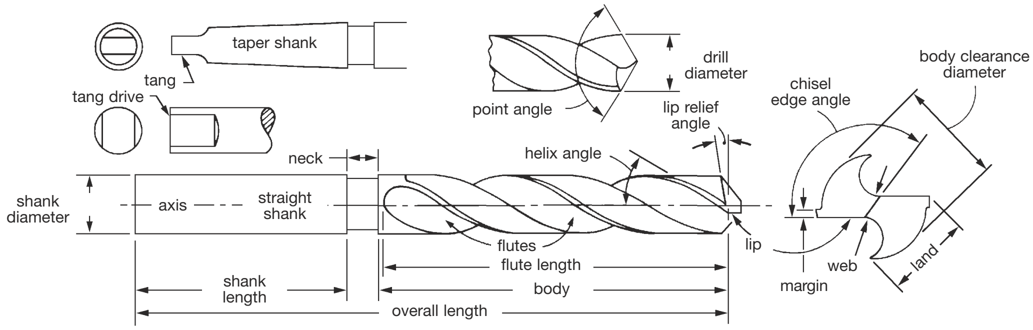
KHSS Drill Dictionary



axis—The imaginary straight line that forms the longitudinal centerline of a drill.

backtaper—A slight decrease in diameter from front to back in the body of a drill.

body—The portion of a drill extending from the shank or neck to the outer corners of the cutting lips.

body clearance diameter—The portion of the land that has been cut away so it will not bind against the walls of the hole.

chisel edge—The edge at the end of the web that connects the cutting lips.

chisel edge angle—The included angle between the chisel edge and cutting lip, as viewed from the end of a drill.

clearance diameter—The diameter over the cut-away portion of the drill lands.

drill—A rotary end cutting tool having one or more cutting lips, and having one or more helical or straight flutes for the passage of chips and the admission of a cutting fluid.

drill diameter—The diameter over the margins of a drill measured at the point.

feeds—Feed rates for drilling are governed by the drill diameter, machinability of materials, and depth of hole. Small drills, harder materials, and deeper holes require additional considerations in selecting the proper feed rates.

flute length—The length from the outer corners of the cutting lips to the extreme back of the flutes. Includes the sweep of the tool used to generate the flutes and therefore does not indicate the usable length of flutes.

flutes—Helical or straight grooves cut or formed in the body of a drill that provide cutting lips, permit removal of chips, and allow cutting fluid to reach the cutting lips.

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helix angle—The angle formed by the leading edge of the land with a plane containing the axis of a drill.

ipm—ipr x rpm = feed rate in inches per minute

ipr—inches per revolution

land—The peripheral portion of the body between adjacent flutes.

land width—The distance between the leading edge and heel of the land; measured at a right angle to the leading edge.

lead—The axial advance of a leading edge of the land in one turn around the circumference.

lip relief angle—The axial relief angle at the outer corner of the lip; measured by projection to a plane tangent to the periphery at the outer corner of the lip.

lips—The cutting edges of a two-flute drill extending from the chisel edge to the periphery.

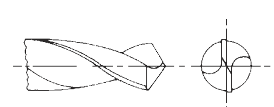
margin—The cylindrical portion of the land, which is not cut away, to provide clearance.

neck—The section of reduced diameter between the body and the shank of a drill.

overall length—The length from the extreme end of the shank to the outer corners of the cutting lip. It does not include the conical shank end often used on straight shank drills, nor the conical cutting point used on both straight and taper shank drills.

point—The cutting end of a drill, made up of the ends of the lands and the web. In form, it resembles a cone, but departs from a true cone to furnish clearance behind the cutting lips.

- *conventional*—Conventional points with 118° included point angles are the most commonly used because they provide satisfactory results in a wide variety of materials. A possible limitation is that the straight chisel edge contributes to walking at the drill point, often making it necessary to spot the hole for improved accuracy.



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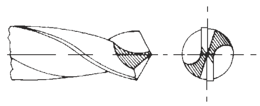
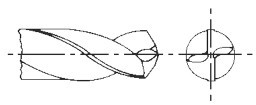
Kennametal Twist Drills

KHSS Drill Dictionary (cont'd.)

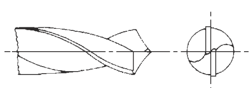
• *split*—Split points (commonly called Crankshaft points) were originally developed for use on drills designed for deep oil holes in automotive crankshafts. Since its inception, the split point has gained widespread use and is applied to both 118° and 135° included point angles. Its main advantages are the ability to reduce thrust and eliminate walking at the drill point. This is a distinct advantage when the drill is used in a portable drill or in drilling applications where bushings cannot be used. The split point also has two positive rake cutting edges extending to the center of the drill, which can assist as a chipbreaker to produce small chips that can readily be ejected.



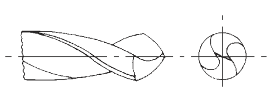
• *notched*—Notched points were developed for drilling tough alloys. Commonly used on heavy web drills, this point design can withstand the higher thrust loads required in drilling these materials. As with the split point, the notched point contains two additional positive rake cutting edges that extend toward the center of the drill. These secondary cutting lips, which extend no further than half the original cutting lip, can assist in chip control and reduce the torque required in drilling tough materials. Notched points can be incorporated on both 118° and 135° included point angles, making them suitable for drilling a wide variety of materials.



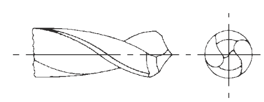
• *helical*—Helical points change the flat blunt chisel to an "S" contour with a radiused crown effect which has its highest point at the center of the drill axis. This crown contour creates a continuous cutting edge from margin to margin across the web. The advantage is its self-centering ability which allows the chisel to cut and enables the drill to cut closer to actual drill diameter. Helical points are not available under 1/16" diameter.



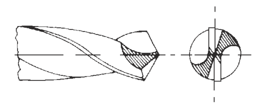
• *Racon®*–Racon points provide a continuously varying point angle, with the lips and margins blending together to form a smooth curve. Because the lips cut on a long, curved cutting edge, there is less load per unit area and therefore less heat generated during the cut. Like the double angle point, the outer periphery of the cutting lip is protected to reduce margin wear. Breakthrough burrs can be eliminated and tool life can be increased when drilling abrasive materials. Its limitation is that it must be used through a guide bushing because it is not self-centering.



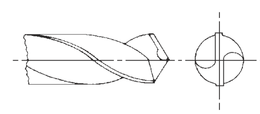
• *Bickford™*—Bickford points are a combination of the helical and Racon point. They combine the self-centering feature of the helical point with the long life and burr-free breakthrough and higher feed capacity of the Racon point. These features make the Bickford an excellent selection for producing accurate holes on N/C machines without the need for prior spot drilling.



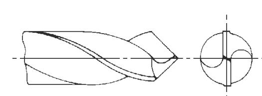
• *double angle*—Double angle points were initially developed for drilling medium and hard cast irons as well as other very abrasive materials. Their purpose was to reduce corner wear at the outer periphery of the cutting lip. The point is generated by first grinding a larger included angle, and then a smaller included angle on the corner. This provides the effect of a chamfer, which not only reduces wear, but improves hole size, acts as a chipbreaker, and reduces chipping corners of the lips when drilling hard materials. This point can be used to reduce breakthrough burr in soft materials. The length of the corner angle should be 1/3 the original cutting lip length.



• *reduced rake (Dub Lip)*—Reduced rake points are generated by flattening or dubbing both cutting lips from the outer periphery to the chisel. This reduces the effective axial rake to 0-5 positive, which translates to a plowing rather than shearing action. This reduction in shearing is an effective method of preventing the drill from grabbing in low tensile strength materials such as brass, bronze, and plastics. Reducing the rake also strengthens the cutting lip and can assist in breaking chips.



• *low angle*—Low angle points generally have an included angle of 60° or 90°. This reduces the effective rake at the outer periphery of the cutting lip, which reduces cracking when drilling plastics and grabbing on breakthrough in low tensile non-ferrous materials. The low angle point is commonly incorporated on low helix drills, commonly used for these materials.



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KHSS Drill Dictionary (cont'd.)

point angle—The included angle between the cutting lips projected upon a plane parallel to the drill axis and parallel to the two cutting lips.

relative lip height—The difference in indicator reading between the cutting lips of a drill. Measured at a right angle to the cutting lip at a specific distance from the axis of the tool.

rpm $= \frac{\text{sfm}}{\text{td}} \times 3.82$ = revolutions per minute

sfm $= \frac{\text{rpm}}{\text{td}} \times .26$ = surface feet per minute

shank—The part of a drill by which it is held and driven.

speeds—The speed of a drill is determined by the rate that the outer periphery of the tool rotates in relation to material being cut. In general, the sfm at which a drill will operate is within a range based upon the workpiece material, its condition, hardness, and depth of hole. The deeper the hole, the greater tendency there is for more heat to be generated, due to length of drill engagement, as well as chip compaction. Thus, speed reduction is often recommended to minimize the amount of heat being generated. By increasing the sfm, fewer holes will result. Therefore, it is usually advisable to start the drilling process at a slower sfm and then increase it to the maximum.

surface treatment—Surface treatments for high-speed steel tools function to condition them. In certain applications, treated tools will outperform tools that have not been treated. Surface treatments do not, however, alter the functional structure of the tool itself.

- **oxide**—This treatment is applied to finished tools and produces a thin black iron oxide surface coating. It also provides additional tempering and stress relieving. This coating reduces galling and chip welding and also increases the ability of the tool to retain lubricants. Recommended in iron and steel drilling applications. It should not be used on non-ferrous metals such as aluminum because it increases the loading tendencies of the tool.

- **nitride**—This treatment produces a hard case that is highly resistant to abrasion. It also retards the tendency of softer materials to cling or load on tools. This treatment is recommended for tools that are used on ferrous, non-ferrous, and non-metallic materials that are abrasive and have loading characteristics.

- **nitride and oxide**—Combines the lubricious advantages of oxide with the abrasion resistance of nitriding. Recommended for abrasive ferrous applications. Not recommended for soft materials such as aluminum, magnesium, or similar non-ferrous applications.

- **chrome plating**—This treatment deposits an extremely thin layer of chromium on the surface of tools. It reduces the coefficient of friction, and resists chip welding and abrasion. Recommended for non-ferrous and non-metallic materials.

- **titanium nitride**—This surface treatment improves tool life by acting as a wear-resistant thermal barrier. It also gives the tool a low coefficient of friction and a very high surface hardness. It reduces friction and chip welding and acts as a thermal insulator between the chip and the tool. Recommended for use on ferrous materials below 40Rc and in non-ferrous materials.

tang—The flattened end of a taper shank, intended to fit into a driving slot in a socket.

tang drive—Two opposite parallel driving flats on the extreme end of a straight shank.

taper shank—Drills having conical shanks suitable for direct fitting into tapered holes in machine spindles, driving sleeves, or sockets. Tapered shanks generally have a tang.

TD—Tool diameter in inches

web—The central portion of the body that joins the lands. The extreme end of the web forms the chisel edge on a two-flute drill.

web thickness—The thickness of the web at the point, unless another specific location is indicated.

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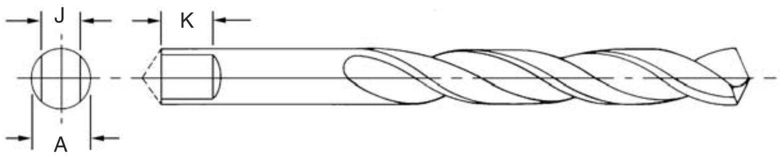
General Dimensions of Tangs for KHSS Straight Shank Drills



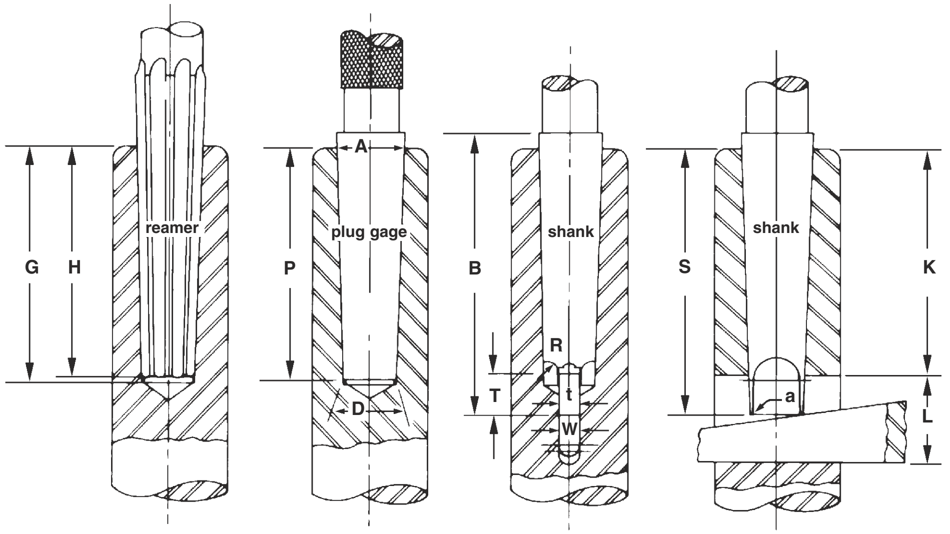
nominal diameter of drill shank (A)				thickness of tang (J)				length of tang (K)	
inches		mm		inches max.	inches min.	mm max.	mm min.	inches	mm
	1/8 to 3/16		3,18 to 4,76	.0940	.0900	2,39	2,29	9/32	7,0
over	3/16 to 1/4	over	4,76 to 6,35	.1220	.1180	3,10	3,00	5/16	8,0
over	1/4 to 5/16	over	6,35 to 7,94	.1620	.1580	4,11	4,01	11/32	8,5
over	5/16 to 3/8	over	7,94 to 9,53	.2030	.1990	5,16	5,06	3/8	9,5
over	3/8 to 15/32	over	9,53 to 11,91	.2430	.2390	6,17	6,07	7/16	11,0
over	15/32 to 9/16	over	11,91 to 14,29	.3030	.2970	7,70	7,55	1/2	12,5
over	9/16 to 21/32	over	14,29 to 16,67	.3730	.3670	9,47	9,32	9/16	14,5
over	21/32 to 3/4	over	16,67 to 19,05	.4430	.4370	11,25	11,10	5/8	16,0
over	3/4 to 7/8	over	19,05 to 22,23	.5140	.5080	13,05	12,90	11/16	17,5
over	7/8 to 1	over	22,23 to 25,40	.6090	.6010	15,47	15,27	3/4	19,0
over	1 to 1 3/16	over	25,40 to 30,16	.7000	.6920	17,78	17,58	13/16	20,5
over	1 3/16 to 1 3/8	over	30,16 to 34,93	.8170	.8090	20,75	20,55	7/8	22,0

concentricity of tang

thickness of tang (J)				total indicator variation (T.I.V.)	
inches		mm		inches	mm
from	.0900 to .2430	from	2,29 to 6,17	.0060	0,16
over	.2430 to .4430	over	6,17 to 11,25	.0070	0,18
over	.4430 to .6090	over	11,25 to 15,47	.0080	0,21
over	.6090 to .8170	over	15,47 to 20,75	.0090	0,23

Kennametal Twist Drills

American National Standard Tapers



*detail dimensions

Morse taper number	shank: diameter of plug at small end D	shank: diameter at end of socket A	shank: whole length B	shank: depth S	shank: depth of drilled hole G	shank: depth of reamed hole H	shank: standard plug depth P	tang: thickness t	tang: length T	tang: radius R	tang: radius a	tang slot: width W	tang slot: length L	tang slot: end of socket to tang slot K	taper per inch	taper per foot
** 0	.25200	.35610	2 11/32	2 7/32	2 1/16	2 1/32	2	5/32	1/4	5/32	3/64	11/64	9/16	1 15/61	.052050	.62460
1	.36900	.47500	2 9/16	2 7/16	2 3/16	2 5/32	2 1/8	13/64	3/8	3/16	3/64	7/32	3/4	2 1/16	.049882	.59858
2	.57200	.70000	3 1/8	2 15/16	2 21/32	2 39/64	2 9/16	1/4	7/16	1/4	1/16	17/64	7/8	2 1/2	.049951	.59941
3	.77800	.93800	3 7/8	3 11/16	3 5/16	3 1/4	3 3/16	5/16	9/16	9/32	5/64	21/64	1 3/16	3 1/16	.050196	.60235
4	1.02000	1.23100	4 7/8	4 5/8	4 3/16	4 1/8	4 1/16	15/32	5/8	5/16	3/32	31/64	1 1/4	3 7/8	.051938	.62326
4 1/2	1.26600	1.50000	5 3/8	5 1/8	4 5/8	4 9/16	4 1/2	9/16	11/16	3/8	1/8	37/64	1 3/8	4 5/16	.052000	.62400
5	1.47500	1.74800	6 1/8	5 7/8	5 5/16	5 1/4	5 3/16	5/8	3/4	3/8	1/8	21/32	1 1/2	4 15/16	.052626	.63151
6	2.11600	2.49400	8 9/16	8 1/4	7 13/32	7 21/64	7 1/4	3/4	1 1/8	1/2	5/32	25/32	1 3/4	7	.052138	.62565
7	2.75000	3.27000	11 5/8	11 1/4	10 5/32	10 5/64	10	1 1/8	1 3/8	3/4	3/16	1 5/32	2 5/8	9 1/2	.052000	.62400

*Table agrees with American National Standards for taper shanks except for angle and undercut of tang.
**Size 0 taper shank not listed in American National Standards

Kennametal Twist Drills

Operating Parameters for KHSS Drills

Feed Per Drill Revolution

drill diameter range	light	medium	heavy
1/16 to 1/8	.0005-.0010	.0010-.0020	.0020-.0040
1/8 to 1/4	.0010-.0030	.0030-.0050	.0040-.0060
1/4 to 3/8	.0030-.0050	.0050-.0070	.0060-.0100
3/8 to 1/2	.0040-.0060	.0050-.0080	.0080-.0120
1/2 to 3/4	.0050-.0070	.0070-.0100	.0090-.0140
3/4 to 1	.0070-.0100	.0090-.0140	.0140-.0200

Speeds and Feeds for Deep-Hole Drilling

Holes that must be drilled 3xD deep or more fall into the "deep-hole" drilling class and some adjustment of feeds and speeds is necessary.

The deeper the hole, the greater the tendency there is for chips to pack and clog the flutes of the drill. This increases the amount of heat generated and prevents coolant from dissipating heat away from the point. A buildup of heat at the point will eventually lead to premature tool failure.

Peck drilling, the practice of drilling a short distance and withdrawing the drill, will often reduce chip packing. The deeper the hole, however, the more frequent the drill must be retracted to be effective.

A reduction in speed and feed to reduce the amount of heat generated is generally required in most deep-hole applications where coolant cannot be effectively applied.

Speed and Feed Reductions (based upon hole depth)

hole depth-to-diameter ratio (times drill diameter)	speed reduction	feed reduction
3	10%	10%
4	20%	10%
5	30%	20%
6	35-40%	20%

Feed Per Revolution — Parabolic Drills

The unique flute form of the parabolic drill contributes to increased chip flow to improve heat dissipation. This is particularly important when drilling holes to depths greater than four times the drill diameter.

Because chip flow is improved with the parabolic drill, there is no need to reduce the feed rate. In fact, it is important to maintain a constant, heavy feed rate regardless of hole depth.

drill diameter range	feed rate
1/16 to 1/8	.0010-.0040
1/8 to 1/4	.0030-.0090
1/4 to 3/8	.0050-.0100
3/8 to 1/2	.0070-.0150
1/2 to 3/4	.0100-.0160
3/4 to 1	.0150-.0220

Speed Reduction - Parabolic Drills (based upon hole depth)

hole depth-to-diameter ratio (times drill diameter)	speed reduction
3	0
4	0
5	5%
6 to 8	10%
8 to 11	20%
11 to 14	30%
14 to 17	40%
17 to 20	50%

Kennametal Twist Drills

Cutting Speed Operating Parameters for KHSS Drills

(fractional size drills)

diameter size	surface feet per minute														
	10'	12'	15'	20'	25'	30'	35'	40'	45'	50'	60'	70'	80'	90'	100'
	revolutions per minute														
1/64	2445	2934	3667	4889	6112	7334	8556	9778	11001	12223	14668	17112	19557	22001	24446
1/32	1222	1467	1833	2445	3056	3667	4278	4889	5500	6112	7334	8556	9778	11001	12223
3/64	815	978	1222	1630	2037	2445	2852	3259	3667	4074	4889	5704	6519	7334	8149
1/16	611	733	917	1222	1528	1833	2139	2445	2750	3056	3667	4278	4889	5500	6112
5/64	489	587	733	978	1222	1467	1711	1956	2200	2445	2934	3422	3911	4400	4889
3/32	407	489	611	815	1019	1222	1426	1630	1833	2037	2445	2852	3259	3667	4074
7/64	349	419	524	698	873	1048	1222	1397	1572	1746	2095	2445	2794	3143	3492
1/8	306	367	458	611	764	917	1070	1222	1375	1528	1833	2139	2445	2750	3056
9/64	272	326	407	543	679	815	951	1086	1222	1358	1630	1901	2173	2445	2716
5/32	244	293	367	489	611	733	856	978	1100	1222	1467	1711	1956	2200	2445
11/64	222	267	333	444	556	667	778	889	1000	1111	1333	1556	1778	2000	2222
3/16	204	244	306	407	509	611	713	815	917	1019	1222	1426	1630	1833	2037
13/64	188	226	282	376	470	564	658	752	846	940	1128	1316	1504	1692	1880
7/32	175	210	262	349	437	524	611	698	786	873	1048	1222	1397	1572	1746
15/64	163	196	244	326	407	489	570	652	733	815	978	1141	1304	1467	1630
1/4	153	183	229	306	382	458	535	611	688	764	917	1070	1222	1375	1528
9/32	136	163	204	272	340	407	475	543	611	679	815	951	1086	1222	1358
5/16	122	147	183	244	306	367	428	489	550	611	733	856	978	1100	1222
11/32	111	133	167	222	278	333	389	444	500	556	667	778	889	1000	1111
3/8	102	122	153	204	255	306	357	407	458	509	611	713	815	917	1019
13/32	94	113	141	188	235	282	329	376	423	470	564	658	752	846	940
7/16	87	105	131	175	218	262	306	349	393	437	524	611	698	786	873
15/32	81	98	122	163	204	244	285	326	367	407	489	570	652	733	815
1/2	76	92	115	153	191	229	267	306	344	382	458	535	611	688	764
9/16	68	81	102	136	170	204	238	272	306	340	407	475	543	611	679
5/8	61	73	92	122	153	183	214	244	275	306	367	428	489	550	611
11/16	56	67	83	111	139	167	194	222	250	278	333	389	444	500	556
3/4	51	61	76	102	127	153	178	204	229	255	306	357	407	458	509
13/16	47	56	71	94	118	141	165	188	212	235	282	329	376	423	470
7/8	44	52	65	87	109	131	153	175	196	218	262	306	349	393	437
15/16	41	49	61	81	102	122	143	163	183	204	244	285	326	367	407
1	38	46	57	76	95	115	134	153	172	191	229	267	306	344	382
1 1/8	34	41	51	68	85	102	119	136	153	170	204	238	272	306	340
1 1/4	31	37	46	61	76	92	107	122	138	153	183	214	244	275	306
1 3/8	28	33	42	56	69	83	97	111	125	139	167	194	222	250	278
1 1/2	25	31	38	51	64	76	89	102	115	127	153	178	204	229	255
1 5/8	24	28	35	47	59	71	82	94	106	118	141	165	188	212	235
1 3/4	22	26	33	44	55	65	76	87	98	109	131	153	175	196	218
1 7/8	20	24	31	41	51	61	71	81	92	102	122	143	163	183	204
2	19	23	29	38	48	57	67	76	86	95	115	134	153	172	191
2 1/4	17	20	25	34	42	51	59	68	76	85	102	119	136	153	170
2 1/2	15	18	23	31	38	46	53	61	69	76	92	107	122	138	153
2 3/4	14	17	21	28	35	42	49	56	63	69	83	97	111	125	139
3	13	15	19	25	32	38	45	51	57	64	76	89	102	115	127
3 1/2	11	13	16	22	27	33	38	44	49	55	65	76	87	98	109

Kennametal Twist Drills

Cutting Speed Operating Parameters for KHSS Drills

(wire size drills)

diameter size	10'	12'	15'	20'	25'	30'	35'	40'	45'	50'	60'	70'	80'	90'	100'
	surface feet per minute														
	revolutions per minute														
1	168	201	251	335	419	503	586	670	754	838	1005	1173	1340	1508	1675
2	173	207	259	346	432	519	605	691	778	864	1037	1210	1382	1555	1728
3	179	215	269	359	448	538	628	717	807	897	1076	1255	1434	1614	1793
4	183	219	274	366	457	548	640	731	822	914	1097	1280	1462	1645	1828
5	186	223	279	372	465	558	651	743	836	930	1115	1301	1487	1673	1859
6	187	225	281	374	468	562	655	749	843	936	1123	1310	1498	1685	1872
7	190	228	285	380	475	570	665	760	855	950	1140	1330	1520	1710	1900
8	192	230	288	384	480	576	672	768	864	960	1151	1343	1535	1727	1919
9	195	234	292	390	487	585	682	780	877	975	1169	1364	1559	1754	1949
10	197	237	296	395	494	592	691	790	888	987	1184	1382	1579	1777	1974
11	200	240	300	400	500	600	700	800	900	1000	1200	1400	1600	1800	2000
12	202	243	303	404	505	606	707	808	909	1010	1213	1415	1617	1819	2021
13	206	248	310	413	516	619	723	826	929	1032	1239	1450	1652	1859	2065
14	210	252	315	420	525	630	735	839	944	1050	1259	1469	1679	1889	2099
15	212	255	318	424	531	637	743	849	955	1064	1276	1489	1702	1914	2127
16	216	259	324	432	540	647	755	863	971	1079	1295	1511	1726	1942	2158
17	221	265	331	442	552	662	773	883	994	1104	1325	1546	1766	1987	2208
18	225	270	338	451	563	676	789	901	1014	1130	1356	1582	1808	2034	2260
19	230	276	345	460	575	690	805	920	1035	1151	1381	1611	1841	2071	2301
20	237	285	356	474	593	712	830	949	1068	1186	1423	1660	1898	2135	2372
21	240	288	360	480	601	721	841	961	1081	1201	1441	1681	1922	2162	2402
22	243	292	365	487	608	730	852	973	1095	1217	1460	1703	1946	2190	2433
23	248	298	372	496	620	744	868	992	1116	1240	1488	1736	1984	2232	2480
24	251	302	377	503	628	754	880	1005	1131	1257	1508	1759	2010	2262	2513
25	255	307	383	511	639	766	894	1022	1150	1276	1533	1789	2044	2300	2555
26	260	312	390	520	650	780	909	1039	1169	1299	1559	1819	2078	2338	2598
27	265	318	398	531	663	796	928	1061	1194	1327	1592	1857	2122	2388	2653
28	272	326	408	544	680	816	952	1087	1223	1360	1631	1903	2175	2447	2719
29	281	337	421	562	702	843	983	1123	1264	1405	1685	1966	2247	2528	2809
30	297	357	446	595	743	892	1040	1189	1338	1487	1784	2081	2378	2676	2973
31	318	382	477	637	796	955	1114	1273	1432	1592	1910	2228	2546	2865	3183
32	329	395	494	659	823	988	1152	1317	1482	1647	1976	2305	2634	2964	3293
33	338	406	507	676	845	1014	1183	1352	1521	1690	2028	2366	2704	3042	3380
34	344	413	516	688	860	1032	1204	1376	1549	1721	2065	2409	2753	3097	3442
35	347	417	521	694	868	1042	1215	1389	1563	1736	2083	2430	2778	3125	3472
36	359	430	538	717	897	1076	1255	1435	1614	1794	2152	2511	2870	3228	3587
37	367	441	551	735	918	1102	1285	1469	1653	1837	2204	2571	2938	3306	3673
38	376	452	564	753	941	1129	1317	1505	1693	1882	2258	2634	3010	3387	3763
39	384	461	576	768	960	1152	1344	1536	1728	1920	2303	2687	3071	3455	3839
40	390	468	585	780	974	1169	1364	1559	1754	1949	2339	2729	3118	3508	3898
41	398	477	597	796	995	1194	1393	1592	1790	1990	2387	2785	3183	3581	3979
42	409	490	613	817	1021	1226	1430	1634	1838	2043	2451	2860	3268	3677	4085
43	429	515	644	858	1073	1288	1502	1717	1931	2146	2575	3004	3434	3863	4292
44	444	533	666	888	1110	1332	1555	1777	1999	2221	2665	3109	3554	3999	4442
45	466	559	699	932	1165	1397	1630	1863	2096	2329	2795	3261	3726	4192	4658
46	472	566	707	943	1179	1415	1650	1886	2122	2358	2830	3301	3773	4244	4716
47	487	584	730	973	1216	1460	1703	1946	2190	2433	2920	3406	3893	4379	4866
48	503	603	754	1005	1256	1508	1759	2010	2262	2513	3016	3518	4021	4523	5026
49	523	628	785	1046	1308	1570	1831	2093	2355	2617	3140	3663	4186	4710	5233
50	546	655	819	1091	1364	1637	1910	2183	2456	2729	3274	3820	4366	4911	5457
51	570	684	855	1140	1425	1710	1995	2280	2565	2851	3421	3991	4561	5131	5701
52	602	722	902	1203	1504	1805	2105	2406	2707	3008	3609	4211	4812	5414	6015
53	642	770	963	1284	1605	1926	2247	2568	2889	3207	3848	4490	5131	5773	6414
54	694	833	1042	1389	1736	2083	2431	2778	3125	3473	4167	4862	5556	6251	6945
55	735	881	1102	1469	1836	2204	2571	2938	3306	3673	4408	5142	5877	6611	7346
56	821	986	1232	1643	2054	2464	2875	3286	3696	4108	4929	5751	6572	7394	8215
57	888	1066	1332	1777	2221	2665	3109	3553	3997	4452	5342	6232	7122	8013	8903
58	909	1091	1364	1819	2274	2728	3183	3638	4093	4547	5456	6367	7275	8186	9095
59	932	1118	1397	1863	2329	2795	3261	3726	4192	4658	5590	6521	7453	8388	9316
60	955	1146	1432	1910	2387	2865	3342	3820	4297	4775	5729	6684	7639	8594	9549

Kennametal Twist Drills

Cutting Speed Operating Parameters for KHSS Drills

(wire size drills (cont'd.))

diameter size	surface feet per minute														
	10'	12'	15'	20'	25'	30'	35'	40'	45'	50'	60'	70'	80'	90'	100'
	revolutions per minute														
61	979	1175	1469	1959	2449	2938	3428	3918	4407	4897	5876	6856	7835	8815	9794
62	1005	1206	1508	2010	2513	3016	3518	4021	4523	5025	6030	7035	8040	9045	10050
63	1032	1239	1549	2065	2581	3097	3613	4129	4646	5160	6192	7224	8256	9288	10320
64	1061	1273	1592	2122	2653	3183	3714	4244	4775	5305	6366	7427	8488	9549	10610
65	1091	1310	1637	2183	2728	3274	3820	4365	4911	5455	6546	7637	8728	9819	10910
66	1157	1389	1736	2315	2894	3472	4051	4630	5207	5790	6948	8106	9264	10422	11580
67	1194	1432	1790	2387	2984	3581	4178	4775	5371	5970	7164	8358	9552	10746	11940
68	1232	1479	1848	2464	3080	3696	4313	4929	5545	6160	7392	8624	9856	11088	12320
69	1308	1570	1962	2616	3270	3924	4578	5232	5887	6530	7836	9142	10488	11754	13060
70	1364	1637	2046	2728	3410	4093	4775	5457	6139	6820	8184	9548	10912	12276	13640
71	1469	1763	2204	2938	3673	4407	5142	5876	6611	7365	8838	10311	11784	13257	14730
72	1528	1833	2272	3056	3820	4584	5348	6112	6875	7640	9168	10696	12224	13752	15280
73	1592	1910	2387	3183	3979	4775	5570	6366	7162	7960	9552	11144	12736	14328	15920
74	1698	2037	2546	3395	4244	5093	5942	6791	7639	8510	10212	11914	13616	15318	17020
75	1819	2183	2728	3638	4547	5457	6366	7276	8185	9095	10914	12733	14552	16371	18190
76	1910	2292	2865	3820	4775	5730	6684	7639	8594	9550	11460	13370	15280	17190	19100
77	2122	2546	3183	4244	5305	6366	7427	8488	9549	10610	12732	14854	16976	19098	21220
78	2387	2865	3581	4775	5968	7162	8356	9549	10743	11935	14322	16709	19096	21483	23870
79	2634	3161	3951	5269	6586	7903	9220	10537	11854	13170	15804	18438	21072	23706	26340
80	2829	3395	4244	5659	7074	8488	9903	11318	12732	14150	16980	19810	22640	25470	28300

Cutting Speed Operating Parameters for KHSS Drills

(letter size drills)

diameter size	surface feet per minute														
	10'	12'	15'	20'	25'	30'	35'	40'	45'	50'	60'	70'	80'	90'	100'
	revolutions per minute														
A	163	196	245	326	408	490	571	653	735	818	982	1145	1309	1472	1636
B	160	193	241	321	401	481	562	642	722	803	963	1124	1284	1445	1605
C	158	189	237	316	395	473	552	631	710	789	947	1105	1262	1420	1578
D	155	186	233	311	388	466	543	621	699	778	934	1089	1245	1400	1556
E	153	183	229	306	382	458	535	611	687	764	917	1070	1222	1375	1528
F	149	178	223	297	372	446	520	595	669	743	892	1040	1189	1337	1486
G	146	176	220	293	366	439	512	585	659	732	878	1024	1170	1317	1463
H	144	172	215	287	359	431	503	574	646	718	862	1005	1149	1294	1436
I	140	169	211	281	351	421	492	562	632	702	842	983	1123	1264	1404
J	138	165	207	276	345	414	483	552	621	690	827	965	1103	1241	1379
K	136	163	204	272	340	408	476	544	612	680	815	951	1087	1223	1359
L	132	158	198	263	329	395	461	527	593	659	790	922	1054	1185	1317
M	129	155	194	259	324	388	453	518	583	648	777	907	1036	1166	1295
N	126	152	190	253	316	379	442	506	569	633	759	886	1012	1139	1265
O	121	145	181	242	302	363	423	484	544	605	725	846	967	1088	1209
P	118	142	177	237	296	355	414	473	532	592	710	828	946	1065	1183
Q	115	138	173	230	288	345	403	460	518	575	690	805	920	1035	1150
R	113	135	169	225	282	338	394	451	507	564	676	789	902	1014	1127
S	110	132	165	220	274	329	384	439	494	549	659	769	878	988	1098
T	107	128	160	213	267	320	373	427	480	533	640	746	853	959	1066
U	104	125	156	208	259	311	363	415	467	519	623	727	830	934	1038
V	101	122	152	203	253	304	355	405	456	507	608	709	810	912	1013
W	99	119	148	198	247	297	346	496	445	495	594	693	792	891	989
X	96	115	144	192	240	289	337	385	433	481	576	672	769	865	962
Y	95	113	142	189	236	284	331	378	425	473	567	662	756	851	945
Z	92	111	139	185	231	277	324	370	416	462	555	647	740	832	925

Recommended SFM and Coolant for KHSS Drills (by Material Application)

Ferrous Materials

materials	Brinell	surface feet per minute	coolant
low-carbon steel	85-125	80-95	soluble oil
medium-carbon steel	125-175	70-85	soluble oil
high-carbon steel	175-225	45-65	soluble oil
steels (alloyed)	under 200	60-90	soluble oil
	200-300	40-70	soluble oil
	over 300	20-30	soluble oil
steel drop forgings (heat treated)	330-370	30-40	cutting oil
	370-420	20-30	cutting oil
	over 420	10-20	cutting oil
gray cast iron (soft)	125	140-150	dry
gray cast iron (medium)	120-200	50-80	soluble oil
gray cast iron (hard)	up to 350	25-40	soluble oil
titanium alloys (Ti)-75A	300-440	50-60	cutting oil
Ti-150A, RS-120	300-440	40-50	cutting oil
Ti-140A, RC-130B	300-440	30-40	cutting oil
Ti-6Al-4V	300-440	20-30	cutting oil
300 series stainless	120-200	20-40	cutting oil
400 series stainless	200-300	40-70	cutting oil
martensitic 416, 420, F416 plus K, 400F,4165SE, 440F	135-185	40-50	cutting oil
precipitation hardening	325-375	30	cutting oil
stainless steel (cast)	400-450	20	cutting oil
heat resisting steels	175-225	10-25	cutting oil
nimonic alloys	200-300	10-20	cutting oil
manganese (12-14% min)	125-220	10-12	cutting oil
spring steels	402	15-30	soluble oil
armor plate	200-250	40	soluble oil
	250-300	35	soluble oil
	300-350	30	cutting oil

Non-Ferrous Materials

materials	Brinell	surface feet per minute	coolant
aluminum (pure)	140-350	130-200	soluble oil
aluminum alloys	140-330	150-300	soluble oil
aluminum (leaded)	40-100	200-325	soluble oil
aluminum (silicon alloy die cast)	40-100	25-50	soluble oil
brass	190-210	200-250	cutting or soluble oil
bronze	150-200	200-250	soluble oil
copper, nickel & copper tin alloy	65-100	140-200	cutting oil or soluble oil
copper aluminum alloys	30-100	120-200	cutting or soluble oil
magnesium alloys (wrought)	50-90	140-330	cutting or soluble oil
magnesium alloys (cast)	50-90	140-365	cutting or soluble oil
nickel alloys (wrought and cast monel)	80-170	70	cutting oil
	115-240	55	or soluble oil
berylilium nickel	200-250	12	soluble oil
zinc alloy	112-126	200-250	soluble oil

Drill Feeds

diameter range (inches)	normal feed (ipr)	heavy feed (ipr)
from 1/16 thru 1/8	.001-.002	.002-.004
over 1/8 thru 1/4	.002-.004	.004-.008
over 1/4 thru 1/2	.004-.008	.008-.016
over 1/2 thru 1	.008-.016	.016-.024
over 1	.016-.024	.024-.032

Kennametal Twist Drills

Operating Parameters (Instructions) for KHSS Drills

To achieve optimal performance, attention must be paid to the following:

1) Machine must have suitable rigidity to minimize spindle deflection, and sufficient horsepower to effectively perform at recommended feeds and speeds.
2) Make sure holders and collets give good concentricity between tool and machine spindle.
3) Rigidly clamp and support workpiece to minimize deflection.
4) Use as short a drill as the application will permit to maximize tool rigidity.
5) Use recommended coolant to improve tool life. Direct the flow of coolant to the cutting edges. Insufficient or poorly directed coolant stream can result in poor tool life.
6) Use appropriate feeds and speeds for the application and material being machined.
7) Re-sharpen or replace drills at first sign of cutting lip dulling or cutting lip corner rounding.

The machining parameters listed here are offered as a starting point. It is best to begin at lower machining conditions and build up to the maximum after trials indicate the optimum level of drill performance.

Series Nomenclature:

J	110	F	B
J - Jobber S - Screw Machine TL - Taper Length TS - Taper Shank EX - Extra Length SP - Special Purpose	Series Number	F - Fractional W - Wire L - Letter	B - Bright X - Surface Treated, Oxide Z - Bronze

Material

Aluminum/Aluminum Alloys
drill style: high helix
point style: conventional
point angle: 118°
speed (sfm): 200-300
feed: medium to heavy
coolant: water soluble

Aluminum Bronze
drill style: high helix
point style: conventional
point angle: 118°
speed (sfm): 50-100
feed: medium to heavy
coolant: water soluble

Brass (Free Machining)
drill style: low helix
point style: conventional
point angle: 118°
speed (sfm): 100-250
feed: medium to heavy
coolant: water soluble

Bronze (Soft and Medium)
hardness: below 200
drill style: general purpose
point style: conventional
point angle: 118°
speed (sfm): 70-150
feed: medium to heavy
coolant: water soluble

Bronze (High Tensile)
drill style: low helix
point style: conventional
point angle: 118°
speed (sfm): 50-100
feed: medium to heavy
coolant: water soluble

Copper/Copper Alloys
drill style: general purpose
point style: conventional
point angle: 118°
speed (sfm): 100-200
feed: medium
coolant: water soluble

High-Temperature Alloys (Cobalt Base)
hardness: 180-300 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 5-20
feed: medium
coolant: activated oils

High-Temperature Alloys (Iron Base)
hardness: 180-300 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 5-20
feed: medium
coolant: activated oils

High-Temperature Alloys (Nickel Base)
hardness: 180-300 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 5-15
feed: medium
coolant: activated oils

Iron (Soft Cast)
hardness: up to 150 HB
drill style: general purpose
point style: conventional or split
point angle: 118° or 135°
speed (sfm): 75-150
feed: medium to heavy
coolant: dry/air

Iron (Medium Cast)
hardness: 150-250 HB
drill style: general purpose
point style: conventional or split
point angle: 118° or 135°
speed (sfm): 50-100
feed: medium
coolant: dry/air

Plastic and Related Materials
drill style: low helix
point style: low angle
point angle: 90°
speed (sfm): 100-200
feed: medium to heavy
coolant: dry/air

Steel (Alloyed Low and Medium Carbon)
hardness: 125-275 HB
drill style: general purpose
point style: conventional
point angle: 118°
speed (sfm): 50-70
feed: medium
coolant: water soluble

hardness: 275-325 HB
drill style: heavy-duty
point style: split or notched
point angle: 135°
speed (sfm): 40-55
feed: medium
coolant: water soluble

hardness: over 325 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 30-50
feed: medium
coolant: water soluble

Steel (Alloyed High Carbon)
hardness: 225-325 HB
drill style: heavy-duty
point style: split or notched
point angle: 135°
speed (sfm): 45-60
feed: medium
coolant: water soluble

hardness: over 325 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 25-40
feed: medium
coolant: water soluble

Steel (Low and Medium Carbon)
hardness: below 175 HB
drill style: general purpose
point style: conventional
point angle: 118°
speed (sfm): 45-95
feed: medium to heavy
coolant: water soluble

Steel (High Carbon)
hardness: 175-225 HB
drill style: general purpose
point style: conventional
point angle: 118°
speed (sfm): 45-65
feed: medium
coolant: water soluble

Stainless Steel (Austenitic/Martensitic)
hardness: below 300 HB
drill style: heavy-duty
point style: split or notched
point angle: 135°
speed (sfm): 40-60
feed: medium to heavy
coolant: water soluble or cutting oil

hardness: over 300 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 20-40
feed: medium
coolant: water soluble or cutting oil

Stainless Steel (Precipitation Hardened)
hardness: below 300 HB
drill style: heavy-duty
point style: split or notched
point angle: 135°
speed (sfm): 40-50
feed: medium
coolant: water soluble or cutting oil

hardness: over 300 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 20-40
feed: medium
coolant: water soluble or cutting oil

Titanium Alpha and Alpha-Beta Alloys
hardness: over 250 HB
drill style: heavy-duty cobalt
point style: split or notched
point angle: 135°
speed (sfm): 20-45
feed: medium
coolant: cutting oil

Zinc
drill style: high helix
point style: conventional
point angle: 118°
speed (sfm): 150-250
feed: medium to heavy
coolant: water soluble

Kennametal Twist Drills

Troubleshooting Guides for KHSS Drills

Problem – Outer Corner Breakdown

Probable Causes	*Possible Solutions*
improper speed and feed	reduce speed, increase feed
insufficient coolant flow	review and adjust
improper clearance	re-sharpen or replace
chip congestion	check geometry references
misalignment	review and adjust
inconsistency in material	review and adjust

Problem – Cutting Lips Chipped

Probable Causes	*Possible Solutions*
excessive clearance	re-sharpen or replace
improper feed	review and adjust

Problem – Margin Chipping

Probable Causes	*Possible Solutions*
misalignment	review and adjust
oversize bushing	replace

Problem – Drill Breaks

Probable Causes	*Possible Solutions*
chip congestion	check geometry references
improper point geometry	re-sharpen or replace
dull drill	re-sharpen or replace
misalignment	review and adjust
vibration and chatter	review setup rigidity and adjust

Problem – Drill Splits Up Center

Probable Causes	*Possible Solutions*
insufficient clearance	resharpen or replace
web too thin	resharpen or replace
improper feed	reduce feed

Problem – Drill Will Not Enter Workpiece

Probable Causes	*Possible Solutions*
insufficient clearance	re-sharpen or replace
web too thick	re-sharpen or replace
dull drill	re-sharpen or replace
chisel edge angle too high	re-sharpen or replace
wrong rotation	change rotation

Problem – Oversize Hole

Probable Causes	*Possible Solutions*
improperly pointed drill	re-sharpen or replace
chip congestion	check geometry references
dull drill	re-sharpen or replace
misalignment	review and adjust

Problem – Rough Hole

Probable Causes	*Possible Solutions*
dull drill	re-sharpen or replace
improper feed	reduce feed
improperly pointed drill	re-sharpen or replace
insufficient coolant flow	review and adjust
chip congestion	check geometry references

Problem – Tang Breaks

Probable Causes	*Possible Solutions*
drill improperly seated in socket	review and adjust