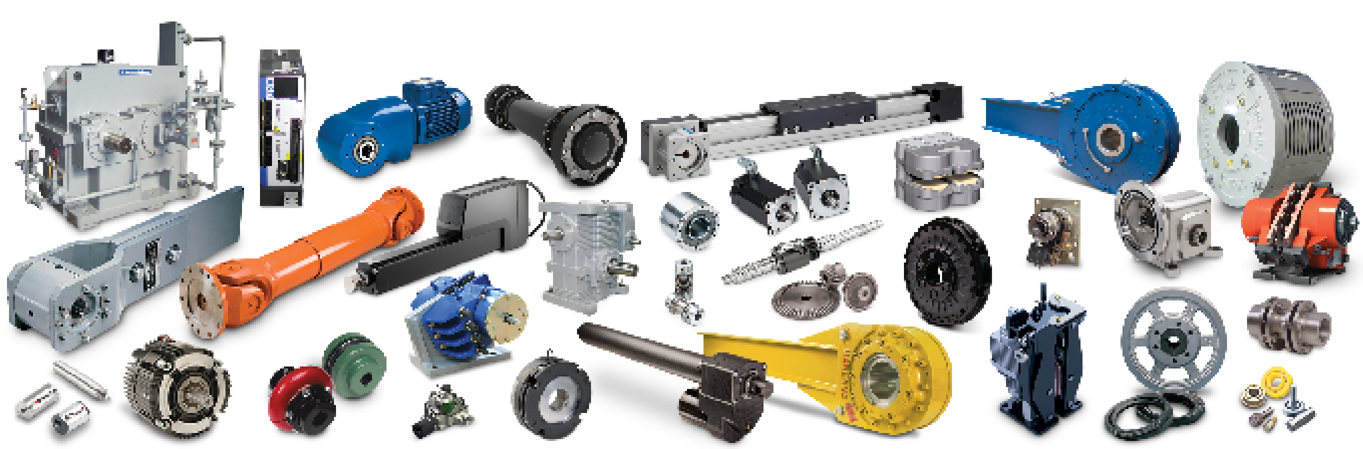


Formsprag Sprag Retainer Assemblies

The Formsprag Sprag Retainer Assembly permits each sprag to have free and independent action. This independence allows each sprag to adapt to variations in annular space (eccentricities) so that when the clutch is engaged, the load is proportionately shared among all sprags, eliminating the possibility of clutch damage resulting from the entire load being absorbed by just a few sprags. This insures dependable performance without compromising size, weight, or cost.

Springs energize the sprags into position for instantaneous engagement with no backlash. Contracting, expanding, and torsional springs have been developed by Formsprag. Selection of spring design depends upon the specific application requirements.

Features

- Free-action Retainer
- Free-action Sprags
- PCE Positive Continuous Engagement
- C/T Centrifugal Throwout Sprags (optional)
- Formchrome Sprags

Benefits

- Instantaneous action, no backlash
- Infinitely changing wear points, more torque, less space
- Protects clutch from damage due to momentary overload
- No rubbing contact yielding longer wear life
- Harder sprag surface yielding longer wear life

Helicopter Main Drive Auto-Rotation Clutch

Formsprag Clutch sprag retainer assemblies are used in the main drive of a single or multi-engine helicopter to provide auto-rotation capability, which helps assure a safe landing in an emergency situation.

Gas Turbine Engine Starter Clutch

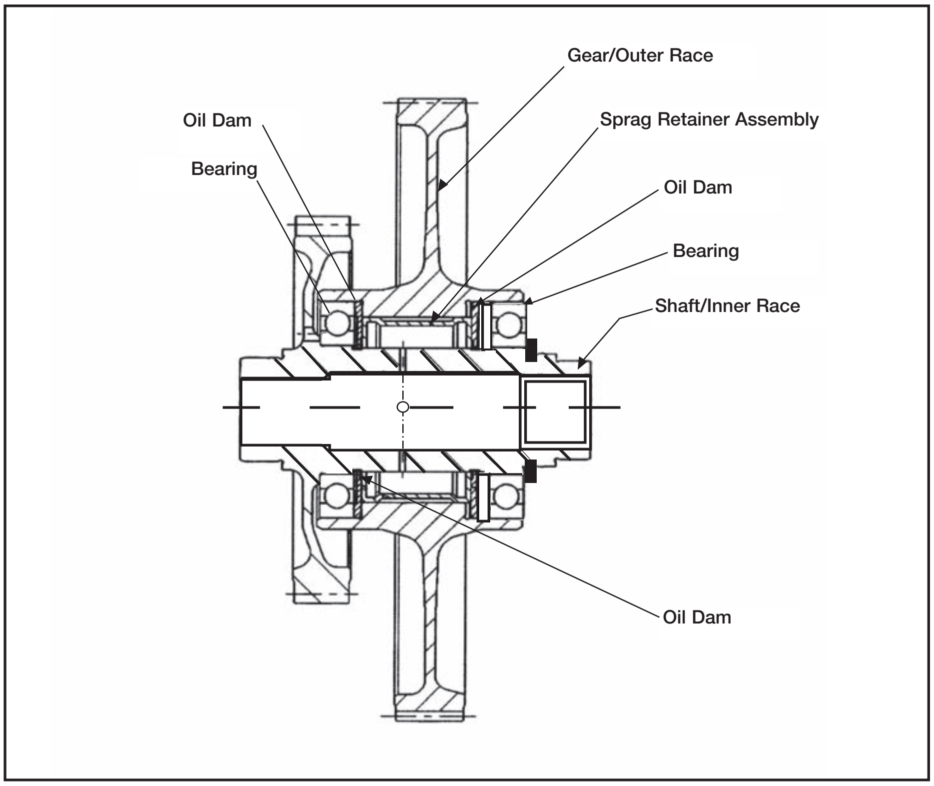
Formsprag Clutch sprag retainer assemblies are used in the starter drive of a jet turbine engine to provide automatic disconnect from the engine upon light-up.

Aircraft Auxiliary Power Unit (APU) Starter Clutch

Formsprag Clutch sprag retainer assemblies are used in the starter drive of APUs to automatically disconnect the starter after powering up.

Helicopter Twinning Gearbox Clutch

Formsprag Clutch sprag retainer assemblies are used in the driveline gearboxes of multi-engine helicopters to allow twinning of the engines for effficient power sharing and synchronization or disengagement of one engine.



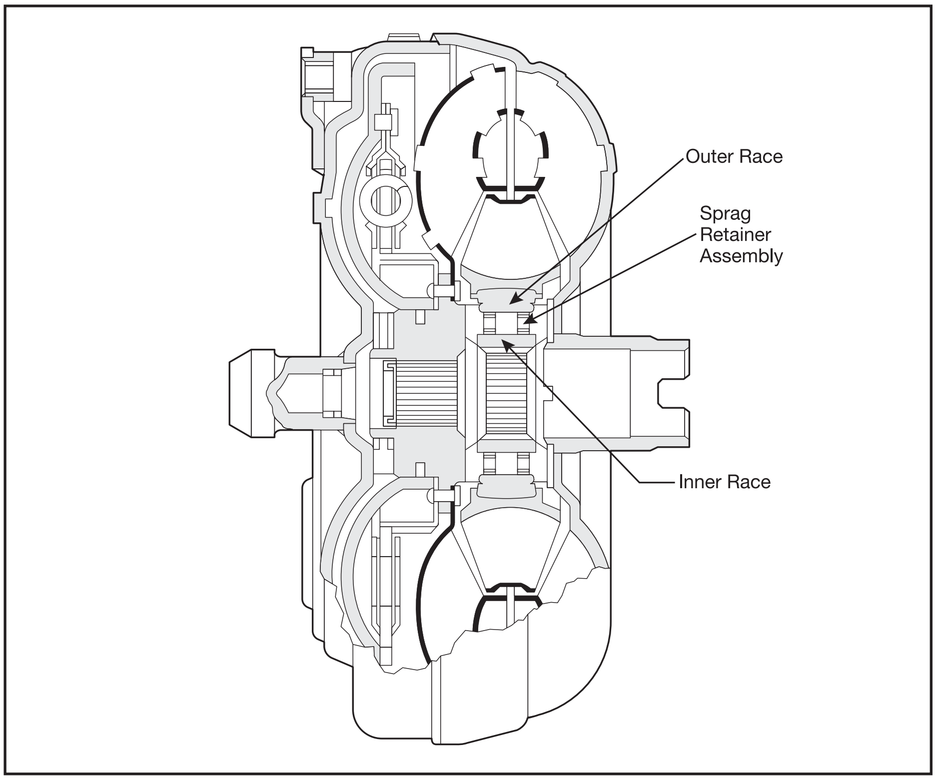
Typical Sprag Retainer Assembly in Aerospace Applications

A Formsprag Clutch sprag retainer assembly is used with a spring set brake to provide a releasable backstopping feature to the winch drive. The Sprag retainer allows the spool to rotate in one direction only unless the spring set brake is released.

A Formsprag Clutch sprag retainer assembly in agriculture transmissions automatically disconnects low speed gears.

Formsprag Clutch sprag retainer assemblies are used in torque converters and special racing transmissions to allow for internal speed differentials.

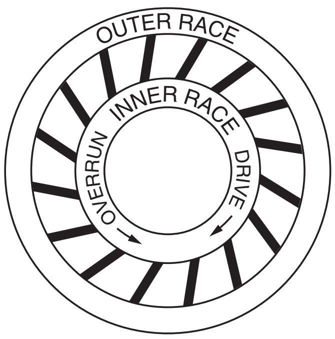
A Formsprag Clutch sprag retainer assembly in the Diesel Engine Turbo Charger provides automatic disconnect at high speeds.



Typical Sprag Retainer Assembly in a Torque Converter Application

Sprag Design

This sprag-type design overrunning clutch generally consists of an inner race, an outer race, a set of sprags, a sprag retainer, energizing springs, and bearings.



The wedging of the sprags between the races transmits power from one race to the other. The sprags have a greater diagonal dimension across one set of corners than across the other (see Figure 1). The wedging action occurs when the relative rotation of the inner and outer races tends to force the sprag to a more upright position where the cross-section is greater.

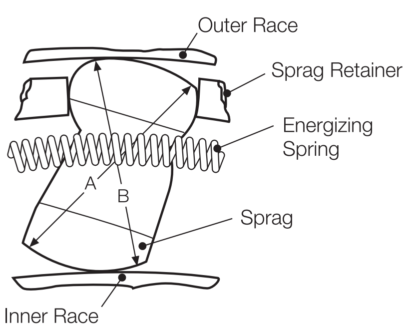


Figure 1
Detail of sprag. Dimension “A” is greater than dimension “B.”

Gripping Angle

Wedging action depends upon the wedging, or gripping angle of the sprags between the races. The fundamental concept of sprag clutches requires that the coefficient of friction of the sprag, with respect to the inner race at the instant torque is applied in the drive direction, must be greater than the tangent of the gripping angle, GA. If the condition is not satisfied, wedging will not occur.

The gripping angle is determined by the construction of Figure 2, where points A and B are the points of contact of the sprag with the inner and outer races, respectively.

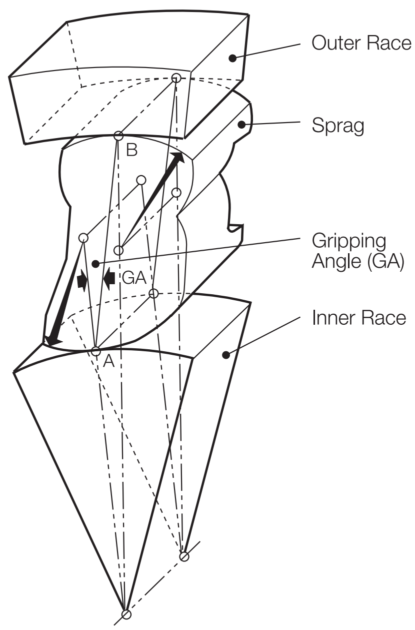


Figure 2
Geometry of sprag, showing gripping angle “GA.”

Sprags are designed to have a low initial gripping angle to insure positive initial engagement. As torque increases, the sprags produce radial forces which cause race deflections, which make the sprags roll to new positions. Sprags are usually designed to have an increasing gripping angle as they roll from overrunning position to maximum load-carrying position. A higher gripping angle reduces the radial load imposed by the sprag, thus permitting higher torques to be transmitted within the limits of race stretch and brinelling.

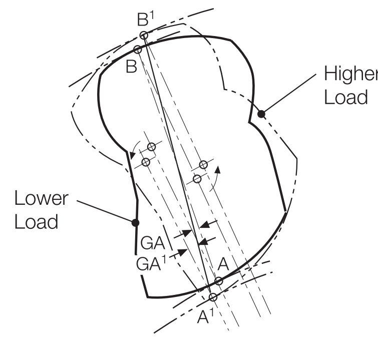


Figure 3
Gripping angle and annular space increase as load increases.

Figure 4
Formsprag manufactures a wide variety of sprag sizes and shapes to meet all application requirements.

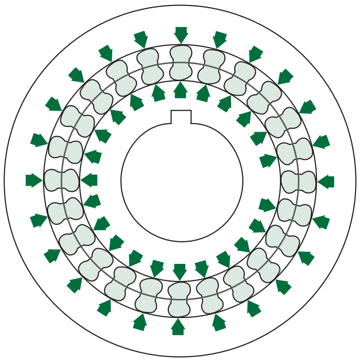


Figure 5

Figure 6

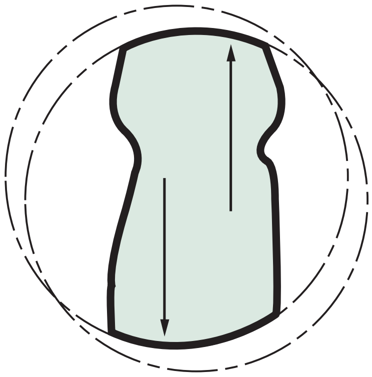


Figure 7

The Formsprag clutch engages in an infinite number of points on both races and, thus, distributes the wear over the entire circumference of both races—as well as giving an infinite number of engaging points.

In other types of overruning clutches, wear is repeatedly imposed on certain fixed points, such as the single tooth of the ratchet or the same spot on each ramp of the roller clutch. In the Formsprag clutch the sprags engage both races constantly with infinitely changing points of contact. As a result of this, as long as the Formsprag clutch is operating, it operates precisely because the contour of each sprag allows it to rotate to compensate for sprag wear.

Not only does the Formsprag clutch have an infinite number of contact points on the races for each sprag, but each Formsprag clutch also carries a full complement of load-transmitting sprags or wedges. This means that the load is being transmitted by the maximum practical number of sprags which spreads the load more completely over the clutch and, as a result, allows the clutch to deliver far more torque capacity for its size than any other type of overrunning mechanism. (see Figure 5)

Each sprag in the Formsprag overrunning clutch is independently energized so that it is always in contact with both races at all times (see Figure 6). Because of the fact that the sprags are always in contact with both races, there is never any relative motion required between the sprags and the races in order to transmit torque. The Formsprag overrunning clutch engages instantly because the sprags are always in contact and will disengage instantly. Because the Formsprag clutch engages instantly, there is never any backlash between the races when torque is transmitted. There will be a certain amount of torsional windup due to the elasticity of all materials but as long as the load applied remains constant, the torsional windup will remain constant and can be canceled out during the initial setup of a mechanism.

The cam surface of each sprag in a Formsprag overrunning clutch is actually a section of a cylinder having a diameter far greater than the annular space between the inner and outer races (see Figure 7). This results in a contact surface for the working radii of the sprags far greater than is possible with any other type of overrunning clutch. This increased contact surface also results in lower stresses on both the sprags and the races with the result of greater resistance against the possibility of brinelling in the presence of maximum torque loadings.

The portions of the cylinders that form the cam surfaces of the sprag have their centers displaced from one another in both the horizontal and vertical planes. The displacement of these centers results in the change in gripping angle previously described and also results in a remarkable tolerance for wear.

As the sprags begin to show wear as the result of long periods of over-running, they will stand a little bit straighter with respect to the radial line. The offset relationship between the centers of the cam surfaces of the sprags results in a sprag having a greater dimension across the “load corner” than across the “overrunning corner” of the sprag. Thus as the sprag does show wear, it simply stands a little straighter and finds a new portion of its cam surface which still continues to fill the annular space between the two races.

The energizing springs, of course, will keep the sprags in contact with both races at all times.

PCE Positive Continuous Engagement Retainer Assembly

The Formsprag PCE (Positive Continuous Engagement) design prevents sprag rollover from momentary torque overload, yet does not interfere with normal retainer engagement or overrunning. It possesses all the advantages of Formsprag Free-Action operation.

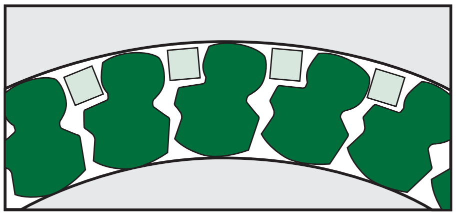
The patented PCE retainer was originally developed to meet the demands of high performance aircraft and helicopter applications. The PCE design provides reliable performance, even under extremes of torsional vibration and severe transient overload. PCE retainers are now available for a wide range of applications.

Formsprag PCE sprags and FreeAction® retainer are ideal for confined space applications with flight weight limitations. The retainer spaces and positions each sprag uniformly, yet allows independent action.

The geometry of the PCE Sprag provides proper top and bottom working surfaces for normal overrunning or engagement. The left hand and right hand flank projections, which prevent roll-over, also provide protection for the energizing springs, and prevent damage under overload conditions.

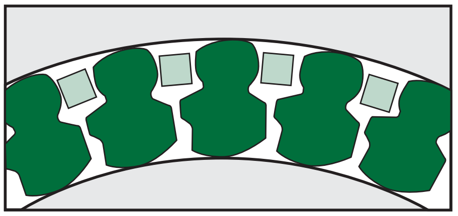
Free-action overrunning condition

The special configuration of the sprags permits individual PCE "Free-Action" in the presence of the normal runouts and eccentricities that occur between inner and outer races, even in a very precise assembly.



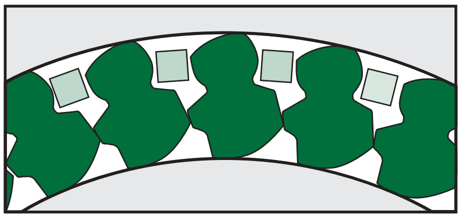
Regular engagement condition

The PCE "Free-Action" retainer permits individual positioning of the sprags so that when the load is applied, each sprag carries a proportionate share of the torque.



Overload imposed conditions

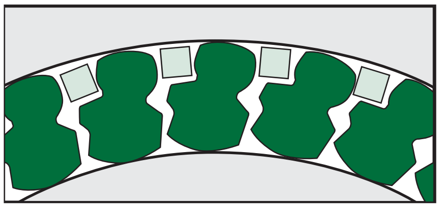
Under extreme overload conditions, the proven PCE sprag retainer configuration results in positive sprag-to-sprag abutment, which prevents excessive clutch windup. The flank of one sprag comes into contact with the flank of the next, resisting further sprag roll. This prevents the sprag from going past the cam corner, protecting the clutch against damage during momentary overload.



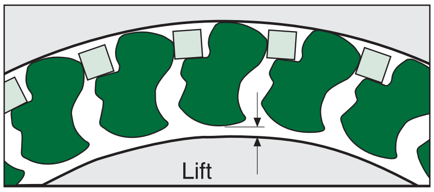
Formsprag Centrifugal Throwout, or C/T, retainer assemblies are designed for high speed overrunning, lower speed drive conditions.

The centrifugally disengaging sprag design locates the center of gravity (CG) of the sprag relative to its contact point on the outer sprag diameter, such that when the outer race is overrunning the centrifugal force on the sprags overcomes the energizing force of the springs. This causes the sprags to completely lift off the inner race. This "lift off" speed must always be greater than the maximum drive speed to insure positive sprag energizing. For C/T action to occur, the outer race must be the overrunning member. Overrunning the inner race does not result in C/T sprag lift off.

The primary advantage of the centrifugal throwout sprag retainer is that when the sprags lift off the inner race there is no rubbing contact. Therefore, the overrunning life of the clutch is determined only by the life of its bearings and seals.



Low RPM-Conventional Overrunning
During low speed overrunning, the C/T retainer possesses all of the benefits of the "Free-Action" retainer.



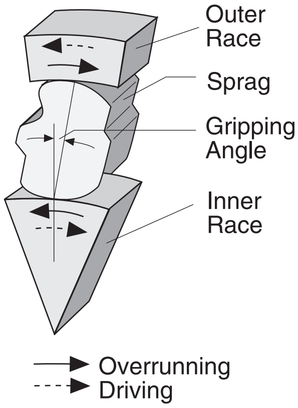
High RPM-C/T Overrunning
At the lift-off speed, the sprags overcome the spring energizing force and lift completely off the inner race, thereby eliminating rubbing contact.

Formchrome® extends sprag life

Formsprag's Formchrome process extends sprag life to lower your equipment costs. This special technique diffuses chromium into the sprag steel to produce an ultrahard, long wearing surface. Formchrome increases the surface hardness of the base metal, SAE 52100 steel, from 800 Knoop to approximately 1,300 Knoop. Subsequent heat treatment ensures a hard sprag core to support the chromized surface.

For the most demanding applications, patented Pink Phase Super Formchrome offers unique protection against wear. An intermediate layer of chromium nitride, the pink phase, is formed by diffusion of nitrogen into the metallic surface. The surface hardness produced by this process is approximately 2,000 Knoop.

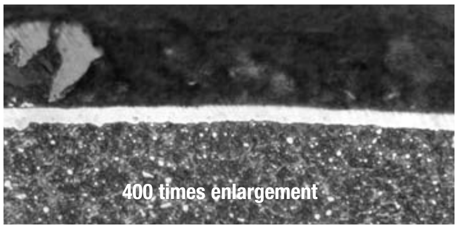
PCE and standard sprags come with Formchrome chromium carbide surfaces as a standard feature. Pink Phase Super Formchrome is optional. Sprags chromized by either method will last significantly longer than plain steel sprags hardened to 800 Knoop.

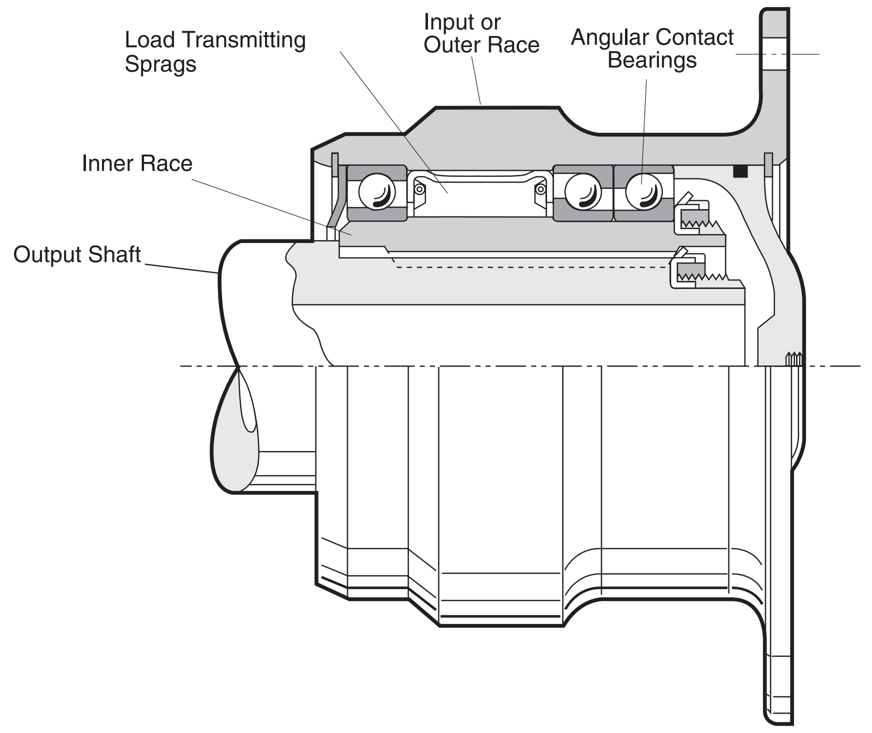


Excessive wear causes gripping angle of a sprag clutch to increase to the point where, eventually, the clutch will not operate properly. High wear resistance in a sprag material is important, particularly when clutches must operate at high speed in the overrunning direction.

Hardness Comparison

Material	Hardness (Knoop)
Diamond	7,000
Titanium Carbide	2,470
Pink-Phase Chromize	2,000
Tungsten Carbide/Cobalt Alloy	1,400-1,480
Chromized SAE52100 Steel	1,200-1,300
Chromium	935
M-50 Steel, or SAE52100 Steel (Rc 63)	800
Glass (Soda-Lime)	530
Silver	60
Cadmium	37





1. Calculate load torque to be transmitted by the clutch.

   Torque (lb.ft.) = $\frac{5252 \times HP}{RPM}$

   Torque (Nm) =

   Torque (lb.ft.) x 1.356 Nm/lb.ft.
2. Select service factor from table below.
3. Determine design torque—multiply load torque by service factor.
4. Select clutch from tables on pages 10 through 12, based on design torque and available space.

- Two retainer assemblies can be used side-by-side with the same inner and outer races, resulting in a torque capacity equal to the sum of the capacities of the two assemblies.

5. Overrunning Considerations: Allowable overrunning speeds are dependent primarily on two variables, sprag contact pressure and lubrication. As speed increases, it becomes more critical to balance these two factors to maximize design life. To insure design optimization, ALL applications should be referred to Formsprag's Application Engineering Department for technical review.

- It is recommended that the design incorporate the inner race as the overrunning member, as this arrangement permits higher overrunning speeds.
- C/T retainers are designed for outer race overrunning and may be used only when the drive speed is substantially less than the overrunning speed.

Service Factors*

Type of Load	Service Factor
Gradually applied steady loads	1.0
Fluctuating load with minor shock	1.5
Suddenly applied loads and indexing	2.0
High torque, severe shock, rugged duty (jogging)	4.0 to 6.0

*Formsprag Clutch always recommends contacting the Formsprag Engineering Department for service factor and application expertise.

Race Requirements

It is essential to control the following design characteristics to ensure proper clutch function: axial taper of the races, surface finish, and cumulative eccentricity (which is dependent upon bearing clearances and eccentricities and race diameter tolerances).

Taper

Axial taper of the ground sprag diameters should be limited to .0002 inch per inch. (0.05mm per 25mm)

Surface Finish

Sprag diameters should be ground to a microfinish of 15 to 25 microinches (0.38 to 0.64 micrometer). These surfaces should be free of any surface defects, such as grinding burns and checks, stringers, laps, or inclusions of any kind.

Runout

Runout of the sprag diameters must be held to the values listed in the chart below. The accumulated eccentricities should be carefully checked to insure that they are under this limit. Aircraft applications at higher RPM must be a tighter concentricity than listed. Consult Formsprag Application Engineering Department.

Inner Race Sprag Diameter in. (mm)	T.I.R. in. (mm)
Below 2 (50)	.001 (.025)
2 to 3 (50-75)	.002 (.051)
Over 3 (over 75)	.003 (.076)

Materials/Races

A carburizing grade of steel, free from inclusions is recommended for use as inner and outer race material. Vacuum degassed steel is preferable and is used in Formsprag clutch designs as a standard material. For best heat treat properties, alloy steels such as SAE 8620 are preferred for smaller races (smaller than 3-1/4 inches outer race diameter), SAE 9310, SAE 8630, or SAE 8640 for larger races (3-1/4 inches and larger outer race diameter).

Hardness

Inner Race Sprag Diameter in. (mm)	Effective Finished Case Depth* Inner and Outer Race Sprag Diameter in. (mm)		
Below 3/4 (19)	.030 (.76)	to	.040 (1.0)
3/4 to 4-1/4 (19-108)	.050 (1.3)	to	.080 (2.0)
Over 4-1/4 (over 108)	.090 (2.30)	to	.100 (2.5)

The surface hardness of the sprag diameters is to be 58-62 Rc and the core hardness of the races is to be 28 Rc minimum.

**Distance from the finished, ground surface to the point where 50 Rockwell "C" reading is obtained is the effective case depth.*

These case depths allow for regrinding of the races for use with over-size sprags as part of our rebuildable design concept. For applications that do not require this rebuilding feature, thinner case depths are possible, contact Formsprag Engineering.

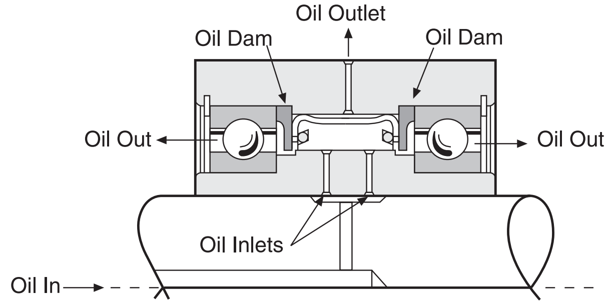
Lubrication

Proper lubrication is essential to sprag retainer life. In any application, the method and type of lubrication must be considered with the initial design.

The following drawing illustrates a method that assures continuous oil flow at the inner race surface during high speed operation. Oil flows into the clutch annulus from the center drilled shaft through the holes in the inner race. Oil dams extend below the inner race surface to maintain the oil level and provide lubrication at the sprag/inner race contact line. A small purge hole is located in the outer race to allow contaminants to escape from the annulus.

Oils containing slippery or anti-wear additives, such as graphite or molybdenum disulfide, or extreme pressure (EP) type lubricant should not be used because the lubrication films will inhibit proper sprag engagement. Operating temperature is also a prime consideration when selecting a lubricant.

Formsprag retainers should be lubricated with a good grade of ATF, SAE 10 or SAE 20 oils. Also, oils meeting specifications MIL-H-5606, MIL-PRF-7808, MIL-PRF-23699 or DOD-L-85734 are acceptable. For a complete list of lubricants approved for use in sprag retainer applications please request Catalog P-1053.

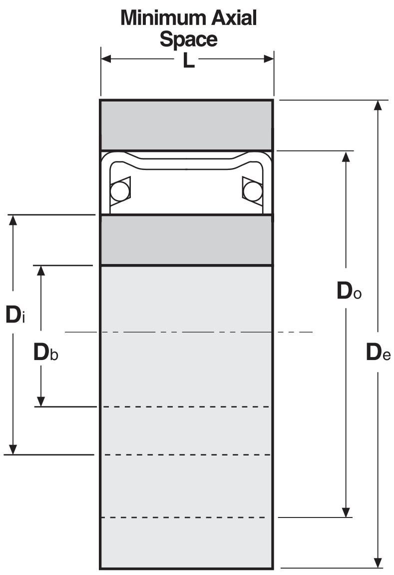


PCE-Positive Continuous Engangement Sprag Retainers

Theoretical Design Sizes

Race design is critical to PCE action. The specific race dimensions listed below must be used to insure sprag lock-up at the proper torque and acceptable stress levels. The race thicknesses listed will yield lock-up at approximately 160% of rated torque. Thicker race sections will result in higher stress levels before PCE Sprag lock-up occurs. Maximum torque is reduced for thin race sections allowing PCE Sprag lock-up to occur at lower torque levels.

The tabulated clutch listings are computer generated. It is intended as an engineering guide for design purposes only. Consult Formsprag Engineering for details



Di = *Inner race diameter*

Do = *Outer race sprag diameter*

Db = *Inner race bore*

De = *Outer race outer diameter*

L = *Minimum axial space (actual retainer width + .005 inches)*

Di Inner Race Sprag Diameter		Do Outer Race Sprag Diameter		Db Inner Race Bore		De Outer Race OD		Mean Annular Space		No. of Sprags
Inch +0.0000 -0.0005	mm +0.000 -0.013	Inch +0.0010 -0.0000	mm +0.025 -0.000	Inch +0.01 -0.01	mm +0.25 -0.25	Inch +0.01 -0.01	mm +0.25 -0.25	Inch	mm	
.8226	20.894	1.3182	33.482	0.500	12.70	1.62	41.15	0.248	6.299	17
.8282	21.036	1.3238	33.625	0.500	12.70	1.74	44.20	0.248	6.299	18
.9333	23.706	1.4289	36.294	0.600	15.24	1.77	44.96	0.248	6.299	19
.9854	25.029	1.4810	37.617	0.600	15.24	1.89	48.01	0.248	6.299	20
1.0651	27.054	1.5607	39.642	0.700	17.78	1.94	49.28	0.248	6.299	21
1.1227	28.517	1.6183	41.105	0.600	15.24	2.15	54.61	0.248	6.299	22
1.1548	29.332	1.6504	41.920	0.500	12.70	2.29	58.17	0.248	6.299	23
1.2479	31.697	1.7435	44.285	0.800	20.32	2.33	59.18	0.248	6.299	24
1.3085	33.236	1.8041	45.824	0.800	20.32	2.44	61.98	0.248	6.299	25
1.3691	34.775	1.8647	47.363	0.800	20.32	2.56	65.02	0.248	6.299	26
1.4287	36.289	1.9243	48.877	0.800	20.32	2.68	68.07	0.248	6.299	27
1.4893	37.828	1.9849	50.416	0.800	20.32	2.81	71.37	0.248	6.299	28
1.5499	39.367	2.0455	51.956	0.800	20.32	2.95	74.93	0.248	6.299	29
1.5698	39.873	2.3168	58.847	1.200	30.48	2.71	68.83	0.374	9.500	20
1.6810	42.697	2.4280	61.671	1.200	30.48	2.94	74.68	0.374	9.500	21
1.7692	44.938	2.5162	63.911	1.200	30.48	3.12	79.25	0.374	9.500	22
1.8594	47.229	2.6064	66.203	1.200	30.48	3.30	83.82	0.374	9.500	23
1.9810	50.317	2.7280	69.291	1.400	35.56	3.40	86.36	0.374	9.500	24
2.0752	52.710	2.8222	71.684	1.400	35.56	3.54	89.92	0.374	9.500	25
2.1654	55.001	2.9124	73.975	1.400	35.56	3.73	94.74	0.374	9.500	26
2.2681	57.610	3.0151	76.584	1.600	40.64	4.06	103.12	0.374	9.500	27
2.3628	60.015	3.1098	78.989	1.600	40.64	4.19	106.43	0.374	9.500	28
2.4570	62.408	3.2040	81.382	1.600	40.64	4.35	110.49	0.374	9.500	29
2.5506	64.785	3.2976	83.759	1.500	38.10	4.41	112.01	0.374	9.500	30
2.6458	67.203	3.3928	86.177	1.500	38.10	4.59	116.59	0.374	9.500	31
2.7410	69.621	3.4880	88.595	1.500	38.10	4.78	121.41	0.374	9.500	32
2.8362	72.039	3.5832	91.013	1.500	38.10	4.98	126.49	0.374	9.500	33
2.9309	74.445	3.6779	93.419	1.500	38.10	5.18	131.57	0.374	9.500	34
3.0261	76.863	3.7731	95.837	1.500	38.10	5.40	137.16	0.374	9.500	35
3.1208	79.268	3.8678	98.242	1.500	38.10	5.62	142.75	0.374	9.500	36
3.2159	81.684	3.9629	100.658	1.500	38.10	5.86	148.84	0.374	9.500	37
3.3116	84.115	4.0586	103.088	1.500	38.10	6.10	154.94	0.374	9.500	38
3.4068	86.533	4.1538	105.507	1.500	38.10	6.37	161.80	0.374	9.500	39
3.5020	88.951	4.2490	107.925	1.500	38.10	6.64	168.66	0.374	9.500	40
3.5937	91.280	4.3407	110.254	1.200	30.48	6.72	170.69	0.374	9.500	41
3.6909	93.749	4.4379	112.723	1.200	30.48	6.96	176.78	0.374	9.500	42
3.7860	96.164	4.5330	115.138	1.200	30.48	7.27	184.66	0.374	9.500	43
3.8812	98.582	4.6282	117.556	1.200	30.48	7.59	192.79	0.374	9.500	44
3.9754	100.975	4.7224	119.949	0.800	20.32	7.68	195.07	0.374	9.500	45
4.0706	103.393	4.8176	122.367	0.800	20.32	8.01	203.45	0.374	9.500	46
4.1648	105.786	4.9118	124.760	0.000	0.00	8.22	208.79	0.374	9.500	47
4.2610	108.229	5.0080	127.203	0.000	0.00	8.55	217.17	0.374	9.500	48
4.3561	110.645	5.1031	129.619	0.000	0.00	8.94	227.08	0.374	9.500	49
4.4513	113.063	5.1983	132.037	0.000	0.00	9.35	237.49	0.374	9.500	50

0.530 Inch	13.5 mm	0.625 Inch	15.9 mm	0.750 Inch	19.1 mm	0.825 Inch	21.0 mm	0.875 Inch	22.2 mm	1.000 Inch	25.4 mm	1.250 Inch	31.8 mm
lb.ft.	Nm	lb.ft.	Nm	lb.ft.	Nm	lb.ft.	Nm	lb.ft.	Nm	lb.ft.	Nm	lb.ft.	Nm
40	54	52	71	69	94	85	115	87	118	111	150	—	—
46	62	61	83	82	111	94	127	102	138	123	167	—	—
55	75	74	100	98	133	113	153	117	159	148	201	—	—
61	83	82	111	109	148	126	171	130	176	164	222	—	—
73	99	97	132	130	176	150	203	154	209	196	266	—	—
81	110	108	146	144	195	165	224	180	244	216	293	—	—
86	117	114	155	153	207	175	237	191	259	229	310	—	—
99	134	133	180	177	240	204	277	209	283	265	359	—	—
109	148	145	197	193	262	222	301	229	310	291	395	—	—
119	161	158	214	212	287	243	329	250	339	319	433	—	—
129	175	172	233	229	310	264	358	272	369	345	468	—	—
140	190	186	252	248	336	286	388	295	400	374	507	—	—
150	203	201	273	268	363	309	419	319	433	405	549	—	—
183	248	259	351	338	458	369	500	389	527	442	599	552	748
200	271	283	384	395	536	462	626	508	689	616	835	767	1040
219	297	310	420	431	584	505	685	554	751	678	919	936	1269
240	325	339	460	471	639	552	748	606	822	741	1005	1024	1388
282	382	398	540	555	752	649	880	714	968	857	1162	1108	1502
309	419	436	591	606	822	711	964	780	1058	955	1295	1211	1642
333	451	470	637	655	888	766	1039	843	1143	1030	1396	1373	1862
366	496	517	701	720	976	843	1143	925	1254	1131	1533	1460	1979
397	538	560	759	780	1058	913	1238	1003	1360	1228	1665	1583	2146
430	583	606	822	843	1143	985	1335	1083	1468	1327	1799	1708	2316
463	628	652	884	906	1228	1063	1441	1165	1580	1425	1932	1837	2491
496	672	700	949	974	1321	1140	1546	1251	1696	1532	2077	1977	2680
532	721	750	1017	1042	1413	1221	1655	1340	1817	1643	2228	2117	2870
568	770	803	1089	1114	1510	1306	1771	1433	1943	1753	2377	2261	3065
607	823	856	1161	1188	1611	1395	1891	1532	2077	1867	2531	2453	3326
645	874	912	1236	1268	1719	1484	2012	1630	2210	1988	2695	2606	3533
686	930	967	1311	1342	1819	1571	2130	1726	2340	2117	2870	2765	3749
727	986	1027	1392	1427	1935	1671	2266	1829	2480	2235	3030	2936	3981
773	1048	1087	1474	1512	2050	1764	2392	1941	2632	2373	3217	3106	4211
818	1109	1146	1554	1597	2165	1864	2527	2052	2782	2510	3403	3289	4459
863	1170	1211	1642	1690	2291	1973	2675	2161	2930	2647	3589	3471	4706
906	1228	1273	1726	1769	2398	2067	2802	2278	3089	2776	3764	3708	5027
957	1298	1346	1825	1874	2541	2190	2969	2400	3254	2927	3968	3847	5216
1007	1365	1419	1924	1964	2663	2298	3116	2519	3415	3073	4166	4043	5481
1057	1433	1481	2008	2067	2802	2403	3258	2653	3597	3238	4390	4239	5747
1105	1498	1551	2103	2154	2920	2523	3421	2768	3753	3403	4614	4458	6044
1154	1565	1635	2217	2272	3080	2643	3583	2900	3932	3544	4805	4647	6300
1211	1642	1704	2310	2372	3216	2760	3742	3030	4108	3706	5025	4948	6708
1270	1722	1789	2426	2473	3353	2902	3935	3186	4320	3868	5244	5170	7009
1328	1801	1857	2518	2591	3513	3017	4090	3314	4493	4058	5502	5386	7302
1386	1879	1940	2630	2687	3643	3158	4282	3467	4701	4215	5715	5644	7652

Torque Ratings for Minimum Axial Space (L)

PCE-Positive Continuous Engagement sprag retainers:

- Provide life and reliability of "Free Action" retainers
- Prevent clutch damage from momentary overloads
- Available with centrifugal throwout (C/T) feature for increased wear life*

PCE sprags protect your clutch from torque overloads. Under excessive torque, sprags roll beyond their normal engagement positions. A severe overload can roll standard sprags past their cam corners and cause the clutch to malfunction. PCE protects against rollover from momentary overload by providing positive, sprag-to-sprag abutment. When the overload is removed, the sprags return to their normal operating positions.

Formsprag has a selection of various over-cam sprag sizes in free action, PCE and C/T designs, see table. The size and design selected is dependent upon the application.

Typical Over-cam sprag dimensions:

in.	(mm)
0.248	(6.299)
0.328	(8.331)
0.374	(9.500)
0.433	(10.988)
0.500	(12.700)
0.622	(15.799)

Consult Formsprag Clutch Engineering for your specific requirements.

* PCE action may not be available with certain C/T retainers.

PCE Sprag Retainers

The Sprag Retainer assemblies listed below represent both past and present designs which may be supplied at short notice. If you are redesigning an installation or have a new design, not shown, please refer to pages 10 and 11 and consult Formsprag Engineering for details.

Di Inner Race Sprag Diameter		Do Outer Race Sprag Diameter		Db Inner Race Bore		De Outer Race OD		Mean Annular Space		No. of Sprags	L Minimum Axial Space		Torque Rating	
Inch +0.0000 -0.0005	mm +0.000 -0.013	Inch +0.0010 -0.0000	mm +0.025 -0.000	Inch +0.01 -0.01	mm +0.25 -0.25	Inch +0.01 -0.01	mm +0.25 -0.25	Inch	mm		Inch	mm	lb.ft.	Nm
.9614	24.420	1.4570	37.008	.625	15.875	2.00	50.800	0.248	6.299	20	0.720	18.288	100	135
1.2720	32.309	.7670	44.895	.875	22.225	2.37	60.325	0.248	6.299	24	0.465	11.811	100	135
1.3542	34.397	1.8502	47.041	.813	20.651	2.62	66.675	0.248	6.299	26	0.600	15.240	160	216
1.3753	34.933	2.1250	59.975	.813	20.651	3.00	76.20	0.374	9.500	18	0.868	22.047	250	339
1.4995	38.087	2.1550	54.757	1.000	25.40	2.75	69.850	0.328	8.331	21	0.588	14.935	165	223
1.6630	42.240	2.3200	58.928	1.188	30.175	3.00	76.20	0.328	8.331	23	1.005	25.527	500	677
1.7500	44.445	2.4060	61.112	1.250	31.750	3.00	76.20	0.328	8.331	24	.626	15.900	300	406
1.8594	47.229	2.6064	66.203	1.250	31.750	3.50	88.90	0.374	9.500	23	.945	24.003	700	949
1.9478	49.474	2.6970	68.504	1.312	33.325	4.25	107.95	0.374	9.500	24	1.268	32.207	1000	1356
1.9577	49.726	2.6130	66.370	1.375	34.925	3.50	88.90	0.328	8.331	27	1.000	25.400	475	644
2.2740	57.760	2.9292	74.402	1.531	38.887	4.00	101.60	0.328	8.331	30	1.000	25.400	912	1236
2.5540	64.872	3.3005	83.833	1.500	38.100	4.50	114.30	0.374	9.500	30	.755	19.685	960	1301
2.8317	71.925	3.5905	91.199	1.813	46.050	5.00	127.000	0.374	9.500	33	1.065	27.051	1790	2426
2.8345	71.996	3.5020	88.951	1.813	46.050	5.00	127.000	0.332	8.331	37	.817	20.752	675	915
2.8440	72.238	3.5910	91.199	1.813	46.050	5.38	136.65	0.374	9.500	33	1.268	32.207	2200	2983
3.2115	81.572	3.9580	100.533	2.250	57.150	5.00	127.000	0.374	9.500	37	1.045	26.543	1500	2033
4.0646	103.241	4.8120	122.225	2.750	69.850	6.00	152.400	0.374	9.500	46	.755	19.050	1300	1762
4.2387	107.663	5.2390	133.071	2.750	69.850	6.50	165.100	0.500	12.700	40	1.260	31.902	4600	2033
4.4925	114.110	5.2390	133.071	3.000	76.200	7.00	177.800	0.374	9.500	51	1.268	32.080	2600	3525
4.8777	123.876	5.6247	142.867	3.250	82.550	7.00	177.800	0.374	9.500	55	1.250	31.623	2700	3660

Standard Stock Retainers

The Sprag Retainers listed below are suitable for industrial applications and are available from stock where lead time is critical. These Sprag Retainer assemblies are not suitable for Aerospace applications. For Aerospace applications contact Formsprag Aerospace Engineering for assistance.

	Di, Inner Race Sprag Diameter		Do, Outer Race Sprag Diameter		Db Inner Race Bore		De Outer Race OD		Mean Annular Space		No. of Sprags	L Minimum Axial Space		Torque Rating	
Part No. (Ends with - spare)	Inch +0.0000 -0.0005	mm +0.000 -0.013	Inch +0.0010 -0.0000	mm +0.025 -0.000	Inch +0.01 -0.01	mm +0.25 -0.25	Inch +0.01 -0.01	mm +0.25 -0.25	Inch	mm		Inch	mm	lb.ft.	Nm
CL41327-	1.0034	25.486	1.4990*	38.075*	0	0	2.00	50.80	0.248	6.299	20	0.655	16.64	85	115
CL42080-	1.3753	34.933	2.1250	53.975	0	0	3.00	76.20	0.374	9.500	18	0.868	22.05	250	339
CL41173-4	1.3783	35.009	2.1250	53.975	0	0	2.88	73.15	0.374	9.500	18	0.855	21.72	275	373
CL41291-	1.7849	45.336	2.5315	64.300	0	0	3.25	82.55	0.374	9.500	22	1.015	25.78	400	542
CL42081-	1.9478	49.474	2.6970	68.504	0	0	4.25	107.95	0.374	9.500	24	1.268	32.21	1,000	1,356
CL41123-1	2.1923	55.684	2.9388	74.646	0	0	3.75	95.25	0.374	9.500	28	1.016	25.81	650	881
CL40517-	2.2738	57.754	3.0203	76.715	0	0	3.94	100.07	0.374	9.499	28	.725	18.41	700	948
CL40741-1	2.5996	66.030	3.3461	84.991	0	0	4.44	112.78	0.374	9.500	32	1.016	25.81	1,300	1,763-
CL40584-	2.6811	68.100	3.4276	87.061	0	0	4.50	114.30	0.374	9.499	34	1.000	25.40	1,100	1,490
CL40557-	2.6811	68.100	3.4276	87.061	0	0	4.50	114.30	0.374	9.499	34	.707	17.95	800	1,084
CL42082-	2.8440	72.238	3.5905	91.199	0	0	5.38	136.65	0.374	9.500	33	1.268	32.21	2,200	2,983
CL42185-	3.3328	84.653	4.0793	103.614	0	0	5.38	136.65	0.374	9.500	38	1.032	26.21	2,200	2,983
CL41212-	3.3328	84.653	4.0793	103.614	0	0	5.50	139.70	0.374	9.500	40	1.011	25.67	1,600	2,168
CL41823-1	3.8002	96.525	4.8005	121.932	0	0	6.50	165.10	0.500	12.700	34	1.247	31.67	3,000	4,065
CL42084-	4.2387	107.663	5.2420	133.147	0	0	7.125	180.97	0.502	12.750	41	1.265	32.13	4,000	5,420

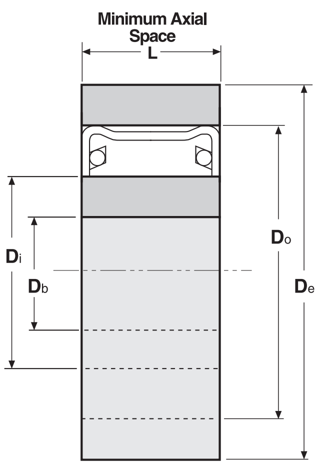
The shaded areas of the chart indicate those retainers that exhibit PCE roll-over protection. Your application will be significantly upgraded by the PCE feature and the superior life characteristics of Formchrome.

*+0.0005 in. +0.013 mm
-0.0000 in. -0.000 mm

Race design is critical to the proper performance of an overrunning clutch. In order to efficiently transmit torque, the design should balance race deflection with contact (Hertz) stress and race Hoop stresses. The torque values shown in this catalog are based on optimum race thicknesses subject to the following maximum stress limits.

		(N/mm^2)
Inner and Outer Race Hertz	...450,000 p.s.i.	(3103)
Inner Race Hoop	......................85,000 p.s.i.	(586)
Outer Race Hoop	.....................75,000 p.s.i.	(517)

These design limits offer a theoretical minimum life of one million cycles from zero torque to maximum catalog torque. The use of race thicknesses different from those shown in the catalog will result in a reduced torque rating. These reduced ratings result from higher stress levels in thicker races and excessive sprag wind-up in thinner races. The application of torque exceeding the catalog rating increases stress levels and reduces cycle life.



Di = *Inner race sprag diameter*
Do = *Outer race sprag diameter*
Db = *Inner race bore*
De = *Outer race outer diameter*
L = *Minimum axial space (actual retainer width + .005 inches)*

Warranty

Formsprag LLC warrants that it will repair or replace (whichever it deems advisable) any product manufactured and sold by it which proves to be defective in material or workmanship within a period of one (1) year from the date of original purchase for consumer, commercial or industrial use. This warranty extends only to the original purchaser and is not transferable or assignable without Formsprag LLC's prior consent. This warranty covers normal use and does not cover damage or defect which results from alteration, accident, neglect, or improper installation, operation, or maintenance. Formsprag LLC's obligation under this warranty is limited to the repair or replacement of the defective product and in no event shall Formsprag LLC be liable for consequential, indirect or incidental damages of any kind incurred by reasons of the manufacture, sale or use of any defective product. Formsprag LLC neither assumes nor authorizes any other person to give any other warranty or to assume any other obligation or liability on its behalf.

Conversion Factors

Length

			1μm	=	.00004 in
1 in	=	25.4 mm = 0.0254 m	1 m	=	39.37 in
1 ft	=	304.8 mm = 0.3048 m	1 m	=	3.28 ft

Area

1 in^2	=	$6.4516 \times 10^{-4}\ m^2$	1 m^2	=	1550 in^2
1 ft^2	=	$9.29 \times 10^{-2}\ m^2$	1 m^2	=	10.764 ft^2

Volume

1 in^3	=	$1.639 \times 10^{-5}\ m^3$	1 m^3	=	61023 in^3
1 ft^3	=	$2.832 \times 10^{-2}\ m^3$	1 m^3	=	35.315 ft^3
1 gal (US)	=	3.7854 l	1 l	=	0.2642 gal (US)

Mass

1 lb $s^2\ ft^{-1}$	=	14.6 kg	1 kg	=	6.85×10^{-2} lb $s^2\ ft^1$

Force

1 lb	=	4.45 N	1 N	=	0.225 lb

Pressure

1 lb in^{-2}	=	$6.895 \times 10^{-3}\ Nmm^{-2}$	1 Nmm^{-2}	=	145 lb in^{-2}
(pai)	=	$6.895 \times 10^{3}\ Nm^{-2}$	1 bar	=	14.2 lb in^{-2}

Torque

1 lb in	=	0.113 Nm	1 Nm	=	8.85 lb in
1 lb ft	=	1.36 Nm	1 Nm	=	0.738 lb ft

Work

1 Btu	=	778 lb ft			
1 Btu	=	1055 J = 1.055 kJ	1 kJ	=	0.948 Btu
1 Btu	=	2.93×10^{-4} kWh	1 kWh	=	3410 Btu

Power

1 hp	=	746 W = 0.746 kW	1 kW	=	1.34 hp

Moment of Inertia

1 lb ft^2	=	0.04214 kgm^2	1 kgm^2	=	23.73 lb ft^2
1 lb in^2	=	$2.93 \times 10^{-4}\ kgm^2$	1 kgm^2	=	3417.17 lb in^2
1 lb ft s^2	=	1.3847 kgm^2	1 kgm^2	=	0.738 lb ft s^2
1 lb in s^2	=	0.1129 kgm^2	1 kgm^2	=	8.8507 lb in s^2

Mass/Volume

1 lb ft^{-3}	=	16.018 kgm^{-3}	1 kgm^{-3}	=	6.24×10^{-2} lb ft^{-3}

Temperature

°F	=	(1.8x°C) + 32	°C	=	5/9x(°F–32)
°F	=	1.8x(K–273) + 32			
K	=	5/9x (°F–32) + 273			

Performance Assurance Rated torque and speeds of Formsprag LLC products are provided in current catalogs to assist the buyer in selecting the proper Formsprag LLC product. In addition, application assistance is offered by Formsprag LLC for guidance to the buyer in selection of a catalog product and application of custom designed products. Since the actual performance characteristics of all Formsprag LLC products in the buyer's application is the responsibility of the buyer, performance assurance is usually accomplished through manufacture of a prototype by Formsprag LLC, and a test or qualification program on the part of the buyer.

Overrunning Clutches Faxable Application Data Form

For Application Assistance call:
+1 586-758-5000 or 1-800-927-3262
Fax To: +1 586-758-5204

Date

Company Name

Address

City State Zip

Name of Contact Title

Phone Fax

Type of equipment

Type of application

☐ Overrunning ☐ Indexing ☐ Backstop

Maximum torque at clutch

_______ Lb. Ft. or (Nm)

_______ H.P. at _______ RPM

Power Source

☐ Electric Motor ☐ Diesel engine
☐ Turbine ☐ Air Motor
☐ Gasoline engine ☐ Hydraulic Motor

Load Application

☐ Smooth ☐ Moderate ☐ Shock

For overrunning or backstop applications

Inner race speed during overrunning _______ RPM max.

Outer race speed during overrunning _______ RPM max.

If both members are rotating during overrunning, are they rotating in the...

☐ Same direction ☐ Opposite directions

Race Diameter Limits

Inner race constraints _______

Outer race constraints _______

Life Requirements

Flight hrs: _____ Utilization factor: _______ %

Number of cycles: _______ Engine Hrs: _____

Lubrication

☐ Grease ☐ Oil Bath ☐ Oil Mist
☐ Pressure Oil ☐ Oil Flow: _______ L/Min

Type or specification of lubricant

Environment

Temperature range _______ to _______ °F (°C)

Other _______

Anticipated quantity required

For this application _______

Prototype required _______

Annually _______

Supply a sketch of your installation.

FORMSPRAG CLUTCH™

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