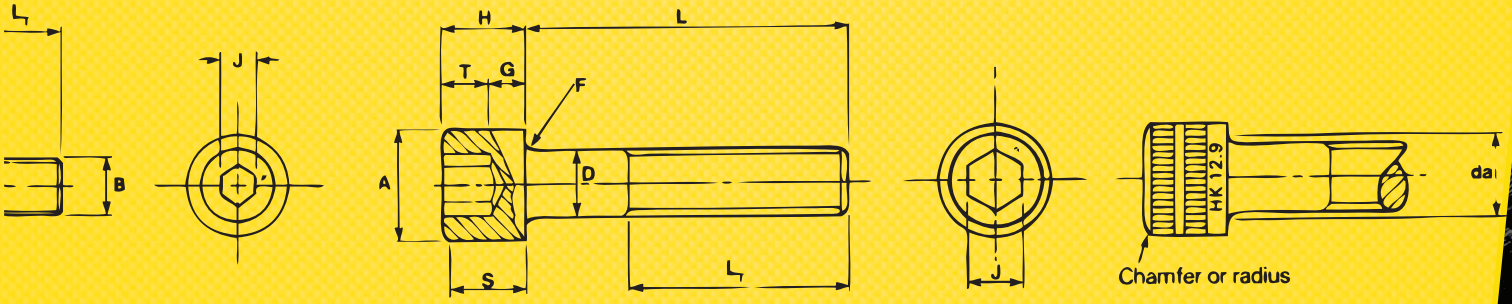
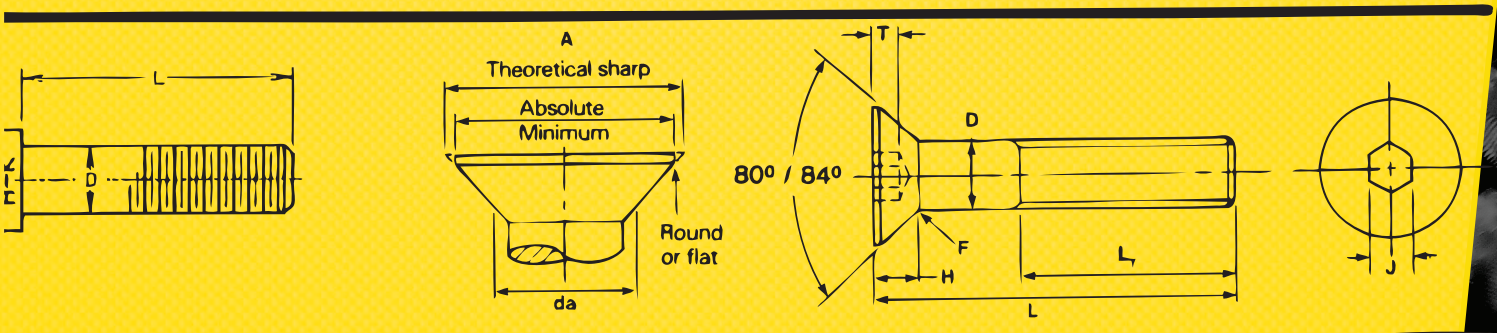
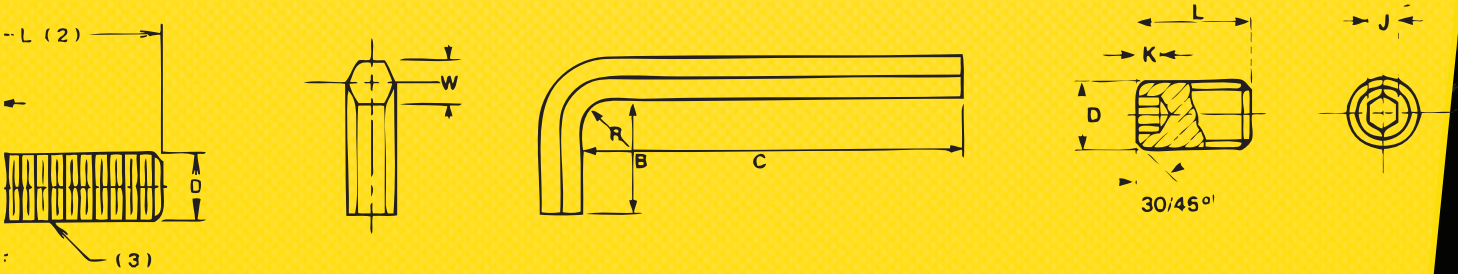
HOLO-KROME®

TECHNICAL HANDBOOK







IMPORTANT

Holo-Krome has published this handbook as a guide to dimensional, mechanical, and application data for Holo-Krome Socket Screw Products. However, the following limitations must be carefully observed in using the information presented in this handbook:

(1) The data in this handbook is subject to change from time to time as a result of changes in products and specifications. To obtain the latest technical data pertaining to Holo-Krome products, contact the Holo-Krome Engineering Department.

(2) Certain products listed in these tables are non-stock products. Specifications of non-stock products may differ slightly from the handbook description, due to differences in the manufacturing process.

(3) Proper screw sizes and tightening torque for any given application is a function of the various design parameters, such as heat, lubrication, etc. Therefore, the data in this handbook should be used only for general guidance in conjunction with the specific design criteria and with the application of proper engineering principles.

(4) Holo-Krome disclaims all responsibility for its products if they are modified in any way, including plating, hardness alterations, drilling, etc. Specials will be quoted complete by Holo-Krome on request.

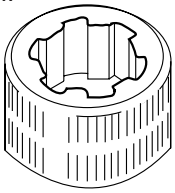
(5) Appropriate specifications are shown with the applicable products. Many of these are written by consensus organizations, and, while Holo-Krome intends that its standard products meet these specifications in all respects, there are changes which take place over the years and must be considered not applicable on a retroactive basis.

(6) This handbook has been revised to provide data for Metric module products as well as those in Inch module. The organization of the book is designed to make it easy for the user to find his information in whatever module he is working. The Dimensional Data in each case is presented for the various products, followed by the Application Data. Inch module is presented complete, followed by the Metric.

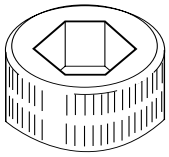
The Holo-Krome Engineering Department welcomes questions regarding fasteners for specific customer applications. Their technical experience and special test facilities in the precision fasteners field are available to help solve your fastener problems.

THE HOLO-KROME QUALITY STORY

Quality is frequently defined as conformance to specification, and at Holo-Krome a great deal of effort is expended in ensuring that the products shipped do, in fact, meet the required specification. From the placing of the raw material order, through the shipping and certification of the finished product, Holo-Krome procedures and specifications are applied to meet that objective.



The definition of the required specification requires a little discussion. Holo-Krome's products, like those of any manufacturer, must meet certain criteria. The definition of those criteria can be done several ways. It is common for people to refer to an "Industry Standard," when they are looking for an easy way to define a product. Actually, any manufactured article must, of necessity, have two sets of characteristics: the dimensional, controlling the size and shape, and the mechanical, controlling the base material and the performance of the product. In the fastener industry, there are many organizations which write standards or specifications for this product. In the case of socket head cap screws, for instance, one set of applicable standards would be the ASME/ANSI B18.3, which defines the dimensional characteristics of this product, and ASTM A574, which defines the mechanical properties. Both of these are quite detailed, providing on the one hand, basic size definitions such as diameter, length and thread size, as well as surface finish, concentricity and method of manufacture, and, on the other hand the basic chemistry, heat treatment, hardness, tensile strength and other metallurgical characteristics, as well as the tests necessary to establish they have been done correctly.

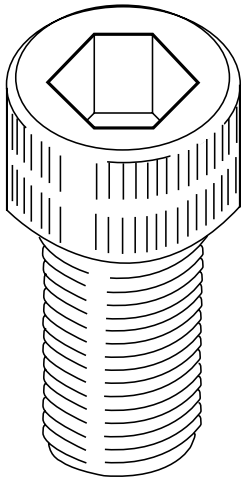


Holo-Krome's specification for raw material has been designed to provide material which will properly make the desired product, without inherent flaws that might be harmful. When the material is received, it is inspected to be sure that it does meet those specifications, and then a Lab Number is assigned, which will provide traceability throughout manufacturing, testing, storage and shipment.

From the first set-up on the first machine, calibrated gages and control charts are used to ensure conformance to the prints which have been assigned, and at heat treatment, utilizing atmosphere-controlled furnaces, testing is performed to the further corroborate adherence to specification. In the case of special products, the customer may request other specifications to meet his own particular needs. There are many specifications in existence for the type of product we are discussing, and the selection of these specifications is a matter of agreement between purchaser and seller. In most cases, the "Industry Standard" is used, which is the combination shown above, for socket head cap screws.

The ingredient necessary to provide all of these assurances lies in Holo-Krome's people, who are trained in the various arts and skills needed to perform the checks and tests required. In addition to these people and their skills is the physical plant and equipment which they use. From indicating thread gages of the latest type, and laser measuring equipment, to automated devices to create metallographic specimens, as well as appropriate testing equipment, the investment has been made to have available whatever is required for assurance that the specifications are being met.

This devotion to quality is a company philosophy, from top management to the last packer on the line. Quality is everybody's job, and every associate in the Holo-Krome organization is aware of that fact, and very much a part of it. Associate Involvement Groups are used in the plant to help solve problems which are broader in scope than a single machine, and these have proven to be successful in the drive for continuous improvement which is the Holo-Krome philosophy.



METRIC FASTENERS

TABLE OF CONTENTS

DIMENSIONAL DATA **Page No.**

Metric Section

Index to Tables

Page No.

Warning Metric Users!

It is very important that the users of Socket Products, particularly Socket Head Cap Screws, be aware that the practice in Europe and other metric areas, is not to restrict the manufacturer of these products to Class 12.9. In the USA, and in inch module parts, it has been customary that the socket head cap screw configuration is always made from alloy steel and always to a high strength level, typically 180,000 psi. Metric countries produce this same configuration in alloy steels in Class 10.9 as well, and in Class 8.8 from carbon steel. It is vitally important that an assembly designed around Class 12.9 cap screws be put together with such screws. Beware of lower strength screws being substituted.

Holo-Krome Metric Socket Screw Products

TYPE	SIZE RANGE	
	DIAMETER	LENGTH
Socket Head Cap Screw 	M3 to M24	5 to 35mm thru 40 to 150mm
Flat Countersunk Head Socket Screws 	M3 to M20	8 to 30 mm thru 35 to 100mm
Button Head Socket Screws 	M3 to M22	8 to 16mm thru 10 to 40mm
Cup Point Socket Set Screws 	M3 to M16	3 to 16mm thru 20 to 50mm
Hexagon Socket Head Shoulder Screws 	6mm to 16mm	10 to 90mm
Metric Allen Wrenches 	**SHORT ARM**	**LONG ARM**
	0.7 to 19mm	0.7 to 19mm

TABLE 36 HOLO-KROME METRIC SOCKET HEAD CAP SCREWS

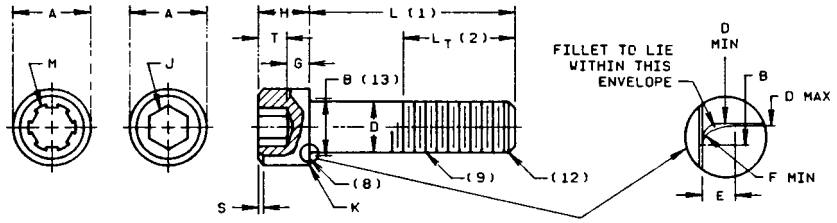


TABLE 36 DIMENSIONS

NOMINAL SIZE AND THREAD PITCH	D		A		H		S	J	M	T	G	B		E	F	K	L_T
	BODY DIAMETER		HEAD DIAMETER		HEAD HEIGHT		CHAMFER OR RADIUS	HEXAGON SOCKET SIZE	SPLINE SOCKET SIZE	KEY ENGAGE-MENT	WALL THICK-NESS	UNDERHEAD FILLET				CHAMFER OR RADIUS	THREAD LENGTH
												TRANSITION DIAMETER		TRANSITION LENGTH	JUNCTURE RADIUS		
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	NOM.	NOM.	MIN.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
M1.6 x0.35	1.60	1.46	3.00	2.87	1.60	1.52	0.16	1.5	1.829	0.80	0.54	2.0	1.8	0.34	0.10	0.08	15.2
M2 x 0.4	2.00	1.86	3.80	3.65	2.00	1.91	0.20	1.5	1.829	1.00	0.68	2.6	2.2	0.51	0.10	0.08	16.0
M2.5 x 0.45	2.50	2.36	4.50	4.33	2.50	2.40	0.25	2.0	2.438	1.25	0.85	3.1	2.7	0.51	0.10	0.08	17.0
M3 x 0.5	3.00	2.86	5.50	5.32	3.00	2.89	0.30	2.5	2.819	1.50	1.02	3.6	3.2	0.51	0.10	0.13	18.0
M4 x 0.7	4.00	3.82	7.00	6.80	4.00	3.88	0.40	3.0	3.378	2.00	1.52	4.7	4.4	0.60	0.20	0.13	20.0
M5 x 0.8	5.00	4.82	8.50	8.27	5.00	4.86	0.50	4.0	4.648	2.50	1.90	5.7	5.4	0.60	0.20	0.13	22.0
M6 x 1	6.00	5.82	10.00	9.74	6.00	5.85	0.60	5.0	5.486	3.00	2.28	6.8	6.5	0.68	0.25	0.20	24.0
M8 x 1.25	8.00	7.78	13.00	12.70	8.00	7.83	0.80	6.0	7.391	4.00	3.20	9.2	8.8	1.02	0.40	0.20	28.0
M10 x 1.5	10.00	9.78	16.00	15.67	10.00	9.81	1.00	8.0	-	5.00	4.00	11.2	10.8	1.02	0.40	0.20	32.0
M12 x 1.75	12.00	11.73	18.00	17.63	12.00	11.79	1.20	10.0	-	6.00	4.80	14.2	13.2	1.87	0.60	0.25	36.0
M14 x 2 (1)	14.00	13.73	21.00	20.60	14.00	13.77	1.40	12.0	-	7.00	5.60	16.2	15.2	1.87	0.60	0.25	40.0
M16 x 2	16.00	15.73	24.00	23.58	16.00	15.76	1.60	14.0	-	8.00	6.40	18.2	17.2	1.87	0.60	0.25	44.0
M20 x 2.5	20.00	19.67	30.00	29.53	20.00	19.73	2.00	17.0	-	10.00	8.00	22.4	21.6	2.04	0.80	0.40	52.0
M24 x 3	24.00	23.67	36.00	35.48	24.00	23.70	2.40	19.0	-	12.00	9.60	26.4	25.6	2.04	0.80	0.40	60.0
M30 x 3.5	30.00	29.67	45.00	44.42	30.00	29.67	3.00	22.0	-	15.00	12.00	33.4	32.0	2.89	1.00	0.40	72.0
M36 x 4	36.00	35.61	54.00	53.37	36.00	35.64	3.60	27.0	-	18.00	14.40	39.4	38.0	2.89	1.00	0.40	84.0
M42 x 4.5	42.00	41.61	63.00	62.31	42.00	41.61	4.20	32.0	-	21.00	16.80	45.6	44.4	3.06	1.20	0.40	96.0
M48 x 5	48.00	47.61	72.00	71.27	48.00	47.58	4.80	36.0	-	24.00	19.20	52.6	51.2	3.91	1.60	0.40	108.0

(1) The M14x2 size is not recommended for use in new designs.

NOTES FOR TABLE 36

1. LENGTH L. The length of the screw is the distance measured on a line parallel to the axis, from the plane of the bearing surface under the head to the plane of the flat of the point. It includes the threads and the body.

2. THREAD LENGTH L_T. Thread length of the screw is the distance from the extreme point to the last complete or full form thread. It is controlled by the grip length, L_G, as defined below. See Table 37 for grip and body lengths of standard screws. L_T min. refers to screws outside the range of Table 37.

3. BODY L_B. The unthreaded cylindrical portion of the shank for screws that are not threaded to the head.

4. GRIP LENGTH L_G. The maximum length representing the design length of the screw. It is measured from the bearing surface of the head, parallel to the axis of the screw, to the face of a GO thread ring gage with the countersink and/or counterbore removed. See page 62 for grip and body lengths of standard screws.

5. HEAD DIAMETER A. Heads may be made plain or knurled at Holo-Krome's option, unless specified on the order. For knurled screws, the maximum head diameter includes the knurl. Minimum head diameter is the diameter of the head before knurling, or any unknurled section or band on the head. Sizes M5 and larger shall be marked with H-K logo and strength level.

6. HEAD CONCENTRICITY. The heads of Holo-Krome Metric Socket Head Cap Screws are concentric with the shank within 2% of the basic screw diameter, or 0.15mm, whichever is greater, FIM (Full Indicator Movement).

7. SOCKET TRUE POSITION. The axis of the socket shall be located at true position relative to the axis of the screw within a tolerance zone having a diameter equal to 3% of the basic screw diameter or 0.26mm, whichever is greater, for nominal screw sizes up to and including 12mm, and equal to 6% of the basic screw diameter for sizes larger than 12mm—regardless of feature size.

8. BEARING SURFACE. The plane of the bearing surface is perpendicular to the axis of the screw within a maximum deviation of 1 degree.

9. THREADS. Threads are Metric coarse series in accordance with ANSI/ASME B 1.13M - Metric Screw Threads, M Profile.

10. THREAD TOLERANCE CLASS. Threads are Tolerance Class 4g6g and for plated screws the allowance g may be consumed by the thickness of plating, so that the maximum limit of six after plating shall be that of Tolerance Class 4h6h.

11. THREAD GAGING. Acceptability of screw threads shall be determined based on System 22 of ANSI/ASME B1.3M.

12. POINT CHAMFER. The point shall be flat or slightly concave and chamfered. The chamfer shall extend slightly below the root of the thread, and the edge between the flat and chamber may be slightly rounded. The included angle of the point shall be approximately 90°. Chamfering on screw sizes up to and including mm and of larger screws with lengths shorter that 0.75 times the basic screw diameter shall be optional.

13. FILLET. For all lengths of screws, the form of the fillet at the junction of head and shank shall be optional within the following provisions: The fillet shall be a smooth and continuous concave curve fairing into the bearing surface within the limits of diameter BV, with a junction radius of not less than F, and blending into the shank at a distance from the head not exceeding E, as determined at the basic screw diameter D.

14. TOTAL RUNOUT. The total runout between the head body and thread on socket cap screws shall be such that the screw will assembly into a compound hole (see Table 38), that is threaded at one end to the basic thread size (class 6H min.) for a depth equivalent to 1.5 times the basic screw diameter and counterbored at the other end of diameter AE and through the center portion to diameter DE as specified in Table 38. These diameters shall b e concentric with the axis of the thread within the equivalent of 10% of the thread pitch diameter tolerance. The starting thread shall be chamfered and the juncture of the corners shall be chamfered or rounded to a diameter equal to B maximum.

Applicable Standards and Specifications
ASME/ANSI B18.3.1M and ASTM A574M

TABLE 37 HOLO-KROME METRIC SOCKET HEAD CAP SCREWS

GRIP LENGTH — L_G. The maximum distance from the bearing surface of the head to the first completed for full form thread. A clamped part thinner than LG would not allow the screw to seat.

BODY LENGTH — L_B. The minimum length of the unthreaded cylindrical portion of the shank.

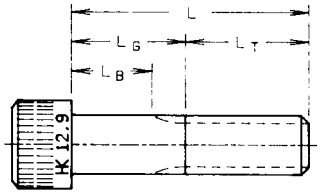


TABLE 37 BODY AND GRIP LENGTHS

NOMINAL SIZE	M1.6		M2		M2.5		M3		M4		M5		M6		M8		M10		M12		M14		M16		M20		M24	
NOMINAL LENGTH	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B
20	4.8	3.0	4.0	2.0																								
25	9.8	8.0	9.0	7.0	8.0	5.7	7.0	4.5																				
30	14.8	13.0	14.0	12.0	13.0	10.7	12.0	9.5	10.0	6.5																		
35	—	—	19.0	17.0	18.0	15.7	17.0	14.5	15.0	11.5	13.0	9.0	11.0	6.0														
40	—	—	24.0	22.0	23.0	20.7	22.0	19.5	20.0	16.5	18.0	14.0	16.0	11.0														
45	—	—	—	—	28.0	25.7	27.0	24.5	25.0	21.5	23.0	19.0	21.0	16.0	17.0	10.7												
50	—	—	—	—	33.0	30.7	32.0	29.5	30.0	26.5	28.0	24.0	26.0	21.0	22.0	15.7	18.0	10.5										
55	—	—	—	—	—	—	37.0	34.5	35.0	31.5	33.0	29.0	31.0	26.0	27.0	20.7	23.0	15.5										
60	—	—	—	—	—	—	42.0	39.5	40.0	36.5	38.0	34.0	36.0	31.0	32.0	25.7	28.0	20.5	24.0	15.2								
65	—	—	—	—	—	—	47.0	44.5	45.0	41.5	43.0	39.0	41.0	36.0	37.0	30.7	33.0	25.5	29.0	20.2	25.0	15.0						
70	—	—	—	—	—	—	—	—	50.0	46.5	48.0	44.0	46.0	41.0	42.0	35.7	38.0	30.5	34.0	25.2	30.0	20.0	26.0	16.0				
80	—	—	—	—	—	—	—	—	60.0	56.5	58.0	54.0	56.0	51.0	52.0	45.7	48.0	40.5	44.0	35.2	40.0	30.0	36.0	26.0				
90	—	—	—	—	—	—	—	—	—	—	68.0	64.0	66.0	61.0	62.0	55.7	58.0	50.5	54.0	45.2	50.0	40.0	46.0	36.0	38.0	25.5		
100	—	—	—	—	—	—	—	—	—	—	78.0	74.0	76.0	71.0	72.0	65.7	68.0	60.5	64.0	55.2	60.0	50.0	56.0	46.0	48.0	35.5	40.0	25.0
110	—	—	—	—	—	—	—	—	—	—	—	—	86.0	81.0	82.0	75.7	78.0	70.5	74.0	65.2	70.0	60.0	66.0	56.0	58.0	45.5	50.0	35.0
120	—	—	—	—	—	—	—	—	—	—	—	—	96.0	91.0	92.0	85.7	88.0	80.5	84.0	75.2	80.0	70.0	76.0	66.0	68.0	55.5	60.0	45.0
130	—	—	—	—	—	—	—	—	—	—	—	—	—	—	102.0	95.7	98.0	90.5	94.0	85.2	90.0	80.0	86.0	76.0	78.0	65.5	70.0	55.0
140	—	—	—	—	—	—	—	—	—	—	—	—	—	—	112.0	105.7	108.0	100.5	104.0	95.2	100.0	90.0	96.0	86.0	88.0	75.5	80.0	65.0
150	—	—	—	—	—	—	—	—	—	—	—	—	—	—	122.0	115.7	118.0	110.5	114.0	105.2	110.0	100.0	106.0	96.0	98.0	85.5	90.0	75.0
160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	132.0	125.7	128.0	120.5	124.0	115.2	120.0	110.0	116.0	106.0	108.0	95.5	100.0	85.0
180	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	148.0	140.5	144.0	135.2	140.0	130.0	126.0	136.0	128.0	115.5	120.0	105.0
200	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	168.0	160.5	164.0	155.2	160.0	150.0	146.0	156.0	148.0	135.5	140.0	125.0
220	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	184.0	175.2	180.0	170.0	166.0	176.0	168.0	155.5	160.0	145.0
240	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	204.0	195.2	200.0	190.0	186.0	196.0	188.0	175.5	180.0	165.0
260	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	220.0	210.0	206.0	216.0	208.0	195.5	200.0	185.0
300		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	246.0	256.0	248.0	235.5	240.0	225.0

NOTES FOR TABLE 37

1. Screws of diameter/length combinations above heavy line shall be threaded full length.

2. For screw sizes and/or lengths not tabulated, see Note 2, Table 36.

TABLE 38 HOLO-KROME METRIC SOCKET HEAD CAP SCREWS

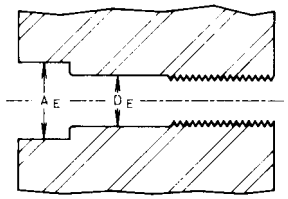


TABLE 38 FUNCTIONAL LIMITS FOR RUNOUT OF HEAD, BODY, AND THREAD ON METRIC SOCKET HEAD CAP SCEWS

NOMINAL SIZE		M1.6		M2		M2.5		M3		M4		M5		M6		M8		M10		M12	
NOMINAL LENGTH		HOLE DIAMETERS FOR SHANK D_E AND FOR HEAD A_E																			
OVER	TO. INCL.	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E
0	6	1.66	3.21	2.05	4.00	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
6	12	1.72	3.27	2.11	4.06	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
12	20	1.80	3.35	2.18	4.13	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	25	1.85	3.40	2.22	4.17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25	35	—	—	2.31	4.26	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
0	12	—	—	—	—	2.60	4.75	3.09	5.74	—	—	—	—	—	—	—	—	—	—	—	—
12	25	—	—	—	—	2.70	4.85	3.18	5.83	—	—	—	—	—	—	—	—	—	—	—	—
25	35	—	—	—	—	2.78	4.93	3.25	5.90	—	—	—	—	—	—	—	—	—	—	—	—
35	50	—	—	—	—	2.90	5.05	3.36	6.01	—	—	—	—	—	—	—	—	—	—	—	—
50	60	—	—	—	—	—	—	3.44	6.09	—	—	—	—	—	—	—	—	—	—	—	—
0	20	—	—	—	—	—	—	—	—	4.13	7.28	5.12	8.77	—	—	—	—	—	—	—	—
20	35	—	—	—	—	—	—	—	—	4.22	7.37	5.20	8.85	—	—	—	—	—	—	—	—
35	60	—	—	—	—	—	—	—	—	4.38	7.53	5.34	8.99	—	—	—	—	—	—	—	—
60	70	—	—	—	—	—	—	—	—	4.44	7.59	5.39	9.04	—	—	—	—	—	—	—	—
70	100	—	—	—	—	—	—	—	—	4.63	7.78	5.56	9.21	—	—	—	—	—	—	—	—
0	25	—	—	—	—	—	—	—	—	—	—	—	—	6.13	10.18	8.11	13.27	10.10	16.30	12.09	18.33
25	50	—	—	—	—	—	—	—	—	—	—	—	—	6.26	10.41	8.22	13.38	10.20	16.40	12.18	18.42
50	70	—	—	—	—	—	—	—	—	—	—	—	—	6.36	10.51	8.31	13.47	10.28	16.48	12.25	18.49
70	100	—	—	—	—	—	—	—	—	—	—	—	—	6.51	10.66	8.44	13.60	10.40	16.60	12.36	18.60
100	150	—	—	—	—	—	—	—	—	—	—	—	—	6.64	10.79	8.64	13.80	10.60	16.80	12.54	18.78

NOMINAL SIZE		M14		M16		M20		M24		M30		M36		M42		M48	
NOMINAL LENGTH		HOLE DIAMETERS FOR SHANK D_E AND FOR HEAD A_E															
OVER	TO. INCL.	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E	D_E	A_E
0	50	14.17	21.45	16.16	24.48	20.14	30.54	24.13	36.61	—	—	—	—	—	—	—	—
50	100	14.34	21.62	16.32	24.64	20.28	30.68	24.26	36.74	—	—	—	—	—	—	—	—
100	150	14.50	21.78	16.47	24.79	20.42	30.82	24.38	36.86	—	—	—	—	—	—	—	—
150	200	14.64	21.92	16.63	24.95	20.56	30.96	24.51	36.99	—	—	—	—	—	—	—	—
200	250	14.64	21.92	16.64	24.96	20.64	31.04	24.64	37.12	—	—	—	—	—	—	—	—
0	150	—	—	—	—	—	—	—	—	30.38	45.98	36.38	55.10	42.38	64.22	48.38	73.34
150	300	—	—	—	—	—	—	—	—	30.75	46.35	36.75	55.47	42.75	64.59	48.75	73.71
300	450	—	—	—	—	—	—	—	—	31.12	46.72	37.12	55.84	43.12	64.96	49.12	74.08
450	600	—	—	—	—	—	—	—	—	31.50	47.10	37.50	56.22	43.50	65.34	49.50	74.46

TABLE 39 HOLO-KROME METRIC SOCKET HEAD CAP SCREWS

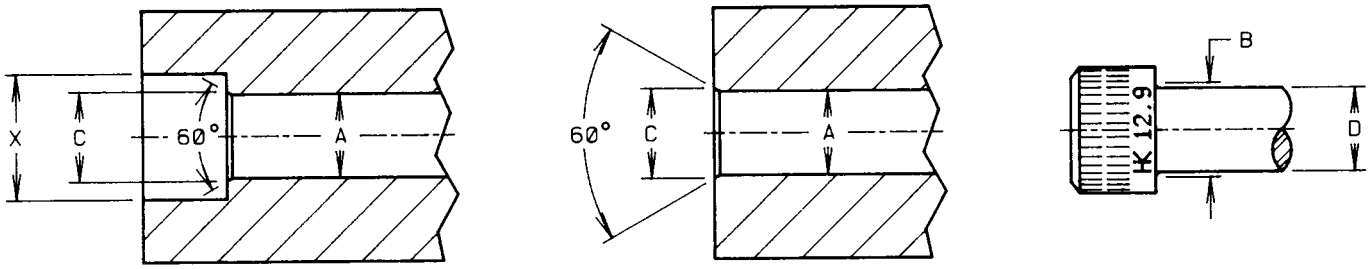


TABLE 39 DRILL AND COUNTERBORE SIZES - METRIC SERIES

NOMINAL SIZE	A		X	C
	NOMINAL DRILL SIZE			
	CLOSE FIT [NOTE (2)]	NORMAL FIT [NOTE (3)]	COUNTERBORE DIAMETER	COUNTERSINK DIAMETER [NOTE (1)]
M1.6	1.80	1.95	3.50	2.0
M2	2.20	2.40	4.40	2.6
M2.5	2.70	3.00	5.40	3.1
M3	3.40	3.70	6.50	3.6
M4	4.40	4.80	8.25	4.7
M5	5.40	5.80	9.75	5.7
M6	6.40	6.80	11.25	6.8
M8	8.40	8.80	14.25	9.2
M10	10.50	10.80	17.25	11.2
M12	12.50	12.80	19.25	14.2
M14	14.50	14.75	22.25	16.2
M16	16.50	16.75	25.50	18.2
M20	20.50	20.75	31.50	22.4
M24	24.50	24.75	37.50	26.4
M30	30.75	31.75	47.50	33.4
M36	37.00	37.50	56.50	39.4

NOTES FOR TABLE 36

1. COUNTERSINK. It is considered good practice to countersink or break the edges of holes that are smaller than B maximum in parts having a hardness that approaches, equals, or exceeds the screw hardness. If such holes are not countersunk, the heads of screws may not seat properly or the sharp edges on the hole may deform the fillets on screws, thereby making them susceptible to fatigue in applications involving dynamic loading. The countersink or corner relief, however, should not be larger than is necessary to insure that the fillet on the screw is cleared. Normally, the diameter of countersink does not have to exceed B maximum.

Countersinks or corner reliefs in excess of this diameter reduce the effective bearing area and introduce the possibility of imbedment where the parts to be fastened are softer than the screws, or of brinnelling or flaring the heads of the screws where the parts to be fastened are harder than the screws.

2. CLOSE FIT. The close fit is normally limited to holes for those lengths of screws that are threaded to the head (see Table 38) in assemblies where only one screw is to be used or where two or more screws are to be used and the mating holes are to be produced either at assembly or by matched and coordinated tooling.

3. NORMAL FIT. The normal fit is intended for screws of relatively long length or for assemblies involving two or more screws of relatively long length or for assemblies involving two or more screws where the mating holes are to be produced by conventional tolerancing methods. It provides for the maximum allowable eccentricity of the longest standard screws and for certain variations in the parts to be fastened, such as: deviations in hole straightness, angularity between the axis of the tapped hole and that of the hole for shank, differences in center distances of the mating holes, etc.

TABLE 40 HOLO-KROME METRIC HEXAGON SOCKET BUTTON HEAD CAP SCREWS

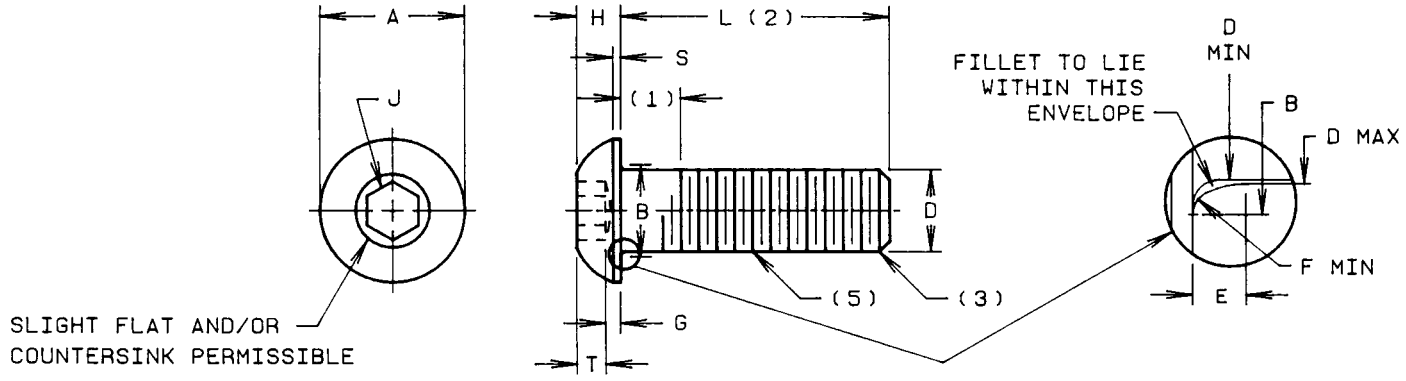


TABLE 40 DIMENSIONS

D	A		H		S	J	T	G	B		E	R	L
NOMINAL SIZE AND THREAD PITCH	HEAD DIAMETER		HEAD HEIGHT		HEAD SIDE HEIGHT	HEXAGON SOCKET SIZE	KEY ENGAGEMENT	WALL THICKNESS	TRANSITION DIAMETER		TRANSITION LENGTH	JUNCTURE RADIUS	MAXIMUM STANDARD LENGTH
	MAX.	MIN.	MAX.	MIN.	REF.	NOM.	MIN.	MIN.	MAX.	MIN.	MAX.	MIN.	NOM.
M3 x 0.5	5.70	5.40	1.65	1.43	0.38	2	1.04	0.20	3.6	3.2	0.51	0.10	12
M4 x 0.7	7.60	7.24	2.20	1.95	0.38	2.5	1.30	0.30	4.7	4.4	0.60	0.20	20
M5 x 0.8	9.50	9.14	2.75	2.50	0.50	3	1.56	0.38	5.7	5.4	0.60	0.20	30
M6 x 1	10.50	10.07	3.30	3.00	0.80	4	2.08	0.74	6.8	6.5	0.68	0.25	30
M8 x 1.25	14.00	13.57	4.40	4.05	0.80	5	2.60	1.05	9.2	8.8	1.02	0.40	40
M10 x 1.5	17.50	17.07	5.50	5.20	0.80	6	3.12	1.45	11.2	10.8	1.02	0.40	40
M12 x 1.75	21.00	20.48	6.60	6.24	0.80	8	4.16	1.63	14.2	13.2	1.87	0.60	60
M16 x 2	28.00	27.48	8.80	8.44	1.50	10	5.20	2.25	18.2	17.2	1.87	0.60	60

NOTES FOR TABLE 40

1. THREAD LENGTH. Screws of nominal lengths equal to or shorter than the length listed in column L shall be threaded full length. The distance measured parallel to the axis of the screw from the underside of the head to the face of a non-countersunk standard GO ring gage assembled by hand as far as the thread will permit, shall not exceed two pitches.

2. LENGTH. The length of the screw (L) shall be measured parallel to the axis of the screw from the plane of the baring surface under the head to the plane of the flat of the point.

3. POINT. The points of button head cap screws shall be chamfered, with the chamfer extending slightly below the root of the thread and the edge between the flat and the chamfer may be slightly rounded. The included angle of the point shall be approximately 90°. Chamfering on screw sizes up to the including 4mm in diameter an of larger sizes with the length shorter than 0.75 times the basic screw diameter, shall be optional..

4. SOCKET TRUE POSITION. The axis of the socket shall be located at true position relative to the axis of the screw within a tolerance zone having a diameter equal to 3% of the basic screw diameter or 0.26mm, whichever is greater, for nominal screw sizes up to 12mm, and qual to 6% of the basic screw diameter for sizes larger than 12mm, regardless of feature size.

5. THREADS AND GAGING. Threads shall be metric coarse series, in accordance with ANSI/ASME B1.13M, Metric Screw Threads, -M Profile. Acceptability of screw threads shall be determined based on System 22 of ANSI/ASME B1.3M.

6. THREAD TOLERANCE CLASS. Threads shall be Tolerance Class 4g6g. For plated screws the allowance g may be consumed by the plating so that the maximum limit of size after plating shall be 4h6h.

Applicable Standards and Specifications
ASME/ANSI B18.3.4M and ASTM F835M

TABLE 41 HOLO-KROME METRIC FLAT COUNTERSUNK SOCKET HEAD CAP SCREWS

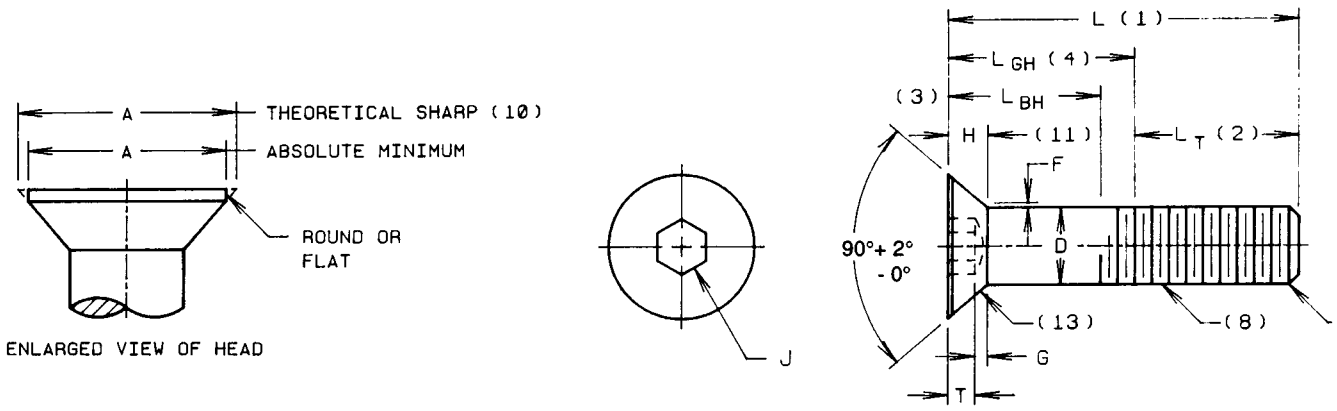


TABLE 41 DIMENSIONS

NOMINAL SIZE AND THREAD PITCH	D		A		H		J	T	G	F
	BODY DIAMETER		HEAD DIAMETER		HEAD HEIGHT		HEXAGON SOCKET SIZE	KEY ENGAGEMENT	SOCKET WALL	FILLET EXTENSION ABOVE D
			THEORETICAL SHARP	ABSOLUTE						
	MAX.	MIN.	MAX.	MIN.	REFERENCE	FLUSHNESS TOLERANCE	NOM.	MIN.	MIN.	MAX.
M3 x 0.5	3.0	2.86	6.72	5.35	1.86	0.25	2.0	1.1	0.31	0.25
M4 x 0.7	4.0	3.82	8.96	7.80	2.48	0.25	2.5	1.5	0.45	0.35
M5 x 0.8	5.0	4.82	11.20	9.75	3.10	0.30	3.0	1.8	0.66	0.40
M6 x 1	6.0	5.82	13.44	11.70	3.72	0.35	4.0	2.4	0.70	0.50
M8 x 1.25	8.0	7.78	17.92	15.60	4.96	0.40	5.0	3.0	1.16	0.60
M10 x 1.5	10.0	9.78	22.40	19.50	6.20	0.40	6.0	3.6	1.62	0.80
M12 x 1.75	12.0	11.73	26.88	23.40	7.44	0.45	8.0	4.6	1.80	0.90
M14* x 2	14.0	13.73	30.80	26.52	8.40	0.50	10.0	5.5	1.80	1.00
M16 x 2	16.0	15.73	33.60	29.01	8.80	0.50	10.0	5.5	2.20	1.00
M20 x 2.5	20.0	19.67	42.00	36.05	11.00	0.75	12.0	7.2	2.20	1.20

NOTE *Not recommended for new design.

NOTES FOR TABLE 41

1. LENGTH L. The length of hexagon socket flat countersunk screws is measured on a line parallel to the axis, from the plane of top of the head to the plane of the flat of the point.

2. THREAD LENGTH. The length of the screw is the distance from the extreme point to the last complete or full form thread. It is controlled by the grip length, L_{GH} as defined below. See Table 42 for grip and body lengths of standard screws.

3. BODY L_{BH}. The unthreaded cylindrical portion of the shank for screws that are not threaded to the head. This represents the minimum length of full body plus the reference head height.

4. GRIP LENGTH L_{GH}. The maximum length representing the design grip length of the screw. It is measured from the top of the head, parallel to the axis of the screw, to the face of a GO thread ring gage with the countersink and/or counterbore removed. See Table 42 for grip and body lengths.

5. POINT> The points of flat countersunk cap screws shall be chamfered, with the chamfer extending slightly below the root of the thread and the edge between the flat and the chamfer may be slightly rounded. The included angle of the point shall be approximately 90°. Chamfering on screw sizes up to and including 4mm in diameter and of larger sizes with the length shorter than 0.75 times the basic screw diameter, shall be optional.

6. SOCKET TRUE POSITION. The axis of the socket shall be located at true position relative to the axis of the screw within a tolerance zone having a diameter equal to 3% of the basic screw diameter or 0.26mm, whichever is greater, for nominal screw sizes up to 12mm, and equal to 6% of the basic screw diameter for sizes larger than 12mm, regardless of feature size.

7. CONCENTRICITY. Concentricity of the thread with the body shall be within 0.13mm per mm of body length (unthreaded portion) full (total) indicator reading, taken directly under the head when the screw is held by the full threads closest to the head of the screw and shall not exceed 0.64mm.

8. THREADS AND GAGING. Threads shall be metric coarse series, in accordance with ANSI/ASME B1.13M, Metric Screw Threads, -M Profile. Acceptability of screw threads to be determined based on System 22 of ANSI/ASME B1.3M.

9. THREAD TOLERANCE CLASS> Threads shall be Tolerance Class 4g6g. For plated screws the allowance g may be consumed by the plating so that the maximum limit of size after plating shall be 4h6h.

10. HEAD DIAMETERS. The maximum sharp values listed under A in Table 41 are theoretical values, as it is not practical to make the edges of the head sharp. The maximum sharp value represents the exact diameter of the hole countersunk to exactly 90° in which a screw having maximum head size will it flush.

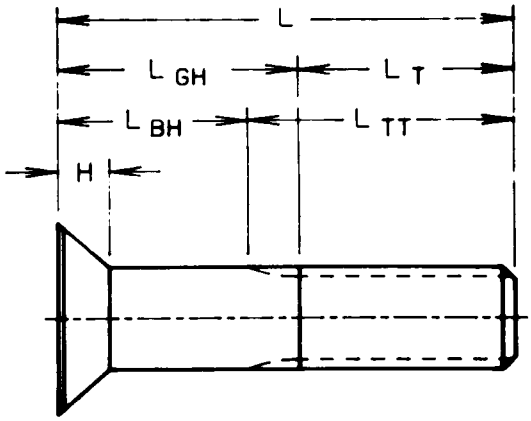
11. HEAD HEIGHT (H). The tabulated values for head height are given for reference only and are calculated to the maximum formulation.

12 FLUSHNESS TOLERANCE. The flushness tolerance is the distance the top surface of the screw having the minimum head size will be below the flush condition in the hole countersunk exactly 90° to the maximum sharp dimension listed under A in Table 41.

13 . BEARING SURFACE. The axis of the conical bearing surface shall be parallel to the axis of the body with 1/2°.

Applicable Standards and Specifications
ASME/ANSI B18.3.5M and ASTM F 835M

TABLE 42 BODY AND GRIP LENGTHS



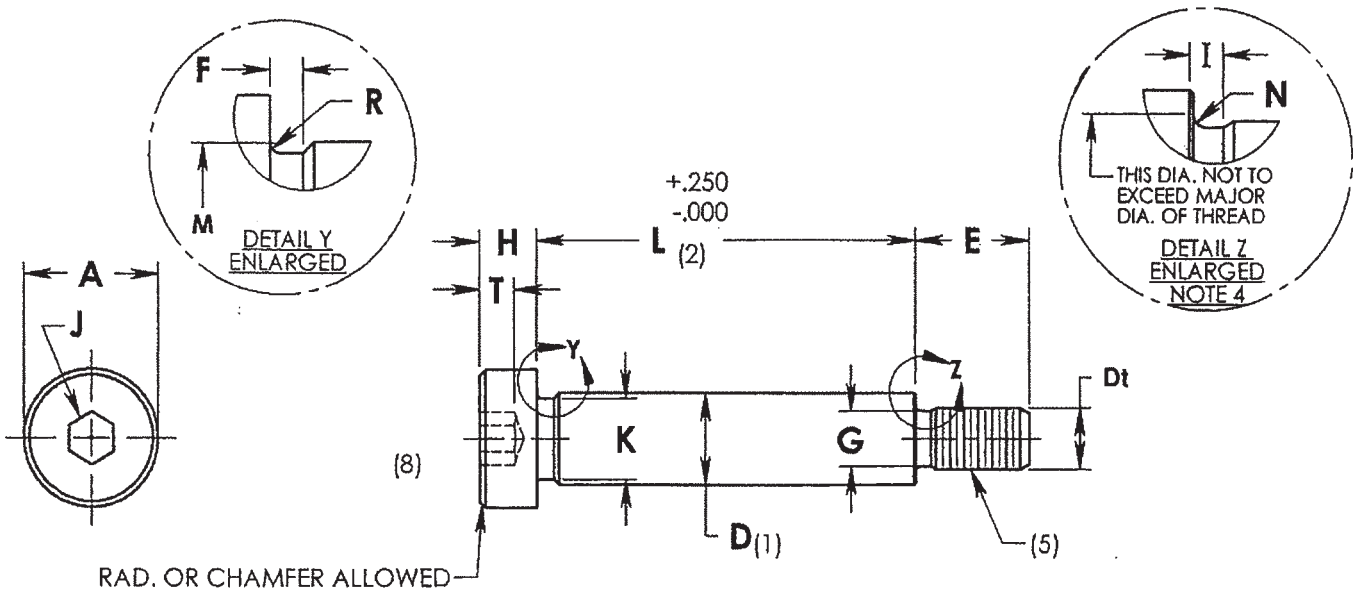
HEXAGON SOCKET FLAT COUNTERSUNK HEAD CAP SCREWS (METRIC SERIES)

NOMINAL DIAMETER	M3		M4		M5		M6		M8		M10		M12		M14		M16		M20	
NOMINAL LENGTH	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}	L_{GH}	L_{BH}
35	17	14.5	15	11.5																
40	22	19.5	20	16.5	18	14														
45	27	24.5	25	21.5	23	19	21	16												
50	32	29.5	30	26.5	28	24	26	21	22	15.7										
55	37	34.5	35	31.5	33	29	31	26	27	20.7										
60			40	36.5	38	34	36	31	32	257	28	20.5								
65			45	41.5	43	39	41	36	37	30.7	33	25.5	29	20.2						
70			50	46.5	48	44	46	41	42	35.7	38	30.5	34	25.2	30	20				
80			60	56.5	58	54	56	51	52	45.7	48	40.5	44	35.2	40	30	36	26		
90					68	64	66	61	62	55.7	58	50.5	54	45.2	50	40	46	36		
100					78	74	76	71	72	65.7	68	60.5	64	55.2	60	50	56	46		
110							86	81	82	75.7	78	70.5	74	65.2	70	60	66	56	58	45.5
120							96	91	92	85.7	88	80.5	84	75.2	80	70	76	66	68	55.5
130									102	95.7	98	90.5	94	85.2	.90	80	86	76	78	65.5
140									112	1057	108	1005	104	95.2	100	90	96	86	88	75.5
150									122	1157	118	1105	114	1052	110	100	106	96	98	85.5

TABLE 42A THREAD LENGTHS FOR LENGTHS NOT TABULATED IN TABLE 42

D NOMINAL SCREW DIAMETER	L_T MINIMUM THREAD LENGTH	L_{TT} MAXIMUM TOTAL THREAD LENGTH
M3	18.0	20.5
M4	20.0	23.5
M5	22.0	26.0
M6	24.0	29.0
M8	28.0	34.3
M10	32.0	39.5
M12	36.0	44.8
M14	40.0	50.0
M16	44.0	54.0
M20	52.0	64.5

TABLE 43 HOLO-KROME METRIC HEXAGON SOCKET HEAD SHOULDER SCREWS



REF.: (h8) SHOULDER DIAMETER TOLERANCE

TABLE 43 DIMENSIONS OF METRIC HEXAGON SOCKET HEAD SHOULDER SCREWS

NOMINAL SCREWS SIZE OR BASIC SHOULDER DIAMETER	D		A		H		J	T	M	R
	SHOULDER DIAMETER		HEAD DIAMETER		HEAD HEIGHT		HEXAGON SOCKET SIZE	KEY ENGAGEMENT	HEAD FILLET EXTENSION DIAMETER	SHOULDER NECK FILLET RADIUS
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	NOM.	MIN.	MAX.	MIN.
6.0	6.00	5.982	10.00	9.78	4.50	4.32	3	2.4	6.8	.25
8.0	8.00	7.978	13.00	12.73	5.50	5.32	4	3.3	9.2	.40
10.0	10.000	9.978	16.00	15.73	7.00	6.78	5	4.2	11.2	.40
12.0	12.000	11.973	18.00	17.73	9.00	8.78	6	4.9	14.2	.60
16.0	16.000	15.973	24.00	23.67	11.00	10.73	8	6.6	18.2	.60
20.0	20.000	19.967	30.00	29.67	14.00	13.73	10	8.8	22.4	.80

TABLE 43 DIMENSIONS (Continued)

NOMINAL SCREWS SIZE OR BASIC SHOULDER DIAMETER	K	F	D_T		G		I	N	E	
	SHOULDER NECK DIAMETER	SHOULDER NECK WIDTH	BASIC THREAD DIAMETER	THREAD PITCH	THREAD NECK DIAMETER		THREAD NECK WIDTH	THREAD NECK FILLET RADIUS	THREAD LENGTH	
	MIN.	MAX.			MAX.	MIN.	MIN.	MAX.	MAX.	MIN.
6.0	5.42	2.5	M5	0.8	3.86	3.68	2.0	0.50	9.75	9.25
8.0	7.42	2.5	M6	1	4.58	4.40	2.5	0.53	11.25	10.75
10.0	9.42	2.5	M8	1.25	6.23	6.03	3.1	0.64	13.25	12.75
12.0	11.42	2.5	M10	1.5	7.89	7.66	3.7	0.77	16.40	15.60
16.0	15.42	2.5	M12	1.75	9.54	9.31	4.4	0.87	18.40	17.60
20.0	19.42	2.5	M16	2	13.20	12.96	5.0	1.14	22.40	21.60

NOTES FOR TABLE 43 (SHOULDER SCREWS)

1. SHOULDER. The shoulder is the enlarged unthreaded shank portion of the screw, the diameter of which serves as the basis for derivation of the nominal screw size. This diameter shall be ground to the limits for D specified in Table 43 and a surface roughness not exceeding 0.8 m Ra.

2. LENGTH. The basic length of the socket head shoulder screw shall be the nominal length of the shoulder, expressed in millimeters, measured parallel to the axis of the screw, from the plane of the bearing surface of the head to the plane of the shoulder at the threaded end.

3. STANDARD LENGTH. The standard lengths for shoulder screws shall be as follows: 10, 12, 16, 20, 25, 30, 40, 50, 60, 70, 80, 90, 1000, 110, and 120mm.

4. THREAD NECK. The neck portion between the thread and shoulder shall allow the face of the shoulder to seat against the face of a standard basic GO ring gage assembled onto the threaded end.

5. THREADS AND GAGING. Threads shall be the metric coarse series, in accordance with ANSI/ASME B1.13M, Metric Screw Threads, M Profile. Acceptability of screw threads shall be based on System 22 of ANSI/ASME B1.3M.

6. THREAD TOLERANCE CLASS. Threads shall be Tolerance Class 4g6g. For plated screws, the allowance g may be consumed by the thickness of the plating so that the maximum size limit after plating shall be that of Tolerance Class 4h6h.

7. CONCENTRICITY. The shoulder and thread pitch diameter shall be concentric with 0.10mm full indicator movement (FIM), determined at a distance of 4.75mm from the face of the shoulder.

Concentricity, parallelism, bow and squareness of the face of the should with the axis of the thread shall be within 0.125mm FIM per 25 .0mm of the shoulder length, with maximum of 0.7mm, when the shoulder face is firmly seated against a threaded bushing and deviation is checked on the shoulder at a distance of 2F from the underside of the head. The thread in the bushing shall be basic size, and the bushing outside diameter and ends shall be concentric and square with the axis of the thread, respectively.

Reference Standards: Similar to ISO7379

TABLE 44 HOLO-KROME METRIC SOCKET SET SCREWS

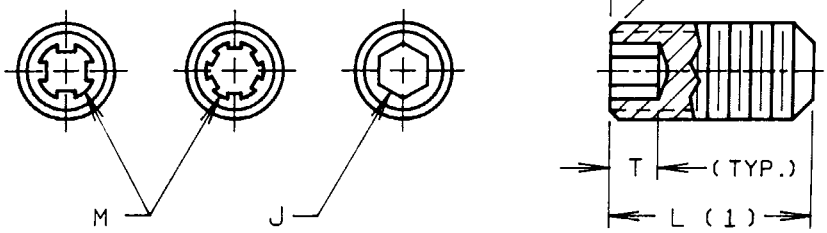
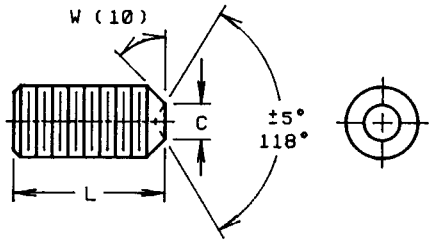
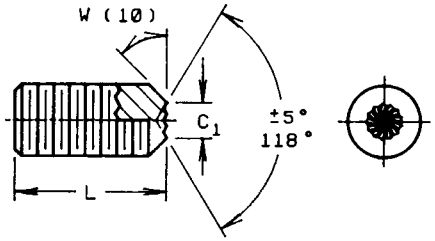


TABLE 44 DIMENSIONS OF METRIC SOCKET SET SCREWS

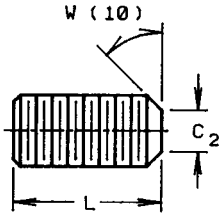
D	J	M	L	T						D	J	M	L	T					
				MINIMUM KEY ENGAGEMENT										MINIMUM KEY ENGAGEMENT					
				CUP AND FLAT POINTS		CONE AND OVAL POINTS		HALF DOG POINTS						CUP AND FLAT POINTS		CONE AND OVAL POINTS		HALF DOG POINTS	
NOMINAL SIZE AND THREAD PITCH	HEXAGON SOCKET SIZE NOM.	SPLINE SOCKET SIZE NOM.	NOMINAL SCREW LENGTHS	HEX T_H MIN.	SPL T_S MIN.	HEX T_H MIN.	SPL T_S MIN.	HEX T_H MIN.	SPL T_S MIN.	NOMINAL SIZE AND THREAD PITCH	HEXAGON SOCKET SIZE NOM.	SPLINE SOCKET SIZE NOM.	NOMINAL SCREW LENGTHS	HEX T_H MIN.	SPL T_S MIN.	HEX T_H MIN.	SPL T_S MIN.	HEX T_H MIN.	SPL T_S MIN.
			1.5	0.6	0.6	0.6	0.6	-	-				4	1.8	1.8	-	-	-	-
			2	0.8	0.7	0.8	0.7	0.6	0.6				5	2.5	2.5	1.8	1.8	1.5	1.5
M1.6 x 0.35	0.7	0.84	2.5	1.0	0.7	1.0	0.7	0.7	0.7	M6 x 1	3	3.68	6	3.0	3.0	2.7	2.7	2.0	2.0
			3	1.25	0.7	1.25	0.7	1.25	0.7				8	3.0	3.0	3.0	3.0	3.0	3.0
			1.5	0.6	0.6	0.6	0.6	-	-				5	1.8	1.8	-	-	-	-
			2	0.8	0.7	0.8	0.7	-	-				6	2.5	2.5	2.3	2.3	1.8	1.8
M2 x 0.4	0.9	0.84	2.5	1.0	0.7	1.0	0.7	0.8	0.7	M8 x 1.25	4	4.65	8	4.0	4.0	3.5	3.5	3.0	3.0
			3	1.2	0.7	1.2	0.7	1.2	0.7				10	4.0	4.0	4.0	4.0	4.0	4.0
			4	1.5	0.7	1.5	0.7	1.5	0.7										
													6	2.0	2.0	-	-	-	-
			2	0.7	0.7	0.7	0.7	-	-				8	3.6	3.6	3.0	3.0	2.5	2.5
M2.5 x 0.45	1.3	1.22	2.5	1.1	1.0	1.1	1.0	0.9	0.9	M10 x 1.5	5	5.49	10	5.0	5.0	4.0	4.0	4.0	4.0
			3	1.5	1.0	1.3	1.0	1.2	1.0				12	5.0	5.0	5.0	5.0	5.0	5.0
			4	1.8	1.0	1.8	1.0	1.8	1.0										
													8	3.0	3.0	-	-	-	-
			2	0.6	0.6	-	-	-	-	M12 x 1.75	6	6.38	10	4.5	4.5	3.8	3.8	3.5	3.5
M3 x 0.5	1.5	1.52	2.5	1.1	1.1	0.7	0.7	-	-				12	6.0	6.0	5.0	5.0	5.0	5.0
			3	1.5	1.2	1.0	1.0	1.0	1.0				16	6.0	6.0	6.0	6.0	6.0	6.0
			4	2.1	1.2	1.5	1.2	2.0	1.2										
			5	2.1	1.2	2.1	1.2	2.1	1.2				10	3.0	3.0	-	-	-	-
										M16 x 2	8	9.45	12	4.8	4.8	3.0	3.0	3.0	3.0
			2.5	1.0	1.0	-	-	-	-				16	8.0	8.0	6.0	6.0	6.0	6.0
M4 x 0.7	2	2.44	3	1.3	1.3	1.0	1.0	1.0	1.0				20	8.0	8.0	8.0	8.0	8.0	8.0
			4	1.8	1.8	1.5	1.5	1.5	1.5										
			5	2.3	2.0	2.0	2.0	2.0	2.0				12	-	-	-	-	-	-
			6	2.3	2.0	2.3	2.0	2.3	2.0	M20 x 2.5	10	11.53	16	6.0	6.0	5.0	5.0	5.0	5.0
													20	9.0	9.0	8.0	8.0	8.0	8.0
			3	1.2	1.2	-	-	-	-				25	10.0	10.0	10.0	10.0	10.0	10.0
			4	2.0	2.0	1.2	1.2	-	-										
M5 x 0.8	2.5	2.82	5	2.7	2.3	1.7	1.7	2.0	2.0				16'	5.0	5.0	-	-	-	-
			6	2.7	2.3	2.0	2.0	2.5	2.3	M24 x 3	12	15.11	20	8.0	8.0	7.0	7.0	6.0	6.0
			8	2.7	2.3	2.7	2.3	2.7	2.3				25	12.0	12.0	10.0	10.0	10.0	10.0
													30	12.0	12.0	12.0	12.0	12.0	12.0



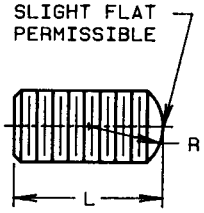
CUP POINT



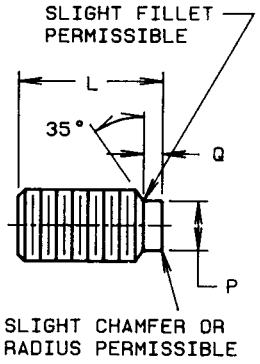
HOLO-KNURL POINT



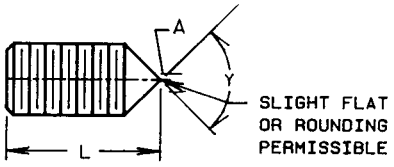
FLAT POINT



OVAL POINT



HALF DOG POINT



CONE POINT

TABLE 45 DIMENSIONS OF METRIC SOCKET SET SCREW POINTS

D	C		C_1		C_2		R		Y	A		P		Q	
NOMINAL SIZE	CUP POINT DIAMETER		CUP POINT DIAMETER FOR HOLO-KNURL POINT		FLAT POINT DIAMETER		OVAL POINT RADIUS		CONE POINT ANGLE 90° FOR THESE LENGTHS AND OVER/118° FOR	FLAT OR TRUNCATION ON CONE POINT		HALF DOG POINT			
												DIAMETER		LENGTH	
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	SHORTER LENGTHS	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
M1.6	0.80	0.55	0.80	0.64	0.80	0.55	1.60	1.20	3	0.16	0	0.80	0.55	0.53	0.40
M2	1.00	0.75	1.00	0.82	1.00	0.75	1.90	1.50	3	0.20	0	1.00	0.75	0.64	0.50
M2.5	1.25	1.05	1.25	1.05	1.50	1.25	2.28	1.88	4	0.25	0	1.50	1.25	0.78	0.63
M3	1.50	1.28	1.50	1.28	2.00	1.75	2.65	2.25	4	0.30	0	2.00	1.75	0.92	0.75
M4	2.00	1.75	2.00	1.75	2.50	2.25	3.80	3.00	5	0.40	0	2.50	2.25	1.20	1.00
M5	2.50	2.22	2.50	2.22	3.50	3.20	4.55	3.75	6	0.50	0	3.50	3.20	1.37	1.25
M6	3.00	2.75	3.00	2.69	4.00	3.70	5.30	4.50	8	1.50	1.2	4.00	3.70	1.74	1.50
M8	4.00	3.65	4.00	3.65	5.50	5.20	6.80	6.00	10	2.00	1.6	5.50	5.20	2.28	2.00
M10	5.00	4.60	5.00	4.60	7.00	6.64	8.30	7.50	12	2.50	2.0	7.00	6.64	2.82	2.50
M12	6.00	5.57	6.00	5.57	8.50	8.14	9.80	9.00	16	3.00	2.4	8.50	8.14	3.35	3.00
M16	8.00	7.50	8.00	7.50	12.00	11.57	12.80	12.00	20	4.00	3.2	12.00	11.57	4.40	4.00
M20	10.00	9.44	10.00	9.44	15.00	14.57	15.80	15.00	25	5.00	4.0	15.00	14.57	5.45	5.00
M24	12.00	11.39	12.00	11.39	18.00	17.57	18.80	18.00	30	6.00	4.8	18.00	17.57	6.49	6.00

NOTES FOR TABLE 44 and 45

1. LENGTH. The length of the screw shall be measured overall, parallel to the axis of the screws.

2. TOLERANCE ON LENGTH. The tolerance on the screw length shall be:

Nominal Screw Length, mm	Length Tolerance, mm
Up to 12, incl.	± 0.3
Over 12 to 50, incl.	± 0.5
Over 50	± 0.8

3. STANDARD LENGTHS. The standard nominal screw lengths are 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 30, 35, 40, 45, 50, 55, 60, 70, 80, 90, and 100mm. The minimum practical screw length for the respective screw sizes and point styles is represented by the shortest lengths listed in Table 44 for which T values are shown.

4. THREADS AND GAGING. Threads shall be the metric coarse series, in accordance with ANSI/ASME B1.3M.

As standard gages provide only for engagement lengths up to the equivalent of 1.5 times the thread diameter, changes in pitch diameter of either or both external and internal thread may be required to longer lengths of engagement.

5. THREAD TOLERANCE CLASS. Threads shall be Tolerance Class 4g6g. For plated screws, the allowance g may be consumed by the thickness of the plating so that the maximum size limit after plating shall be that of Tolerance Class 4h6h.

6. KEY ENGAGEMENT. For screws of nominal lengths exceeding those in Table 44, the minimum key engagement T for the longest length shown shall apply. This represents the minimum key engagement necessary to develop the full functional capability of the keys conforming to ANSI B18.3.2M, Metric series Hexagon Keys and Bits.

7. SOCKET GAGING. Acceptability of hexagon sockets shall be determined by the use of hexagon socket gages specified in ASME/ANSI B18.3.6M. The hexagon sockets shall allow the GO members of the gage to enter freely to the minimum engagement depth. The NOT GO members shall be permitted to enter only to a depth of 10% of the nominal size for sockets up to and including 1.5mm, and 7.5% of the nominal socket size for larger sizes. Acceptability of spline sockets shall be determined in similar fashion, using the spline gages specified in ASME/ANSI B18.3.6M.

8. SOCKET TRUE POSITION. The axis of the socket shall be located at true position relative to the axis of the screw within a tolerance zone having a diameter of 0.25mm, regardless of feature size.

9. FACE CHAMFER. The face on screws having a nominal length longer than the screw diameter shall be chamfered. The chamfer angle V shall be between 30° and 45°. The chamfer shall extend below the root of the thread, and the edge between the face and the chamfer may be slightly rounded. For screws having a nominal length equal to or shorter than the nominal diameter, chamfering shall be at the option of the manufacturer.

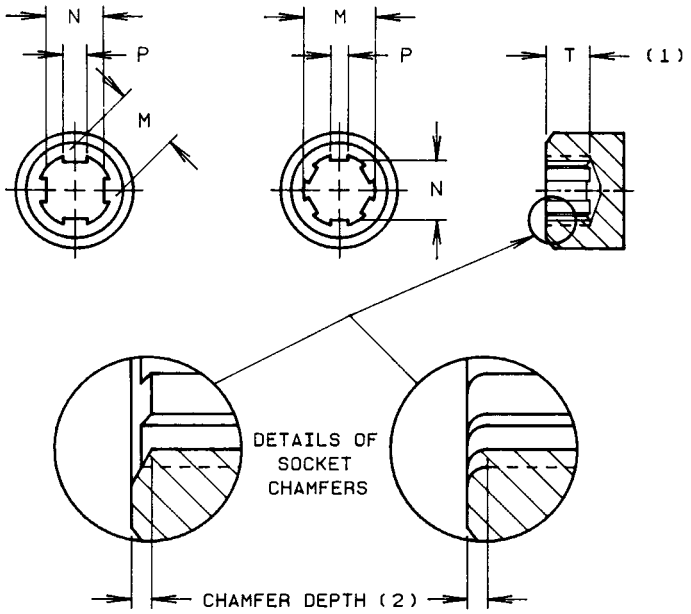
10. POINT ANGLE. The point angles specified shall apply only to those portions of the angles that lie below the root of the thread. The point angle W for flat and cup points shall be 45° +5°, -0°, for screws of length equal to the nominal screw diameter and longer, and 30° minimum for shorter screws.

11. OTHER POINTS. For other point configurations, see ASME/ANSI B18.3.6M

Applicable Standards and Specifications

ASME/ANSI B18.3.6M and ASTM F 912M.

TABLE 46 and 47 METRIC HEXAGON AND SPLINE SOCKETS



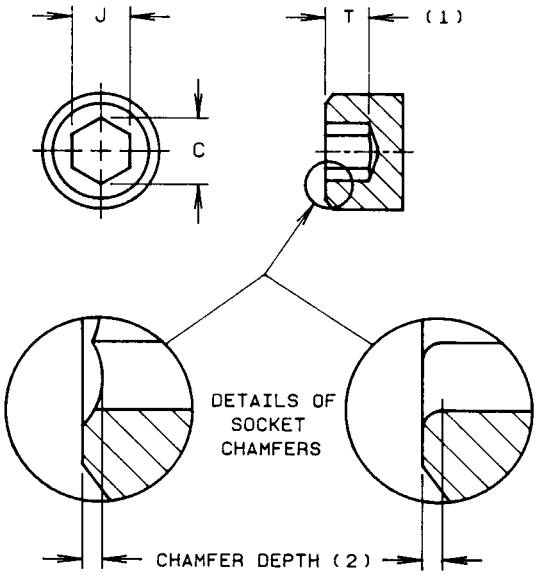


TABLE 46 DIMENSIONS OF METRIC SPLINE SOCKETS

NOMINAL SPLINE SOCKET SIZE	NUMBER OF TEETH	M		N		P	
		SOCKET MAJOR DIAMETER		SOCKET MINOR DIAMETER		WIDTH OF TOOTH	
		MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
0.84	4	0.889	0.864	0.660	0.648	0.305	0.292
1.22	6	1.270	1.245	1.041	1.016	0.379	0.254
1.52	6	1.575	1.549	1.295	1.270	0.356	0.330
2.44	6	2.489	2.464	2.083	2.032	0.559	0.533
2.82	6	2.921	2.870	2.489	2.438	0.635	0.584
3.68	6	3.785	3.734	3.251	3.200	0.813	0.762
4.65	6	4.775	4.724	4.140	4.089	0.991	0.940
5.49	6	5.613	5.563	4.826	4.775	1.270	1.219
6.38	6	6.502	6.452	5.613	5.563	1.524	1.473
98.45	6	9.652	9.576	8.103	8.026	2.337	2.261
11.53	6	11.760	11.684	8.804	9.728	2.845	2.769
15.11	6	15.342	15.265	12.929	12.852	3.505	3.404

NOTES FOR TABLE 46

1. The tabulated dimensions represent direct soft metric conversions of the equivalent inch size spline sockets shown in Table 11. Therefore, the spline keys and bits shown in Table 49 are applicable for wrenching the corresponding size metric spline sockets.

2. Where spline sockets are chamfered, the depth of chamfer shall not exceed 10% of the nominal socket size for sizes up to and including 1.52 and 7.5% for larger sizes. For chamfered sockets, it is permissible for the NOT GO socket gage to enter to the depth of chamfer.

NOTES FOR TABLES 46 AND 47

1. SOCKET DEPTH (T). Applicable socket depths are specified in the dimensional tables and notes for the respective screw types.

2. SOCKET CHAMFER. Where sockets are chamfered, the depth of chamfer shall not exceed 10% of the nominal socket size, up to and including 1.5mm, and 7.5% for larger sizes. This is determined by measuring the depth of penetration of a NOT GO socket gage.

TABLE 47 DIMENSIONS OF METRIC HEXAGON SOCKETS

NOMINAL SOCKET SIZE	J		C
	DIMENSIONS ACROSS FLATS		DIMENSIONS ACROSS CORNERS
	MAX.	MIN.	
0.7	0.724	0.711	0.803
0.9	0L902	0.889	1.003
1.3	1.295	1.270	1.427
1.5	1.545	1.520	1.730
2	2.045	2.020	2.300
2.5	2.560	2.520	2.870
3	3.071	3.020	3.440
4	4.084	4.020	4.580
5	5.084	5.020	5.720
6	6.095	6.020	6.860
8	8.115	8.025	9.150
10	10.127	10.025	11.500
12	12.146	12.032	13.800

TABLE 48 METRIC ALLEN WRENCHES AND BITS

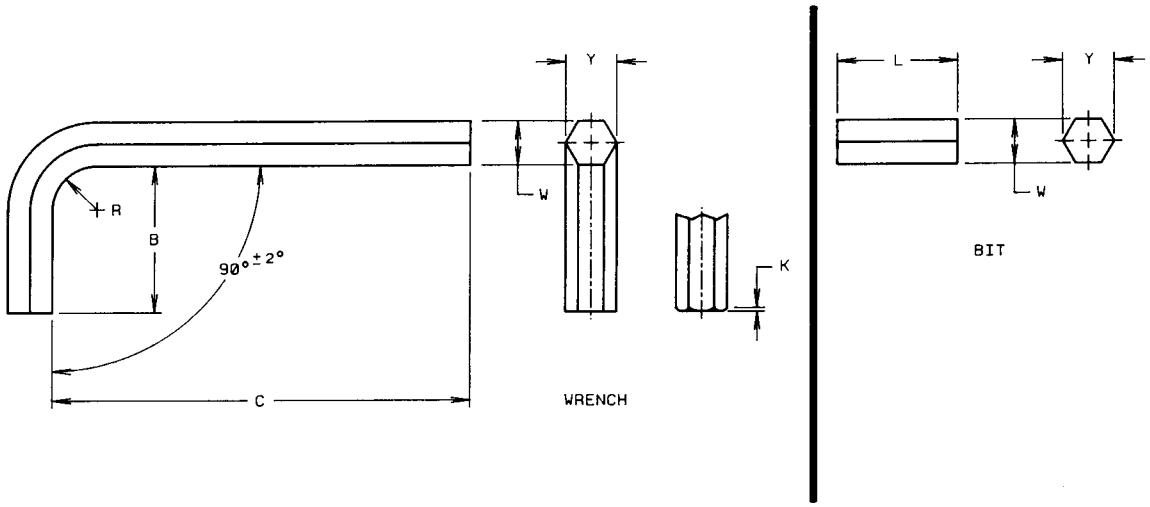


TABLE 48 DIMENSIONS (2)

NOMINAL WRENCH OR BIT SIZE	W		Y		B		C				R	L	K
	HEXAGON WIDTH ACROSS FLATS		HEXAGON WIDTH ACROSS CORNERS		LENGTH OF SHORT ARM		LENGTH OF LONG ARM				RADIUS OF BEND	LENGTH OF BIT	CHAMFER LENGTH
							SHORT SERIES		LONG SERIES				
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MIN.	± 1.5	MAX.
0.7	0.711	0.698	0.798	0.762	8	3	34	28	69	63	1.5	-	0.08
0.9	0.899	0.876	0.998	0.960	11	6	34	28	71	65	1.5	-	0.10
1.3	1.270	1.244	1.422	1.372	16	11	44	39	75	69	1.5	-	0.14
1.5	1.500	1.470	1.690	1.640	14	13	45	43	78	76	1.5	-	0.14
2	2.000	1.970	2.250	2.200	16	15	50	48	83	81	2.0	-	0.14
2.5	2.500	2.470	2.820	2.770	18	17	56	53	90	86	2.5	-	0.14
3	3.000	2.960	3.399	3.340	20	18	63	60	100	97	3.0	-	0.18
4	4.000	3.960	4.532	4.470	24	23	70	66	106	102	4.0	-	0.24
5	5.000	4.960	5.690	5.630	28	26	80	76	118	114	5.0	-	0.30
6	6.000	5.950	6.828	6.760	32	30	90	86	140	136	6.0	-	0.36
8	8.000	7.950	9.136	9.030	36	34	100	95	160	155	8.0	-	0.49
10	10.000	9.950	11.470	11.340	40	38	112	106	170	164	10.0	-	0.62
12	12.000	11.950	13.764	13.590	45	43	125	119	212	206	12.0	-	0.76
14	14.000	13.930	16.058	15.880	56	53	140	133	236	229	14.0	-	0.85
17	17.000	16.930	19.499	19.300	63	60	160	152	250	242	17.0	-	1.04
19	19.000	18.930	21.793	21.580	70	67	180	171	280	271	19.0	-	1.16
22	22.000	21.930	25.234	25.000	80	76	200	190	335	325	22.0	-	1.36
24	24.000	23.930	27.525	27.240	90	86	224	213	375	364	24.0	-	1.49
27	27.000	26.870	30.969	30.710	100	95	250	238	-	-	27.0	100.0	1.68
32	32.000	31.840	36.704	36.430	125	119	315	300	-	-	32.0	100.0	1.99
36	36.000	35.840	41.292	40.900	140	133	355	338	-	-	36.0	100.0	2.25

Bits smaller than 27mm are available, but lengths have not been standardized.

NOTES FOR TABLE 48

1. ENDS. Each end shall be perpendicular to the axis of the respective arms of the keys and the longitudinal axis of bits within 4° and the edges may be sharp, radiused or chamfered at the option of Holo-Krome, the chamfer not to exceed K.

2. ANGLE OF BEND. The angle of bend between the axis of the short arm and the axis of the long arm shall be 90°, ±2°.

3. PLATED PRODUCT. For plated wrenches and bits, all dimensions are before plating.

4. INTERCHANGEABILITY. The user is cautioned that ISO metric keys and bits of the same nominal size may not be able to perform adequately due to variations in size tolerances which may cause reaming. The use of Allen Metric Hexagon keys and bits is strongly recommended.

Applicable Standards and Specifications
ASME/ANSI B18.3.2M

TABLE 49 METRIC ALLEN SPLINE KEYS AND BITS

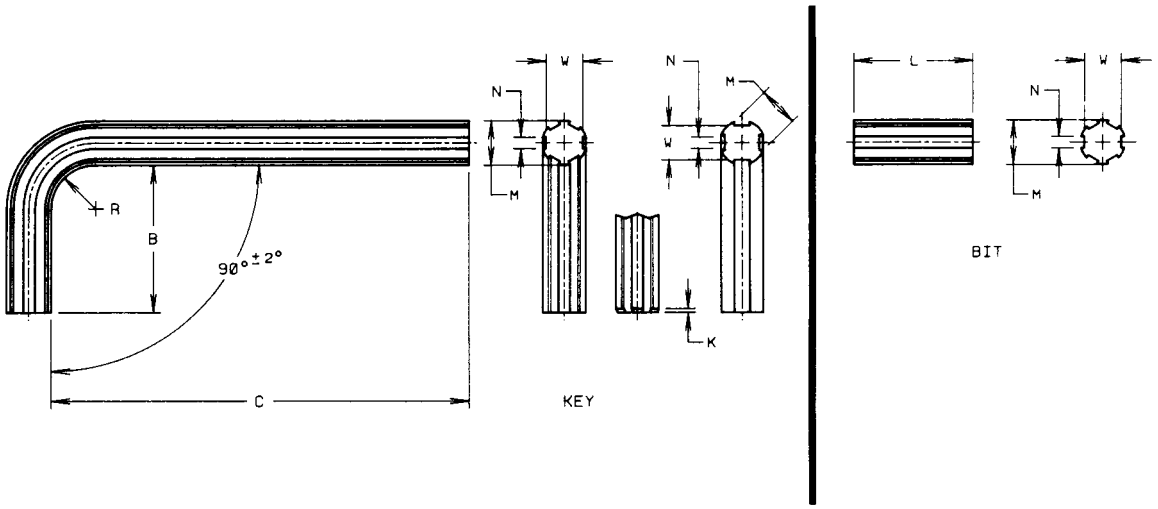


TABLE 49 DIMENSIONS (2)

NOMINAL KEY OR BIT SIZE	M		W		NO. OF SPLINES	N		B		C				R	K
	MAJOR DIAMETER		MINOR DIAMETER			WIDTH OF SPACE		LENGTH OF SHORT ARM		LENGTH OF LONG ARM				RADIUS OF BEND	CHAM-FER
										SHORT SERIES		LONG SERIES			
	MAX.	MIN.	MAX.	MIN.		MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.
0.838	0.838	0.813	0.635	0.635	4	0.356	0.330	7.925	3.175	33.325	28.575	-	-	1.575	0.076
1.219	1.219	1.194	0.965	0.965	6	0.330	0.305	11.125	6.350	33.325	28.575	-	-	1.575	0.102
1.524	1.524	1.499	1.245	1.245	6	0.406	0.381	15.875	11.913	44.450	39.675	-	-	1.575	0.152
1.829	1.829	1.803	1.575	1.575	6	0.483	0.457	16.662	11.913	46.838	42.062	-	-	1.575	0.203
2.438	2.438	2.413	2.007	2.007	6	0.610	0.584	17.856	13.106	50.013	45.237	-	-	1.981	0.203
2.819	2.819	2.794	2.388	2.388	6	0.711	0.686	19.050	14.275	53.188	48.412	-	-	2.388	0.229
3.378	3.378	3.327	2.896	2.896	6	0.864	0.813	20.244	15.469	56.363	51.588	92.863	88.113	3.175	0.356
3.683	3.683	3.645	3.150	3.150	6	0.902	0.864	21.438	16.662	59.538	54.763	97.638	92.863	3.175	0.381
4.267	4.267	4.216	3.658	3.658	6	1.041	0.991	22.631	17.856	62.713	57.938	102.388	97.638	3.962	0.406
4.648	4.648	4.610	4.013	4.013	6	1.118	1.080	23.825	19.050	65.888	61.113	107.163	102.388	3.962	0.406
5.4686	5.4686	5.448	4.674	4.674	6	1.397	1.359	26.187	21.438	72.238	67.463	116.688	111.913	-	-
6.375	6.375	6.337	5.436	5.436	6	1.664	1.626	28.575	23.825	78.588	73.813	126.213	121.438	5.563	0.610
7.391	7.391	7.353	6.248	6.248	6	1.969	1.930	30.963	26.187	84.938	80.163	135.738	130.963	6.350	0.762
9.449	9.449	9.411	7.874	7.874	6	2.477	2.438	34.138	29.362	97.638	92.863	154.788	150.013	7.925	0.813
11.532	11.532	11.494	9.576	9.576	6	3.010	2.972	37.313	32.537	110.228	105.563	173.838	156.363	9.525	1.118
15.113	15.113	15.075	12.700	12.700	6	3.708	3.670	43.663	38.887	135.738	130.963	211.938	207.163	12.700	1.270
15.748	15.748	15.685	13.310	13.310	6	4.102	4.039	46.838	42.062	148.438	143.663	230.988	226.213	12.700	1.346
17.729	17.729	17.666	15.062	15.062	6	4.585	4.521	46.838	42.062	148.438	143.663	-	-	14.275	1.397
20.066	20.066	20.003	17.120	17.120	6	5.017	4.953	50.013	45.237	161.138	156.363	-	-	15.875	1.778

Bits are available, but lengths have not been standardized.

NOTES FOR TABLE 49

1. ENDS. Each end shall be perpendicular to the axis of the respective arms of the keys and the longitudinal axis of bits with 4° and the edges may be sharp, radiused, or chamfered at the option of Holo-Krome, the chamfer not to exceed K.

2. PLATED PRODUCT. For plated keys and bits, all dimensions are before plating.

3. SOFT CONVERSION. The spline keys and bits are soft conversions from the inch system, and are therefore interchangeable with Inch product.

TABLE 50 HOLO-KROME METRIC DOWEL PINS

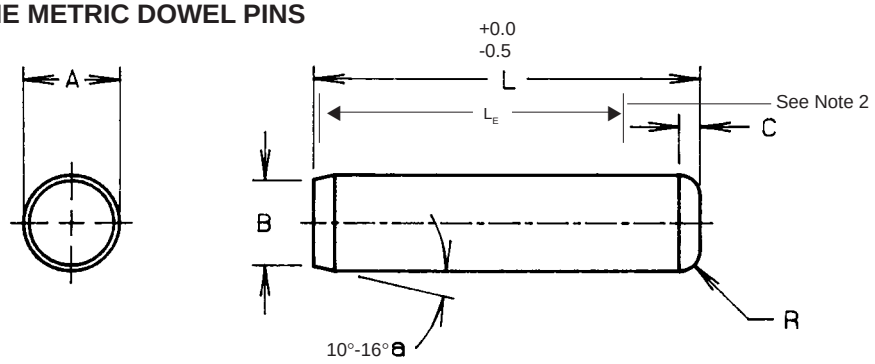


TABLE 50 DIMENSIONS OF METRIC DOWEL PINS

NOMINAL SIZE OR NOMINAL PIN DIAMETER	A		B		C	R	L_E
	PIN DIAMETER		POINT DIAMETER		CROWN HEIGHT	CROWN RADIUS	MIN.
	MAX.	MIN.	MAX.	MIN.	MAX.	MIN.	MIN.
1.5	1.508	1.503	1.4	1.2	0.6	0.2	3.5
2	2.008	2.003	1.9	1.7	0.6	0.2	3.5
2.5	2.508	2.503	2.4	2.2	0.7	0.3	4.0
3	3.008	3.003	2.9	2.6	0.8	0.3	4.0
4	4.009	4.004	3.9	3.6	0.9	0.4	4.5
5	5.009	5.004	4.9	4.6	1.0	0.4	4.5
6	6.010	6.004	5.8	5.4	1.1	0.4	5.0
8	8.012	8.006	7.8	7.4	1.3	0.5	5.5
10	10.012	10.006	9.8	8.4	1.4	0.6	6.0
12	12.013	12.007	11.8	11.4	1.6	0.6	6.0
16	16.013	16.007	15.8	15.3	1.8	0.8	7.0
20	20.014	20.008	19.8	19.3	2.0	0.8	7.0
25	25.014	25.008	24.8	24.3	2.3	1.0	7.5

NOTES FOR TABLE 50

1. POINT LENGTH. The point length is decreased and the point angle increased on short dowel pins.

2. EFFECTIVE LENGTH. The effective length (that portion of the pin between the start of the point angle and the radius point of the crown) on short dowel pins shall not be less than 75% of the overall length of the pin. For short pins, it may be necessary to deviate from the specified dimensions by reducing the crown radius or height, and increasing the point angle, or both.

3. STRAIGHTNESS. Dowel pins shall be straight over the effective length within an accumulative total of 0.013mm per 25mm of length for nominal lengths up to and including 100, and within 0.05mm total for all nominal lengths above 100.

4. END CONTOURS> The ends of hardened ground dowel pins shall be essentially perpendicular to the axis of pin. One end of the pin shall be pointed and the other end crowned to the dimensions specified in Table 50. On the pointed end, the edge formed by the surface of point and the end of pin may be slightly rounded or broken. The center of the pointed end may be flat or concave. See Fig. 1. The crowned end shall be essentially flat to convex.

5. POINT CONCENTRICITY. The diameter of the point may be eccentric with the pin diameter to an extent such that the minimum length of point on the pin is no less than 0.3 mm. See Fig. 1.

FIGURE 1

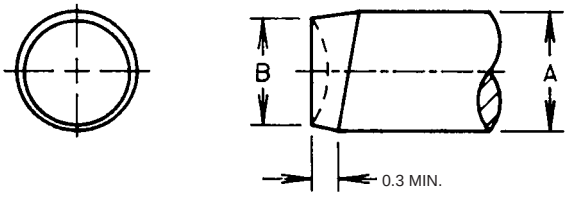


TABLE 51 HOLO-KROME METRIC SCREW THREAD STANDARDS

Holo-Krome Metric Product is threaded to the requirements of ANSI/ASME B1.13M, Metric Screw Threads, M Profile, coarse series, with a Tolerance Class of 4g6g. Because of the lack of familiarity with the ISO system of tolerance designation, a summary is presented here.

METRIC THREAD DESIGNATIONS AND FITS

ISO Metric threads have a designation system which, like the Inch, provides the ability to define a class of fit to meet the degree of precision necessary to the joint.

The designation applies to both internal and external threads, and is designed to prevent the possibility of interference fit unless specifically designated. Accommodation is provided to vary the amount of tolerance (tolerance grade) and the location of the tolerance starting position (allowance) for both the pitch diameter and the major diameter on external threads and the pitch diameter and the minor diameter on internal threads. The chart below illustrates these designations.

TOLERANCE GRADE AND TOLERANCE POSITION SYMBOLS USED TO DESIGNATE TOLERANCE CLASSES IN ISO METRIC THREADS.

AMOUNT	EXTERNAL THREADS			INTERNAL THREADS		
	TOLERANCE GRADE (TOLERANCE)		TOLERANCE POSITION (ALLOWANCE)	TOLERANCE GRADE (TOLERANCE)		TOLERANCE POSITION (ALLOWANCE)
	MAJOR DIAMETER	PITCH DIAMETER		MAJOR DIAMETER	PITCH DIAMETER	
0	-	-	h	-	-	H
Small	-	-		-	-	
	4	4		4	4	
	-	-		5	5	
	6	6	g	6	6	G
	-	-		7	7	
	8	8		8	8	
	-	-		-	-	
Large			e			-

To illustrate a complete designation, let us use the example M5 x 0.5 5g6g. This delineates a thread 5 millimeters in nominal diameter, with a pitch of 0.5. This is a fine thread, because a coarse thread (0.8) would be omitted from the designation. In other words, in common practice a coarse thread would be referred to as M5 - 5g6g.

The 5g represents the pitch diameter information - a tolerance grade of 5, which is fairly small, and a tolerance position of g, which indicates an allowance for plating has been built into the size. The 6g represents the same information for the major diameter - a somewhat larger tolerance but also with a plating allowance.

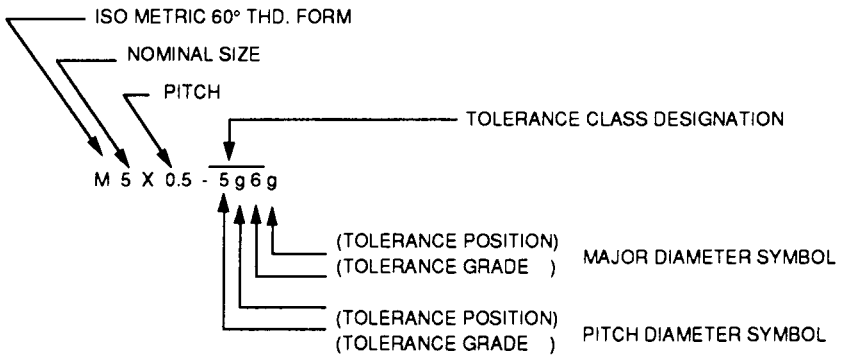


TABLE 52 EXTERNAL THREAD-LIMITING DIMENSIONS M PROFILE

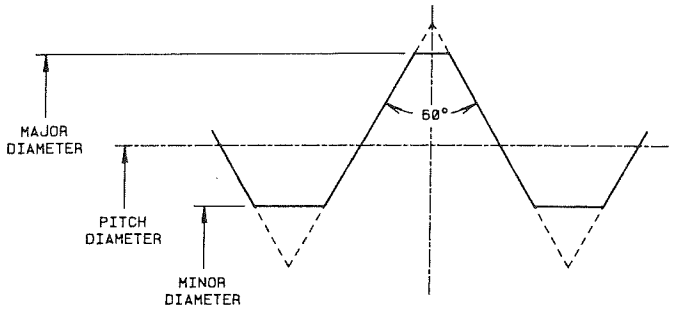


TABLE 52 EXTERNAL THREAD-LIMITING DIMENSIONS M PROFILE

BASIC THREAD DESIGNATION	TOLERANCE CLASS	ALLOWANCE, ES (2)	MAJOR DIAMETER, D		PITCH DIAMETER, D_2			MINOR DIAM., D_1 (FLAT FORM) MAX.	MINOR DIAM., D_3 (ROUNDED FORM) MIN. (FOR REFERENCE)
			MAX.	MIN.	MAX.	MIN.	TOL.		
M1.6 x 0.35	4g6g	0.019	1.581	1.496	1.354	1.314	0.040	1.202	1.098
M2 x 0.4	4g6g	0.019	1.981	1.886	1.721	1.679	0.042	1.548	1.433
M2.5 x 0.45	4g6g	0.020	2.480	2.380	2.188	2.143	0.045	1.993	1.866
M3 x 0.5	4g6g	0.020	2.980	2.874	2.655	2.607	0.048	2.439	2.299
M4 x 0.7	4g6g	0.022	3.978	3.838	3.523	3.467	0.056	3.220	3.036
M5 x 0.8	4g6g	0.024	4.976	4.826	4.456	4.396	0.060	4.110	3.904
M6 x 1	4g6g	0.026	5.974	5.794	5.324	5.253	0.071	4.891	4.637
M8 x 1.25	4g6g	0.028	7.972	7.760	7.160	7.085	0.075	6.619	6.315
M10 x 1.5	4g6g	0.032	9.968	9.732	8.994	8.909	0.085	8.344	7.985
M12 x 1.75	4g6g	0.034	11.966	11.701	10.829	10.734	0.095	10.072	9.656
M14 x 2	4g6g	0.038	13.962	13.682	12.663	12.563	0.100	11.797	11.331
M16 x 2	4g6g	0.038	15.962	15.682	14.663	14.563	0.100	13.797	13.331
M20 x 2.5	4g6g	0.042	19.958	19.623	18.334	18.228	0.106	17.252	16.688
M24 x 3	4g6g	0.048	23.952	23.577	22.003	21.878	0.125	20.704	20.030
M30 x 3.5	4g6g	0.053	29.947	29.522	27.674	27.542	0.132	26.158	25.386
M36 x 4	4g6g	0.060	35.940	35.465	33.342	33.202	0.140	31.610	30.738

Applicable Standards and Specifications
ANSI/ASME B1.13M, B1.3M

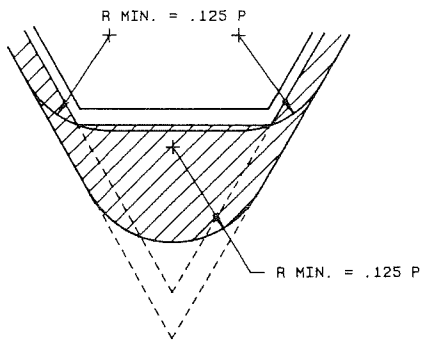


TABLE 52A LIMIT VALUES FOR M PROFILE MINIMUM ROUNDED ROOT RADIUS

P	ROOT RADIUS 0.125P MIN.	P	ROOT RADIUS 0.125P MIN.
0.2	0.025	1.25	0.156
0.25	0.031	1.5	0.188
0.3	0.038	1.75	0.219
0.35	0.044	2	0.250
0.4	0.050	2.5	0.312
0.45	0.056	3	0.375
0.5	0.062	3.5	0.438
0.6	0.075	4	0.500
0.7	0.088	4.5	0.562
0.75	0.094	5	0.625
0.8	0.100	5.5	0.688
1	0.125	6	0.750
		8	1.000

TABLE 53 DIAMETER/THREAD PITCH COMPARISON

INCH SERIES

SIZE	DIAMETER (IN.)	TPI
#0	0.060	80
#1	0.073	64 72
#2	0.086	56 64
#3	0.099	48 56
#4	0.112	40 48
#5	0.125	40 44
#6	0.138	32 40
#8	0.164	32 36
#10	0.190	24 32
1/4	0.250	20 28
5/16	0.312	18 24
3/8	0.375	16 24
7/16	0.437	14 20
1/2	0.500	13 20
5/8	0.625	11 18
3/4	0.750	10 16
7/8	0.875	9 14
1"	1.000	8 12

METRIC SERIES

SIZE	DIAMETER (IN.)	PITCH (MM)	TPI (APPROX.)
M1.4	0.055	0.3 0.2	85 127
M1.6	0.063	0.35 0.2	74 127
M2	0.079	0.4 0.25	64 101
M2.5	0.098	0.45 0.35	56 74
M3	0.118	0.5 0.35	51 74
M4	0.157	0.7 0.5	36 51
M5	0.196	0.8 0.5	32 51
M6	0.236	1.0 0.75	25 34
M8	0.315	1.25 1.0	20 25
M10	0.393	1.5 1.25	17 20
M12	0.472	1.75 1.25	14.5 20
M14	0.551	2 1.5	12.5 17
M16	0.630	2 1.5	12.5 17
M18	0.709	2.5 1.5	10 17
M20	0.787	2.5 1.5	10 17
M22	0.866	2.5 1.5	10 17
M24	0.945	3 2	8.5 12.5
M27	1.063	3 2	8.5 12.5

MECHANICAL PROPERTIES AND APPLICATION DATA METRIC PRODUCT

MECHANICAL REQUIREMENTS

MATERIALS

Holo-Krome Metric socket products are made from Alloy Steel, containing one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium in sufficient quantity to assure that the specified strength properties are met after oil quenching and tempering at an appropriate tempering temperature. The requirements for Class 12.9 in ASTM F-568 are applied, which is parallel to the ISO specification 898 Part I for strengths of fasteners.

HEAT TREATMENT PRACTICE

Holo-Krome Metric socket screw products are hardened and tempered in atmospherically controlled furnaces and quenched in oil above the specified minimum tempering temperature.

HEADING PRACTICE

Screws from M1.6 to M24 are normally Thermo-Forged® to insure proper grain flow and reduced internal stresses. Screws over M24 nominal size are hot formed.

THREADING PRACTICE

Standard metric socket head cap screws up to M36 can be rolled at Holo-Krome. For thread lengths longer than standard, or special thread pitches, the threads may be rolled or cut. Set screw threads may be rolled, cut or ground.

APPLICATION DATA

Standard Holo-Krome Metric alloy socket products are manufactured from alloy steels designed to obtain the optimum performance characteristics for each product.

Holo-Krome Metric socket screws are Thermo-Forged to insure optimum grain flow without causing fractures, bursts or strain-hardening of the parts. The forming process allows grain lines to flow through the part for greater part strength and head integrity. Socket walls are smooth and flat and the bottom of the socket does not have broaching chips that reduce socket depth and create a possible starting point for corrosion. Dimensional control is also easier to maintain.

WARNING

It is very important that the users of Socket Products, particularly Socket Head Cap Screws, be aware that the practice in Europe and other metric areas, is not to restrict the manufacture of these products to Property Class 12.9.

In the USA, and in inch module parts, it has been customary that the socket head cap screw configuration is always made from alloy steel and always to a high strength level, typically 180,000 psi. Metric countries produce this same configuration in alloy steels in Class 10.9 as well, and in Class 8.8 from carbon steel. It is vitally important that an assembly designed around Class 12.9 cap screws be put together with such screws. Beware of lower strength screws being substituted.

TABLE 54 METRIC SOCKET HEAD CAP SCREWS, MECHANICAL PROPERTIES

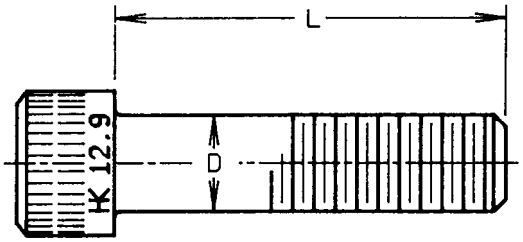


TABLE 54 TENSILE, YIELD, AND SHEAR STRENGTH OF METRIC SOCKET HEAD CAP SCREWS

NOMINAL SIZE AND THREAD PITCH	THREAD STRESS AREA	TENSILE STRENGTH	YIELD* STRENGTH	SINGLE SHEAR STRENGTH	
	(mm^2)	(kN)	(kN)	THD. SEC. (kN)	BODY SEC. (kN)
M1.6 x 0.35	1.27	1.55	1.40	0.96	1.22
M2 x 0.4	2.07	2.53	2.28	1.57	1.99
M2.5 x 0.45	3.39	4.14	3.73	2.57	3.29
M3 x 0.5	5.03	6.14	5.53	3.81	4.70
M4 x 0.7	8.78	10.7	9.63	6.63	8.39
M5 x 0.8	14.2	17.3	15.6	10.7	13.4
M6 x 1	20.1	24.5	22.1	15.2	19.5
M8 x 1.25	36.6	44.6	40.1	27.7	34.8
M10 x 1.5	58.0	70.8	63.7	43.9	55.0
M12 x 1.75	84.3	103	92.7	63.9	79.1
M14 x 2	115	140	126	86.8	108
M16 x 2	157	192	173	119	142
M20 x 2.5	245	299	269	185	222
M24 x 3	353	431	388	267	327
M30 x 3.5	561	684	616	424	506
M36 x 4	817	997	897	618	729

*Determined on machined specimens only

NOTES FOR TABLE 54

The Mechanical Properties listed are for standard metric screws tested at room temperature. In applications where the temperatures are considerably above or below room temperature the effect of the temperature on the properties of the screw must be considered. Short time tensile, creep and stress relaxation should be considered for applications where the temperature exceeds 200° C. Lower ductility, impact strength and fatigue life must be considered for screws subject to temperatures below -29° C.

The materials and heat treatment used for standard Metric Holo-Krome Alloy Steel Socket Products were selected to provide products that would have optimum tensile, impact and fatigue strengths. These materials and heat treatments also meet the requirements of both the USA and ISO specifications for metric products.

Applicable Standards and Specifications
ASTM A 574M

TABLE 55 METRIC SOCKET HEAD CAP SCREWS, TORQUE DATA

TABLE 55 TIGHTENING TORQUE DATA

NOMINAL SIZE AND THREAD PITCH	TENSION INDUCED, (kN)	RECOMMENDED TIGHTENING TORQUE (N•m)
M1.6	0.95	0.34
M2	1.50	0.69
M2.5	2.49	1.43
M3	3.59	2.48
M4	6.36	5.85
M5	10.4	12.0
M6	14.7	20.3
M8	26.5	48.8
M10	42.4	97.5
M12	59.8	165
M14	82.3	265
M16	112	413
M20	179	825
M24	258	1425
M30	402	2775
M36	589	4875

NOTES FOR TABLE 55

These are average values for standard Holo-Krome Metric Socket Head Cap Screws, with standard black finish, tested with hardened steel plates and hardened nuts, with the threads and bearing areas lubricated with plain, medium viscosity machine oil.

The relationship between the torque and the induced tension or preload, can be expressed by the empirical formula T=KDP, in which T is the tightening torque in Newton-meters, D is the diameter of the screw in mm, P is the tension in kiloNewtons and K is the torque coefficient. The torque coefficient is not constant, but varies with the material, surface finish and lubricity of the threads and head bearing surface of the screw and the parts being tightened.

For the condition shown above (standard alloy steel black finished screws clamping hardened steel parts), K will range from 0.19 to 0.25. For cadmium plated screws with steel parts, K will usually fall between 0.13 and 0.17. For zinc plated screws, K may fall between 0.30 and 0.34. When the thread and head bearing surfaces are covered with certain types of lubricants, or with anti-seize compounds, K can drop to as low as 0.05. At the other extreme, combinations of certain materials, such as austenitic stainless steel screws and unlubricated parts, can result in K values above 0.35.

Because the induced tension can vary considerably from one type of assembly to another, the above data must be used with caution, particularly in applications where the control of preload is critical and must be obtained by Torque Wrench method. For such applications, the relationship between torque and induced load should be determined experimentally for the actual parts and lubrication practice used.

TIGHTENING TORQUES. At the recommended tightening torques listed, standard Holo-Krome Metric Socket Head Cap Screws, used under the conditions described, will be preloaded to approximately 75% of the tension induced at yield. The bearing stress under the head will be approximately 530 MPa, so indentation should not occur when the clamped parts are made of steel or cast iron with a hardness equal to or greater than HRB 85. With softer materials, washers may be required under the heads of the screws to prevent indentation.

In applications where screws are subject to fatigue from dynamic loading, the importance of proper preloading during assembly can not be overemphasized. The proper preload is especially important for rigid type (metal-to-metal) joints where it has been found that the use of preload greater than the dynamic external load will usually eliminate the probability of fatigue failure. For this reason, the preferred practice for such assemblies is to preload to 75% of the induced tension at yield.

For flexible type joints, however, and for assemblies exposed to elevated temperatures, much lower preloads may be required. No general recommendations are possible for the wide range of applications and service conditions. Each application must be analyzed individually, because the preload requirements may vary considerably from one application to another. Users who desire suggestions for the preload or tightening torque to be used for a specific application are invited to contact the Holo-Krome Engineering Department.

TABLE 56 DECARBURIZATION AND DISCONTINUITY LIMITS

CARBURIZATION OR DECARBURIZATION

Surface carbon content variations conform to the limits specified in Table when tested in accordance with ASTM A 574M. There should be no complete decarburization nor carburization. Carburization or decarburization can only be measured accurately on a screw that has been sectioned on a plane that is parallel to and passes through the screw axis.

DISCONTINUITIES

SOCKET DISCONTINUITIES

Discontinuities in the socket area allowed to a maximum depth of 0.03D or 0.13 mm (whichever is greater), providing they do not affect the usability and performance of the screw.

Longitudinal discontinuities must not exceed .25T in length. Permissible and nonpermissible discontinuities are shown in Figure 1.

PERMISSIBLE HEAD AND SHANK DISCONTINUITIES

Discontinuities as defined above are permitted in the location illustrated in Figure 1 to the depths described above, with the addition that peripheral discontinuities are permitted a maximum depth = .06D, but not over 1.6mm. These discontinuities are permitted providing they do not affect the usability and performance of the screw. All discontinuities are measured perpendicular to the indicated surface.

When the engineering requirments of the application require that surface discontinuities must be more closely controlled, the purchaser should specify the applicable limits in the original inquiry and in the purchase order.

REJECTION

Rejections should be reported to Holo-Krome within 30 days of receipt of the parts, by the purchaser. The rejection may be in writing to the distributor or directly to the Holo-Krome Sales Department. When no special requirements are specified, industry standards such as ASTM A574M will be used as referee documents.

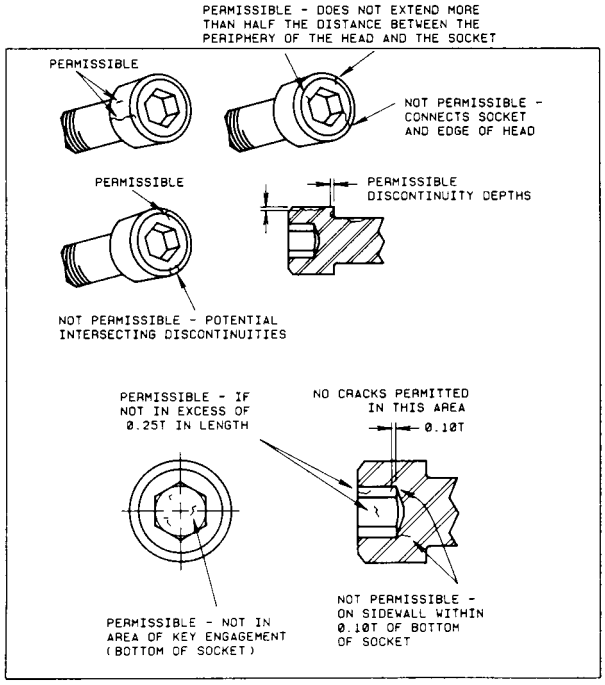


FIGURE 1

T = KEY ENGAGEMENT

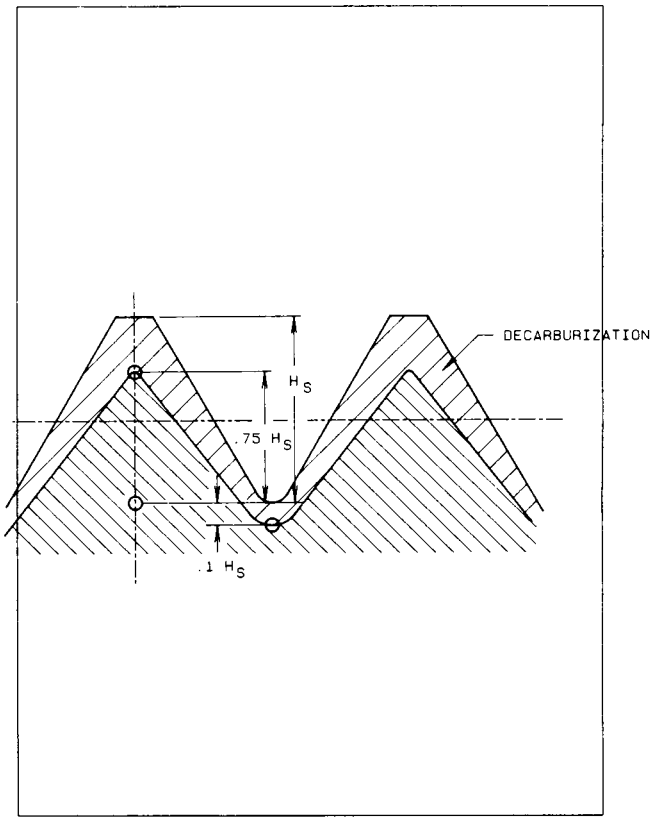
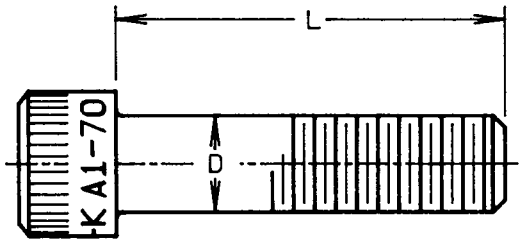


TABLE 56 DECARBURIZATION LIMITS

THREAD PITCH mm	THREAD HEIGHT H. mm	0.75 H. FROM ROOT TO CREST, MIN. mm
0.35	0.215	0.161
0.4	0.245	0.184
0.45	0.276	0.207
0.5	0.307	0.230
0.7	0.429	0.322
0.8	0.491	0.368
1.0	0.613	0.460
1.25	0.767	0.575
1.5	0.920	0.690
1.75	1.074	0.806
2	1.227	0.920
2.5	1.534	1.151
3	1.840	1.380
3.5	2.147	1.610
4	2.454	1.841

TABLE 57 HOLO-KROME STAINLESS STEEL METRIC SOCKET HEAD CAP SCREWS



MATERIAL

Standard Holo-Krome Stainless Steel Metric Socket Head cap screws are made from austenitic (18-8) stainless steel. They withstand all ordinary rusting, are immune to all foodstuffs, sterilizing solutions, most of the inorganic chemicals, dyestuffs and a wide variety of inorganic chemicals. They resist nitric acid well, halogen acids poorly and sulfuric acids moderately.

Holo-Krome Stainless Steel Cap Screws are passivated by immersion in a nitric acid bath subsequent to the last manufacturing operation. This rids the surface of contaminants picked up during fabrication that can cause surface staining or rusting.

Holo-Krome Standard Stainless Steel Cap Screws have low magnetic permeability which makes them suitable for electrical applications where non-magnetic parts are required.

TABLE 57 MECHANICAL PROPERTIES OF THREADED TO THE HEAD STAINLESS STEEL METRIC SOCKET HEAD CAP SCREWS

NOMINAL SIZE AND THREAD PITCH	TENSILE STRENGTH	YIELD STRENGTH*	SINGLE SHEAR STRENGTH	TIGHTENING TORQUE
	(kN)	(kN)	THREAD SEC. (kN)	(N·m)
M1.6 x 0.35	.84	.58*	0.55	0.18
M2 x 0.4	1.38	. 83*	0.90	0.37
M2.5 x 0.45	2.25	1.37*	1.47	0.76
M3 x 0.5	3.35	2.01*	2.19	1.31
M4 x 0.7	5.84	3.51*	3.80	3.10
M5 x 0.8	9.44	5.68*	6.14	6.36
M6 x 1	13.4	8.04	8.72	10.8
M8 x 1.25	24.3	14.6	15.9	25.9
M10 x 1.5	38.6	23.2	25.2	51.7
M12 x 1.75	56.1	33.7	36.7	87.5

*Yield strength for information only-sizes through M5 are tested for torsional strength only per ASTM F738. Values based on ASTM F837M.

NOTES FOR TABLE 57

Tensile strengths given above are for standard stainless steel metric socket head cap screws tested at room temperatures. When screws are to be exposed to higher temperatures the effect of temperature upon the short time properties and the possibility of plastic deformation, or creep, should be considered. At 425°C, the tensile strength of standard stainless steel screws will be approximately 75% of the room temperature strength, and the screws have good creep resistance. Normally, standard stainless steel screws are not used above 425°C, because above this temperature the material is subject to intergranular corrosion.

The property class designation for Holo-Krome Stainless Steel Metric Cap Screws is A1-70, as defined by ASTM F738.

Applicable Standards and Specifications
ASTM F837M

TABLE 58 HOLO-KROME METRIC BUTTON HEAD AND FLAT COUNTERSUNK HEAD SOCKET CAP SCREWS

MECHANICAL PROPERTIES

Standard Metric Holo-Krome Alloy Steel Button and Flat Countersunk Head Cap Screws are manufactured from Holo-Krome analysis high grade alloy steel, hardened and tempered to provide the following mechanical properties.

The tensile strength of the screws, because of head configuration are based on 980 MPa as shown in ASTM F 835M.

Tensile Strength * ..... 1220 MPa
Yield Strength* ..... 1100 MPa
Elongation in 2 inches* 8%
Reduction of Area* 35%
Hardness ..... 38 Rockwell C min.
*Apply to cylindrical test specimens only.

TABLE 58 HOLO-KROME METRIC BUTTON HEAD AND FLAT COUNTERSUNK HEAD SOCKET CAP SCREWS

NOMINAL SIZE AND THREAD PITCH MM	THREAD STRESS AREA (mm^2)	TENSILE STRENGTH (kN)	SINGLE SHEAR STRENGTH (THREAD SEC.) (kN)
M3 x 0.5	5.03	4.93	3.81
M4 x 0.7	8.78	8.60	6.65
M5 x 0.8	14.2	13.9	10.7
M6 x 1	20.1	19.7	15.2
M8 x 1.25	36.6	35.9	27.7
M10 x 1.5	58.0	56.8	43.9
M12 x 1.75	84.3	82.6	63.9
M16 x 2	157	155	119
M20 x 2.5	245	240	185

NOTES FOR TABLE 58

BUTTON HEAD CAP SCREWS ARE DESIGNED FOR LIGHT FASTENING APPLICATIONS ONLY, SUCH AS SHEETMETAL COVERS, PLASTIC GUARDS, ETC. THEY SHOULD NOT BE USED IN CRITICAL HIGH STRENGTH APPLICATIONS WHERE SOCKET HEAD CAP SCREWS SHOULD BE USED.

The mechanical properties listed are for screws tested at normal room temperatures. In applications where the temperature are considerably above or below room temperature the effect of the temperature on the screw strength must be considered. Short time tensile, creep and stress relaxation should be considered for applications where the temperature exceeds 204° C. Lower ductility, impact strength and fatigue life must be considered for screws subject to temperatures below -29° C.

Applicable Standards and Specifications
ASTM F 835M

TABLE 59 TIGHTENING TORQUE - N•m

NOMINAL SIZE AND THREAD PITCH MM	BUTTON HEAD		FLAT COUNTERSUNK HEAD
	HEX KEY SIZE (mm)	MAX. TIGHTENING TORQUE (N·m)	MAX. TIGHTENING TORQUE (N·m)
M3 x 0.5	2	1.25	1.85
M4 x 0.7	2.5	2.9	3.4
M5 x 0.8	3	5.9	6.9
M6 x 1	4	10	12
M8 x 1.25	5	24	28
M10 x 1.5	6	48	56
M12 x 1.75	8	84	99
M16 x 2	10	207	246
M20 x 2.5	12		400

Torque to tighten screw with key, not by turning nut.

These torques apply to standard black screws in rigid joints, when torqued with standard hex keys or bits.

TABLE 60 HOLO-KROME METRIC SHOULDER SCREWS

SHOULDER SCREWS

Shoulder screws, commonly referred to as stripper bolts, are used in a variety of applications. In die sets, they can be used for stripper springs and as guides. They are used as pivots for linkages, pulleys and sprockets and as hinges.

Holo-Krome metric socket shoulder screws are made from alloy steel.

MECHANICAL PROPERTIES

Tensile Strength ..... 1220 MPa*
Hardness ..... 39-44 Rockwell C
*Based on stress area of the thread neck.

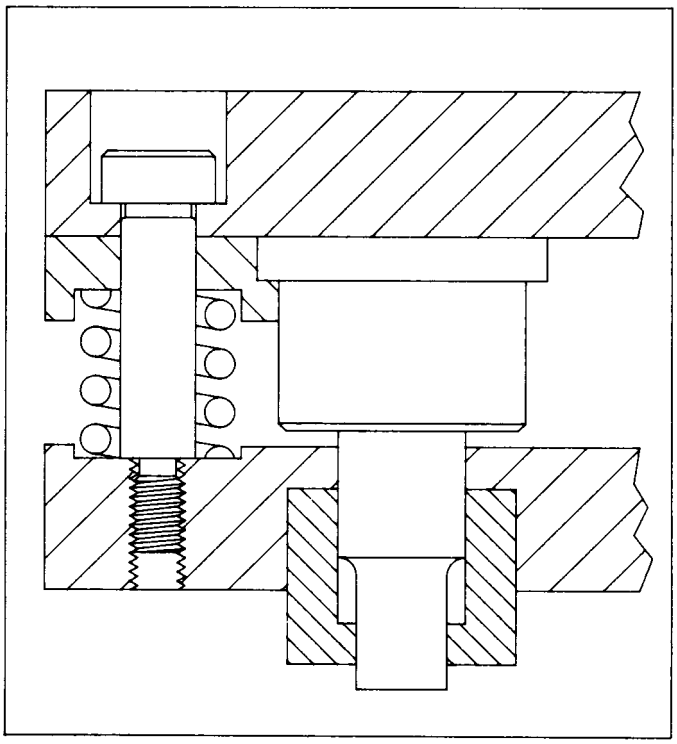


TABLE 60 MECHANICAL PROPERTIES

NOMINAL SHOULDER DIAMETER (mm)	NOMINAL THREAD SIZE (MM)	THREAD NECK SECTION TENSILE STRENGTH (kN)	SINGLE SHEAR STRENGTH (kN)		HEX KEY SIZE (mm)	TIGHTENING TORQUE** (N·m)
			THREAD NECK	SHOULDER		
6.5	M5 x 0.8	11.7	7.0	21.6	3	6.9
8	M6 x 1	15.2	10.0	32.7	4	12
10	M8 x 1.25	28.6	18.9	51.3	5	28
13	M10 x 1.5	51.1	30.7	86.8	6	56
16	M12 x 1.75	75.5	45.3	13.1	8	99
20	M16 x 2	145	87.1	206	10	250
25	M20 x 2.5	230	137	322	12	400

** It is recommended that tightening torque be limited to these values when screws are to be tightened or loosened with standard keys or bits.

TABLE 61 HOLO-KROME METRIC SOCKET SET SCREWS - AXIAL HOLDING POWER

AXIAL HOLDING POWER OF CUP POINT SET SCREWS (ALLOY STEEL)

NOMINAL SIZE (mm)	HEX KEY SIZE (mm)	TIGHTENING TORQUE (N•m)	AXIAL HOLDING POWER (N)
1.6	.7	0.1	44
2	.9	0.2	87
2.5	1.3	0.6	306
3	1.5	1.0	880
4	2.0	2.1	1570
5	2.5	4.7	2400
6	3.0	7.7	3380
8	4.0	17.8	5800
10	5.0	35	9360
12	6.0	55	13,300
16	8.0	125	23,100
20	10.0	250	34,700
24	12.0	425	51,500

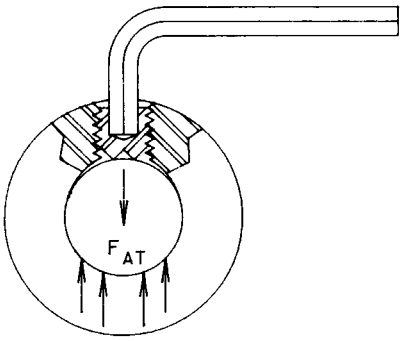
NOTE:
The values above have been developed experimentally by assembling steel collars to cold finished steel bars (Rockwell B 80-100) with standard Holo-Krome Metric alloy steel Cup Point Set Screws with the black finish. The set screws were all as long as or longer than their nominal diameter. The axial holding power listed above was the average force required to cause .125 mm movement of the collar along the shaft after tightening the set screw to the listed torque. For specific applications, values may vary as much as ±30 percent from values shown.

Giving a cup point a relative holding power of 1, the holding power of a cone point is 1.07, a flat point or dog point 0.92 and an oval point 0.9.

For torsional holding power, multiply the axial holding power value by the shaft radius.

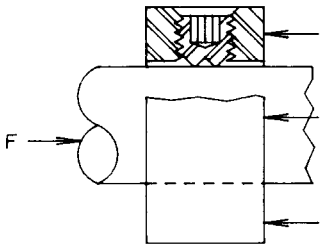
SET SCREW HOLDING POWER

FIG A.



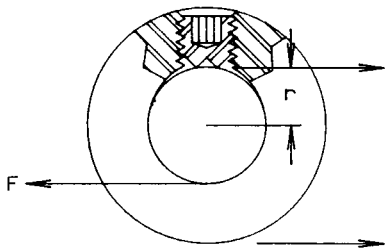
AXIAL THRUST = F_{AT}

FIG. B



AXIAL HOLDING POWER = F

FIG. C



TORSIONAL HOLDING POWER
T = Fr

Applicable Standards and Specifications
ASTM F 912M

INTRODUCTION. Set screws, unlike most other fasteners, are basically compression fasteners. Because studies made of tension fasteners do not apply and because of the complex nature of this type of joint, the holding power of a set screw is more difficult to predict and control than the typical cap screw joint. Many variables introduced by a particular application may affect the holding power performance of a set screw. It is therefore important for the designer to understand set screw holding power and the nature of the variables involved when designing a set screw joint.

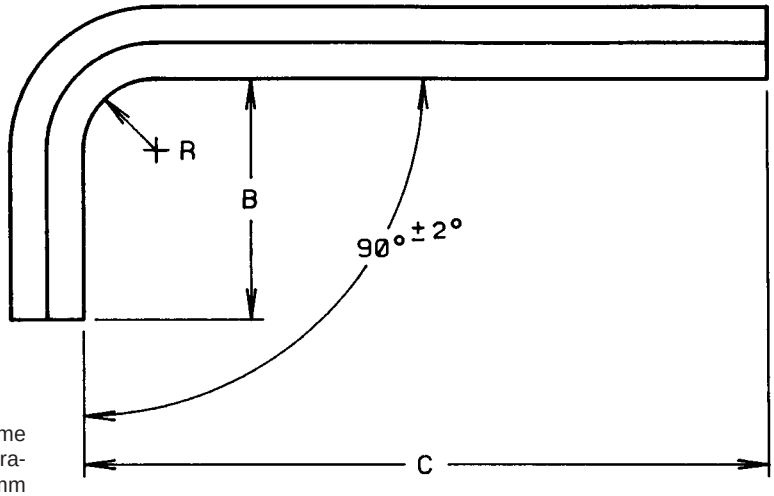
HOLDING POWER. The forces which a set screw assembled joint can transmit or withstand without relative displacement of the two parts is a measure of the holding power of the screw. This holding power can best be described in terms of the forces acting to cause relative movement between the assembled parts.

1. AXIAL HOLDING POWER. Using a simple shaft collar application as an illustration, the force acting on the collar to move it along the shaft is called the axial force. The ability of the set screw to withstand this force without relative displacement is called its Axial Holding Power.

2. TORSIONAL HOLDING POWER. Using a shaft pulley or gear application as an example, the force (F) acting to rotate or slip the pulley around the shaft is frequently called the rotational force. The ability of a set screw to withstand these forces tending to rotate the part on the shaft without relative movement of the two parts is called its Torsional Holding Power.

NOTE. For further discussion of holding power see page 38.

TABLE 62 METRIC ALLEN WRENCHES AND BITS



MECHANICAL PROPERTIES

Standard Allen Wrenches and Bits are manufactured from Holo-Krome Alloy Steel, hardened by quenching in oil from the hardening temperature and tempered to a hardness range of HRC 50-57 for keys 2.5mm to 12mm, HRC 45-53 for 14mm and larger, and Knoop 565-685 for sizes 2mm and smaller, to provide the following torsional properties.

TABLE 62 METRIC ALLEN WRENCHES

MECHANICAL

NOMINAL SIZE mm	TORQUE RATING (N·m)
0.7	0.1
0.9	0.2
1.3	0.6
1.5	1.0
2	2.1
2.5	4.7
3	7.7
4	17.8
5	35
6	57
8	126
10	252
12	420
14	670
17	1180
19	1670
22	2450
24	3200
27	4300
32	6800
36	10,000

APPLICATION DATA

NOMINAL SIZE mm	CAP SCREWS	FLAT COUNTERSUNK HEAD CAP SCREWS	BUTTON HEAD CAP SCREWS	SHOULDER SCREWS	SET SCREWS
		NOMINAL SCREW SIZES			
0.7	—	—	—	—	M1.6
0.9	—	—	—	—	M2
1.3	—	—	—	—	M2.5
1.5	M1.6	—	—	—	M3
2	M2.5	M3	M3	—	M4
2.5	M3	M4	M4	—	M5
3	M4	M5	M5	6.5	M6
4	M5	M6	M6	8	M8
5	M6	M8	M8	10	M10
6	M8	M10	M10	13	M12
8	M10	M12	M12	16	M16
10	M12	M16	M16	20	M20
12	M14	M20	—	25	M24
14	M16	—	—	—	—
17	M20	—	—	—	—
19	M24	—	—	—	—
22	M30	—	—	—	—
24	—	—	—	—	—
27	M36	—	—	—	—

TORQUE RATING-Standard Allen Wrenches cut into bits for use in torque wrenches will transmit the above torques. These torque values are 90% of average torque required to develop a permanent visible twist in bits which have 25mm of hexagon exposed between the torque wrench and the socket. These are also the torque values which keys transmit when the short arm is inserted in a socket and the long arm is deflected or bent through an angle of 25 to 30° by the application of force near the end of the long arm.

Applicable Standards and Specifications
ASME/ANSI B18.3.2M

TABLE 63 HOLO-KROME METRIC DOWEL PINS

MECHANICAL PROPERTIES

Standard Holo-Krome Metric Dowel Pins are manufactured from Holo-Krome analysis High Grade Alloy Steels heat treated to a core hardness of HRC 47-58 for toughness and strength and a surface hardness of HRC 60 minimum for wear resistance.

CAUTION: Holo-Krome recommends dowel pins be inserted by application of a constant pressure, with the pin being shielded in case of fracture. A striking force can cause the pin to shatter.

TABLE 63 HOLO-KROME METRIC DOWEL PINS

NOMINAL SIZE mm	MINIMUM CASE DEPTH mm	SINGLE SHEAR STRENGTH (kN)	DOUBLE SHEAR STRENGTH (kN)	RECOMMENDED HOLE SIZE mm	
				MAX.	MIN.
1.5	0.25	1.85	3.7	1.500	1.487
2.0	0.25	3.3	6.6	2.000	1.987
2.5	0.25	5.15	10.3	2.500	2.487
3.0	0.25	7.4	14.8	3.000	2.987
4.0	0.25	13.2	26.4	4.000	3.987
5.0	0.38	20.6	41.2	5.000	4.987
6.0	0.38	29.7	59.4	6.000	5.987
8.0	0.38	52.5	105	8.000	7.987
10.0	0.38	82.5	165	10.000	9.987
12.0	0.38	119	238	12.000	11.987
16.0	0.38	211	422	16.000	15.987
20.0	0.38	330	660	20.000	19.987
25.0	0.38	515	1030	25.000	24.987

TABLE 64 METRIC FASTENER RELATED STANDARDS

ANSI/ASME

B1.13M	Metric Screw Thread-M Profile
B1.3M	Screw Thread Gaging Systems for Acceptability of Metric Screw Threads
B1.7M	Nomenclature, definitions, and Letter Symbols for Screw Threads
B1.16M	American Gaging Practice for Metric Screw Threads
B18.3.1M	Socket Head Cap Screws, Metric Series
B18.3.2M	Hexagon Keys and Bits, Metric Series
B18.3.3M	Hexagon Socket Head Shoulder Screws, Metric Series
B18.3.4M	Hexagon Socket Button Head Cap Screws, Metric Series
B18.3.5M	Hexagon Socket Flat CountersukCap Screws, Metric Series
B18.3.6M	Socket Set Screws, Metric Series
B18.8.3M	Metric Dowel Pins
B18.12	Glossary of Terms for Mechanical Fasteners
B18.13.1M	Screw and Washer Assemblies-Sems, Metric Series
B18.22.1M	Plain Washers, Metric Series
B1.20.4	Dryseal Pipe Threads (Metric Translation of B1.20.3, 1976)

ASTM

A574M	Allooy Socket Head Cap Screws
F837M	Stainless Steel Socket Head Cap Screws
F835M	Alloy Steel Button Head and Flat Head Cap Screws
F879M	Stainless Steel Button Head and Flat Head Cap Screws
F912M	Alloy Steel Set Screws
F880M	Stainless Steel Set Screws

ISO

ISO-4762	Socket Head Cap Screws
ISO-4379	Socket Head Shoulder Screws
ISO-7380	Hexagon Socket Button Head Screws
ISO-4026	Socket Set Screws - Flat Point
ISO-4027	Socket Set Screws - Cone Point
ISO-4028	Socket Set Screws - Dog Point
ISO-4029	Socket Set Screws - Cup Point
ISO-2936	Hexagon Keys - Metric

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