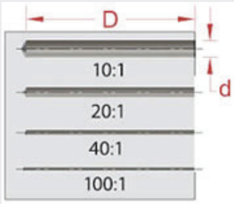
Deep Hole Definition

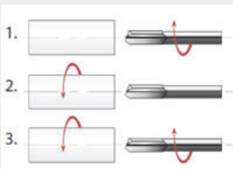


Depth to diameter ratio

HOLE DEPTH : DIAMETER (D:d)

5:1	Common twist drills
10:1	High performance twist drills with through-tool coolant
20:1	Special deep hole drilling tools with through-tool coolant
100:1	Deep hole drilling tools on dedicated deep hole drilling machines
200:1	Gundrilling tools on high performance gundrilling machines
400:1	Extreme drilling range, proprietary processes and equipment required

Drilling Process



Tool and workpiece rotation

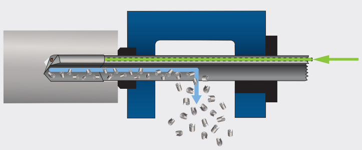
1. ROTATING TOOL - Typically used for non-symmetrical components, or off-center hole requirements

2. ROTATING WORKPIECE - Used for round parts with a deep on-center hole, and allows for a reduction in drill drift.

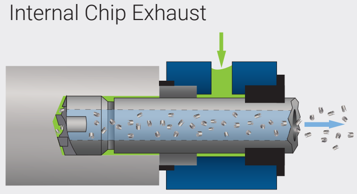
3. COUNTER-ROTATING TOOL AND WORKPIECE - Used for round parts with a deep on-center hole, provides the best hole straightness and concentricity.

Deep Hole Drilling Methods

GUNDRILL
Internal Coolant Delivery
External Chip Exhaust



BTA
External Coolant Delivery
Internal Chip Exhaust



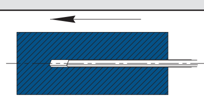
Deep hole drilling processes work by using special tools and setups to deliver high pressure coolant, evacuate chips cleanly, and achieve depth-to-diameter holes into metal beyond what a common CNC machine can reach. The two most common deep hole drilling systems are gundrilling and BTA drilling.

UNISIG will provide application advice after reviewing part drawings, tolerance requirements and production volume. Feed and speed recommendations are made by UNISIG based on reputable tooling manufacturer's technical data and our deep hole drilling experience.

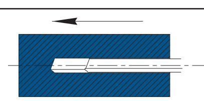
Tooling for Deep Hole Drilling

GUNDRILLING TOOLING

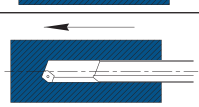
Solid Carbide
0.5 - 12 mm
[0.02 – 0.47 in]



Brazed
2 - 50 mm
[0.08 – 2.00 in]

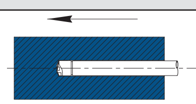


Indexable
13.5 - 50 mm
[0.53 – 2.00 in]

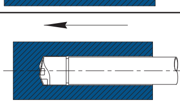


BTA DRILLING TOOLING

Brazed
12 - 65 mm
[0.47 – 2.56 in]



Indexable
25 - 630 mm
[1.0 – 24.8 in]

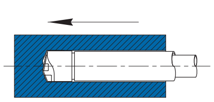


These tooling application ranges are generalized and will vary by tooling manufacturers

EJECTOR DRILLING - LESS COMMON, TWO-TUBE SYSTEM

- Coolant is introduced via the space between the inner and outer tubes
- Chips are discharged through the inside diameter of the inner tube and exhausted through an adapter mounted to the front of the machining spindle

Ejector
20 - 200 mm
[0.79 – 7.87 in]



BTA Drill Tube Size and Solid Drill Diameter Standards

Tube OD (mm)	Ref. Size	Drilled Hole Diameter (mm)	Drilled Hole Diameter (inch)
11	794	12.6 - 13.6	0.496 - 0.535
12	795	13.6 - 14.6	0.536 - 0.575
13	796	14.6 - 15.6	0.576 - 0.614
14	797	15.6 - 16.7	0.615 - 0.657
15	798	16.7 - 17.7	0.658 - 0.696
16	799	17.7 - 18.9	0.697 - 0.744
17	800	18.9 - 20.0	0.745 - 0.787
18	801	20.0 - 21.8	0.788 - 0.858
20	802	21.8 - 24.1	0.859 - 0.948
22	803	24.1 - 26.4	0.949 - 1.039
24	804	26.4 - 28.7	1.040 - 1.129
26	805	28.7 - 31.0	1.130 - 1.220
28	806	31.0 - 33.3	1.221 - 1.311
30	807	33.3 - 36.2	1.312 - 1.425
33	808	36.2 - 39.6	1.426 - 1.559
36	809	39.6 - 43.0	1.560 - 1.692
39	810	43.0 - 47.0	1.693 - 1.850
43	811	47.0 - 51.7	1.851 - 2.035
47	812	51.7 - 56.2	2.036 - 2.212
51	813	56.2 - 65.0	2.213 - 2.559
56	813E	60.6 - 65.0	2.386 - 2.559
56	814	65.0 - 67.0	2.559 - 2.637
62	815	67.0 - 73.0	2.638 - 2.873
68	816	73.0 - 80.0	2.874 - 3.149
75	817	80.0 - 87.0	3.150 - 3.424
82	818	87.0 - 100.0	3.425 - 3.936
94	819	100.0 - 112.0	3.937 - 4.408
106	820	112.0 - 124.0	4.409 - 4.881
118	821	124.0 - 136.0	4.882 - 5.353
130	822	136.0 - 148.0	5.354 - 5.826
142	823	148.0 - 160.0	5.827 - 6.298
154	824	160.0 - 171.9	6.299 - 6.767
166	825	172.0 - 183.9	6.772 - 7.240
178	826	184.0 - 195.9	7.244 - 7.712
190	827	196.0 - 207.9	7.717 - 8.185
202	828	208.0 - 219.9	8.189 - 8.657
214	829	220.0 - 231.9	8.661 - 9.130
226	830	232.0 - 243.9	9.134 - 9.602
238	831	244.0 - 255.9	9.606 - 10.075
250	832	256.0 - 267.9	10.079 - 10.547
262	833	268.0 - 279.9	10.551 - 11.020
274	834	280.0 - 291.9	11.024 - 11.492
286	835	292.0 - 303.9	11.496 - 11.964
298	836	304.0 - 315.9	11.968 - 12.436
310	837	316.0 - 327.9	12.440 - 12.909

Updated Feb 2024

UNISIG
DEEP HOLE DRILLING SYSTEMS

Tooling Methods, Applications, and Parameters

Applications and Tolerances

PROCESS	CONFIGURATION	HOLE SIZE	HOLE STRAIGHTNESS (inch/foot)	HOLE STRAIGHTNESS (mm/meter)	SURFACE FINISH µ-inch Ra	SURFACE FINISH µ-m Ra
Gundrilling	Tool rotate-Work rotate	IT6-IT11 (heavily influenced by work material)	0.001-0.004	0.08-0.33	8-248	0.2-6.3
	Tool stationary-Work rotate		0.002-0.006	0.16-0.5		
	Tool rotate-Work stationary		0.012	1.00		
BTA • Solid drilling • Trepanning • Counterboring	Tool rotate – Work rotate	IT8-IT10	0.001-0.010	0.08-0.254	60-125	1.5-3.2
	Tool stationary – Work rotate		0.003-0.015	0.25-0.381		
	Tool rotate – Work stationary		0.025	0.635		
Pull boring	Tool rotate-Work rotate	IT7-IT9	0.001	0.08	32-125	1.5-3.2
Skive-burnishing	Tool rotate-Work stationary	IT8-IT9	as received	as received	< 8.0	< 0.2

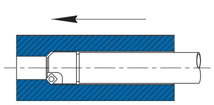
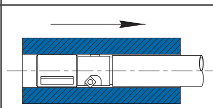
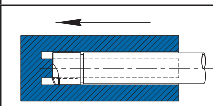
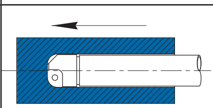
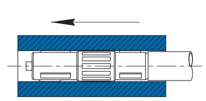
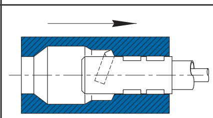
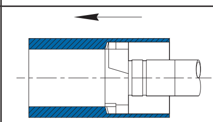
APPLICATION	OBJECTIVE
Solid drilling	Large stock removal.
Counterboring / Reaming	Large stock removal; may be used for finishing operations
Trepanning	Large stock removal at lower horsepower; useable core-slug is left
Pull counterboring	Straighten the hole or achieve uniform wall thickness
Skiving	Create a geometrically true round hole
Roller burnishing	Create a mirror-surface finish or impart desired surface qualities
Skive-burnishing	Combines skiving & burnishing applications to increase productivity
Honing	Eliminate the residual stress layer left by machining process and control the hole diameter.

The tooling application ranges above are generalized and will vary by tooling manufacturers. The tolerances provided are estimates, commonly quoted by tool manufacturers for applications with depth to diameter ratio up to 100:1 and under optimal conditions. As with any machining process, achieved tolerances depend on several factors; process parameters, workpiece condition or dimensions, tool geometry, desired trade-offs between productivity and tool life, cutting oil, etc. Individual results may vary. Diameter ranges beyond the nominal stated may be possible with UNISIG machines. Visit www.unisig.com for more information.

DIAMETER RANGE over	DIAMETER RANGE incl	IT6	IT7	IT8	IT9	IT10	IT11
		tolerance - millimeters					
0	3	0.006	0.010	0.014	0.025	0.040	0.060
3	6	0.008	0.012	0.018	0.030	0.048	0.075
6	10	0.009	0.015	0.022	0.036	0.058	0.090
10	18	0.011	0.018	0.027	0.043	0.070	0.110
18	30	0.013	0.021	0.033	0.052	0.084	0.130
30	50	0.016	0.025	0.039	0.062	0.100	0.160
50	80	0.019	0.030	0.046	0.074	0.120	0.190
80	120	0.022	0.035	0.054	0.087	0.140	0.220
120	180	0.025	0.040	0.063	0.100	0.160	0.250
180	250	0.029	0.046	0.072	0.115	0.185	0.290
250	315	0.032	0.052	0.081	0.130	0.210	0.320
315	400	0.036	0.057	0.089	0.140	0.230	0.360
400	500	0.040	0.063	0.097	0.155	0.250	0.400

DIAMETER RANGE over	DIAMETER RANGE incl	IT6	IT7	IT8	IT9	IT10	IT11
		tolerance - inches					
0	0.1181	0.0002	0.0004	0.0006	0.0010	0.0016	0.0024
0.1181	0.2362	0.0003	0.0005	0.0007	0.0012	0.0019	0.0030
0.2362	0.3937	0.0004	0.0006	0.0009	0.0014	0.0023	0.0035
0.3937	0.7087	0.0004	0.0007	0.0011	0.0017	0.0028	0.0043
0.7087	1.1811	0.0005	0.0008	0.0013	0.0020	0.0033	0.0051
1.1811	1.9685	0.0006	0.0010	0.0015	0.0024	0.0039	0.0063
1.9685	3.1496	0.0007	0.0012	0.0018	0.0029	0.0047	0.0075
3.1496	4.7244	0.0009	0.0014	0.0021	0.0034	0.0055	0.0087
4.7244	7.0866	0.0010	0.0016	0.0025	0.0039	0.0063	0.0098
7.0866	9.8425	0.0011	0.0018	0.0028	0.0045	0.0073	0.0114
9.8425	12.4016	0.0013	0.0020	0.0032	0.0051	0.0083	0.0126
12.4016	15.7480	0.0014	0.0022	0.0035	0.0055	0.0091	0.0142
15.7480	19.6850	0.0016	0.0025	0.0038	0.0061	0.0098	0.0157

Secondary Machining and Finishing Tools / Operations

PUSH- COUNTERBORING / REAMING 20 - 630 mm [0.79 – 24.8 in] *External coolant*		• Counterboring enlarges an existing hole that is drilled or cast • Push configuration tools pilot off a finished bore They can also be designed to pilot off the pre-bore for stringent concentricity requirements
PULL BORING 20 - 630 mm [0.79 – 24.8 in] *External coolant*		• Enlarges the existing bore as it is pulled through the workpiece • Boring bar is in tension rather than compression, providing better control over hole straightness • Can be used to straighten a hole with specialized tools
TREPANNING 20 - 500 mm [0.79 – 20.0 in] *External coolant*		• Process performed on blank material without a pre-drilled hole. • The tool leaves a solid core in the middle of the hole • Consumes less power than solid drilling the same hole diameter • Trepanning in blind hole applications may not be practical due to the difficulty in removing the core
BOTTOM FORMING 20 - 500 mm [0.79 – 20.0 in] *External coolant*		• Form tooling operation for finishing off the base of a hole • Tools are guided with wear pads along the finished hole diameter, and have very specific designs depending on customer needs • Radius, steps, and flat bottom forms are common
SKIVING AND ROLLER BURNISHING 20 - 500 mm [0.79 – 20.0 in] *External coolant*		• A skiving tool is used to finish the surface when close diameter and roundness tolerances are required • Rapid stock removal; high penetration rates and low radial DOC • Burnishing cold works the workpiece surface; one or more rollers pressed against the surface plasticize the material's top layer
BOTTLE BORING Special application *External coolant*		• Also known as internal profiling or chamber boring • The boring tool extends and retracts to produce the intended contour inside the workpiece. • The internal profile is then larger than the entry and exit • CNC programming is used to achieve desired profiles
TUBE FINISHING LARGE DIAMETER COUNTERBORE 300 - 1200 mm [12.0 - 4 8.0 in] *Internal coolant*		• Requires specially configured counter boring tools • Think of it as a push counter boring operation with internal coolant supply, and BTA type indexable tooling • Extreme diameters need extreme amounts of coolant flow

Deep Hole Drilling Process Parameters

Cutting Speed (M/min or SFM) **Chip Load** (mm/rev or in/rev)	Determined by material type, hardness, condition, tool type, substrate, and coating. Use tool manufacturer or UNISIG engineering recommendations.
Spindle Speed (rev/min)	Calculated by machine or operator using cutting speed and tool diameter
M/min = RPM x 0.00314 x DIAMETER (mm) RPM = M/min x 318 / DIAMETER (mm) SFM = RPM x 0.262 x DIAMETER (inches) RPM = FPM x 3.820 / DIAMETER (inches) FPM = M/min x 3.281 M/min = FPM x 0.305	
Feed Rate (mm/min or in/min)	Calculated by machine or operator using spindle speed and chip load
mm/min = mm/rev x RPM in/min = in/rev x RPM mm/min = in/min x 25.4 in/min = mm/min / 25.4	
Cutting Fluid Flow Rate (L/min or gpm)	The amount of cutting fluid that passes through the tool, and carries chips and heat from the process. Parameter values change by tooling type.
Approximate starting values	3.7 - 4.5 L/min per mm of tool diameter 25 - 30 gal/min per inch of tool diameter
Cutting Fluid Pressure (bar or PSI)	Pressure is developed due to the restriction of flow through process. Pressure is typically monitored for safety and tool condition and programmed for a maximum value. Coolant flow is of primary importance.