

Keeping our customers in the lead

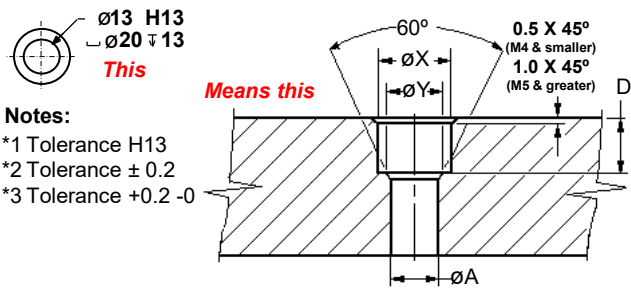
Supplier Quick Reference
Common Drawing Features and Manufacturing Practices

All dimensions in millimeters unless otherwise specified

1) Scope and Purpose

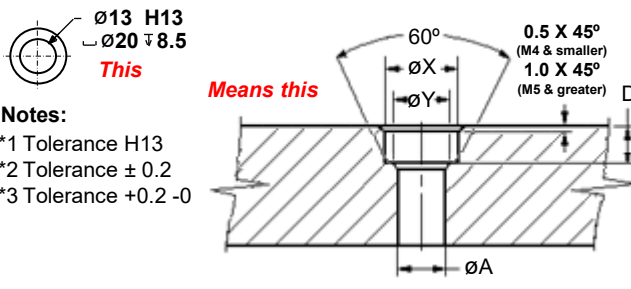
This document is a quick reference for Husky Suppliers. It is designed to complement drawings that do not fully describe specific component features. This document is not intended to replace or supersede drawing specifications: Full detail of these features is obtained by combining the drawing with the quick reference information. The quick reference is applicable on drawings where designated as follows: UNDEFINED DRAWING FEATURES TO COMPLY WITH HS534 "SUPPLIER QUICK REFERENCE"

2) Metric Counterbore Holes



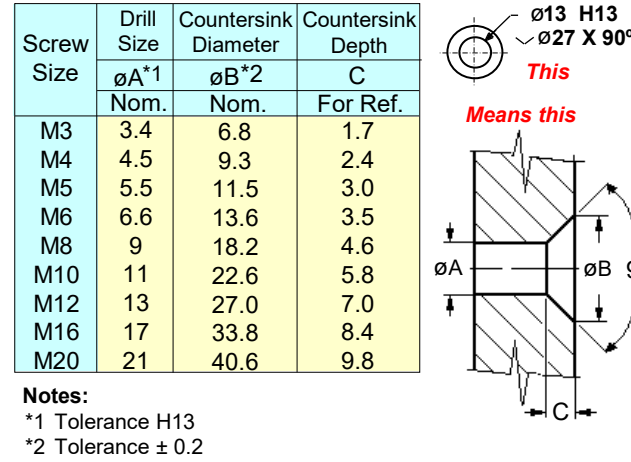
Screw Size	Drill Size	Counterbore Diameter	Countersink Diameter	Counterbore Depth
	ØA*1	ØX*2	ØY*3	D*2
	Nom.	Nom.	Min.	Nom.
M1.6	1.8	3.5	2.0	1.8
M2	2.4	4.2	2.6	2.2
M2.5	2.9	5.0	3.1	2.7
M3	3.4	6.0	3.6	3.4
M4	4.5	8.0	4.7	4.6
M5	5.5	10.0	5.7	5.7
M6	6.6	11.0	6.8	6.8
M8	9.0	15.0	9.2	9.0
M10	11.0	18.0	11.2	11.0
M12	13.0	20.0	14.2	13.0
M16	17.0	26.0	18.2	17.5
M20	21.0	33.0	22.4	21.5
M24	25.0	38.0	26.4	25.5
M30	31.0	48.0	33.4	31.5
M36	37.0	57.0	39.4	37.5
M42	43.0	66.0	45.6	43.5
M48	49.0	75.0	52.6	50.0

3) Counterbore Holes for Metric LHCS



Screw Size	Drill Size	Counterbore Diameter	Countersink Diameter	Counterbore Depth
	ØA*1	ØX*2	ØY*3	D*2
	Nom.	Nom.	Min.	Nom.
M3	3.4	6.0	3.6	2.4
M4	4.5	8.0	4.7	3.2
M5	5.5	10.0	5.7	4.0
M6	6.6	11.0	6.8	4.7
M8	9.0	15.0	9.2	6.0
M10	11.0	18.0	11.2	7.0
M12	13.0	20.0	14.2	8.5
M16	17.0	26.0	18.2	10.5
M20	21.0	33.0	22.4	13.0

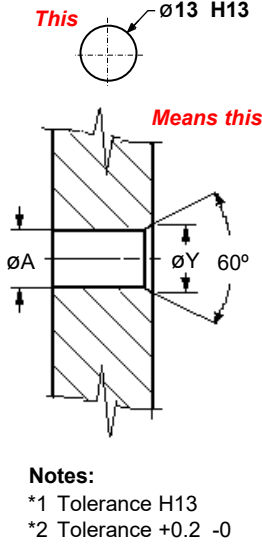
4) Metric Countersink Holes



Notes:
*1 Tolerance H13
*2 Tolerance ± 0.2
*3 Tolerance +0.2 -0

5) Metric Clearance Holes

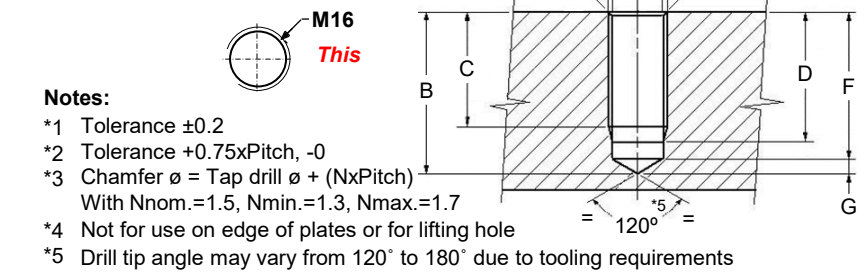
Screw Size	Drill Size	Countersink Diameter
	ØA*1	ØY*2
	Nom.	Nom.
M1.6	1.8	2.0
M2	2.4	2.6
M2.5	2.9	3.1
M3	3.4	3.6
M4	4.5	4.7
M5	5.5	5.7
M6	6.6	6.8
M8	9.0	9.2
M10	11.0	11.2
M12	13.0	14.2
M16	17.0	18.2
M20	21.0	22.4
M24	25.0	26.4
M30	31.0	33.4
M36	37.0	39.4
M42	43.0	45.6
M48	49.0	52.6



Notes:
*1 Tolerance H13
*2 Tolerance +0.2 -0

6) Metric Thread Installations

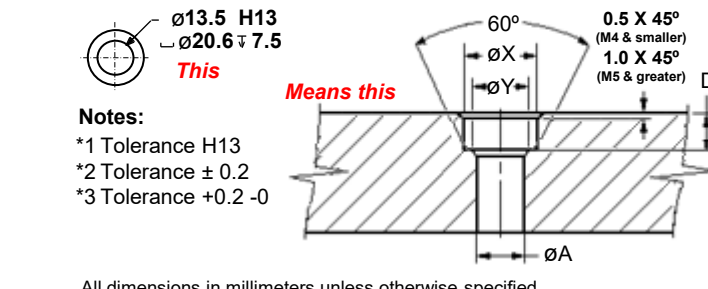
- General purpose. "Type 1" tapped holes (HS 259)
- ISO965 threads, coarse pitch
- Tolerance class 6H



Notes:
*1 Tolerance ±0.2
*2 Tolerance +0.75xPitch, -0
*3 Chamfer ø = Tap drill ø + (NxPitch)
With Nnom.=1.5, Nmin.=1.3, Nmax.=1.7
*4 Not for use on edge of plates or for lifting hole
*5 Drill tip angle may vary from 120° to 180° due to tooling requirements

Thread	Pitch	Tap Drill			Tapping		Chamfer		For Ref.	
		ØA	Max.	Min.	B*1	D*2	ØE*3	Tol.	Nom.	Nom.
M3	0.5	2.5	2.599	2.459	9.5	6	7.5	±0.1	8.778	0.722
M4	0.7	3.3	3.422	3.242	12.5	8	10.1	±0.14	11.547	0.953
M5	0.8	4.2	4.334	4.134	16	10	12.4	±0.16	14.788	1.212
M6	1	5	5.153	4.917	18.5	12	15	±0.2	17.057	1.443
M8	1.25	6.75	6.912	6.647	24	16	19.75	±0.25	22.051	1.949
M10	1.5	8.5	8.676	8.376	30	20	24.5	±0.3	27.546	2.454
M12	1.75	10.25	10.441	10.106	35	24	29.25	±0.35	32.041	2.959
M16	2	14	14.21	13.835	45	32	38	±0.4	40.959	4.041
M20*4	2.5	17.5	17.744	17.294	56	40	47.5	±0.5	50.948	5.052
M24	3	21	21.252	20.752	67	48	57	±0.6	60.938	6.062
M30	3.5	26.5	26.771	26.211	83	60	70.5	±0.7	75.35	7.65
M36	4	32	32.27	31.67	98	72	84	±0.8	88.762	9.238
M42	4.5	37.5	37.799	37.129	114	84	97.5	±0.9	103.175	10.825
M48	5	43	43.297	42.587	130	96	111	±1.0	117.587	12.413
M56	5.5	50.5	50.796	50.046	150	112	128.5	±1.1	135.422	14.578

7) Counterbore Holes for Inch LHCS

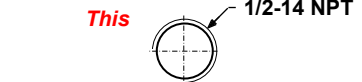


Notes:
*1 Tolerance H13
*2 Tolerance ± 0.2
*3 Tolerance +0.2 -0

Screw Size		Drill Size	Counterbore Diameter	Countersink Diameter	Counterbore Depth
		ØA*1	ØX*2	ØY*3	D*2
		Inch	Inch	Nom.	Nom.
#4	0.1120	3.5	5.5	-	2.0
#8	0.1640	4.9	8.0	-	2.5
#10	0.1900	5.6	9.5	-	3.0
1/4	0.2500	7.1	11.1	-	4.0
5/16	0.3125	8.7	13.5	-	5.0
3/8	0.375	10.3	15.9	10.5	6.0
1/2	0.5000	13.5	20.6	14.0	7.5

8) NPT / NPTF Pipe Threads

- NPT – National Pipe Thread Taper
- NPTF – Dryseal American National Standard Taper Pipe Thread
- Sealant required on NPT
- 60° Thread Angle
- Pitch measured in inches
- Truncation of root and crest are flat
- Taper angle 1° 47' (taper 1:16)



NPT Thread (Inch)	Threads Per Inch	Outside Pipe Diameter	Pitch of Thread	Height of Thread	Truncation Max.*1	Pitch Diameter Start of Ext. Thread	Handtight Engagement		Effective Thread		Wrench Makeup Length, Internal		Vanish Thread Length	Tapping Drills *3	
							Length	Diameter	Length	Diameter	Length	Diameter		Drill Size (Inch)	Eq. (mm)
		øD	P	h	f	øE0	L1	øE1	L2	øE2	L3	øE3	V		
1/16"	27	7.9375	0.940816	0.752602	0.09144	6.887972	4.064	7.141972	6.63194	7.3025	2.82194	6.711696	3.2639	C	6.1468
1/8"	27	10.287	0.940816	0.752602	0.09144	9.233154	4.1148	9.48944	6.70306	9.652	2.82194	9.056624	3.2639	Q	8.4328
1/4"	18	13.716	1.411224	1.128776	0.12446	12.125706	5.7912	12.487402	10.20572	12.7635	4.23418	11.861038	4.89712	7/16"	11.1125
3/8"	18	17.145	1.411224	1.128776	0.12446	15.545054	6.096	15.926054	10.35812	16.1925	4.23418	15.28064	4.89712	3/4"	14.68374
1/2"	14	21.336	1.814322	1.451356	0.14224	19.264122	8.128	19.772122	13.55598	20.11466	5.44322	18.924016	6.29412	45/64"	17.85874
3/4"	14	26.67	1.814322	1.451356	0.14224	24.579072	8.6106	25.117298	13.86078	25.445466	5.44322	24.238966	6.29412	29/32"	23.02002
1"	11 1/2	33.401	2.208784	1.767078	0.16002	30.826202	10.16	31.461202	17.34312	31.91002	6.62686	30.412182	7.66318	1-9/32"	32.54502
1 1/4"	11 1/2	42.164	2.208784	1.767078	0.16002	39.551102	10.668	40.217852	17.95272	40.67302	6.62686	39.137082	7.66318	1-15/32"	37.30752
1 1/2"	11 1/2	48.26	2.208784	1.767078	0.16002	45.620686	10.2108	46.287436	18.3769	46.76902	6.62686	45.206412	7.66318	1-23/32"	43.65752
M20	11 1/2	60.325	2.208784	1.767078	0.16002	57.633108	11.0744	58.325258	19.2151	58.83402	6.62686	57.219088	7.66318	2-5/32"	54.77002
2 1/2"	8	73.025	3.175	2.54	0.19812	69.076062	17.3228	70.15861	28.8925	70.881748	6.35	68.679314	11.01598	2-25/32"	70.64502
3"	8	88.9	3.175	2.54	0.19812	84.851748	19.4564	86.0679	30.48	86.756748	6.35	84.455	11.01598	3-9/32"	83.34502

All dimensions in millimeters unless otherwise specified

9) SAE Straight Thread Ports

- Notes:
- Tolerance ±1.0. Exception: ±0.2 for SAE2 (1/8") plugs.
 - Recommended drills as per HS 225.
 - Tolerance +0.13 -0.00
 - Diameter d5 to be concentric with thread pitch diameter within 0.127mm. No longitudinal and spiral tool marks allowed. Annular marks up to 2.5µm permissible.
 - Tolerance +0.4 -0.0
 - Tap drill depths given require use of bottoming taps to produce specified full thread lengths.
 - Recommended spotface depth. Tolerance +0.3 -0.2
 - Full thread depth
 - Tolerance ±1°
 - Standard hydraulic applications: 90 durometer nitrile (N552-90)

d1		Thread				ød2 ^{*1}		ød3 ^{*2}		ød4		ød5 ^{*3}		L1 ^{*4}		L2 ^{*5}		L3 ^{*6}		L4 ^{*7}		Z ^{*8}		O-Ring Size ^{*9}	
		Nominal Size (Inch)		Tap Drill Dia (mm)		Fittings & Plugs [Standard]	Plugs Only [Optional]											Fittings	Plugs						
INCH	SAE #																								
Nom.	Nom.		Min.	Max.	Nom.	Nom.	Max.	Min.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Nom.	Min.	Nom.						
1/8"	-2	5/16-24 UNF-2B	6.78	7.04	17	12	6.35	11	9.1	1.9	12	0.3	3.5	10	12"										
1/4"	-4	7/16-20 UNF-2B	9.73	10.03	21	16	8.7	15	12.4	2.4	14	0.3	3.5	11.5	12"										
5/16"	-5	1/2-20 UNF-2B	11.32	11.60	23	19	11.2	16	14	2.4	14	0.3	3.5	11.5	12"										
3/8"	-6	9/16-18 UNF-2B	12.75	13.08	25	21	11.2	18	15.6	2.5	15.5	0.3	3.5	12.7	12"										
1/2"	-8	3/4-16 UNF-2B	17.32	17.68	30	24	16	22	20.6	2.5	17.5	0.3	5	14.3	15"										
5/8"	-10	7/8-14 UNF-2B	20.27	20.68	34	28	20	26	23.9	2.5	20	0.3	5	16.7	15"										
3/4"	-12	1 1/16-12 UN-2B	24.69	25.15	41	34	20	32	29.2	3.3	23	0.3	5	19	15"										
7/8"	-14	1 3/16-12 UN-2B	27.86	28.32	45	38	25	35	32.3	3.3	23	0.3	5	19	15"										
1"	-16	1 5/16-12 UN-2B	31.04	31.50	49	42	30	38	35.5	3.3	23	0.3	5	19	15"										
1 1/4"	-20	1 5/8-12 UN-2B	38.99	39.45	58	50	38	48	43.5	3.3	23	0.3	5	19	15"										
1 1/2"	-24	1 7/8-12 UN-2B	45.34	45.80	65	58	45	54	49.8	3.3	23	0.3	5	19	15"										
2"	-32	2 1/2-12 UN-2B	61.21	61.67	88	75	50	70	65.7	3.3	23	0.3	5	19	15"										

All dimensions in millimeters unless otherwise specified

13) ISO 7/1 - Rc, Rp or R Pipe Threads (BSPT)

ISO 7/1

Internal Threads
(sealing on the thread)

- ISO 7/1-Rc: taper pipe thread
- ISO 7/1-Rp: parallel pipe thread

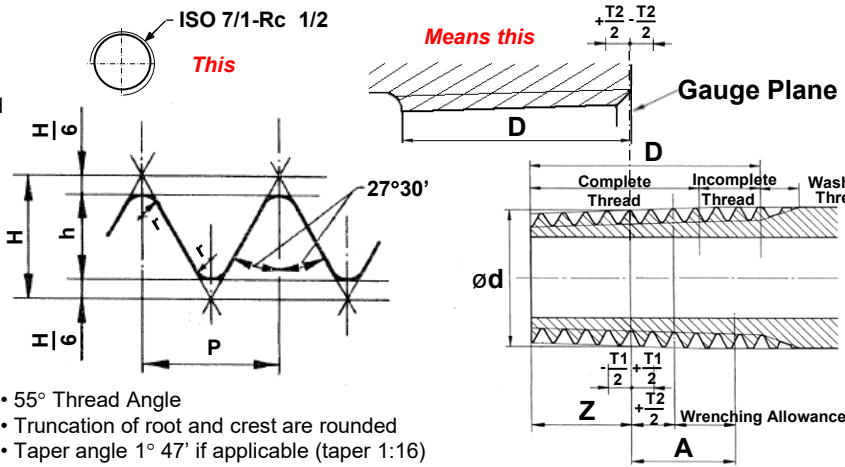
External Threads
(sealing on the thread)

- ISO 7/1-R: taper (always) pipe thread

$$\begin{cases} H = .960491 P \\ h = .640327 P \\ r = .137329 P \end{cases}$$

Thread Inspection

- ISO 7/2



ISO 7/1 Thread	Thread Per Inch	Pitch of Thread	Depth of Thread	Basic Diameter at Gauge Plane					Gauge Length (distance to Pipe end)				Gauge Plane Position	Length of Useful Thread (Pipe)			Fitting Allowance	
				P	h	ød	ød2	ød1	Z	T1/2	Z	T2/2		D				A
				Nom.	Nom.	Major	Pitch	Minor	Basic	(+/-)	Max.	Min.		(+/-)	Basic	Max.		Min.
1/16"	28	0.907	0.581	7.723	7.142	6.561	4	0.9	4.9	3.1	1.1	6.5	7.4	5.6	2.5			
1/8"	28	0.907	0.581	9.728	9.147	8.566	4	0.9	4.9	3.1	1.1	6.5	7.4	5.6	2.5			
1/4"	19	1.337	0.856	13.157	12.301	11.445	6	1.3	7.3	4.7	1.7	9.7	11	8.4	3.7			
3/8"	19	1.337	0.856	16.662	15.806	14.95	6.4	1.3	7.7	5.1	1.7	10.1	11.4	8.8	3.7			
1/2"	14	1.814	1.162	20.955	19.793	18.631	8.2	1.8	10	6.4	2.3	13.2	15	11.4	5			
3/4"	14	1.814	1.162	26.441	25.279	24.117	9.5	1.8	11.3	7.7	2.3	14.5	16.3	12.7	5			
1"	11	2.309	1.479	33.249	31.77	30.291	10.4	2.3	12.7	8.1	2.9	16.8	19.1	14.5	6.4			
1-1/4"	11	2.309	1.479	41.91	40.431	38.952	12.7	2.3	15	10.4	2.9	19.1	21.4	16.8	6.4			
1-1/2"	11	2.309	1.479	47.803	46.324	44.845	12.7	2.3	15	10.4	2.9	19.1	21.4	16.8	6.4			
2"	11	2.309	1.479	59.614	58.135	56.656	15.9	2.3	18.2	13.6	2.9	23.4	25.7	21.1	7.5			
2-1/2"	11	2.309	1.479	75.184	73.705	72.226	17.5	3.5	21	14	3.5	26.7	30.2	23.2	9.2			
3"	11	2.309	1.479	87.884	86.405	84.926	20.6	3.5	24.1	17.1	3.5	29.8	33.3	26.3	9.2			
4"	11	2.309	1.479	113.03	111.551	110.072	25.4	3.5	28.9	21.9	3.5	35.8	39.3	32.3	10.4			
5"	11	2.309	1.479	138.43	136.951	135.472	28.6	3.5	32.1	25.1	3.5	40.1	43.6	36.6	11.5			
6"	11	2.309	1.479	163.83	162.351	160.872	28.6	3.5	32.1	25.1	3.5	40.1	43.6	36.6	11.5			

All dimensions in millimeters unless otherwise specified

14) ISO 228 - G Pipe Threads (BSPP)

ISO 228-1

Internal Threads

(sealing not made on the thread)

- ISO 228-1- G: parallel pipe thread

External Threads

(sealing not made on the thread)

- ISO 228-1- G: parallel pipe thread, Tolerance class A

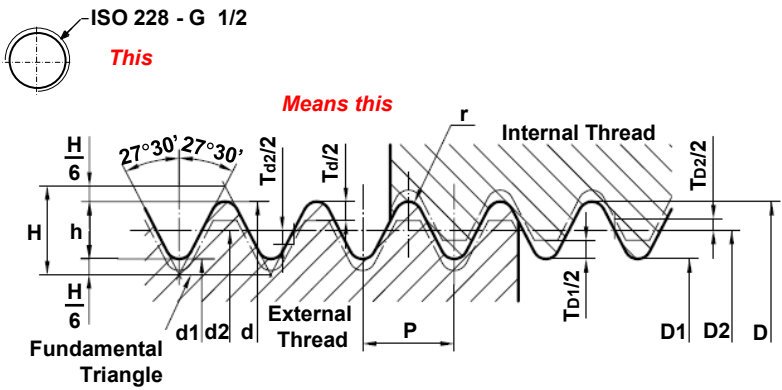
$$\begin{cases} H = .960491 P \\ h = .640327 P \\ r = .137329 P \end{cases}$$

For Port Applications

An o-ring and washer or a bonded washer is needed to achieve a proper seal

Thread Inspection

- ISO 228-2



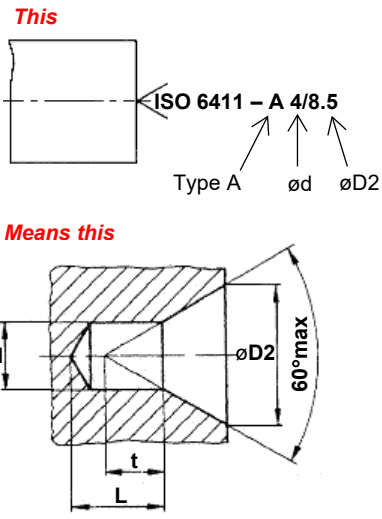
ISO 228-1 Thread	Thread Per Inch	Pitch of Thread	Depth of Thread	Basic Diameters at Gauge Plane					Tolerances on Pitch Diameter				Tolerances on Minor Diameter		Tolerances on Major Diameter	
				P	h	d=D	d2=D2	d1=D1	Td2	Td2	Td1	Td1	Lower	Upper	Lower	Upper
				Nom.	Nom.	Major	Pitch	Minor	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
1/16"	28	0.907	0.581			7.723	7.142	6.561	0	0.107	-0.107	0	0	0.282	-0.214	0
1/8"	28	0.907	0.581			9.728	9.147	8.566	0	0.107	-0.107	0	0	0.282	-0.214	0
1/4"	19	1.337	0.856			13.157	12.301	11.445	0	0.125	-0.125	0	0	0.445	-0.25	0
3/8"	19	1.337	0.856			16.662	15.806	14.95	0	0.125	-0.125	0	0	0.445	-0.25	0
1/2"	14	1.814	1.162			20.955	19.793	18.631	0	0.142	-0.142	0	0	0.541	-0.284	0
5/8"	14	1.814	1.162			22.911	21.749	20.587	0	0.142	-0.142	0	0	0.541	-0.284	0
3/4"	14	1.814	1.162			26.441	25.279	24.117	0	0.142	-0.142	0	0	0.541	-0.284	0
7/8"	14	1.814	1.162			30.201	29.039	27.877	0	0.142	-0.142	0	0	0.541	-0.284	0
1"	11	2.309	1.479			33.249	31.77	30.291	0	0.18	-0.18	0	0	0.64	-0.36	0
1-1/8"	11	2.309	1.479			37.897	36.418	34.939	0	0.18	-0.18	0	0	0.64	-0.36	0
1-1/4"	11	2.309	1.479			41.91	40.431	38.952	0	0.18	-0.18	0	0	0.64	-0.36	0
1-1/2"	11	2.309	1.479			47.803	46.324	44.845	0	0.18	-0.18	0	0	0.64	-0.36	0
1-3/4"	11	2.309	1.479			53.746	52.267	50.788	0	0.18	-0.18	0	0	0.64	-0.36	0
2"	11	2.309	1.479			59.614	58.135	56.656	0	0.18	-0.18	0	0	0.64	-0.36	0
2-1/4"	11	2.309	1.479			65.71	64.231	62.752	0	0.217	-0.217	0	0	0.64	-0.434	0
2-1/2"	11	2.309	1.479			75.184	73.705	72.226	0	0.217	-0.217	0	0	0.64	-0.434	0
2-3/4"	11	2.309	1.479			81.534	80.055	78.576	0	0.217	-0.217	0	0	0.64	-0.434	0
3"	11	2.309	1.479			87.884	86.405	84.926	0	0.217	-0.217	0	0	0.64	-0.434	0
3-1/2"	11	2.309	1.479			100.33	98.851	97.372	0	0.217	-0.217	0	0	0.64	-0.434	0
4"	11	2.309	1.479			113.03	111.551	110.072	0	0.217	-0.217	0	0	0.64	-0.434	0
4-1/2"	11	2.309	1.479			125.73	124.251	122.772	0	0.217	-0.217	0	0	0.64	-0.434	0
5"	11	2.309	1.479			138.43	136.951	135.472	0	0.217	-0.217	0	0	0.64	-0.434	0
5-1/2"	11	2.309	1.479			151.13	149.651	148.172	0	0.217	-0.217	0	0	0.64	-0.434	0
6"	11	2.309	1.479			163.83	162.351	160.872	0	0.217	-0.217	0	0	0.64	-0.434	0

All dimensions in millimeters unless otherwise specified

15) Centre Holes (for Manufacturing)

- ISO 6411 - Simplified representation of centre holes
- Type A centre holes (as per ISO 866)
- No protecting chamfers
- Center holes required on finished part
- Dimension L depends on length of centre drill
- L should not be less than t

Pilot Diameter	Countersink Diameter	Length
ød	øD2	t
Nom.	Nom.	For Ref.
1	2.12	0.9
2	4.25	1.8
4	8.5	3.5
6.3	13.2	5.5
10	21.2	8.7



18) Surface Roughness

Surface Roughness Selection (ANSI Y14.36M, HS 514)

Ra (µm)	Recommended Applications
≥ 12.5	Not machined sand mold casting, flame cut or hot rolled parts surfaces
12.5	Machined and then painted clearance surfaces or clearance surfaces not visible in parts assembly
6.3	Large clearance outside diameters or drilled clearance holes (vibrations)
3.2	Turned and milled datum surfaces (tol. ≥ 0.025mm), housing fits (no gasket or seal), mating surfaces (e.g. pad, face)
1.6	Turned and milled datum surfaces (tol. < 0.025mm), pressed fits, keyways, etc.
0.8	Apply only where required for the functionality or assembly of the parts. Limit to areas where absolutely needed
≤ 0.4	Precision sliding or rotating surfaces, friction surfaces, precision bearings, etc.

Standard Roughness Cutoff *

X < Ra ≤ Y (unit: µm)	Roughness Cutoff (unit: mm)
-	0.02
0.02	0.1
0.1	2
2	10
10	-

* If no roughness cutoff value is indicated

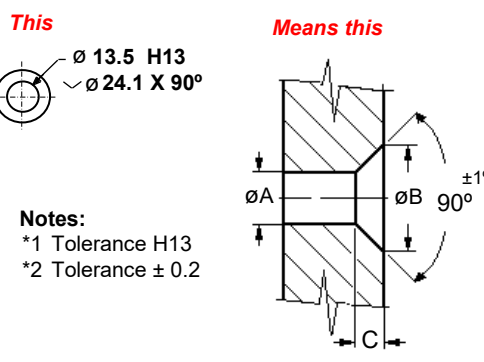
Symbol Value Application

- a = roughness value Ra in micrometers
 - b = production method, treatment, coating, other text, or note callout
 - c = roughness cutoff or sampling length in millimeters
 - d = direction of lay
 - e = minimum material removal requirement in millimeters
 - f = roughness value other than Ra in micrometers preceded by its parameter symbol. Note: Rz shall not be used.
- Note: b, c, d, e and f are optional

16) Inch Countersink Holes

Screw Size	Drill Size	Countersink Diameter	Countersink Depth
		øA*1	øB*2
Inch	Inch	Nom.	Nom.
#4	0.1120	3.5	6.7
#8	0.1640	4.9	9.3
#10	0.1900	5.6	10.6
1/4	0.2500	7.1	13.7
5/16	0.3125	8.7	16.9
3/8	0.0375	10.3	20.1
1/2	0.5000	13.5	24.1
5/8	0.6250	16.7	30.5
3/4	0.7500	19.8	36.8

All dimensions in millimeters unless otherwise specified



- Notes:
- *1 Tolerance H13
- *2 Tolerance ± 0.2

19) ISO Limits and Fits

ISO 286, Parts 1 & 2

This 50 P7	Means this 50 - .017 - .042	This 50 u6	Means this 50 + .086 + .070	All values in micrometers unless otherwise specified (1 µm = 0.001mm)
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Basic Size (mm)	Holes (Internal Features)																												
	Over	To	C11	D9	F8	E8	G7	H6	H7	H8	H9	H10	H11	H12	H13	K7	N7	P7	S7	U7	c11	d9	e9	f7	f8	g6	h6	h7	
0	3		+120	+45	+20	+28	+12	+6	+10	+14	+25	+40	+60	+100	+140	0	-4	-6	-14	-18	-60	-20	-14	-6	-2	0	0	0	0
			+60	+20	+6	+14	+2	0	0	0	0	0	0	0	0	-10	-14	-16	-24	-28	-120	-45	-39	-16	-20	-8	-6	-10	-14
3	6		+145	+60	+28	+38	+16	+8	+12	+18	+30	+48	+75	+120	+180	+3	-4	-8	-15	-19	-70	-30	-20	-10	-10	-4	0	0	0
			+70	+30	+10	+20	+4	0	0	0	0	0	0	0	0	-9	-16	-20	-27	-31	-145	-60	-50	-22	-28	-12	-8	-12	-18
6	10		+170	+76	+35	+47	+20	+9	+15	+22	+36	+58	+90	+150	+220	+5	-4	-9	-17	-22	-80	-40	-25	-13	-13	-5	0	0	0