STANLEY®
Engineered Fastening

Camcar® Socket Screw Technical Manual

Camcar® Socket Screws

Founded on Innovation and Technical Expertise

The Camcar brand began in 1943, cold forming a component others said “couldn't be made”. From that manufacturing innovation – the Raycarl® cold forming process – to the TORX PLUS® Drive System and other leading-edge products, the Camcar name has become synonymous with outstanding fastening solutions.

WARRANTY

STANLEY Engineered Fastening makes no warranty, express or implied, except that goods sold by description, sample or model shall substantially conform to the description, sample or model, and in such case, the responsibility of STANLEY Engineered Fastening shall be limited to the replacement of nonconforming goods returned to STANLEY Engineered Fastening within one month after delivery to Buyer (f.o.b. at point of delivery to carrier), provided that such goods have been solely used for the purpose for which manufactured. All replaced goods are to be returned to Infastech after receiving authorization from Infastech. This warranty does not apply when any physical or chemical change in the form of the product is made by the Buyer or any other party. There are no warranties which extend beyond the description stated herein. Infastech shall not otherwise be liable for any costs or expenses incurred in the replacement of any defective or nonconforming products and in no event shall STANLEY Engineered Fastening be liable for incidental or consequential damages. The foregoing warranty and such other warranties made by STANLEY Engineered Fastening, as are expressly stated herein, are specifically in lieu of any other warranties, express or implied, including the implied warranties of merchantability and fitness for a particular purpose. The selection of a product for a particular application or use is the responsibility of the customer. The applications engineers at Decorah Operations are available to assist customers in selecting the appropriate product for a particular application or use. All warranties are void if the product is plated or modified in any manner by any person other than STANLEY Engineered Fastening.

STANLEY Engineered Fastening has strived for total accuracy throughout this engineering manual. However, STANLEY Engineered Fastening shall not be liable or responsible for any typographical errors that may occur. If any questions arise as to the accuracy within this catalog, please contact the applications engineers at Decorah Operations.

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About this Manual

This technical manual is designed to provide easy access to the required dimensional, mechanical and application information specific to Camcar Socket Screw products. Every effort has been made to include the most up-to-date information and to ensure its accuracy. However, since product and dimensional data for standard products can change over time, you can contact the Applications Department at Decorah Operations to ensure you have the latest information.

STANLEY Engineered Fastening will not be responsible or liable for the misapplication or misuse of the products or information contained in this manual. All warranties are void if the product is plated or modified in any manner not under the control of STANLEY Engineered Fastening.

The inclusion of dimensional data, such as consecutive length designations, is not intended to imply that all diameters and lengths shown are available as stock items. Customers should consult their local key distributor or the sales service representatives at Decorah Operations for stock availability.

For applications assistance or questions on specific fastening requirements, please contact the applications specialists at STANLEY Engineered Fastening Decorah Operations at 1-563-382-4216.

The following ANSI/ASME standards, in part or in whole, are reprinted with the permission of the American Society of Mechanical Engineers: B1.1, B2.2, B18.3, B18.8.2, B18.13, B1.13M, B18.3.1M, B18.3.2M, B18.3.3M, B18.3.4M, 818,3.5M, and B18.3.6M.

ASTM A 574 and A 574M reprinted, with permission, from the annual book of ASTM standards.

Camcar® Socket Screws

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Company Overview

Camcar® Socket Screws

At STANLEY Engineered Fastening, there's the pride in designing, producing and delivering superior products you would expect from the industry's leading innovator. That pride, combined with the latest fastener technology and engineering expertise, provides you with one of the most reliable sources of socket screw products in the industry today.

STANLEY Engineered Fastening is committed to offering a broad range of socket screw products, including inch and metric sizes, TORX PLUS® Drive and hex drive systems, and tooling.

Also, STANLEY Engineered Fastening can supply you with innovative socket screw specials or socket screw products for high-temperature or corrosive environments. Any products not shown in this handbook may be considered specials. Please contact the application specialists at Decorah Operations for design assistance or further information.

Commitment to Quality

All Camcar socket screws are made from carefully selected and analyzed raw material, and critically inspected during the manufacturing processes. We utilize both Statistical Process control and Quality at the Source methods to ensure our socket screws meet your quality requirements.

Each manufacturing lot is assigned an identification number to give you complete traceability in the finished product. Also, many Camcar socket screw products are marked with the "Camcar" name for further assurance of the manufacturing source.

ISO/TS 16949:2009 Registration

Our STANLEY Engineered Fastening Decorah facility has been assessed and registered by Intertek as conforming to the requirements of ISO/TS 16949:2009: Manufacture of Threaded Cold Formed Fasteners and Metal Components. It has been audited in accordance with the "Rules for achieving IATF recognition 3rd Edition for ISO/TS 16949:2009", including manufacturing, heat treat and plating.

International Automotive Task Force

IATF Certificate Number: 0179164
Certificate Number: 2014-0006
Initial Certification Date: 6 February 2014
Certificate Issue Date: 6 February 2014
Certificate Expiry Date: 5 February 2017

Camcar Socket Screws available around the World

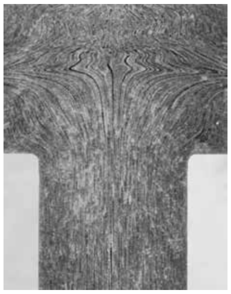
The broad Camcar socket screw product line is readily available through our network of key distributors. Our key distributors can offer your company:

- full STANLEY Engineered Fastening product line, including socket screws, TORX PLUS® Drive, TAPTITE®, Crest Cup and Crimptite® fasteners, fasteners for plastics, cold formed specials and more
- wide array of industrial products and supplies for your operations;
- timely local service in order to meet your specific needs
- customized stocking and JIT programs to satisfy the individual requirements of your company
- design assistance for problem applications
- reduced purchasing accounting and inventory costs

While this engineering manual does not include prices, a price catalog is available from either STANLEY Engineered Fastening or an authorized stocking distributor.

Camcar® Socket Screws

Materials



Camcar socket screw products are manufactured from a medium carbon steel, unless otherwise noted. To achieve desired results, one or more alloying elements, such as manganese, phosphorous, molybdenum, silicon, sulfur or boron can be added. Alloying elements allow for strength, ductility, toughness or improved responsiveness to heat treating. All heats of medium carbon steel are checked by STANLEY Engineered Fastening and an independent lab to ensure compliance with application specifications.

Cold Forming Operations

Most Camcar socket screws are cold formed. The STANLEY Engineered Fastening cold forming process provides an uninterrupted grain flow through the part, and when complemented with the thread rolling process including radius root run-out threads, improves manufacturing efficiency and reduces scrap material for lower costs.

Inside

- In high-strength applications, the bearing surface provides high load capacity without compression of the bearing surface material
- Smooth fillet at head-shank provides uninterrupted grain flow
- Roll formed threads are smoother and more consistent, when compared to machined threads
- Radius root threads precision rolled to UNRC and UNRF Class 3A Standard

Outside

- Deep, straight-sided forged sockets are precisely centered in the head
- Radiused corners reduce stress concentrations
- Chamfered head perimeter with smooth burr-free finish
- Deep straight knurls ease turning by hand

Drive System Availability

STANLEY Engineered Fastening is committed to offering the marketplace the high performance in fastening solutions. As such, many of our most popular socket screw products are available with the TORX PLUS® Drive System along with the hex drive system. See how the two drives compare on the following page.

Drive System Selection

There are several issues impacting proper drive system selection which must be reviewed prior to specification, including:

- Does the drive system's torque capabilities meet the requirements of my application?
- Will the drive system withstand the high torque levels used in fastening socket screws?
- Is the required tooling readily available?
- Will I need separate tooling for inch and metric screws?
- Will the drive system enhance my overall operations?

In order to answer these questions, it is important to compare the available drive systems.

The TORX PLUS® Drive System

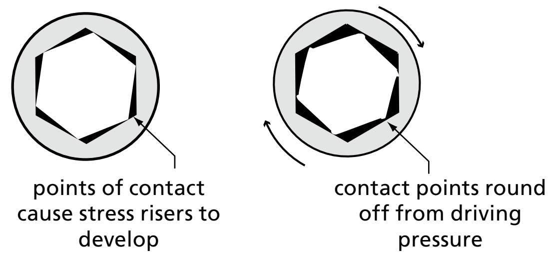
Developed as an improvement of the original TORX® Drive System, the TORX PLUS Drive consistently outperforms hex and other commonly-used drive systems. Used in virtually every industrialized nation in a multitude of industries, the TORX PLUS Drive System can enhance product reliability, increase productivity, and reduce total assembly costs.

The TORX PLUS Drive System offers a 100% improvement in driver bit fatigue life and a 25% average improvement in driver bit torsional strength. In addition, its unique design provides optimum torque transfer and eliminates the need for excessive end load pressure while driving the fastener. The TORX PLUS configuration also virtually eliminates tool camout and slippage that can damage the head of the fastener and cause reduced tool life.

TORX PLUS Drive System vs. Hex Drive

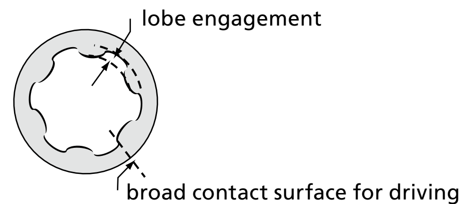
The hex drive has weaknesses inherent in its design which can cause problems during assembly. The engagement of the hex drive tool to the recess produces highly concentrated stress at the six corners of the drive tool (see below).

Hex Drive



With the hex drive, tool and fastener damage is common

TORX PLUS Drive



The TORX PLUS Drive virtually eliminates tool or fastener damage during installation and removal

This stress at the thin cross-sectional areas of the fastener crushes the corners of the hex tool. This reduces the amount of wrenching engagement, causing reamed socket recesses and/or damaged socket tooling. This type of failure with the hex drive system is so common, it is often accepted as normal practice.

The TORX PLUS Drive System features deep engaging lobes with broad contact surfaces that spread out driving forces, preventing stress risers from forming. This minimizes damage to the drive tool and fastener, resulting in longer tool life. Customers have reported driving 2 to 10 times more fasteners per drive tool after switching to the TORX PLUS Drive.

TORX PLUS Drive Tooling Availability

TORX PLUS Drive tools are readily available throughout the world from licensed manufacturers and authorized distributors. Your existing tooling suppliers and STANLEY Engineered Fastening also carry TORX PLUS Drive tools, in many standard styles and sizes to meet your installation requirements.

For service in the field, TORX PLUS Drive fasteners can be removed and reinstalled using commonly available TORX PLUS Drive or TORX Drive tooling. However, in order to fully realize the benefits of the TORX PLUS Drive, including extended bit life, TORX PLUS Drive tools should be used.

Inch Socket Screw Standards

Camcar® inch socket screw products are manufactured to meet the specified ANSI/ASME B18 standards and tested to meet the specified ASTM standards, unless otherwise noted.

Contents – Inch Size Specifications

Related Standards

ANSI/ASME

B1.1 .... Unified Inch Screw Threads (UN and UNR Thread Form)
B1.2...Gage and Gaging for Unified Screw Threads
B1.3..Screw Thread Gaging System
B1.7.................... Nomenclature, Definitions and Letter Symbols for Screw Threads
B18.3 .... Socket Cap, Shoulder and Set Screws
B18.8.2 ....Machine Pins (Dowel, Taper, Grooved)
B18.12 .... Glossary of Terms for Mechanical Fasteners
B18.13 ....Screw and Washer Assemblies – Sems
B46.1... Surface Texture

ASTM

A 574 .... Alloy Steel Socket Head Cap Screws
F835.. Alloy Steel Button Head and Flat Head Cap Screws
F837...Stainless Steel Socket Head Cap Screws
F912 .... Alloy Steel Socket Set Screws

Thread Designations and Fits - Inch Sizes

The basic method of designating a screw thread is used where the standard tolerances or limits of size based on the standard length of engagement are applicable. The designation specifies in sequence the nominal size, number of threads per inch, thread series symbol, and thread class symbol. The nominal size is the basic major diameter and is specified as the fractional diameter, screw number, or their decimal equivalent. When decimal equivalents are used for size call-out, they shall be interpreted as being nominal size designation only and shall have no dimensional significance beyond the fractional size or number designation.

Examples: 1/4-20 UNRC-24A or 0.250-20 UNRC-2A
7/16-20 UNRF-2A or 0.4375-20 UNRF-2A
10-32 UNRF-2A or 0.190-32 UNRF-2A
2-12 UN-2A or 2.000-12 UN-2A

For uncoated standard series threads, these designations may optionally be supplemented by the addition of the pitch diameter limits of size.

Example: 1/4-20 UNRC-2A
PD 0.2164-0.2127 (Optional for uncoated threads)

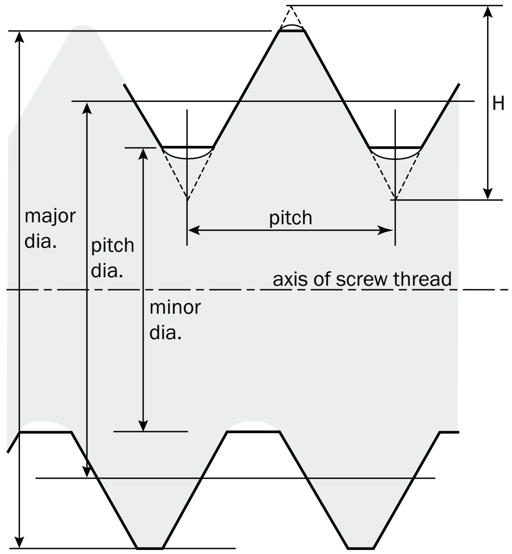
Designating Coated Threads: For coated (or plated) Class 14 external threads, the basic (max) major and basic (max) pitch diameters are given followed by the words AFTER COATING. The major and pitch diameter limits of size before coating are also given followed by the words BEFORE COATING.

Example: 3/4-10 UNRC-2A
*Major dia. 0.7500 max
PD 0.6850 max } AFTER COATING
†Major dia. 0.7482 – 0.7353
PD 0.6832 – 0.6773 } BEFORE COATING

* Major and PD values are equal to basic and correspond to those for Class 3A. † Major and PD limits are Class 2A.

Certain applications require an allowance for rapid assembly, to permit application of a proper lubricant, or for residual growth due to high temperature expansion. In those applications when the thread is coated and 2A allowance is not permitted to be consumed by such coating, the thread class symbol is qualified by the addition of the letter G (old symbol for allowance) following the class symbol; the maximum major and maximum pitch diameters are reduced below basic size by the amount of the 2A allowance and followed by the words AFTER COATING, thereby insuring that the allowance is maintained. The major and pitch diameter limits of size before coating shall also be given followed by SPL and BEFORE COATING.

Coarse Thread Series: The coarse thread series (UNC/UNRC) is generally used for bulk production of screws, bolts, and nuts. It is commonly used in relatively low strength materials such as cast iron, aluminum, magnesium, brass, bronze, and plastic, because the coarse series threads provide more resistance to internal thread stripping than the fine or extra-fine series. Coarse series threads are advantageous where rapid assembly or disassembly is required, or if corrosion or damage from nicks due to handling or use is likely.



Unified Thread (External)

Fine Thread Series: The fine threads series (UNF/UNRF) is commonly used for bolts and nuts in high strength applications. This series has less thread depth and a larger minor diameter than coarse series thread. Consequently, more strength is available to external threads than for coarse series threads of the same nominal size. For both fine and coarse series threads, length of engagement in tapped holes must be selected to meet strength requirements. Fine series threads have less tendency to loosen under vibration than coarse series threads, because they provide a higher load capability.

Thread Designations and Fits - Inch Sizes

Thread Classes (see Tables I-1 **and** I-2 **on following page):** Thread classes are distinguished from each other by the amounts of tolerance and allowance. Classes 2A and 3A apply to external threads only. Allowance is specified only for Class 2A. Tolerance decreases as class number increases (e.g., tolerance for Class 3A is less than that for Class 2A).

Class 2A threads are the most commonly used for general applications, including production of bolts, screws, nuts, and similar threaded fasteners. The maximum diameters of Class 2A uncoated threads are less than basic by the amount of the allowance, The allowance minimizes galling and seizing in high-cycle wrench assembly, or it can be used to accommodate plated finishes or other coating. However, for threads with additive finish, the maximum diameters of Class 2A may be exceeded by the amount of the allowance; i.e., the 2A maximum diameters apply to an unplated part or to a part before plating, whereas the basic diameters (the 2A maximum diameter plus allowance) apply to a part after plating.

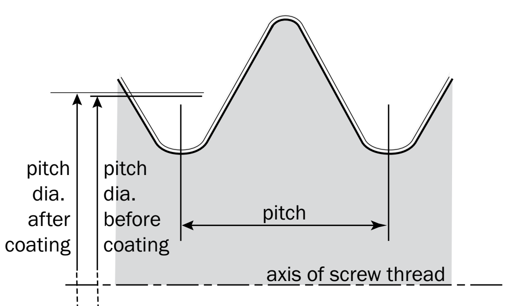
Class 3A threads provide for applications where closeness of fit and or accuracy of thread elements are important. The maximum diameters of Class 3A threads, whether or not plated or coated, are basic, affording no allowance or clearance for assembly at maximum-material limits.

Allowance: Allowance is specified only for Class 2A external threads. For Class 2A threads, the allowance may be used to accommodate plating or coating. Allowance is based on Class 2A pitch diameter tolerance for the respective series standard length of engagement and is applicable for all lengths of engagement.

Coated Threads: It is not within the scope of the ANSI/ASME Standard to make recommendations for thickness of, or to specify limits for, coatings. However, it will aid mechanical interchangeability if certain principles are followed wherever conditions permit.

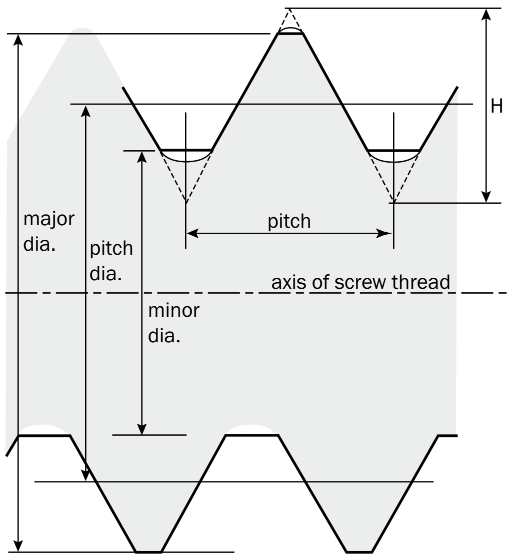
Only in Class 2A threads is the allowance available to accommodate coatings. Thus, in all other classes of threads, limits of size must be adjusted before plating to provide suitable provision for the desired coating.

Unless otherwise specified, size limits for standard external thread Class 2A apply prior to coating. The external thread allowance may thus be used to accommodate the coating thickness on coated pans, provided that the maximum coating thickness is no more than one-fourth of the allowance. Where the external thread has no allowance, or allowance must be maintained after coating, and for standard internal threads, sufficient allowance must be provided prior to coating to assure that finished product threads do not exceed the maximum material limits specified.



For additional information on inch screw threads, refer to ANSI/ASME B1.1 (Unified Screw Threads).

Thread Standards - Inch Sizes



Unified Thread (External)

Table I-1: Unified Series Class 3A

Nominal Size	Coarse Series Threads per Inch UNRC	Pitch Dia. max.	Pitch Dia. min.	Major Dia. max.	Major Dia. min.	Max. Minor Dia. ref.	Fine Series Threads per Inch UNRF	Pitch Dia. max.	Pitch Dia. min.	Major Dia. max.	Major Dia. min.	Max. Minor Dia. ref.
0							80	0.0519	0.0506	0.0600	0.0568	0.0451
1	64	0.0629	0.0614	0.0730	0.0692	0.0544	72	0.0640	0.0626	0.0730	0.0695	0.0565
2	56	0.0744	0.0728	0.0860	0.0819	0.0648	64	0.0759	0.0744	0.0860	0.0822	0.0674
3	48	0.0855	0.0838	0.0990	0.0945	0.0741	56	0.0874	0.0858	0.0990	0.0949	0.0778
4	40	0.0958	0.0939	0.1120	0.1069	0.0822	48	0.0985	0.0967	0.1120	0.1075	0.0871
5	40	0.1088	0.1069	0.1250	0.1199	0.0952	44	0.1102	0.1083	0.1250	0.1202	0.0979
6	32	0.1177	0.1156	0.1380	0.1320	0.1008	40	0.1208	0.1198	0.1380	0.1329	0.1082
8	32	0.1437	0.1415	0.1640	0.1580	0.1268	36	0.1460	0.1439	0.1640	0.1585	0.1309
10	24	0.1629	0.1604	0.1900	0.1828	0.1404	32	0.1697	0.1674	0.1900	0.1840	0.1528
1/4	20	0.21785	0.2147	0.2500	0.2419	0.1905	28	0.2268	0.2243	0.2500	0.2435	0.2074
5/16	18	0.2764	0.2734	0.3125	0.3038	0.2464	24	0.2854	0.2827	0.3125	0.3053	0.2629
3/8	16	0.3344	0.3311	0.3750	0.3656	0.3005	24	0.3479	0.3450	0.3750	0.3678	0.3254
7/16	14	0.3911	0.3876	0.4375	0.4272	0.3525	20	0.4050	0.4019	0.4375	0.4294	0.3780
1/2	13	0.4500	0.4463	0.5000	0.4891	0.4084	20	0.4675	0.4643	0.5000	0.4919	0.4405
5/8	11	0.5660	0.5619	0.6250	0.6129	0.5168	18	0.5889	0.5854	0.6250	0.6163	0.5589
3/4	10	0.6850	0.6806	0.7500	0.73714	0.6309						
7/8	9	0.8028	0.7981	0.8750	0.8611	0.7427						
1	8	0.9188	0.9137	1.0000	0.9850	0.8512						

Table I-2: Unified Series Class 2A

Nominal Size	Coarse Series Threads per Inch UNRC	Pitch Dia. max.	Pitch Dia. min.	Major Dia. max.	Major Dia. min.	Max. Minor Dia. ref.	Fine Series Threads per Inch UNRF	Pitch Dia. max.	Pitch Dia. min.	Major Dia. max.	Major Dia. min.	Max. Minor Dia. ref.
1-1/4	7	1.1550	1.1476	1.2478	1.2314	1.0777	12	1.1941	1.1879	1.2482	1.2368	1.1490
1-1/2	6	1.3893	1.3812	1.4976	1.4794	1.2992	12	1.4440	1.4376	1.4981	1.4867	1.3989

Socket Head Cap Screws 1960 Series - Inch Sizes

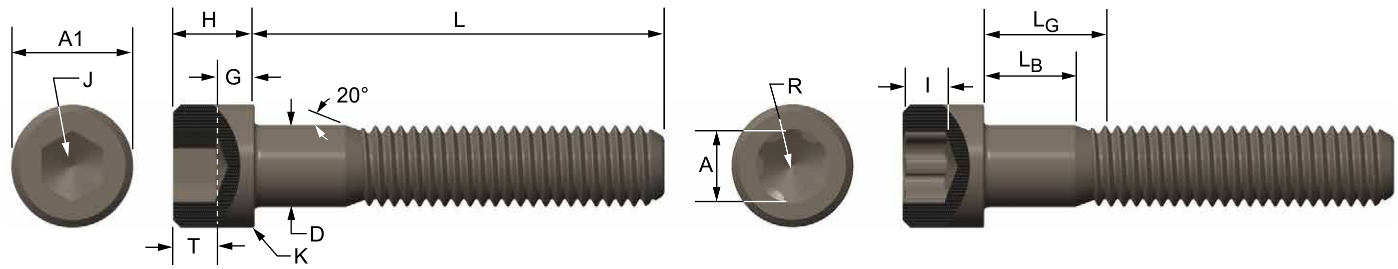


Table I-3: Dimensions of Hex and TORX PLUS® Socket Head Cap Screws

		D		A1		H		R	A	I	J		T	G	K
								TORX PLUS							
Nom. Size	Basic Screw Dia.	Body Dia. max.	Body Dia. min.	Head Dia. max.	Head Dia. min.	Head Height max.	Head Height min.	Drive Size	Recess Dim. ref.	Key Engmt. min.	Hex Socket Size nom.	Hex Socket Size dec.	Hex Key Engmt. min.	Wall Thick-ness min.	Chamfer or Radius max.
0	0.0600	0.0600	0.0568	0.096	0.091	0.060	0.057	6IP	0.069	0.027		0.050	0.025	0.020	0.007
1	0.0730	0.0730	0.0695	0.118	0.112	0.073	0.070	7IP	0.081	0.036	1/16	0.062	0.031	0.025	0.007
2	0.0860	0.0860	0.0822	0.140	0.134	0.086	0.083	8IP	0.094	0.037	5/64	0.078	0.038	0.029	0.007
3	0.0990	0.0990	0.0949	0.161	0.154	0.099	0.095	8IP	0.094	0.041	5/64	0.078	0.044	0.034	0.007
4	0.1120	0.1120	0.1075	0.183	0.176	0.112	0.108	10IP	0.111	0.049	3/32	0.094	0.051	0.038	0.008
5	0.1250	0.1250	0.1202	0.205	0.198	0.125	0.121	10IP	0.111	0.049	3/32	0.094	0.057	0.043	0.008
6	0.1380	0.1380	0.1329	0.226	0.218	0.138	0.134	15IP	0.132	0.058	7/64	0.109	0.064	0.047	0.008
8	0.1640	0.1640	0.1585	0.270	0.262	0.164	0.159	25IP	0.178	0.078	9/64	0.141	0.077	0.056	0.008
10	0.1900	0.1900	0.1840	0.312	0.303	0.190	0.185	27IP	0.200	0.088	5/32	0.156	0.090	0.065	0.008
1/4	0.2500	0.2500	0.2435	0.375	0.365	0.250	0.244	30IP	0.221	0.097	3/16	0.188	0.120	0.095	0.010
5/16	0.3125	0.3125	0.3053	0.469	0.457	0.312	0.306	45IP	0.312	0.137	1/4	0.250	0.151	0.119	0.010
3/8	0.3750	0.3750	0.3678	0.562	0.550	0.375	0.368	50IP	0.352	0.155	5/16	0.312	0.182	0.143	0.010
7/16	0.4375	0.4375	0.4294	0.656	0.642	0.438	0.430	55IP	0.446	0.202	3/8	0.375	0.213	0.166	0.010
1/2	0.5000	0.5000	0.4919	0.750	0.735	0.500	0.492	55IP	0.446	0.202	3/8	0.375	0.245	0.190	0.015
5/8	0.6250	0.6250	0.6163	0.938	0.921	0.625	0.616	70IP	0.619	0.291	1/2	0.500	0.307	0.238	0.015
3/4	0.7500	0.7500	0.7406	1.125	1.107	0.750	0.740	80IP	0.699	0.332	5/8	0.625	0.370	0.285	0.015
7/8	0.8750	0.8750	0.8467	1.312	1.293	0.875	0.864	100IP	0.882	0.425	3/4	0.750	0.432	0.333	0.015
1	1.0000	1.0000	0.9886	1.500	1.479	1.000	0.988	100IP	0.882	0.425	3/4	0.750	0.495	0.380	0.020
1-1/4	1.2500	1.2500	1.2336	1.875	1.852	1.250	1.236				7/8	0.875	0.620	0.475	0.020
1-1/2	1.5000	1.5000	1.4818	2.250	2.224	1.500	1.485				1	1.000	0.745	0.570	0.020

Notes For Socket Head Cap Screws:

1. **Head Chamfer:** The head shall be chamfered at an angle with the plane of the top of the head. The edge between the top of the head and the chamfer may be slightly rounded.
2. **Bearing Surface:** The plane of the bearing surface shall be perpendicular to the axis of the screw within a maximum deviation of 1°.
3. **Edge of Head:** The edge between the bearing surface and the side of the head may be broken (rounded or chamfered) but the radius or chamfer measured along the bearing surface shall not exceed the values listed for "K".
4. **Nominal Size:** Where specifying nominal size in decimals, zeros preceding decimal and the fourth decimal place shall be omitted.
5. **Body:** The term body refers to the unthreaded portion of the shank for screws not threaded to the head.
6. **Head Diameter:** Heads may be plain or knurled at the option of the manufacturer, unless specified by the customer. For knurled screws, the maximum head diameter shall be measured across the tops of the knurl portion, or the diameter across the tops of the knurls for those screws not having an knurled portion, just above the radius or chamfer at the bottom edge of the head.

7. Concentricity

a. The head shall be concentric with the shank within 1% of the basic screw diameter, "D" maximum (2% of total run-out) or 0.006" total run-out, whichever is greater, when held within one diameter of the head, but beyond the fillet.

b. The socket shall be concentric with the shank within 1-1/2 percent of the basic screw diameter, "D" maximum (3 percent of total run-out) or 0.0005" total runout, whichever is greater, for sizes through 1/2" and 3 percent (6 percent of total runout) for sizes above 1/2".

c. Total run-out between thread, body, and head: screws shall assemble into a compound hole that is threaded at one end to the basic thread size (3B minimum) for a length equivalent to 1.5D, counterbored at the other end to diameter H_D listed in Table I-7, and whose center portion is equal to S_D. Diameters S_D and H_D shall be concentric with the axis of the thread. The length of the center portion shall be equal to the screw length minus two screw diameters (2D). The starting thread shall be chamfered and the junction between diameters H_D and S_D shall be rounded to a value equal to "F" maximum.

8. Fillet: For all lengths of screws, the form of the underhead fillet shall be optional, as depicted in the illustration above Table I-4, provided it is a smooth and continuous concave curve fairing into the bearing surface of the head, and the screw shank is within the envelope established by the limits for fillet extension, length and juncture radius specified in Table I-4.

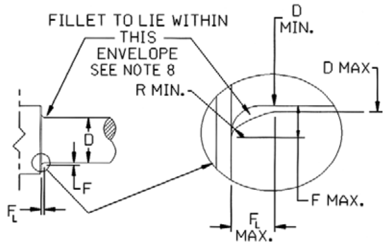


Table I-4: Dimensions of Underhead Fillets

Nom. Screw Size	F Fillet Extension max.	F Fillet Extension min.	F_L Fillet Length max.	R Juncture Radius min.
0	0.007	0.003	0.012	0.002
1	0.007	0.003	0.012	0.003
2	0.008	0.004	0.014	0.003
3	0.008	0.004	0.014	0.004
4	0.009	0.005	0.015	0.004
5	0.010	0.006	0.017	0.005
6	0.010	0.006	0.017	0.005
8	0.012	0.007	0.020	0.006
10	0.014	0.009	0.024	0.006
1/4	0.014	0.009	0.024	0.007
5/16	0.017	0.012	0.029	0.009
3/8	0.020	0.015	0.034	0.012
7/16	0.023	0.018	0.039	0.014
1/2	0.026	0.020	0.044	0.016
5/8	0.032	0.024	0.054	0.021
3/4	0.039	0.030	0.066	0.025
7/8	0.044	0.034	0.075	0.031
1	0.050	0.040	0.085	0.034
1-1/4	0.060	0.050	0.102	0.044
1-1/2	0.070	0.060	0.119	0.052

9. Length: 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. The basic length dimension on the product shall be nominal length expressed as a two-place decimal.

10. Standard Lengths: The standard length increments for socket head cap screws should be as shown to the right.

Standard Lengths

Nom. Screw Size	Nom. Screw Length	Standard Length Increment
0 to 1" incl.	1/8 thru 1/4	1/16
	1/4 thru 1	1/8
	1 thru 3-1/2	1/4
	3-1/2 thru 7	1/2
	7 thru 10	1
over 1"	1 thru 7	1/2
	7 thru 10	1

11. Length Tolerances: The allowable tolerance on length should be as shown to the lower right.

Length Tolerances

Nom. Screw Size	0 thru 3/8 incl.	7/16 thru 3/4 incl.	7/8 thru 1-1/2 incl.
Nom. Screw Length	**Tolerance on Length**		
Up to 1", incl.	-0.03	-0.03	-0.05
Over 1" to 2-1/2", incl.	-0.04	-0.06	-0.10
Over 2-1/2" to 6", incl.	-0.06	-0.08	-0.14
Over 6"	-0.12	-0.12	-0.20

12. Threads: Threads should be Unified External Threads with radius root Class 3A UNRC and UNRF Series for Screw sizes 0 (0.060") through 1"; Class 2A UNRC and UNRF Series for sizes over 1" and up to and including 1-1/2". Acceptability of screw threads are based upon System 22, ANSI/ ASME B1.3. Camcar standard socket head cap screws have UNR root radius threads to improve overall resistance to fatigue, since it reduces the potential of stress risers.

Plating Allowance: Class 3A thread standards do not provide a plating allowance. When plated socket screws are required, it is recommended that STANLEY Engineered Fastening be contacted for plating allowance recommendations.

Radiused Run-out Threads: Incomplete threads which are within one or two pitch lengths of the underside of the head, per ANSI B1.1.

13. Thread Length L_T: The length of the thread is measured, parallel to the axis of the screw, from the extreme point to the last complete (full-form) thread. The thread length on socket head cap screws are defined by Table I-6, page 16 and the notes stated.

14. Screw Point Chamfer: The point should be flat or slightly concave and chamfered. The plane of the point shall be approximately normal to the axis of the screw. The chamfer should extend slightly below the root of the thread, and the edge between the flat and chamfer may be slightly rounded. The included angle of the point should be approximately 90°. Chamfering of screw sizes up to and including size 8 (0.164") and lengths below 0.751" shall be optional.

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15. Designation: TORX PLUS Drive and Hex Socket Head Cap Screws should be designated by the following data in the sequence shown: nominal size (number, fraction or decimal equivalent) threads per inch; length (fractional or decimal equivalent); product name; material and plating, if required.

Example:
#6 x 0.75 TORX PLUS Drive Socket Head Cap Screw, Alloy Steel Zinc Plated

16. Grip Length L_G: Grip length is the distance, measured parallel to the axis of the screw, from the bearing surface of the head to the first complete (full-form) thread under the head. The part being clamped must not be thinner than the Grip Length (L_G), in order to ensure the screw can be properly seated.

17. Body Length L_B: Body length is the length, measured parallel to the axis of the screw, of the unthreaded portion of the shank.

Table I-5: Body and Grip Length

Nom. Size	0		1		2		3		4		5		6		8		10	
Nom. 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
3/4	0.25	0.19																
7/8	0.25	0.19	0.25	0.17	0.25	0.16	0.25	0.15										
1	0.50	0.44	0.25	0.17	0.25	0.16	0.25	0.15	0.25	0.12	0.25	0.12						
1-1/4	0.75	0.69	0.62	0.55	0.62	0.54	0.62	0.52	0.25	0.12	0.25	0.12	0.50	0.34	0.38	0.22	0.38	0.17
1-1/2			0.88	0.80	0.88	0.79	0.88	0.77	0.75	0.62	0.75	0.62	0.50	0.34	0.38	0.22	0.38	0.17
1-3/4					1.12	1.04	1.12	1.02	0.75	0.62	0.75	0.62	1.00	0.84	0.88	0.72	0.88	0.67
2							1.38	1.27	1.25	1.12	1.25	1.12	1.00	0.84	0.88	0.72	0.88	0.67
2-1/4									1.25	1.12	1.25	1.12	1.50	1.34	1.38	1.22	1.38	1.17
2-1/2											1.75	1.62	1.50	1.34	1.38	1.22	1.38	1.17
2-3/4													2.00	1.84	1.88	1.72	1.88	1.67
3															1.88	1.72	1.88	1.67
Nom. Size	**1/4**		**5/16**		**3/8**		**7/16**		**1/2**		**5/8**		**3/4**		**7/8**		**1**	
Nom. 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
1-1/2	0.50	0.25																
1-3/4	0.50	0.25	0.62	0.35	0.50	0.19												
2	1.00	0.75	0.62	0.35	0.50	0.19	0.62	0.27										
2-1/4	1.00	0.75	1.12	0.85	1.00	0.69	0.62	0.27	0.75	0.36								
2-1/2	1.50	1.25	1.12	0.85	1.00	0.69	1.12	0.77	0.75	0.36	0.75	0.30						
2-3/4	1.50	1.25	1.62	1.35	1.50	1.19	1.12	0.77	0.75	0.36	0.75	0.30						
3	2.00	1.75	1.62	1.35	1.50	1.19	1.62	1.27	1.50	1.12	0.75	0.30	1.00	0.50				
3-1/4	2.00	1.75	2.12	1.85	2.00	1.69	1.62	1.27	1.50	1.12	1.50	1.04	1.00	0.50	1.00	0.44		
3-1/2	2.50	2.25	2.12	1.85	2.00	1.69	2.12	1.77	1.50	1.12	1.50	1.04	1.00	0.50	1.00	0.44	1.00	0.38
3-3/4	2.50	2.25	2.62	2.35	2.50	2.19	2.12	1.77	2.25	1.86	1.50	1.04	1.00	0.50	1.00	0.44	1.00	0.38
4	3.00	2.75	2.62	2.35	2.50	2.19	2.62	2.27	2.25	1.86	2.25	1.80	2.00	1.50	1.00	0.44	1.00	0.38
4-1/4	3.00	2.75	3.12	2.85	3.00	2.69	2.62	2.27	2.25	1.86	2.25	1.80	2.00	1.50	2.00	1.44	1.00	0.38
4-1/2	3.50	3.25	3.12	2.85	3.00	2.69	3.12	2.77	3.00	2.62	2.25	1.80	2.00	1.50	2.00	1.44	2.00	1.38
4-3/4	3.50	3.25	3.62	3.35	3.50	3.19	3.12	2.77	3.00	2.62	3.00	2.54	2.00	1.50	2.00	1.44	2.00	1.38
5	4.00	3.75	3.62	3.35	3.50	3.19	3.62	3.27	3.00	2.62	3.00	2.54	3.00	2.50	2.00	1.44	2.00	1.38
5-1/4			4.12	3.85	4.00	3.69	3.62	3.27	3.75	3.36	3.00	2.54	3.00	2.50	3.00	2.44	2.00	1.38
5-1/2			4.12	3.85	4.00	3.69	4.12	3.77	3.75	3.36	3.75	3.30	3.00	2.50	3.00	2.44	3.00	2.38
5-3/4			4.62	4.35	4.50	4.19	4.12	3.77	3.75	3.36	3.75	3.30	3.00	2.50	3.00	2.44	3.00	2.38
6			4.62	4.35	4.50	4.19	4.62	4.27	4.50	4.12	3.75	3.30	4.00	3.50	3.00	2.44	3.00	2.38
6-1/4			5.12	4.85	5.00	4.69	4.62	4.27	4.50	4.12	4.50	4.04	4.00	3.50	4.00	3.44	3.00	2.38
6-1/2					5.00	4.69	5.12	4.77	4.50	4.12	4.50	4.04	4.00	3.50	4.00	3.44	4.00	3.38
6-3/4					5.50	5.19	5.12	4.77	5.25	4.86	4.50	4.04	4.00	3.50	4.00	3.44	4.00	3.38
7					5.50	5.19	5.62	5.27	5.25	4.86	5.25	4.80	5.00	4.50	4.00	3.44	4.00	3.38
7-1/4					6.00	5.69	5.62	5.27	5.25	4.86	5.25	4.80	5.00	4.50	5.00	4.44	4.00	3.38
7-1/2					6.00	5.69	6.12	5.77	6.00	5.62	5.25	4.80	5.00	4.50	5.00	4.44	5.00	4.38
7-3/4							6.12	5.77	6.00	5.62	6.00	5.54	5.00	4.50	5.00	4.44	5.00	4.38
8							6.62		6.00	5.62	6.00	5.54	6.00	5.50	5.00	4.44	5.00	4.38

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18. Table I-5 Notes

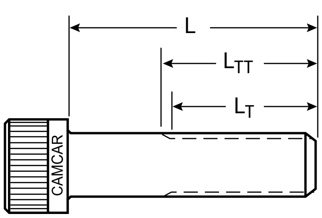
a. The tabulated L_G values are maximum and represent the minimum design grip length of the screw. It is measured from the bearing surface to the face of a GO thread ring gage, having the thread countersink and/or counterbore removed, which has been assembled by hand as far as the thread will permit. The tabulated L_B values are minimum and represent the minimum body length of the screw. They are equal to L_G minus 5 times the pitch of the UNRC thread for the respective screw size.

b. Screws having nominal lengths falling between those for which L_G and L_B values are tabulated in Table I-5, should have L_G and L_B dimensions conforming with those of the next shorter tabulated nominal length for the respective screw size. For example: 1/4" screw, 1.88" long, L_G=0.50" and L_B=0.25".

c. For screws of nominal lengths above the sizes shown in Table I-5, the full form threads, measured with a thread ring gage having the thread chamfer and/or counterbore removed, shall extend to within two pitches of the head for sizes 0 through and including 8" and should extend as close to the head as possible for sizes larger than 5/8".

Screws over 1" in diameter and of lengths shorter than the minimum thread length (L_T plus 5 times the pitch of the UNRC thread for the respective screw size) should have full form threads extending as close to the head as possible.

d. For screws of nominal lengths longer than those for which L_G and L_B values are tabulated in Table I-5 and for screws over 1" in diameter, the maximum grip gaging length L_G and the minimum body length L_B of the screws is determined as shown in Table I-6:



$L_G = L - L_T$

$L_B = L - L_{TT}$

Table I-6: Screws Beyond Sizes In Table I-5

Nom. Size	Basic Screw Dia.	L_T Thread Length min.	L_{TT} Total Thread Length max.	Nom. Size	Basic Screw Dia.	L_T Thread Length min.	L_{TT} Total Thread Length max.
0	0.0600	0.05	0.62	5/16	0.3125	1.12	1.71
1	0.0730	0.62	0.77	3/8	0.3750	1.25	1.94
2	0.0860	0.62	0.80	7/16	0.4375	1.38	2.17
3	0.0990	0.62	0.83	1/2	0.5000	1.50	2.38
4	0.1120	0.75	0.99	5/8	0.6250	1.75	2.82
5	0.1250	0.75	1.00	3/4	0.7500	2.00	3.25
6	0.1380	0.75	1.05	7/8	0.8570	2.25	3.39
8	0.1640	0.88	1.19	1	1.0000	2.50	4.12
10	0.1900	0.88	1.27	1-1/4	1.2500	3.12	5.09
1/4	0.2500	1.00	1.50	1-1/2	1.5000	3.75	6.08

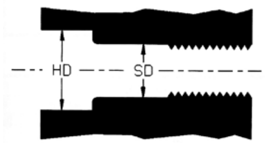


Table I-7: Functional Limits for Run-Out of Head, Body and Thread

Nom. Size		0		1		2		3	
Nom. Length		Hole Diameters for Shank (SD) and Head (HD)							
Over	To, incl.	SD	HD	SD	HD	SD	HD	SD	HD
0	1/4	.063	.105	.076	.127				
1/4	1/2	.065	.107	.078	.129				
0	1/2					.090	.150	.103	.171
Nom. Size		4		5		6		8	
Nom. Length		Hole Diameters for Shank (SD) and Head (HD)							
Over	To, incl.	SD	HD	SD	HD	SD	HD	SD	HD
0	1/2	.116	.193						
1/2	1	.120	.197						
0	3/4			.130	.216	.143	.237	.168	.280
3/4	1-1/2					.148	.242	.173	.285
1-1/2	2-1/4					.153	.247	.178	.290
2-1/4	3							.183	.295
Nom. Size		10		1/4		5/16		3/8	
Nom. Length		Hole Diameters for Shank (SD) and Head (HD)							
Over	To, incl.	SD	HD	SD	HD	SD	HD	SD	HD
0	1	.196	.324	.255	.386	.317	.480	.379	.574
1	2	.201	.329	.260	.391	.322	.485	.383	.578
2	3	.207	.335	.265	.396	.326	.489	.387	.582
3	4			.270	.401	.331	.494	.391	.586
4	6							.400	.595
Nom. Size		7/16		1/2		5/8		3/4	
Nom. Length		Hole Diameters for Shank (SD) and Head (HD)							
Over	To, incl.	SD	HD	SD	HD	SD	HD	SD	HD
0	1	.441	.669						
1	2	.445	.673						
2	3	.449	.676						
3	4	.453	.680						
0	2			.507	.767	.631	.956	.756	1.146
2	4			.514	.774	.638	.963	.762	1.152
4	6			.521	.781	.644	.969	.767	1.157
6	8			.525	.785	.650	.975	.773	1.163
Nom. Size		7/8		1		1-1/4		1-1/2	
Nom. Length		Hole Diameters for Shank (SD) and Head (HD)							
Over	To, incl.	SD	HD	SD	HD	SD	HD	SD	HD
0	2	.880	1.335	1.005	1.525				
1	2	.886	1.341	1.010	1.530				
4	6	.891	1.346	1.015	1.535				
6	8	.897	1.352	1.020	1.540				
0	6					1.265	1.915	1.515	2.295
6	12					1.280	1.930	1.530	2.310

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Table I-8: Mechanical Properties

Nominal Size	Tensile Strength PSI min.	Yield Strength* PSI min.	Elongation* In 2 Inches Percent min.	Reduction of Area* Percent min.	Hardness Rockwell C
0 to 1/2"	180,000	153,000	10%	35%	39 – 45
Over 1/2"	170,000	153,000	10%	35%	37 – 45

*The values for elongation and reduction of area apply only to cylindrical test specimens.

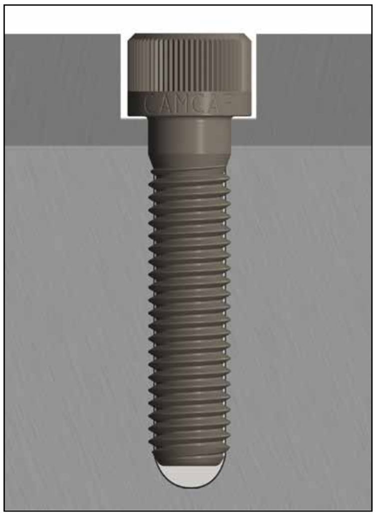
Table I-9: Performance Data

Nominal Size	Basic Screw Dia.	Tensile Stress Area		Tensile Strength (lb. min.)		Yield Strength (lb. min.)		Single Shear Strength* (lb. min.)
		UNRC	UNRF	UNRC	UNRF	UNRC	UNRF	Body Section
0	0.0600		0.00180		324		275	280
1	0.0730	0.00263	0.00278	473	500	402	425	420
2	0.0860	0.00370	0.00394	666	709	566	603	580
3	0.0990	0.00487	0.00523	877	941	745	800	770
4	0.1120	0.00604	0.00661	1,090	1,190	924	1,011	985
5	0.1250	0.00796	0.00830	1,430	1,490	1,218	1,270	1,225
6	0.1380	0.00909	0.01015	1,640	1,830	1,391	1,553	1,495
8	0.1640	0.01400	0.01474	2,520	2,650	2,142	2,255	2,110
10	0.1900	0.01750	0.02000	3,150	3,600	2,678	3,060	2,835
1/4	0.2500	0.03180	0.03640	5,725	6,500	4,865	5,569	4,910
5/16	0.3125	0.05240	0.05800	9,430	10,400	8,017	8,874	7,670
3/8	0.3750	0.07750	0.08780	13,950	15,800	11,858	13,433	11,045
7/16	0.4375	0.10630	0.11870	19,135	21,400	16,264	18,161	15,035
1/2	0.5000	0.14190	0.15990	25,540	28,800	21,711	24,465	19,635
5/8	0.6250	0.22600	0.25600	38,400	43,500	34,550	39,150	30,680
3/4	0.7500	0.33400	0.37300	56,750	63,400	51,100	57,050	44,180
7/8	0.8750	0.46200	0.50900	78,500	86,500	70,700	77,850	60,130
1	1.0000	0.60600	0.66300	103,000	113,000	92,700	101,450	78,540
1-1/4	1.2500	0.96900	1.07300	164,700	182,000	148,250	164,150	122,720
1-1/2	1.5000	1.40500	1.48100	238,800	269,000	214,950	241,900	176,710

19. Mechanical Properties: The mechanical properties included in the above charts are based on testing that was performed at normal room temperatures. When application environment temperatures fall dramatically below or are substantially higher than room temperatures, certain variables need to be taken into consideration. If temperatures exceed 400° F (204° C), short time tensile, creep and relaxation need to be evaluated. When application temperatures drop below -20° F (-29° C), lower ductility, impact strength and fatigue life should be taken into account.

20. Material: STANLEY Engineered Fastening Socket Head Cap Screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium, in sufficient quantity to assure that the specified hardness range of Rockwell C39 – 45 for sizes #0 to 1/2" and C37 – 45 for sized over 1/2" is achieved.

Decarburization and carbonization limits shall be the same as those specified for Socket Head Cap Screws in ASTM Specification A 574, Alloy Steel Socket Head Cap Screws.



Applications

This product is a high tensile strength fastener designed for use in applications where the material being clamped is of sufficient hardness (generally Rockwell B90/614 MPa ultimate tensile strength for steel and cast iron is adequate for the preload induced by the above seating torques; softer material may require a washer under the head to prevent indentation). The application can be recessed with a counterbore where clearance for open and socket wrenches is a problem. Typical applications include use in a machine assembly, punch press tooling, bearing caps, split collars, etc.

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Table I-10: Torque – Tension Data

Nom. Size	Basic Screw Dia.	Tension Induced in Screws Torqued as Recommended* (lb.)		Suggested Seating Torque** (lb.-in.)	
		UNRC	UNRF	UNRC	UNRF
0	0.0600		207		2.6
1	0.0730	302	319	4.6	4.9
2	0.0860	425	452	7.7	8.2
3	0.0990	559	600	11.6	12.5
4	0.1120	693	758	16.3	17.8
5	0.1250	913	952	24.0	25.0
6	0.1380	1,043	1,165	30.2	33.8
8	0.1640	1,607	1,691	55.3	58.3
10	0.1900	2,008	2,295	50.2	57.4
1/4	0.2500	3,649	4,177	191.6	219.3
5/16	0.3125	6,013	6,656	394.0	436.1
3/8	0.3750	8,893	10,075	700.3	793.4
7/16	0.4375	12,198	13,621	1,119.4	1,250.0
1/2	0.5000	16,283	18,349	1,709.7	1,926.6
5/8	0.6250	25,910	29,560	3,401.0	3,854.0
3/4	0.7500	38,320	42,790	6,036.0	6,739.0
7/8	0.8750	53,020	53,390	9,743.0	10,728.0
1	1.0000	69,525	76,087	14,600.0	15,978.0
1-1/4	1.2500	111,120	123,113	29,186.0	32,317.0
1-1/2	1.5000	161,212	181,425	50,782.0	57,147.0

*Calculated to be 75% of yield **Seating torques calculated to create listed tension using a "K" factor of 0.21

Notes for Table I-10:
This data for STANLEY Engineered Fastening inch socket screws was developed through laboratory testing under controlled conditions. The testing was performed with alloy steel socket head cap screw with a black finish, utilizing hardened steel plates and nuts. The threads and bearing areas were lubricated to create the desired testing environment.

The suggested seating torques listed in Table I-10 were developed by preloading the fasteners to 75% of their yield strength. This will create a bearing stress under the head of approximately 80,000 psi, which should prevent indentation in joint materials with hardness values of Rockwell B85 and higher. If the joint materials are less than this, it is recommended that washers be used to prevent indentation. However, in some soft joints, much lower preloads may be required.

This information is provided to facilitate joint design and proper installation procedures. However, because of the diversity of potential assembly and service conditions, it is not possible to make general recommendations. Each assembly, particularly those of a critical nature, should be analyzed and tested to ensure the desired preload and service life are achieved by the joint. For further design assistance, contact an applications specialist at STANLEY Engineered Fastening.

Determining Torque Values
Desired seating torque values can be easily determined using the formula T=KDP. 'T' is the tightening torque expressed in pounds/inch; "K" (also called "K-factor") is the torque coefficient; "D" is the nominal diameter of the fastener in inches; and "P" is the tension induced in the fastener when it is torqued as recommended. Using a 1/2" socket screw with UNRC threads, and a "K" factor of 0.21, we can determine a seating torque using Table I-10: T = 0.21 x 5000 x 17,240 gives us T = 1,801 lb.-in.

It is important to be aware of the impact that changes in the torque coefficient can have on seating torques and the outcome of the final joint. The "K" factor is a variable figure that is dependent upon the fastener and joint material, their finish, and the lubricity of the threads and heating surface. Typically, alloy steel socket screws have a "K" factor range of 0.19 to 0.25. However, lubricants and other anti-seize compounds which are used in some joints can change the "K" factor by 0.05, or, austenitic stainless steel or uncoated parts can have a "K" factor over 0.35. These ranges can cause significant variations in seating torques, and ultimately impact the life of the fastened joint.

Therefore, these suggested seating torques should be used with caution it is the recommendation of STANLEY Engineered Fastening that actual seating torques be determined through proper testing, especially in joints where the control of preload in the joint is critical.

Important Note: When extremely high-stressed socket screw fasteners are used in a corrosive environment, the potential for stress corrosion failure increases. You can reduce the risk of failure by not combining high-stressed socket screw applications and corrosive environments.

Socket Head Cap Screws 1960 Series - Inch Sizes

Stainless Steel Socket Head Cap Screws (ASTM F837)

Tensile Strength (psi min.): 80,000

Yield Strength (psi min.): 40,000

Hardness:...50 HRA Min.

1. Material

STANLEY Engineered Fastening standard stainless steel socket head cap screws are made from an austenitic 302 stainless steel. These stainless steel fasteners are designed for use in applications where corrosion, sterility and cosmetic appearance are a concern, such as appliances, food processing, medical and computers. These fasteners can also offer the desired non-magnetic characteristics for use in computers, electronic and other similar products.

An austenitic stainless steel is desired because it allows work hardening of the fastener during the manufacturing process to provide higher tensile strengths and eliminate subsequent heat treating.

Table I-11: Mechanical Properties of Stainless Steel Socket Head Cap Screws

Nominal Size	Basic Screw Diameter	Tensile Strength (lb. min.)		Yield Strength (lb. min.)		Single Shear Strength (lb. min.)*	Suggested Seating Torque** (lb.-in.)	
		UNRC	UNRF	UNRC	UNRF	Body Section	UNRC	UNRF
2	0.0860	296	315	148	158	331	3.0	3.2
4	0.1120	483	529	242	264	562	6.5	7.1
6	0.1380	727	812	364	406	853	12.0	13.0
8	0.1640	1120	1179	560	590	1,204	22.0	23.0
10	0.1900	1400	1600	700	800	1,616	32.0	36.0
1/4	0.2500	2544	2912	1272	1456	2,798	76.0	87.0
5/16	0.3125	4192	4640	2096	2320	4,371	157.0	174.0
3/8	0.3750	6200	7024	3100	3512	6,295	279.0	316.0
1/2	0.5000	11352	12792	5676	6396	11,191	681.0	767.0

*Calculated using 57,000 psi shear strength
**Seating torques calculated to induce 48,000 psi tensile stress with a “K” factor of 0.20.

Notes for Table I-11

The tensile strength data included in Table I-11 is based on testing that was performed at normal room temperatures. When application temperatures are substantially higher than room temperature, certain variables need to be taken into consideration, including the effect of temperature on term properties and the possibility of plastic deformation or creep.

To prevent a change in the material’s metallurgical properties and reduce the risk of corrosion, stainless steel fasteners are typically not specified for applications where temperatures may exceed 800° F.

For applications requiring a non-standard grade of stainless steel or a size or length not stocked, contact a STANLEY Engineered Fastening applications specialist for mechanical properties and torquing data.

Socket Head Cap Screws 1960 Series - Inch Sizes

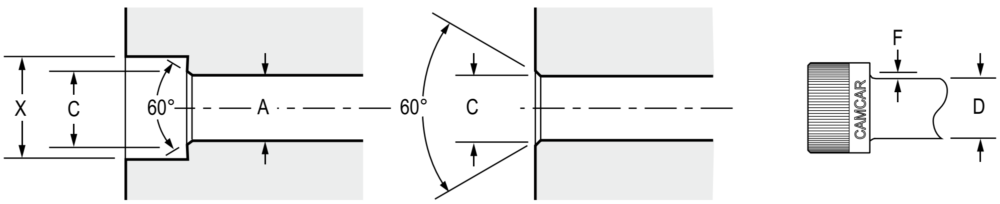


Table I-12: Drill and Counterbore Sizes

Nom. Size	Basic Screw Dia.	Drill Size for Hole A Close Fit nom.	Close Fit dec.	Normal Fit nom.	Normal Fit dec.	X Counterbore Dia.	C Countersink Dia. D max. + 2F (max.)
0	0.0600	51*	0.0670	49*	0.0730	1/8	0.074
1	0.0730	46*	0.0810	43*	0.0890	5/32	0.087
2	0.0860	3/32	0.0937	36*	0.1065	3/16	0.102
3	0.0990	36*	0.1065	31*	0.1200	7/32	0.115
4	0.1120	1/8	0.1250	29*	0.1360	7/32	0.130
5	0.1250	9/64	0.1406	23*	0.1540	1/4	0.145
6	0.1380	23*	0.1540	18*	0.1695	9/32	0.158
8	0.1640	15*	0.1800	10*	0.1935	5/16	0.188
10	0.1900	5*	0.2055	2*	0.2210	3/8	0.218
1/4	0.2500	17/64	0.2656	9/32	0.2812	7/16	0.278
5/16	0.3125	21/64	0.3281	11/32	0.3437	17/32	0.346
3/8	0.0375	25/64	0.3906	13/32	0.4062	5/8	0.415
7/16	0.4375	29/64	0.4531	15/32	0.4687	23/32	0.483
1/2	0.5000	33/64	0.5156	17/32	0.5312	13/16	0.552
5/8	0.6250	41/64	0.6406	21/32	0.6562	1	0.689
3/4	0.7500	49/64	0.7656	25/32	0.7812	1-3/16	0.828
7/8	0.8750	57/64	0.8906	29/32	0.9062	1-3/8	0.963
1	1.0000	1 1/64	1.0156	1 1/32	1.0312	1-5/8	1.100
1-1/4	1.2500	1 9/32	1.2812	1 5/16	1.3125	2	1.370
1-1/2	1.5000	1 17/32	1.5312	1 9/16	1.5625	2-3/8	1.640

*Wire Size Drill

Notes for Table I-12

Close Fit: Normally limited to holes for those lengths of screws threaded to the head in assemblies in which

1. only one screw is used; or
2. two or more screws are used and the mating holes are produced at assembly or by matched and coordinated tooling.

Normal Fit: Intended for:

1. screws of relatively long length; or
2. assemblies that involve two or more screws and where the mating holes are produced by conventional tolerancing methods.

It provides for the maximum allowable eccentricity of the longest standard screws and for certain deviations in the parts being fastened, such as deviations in hole straightness; angularity between the axis of the tapped hole and that of the hole for the shank; differences in center distances of the mating holes and other deviations.

Chamfering: It is considered good practice to chamfer or break the edges of holes that are smaller than “B” maximum in parts in which hardness approaches, equals or exceeds the screw hardness. If holes are not chamfered, the heads may not seat properly or the sharp edges may deform the fillets on the screws, making them susceptible to fatigue in applications that involve dynamic loading. The chamfers, however, should not be larger than needed to ensure that the heads seat properly or that the fillet on the screw is not deformed. Normally, the chamfers do not need to exceed “B” maximum. Chamfers exceeding these values reduce the effective bearing area and introduce the possibility of indentation when the parts fastened are softer than the screws, or the possibility of brinelling of the heads of the screws when the parts are harder than the screws.

Socket Head Shoulder Screws - Inch Sizes

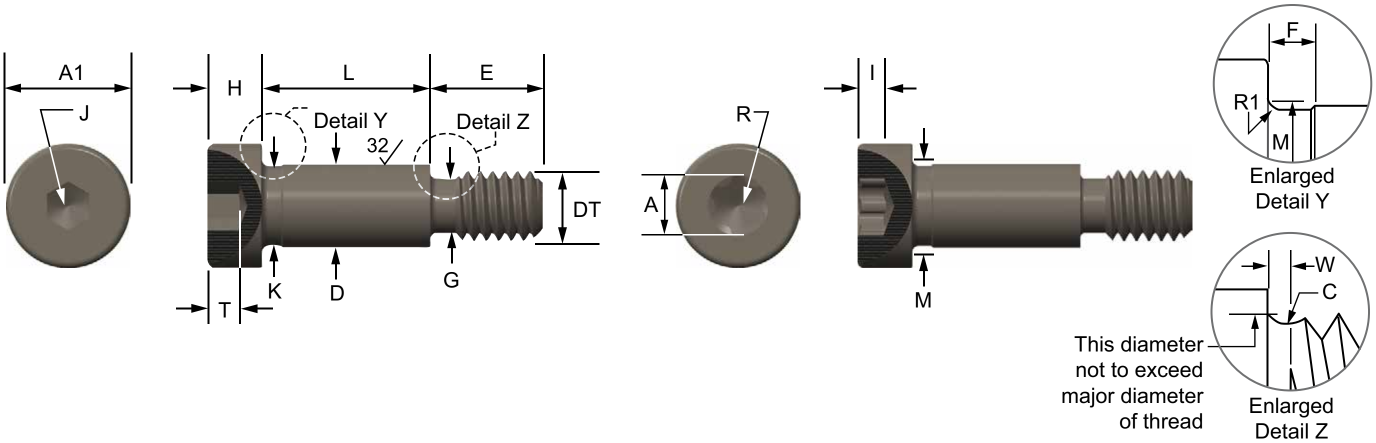


Table I-13: Dimensions of Hex and TORX PLUS® Socket Head Shoulder Screws

		D		A1		H		R	A	I	J		T	M	R1
								TORX PLUS					Hex	Head Fillet	Head
Nom. Screw Size	Basic Screw Dia.	Shoulder Diameter		Head Diameter		Head Height		Drive Size	Recess Dim	Key Engmt.	Hex Socket Size		Key Engmt.	Transition Dia.	Fillet Radius
		max.	min.	max.	min.	max.	min.		ref.	min.	nom.		min.	max.	min.
1/4	0.2500	0.2480	0.2460	0.375	0.357	0.188	0.177	20IP	0.155	0.068	1/8	0.125	0.094	0.276	0.009
5/16	0.3125	0.3105	0.3085	0.438	0.419	0.219	0.209	27IP	0.200	0.088	5/32	0.156	0.117	0.345	0.012
3/8	0.3750	0.3730	0.3710	0.562	0.543	0.250	0.240	40IP	0.266	0.117	3/16	0.188	0.141	0.413	0.015
1/2	0.5000	0.4980	0.4960	0.750	0.729	0.312	0.302	45IP	0.312	0.137	1/4	0.250	0.188	0.550	0.020
5/8	0.6250	0.6230	0.6210	0.875	0.853	0.375	0.365	55IP	0.446	0.196	5/16	0.312	0.234	0.687	0.024
3/4	0.7500	0.7480	0.7460	1.000	0.977	0.500	0.490	60IP	0.529	0.245	3/8	0.375	0.281	0.826	0.030

Table I-13, Continued

		K	F	DT			G		W	C		E
Nom. Screw Size	Basic Screw Dia.	Shoulder Neck Diameter	Shoulder Neck Width	Nominal Thread Size	Basic Thread Dia.	Threads per Inch	Thread Neck Diameter		Thread Neck Width	Thread Neck Fillet		Thread Length
		min.	max.				max.	min.	max.	max.	min.	Basic
1/4	0.2500	0.227	0.093	10	0.1900	24	0.142	0.133	0.083	0.023	0.017	0.375
5/16	0.3125	0.289	0.093	1/4	0.2500	20	0.193	0.182	0.100	0.028	0.022	0.438
3/8	0.3750	0.352	0.093	5/16	0.3125	18	0.249	0.237	0.111	0.031	0.025	0.500
1/2	0.5000	0.477	0.093	3/8	0.3750	16	0.304	0.291	0.125	0.035	0.029	0.625
5/8	0.6250	0.602	0.093	1/2	0.5000	13	0.414	0.397	0.154	0.042	0.036	0.750
3/4	0.7500	0.727	0.093	5/8	0.6250	11	0.521	0.502	0.182	0.051	0.045	0.875

Notes For Socket Head Shoulder Screws:

1. **Shoulder:** Shoulder refers to the enlarged, unthreaded portion of the screw, the diameter of which serves as the basis for the derivation of the nominal size.
2. **Head Diameter:** Heads may be plain or knurled at the option of the manufacturer, unless specified by the customer.
3. **Head Chamfer:** The head shall be chamfered or radiused at the manufacturer's option. See ASME B18.3 for dimensions.
4. **Neck and Fillet Under Head:** Screws may be necked under the head at the option of the manufacturer. The fillet extension above "D", at intersection of the head bearing surface and neck or shoulder, should be within the tabulated limits for "M".
5. **Bearing Surface:** The plane of the bearing surface shall be perpendicular to the axis of the shoulder with a maximum deviation of 2°.
6. **Neck Under Shoulder:** The neck under the shoulder should allow the shoulder to seat against the face of a standard basic GO thread ring gage.

Socket Head Shoulder Screws - Inch Sizes

7. **Edge of Shoulder:** The edge of the shoulder may be broken. The radius or chamfer shall not exceed 0.005" for shoulders to 0.373" diameter and 0.008" for larger diameters.
8. **Concentricity:**
   a. The head shall be concentric with the shoulder within 1 percent (2% total runout) of the nominal diameter, “D” or 0.003" (0.006" total runout), whichever is greater.
   b. Pitch diameter and shoulder shall be concentric within 0.004" total runout, when checked at a distance of 0.188" from the shoulder at the threaded end.
   c. Concentricity, parallelism, bow and squareness of shoulder to thread shall be within 0.005" total runout per inch of shoulder length, with a maximum of 0.025" when firmly seated against the shoulder in a threaded bushing and checked on the shoulder at a distance 2F from the underside of the head. Threads of bushing shall be basic size, and bushing OD and ends shall be concentric and square with the axis.
9. **Length:** The length of the screw is the distance measured on the line parallel to the axis of the screw, from the plane of the bearing surface under the head to the plane of the shoulder at threaded end. The basic length dimension on the product shall be nominal length expressed as a three-place decimal.
10. **Standard Lengths:** The difference between consecutive lengths of standard screws shall be as designated in the following table:

Nominal Screw Length	Standard Length Increment
1/4 thru 3/4	1/8
3/4 thru 5	1/4
Over 5	1/2

11. **Threads:** Threads shall be Unified external thread, Class 3A, UNRC Series. Acceptability is to be based on System 22, ANSI B1.3.

    Class 3A does not provide a plating allowance. When plated products are required, it is recommended they be purchased from STANLEY Engineered Fastening.
12. **Thread Length Tolerance:** The tolerance on thread length “E” shall be -0.020" for screw sizes up to and including 3/8" and -0.030" for screw sizes larger than 3/8".
13. **Screw Point Chamfer:** The point shall be flat or slightly concave, and chamfered. The plane of the point shall be approximately normal to the axis of the screw. The chamfer shall extend slightly below the root of the thread, and the edge between flat and chamfer may be slightly rounded. The included angle of the point should be approximately 90°.
14. **Material:** Shoulder screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium, in sufficient quantity to assure a core hardness range of Rockwell C32 to 43 is met when hardened by quenching from the austenitizing temperature and tempered at not lower than 343°C (650°F). Decarburization and carburization limits shall be the same as those specified for Socket Head Cap Screws in ASTM specification A 574, Alloy Steel Socket Head Cap Screws.

    Shoulder screws shall meet the following mechanical property requirements:

a. Ultimate tensile strength of 140,000 psi based on the minimum thread neck area.

b. Shear strength of 84,000 psi in thread neck area based on the minimum thread neck area.

c. Shear strength of 84,000 psi in the shoulder area based on the minimum shoulder area.

Table I-14: Material, Mechanical and Application Data

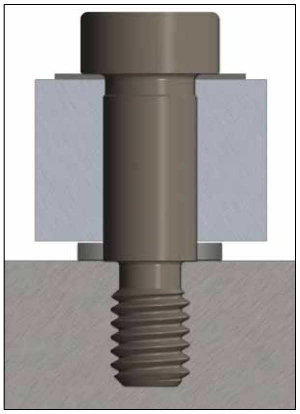
Nominal or Basic Shoulder Diameter		Mechanical Properties: Tensile Strength Thread Neck Area lb. min.	Shear Strength: Shoulder Area lb. min.	Shear Strength: Thread Neck Area lb. min.	Application Data: Suggested Seating Torque* lb.-in.
1/4	0.2500	1,950	8,246	1,167	36
5/16	0.3125	3,640	12,885	2,185	89
3/8	0.3750	6,170	18,555	3,706	188
1/2	0.5000	9,310	32,986	5,587	340
5/8	0.6250	17,300	51,541	10,398	845
3/4	0.7500	27,700	74,220	16,625	1688

*Seating torques calculated to induce 65,000 psi tensile stress with a “K” factor of 0.21.

Tensile Strength (psi min.): 140,000

Yield Strength (psi min.): 84,000

Hardness:.......................................Rockwell C32 to 43



Applications

Socket head shoulder screws are designed and recommended for use with stripper springs and guides in punch press die sets. Additional applications can include attaching cams, rollers, links and levers. They can also be used as journals, pins, or sliding-element guides.

Socket Button Head Cap Screws - Inch Sizes

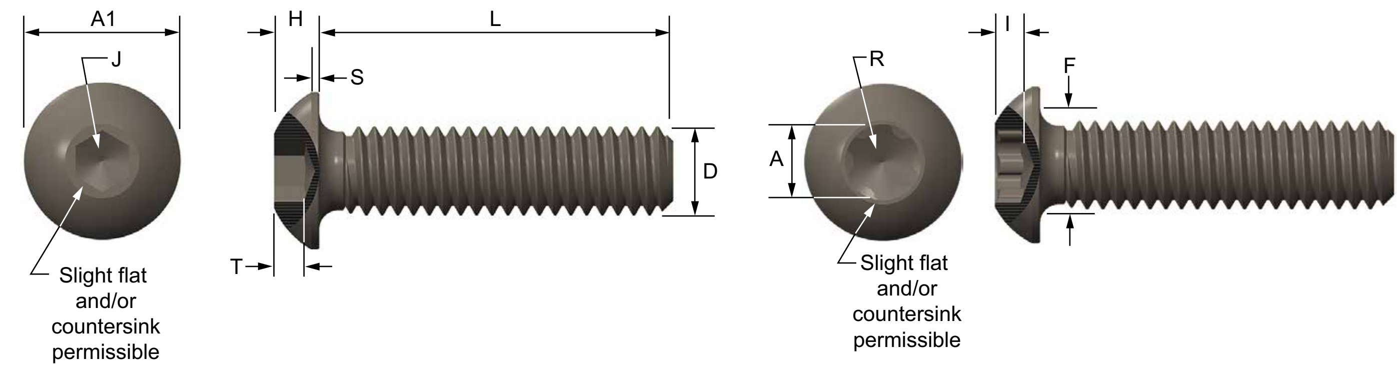


Table I-15: Dimensions of Hex and TORX PLUS® Socket Button Head Cap Screws

		A1		H		S	R	A	I	J		T	F		L
Nom. Size	Basic Screw Dia.	Head Diameter		Head Height		Head Side Height	TORX PLUS Drive Size	TORX PLUS Recess Dim.	TORX PLUS Key Engmt.	Hex Socket Size		Hex Key Engmt.	Fillet Diameter		Maximum Standard Length
		max.	min.	max.	min.	ref.		ref.	min.	nom.	dec.	min.	max.	min.	nom.
0	0.0600	0.114	0.104	0.032	0.026	0.010	5IP	0.058	0.017		0.035	0.020	0.080	0.070	1/2
1	0.0730	0.139	0.129	0.039	0.033	0.010	5IP	0.058	0.020		0.050	0.028	0.093	0.083	1/2
2	0.0860	0.164	0.154	0.046	0.038	0.010	6IP	0.069	0.023		0.050	0.028	0.106	0.096	1/2
4	0.1120	0.213	0.201	0.059	0.051	0.015	8IP	0.094	0.032	1/16	0.062	0.035	0.132	0.122	1/2
6	0.1380	0.262	0.250	0.073	0.063	0.015	10IP	0.111	0.038	5/64	0.078	0.044	0.158	0.148	5/8
8	0.1640	0.312	0.298	0.087	0.077	0.015	15IP	0.132	0.045	3/32	0.094	0.052	0.194	0.184	3/4
10	0.1900	0.361	0.347	0.101	0.091	0.020	25IP	0.178	0.052	1/8	0.125	0.070	0.220	0.210	1
1/4	0.2500	0.437	0.419	0.132	0.122	0.031	27IP	0.200	0.068	5/32	0.156	0.087	0.290	0.280	1
5/16	0.3125	0.547	0.527	0.166	0.152	0.031	40IP	0.266	0.090	3/16	0.188	0.105	0.353	0.343	1
3/8	0.3750	0.656	0.636	0.199	0.185	0.031	45IP	0.312	0.106	7/32	0.219	0.122	0.415	0.405	1-1/4
1/2	0.5000	0.875	0.851	0.265	0.245	0.046	55IP	0.446	0.158	5/16	0.312	0.175	0.560	0.540	2
5/8	0.6250	1.000	0.970	0.331	0.311	0.062	60IP	0.529	0.192	3/8	0.375	0.210	0.685	0.665	2

Notes For Socket Button Head Cap Screws:

1. **Nominal Size:** Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth decimal place should be omitted.
2. **Head Height:** The tabulated head heights represent metal to metal measurements; i.e., the truncation of the rounded surface caused by the socket is not considered part of the head height.
3. **Bearing Surface:** The plane of the bearing surface is to be perpendicular to the axis of the shank within 2°.
4. **Concentricity:** The head is to be concentric to the axis of the shank of the screws within 3% of the maximum head diameter, "A1", or 0.004" (0.008" total runout), whichever is greater.

   Concentricity is defined as 1/2 the total indicated value obtained by holding the screw by the threads next to the head and indicating the outer surface of the head on the rounded portion, adjacent to, but not on, the extreme periphery of the head.
5. **Fillet:** For all lengths of screws, the form of the fillet is optional, provided it fairs into the bearing surface within the limits of "F", and is a smooth and continuous curve having a bearing surface juncture radius no less than that tabulated below:

Nominal Screw Size	Juncture Radius min.	Nominal Screw Size	Juncture Radius min.
0	0.002	10	0.006
1	0.003	1/4	0.007
2	0.003	5/16	0.009
4	0.004	3/8	0.012
6	0.005	1/2	0.016
8	0.006	5/8	0.021

6. **Length:** The length of the screw shall be measured parallel to the axis of the screw from the plane of the bearing surface under the head to the plane of the flat of the point. The portion of the screw contained within dimension "L" is commonly called the shank.

Socket Button Head Cap Screws - Inch Sizes

7. **Standard Lengths:** The difference between consecutive lengths of socket button head cap screws shall be designated in the following table:

Nominal Screw Length	Standard Length Increment
1/8 thru 1/4	1/16
1/4 thru 1	1/8
1 thru 2	1/4

8. **Length Tolerances:** The allowable tolerance on length shall be as tabulated below:

Nominal Screw Size	0 thru & incl. 3/8	1/2 & 5/8 inclusive
Nominal Screw Length	Tolerance on Length	
Up to 1", incl.	-0.03	-0.03
Over 1" to 2, incl.	-0.04	-0.06

9. **Threads:** Threads shall be unified external threads with radius root Class 3A UNRC and UNRF Series. Acceptability is to be based on System 22, ANSI B1.3.

   Class 3A does not provide a plating allowance. When plated products are required, it is recommended they be purchased from STANLEY Engineered Fastening.

10. **Thread Length Tolerance:** For screws of nominal lengths equal to or shorter than maximum lengths "L" listed in Table I-15, the complete (full form) threads, measured with a thread ring gage having the thread chamfer and/or counterbore removed, shall extend to within two pitches (threads) of the bearing surface of the head. For longer screws, the length of the complete thread, at the option of the manufacturer, is to be between a minimum of twice the basic screw diameter plus 0.50", and a maximum of within two pitches (threads) of the head.

Table I-16: Mechanical and Application Data

Nom. Size	Basic Screw Dia.	Mechanical Properties: Tensile Strength lb. min. UNRC	Tensile Strength lb. min. UNRF	Single Shear Strength* lb. Body Section	Application Data: Suggested Seating Torque** lb.-in. UNRC†	UNRF†
0	0.060	n/a	260	282	1	1
1	0.073	380	400	420	2	2
2	0.086	540	570	580	3	3
4	0.112	880	960	985	7	8
6	0.138	1150	1200	1,495	13	14
8	0.164	2030	2140	2,110	23	24
10	0.190	2540	2900	2,835	34	38
1/4	0.250	4610	5275	4,910	80	92
5/16	0.3125	7600	8450	7,670	165	182
3/8	0.375	11200	12700	11,045	293	332
1/2	0.500	20600	23200	19,633	715	806
5/8	0.625	30500	34500	30,680	1,425	1,610

* Some shear values derived by calculation.
** Seating torques calculated to induce 48,000 psi tensile stress with a "K" factor of .21.
† Plain Finish

11. **Screw Point Chamfer:** The point shall be flat or slightly concave, and chamfered. The plane of the point shall be approximately normal to the axis of the screw. The chamfer shall extend slightly below the root of the thread, and the edge between flat and chamfer may be slightly rounded. The included dangle of the point should be approximately 90°. Chamfering of screw sizes up to size 8 (0.164") and lengths below 0.75d is optional.

12. **Material:** Socket button head cap screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium, in sufficient quantity to assure that the specified core hardness range of Rockwell C39 to 44 for sizes up to and including 1/2" (0.500) and C37 – 44 for sizes over 1/2" (0.500) is met when hardened by quenching from the austenitizing temperature and tempered at not lower than 343°C (650°F). Decarburization and carburization limits are specified in ASTM F 835 Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.

Hardness:
Sizes 1/2" and smaller ....Rockwell C39 to 44
Sizes larger than 1/2" ....Rockwell C37 to 44

Tensile Test Load: Standard sizes in both UNRC and UNRF threads must withstand, without failure, the static tensile load values listed in Table I-16 when tested with a suitable fixture which measures axial loading. When tested to failure, screws may fracture in the thread or head.

Note: For non-standard screws, such as diameters and lengths which are not stock production sizes, or screws made from material other than heat treated alloy steel, contact STANLEY Engineered Fastening Decorah Operations.

Applications
This product is designed and recommended for applications where a lower profile is desired. Wrenchability is significantly reduced due to the smaller sockets and shallower key engagements. Because of the head configuration, this product is not recommended for use in high-strength applications or where maximum fatigue resistance is required.

Socket Flange Button Head Cap Screws - Inch Sizes

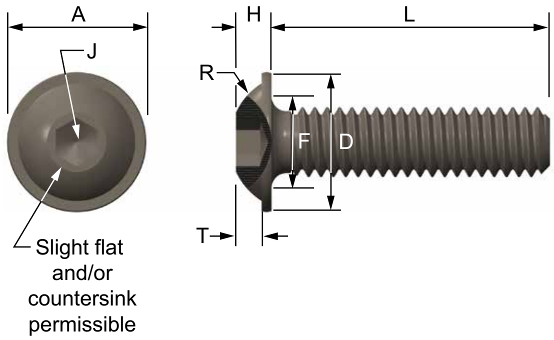


Table I-17: Dimensions of Socket Flange Button Head Cap Screws

Nom. Size	Basic Screw Dia.	A Head Diameter max.	A Head Diameter min.	H Head Height max.	H Head Height min.	J Hex Socket Size nom.	J Hex Socket Size dec.	T Hex Key Engage. min.	D Bearing Surface min.	F Fillet Diameter max.	F Fillet Diameter min.	R Head Radii min.
4	0.112	0.240	0.228	0.059	0.051	1/16	0.062	0.035	0.203	0.132	0.122	0.138
6	0.138	0.292	0.277	0.073	0.063	5/64	0.078	0.044	0.252	0.158	0.148	0.158
8	0.164	0.367	0.339	0.087	0.077	3/32	0.094	0.052	0.312	0.194	0.184	0.185
10	0.190	0.387	0.357	0.101	0.091	1/8	0.125	0.070	0.357	0.220	0.210	0.213
1/4	0.250	0.532	0.496	0.122	0.122	5/32	0.156	0.087	0.496	0.290	0.280	0.249
5/16	0.312	0.646	0.603	0.152	0.152	3/16	0.188	0.105	0.603	0.353	0.343	0.309
3/8	0.375	0.769	0.721	0.185	0.185	7/32	0.219	0.122	0.721	0.415	0.405	0.368
1/2	0.500	1.017	0.960	0.245	0.245	5/16	0.312	0.175	0.960	0.560	0.540	0.481

Notes: See notes for Button Head Socket Screws, pages 23 – 24.

Socket Low Cap Screws - Inch Sizes

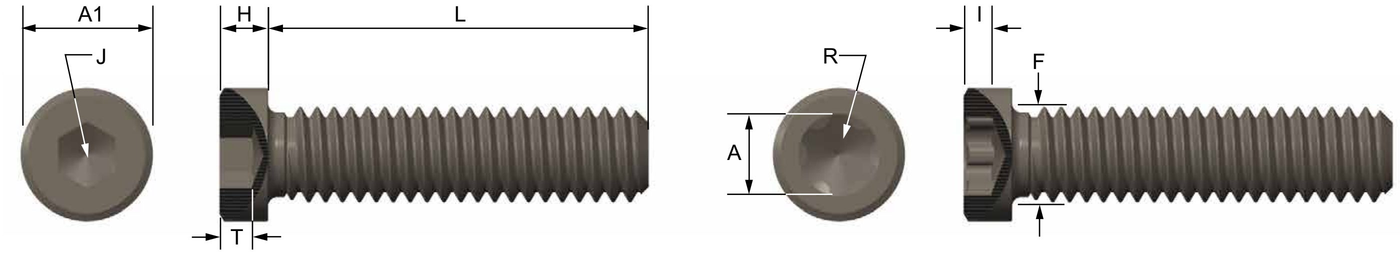


Table I-18: Dimensions of Hex and TORX PLUS® Socket Low Head Cap Screws

		A1		H		R	A	I	J		T	F	
							TORX PLUS				Hex		
Nom. Size	Basic Screw Dia.	Head Diameter		Head Height		Drive Size	Recess Dim.	Key Engmt.	Hex Socket Size		Key Engmt.	Fillet Diameter	
		max.	min.	max.	min.		ref.	min.	nom.	ref.	min.	max.	min.
4	0.112	0.183	0.176	0.059	0.053	6IP	0.081	0.036		0.0500	0.038	0.130	0.117
5	0.125	0.205	0.198	0.065	0.059	8IP	0.094	0.041	1/16	0.0625	0.044	0.145	0.132
6	0.138	0.226	0.218	0.072	0.066	10IP	0.111	0.038	1/16	0.0625	0.050	0.158	0.144
8	0.164	0.270	0.265	0.082	0.079	15IP	0.132	0.045	5/64	0.0781	0.060	0.188	0.172
10	0.190	0.312	0.307	0.095	0.092	20IP	0.155	0.053	3/32	0.0938	0.072	0.218	0.202
1/4	0.250	0.375	0.369	0.125	0.121	27IP	0.200	0.068	1/8	0.1250	0.094	0.278	0.261
5/16	0.3125	0.437	0.431	0.156	0.152	30IP	0.221	0.075	5/32	0.1562	0.120	0.347	0.329
3/8	0.375	0.562	0.556	0.187	0.182	40IP	0.266	0.090	3/16	0.1875	0.145	0.415	0.397
1/2	0.500	0.750	0.743	0.250	0.244	50IP	0.352	0.120	1/4	0.2500	0.184	0.552	0.531

Notes for Socket Low Head Cap Screws:

1. **Nominal Size:** Where specifying nominal size in decimals, zeros proceeding decimal and in the fourth decimal place should be omitted.
2. **Head Diameter:** Heads shall be plain.
3. **Length:** The length of the screw shall be measured parallel to the axis of the screw from the plane of the bearing surface under the head to the plane of the flat of the point. The portion of the screw contained within dimension L is commonly call the shank. The basic length dimension on the product is the nominal length expressed as a two-place decimal.
4. **Standard Lengths:** The difference between consecutive lengths of Socket Low Head Cap Screws shall be as designated in the following table:

Nominal Screw Length	Standard Length Increment
1/8 thru 1/4	1/16
1/4 thru 1	1/8
1 thru 2	1/4

5. **Length Tolerances:** The allowable tolerance on length shall be as tabulated below:

Nom. Screw Size	0 to 3/8", incl.	1/2" and 5/8" incl.
Nom. Screw Length	Tolerance on Length	
Up to 1", incl.	-0.03	-0.03
Over 1: to 2 incl.	-0.04	-0.06

6. **Thread Length:** On all stock lengths, the last complete (full form) thread measured with a thread ring gage (having the thread chamfer and/or counterbore removed) extends to within two threads of the head. On other lengths and diameters, the length of the thread will conform to cap screw thread lengths.

Socket Low Head Cap Screws - Inch Sizes

7. **Screw Point Chamfer:** The point shall be flat or slightly concave, and chamfered. The plane of the point shall be approximately normal to the axis of the screw. The chamfer shall extend slightly below the root of the thread, and the edge between flat and chamfer may be slightly rounded.

   The included angle of the point should be approximately 90°. Chamfering of screw sizes up to and including size 8 (0.164") and lengths below 0.75d is optional.

8. **Threads:** Threads shall be Unified external threads with radius root Class 3A UNRC and UNRF Series. Acceptability is based on System 22, ANSI B1.3.

   Class 3A does not provide a plating allowance. When plated products are required, it is recommended they be procured from STANLEY Engineered Fastening Decorah Operations.

9. **Material:** Socket low head cap screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium, in sufficient quantity to assure that the specified core hardness range of Rockwell C39 to 45 for sizes up to and including 5/8" is met when hardened by quenching from the austenitizing temperature and tempered at not lower than 343°C (650°F). Decarburization and carburization limits are the same as those specified for Socket Head Cap Screws in ASTM Specification A 574, Alloy Steel Socket Head Cap Screws.

   For non-standard screws, such as diameters and lengths which are not stock production sizes, or screws made from materials other than heat treated alloy steel, contact STANLEY Engineered Fastening Decorah Operations.

Tensile Strength (psi min.): 145,000

NOTE: Tensile strength is reduced due to head design.

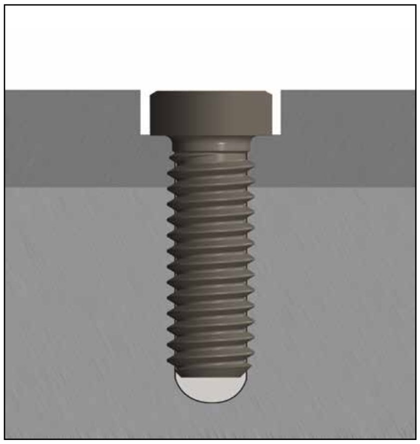
Hardness:.......................................Rockwell C39 to 45

Table I-19: Mechanical and Application Data

Nom. Size	Basic Screw Dia.	Mechanical Properties: Tensile Strength lb. min. UNRC	Tensile Strength lb. min. UNRF	Single Shear Strength* lb. Body Section	Application Data: Suggested Seating Torque ** lb.-in. UNRC	Suggested Seating Torque ** lb.-in. UNRF
4	0.112	876	958	985	7	8
5	0.125	1,154	1,204	1225	10	11
6	0.138	1,318	1,472	1495	13	14
8	0.164	2,380	2,510	2,110	23	24
10	0.190	2,980	3,400	2,835	34	38
1/4	0.250	5,400	6,100	4,910	80	92
5/16	0.3125	8,900	9,800	7,670	165	182
3/8	0.375	13,100	14,900	11,045	293	332
1/2	0.500	24,100	27,100	19,633	715	806

* Some shear values derived by calculation.

** Seating torques calculated to induce 48,000 psi tensile stress with a “K" factor of 0.21



Applications

Socket low head cap screws are precision fasteners designed for applications where head height clearance is an issue. Because of their reduced head height and smaller socket size, they normally cannot be preloaded as high as standard socket head cap screws and should not be subjected to high tensile loads.

Socket Flat Countersunk Head Cap Screws - Inch Sizes

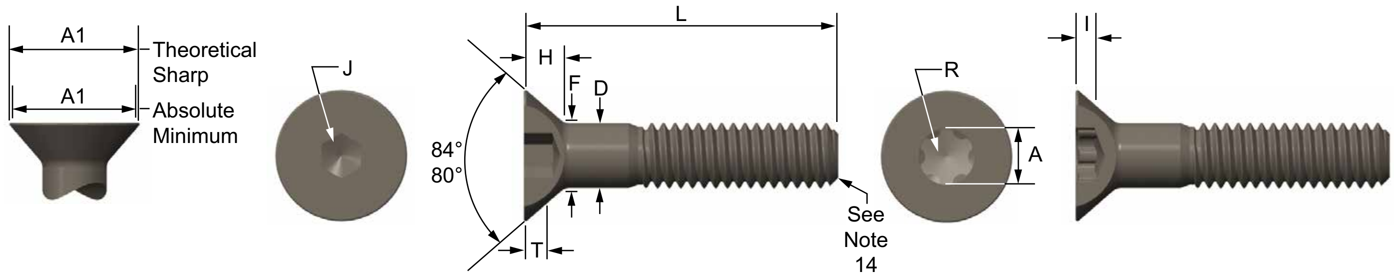


Table I-20: Dimensions of Hex and TORX PLUS® Socket Flat Countersunk Head Cap Screws

Nom. Size	Basic Screw Dia.	D Body Dia. max.	D Body Dia. min.	A1 Head Diameter Theor. Sharp max.	A1 Head Diameter Absol. min.	H Head Height ref.	R TORX PLUS Drive Size	A TORX PLUS Recess Dim. ref.	I TORX PLUS Key Engmt. min.	J Hex Socket Size nom.	J Hex Socket Size dec.	T Hex Key Engmt. min.	F Fillet Dia. max.
0	0.0600	0.0600	0.0568	0.138	0.117	0.044	3IP	0.047	0.016		0.035	0.025	0.072
1	0.0730	0.0730	0.0695	0.168	0.143	0.054	6IP	0.081	0.036		0.050	0.031	0.089
2	0.0860	0.0860	0.0822	0.197	0.168	0.064	6IP	0.081	0.036		0.050	0.038	0.106
3	0.0990	0.0990	0.0949	0.226	0.193	0.073	8IP	0.094	0.041	1/16	0.062	0.044	0.119
4	0.1120	0.1120	0.1075	0.255	0.218	0.083	10IP	0.111	0.038	1/16	0.062	0.055	0.136
5	0.1250	0.1250	0.1202	0.281	0.240	0.090	10IP	0.111	0.038	5/64	0.078	0.061	0.153
6	0.1380	0.1380	0.1329	0.307	0.263	0.097	15IP	0.132	0.045	5/64	0.078	0.066	0.168
8	0.1640	0.1640	0.1585	0.359	0.311	0.112	20IP	0.155	0.053	3/32	0.094	0.076	0.194
10	0.1900	0.1900	0.1840	0.411	0.359	0.127	25IP	0.178	0.061	1/8	0.125	0.087	0.220
1/4	0.2500	0.2500	0.2435	0.531	0.480	0.161	30IP	0.221	0.075	5/32	0.156	0.111	0.280
5/16	0.3125	0.3125	0.3053	0.656	0.600	0.198	40IP	0.266	0.090	3/16	0.188	0.135	0.343
3/8	0.3750	0.3750	0.3678	0.781	0.720	0.234	45IP	0.312	0.106	7/32	0.219	0.159	0.405
7/16	0.4375	0.4375	0.4294	0.844	0.781	0.234	50IP	0.352	0.120	1/4	0.250	0.159	0.468
1/2	0.5000	0.5000	0.4919	0.938	0.872	0.251	50IP	0.352	0.120	5/16	0.312	0.172	0.530
5/8	0.6250	0.6250	0.6163	1.188	1.112	0.324	55IP	0.446	0.158	3/8	0.375	0.220	0.655
3/4	0.7500	0.7500	0.7406	1.438	1.355	0.396	60IP	0.529	0.192	1/2	0.500	0.220	0.780

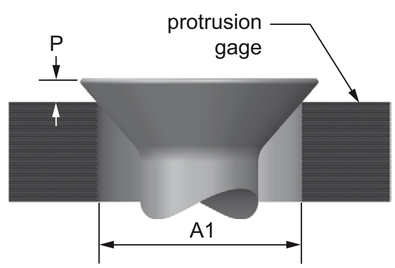


Table I-20 continued

Nom. Size	Basic Screw Dia.	G Protrusion Gage Dia. max.	G Protrusion Gage Dia. min.	P Protrusion max.	P Protrusion min.
0	0.0600	0.078	0.077	0.044	0.026
1	0.0730	0.101	0.100	0.048	0.028
2	0.0860	0.124	0.123	0.051	0.031
3	0.0990	0.148	0.147	0.054	0.033
4	0.1120	0.172	0.171	0.057	0.036
5	0.1250	0.196	0.195	0.059	0.037
6	0.1380	0.220	0.219	0.060	0.037
8	0.1640	0.267	0.266	0.063	0.039
10	0.1900	0.313	0.312	0.066	0.041
1/4	0.2500	0.424	0.423	0.072	0.043
5/16	0.3125	0.539	0.538	0.078	0.047
3/8	0.3750	0.653	0.652	0.088	0.050
7/16	0.4375	0.690	0.689	0.104	0.063
1/2	0.5000	0.739	0.738	0.131	0.087
5/8	0.6250	0.962	0.961	0.146	0.096
3/4	0.7500	1.186	1.185	0.170	0.105

Socket Flat Countersunk Head Cap Screws - Inch Sizes

Notes for Socket Flat Countersunk Head Cap Screws:

1. **Nominal Size:** Where specifying nominal size in decimals, zeros proceeding decimal and in the fourth decimal place should be omitted.
2. **Body:** The term body refers to the unthreaded cylindrical portion of the shank for those screws not threaded to the head.
3. **Head Diameter:** The maximum sharp values under Column A1 are theoretical values only, 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 82° in which a screw having maximum head height will just fit flush.
4. **Head Height:** The tabulated values for head height are given for reference only and are calculated to the maximum formulation.
5. **Bearing Surface:** The axis of the conical bearing surface shall be parallel to the axis of the body within 1°.
6. **Fillet:** A fillet between the conical bearing surface of the head and the shank (body) of the screw is allowable above the maximum tabulated value for “D” with the value listed for “F”.
7. **Length:** The length of the screw shall be measured, parallel to the axis of the screw, from the plane of the top of the head to the plane of the flat of the point. The basic length dimension on the product should be the nominal length expressed as a two-place decimal.
8. **Standard Lengths:** Standard length increments shall be as designated in the following table:

Nominal Screw	0 to 3/8, incl.	7/16 to 3/4 incl.
Nominal Screw Length	Tolerance on Length	
Up to 1", incl.	-0.03	-0.03
Over 1" to 2 ½", incl.	-0.04	-0.06
Over 2 ½ to 6", incl.	-0.06	-0.08

9. **Length Tolerances:** The allowable tolerance on length shall be as tabulated below:

Nominal Screw Length	Standard Length Increment
1/8" to 1/4", incl.	1/16"
1/4" to 1", incl.	1/8"
1" to 3-1/2", incl.	1/4"

10. **Threads:** Threads shall be unified external threads with radius root: Class 3A UNRC and UNRF Series. Acceptability is based on System 22, ANSI B1.3.

    Class 3A does not provide a plating allowance. When plated products are required, it is recommended they are procured from STANLEY Engineered Fastening Decorah Operations.
11. **Thread Length L_T:** The thread length is measured parallel to the screw axis, from the extreme point to the last complete (full form) thread.
12. **Grip Gaging Length L_G:** The grip gaging length is the distance, measured parallel to the axis of the screw, from the top of the head to the first complete (full form) thread under the head.
13. **Body Length L_B:** The body length is the length of the unthreaded portion of the shank and the head height.
14. **Screw Point Chamfer:** The point can be flat or slightly concave, and chamfered. The plane of the point is to be approximately normal to the screw axis. The chamfer shall extend slightly below the root of the thread, and the edge between the flat and chamfer may be slightly rounded. The included angle of the point should be approximately 90°. Chamfering of the screw sizes up to and including size 8 (0.164") and lengths below 0.75d.
15. **Protrusion:** Suitability of socket flat countersunk head cap screw for application in countersinks designed to the principal dimensions of the screws shall be determined by use of a protrusion gage. The protrusion limits shown shall apply only when the gaging diameter is exactly as indicated with the gaging edge of a sharpness obtained by lapping the hole and the top surface of the gage. The top of the head shall be flat within the limits of the protrusion tolerance.
16. **Runout:** The runout of the socket with the axis of the shank of the screw shall be within 3% of the maximum screw diameter “D” or 0.005, whichever is greater, for nominal sizes through 1/2 inch diameter, and 6% for nominal sizes above 1/2 inch diameter.

    Runout for above is defined as the full indicator movement (FIM) obtained by holding the screw on the body or major thread diameter within one diameter of the bearing surface of the head, but beyond the maximum length of the fillet, F, rotating 360° indicating on each of the six hexagon flats.

Socket Flat Countersunk Head Cap Screws - Inch Sizes

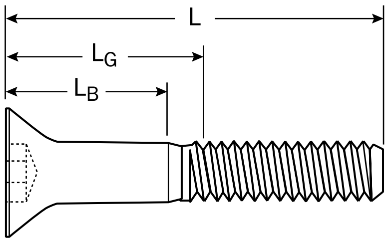


Table I-21: Body and Grip Length

Nom. Size	0		1		2		3	
Nom. Len.	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B
0.75	0.25	0.19						
0.88	0.25	0.19	0.25	0.17	0.25	0.16	0.25	0.15
1.00	0.50	0.44	0.25	0.17	0.25	0.16	0.25	0.15
1.25	0.75	0.69	0.62	0.55	0.62	0.54	0.62	0.52
1.50			0.88	0.80	0.88	0.79	0.88	0.77
1.75					1.12	1.04	1.12	1.02
2.00							1.38	1.27

Nom. Size	4		5		6		8		10	
Nom. Len.	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B
1.25	0.50	0.38	0.50	0.38	0.50	0.34	0.38	0.22		
1.50	0.50	0.38	0.50	0.38	0.50	0.34	0.38	0.22	0.62	0.42
1.75	1.00	0.88	1.00	0.88	1.00	0.84	0.88	0.72	0.62	0.42
2.00	1.00	0.88	1.00	0.88	1.00	0.84	0.88	0.72	1.12	0.92
2.25	1.50	1.38	1.50	1.38	1.50	1.34	1.38	1.22	1.12	0.92
2.50					1.50	1.34	1.38	1.22	1.62	1.42
2.75					2.00	1.84	1.88	1.72	1.62	1.42
3.00							2.38	2.22	2.12	1.92

Nom. Size	1/4		5/16		3/8		7/16		1/2	
Nom. Len.	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B
1.75	0.75	0.50								
2.00	0.75	0.50	0.88	0.60						
2.25	1.25	1.00	0.88	0.60	1.00	0.69				
2.50	1.25	1.00	1.38	1.10	1.00	0.69	1.12	0.77	1.00	0.62
2.75	1.75	1.50	1.38	1.10	1.50	1.19	1.12	0.77	1.00	0.62
3.00	1.75	1.50	1.88	1.60	1.50	1.19	1.62	1.27	1.00	0.62

Table I-22: Screws Beyond Sizes In Table I-21

Nom. Size	Basic Screw Dia.	L_T Thread Length min.	L_{TT} Total Thread Length max.	Nom. Size	Basic Screw Dia.	L_T Thread Length min.	L_{TT} Total Thread Length max.
0	0.0600	0.50	0.62	10	0.1900	0.88	1.27
1	0.0730	0.62	0.77	1/4	0.2500	1.00	1.50
2	0.0860	0.62	0.80	5/16	0.3125	1.12	1.71
3	0.0990	0.62	0.93	3/8	0.3750	1.25	1.94
4	0.1120	0.75	0.99	7/16	0.4375	1.38	2.17
5	0.1250	0.75	1.00	1/2	0.5000	1.50	2.38
6	0.1380	0.75	1.05	5/8	0.6250	1.75	2.82
8	0.1640	0.88	1.19	3/4	0.7500	2.00	3.25

Notes for Table I-21:

The tabulated L_G values are maximum and represent the minimum design grip length of the screw. It is measured from the bearing surface to the face of a GO thread ring gage, having the thread countersink and/or counterbore removed, which has been assembled by hand as far as the thread will permit. The tabulated L_B values are minimum and represent the minimum body length of the screw. They are equal to L_G minus 5 times the pitch of the UNRC thread for the respective screw size.

Screws having nominal lengths falling between those for which L_G and L_B values are tabulated in Table I-21 should have L_G and L_B dimensions conforming with those of the next shorter tabulated nominal length for the respective screw size. For example:

1/4 screw, 2.00" long, L_G=0.75" and L_B=0.50"

For screws of nominal lengths above the lines in Table I-21, the full form threads, measured with a thread ring gage having the thread chamfer and/or counterbore removed, shall extend to within two pitches of the head for sizes 0 through and including 5/8", and should extend as close to the head as possible for sizes larger than 5/8".

For screws of nominal lengths longer than those for which L_G and L_B values are tabulated in Table I-21 and for screws over 1" in diameter, the maximum grip gaging length L_G and the minimum body length L_B of the screws is determined as shown in Table I-22.

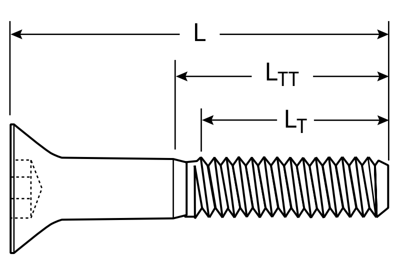
$L_G = L - L_T$ $\quad\quad$ $L_B = L - L_{TT}$

Where:

L = Nominal Length

L_T = Minimum Thread Length from Table I-22

L_{TT} = Maximum Total Thread Length from Table I-22



Socket Flat Countersunk Head Cap Screws - Inch Sizes

Table I-23: Mechanical and Application Data

		Mechanical Properties					Application Data	
		Tensile Strength lb. min.		Single Shear Strength* lb.			Suggested Seating Torque** lb.-in.	
					Thread Section		UNRC	UNRF
Nominal Size	Basic Screw Diameter	UNRC	UNRF	Body Section	UNRC	UNRF	Plain Finish	Plain Finish
0	0.0600	N/A	260	N/A†	N/A	189	1.2	1.3
1	0.0730	380	400	N/A†	276	292	2.4	2.5
2	0.0860	540	570	N/A†	389	414	3.9	4.2
3	0.0990	710	760	N/A†	511	549	6.0	6.4
4	0.1120	880	960	950	630	690	8.4	9.2
5	0.1250	1150	1200	1,190	830	870	12.2	13.0
6	0.1380	1320	1470	1,460	950	1,060	16.0	18.0
8	0.1640	2030	2140	2,070	1,470	1,550	29.0	30.0
10	0.1900	2540	2900	2,790	1,840	2,100	42.0	47.0
1/4	0.2500	4610	5275	4,900	3,340	3,830	99.0	114.0
5/16	0.3125	7600	8450	7,700	5,500	6,100	204.0	226.0
3/8	0.3750	11200	12700	11,100	8,100	9,200	363.0	411.0
7/16	0.4375	15400	17000	15,200	11,100	12,400	580.0	648.0
1/2	0.5000	20600	23200	20,000	14,900	16,800	885.0	998.0
5/8	0.6250	30500	34500	31,400	23,700	26,900	1,763.0	1,997.0
3/4	0.7500	45100	50700	45,300	35,100	39,200	3,126.0	3,491.0

† These diameters are fully threaded. * Some shear values are derived by calculation.
** Seating torques calculated to induce 48,000 psi tensile stress with a “K" factor of 0.26.

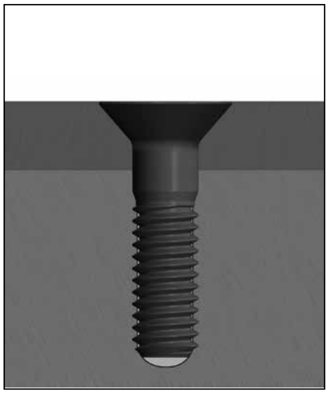
17. Material: Socket Flat Countersunk Head Cap Screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium, in sufficient quantity to assure that the specified hardness range of Rockwell C39 to 44 for sizes up to and including 1/2" and C37 to 44 for sizes larger than 1/2" is met when hardened by quenching from the austenitizing temperature, and tempered at not lower than 343°C (650°F). Decarburization and carbonization limits are specified in ASTM F 835, Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.

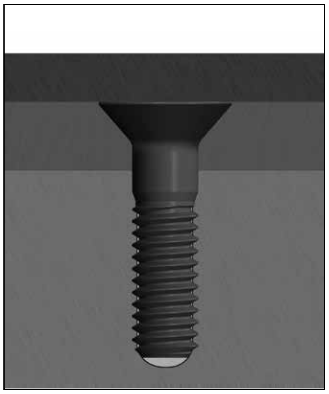
If fastener specifications vary from the standard product in terms of length, diameter or type of heat treat, for example, an applications specialist at STANLEY Engineered Fastening Decorah Operations should be contacted.

Hardness:

Sizes 1/2" and smaller ....Rockwell C39 to 44

Sizes larger than 1/2" ....Rockwell C37 to 44





Applications

Socket flat countersunk head cap screws are designed and recommended for applications where a flush seating socket head screw is desired. Wrenchability is limited by the socket size and key engagement. Because of the head configuration, this product is not recommended for use in high-strength applications or where maximum fatigue resistance is required.

Socket Set Screws - Inch Sizes

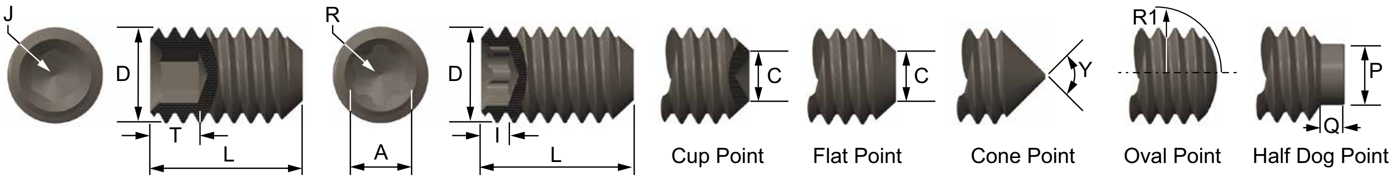


Table I-24: Dimensions of Hex and TORX PLUS® Socket Set Screws

D		R	A	I	J		T	C		R1
		TORX PLUS Recess			Hex Socket Size		Min. Key Engmt. to Develop Functional Capability of Key	Cup and Flat Point Diameters		Oval Point Radius
Nom. Size	Basic Screw Dia.	Size	Recess Dia ref.	Key Engmt. min.	nom.	dec.	Hex Socket T min.	max.	min.	Basic
0	0.0600	–	–	–		0.028	0.050	0.033	0.027	0.045
1	0.0730	–	–	–		0.035	0.060	0.040	0.033	0.055
2	0.0860	–	–	–		0.035	0.060	0.047	0.039	0.064
3	0.0990	–	–	–		0.050	0.070	0.054	0.045	0.074
4	0.1120	6IP	0.069	0.027		0.050	0.070	0.061	0.051	0.084
5	0.1250	7IP	0.081	0.036	1/16	0.062	0.080	0.067	0.057	0.094
6	0.1380	7IP	0.081	0.036	1/16	0.062	0.080	0.074	0.064	0.104
8	0.1640	8IP	0.094	0.041	5/64	0.078	0.090	0.087	0.076	0.123
10	0.1900	10IP	0.111	0.049	3/32	0.094	0.100	0.102	0.088	0.142
1/4	0.2500	15IP/20IP	0.155	0.068	1/8	0.125	0.125	0.132	0.118	0.188
5/16	0.3125	25IP/27IP	0.200	0.088	5/32	0.156	0.156	0.172	0.156	0.234
3/8	0.3750	30IP	0.221	0.097	3/16	0.188	0.188	0.212	0.194	0.281
7/16	0.4370	40IP	0.266	0.117	7/32	0.219	0.219	0.252	0.232	0.328
1/2	0.5000	45IP	0.312	0.137	1/4	0.250	0.250	0.291	0.270	0.375
5/8	0.6250	55IP	0.446	0.202	5/16	0.312	0.312	0.371	0.347	0.469
3/4	0.7500	60IP	0.529	0.245	3/8	0.375	0.375	0.450	0.425	0.562
7/8	0.8750	70IP	0.619	0.291	1/2	0.500	0.500	0.530	0.502	0.656
1	1.0000	70IP	0.619	0.291	9/16	0.562	0.562	0.609	0.579	0.750

Table I-24: Dimensions of Hex and TORX PLUS® Socket Set Screws, continued

D		Y	P		Q		B		
		Cone Point 90° ±2°for these Nominal Lengths or Longer, 118° ±2° for Shorter Nominal Lengths	Half Dog Point				Shortest Optimum Nominal Length to Which Column T Applies		
Nom. Size	Basic Screw Dia.		Diameter max.	Diameter min.	Length max.	Length min.	Cup and Flat Points	90° Cone & Oval Points	Half Dog Points
0	0.0600	0.09	0.040	0.037	0.017	0.013	0.13	0.13	0.13
1	0.0730	0.09	0.049	0.045	0.021	0.017	0.13	0.19	0.13
2	0.0860	0.13	0.057	0.053	0.024	0.020	0.13	0.19	0.19
3	0.0990	0.13	0.066	0.062	0.027	0.023	0.19	0.19	0.19
4	0.1120	0.19	0.075	0.070	0.030	0.026	0.19	0.19	0.19
5	0.1250	0.19	0.083	0.078	0.033	0.027	0.19	0.19	0.19
6	0.1380	0.19	0.092	0.087	0.038	0.032	0.19	0.25	0.19
8	0.1640	0.25	0.109	0.103	0.043	0.037	0.19	0.25	0.25
10	0.1900	0.25	0.127	0.120	0.049	0.041	0.19	0.25	0.25
1/4	0.2500	0.31	0.156	0.149	0.067	0.059	0.25	0.31	0.31
5/16	0.3125	0.38	0.203	0.195	0.082	0.074	0.31	0.44	0.38
3/8	0.3750	0.44	0.250	0.241	0.099	0.089	0.38	0.44	0.44
7/16	0.4375	0.50	0.297	0.287	0.114	0.104	0.44	0.63	0.50
1/2	0.5000	0.57	0.344	0.334	0.130	0.120	0.50	0.63	0.63
5/8	0.6250	0.75	0.469	0.456	0.164	0.148	0.63	0.88	0.88
3/4	0.7500	0.88	0.562	0.549	0.196	0.180	0.75	1.00	1.00
7/8	0.8750	1.00	0.656	0.642	0.227	0.211	0.88	1.00	1.00
1	1.0000	1.13	0.938	0.920	0.323	0.303	1.00	1.25	1.25

Note: Non-standard set screw sizes available upon request. Please contact an applications specialist for information.

Socket Set Screws - Inch Sizes

Notes for Socket Set Screws:

1. **Nominal Size:** Where specifying nominal size in decimals, zeros preceding decimal and in the fourth decimal place shall be omitted.
2. **Socket Depths:** The key engagement dimension in Table I-24 shall apply only to nominal screw lengths equal to or longer than the lengths listed in Column “B”. For hex socket key engagement, dimensions in screws of shorter nominal lengths than listed in Column “B” of Table I-24. TORX PLUS sockets in screws shorter than those listed in Table I-24 shall have a key engagement as deep as practicable.

   CAUTION: The use of set screws having a key engagement shallower than the deepest listed in Table I-24 for the respective screw size can result in failure of the socket, key, or mating thread during tightening because the key engagement and thread length are less than optimum. It is, therefore, strongly recommended that longer screw lengths having deepest minimum key engagements be used wherever possible.
3. **Face:** The plane of the face on socket end of the screws shall be approximately normal to the axis of the screw, and on screws longer than lengths listed in Table I-24, Column “B”, chamfered. The chamfer shall extend slightly below the root diameter of the thread and the edge between flat and chamfer may be slightly rounded. For screws equal to or shorter than the lengths listed in Column “B", chamfering shall be at the option of the manufacturer. If chamfered, the chamfer angle, “V”, shall not exceed 45°.
4. **Length:** The length of the screw shall be measured overall, parallel to the axis of screw. The basic length dimension on the product shall be the nominal length expressed as a two-place decimal.
5. **Standard Length:** The standard length increments for set screws shall be as tabulated below:

Length nom.	Standard Length Increments in.
1/8 through 3/16	0.030
3/16 through 1/2	0.060
1/2 through 1	0.130
1 through 2	0.250
2 through 6	0.500
over 6	1.000

6. **Tolerance On Length:** The tolerance on length shall be bilateral as tabulated below:

Nominal Screw Length	Tolerance on Length
Up to 5/8", incl.	±0.01
Over 5/8" to 2", incl.	±0.02
Over 2" to 6", incl.	±0.03

7. **Threads:** Threads shall be Unified external thread; Class 3A, UNRC and UNRF Series. Since standard gages provide only for engagement lengths up to 1-1/2 diameters, changes in pitch diameter of either or both external and internal thread may be required for longer lengths of engagement. Acceptability shall be based on System 22, ANSI B1.3. Class 3A does not provide a plating allowance. When plated products are required, it is recommended that they be procured from STANLEY Engineered Fastening.
8. **Point Angles:** The point angles specified shall apply only to those portions of the angles which lie below the root diameter of the thread, it being recognized that the angle may vary in the threaded portion due to manufacturing processes. The point angle or cup points shall be 45°; plus 5° minus 0° for screws of length equal to the nominal screw diameter and longer, and 30° minimum for shorter screws.
9. **Oval Point Radius Tolerance:** The tolerance shall be +0.015" for screw nominal sizes through 5 (0.125") and +0.031" for screw nominal sizes 6 (0.138") and larger.
10. **Half Dog Point Eccentricity:** The permissible eccentricity of the half dog axis, with respect to the axis of the thread, shall not exceed 3% of the basic diameter of the screw, and in no case shall be greater than 0.005" for sizes up to and including 3/4". For sizes over 3/4" it shall not be greater than 0.010". (Total runout shall not exceed twice the permissible eccentricity).
11. **Cone Point Configuration:** The apex of the cone may be flattened or rounded to the extent of 10% of the basic diameter of the screw.
12. **Material:** Socket set screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum, or vanadium, in sufficient quantity to assure that the specified core hardness range of Rockwell C45 to C53 is met when screw are hardened by quenching from the austenitizing temperature and tempered. Decarburization and carburization limits are specified in ASTM F912, Alloy Steel Set Screws.

Hardness:.......................................Rockwell C45 to 53

Socket Set Screws - Inch Sizes

Table I-25: Application Data

Nom. Size	Basic Screw Size	Suggested Seating Torque*	Axial Holding Power lbs.
2	0.0860	1.6	85
3	0.0990	4.8	120
4	0.1120	4.8	160
5	0.1250	8.9	200
6	0.2030	8.9	250
8	0.1640	17.9	385
10	0.1900	31.4	540
1/4	0.2500	73.0	1,000
5/16	0.3125	144.0	1,500
3/8	0.3750	251.0	2,000
7/16	0.4375	361.0	2,500
1/2	0.5000	536.0	3,000
5/8	0.6250	1,063.0	4,000
3/4	0.7500	1,828.0	5,000
7/8	0.8750	4,335.0	5,600
1	1.0000	5,865.0	6,500

*Calculated to reach 85% of minimum key strength.

NOTE: Set screws must have minimum recess depth shown in Table I-24 to generate full recess strength.

The axial holding power data in Table I-25 is for cup point set screws and is provided for reference only, as actual holding power may vary by ±25%. It is recommended that laboratory testing of your set screw application be performed to verify results.

Using Socket Set Screws

Set screws are most commonly installed in collar-type applications to prevent lateral and rotational movement along a shaft. However, they are also used to hold components together in a wide variety of applications. Due to their distinct manner, several variables must be considered in the selection and use of socket set screws, such as point style, size, drive system, required holding power and more.

Point Selection

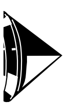
Point selection is fully dependent upon the application. Considerations in selecting a point style include holding power, frequency of setting and hardness of mating pairs, as well as other variables. The ability to develop holding power will vary between point styles.

Highest Holding Power
Cone Point
Cup Point
Flat Point
Dog Point
Oval Point
Lowest Holding Power

Type A Cup Point: The most widely used point style, it is considered very effective in securing a variety of components to a shaft. Secure set is enabled by the sharp cup edges' ability to cut in the shaft.

Flat Point: Recommended where continued re-adjustments are made and minimal mating part deformation is necessitated. Recommended for thin wall thicknesses and/or soft plugs.

Type C External Knurled Cup Point: Allows quick and permanent location of collars, gears, knobs, pulleys, shafts, and other similar products. The knurls help the fastener resist rotation -and loosening due to vibration.



Cone Point: Used for permanent location of parts. Deep penetration gives highest axial and torsional holding power. In material over Rockwell C15, the point is spotted to half its length to develop shear strength across the point. Also used for pivots and fine adjustments.

Oval Point: Recommended where periodic adjustments are required. This design is beneficial where minimal contact surface deformation is desired. The radial point configuration allows a consistent firm contact when seated in varying degrees from perpendicularity. The oval point is also recommended for use when seating into shaft grooves of varying types.

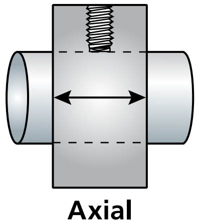
Half Dog Point: Generally used for the permanent location of one part to another. Point is spotted in hole drilled in shaft or against flat (milled). Often replaces dowel pins. Works well against hardened members or hollow tubing if plastic locking element is used to hold it in place.

Type G Internal Knurled Cup Point: Engineered for use in applications normally associated with the cup point. Locking knurls provide additional back out resistance under vibration.

Socket Set Screws - Inch Sizes

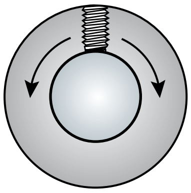
Holding Power: Whereas socket screws rely on tension to create clamping forces, set screws rely on compression to develop holding power, which is the key component in set screw joints. Holding power, typically defined as the amount of force a set-screw joint can withstand without movement, is created by frictional resistance developed when the set screw is tightened. In set screws joints, there are three types of holding power the engineer should be aware of: axial, torsional and dynamic. In some joints, only one type will affect the joint, while in others all three could affect the joint.

Axial holding power is the amount of resistance to lateral movement the set screw can provide. See Table I-25 for the maximum amounts of axial holding power a cup point set screw can offer by size. However, the maximum amounts should never be used, as over-torquing to develop holding power can cause damage to the set screw and a loss of compressive power.



Axial Holding Power

Torsional holding power is the amount of resistance to rotational movement the set screw can provide. Both axial and torsional holding power are considered static, as they are based upon resistance under load. The approximate amount of torsional holding power a set screw can provide can be determined by multiplying axial holding power by the shaft radius in inches (or T=F X R). For example, a 1/4" set screw being used on a 1/2" diameter shaft will provide 1000 lbs. of axial force. Taking 1000 lbs. of axial force (F) times the shaft radius of 1/4" (R) will net a torsional holding power of 250 in-lb.

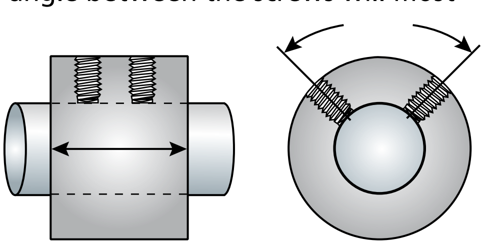


Torsional Holding Power

Dynamic holding power is based upon the set screw's ability to keep the joint fastened under vibration and other dynamic loads. Failure or loosening due to dynamic loading will only occur if the forces acting upon the fastener exceed the axial or torsional holding powers, or there is a deformation of the fastener or engagement material.

Holding power can be negatively impacted by such factors as improper hole alignment between the set screw and the axis of the shaft, high lubricity on the mating surface or improper seating torque.

In some instances, more than one set screw will be required to attain the holding power required by the application. If more than one is used, the angle between the screws will most significantly affect the holding power. When the second screw is installed at a 180° angle from the first, holding power is increased by only 30%. As the angle between the screws decreases, the overall holding power should increase up to approximately 100%. Actual holding power in your application should be determined through laboratory testing.



Multiple Set Screws

Size: The diameter of the set screw will depend upon the application and the required holding power. As the diameter of the set screw increases, so does the holding power. For example, a 1/4" set screw typically provides a maximum of 1000 lbs holding power, while increasing the diameter to 5/16" will increase maximum holding power to 1500 lbs. The diameter of the set screw, in most cases, should be approximately half the diameter of the shaft. For example, when using a 1/2" diameter shaft, the set screw should be 1/4" in diameter.

Seating Torque: Attaining proper seating torque is key in developing the desired axial and/or torsional holding powers. If the set screw is under-torqued, it will not develop enough compressive force to resist lateral and rotational movement. If it is over-torqued, recess and/or thread damage can occur, which will lead to application damage.

Drive System: Most set screw users rely on the hex drive system. However, for high torque set screw applications, or automated assembly situations, the TORX PLUS® Drive System is recommended. Some manufacturers have experienced recess splitting when using hex set screws in high torque applications, causing excessive rework and assembly line downtime. By converting to the TORX PLUS Drive, they are able to drive the set screws at very high torque levels without recess damage. Also, the TORX PLUS Drive allows quicker engagement of the screw on the assembly line for increased production speed.

Other Variables: Other issues to consider include the relative hardness of the set screw point and the shaft and the frequency of the screws' setting – i.e., are they permanent, semi-permanent, or frequently re-set.

Hardened Ground Machine Dowel Pins - Inch Sizes

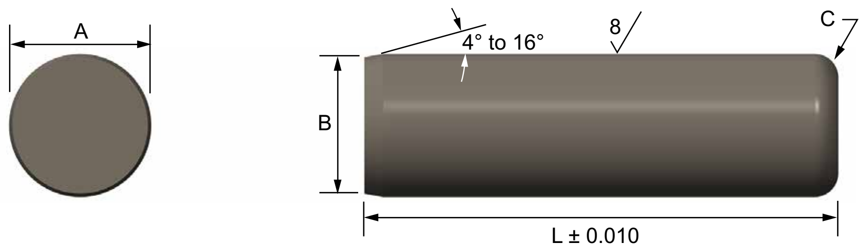


Table I-26: Dimensions of Hardened Ground Machine Dowel Pins

Nominal Size	Nominal Pin Dia.	A Pin Diameter: Standard Series Pins			A Pin Diameter: Oversize Series Pin			B Point Diameter		C Crown Height or Radius	
		Basic	max.	min.	Basic	max.	min.	max.	min.	max.	min.
1/16	0.0625	0.0627	0.0628	0.0626	0.0635	0.0636	0.0634	0.058	0.048	0.020	0.008
3/32	0.0938	0.0940	0.0941	0.0939	0.0948	0.0949	0.0947	0.089	0.079	0.031	0.012
1/8	0.1250	0.1252	0.1253	0.1251	0.1260	0.1261	0.1259	0.120	0.110	0.041	0.016
3/16	0.1875	0.1877	0.1878	0.1876	0.1885	0.1886	0.1884	0.180	0.170	0.062	0.023
1/4	0.2500	0.2502	0.2503	0.2501	0.2510	0.2511	0.2509	0.240	0.230	0.083	0.031
5/16	0.3125	0.3127	0.3128	0.3126	0.3135	0.3136	0.3134	0.302	0.290	0.104	0.039
3/8	0.3750	0.3752	0.3753	0.3751	0.3760	0.3761	0.3759	0.365	0.350	0.125	0.047
7/16	0.4375	0.4377	0.4378	0.4376	0.4385	0.4386	0.4384	0.424	0.409	0.146	0.055
1/2	0.5000	0.5002	0.5003	0.5001	0.5010	0.5011	0.5009	0.486	0.471	0.167	0.063
5/8	0.6250	0.6252	0.6253	0.6251	0.6260	0.6261	0.6259	0.611	0.595	0.208	0.078
3/4	0.7500	0.7502	0.7503	0.7501	0.7510	0.7511	0.7509	0.735	0.715	0.250	0.094
7/8	0.8750	0.8752	0.8753	0.8751	0.8760	0.8761	0.8759	0.860	0.840	0.293	0.109
1	1.0000	1.0002	1.0003	1.0001	1.0010	1.0011	1.0009	0.980	0.960	0.333	0.125

Notes for Hardened Ground Machine Dowel Pins

1. **Diameters**

   a. **Size:** Hardened ground machine dowel pins are furnished in two diameter series:

   - Standard series with basic diameters 0.0002" over the nominal diameter, intended for initial installations.

   - Oversized series with basic diameters 0.001" over the nominal diameter, intended for replacement use.

   For both series, the diameter is to be ground, or ground and lapped, to within ±0.0001" of the respected basic diameters, as specified in Table I-26.

   b. **Roundness:** The outer periphery of hardened ground machined dowel pins is to conform to true round about the longitudinal axis of the pin within 0.0001", when measured with equipment that will detect a lobed surface.

2. **Length**

   a. **Measurement:** The length of the hardened ground machine dowel pin is to be measured overall from end to end, parallel to the axis of the pin.

   b. **Tolerance on length:** The tolerance on the length of the hardened ground machine dowel pin is to be ±0.010".

   c. **Preferred lengths** are shown in the table below.

Pin Size	Preferred Lengths
1/16	3/16, 1/4, 5/16, 3/8, 7/16, 1/2, 5/8, 3/4, 1
5/32	3/16, 1/4, 5/16, 3/8, 7/16, 1/2, 5/8, 3/4, 1
1/8	3/8, 7/16, 1/2, 5/8, 3/4, 1, 1-1/4, 1-3/4, 2
3/16	1/2, 5/8, 3/4, 1, 1-1/4, 1-3/4, 2
1/4	1/2, 5/8, 3/4, 1, 1-1/4, 1-3/4, 2, 2-1/4, 2-1/2
5/16	1/2, 5/8, 3/4, 1, 1-1/4, 1-3/4, 2, 2-1/4, 2-1/2, 3
3/8	1/2, 5/8, 3/4, 1, 1-1/4, 1-3/4, 2, 2-1/4, 2-1/2, 3
7/16	1, 1-1/4, 1-3/4, 2, 2-1/4, 2-1/2, 3
1/2	3/4, 1, 1-1/4, 1-3/4, 2, 2-1/4, 2-1/2, 3, 3-1/2, 4
5/8	1, 1-1/4, 1-3/4, 2, 2-1/4, 2-1/2, 3, 3-1/2, 4
3/4	2, 2-1/4, 2-1/2, 3, 3-1/2, 4, 4-1/2, 5, 6
7/8	2, 3, 4, 5, 6
1	2, 2-1/2, 3, 3-1/2, 4, 4-1/2, 5, 6

   d. **Effective length:** The effective length "L" (that portion of the pin bounded by the length of point on one end and the radius of the crown on the other) on short dowel pins shall not be less than 75% of the overall length of the pin. For the pin lengths affected, it may be necessary to deviate from the specified dimensions by reducing the crown radius and height or increasing the point angle, or both.

   e. **Straightness:** Machine dowel pins are to be straight over the effective length with an accumulative total of 0.0005" per inch of length for nominal lengths up to and including 4", and within 0.002" total for all nominal lengths over 4".

Hardened Ground Machine Dowel Pins - Inch Sizes

3. **Surface Roughness:** The surface roughness on hardened ground machine dowel pins is not to exceed 8 microinches (mathematical average) on the effective length nor 125 microinches (mathematical average) on all other surfaces. Refer to ANSI B46.1, Surface Texture. For pins having additive finishes, these limits will apply prior to coating.
4. **End Contours:** The ends of hardened ground machine dowel pins are to be reasonably flat and perpendicular to the axis of the pin. One end of the pin shall be pointed and the other end crowned to the dimensions specified in Table I-26. On the pointed end, the edge formed by the surface of point and the end of pin may be slightly rounded or broken.
5. **Point Concentricity**: For pins having nominal lengths equal to four times the basic pin diameter and longer, the concentricity between the diameter of the point and the pin diameter is to be such that the minimum length of point on the pin is not less than 0.010".
6. **Designation**: Hardened ground machine dowel pins shall be designated by the following data, in the sequence shown: product name (noun first) including pin series; nominal pin diameter (fraction or decimal equivalent); length (fraction or decimal equivalent); material and protective finish, if required. Examples:

   Pin, Hardened Ground Machine Dowel – Standard Series, 3/8" x 1-1/2", Steel, Phosphate-Coated

   Pin, Hardened Ground Machine Dowel – Oversize Series, 0.6150" x 2.500", Steel
7. **Material:** Hardened ground machine dowel pins shall be made from any carbon or alloy steel capable of being heat-treated to a core hardness of Rockwell C50 minimum and having sulphur and phosphorous content not in excess of 0.05% and 0.04% respectively.

Hardness (case hardened) **Surface – Rockwell C60**
Core – Rockwell C47 to C58

Hardness (through hardened) **Rockwell C50 to C58**

8. **Heat treatment:** Pins shall be hardened by quenching in oil from the austenitizing temperature and tempering to meet the following:
   a. **Case hardened pins:** Pins shall be case hardened to a minimum case depth of 0.010" for nominal pin sizes 5/32", or smaller, and 0.015" for nominal pin sizes 3/16" and larger. The case is to have a minimum surface hardness of Rockwell C60, or equivalent, and the core hardness is to be Rockwell C47 to C58.
   b. **Through Hardened Pins:** At manufacturer's option, pins smaller than 1/8" nominal size may be through hardened to a hardness of Rockwell C50 to C58. However, in no instance is the hardness of the pin surface to be softer than that of the core.
   c. **Shear Strength:** Hardened ground machine dowel pins are to have a single shear strength of 130,000 psi minimum. They are to be capable of withstanding the minimum double shear loads specified in Table I-27 when tested in accordance with Double Shear Testing of Pins ANSI B18.8.2.
   d. **Ductility:** Hardened ground machine dowel pins shall have sufficient ductility to withstand being press into a hole 0.0005" smaller than the nominal diameter in hardened steel without cracking or shattering.
9. **Hole Sizes:** Because of the wide variety of materials and design requirements in which dowel pins are used, it is not possible to provide hole size recommendations that will be suitable for all applications. The suggested hole sizes in Table I-27 are commonly used from press fitting standard series machine dowel pins into materials such as mild steel and cast iron. In soft materials, such as aluminum or zinc die castings, hole size limits are usually decreased by 0.0005" to increase the press fit.

   Holes for oversize series machine dowel pins may best be determined by the user to suit the particular application.

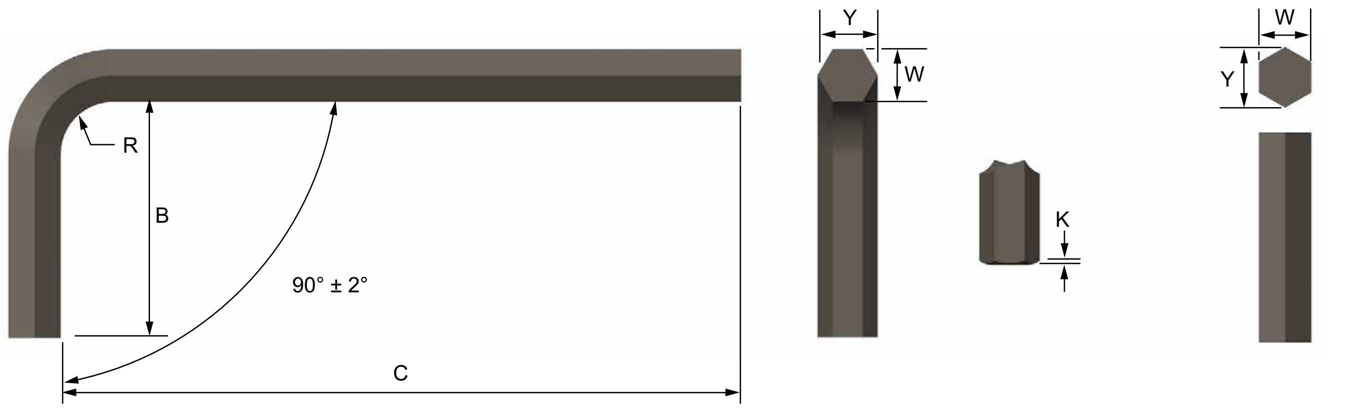
Table I-27: Mechanical and Application Data

Nom. Size	Suggested Hole Diameter for Standard Series Pins		Double Shear Load (lb)
	max.	min.	min.
1/16	0.0625	0.0620	800
5/64	0.0781	0.0776	1240
3/32	0.0938	0.0933	1800
1/8	0.1250	0.1245	3200
5/32	0.1562	0.1557	5000
3/16	0.1875	0.1870	7200
1/4	0.2500	0.2495	12800
5/16	0.3125	0.3120	20000
3/8	0.3750	0.3745	28700
7/16	0.4375	0.4370	39100
1/2	0.5000	0.4995	51000
5/8	0.6250	0.6245	79800
3/4	0.7500	0.7495	114000
7/8	0.8750	0.8745	156000
1	1.0000	0.9995	204000

Applications

Hardened ground machine dowel pins are intended for applications where precise locating of mating parts is essential, such as for doweling hardened tool and machine components or to serves as stops, guides, load-bearing pins, etc. where strength, shock or wear features necessitate a hardened pin.

Hex Keys and Bits - Inch Sizes



Wrench **Bit**

Table I-28: Dimensions of Hex Keys and Bits

Key or Bit Size and Socket Size		W Hex Width Across Flats		Y Hex Width Across Corners		B Length of Short Arm		C Length of Long Arm				R Radius of Bend	K Chamfer Length
								Short Series		Long Series			
nom.	dec.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	min.	max.
	0.028	0.0280	0.0275	0.0314	0.0300	0.312	0.125	1.132	1.125	2.688	2.500	0.062	0.003
	0.035	0.0350	0.0345	0.0393	0.0378	0.438	0.250	1.132	1.125	2.766	2.578	0.062	0.004
	0.050	0.0500	0.0490	0.0560	0.0540	0.625	0.438	1.750	1.562	2.938	2.750	0.062	0.006
1/16	0.062	0.0625	0.0615	0.0701	0.0680	0.656	0.468	1.844	1.656	3.094	2.906	0.062	0.008
5/64	0.078	0.0781	0.0771	0.0880	0.0859	0.703	0.516	1.969	1.781	3.281	3.094	0.078	0.008
3/32	0.094	0.0937	0.0927	0.1058	0.1035	0.750	0.562	2.094	1.906	3.469	3.281	0.094	0.009
7/64	0.109	0.1094	0.1079	0.1238	0.1210	0.797	0.609	2.219	2.031	3.656	3.468	0.109	0.014
1/8	0.125	0.1250	0.1235	0.1418	0.1390	0.844	0.656	2.344	2.156	3.844	3.656	0.125	0.015
9/64	0.141	0.1460	0.1391	0.1593	0.1566	0.891	0.703	2.469	2.281	4.031	3.843	0.141	0.016
5/32	0.156	0.1562	0.1547	0.1774	0.1745	0.938	0.750	2.594	2.406	4.219	4.031	0.156	0.016
3/16	0.188	0.1875	0.1860	0.2135	0.2105	1.031	0.844	2.844	2.656	4.594	4.406	0.188	0.022
7/32	0.219	0.2187	0.2172	0.2490	0.2460	1.125	0.938	3.094	2.906	4.969	4.781	0.219	0.024
1/4	0.250	0.2500	0.2485	0.2845	0.2815	1.219	1.031	3.344	3.156	5.344	5.156	0.250	0.030
5/16	0.312	0.3125	0.3110	0.3570	0.3531	1.344	1.156	3.844	3.656	6.094	5.906	0.312	0.032
3/8	0.375	0.3750	0.3735	0.4285	0.4238	1.469	1.281	4.344	4.156	6.844	6.656	0.375	0.044
7/16	0.438	0.4375	0.4355	0.5005	0.4944	1.594	1.406	4.844	4.656	7.594	7.406	0.438	0.047
1/2	0.500	0.5000	0.4975	0.5715	0.5650	1.719	1.531	5.344	5.156	8.344	8.156	0.500	0.050
9/16	0.562	0.5625	0.5600	0.6420	0.6356	1.844	1.656	5.844	5.656	9.094	8.906	0.562	0.053
5/8	0.625	0.6250	0.6225	0.7146	0.7080	1.969	1.781	6.344	6.156	9.844	9.656	0.625	0.055
3/4	0.750	0.7500	0.7470	0.8580	0.8512	2.219	2.031	7.344	7.156	11.344	11.156	0.750	0.070
7/8	0.875	0.8750	0.8720	1.0020	0.9931	2.469	2.281	8.344	8.156	12.844	12.656	0.875	0.076
1	1.000	1.0000	0.9970	1.4700	1.1350	2.719	2.531	9.344	9.156	14.344	14.156	1.000	0.081

Notes for Hex Keys and Bits

1. **Ends:** Each end shall be square with the axis of the respective arms of keys and the longitudinal axis of bits within 4°. The edges may be sharp radiused or chamfered at the option of the manufacturer. Where ends are chamfered, the length of the chamfer shall not exceed the values listed for "K" in Table I-28.
2. **Truncation of Hex Corners:** The truncation or rounding of the hexagon corners within the specified width across corner dimensions shall be evident on all corners.
3. **Plated Keys and Bits:** For plated hex keys or bits, all dimensions are before plating.
4. **Designation:** Hex keys are bits shall be designated by the following data in the sequence shown below.

   Nominal key (or bit) size, product name, series (for keys), protective coating, if required.

   Examples:

   1/8 Hex Key, Short Series

   0.125 Hex Key, Long Series, Nickel Plated

Hex Keys and Bits - Inch Sizes

Table I-29: Applicability of Hex Keys and Bits

Key or Bit Size nom.	Key or Bit Size dec.	Cap Screws	Low Head Cap Screws	Flat Countersunk Head Cap Screws	Button Head Cap Screws	Shoulder Screws	Set Screws
		Nominal Screw Size					
	0.028						0 & 1
	0.035			0	0 & 1		2
	0.050	0	4	1 & 2	2		3 & 4
1/16	0.062	1	5 & 6	3 & 4	3 & 4		5 & 6
5/64	0.078	2 & 3	8	5 & 6	5 & 6		8
3/32	0.094	4 & 5	10	8	8		10
7/64	0.109	6					
1/8	0.125		1/4	10	10	1/4	1/4
9/64	0.141	8					
5/32	0.156	10	5/16	1/4	1/4	5/16	5/16
3/16	0.188	1/4	3/8	5/16	5/16	3/8	3/8
7/32	0.219		7/16	3/8	3/8		7/16
1/4	0.250	5/16	1/2	7/16		1/2	1/2
5/16	0.312	3/8	5/8	1/2	1/2	5/8	5/8
3/8	0.375	7/16 & 1/2		5/8	5/8	3/4	3/4
7/16	0.438						
1/2	0.500	5/8		3/4		1	7/8
9/16	0.562			7/8			1 & 1-1/4
5/8	0.625	3/4		1		1-1/4	1-1/4 & 1-3/8
3/4	0.750	7/8 & 1		1-1/8			1-1/2
7/8	0.875	1-1/8 & 1-1/4					
1	1.000	1-3/8 & 1-1/2		1-1/2		1-3/4	1-3/4 & 2

Table I-30: Torsional Strength

Key Size nominal	Key Size decimal	Torsional Strength lb.-in. min.
	0.028	0.94
	0.035	1.80
	0.050	5.25
1/16	0.062	10.25
5/64	0.078	20.00
3/32	0.094	35.00
7/64	0.109	55.00
1/8	0.125	82.00
9/64	0.141	118.00
5/32	0.156	160.00
3/16	0.188	278.00
7/32	0.219	440.00
1/4	0.250	665.00
5/16	0.312	1,275.00
3/8	0.375	2,200.00
7/16	0.438	3,500.00
1/2	0.500	5,200.00
9/16	0.562	6,500.00
5/8	0.625	9,000.00
3/4	0.750	15,500.00
7/8	0.875	24,600.00
1	1.000	28,800.00

5. **Material:** Hex keys and bits shall be fabricated from an alloy steel having two or more of the following alloying elements: chromium, nickel, molybdenum or vanadium in sufficient quantity to assure that the minimum hardness of Rockwell C48 at the surface for sizes up to and including 3/8" and C45 for sizes over 3/8" can be met when the keys and bits are hardened by quenching from the austenitizing temperature and tempered.

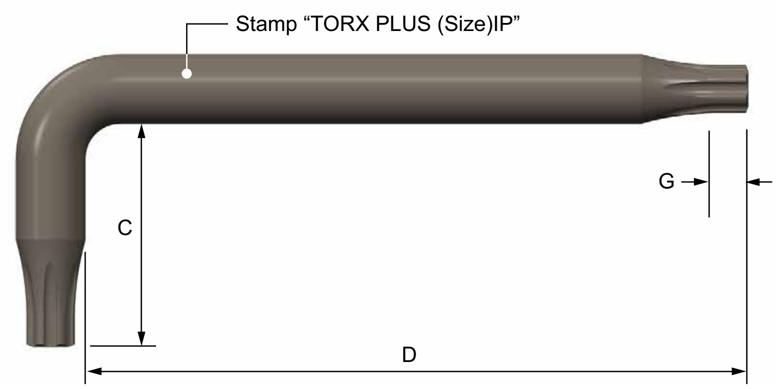
   Torsional strength requirements and test procedures for inch hex keys and bits are per Federal Spec. GGG-K-275.

   Hardness:

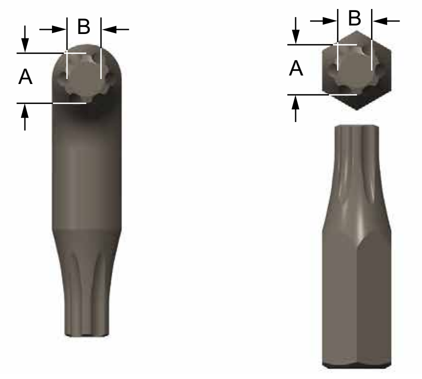
   Sizes up to and including 3/8"............ Rockwell C48

   Sizes over 3/8" ....Rockwell C45

TORX PLUS® Keys and Bits - Inch Sizes



Wrench



Bit

Table I-31: Dimensions of TORX PLUS Drive Keys and Bits

Drive Size	A TORX PLUS Width including Lobes ref.	B Width max.	G Length of Configuration min.	C Length of Short Arm nom.	D Length of Long Arm Short Series nom.	D Length of Long Arm Long Series nom.
6IP	0.066	0.057	0.035	0.61	1.66	
7IP	0.078	0.058	0.042	0.61	1.88	
8IP	0.090	0.069	0.048	0.61	1.88	
9IP	0.098	0.075	0.052	0.61	1.88	
10IP	0.107	0.082	0.057	0.66	2.00	3.38
15IP	0.128	0.099	0.067	0.70	2.13	3.56
20IP	0.151	0.118	0.079	0.75	2.25	3.75
25IP	0.173	0.132	0.091	0.80	2.38	3.94
27IP	0.195	0.152	0.102	0.84	2.50	4.13
30IP	0.216	0.168	0.113	0.94	2.75	4.50
40IP	0.260	0.202	0.136	1.03	3.00	4.88
45IP	0.306	0.241	0.159	1.13	3.25	5.25
50IP	0.346	0.269	0.180	1.25	3.75	6.00
55IP	0.440	0.351	0.225	1.38	4.25	6.75
60IP	0.520	0.407	0.270	1.50	4.75	7.50
70IP	0.610	0.481	0.315	1.63	5.25	8.25
80IP	0.689	0.537	0.356	1.75	5.75	9.00
90IP	0.783	0.618	0.405	1.88	6.25	9.75
100IP	0.870	0.686	0.450	2.13	7.25	11.25

Notes for TORX PLUS Drive Keys

1. All hand tools (keys) are to have straight end or 5° point chamfer as shown in Table I-31 above. No shear taper or burrs allowed on end.
2. **Plating:** For TORX PLUS Drive keys, all dimensions are before plating. If plating is required, keys will be considered special.
3. **Dimensions:** "A" and "B" are to be gaged.
4. **Designation:** TORX PLUS keys shall be designated by the following data in the sequence shown below.
   TORX PLUS key size, product name, series and protective coating (if required). Examples:

   8IP TORX PLUS key, short series

   30IP TORX PLUS key, long series, nickel plated

TORX PLUS® Keys and Bits - Inch Sizes

Table I-32: Applicability of TORX PLUS Keys and Bits

Drive Size	Cap Screws	Low Head Cap Screws	Flat Countersunk Head Cap Screws	Button Head Cap Screws	Shoulder Screws	Set Screws
6IP						3
7IP	0			2		4
8IP	1					5 & 6
9IP	2 & 3			4		8
10IP	4 & 5		4 & 5	6		10
15IP	6	8	6	8		
20IP		10	8		1/4	1/4
25IP	8			10		
27IP	10	1/4		1/4	5/16	5/16
30IP	1/4	5/16	1/4			3/8
40IP		3/8	5/16	5/16	3/8	7/16
45IP	5/16		3/8	3/8	1/2	1/2
50IP	3/8	1/2	7/16 & 1/2			
55IP	7/16 & 1/2		5/8	1/2	5/8	5/8
60IP	5/8		3/4	5/8	3/4	3/4
70IP	3/4					7/8 & 1
80IP	7/8					
90IP	1					
100IP	1-1/4					

Table I-33: Torsional Strength of TORX PLUS Keys

Drive Size		Torsional Strength lb.-in. min.
6IP	0.066	8.11
7IP	0.077	14.90
8IP	0.090	24.70
9IP	0.097	30.90
10IP	0.107	39.60
15IP	0.128	71.40
20IP	0.151	119.00
25IP	0.173	173.00
27IP	0.195	256.00
30IP	0.216	348.00
40IP	0.260	605.00
45IP	0.306	1,013.00
50IP	0.345	1,435.00
55IP	0.440	3,061.00
60IP	0.520	4,922.00
70IP	0.610	8,058.00
80IP	0.689	11,422.00
90IP	0.783	17,036.00
100IP	0.870	23,412.00

5. **Material:** TORX PLUS keys shall be made of an alloy steel hardened and tempered so as to comply with the physical and mechanical requirements of Federal Specification GGG-K-275 and TORX PLUS Standard TXD-703.
6. **Torque:** Maximum ultimate torque to be tested to fixture per TORX PLUS Standard TXD-821.

Applications: TORX PLUS keys and bits are intended to be used for tightening and loosening all fasteners incorporating a TORX PLUS Drive recess.

Use With Socket Screws: For applicability of TORX PLUS keys to various socket screw types and sizes, see Table I-32 at the top of this page.

Notes

Metric Socket Screw Standards

Contents – Metric Sizes

Any Camcar® metric socket screw can meet either ANSI/ASME or ISO standards per your request. All dimensional data contained in this manual are per ANSI standards. Please contact an applications specialist at Decorah Operations for ISO information.

Related Standards

ANSI/ASME

B1.3M .... Screw Thread Gaging Systems for Acceptability of Metric Screw Threads
B1.7M ....Nomenclature, Definitions and Letter Symbols for Screw Threads
B1.13M.. Metric Screw Thread – M Profile
B1.16M...................................American Gaging Practice for Metric Screw Threads
B18.3.1M..Socket Head Cap Screws, Metric Series
B18.3.2.M ....Hex Keys and Bits, Metric Series
B18.3.3M ....Hex Socket Head Shoulder Screws, Metric Series
B18.3.4M ....Hex Socket Button Head Cap Screws, Metric Series
B18.3.5M ....Hex Socket Flat Countersunk Cap 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 Sems
B18.22M .... Plain Washers, Metric Series

ASTM

A 574M...Alloy Steel Socket Head Cap Screws
F 835M ....Alloy Steel Button Head and Flat Head Cap Screws
F 912M...Alloy Steel Set Screws

ISO

ISO-68 .... General Purpose Screw Threads – Basic Profile
ISO-262.........................General Purpose Metric Screw Threads – Selected Sizes for Screws, Bolts and Nuts
ISO-2936.. Hex Keys – Metric
ISO-7379..Socket Head Shoulder Screws
ISO-4762.. Socket Head Cap 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-7380..Hex Socket Button Head Screws

Socket Screw Standards - Metric Sizes

Camcar® metric socket screw threads meet the requirements of ANSI/ASME B1.13M, Metric Screw Threads, M Profile, Coarse Series, with a Tolerance Class of 4g6g or 6g6g. The following provides a quick overview of ISO thread tolerancing. For more information on metric screw thread Tolerance Grades and Positions, refer to ANSI B1.13M.

Table M-1: Tolerance Grade and Position Designations

Amount of Tolerance	Tolerance Grade		Tolerance Position (Allowance)
	For Major Dia.	For Pitch Dia.	
0			h
↑		3	
	4	**4**	
		5	
	6	**6**	g
		7	
	8	8	
↓		9	
Large			e

NOTE: Be sure to use small letters (h, g, e) to designate external threads; capital letters designate internal threads. Bold numbers in the table above indicate tolerance grade used with normal length of thread engagement.

4g6g
- Tolerance Position, Tolerance Grade } Major Diameter
- Tolerance Position, Tolerance Grade } Pitch Diameter

The thread designations shown in Table M-1 apply to external threads. They are designed to prevent the potential for interference with the desired fit unless specifically designed. 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.

The grade designations can be seen in Table M-1 to the left. A tolerance position of "h" provides no allowance in tolerance, creating a tighter fit. The tolerance position "g" provides some tolerance allowance, while "e" provides the most tolerance allowance. Position "g" indicates an allowance for plating has been built into the size.

Proper Thread Designation for Metric Fasteners
Example:

M8 x 1.25 4g6g
- Tolerance Class for Major Diameter
- Tolerance Class for Pitch Diameter
- Thread Pitch
- Nominal Diameter

Camcar metric socket head cap screws are manufactured to property class 12.9, which is the ANSI B18.3M specification. However, outside the United States, manufacturing of socket head cap screws to other classes is permitted. If your application requires property class 12.9 socket head cap screws, it is important that you verify with your supplier that what you are buying meets those specifications.

Combining high-stressed socket screws joints with a corrosive environment increases the risk of stress corrosion failure.

Socket Screw Standards - Metric Sizes

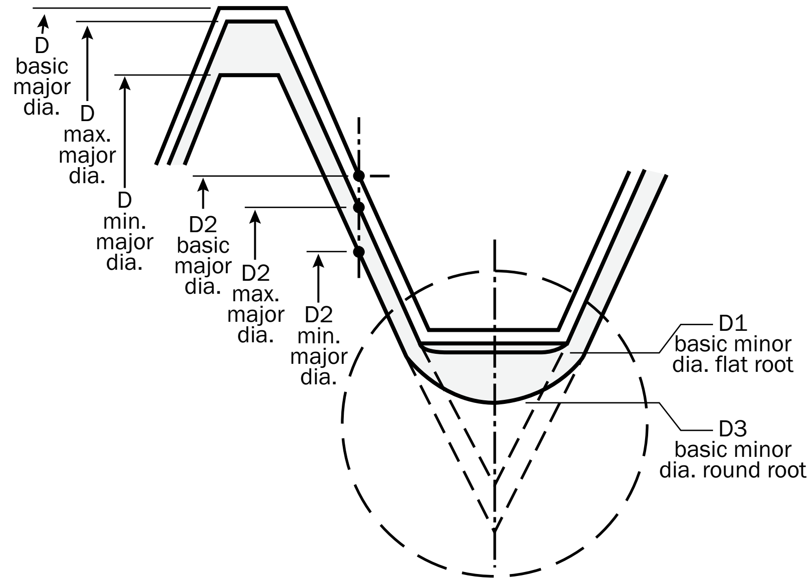
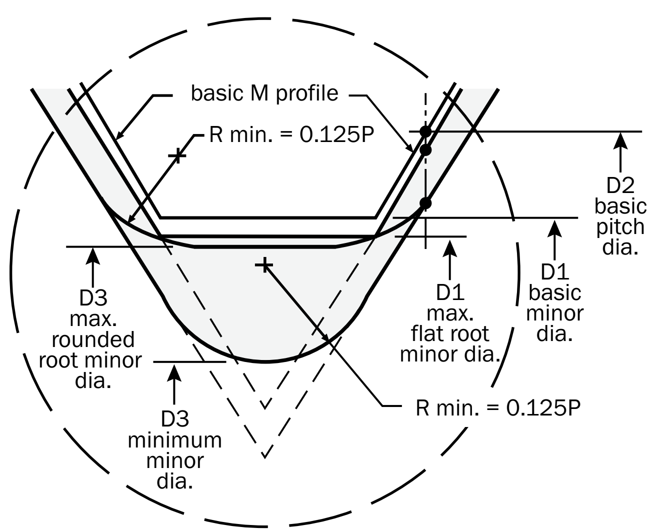


Table M-2: External Thread-Limiting Dimensions for M Profile

Basic Thread Designation	Tolerance Classes 4g & 6g			Tolerance Class 4g6g					Tolerance Class 6g				
		D Major Diameter		D2 Pitch Dia.			D1 Minor Dia. Flat Form	D3 Minor Dia. Round Form	D2 Pitch Dia.			D1 Minor Dia. Flat Form	D3 Minor Dia. Round Form
	Allowance	max.	min.	max.	min.	Tol.	max.	min.	max.	min.	Tol.	max.	min.
M1.6 x 0.35	0.019	1.581	1.496	1.354	1.314	0.040	1.202	1.098	1.354	1.291	0.063	1.202	1.075
M2 x 0.4	0.019	1.981	1.886	1.721	1.679	0.042	1.548	1.433	1.721	1.654	0.067	1.548	1.408
M2.5 x 0.45	0.020	2.480	2.380	2.188	2.143	0.045	1.993	1.866	2.188	2.117	0.071	1.993	1.840
M3 x 0.5	0.020	2.980	2.874	2.655	2.607	0.048	2.439	2.299	2.655	2.580	0.075	2.439	2.272
M4 x 0.7	0.022	3.978	3.838	3.523	3.467	0.056	3.220	3.036	3.523	3.433	0.090	3.220	3.002
M5 x 0.8	0.024	4.976	4.826	4.456	4.396	0.060	4.110	3.904	4.456	4.361	0.095	4.110	3.869
M6 x 1	0.026	5.974	5.794	5.324	5.253	0.071	4.891	4.637	5.324	5.212	0.112	4.891	4.596
M8 x 1.25	0.028	7.972	7.760	7.160	7.085	0.075	6.619	6.315	7.160	7.042	0.118	6.619	6.272
M10 x 1.5	0.032	9.968	9.732	8.994	8.909	0.085	8.344	7.850	8.994	8.862	0.132	8.344	7.938
M12 x 1.75	0.034	11.966	11.701	10.829	10.734	0.095	10.072	9.656	10.829	10.679	0.150	10.072	9.601
M16 x 2	0.038	15.962	15.682	14.663	14.563	0.100	13.797	13.331	14.663	14.503	0.160	13.797	13.271
M20 x 2.5	0.042	19.958	19.623	18.334	18.228	0.106	17.252	16.688	18.334	18.164	0.170	17.252	16.624
M24 x 3	0.048	23.952	23.577	22.003	21.878	0.125	20.704	20.030	22.003	21.803	0.200	20.704	19.955

Table M-3: 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	0.620	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



Socket Head Cap Screws - Metric Sizes

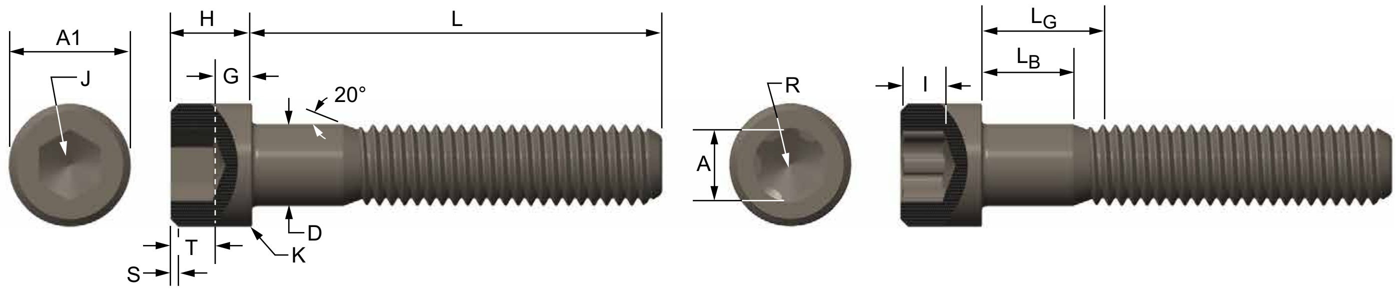


Table M-4: Dimensions of Hex and TORX PLUS® Metric Socket Head Cap Screws

Nominal Size x Thread Pitch	D Body Dia.		A1 Head Dia.		H Head Height		S Chamfer or Radius	R TORX PLUS Drive Size	A TORX PLUS Recess Dim.	I TORX PLUS Key Engmt.	J Hex Socket Size	T Key Engmt.	G Wall Thick.	K Chamfer or Radius
	max.	min.	max.	min.	max.	min.	max.		ref.	min.	nom.	min.	min.	max.
M1.6 x 0.35	1.60	1.46	3.00	2.87	1.60	1.52	0.16				1.5	0.80	0.54	0.08
M2 x 0.4	2.00	1.86	3.80	3.65	2.00	1.91	0.20	6IP	1.75	0.77	1.5	1.00	0.68	0.08
M2.5 x 0.45	2.50	2.36	4.50	4.33	2.50	2.40	0.25	8IP	2.39	1.05	2.0	1.25	0.85	0.08
M3 x 0.5	3.00	2.86	5.50	5.32	3.00	2.89	0.30	10IP	2.82	1.24	2.5	1.50	1.02	0.13
M4 x 0.7	4.00	3.82	7.00	6.80	4.00	3.88	0.40	25IP	4.52	1.76	3.0	2.00	1.52	0.13
M5 x 0.8	5.00	4.82	8.50	8.27	5.00	4.86	0.50	27IP	5.08	2.24	4.0	2.50	1.90	0.13
M6 x 1	6.00	5.82	10.00	9.74	6.00	5.85	0.60	30IP	5.61	2.47	5.0	3.00	2.28	0.20
M8 x 1.25	8.00	7.78	13.00	12.70	8.00	7.83	0.80	45IP	7.92	3.48	6.0	4.00	3.20	0.20
M10 x 1.5	10.00	9.78	16.00	15.67	10.00	9.81	1.00	50IP	8.94	3.93	8.0	5.00	4.00	0.20
M12 x 1.75	12.00	11.73	18.00	17.63	12.00	11.79	1.20	55IP	11.33	5.15	10.0	6.00	4.80	0.25
M16 x 2	16.00	15.73	24.00	23.58	16.00	15.76	1.60	70IP	15.72	7.39	14.0	8.00	6.40	0.25
M20 x 2.5	20.00	19.67	30.00	29.53	20.00	19.73	2.00	90IP	20.19	9.67	17.0	10.00	8.00	0.40
M24 x 3	24.00	23.67	36.00	35.48	24.00	23.70	2.40	100IP	22.10	10.79	19.0	12.00	9.60	0.40

Notes For Metric Socket Head Cap Screws:

1. **Body Diameter:** The diameter of body throughout the body length shall be within the limits for "D" specified in Table M-4. For screws which are threaded full length, the diameter of the unthreaded portion of shank shall be within "D" maximum and the specified minimum pitch diameter.
2. **Head Diameter:** Heads may be plain or knurled at the option of the manufacturer, unless specified by the customer. For knurled screws, the maximum head diameter shall be measured across the tops of the knurl portion, or the diameter across the tops of the knurls for those screws not having an knurled portion, just above the radius or chamfer at the bottom edge of the head.
3. **Top of Head:** The top of head, excluding socket, shall be flat and chamfered or radiused at the periphery. The length of the chamfer or rounding measured on the side of the head shall not exceed the tabulated value for "S".
4. **Bearing Surface:** The plane of the bearing surface shall be perpendicular to the axis of the screw within a maximum deviation of 1°.
5. **Edge of Head:** The edge between the bearing surface and the side of the head may be broken (rounded or chamfered) but the radius or chamfer measured along the bearing surface shall not exceed the values listed for "K".
6. **Total Runout:** The total runout between thread, body and head on socket head cap screws shall assemble into a compound hole threaded at one end to the basic thread size (tolerance class 6H minimum) for a depth equivalent to 1.5 times the basic screw diameter, and counterbored at the other end to diameter A_E in Table M-7 (page 49), and whose center portion is equal to D_E. Diameters D_E and A_E shall be concentric with the axis of the thread within the equivalent 10% of the thread pitch diameter, The starting thread shall be chamfered and the corner at the junction of diameters A_E and D_E shall be rounded to a diameter equal to B maximum.

Socket Head Cap Screws - Metric Sizes

7. **Concentricity:** The head shall be concentric with the shank within 2% of the basic screw diameter, or 0.15mm, whichever is greater, FIM (Full Indicator Movement). Concentricity shall be measured with the screw being held within a distance equal to one screw diameter from the underside of head but beyond the underhead fillet.
   a. **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. **Underhead Fillet:** For all lengths of screws, the form of the underhead fillet shall be optional within the following provisions (see Table M-5): The fillet shall be a smooth and continuous concave curve fairing into the bearing surface within the limits for diameter "B", with a juncture 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" (see illustration above Table M-5).
9. **Length:** 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 extreme end of the shank.
10. **Standard Lengths:** The standard length increments for metric socket head cap screws shall be as follows: 5, 6, 8, 10, 12, 16, 20, 25, 30, 40, 45, 50, 55, 60, 70, 75, 80, 90, 100, 110, 120, 130, 140 and 150mm.
11. **Length Tolerances:** The allowable tolerance on length shall be bilateral as shown to the right.
12. **Thread Series and Form:** Unless otherwise specified, threads shall be the metric coarse series in accordance with ANSI B1.13M, Metric Screw Threads – M Profile.
13. **Thread Tolerance Class:** Threads shall be tolerance class 4g6g. For plated screws, the allowance g may be consumed by the thickness of plating, so that the maximum limit of size after plating shall be tolerance class 4h6h. Thread limits shall be in accordance with ANSI B1.13M. Gaging shall be in conformance to System 22 of ANSI B1.3M.

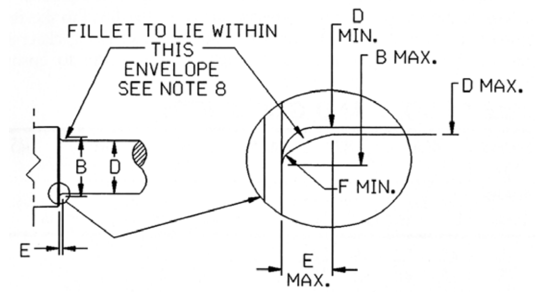


Table M-5: Dimensions of Underhead Fillets

Nom. Size	Thread Pitch	B Transition Diameter max.	B Transition Diameter min.	E Transition Length max.	F Juncture Radius max.
M1.6	0.35	2.0	1.8	0.34	0.10
M2	0.4	2.6	2.2	0.51	0.10
M2.5	0.45	3.1	2.7	0.51	0.10
M3	0.5	3.6	3.2	0.51	0.10
M4	0.7	4.7	4.4	0.60	0.20
M5	0.8	5.7	5.4	0.60	0.20
M6	1	6.8	6.5	0.68	0.25
M8	1.25	9.2	8.8	1.02	0.40
M10	1.5	11.2	10.8	1.02	0.40
M12	1.75	14.2	13.2	1.87	0.60
M16	2	18.2	17.2	1.87	0.60
M20	2.5	22.4	21.6	2.04	0.80
M24	3	26.4	25.6	2.04	0.80

Length Tolerances

Nom. Screw Size	M1.6 thru M10	M12 thru M20	Over M20
Nom. Screw Length	**Tolerance on Length**		
Up to 16mm, incl.	±0.3	±0.3	–
Over 16 to 50mm, incl.	±0.4	±0.4	±0.7
Over 50 to 120mm, incl.	±0.7	±1.0	±1.5
Over 120mm to 200mm, incl.	±1.0	±1.5	±2.0
Over 200 mm	±2.0	±2.5	±3.0

14. **Thread Length:** The length of complete thread L_T shall be controlled by the grip length L_G and the length of total thread L_{TT} shall be controlled by the body length L_B. The L_T minimum and L_{TT} maximum values shown on Table M-8 are reference dimensions intended for calculation purposes only, in accordance with Note 19.
15. **Point:** The end on screws of 5mm nominal size and larger, and of nominal lengths equivalents to 0.75 times the basic screw diameter, shall be chamfered. The chamfer shall extend slightly below the root of the thread and the edge between the flat and chamfer may be slightly rounded. The included angle of the point shall be approximately 90°. Chamfering on screw sizes up to and including 4mm and of larger sizes having lengths shorter than 0.75 times the basic screw diameter shall be optional.
16. **Threaded Full Length Screws:** Screws of nominal lengths above those shown in Table M-4 or, for nominal sizes larger than 24mm, have lengths which are equal to or shorter than L_{TT}, shall be threaded for full length. On these screws for nominal sizes 1.6 through 16mm, the complete (full-form) threads, as determined by a GO thread ring gage, having the countersunk and a counterbore removed, assembled by hand as far as the thread will permit, shall extend to within two pitches (threads) of the underside of the head. For sizes larger than 16mm, the complete threads shall extend as close to the head as possible.

Socket Head Cap Screws - Metric Sizes

17. Grip Length L_G: Grip Length is the distance, measured parallel to the axis of the screw, from the bearing surface of the head to the first complete (full-form) thread under the head. The part being clamped must not be thinner than the grip length, L_G, in order to ensure the screw can properly be seated.

18. Body Length L_B: Body length is the length, measured parallel to the axis of the screw, of the unthreaded portion of the shank.

19. Non-Tabulated Sizes and Lengths: For screws of nominal lengths not listed in Table M-5 and for nominal sizes larger than 24mm, the length shall be calculated as follows:
Maximum grip length: $L_G = L - L_T$
Minimum body length: $L_B = L - L_{TT}$

Where

L = Nominal screw length

L_T = Minimum thread length

L_{TT} = Maximum total thread length

Screws having nominal lengths falling between those for which L_G and L_B values are tabulated in Table M-6 shall have L_G and L_B dimensions conforming to the next shorter tabulated nominal length for the respective screw size.

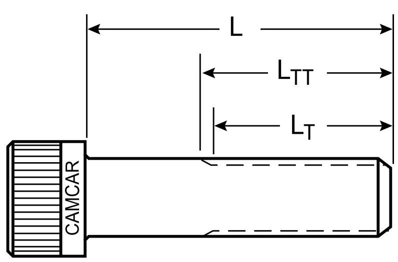


Table M-6: Body and Grip Length

Nom Size	M1.6		M2		M2.5		M3		M4	
Nom. Length	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
40			24.0	22.0	23.0	20.7	22.0	19.5	20.0	16.5
45					28.0	25.7	27.0	24.5	25.0	21.5
50					33.0	30.7	32.0	29.5	30.0	26.5
55							37.0	34.5	35.0	31.5
60							42.0	39.5	40.0	36.5
65							47.0	44.5	45.0	41.5
70									50.0	46.5
80									60.0	56.5

Nom Size	M5		M6		M8		M10	
Nom. Length	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B
35	13.0	9.0	11.0	6.0				
40	18.0	14.0	16.0	11.0				
45	23.0	19.0	21.0	16.0	17.0	10.7		
50	28.0	24.0	26.0	21.0	22.0	15.7	18.0	10.5
55	33.0	29.0	31.0	26.0	27.0	20.7	23.0	15.5
60	38.0	34.0	36.0	31.0	32.0	25.7	28.0	20.5
65	43.0	39.0	41.0	36.0	37.0	30.7	33.0	25.5
70	48.0	44.0	46.0	41.0	36.0	37.0	30.7	33.0
80	58.0	54.0	56.0	51.0	52.0	45.7	48.0	40.5
90	68.0	64.0	66.0	61.0	62.0	55.7	58.0	50.5
100	78.0	74.0	76.0	71.0	72.0	65.7	68.0	60.5
110			86.0	81.0	82.0	75.7	78.0	70.5
120			96.0	91.0	92.0	85.7	88.0	80.5
130					102.0	95.7	98.0	90.5
140					112.0	105.7	108.0	100.5
150					122.0	115.7	118.0	110.5

Nom Size	M12		M16		M20		M24	
Nom. Length	L_G	L_B	L_G	L_B	L_G	L_B	L_G	L_B
60	24.0	15.2						
65	29.0	20.2						
70	29.0	20.2						
80	44.0	35.2	36.0	26.0				
90	54.0	45.2	46.0	36.0	38.0	25.5		
100	64.0	55.2	56.0	46.0	48.0	35.5	40.0	25.0
110	74.0	65.2	66.0	56.0	58.0	45.5	50.0	35.0
120	84.0	75.2	76.0	66.0	68.0	55.5	60.0	45.0
130	94.0	85.2	86.0	76.0	78.0	65.5	70.0	55.0
140	104.0	95.2	96.0	86.0	88.0	75.5	80.0	65.0
150	114.0	105.2	106.0	96.0	98.0	85.5	90.0	75.0

Socket Head Cap Screws - Metric Sizes

Table M-7: Functional Limits for Runout of Head, Body and Thread

Nom. Size	M1.6		M2	
Nom. Length over – to, incl.	Hole Diameters for Shank (D_E) and Head (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
Nom. Size	**M2.5**		**M3**	
Nom. Length over – to, incl.	Hole Diameters for Shank (D_E) and Head (A_E)			
	D_E	A_E	D_E	A_E
0 - 12	2.60	4.75	3.09	5.74
12 - 25	2.70	4.85	3.18	5.83
20 - 25	2.78	4.93	3.25	5.90
25 - 35	2.90	5.05	3.36	6.01
Nom. Size	**M4**		**M5**	
Nom. Length over – to, incl.	Hole Diameters for Shank (D_E) and Head (A_E)			
	D_E	A_E	D_E	A_E
0 - 20	4.13	7.28	5.12	8.77
20 - 35	4.22	7.37	5.20	8.85
35 - 60	4.38	7.58	5.34	8.99
60 - 70	4.44	7.59	5.39	9.04
Nom. Size	**M6**		**M8**	
Nom. Length over – to, incl.	Hole Diameters for Shank (D_E) and Head (A_E)			
	D_E	A_E	D_E	A_E
0 - 25	6.13	10.18	8.11	13.27
25 - 50	6.26	10.41	8.22	13.38
50 - 70	6.36	10.51	8.31	13.47
70 - 100	6.51	10.66	8.44	13.60
100 - 150	6.64	10.79	8.64	13.80
Nom. Size	**M10**		**M12**	
Nom. Length over – to, incl.	Hole Diameters for Shank (D_E) and Head (A_E)			
	D_E	A_E	D_E	A_E
0 - 25	10.10	16.30	12.09	18.33
25 - 50	10.20	16.40	12.18	18.42
50 - 70	10.28	16.48	12.25	18.49
70 - 100	10.40	16.60	12.36	18.60
100 - 150	10.60	16.80	12.54	18.78
Nom. Size	**M16**		**M20**	
Nom. Length over – to, incl.	Hole Diameters for Shank (D_E) and Head (A_E)			
	D_E	A_E	D_E	A_E
0 - 50	16.16	24.48	20.14	30.54
50 - 100	16.16	24.64	20.28	30.68
100 - 150	16.47	24.79	20.42	30.82

Nom. Size	M24	
Nom. Length over – to, incl.	Hole Diameters for Shank (D_E) & Head (A_E)	
	D_E	A_E
0 - 50	24.13	36.61
50 - 100	24.26	36.74
100 - 150	24.38	36.86

20. **Surface Roughness:** For alloy steel screws of nominal sizes up to and including 16mm, and nominal lengths equal to and less than 8 times the basic screw diameter, the surface roughness on the screws before plating shall not exceed 1.6 micrometers AA on the fillet and head bearing surfaces, nor exceed 0.8 micrometers AA on the threads.

    For larger sizes and longer lengths, the surface roughness of the screws prior to plating shall not exceed 3.2 micrometers AA on the body, fillet and head bearing surfaces.

    Normally, it should be sufficient to ascertain that these surfaces on screws have the equivalent of a smooth machined finish by visual comparison with known surface standards. However, where it is practical and deemed necessary to measure those screw surfaces with commercially available equipment, roughness measurements shall be taken axially on the body and fillet surfaces, and circumstantially on the bearing surface.

Table M-8: Screws Beyond Sizes in Table M-6

Nominal Screw Size	L_T Thread Length min.	L_{TT} Total Thread Length max.
M1.6	15.2	17.0
M2	16.0	18.0
M2.5	17.0	19.3
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
M16	44.0	54.0
M20	52.0	64.5
M24	60.0	75.0

NOTE: The L_T minimum and L_{TT} maximum values shown on Table M-8 are reference dimensions intended for calculation purposes only, in accordance with Note 19.

Socket Head Cap Screws - Metric Sizes

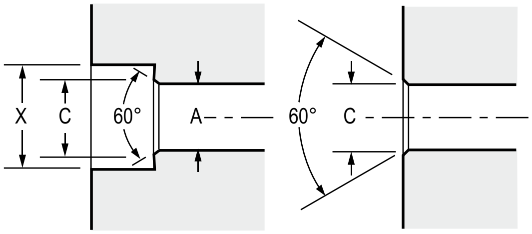


Table M-9:
Drill and Counterbore Sizes

Nom. Screw Size	A Nominal Drill Size Close Fit	A Nominal Drill Size Normal Fit	X Counter-bore Dia.	C Counter-sink Dia.
M1.6	1.80	7.95	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
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

Table M-10:
Mechanical and Application Data

Nominal Size x Thread Pitch	Tensile Strength Min.		Single Shear* Body Section		Suggested Seating Torque** Plain Finish	
	kN	lbf	kN*	lbf*	Nm**	lb.-in.**
M3 x 0.5	6.14	1,380	4.9	1,095	2.6	23
M4 x 0.7	10.7	2,410	8.7	1,947	6.1	54
M5 x 0.8	17.3	3,890	13.5	3,043	12.39	109
M6 x 1	24.5	5,510	19.5	4,382	20.9	185
M8 x 1.25	44.6	10,030	34.6	7,791	50.8	450
M10 x 1.5	70.8	15,920	54.1	12,173	100.8	892
M12 x 1.75	103.0	23,150	78.0	17,530	175.9	1,554
M16 x 2	192.0	43,160	138.6	31,164	437.0	3,964
M20 x 2.5	299.0	67,220	217.0	48,695	851.0	7,536
M24 x 3	431.0	96,890	312.0	70,120	1,471	13,026

* Based on 100 ksi shear strength
** Seating torques calculated to induce 65,000 psi tensile stress with a "K" factor of 0.21

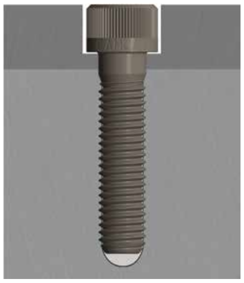
21. Close Fit is normally limited to holes for those lengths of screws threaded to the head in assemblies in which (1) only one screw is used or (2) two or more screws are used but the mating holes are produced at assembly or by matched and coordinated tooling.

22. Normal Fit: Intended for (1) screws of relatively long length or (2) assemblies that involve two or more screws and where the mating holes are produced by conventional tolerancing methods. It provides for the maximum allowable eccentricity of the longest standard screws and for certain deviations in the parts being fastened, such as deviations in hole straightness; angularity between the axis of the tapped hole and that the shank hole; differences in center distances of the mating holes; and other deviations.

23. Countersink: It is considered good practice to countersink the edges of holes which are smaller than "C" max. (see Table M-9) in parts having a hardness which 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 the screws, making them susceptible to fatigue in applications involving dynamic loading. The countersink, or corner relief, should not be longer than is necessary to insure that the fillet on the screw is cleared. The diameter of countersink does not have to exceed "C" max. Countersinks in excess of this diameter reduce the effective bearing area and introduce the possibility of embedment where the parts to be fastened are softer than the screws or of brinelling or flaring the heads of the screws where the parts to be fastened are harder than the screws.

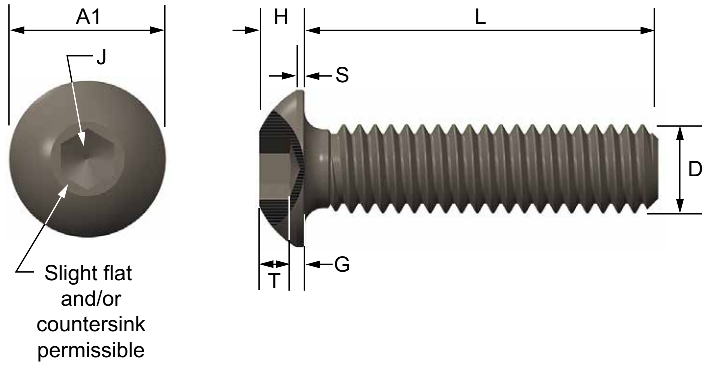
24. Material: STANLEY Engineered Fastening metric socket head cap screws shall conform to property class 12.9 and be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vandium, in suffidient quantity to assure that the specified hardness range of Rockwell C38 to C44. Decarbutization and carburization limits shall be the same as those specified for metric socket head cap screws in ASTM Specification A 574M, Alloy Steel Socket Head Cap Screws (Metric).

Tensile Strength (PSI min.): 177,000
Tensile Strength (MPa min.): 1,220
Yield Strength (PSI min.) 160,000
Yield Strength (MPa min.) 1,100
Hardness ....Rockwell C38 to C44



Applications
This product is a high tensile strength fastener designed for use in applications where the material being clamped is of sufficient hardness – generally Rockwell B90/614 MPa ultimate tensile strength for steel and cast iron is adequate for the pre-load induced by the above seating torques; softer materials may require a washer under the head to prevent indentation. The application can be recessed with a counterbore where clearance for open and socket wrenches is a problem. Typical applications include use in a machine assembly, punch press tooling, bearing caps, split collars, etc.

Button Head Cap Screws - Metric Sizes



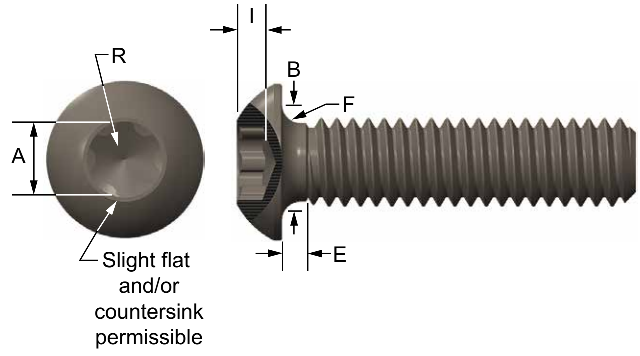


Table M-11: Dimensions of Hex and TORX PLUS® Metric Button Head Cap Screws

D	A1		H		S	R	A	I	J	T	G	B		E	F	L
						TORX PLUS			Hex	Hex						
Nom. Size x Thread Pitch	Head Diameter		Head Height		Side Height	Drive Size	Recess Dia.	Key Eng.	Socket Size	Key Eng.	Wall Thickness	Transition Diameter		Transition Length	Juncture Radius	Max. Length
	max.	min.	max.	min.	ref.		ref.	min.	nom.	min.	min.	max.	min.	max.	min.	nom.
M3 x 0.5	5.70	5.40	1.65	1.43	0.38	8IP	2.39	0.81	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	15IP	3.35	1.14	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	25IP	4.52	1.54	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	27IP	5.08	1.73	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	40IP	6.76	2.30	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	45IP	7.92	2.69	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	55IP	11.33	4.02	8	4.16	1.63	14.2	13.2	1.87	0.60	60

Notes For Socket Button Head Cap Screws:

1. **Head Height:** The tabulated head heights represent metal to metal measurements; i.e., the truncation of the rounded surface caused by the socket is not considered part of the head height.
2. **Bearing Surface:** The plane of the bearing surface is to be perpendicular to the axis of the shank within 2°.
3. **Concentricity:** The head is to be concentric to the axis of the shank of the screws within 6% of the specified head diameter or 0.2mm, whichever is greater, FIM (Full Indicator Movement).

   Concentricity shall be measured with the screw being held by the threads next to the head (within a distance equal to one screw diameter) and indicating the outer surface of the head on the rounded portion, adjacent to, but not on, the extreme periphery of the head.
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 and including 12mm, and equal to 6% of the basic screw diameter for sizes larger than 12mm, regardless of feature size.
5. **Fillet:** For all lengths of screws, the form of the fillet at 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 for diameter "B", with a juncture 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".
6. **Wall Thickness:** The minimum wall thickness, "G", specified in Table M-11, shall apply only to screws having nominal lengths shorter than two times the basic screw diameter which are not subject to tensile testing in accordance with Paragraph 16.
7. **Length:** The length of metric socket button head cap screws shall be measured parallel to the axis of the screw from the plane of the bearing surface under the head to the plane of the flat of the point.

Socket Head Cap Screws - Metric Sizes

8. **Standard Lengths:** The standard lengths for metric socket button head cap screws shall be as follows: 8, 10, 12, 16, 20, 25, 30, 35 and 40mm.
9. **Length Tolerances:** The allowable tolerance on length shall be as tabulated below:

Nominal Screw Length	Tolerance on Length
Up to 16mm, incl.	±0.03
Over 16mm to 60mm incl.	±0.04

10. **Threads:** Unless otherwise specified, threads shall be the metric coarse series in accordance with American National Standard, Metric Screw Threads – M Profile, ANSI B1.13M or International Standard, General Purpose Metric Screw Threads – Selected Sizes for Screws, Bolts and Nuts, ISO 262-1973. The thread form shall conform to International Standard, General Purpose Metric Screw Threads – Basic Profile, ISO 68-1973.
11. **Tolerance Class:** Threads shall be ISO Tolerance Class 4g6g. For plated screws, the allowance "g" may be consumed by the thickness of the plating, so that the maximum limit of size after plating shall be Tolerance Class 4h6h. Thread limits shall be in accordance with ANSI B1.13M. See Table M-2 on page 45, wherein the limiting dimensions applicable to threads before and after plating are given for reference purposes. The allowable "g" shown therein for those sizes has been increased over that specified in B1.13M. However, because the minimum limits are unchanged, the screws will be totally interchangeable.
12. **Thread Gaging:** Acceptability of screw threads shall be determined based upon System 22 of ANSI/ASME B1.3M.
13. **Thread Length:** Screws of nominal lengths equal to or shorter than the longest standard lengths listed under Column "L" in Table M-10 shall be threaded full length. The distance measure, parallel to the axis of screw, from the underside of the head to the face of a non-counterbored or non-countersunk standard GO thread ring gage assembly by hand as far as the thread will permit shall not exceed two pitches (threads).
14. **Point:** The end on screws of 5mm nominal size and larger, and of nominal lengths equivalent to 0.75 times the basic screw diameter or longer, shall be chamfered. The chamfer shall extend slightly below the root of the thread and the edge between the flat, and chamfer may be slightly rounded. The included angle of the point shall be approximately 90°. Chamfering on screw sizes up to and including 4mm and of larger sizes having lengths less than 0.75 times the basic screw diameter shall be optional.
15. **Material:** Metric socket button head cap screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium, in sufficient quantity to assure that the specified core hardness range of Rockwell C38 to C44 is met when hardened by quenching from the austenitizing temperature and tempered at not lower than 343°C (650°F). Decarburization and carburization limits are specified in ASTM F 835M Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.

    Hardness .... Rockwell C38 to C44
16. **Tensile Strength:** Screws having a nominal length equal to or exceeding 2-1/4 times the basic screw diameter shall withstand without failure, the static tensile load listed in Table M-12 when tested in accordance with ASTM F 835M. Screws of shorter nominal lengths shall not be subject to tensile testing but accepted on the basis of meeting the hardness requirements.

Applications
This product is designed and recommended for applications where a lower profile then that of the normal socket head cap screw is required to prevent interference. Wrenchability is significantly reduced due to the smaller sockets and shallower key engagements and, because of the head configuration, the property class 12.9 tensile loads will not be met.

Table M-12: Mechanical and Application Data

Nominal Size x Thread Pitch	Tensile Strength min.		Single Shear Body Section		Suggested Seating Torque Plain Finish	
	kN	lbf	kN*	lbf*	Nm**	lb.-in.**
M3 x 0.5	4.93	1,108.3	4.9	1,095	1.4	12.5
M4 x 0.7	8.60	1,933.4	8.7	1,947	3.3	29.0
M5 x 0.8	13.90	3,124.8	13.5	3,043	6.7	59.0
M6 x 1	19.70	4,428.7	19.5	4,382	11.3	100.0
M8 x 1.25	35.90	8,070.6	34.6	7,781	27.5	244.0
M10 x 1.5	56.80	12,769.0	54.1	12,173	54.6	483.0
M12 x 1.75	82.60	18,569.0	78.0	17,530	95.1	842.0

* Based on 100 ksi shear strength
** Seating torques calculated to induce 65,000 psi tensile stress with a "K" factor of 0.21

Flat Countersunk Head Cap Screws - Metric Sizes

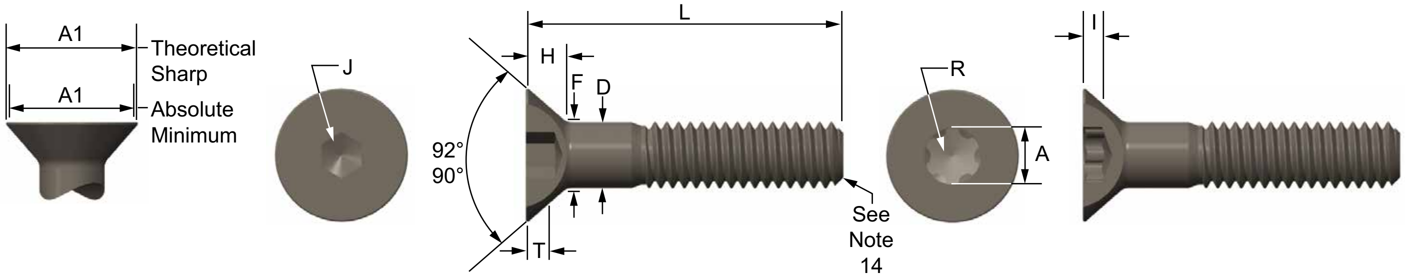


Table M-13: Dimensions of Hex and TORX PLUS® Metric Flat Countersunk Head Cap Screws

Nominal Size x Thread Pitch	D Body Diameter		A1 Head Dia.		H Head Height		R TORX PLUS Drive Size	A TORX PLUS Recess Dim.	I TORX PLUS Key Engmt.	J Hex Socket Size	T Hex Key Engmt.	G Wall Thickness	F Fillet Extension Above D	M Drill Allow.
	max.	min.	Theoretical Sharp	Absol. min.	ref.	Flush Tol.	ref.	ref.	min.	nom.	min.	min.	max.	max.
M3 x 0.5	3.00	2.86	6.72	5.35	1.86	0.30	10IP	2.82	0.96	2.0	1.1	0.25	0.25	0.3
M3 x 0.5	3.00	2.86	6.72	5.35	1.86	0.30	10IP	2.82	0.96	2.0	1.1	0.25	0.25	0.3
M4 x 0.7	4.00	3.82	8.96	7.80	2.48	0.30	20IP	3.94	1.34	2.5	1.5	0.45	0.35	0.4
M5 x 0.8	5.00	4.82	11.20	9.75	3.10	0.35	25IP	4.52	1.54	3.0	1.9	0.66	0.40	0.5
M6 x 1	6.00	5.82	13.44	11.70	3.72	0.35	30IP	5.61	1.91	4.0	2.2	0.70	0.50	0.6
M8 x 1.25	8.00	7.78	17.92	15.60	4.96	0.40	40IP	6.76	2.30	5.0	3.0	1.16	0.60	0.8
M10 x 1.5	10.00	9.78	22.40	19.50	6.20	0.50	50IP	8.94	3.04	6.0	3.6	1.62	0.80	0.9

Notes For Metric Socket Flat Countersunk Head Cap Screws:

1. **Body Diameter:** The term body refers to the unthreaded cylindrical portion of the shank for those screws not threaded to the head.
2. **Head Diameter:** The maximum sharp values under Column A1 are theoretical values only 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 82° in which a screw having maximum head height will just fit flush.
3. **Head Height:** The tabulated values for head height are given for reference only and are calculated to the maximum formulation.
4. **Flushness Tolerance:** The flushness tolerance is the distance the top surface of a screw having the minimum head size will be below the flush condition in a hole countersunk exactly 82° to the maximum sharp dimension listed in Column A1. The top of the head is to be flat within the limits of the flushness tolerance.
5. **Concentricity:** Concentricity of the thread with the body is to 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 closet to the head of the screw and is not to exceed 0.64mm.
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 and including 12mm, and equal to 6% of the basic screw diameter for sizes larger than 12mm, regardless of feature size.
7. **Fillet:** A fillet between the conical bearing surface of the head and the shank (body) of the screw is allowable above the maximum tabulated value for "D" with the value listed for "F".
8. **Length Measurement:** The length of the screw shall be measured parallel to the axis of the screw from the plane of the top of the head to the extreme end of the shank.

Flat Countersunk Head Cap Screws - Metric Sizes

Table M-14: Body and Grip Length

Nom. Size	M3		M4	
Nom. Length	L_G	L_B	L_G	L_B
35	17.0	14.5	15.0	11.5
40	22.0	19.5	20.0	16.5
45	27.0	24.5	25.0	21.5
50	32.0	29.5	30.0	26.5
55	37.0	34.5	35.0	31.5
60			40.0	36.5
65			45.0	41.5
70			50.0	46.5
80			60.0	56.5
Nom. Size	**M5**		**M6**	
Nom. Length	L_G	L_B	L_G	L_B
40	18.0	14.0		
45	23.0	19.0	21.0	16.0
50	28.0	24.0	26.0	21.0
55	33.0	29.0	31.0	26.0
60	38.0	34.0	36.0	31.0
65	43.0	39.0	41.0	36.0
70	48.0	44.0	46.0	41.0
80	58.0	54.0	56.0	51.0
90	68.0	64.0	66.0	61.0
100	78.0	74.0	76.0	71.0
110			86.0	81.0
120			96.0	91.0
Nom. Size	**M8**		**M10**	
Nom. Length	L_G	L_B	L_G	L_B
50	22.0	15.7		
55	27.0	20.7		
60	32.0	25.7	28.0	20.5
65	37.0	30.7	33.0	25.5
70	42.0	35.7	38.0	30.5
80	52.0	45.7	48.0	40.5
90	62.0	55.7	58.0	50.5
100	72.0	65.7	68.0	60.5
110	82.0	75.7	78.0	70.5
120	92.0	85.7	88.0	80.5
130	102.0	95.7	98.0	90.5
140	112.0	105.7	108.0	100.5
150	122.0	115.7	118.0	110.5
Nom. Size	**M12**		**M16**	
Nom. Length	L_G	L_B	L_G	L_B
65	29.0	20.2		
70	34.0	25.2		
80	44.0	35.2	36.0	26.0
90	54.0	45.2	46.0	36.0
100	64.0	55.2	56.0	46.0
110	74.0	65.2	66.0	56.0
120	84.0	75.2	76.0	66.0
130	94.0	85.2	86.0	76.0
140	104.0	95.2	96.0	86.0
150	114.0	105.2	106.0	96.0

9. **Standard Lengths:** The standard length increments for metric socket head cap screws shall be as follows: 5, 6, 8, 10, 12, 16, 20, 25, 30, 40, 45, 50, 55 and 60mm.

10. **Length Tolerances:** The allowable tolerance on length shall be as tabulated below:

Nominal Screw Length	Standard Length Increment
Up to 16mm, incl.	±0.3mm
Over 16mm to 60mm, incl.	±0.5mm
Over 60mm to 150 mm, incl.	±0.8mm

11. **Threads:** Unless otherwise specified, threads shall be metric coarse series in accordance with American National Standard, Metric Screw Threads – M Profile, ANSI B1.13M.

12. **Thread Tolerance Class:** Threads shall be tolerance class 4g6g. For plated screws, the allowance g may be consumed by the thickness of plating, so that the maximum limit of size after plating shall be tolerance class 4h6h. Thread limits shall be in accordance with ANSI B1.13M. Gaging shall be in conformance to System 22 of ANSI B1.3M.

13. **Thread Length L_T:** The thread length is controlled by the grip length L_G specified in Table M-14.

14. **Grip Length L_G:** The grip length is the distance, measured parallel to the axis of the screw, from the top of the head to the first complete (full form) thread under the head (see Table M-13). The tabulated L_G values are maximum and represent the minimum design grip length, including the reference head height of the screw. They should be measured from the top of the head to the face of a GO thread ring gage, having the thread countersink and/or counterbore removed, which has been assembled by hand as far as the thread will permit. The tabulated L_B values are minimum and represent the minimum body length, including the reference head height of the screw. They are equal to L_G minus 5 times the pitch of the thread for the respective screw size.

    Screws having nominal lengths falling between those for which L_G and L_B values are tabulated in Table M-13 should have L_G and L_B dimensions conforming with those of the next shorter nominal length for the desired screw size.

15. **Thread to Head:** For screws of nominal lengths above those shown in Table M-14, the thread length shall govern the grip and body lengths. On these screws, the complete full-form thread, measured with a thread ring gage, having the thread chamfer and/or counterbore removed, should extend to within 2 pitches (threads) of the intersection of the conical portion of the head with the body diameter.

Flat Countersunk Head Cap Screws - Metric Sizes

16. Body Length L_B: The body length is the length of the unthreaded portion of the shank and the head height.

17. Point: The end on screws of 5mm nominal size and larger and of nominal lengths equivalent to 1.5 times the basic screw diameter or longer shall be chamfered. The chamfer shall extend slightly below the root of the thread and the edge between the flat, and chamfer may be slightly rounded. The included angle of the point shall be approximately 90°. Chamfering on screw sizes up to and including 4mm and of larger sizes having lengths less than 1.5 times the basic screw diameter shall be optional.

18. Non-tabulated Sizes and Lengths: For screws of nominal length not listed in Table M-14 and for nominal sizes larger than 24mm, the maximum grip length LG and minimum body length L_B shall be determined from the following:

Maximum grip length: $L_G = L - L_T$

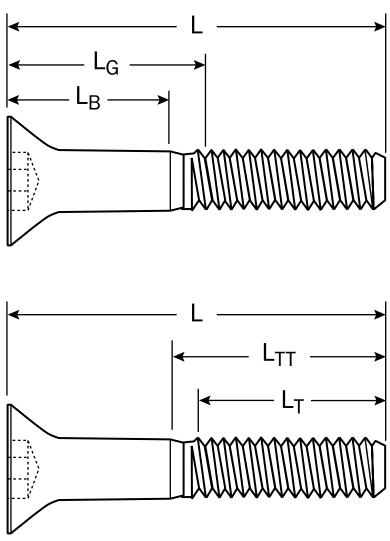
Minimum body length: $L_B = L - L_{TT}$

Where

L = Nominal screw length

L_T = Minimum thread length from Table M-14

L_{TT} = Maximum total thread length from Table M-14



19. Surface Roughness: For alloy steel screws of nominal sizes up to and including 16mm, and nominal lengths equal to and less than 8 times the basic screw diameter, the surface roughness on the screws before plating shall not exceed 1.6 micrometers AA on the fillet and head bearing surfaces, nor exceed 0.8 micrometers AA on the threads.

For larger sizes and longer lengths, the surface roughness of the screws prior to plating shall not exceed 3.2 micrometers AA on the body, fillet and head bearing surfaces.

Normally, it should be sufficient to ascertain that these surfaces on screws have the equivalent of a smooth machined finish by visual comparison with known surface standards. However, where it is practical and deemed necessary to measure those screw surfaces with commercially available equipment, roughness measurements shall be taken axially on the body and fillet surfaces, and circumstantially on the bearing surface.

20. Material: Metric socket button head cap screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum or vanadium, in sufficient quantity to assure that the specified core hardness range of Rockwell C38 to C44 is met when hardened by quenching from the austenitizing temperature and tempered at not lower than 343°C (650°F). Decarburization and carburization limits are specified in ASTM F 835 Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.

Hardness.................................... Rockwell C38 to C44

Table M-15: Screws Beyond Sizes in Table M-13

Nominal Screw Size	LT Thread Length min.	LTT Total Thread Length max.
M1.6	15.2	17.0
M2	16.0	18.0
M2.5	17.0	19.3
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
M16	44.0	54.0
M20	52.0	64.5
M24	60.0	75.0

Flat Countersunk Head Cap Screws - Metric Sizes

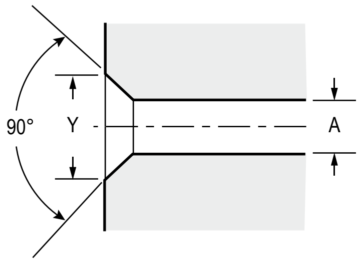


Table M-16: Drill and Counterbore Sizes

Nominal Screw Size	A Nominal Drill Size		X Counterbore Diameter	C Countersink Diameter
	Close Fit	Normal Fit		
M1.6	1.80	7.95	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
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

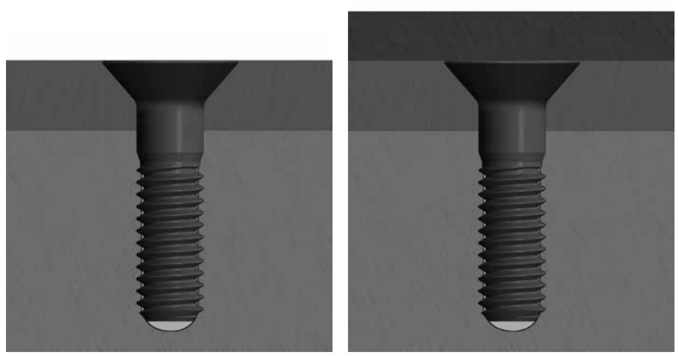
Table M-17: Mechanical and Application Data

Nominal Size x Thread Pitch	Tensile Strength Min.		Single Shear* Body Section		Suggested Seating Torque** Plain Finish	
	kN	lb	kN	lb	Nm	lb.-in.
M3 x 0.5	4.93	1,108.3	4.9	1,095	1.7	15.5
M4 x 0.7	8.60	1,933.4	8.7	1,947	4.1	36.0
M5 x 0.8	13.90	3,124.8	13.5	3,043	8.2	73.0
M6 x 1	19.70	4,428.7	19.5	4,382	14.0	124.0
M8 x 1.25	35.90	8,070.6	34.6	7,791	34.1	302.0
M10 x 1.5	56.80	12,769.0	54.1	12,173	67.5	598.0
M12 x 1.75	82.60	18,569.0	78.0	17,530	117.0	1,042.0
M16 x 2	155.00	34,845.0	138.0	31,164	293.0	2,591.0
M20 x 2.5	240.00	53,954.0	217.0	48,695	571.0	5,054.0

* Based on 100 ksi shear strength

** Seating torques calculated to induce 65,000 psi tensile stress with a "K" factor of 0.21.

21. Tensile Strength: Screws having a nominal length equal to or exceeding 2-1/4 times the basic screw diameter shall withstand without failure, the static tensile load listed in Table M-16 when tested in accordance with ASTM F 606M. Screws of shorter nominal lengths shall not be subject to tensile testing but accepted on the basis of meeting the hardness requirements.



Applications

Socket flat countersunk head cap screws are designed and recommended for applications where a flush-seating socket head screw is desired. Wrenchability is limited by the socket size and key engagement. Because of the head configuration, this product is not recommended for use in high-strength applications or where maximum fatigue resistance is required.

Socket Set Screws - Metric Sizes

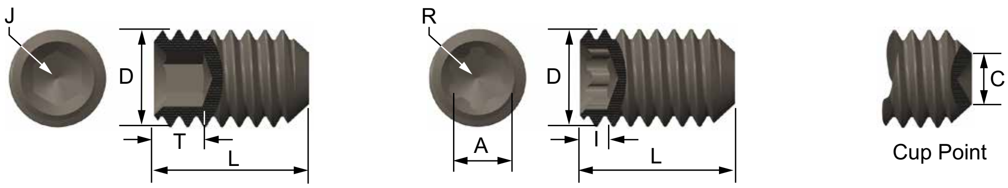


Table M-18: Dimensions of Hex and TORX PLUS® Metric Cup Point Socket Set Screws

D	R	A	I	J	L	T
Nominal Size x Thread Pitch	TORX PLUS Recess Size	TORX PLUS Recess Dia. ref.	TORX PLUS Key Engmt. min.	Hex Socket Size nom.	Nom. Screw Lengths	Min. Key Engmt. Cup Point
M3 x 0.5	6IP	1.75	0.77	1.5	2	0.6
					2.5	1.1
					3	1.5
					4	2.1
					5	2.1
M4 x 0.7	8IP	2.39	1.05	2	2.5	1.0
					3	1.3
					4	1.8
					5	2.3
					6	2.3
M5 x 0.8	10IP	2.82	1.24	2.5	3	1.2
					4	2.0
					5	2.7
					6	2.7
					8	2.7
M6 x 1	15IP/ 20IP	3.94	1.74	3	4	1.8
					5	2.5
					6	3.0
					8	3.0

D	R	A	I	J	L	T
Nominal Size x Thread Pitch	TORX PLUS Recess Size	TORX PLUS Recess Dia. ref.	TORX PLUS Key Engmt. min.	Hex Socket Size nom.	Nom. Screw Lengths	Min. Key Engmt. Cup Point
M8 x 1.25	25IP/ 27IP	5.08	2.24	4	5	1.8
					6	2.5
					8	4.0
					10	4.0
M10 x 1.5	40IP	6.76	2.97	5	6	2.0
					8	3.6
					10	5.0
					12	5.0
M12 x 1.75	45IP	7.92	3.48	6	8	3.0
					10	4.5
					12	6.0
					16	6.0
M16 x 2	55IP	11.33	5.15	8	10	3.0
					12	4.8
					16	8.0
					20	8.0
M20 x 2.5	6IP			10	12	
					16	6.0
					20	9.0
					25	10.0

Notes for Metric Cup Point Socket Set Screws:

1. **Hex Key Engagement:** For screws of nominal lengths exceeding those listed in Table M-18, the minimum key engagement "T" for the longest lengths shown shall apply. They represent the minimum key engagement depth necessary to develop the full functional capability of keys conforming to ANSI Metric Series Hexagon Keys and Bits, ANSI B18.3.2M-1979. Compliance with minimum depth requirements shall be determined by gaging in accordance with Table A-7, page 71.
   CAUTION: The use of set screws having a key engagement shallower than the deepest listed in Table M-18 for the respective screw size can result in failure of the socket, key, or mating thread during tightening because the key engagement and thread length are less than optimum. It is, therefore, strongly recommended that longer screw lengths having deepest minimum key engagements be used wherever possible.
2. **TORX PLUS Drive Key Engagement:** "I" shall apply for nominal lengths exceeding those listed in Table M-18. Screws shorter than those listed in Table M-18 shall have a key engagement as deep as practicable.
3. **Face:** The face is the flat surface on the socket end of the screw, bounded by the thread and the socket.
   a. **Face angularity:** The plane of the face shall be approximately perpendicular to the axis of the screw.
   b. **Face Chamfer:** The face on screws having a nominal length longer than the nominal screw diameter shall be chamfered. The chamfer angle V shall be between 30° and 45°. The chamfer shall extend slightly below the root of the thread, and the edge between the face and chamfer may be slightly rounded.
   For screws having a nominal length equal to the nominal diameter or shorter, chamfering shall be at the option of the manufacturer. If chamfered, the chamfer angle V shall not exceed 45°.
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 of 0.25mm regardless of feature size.
5. **Length:** The length of the screw shall be measured overall, parallel to the axis of screw.

Socket Set Screws - Metric Sizes

6. **Standard Lengths:** The standard nominal lengths for set screws shall be as follows: 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 30, 40, 45, 50, 55 and 60mm. The minimum practical screw lengths for the respective screw sizes and point styles is represented by the shortest lengths listed in Table M-18 for which "T" and "I" values are shown.
7. **Tolerance On Length:** The tolerance on length shall be bilateral as tabulated below:

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

8. **Threads:** Unless otherwise specified, threads shall be the metric course series in accordance with ANSI Metric Screw Threads – M Profile, ANSI B1.13M.
9. **Thread Tolerance Class:** Threads shall be ISO Tolerance Class 4g6g. For plated screws, the allowance "g" may be consumed by the thickness of the plating, so that the maximum limit of size after plating shall be Tolerance Class 4h6h. Thread limits shall be in accordance with ANSI B1.13M. See Table M-2 on page 45, wherein the limiting dimensions applicable to threads before and after plating are given for reference purposes. The allowable "g" shown therein for those sizes has been increased over that specified in B1.13M. However, because the minimum limits are unchanged, the screws will be totally interchangeable.
10. **Thread Gaging:** At the maximum material limit, threads must be acceptable to thread GO ring gages conforming to American National Standard, American Gaging Practice for Metric Screw Threads, ANSI B1.16M. For the minimum material limit, threads shall be gaged with an indicating type gage having best wire size, single rib, radial contacts spaced 120 degrees apart, set with the respective Class W tolerance thread setting plug gage. Since 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 or internal threads may be required for longer lengths of engagement.
11. **Points:** Unless otherwise specified by the purchaser, Camcar metric socket set screws shall have a cup point conforming to the dimensions in Table M-18.
12. **Point Angles:** The point angles specified shall apply only to those portions of the angles which lie below the root diameter of the thread, it being recognized that the angle may vary in the threaded portion due to manufacturing processes. The point angle or cup points shall be 45°; plus 5° minus 0° for screws of length equal to the nominal screw diameter and longer, and 30° minimum for shorter screws.
13. **Cup Points:** Cup points are produced as Type I or Type III, as shown below. If another point type is required by a customer, it will be considered a special.

Type I  **Type III** 

Table M-19: Diameters of Metric Cup Point Socket Set Screw Points

D	C	
	Cup Point Dia. for Types I and III	
Nom. Size	max.	min.
M3	1.40	1.15
M4	2.00	1.75
M5	2.50	2.25
M6	3.00	2.75
M8	5.00	4.70
M10	6.00	5.70
M12	8.00	7.64
M16	10.00	9.64
M20	14.00	13.57

14. **Material:** Metric socket set screws shall be fabricated from an alloy steel having one or more of the following alloying elements: chromium, nickel, molybdenum, or vanadium, in sufficient quantity to assure that the specified core hardness range of Rockwell C48 to C53 for sizes up to and including 8mm and Rockwell C45 to C53 for sizes over 8mm is met when screw are hardened by quenching from the austenitizing temperature and tempered, meeting the requirements of ASTM F912M. Decarburization and carburization limits shall be as specified in ASTM F912M.

Hardness

Sizes up to and including 8mm ... Rockwell C48 to C53

Sizes over 8mm .... Rockwell C45 to C53

Table M-20: Mechanical and Application Data

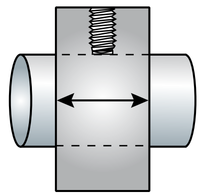
	Hex			TORX PLUS		
Nom. Screw Size	Nom. Key Size	Min. Torsional Strength		Nom. Key Size	Min. Torsional Strength	
		Nm	lb.-in.		Nm	lb.-in.
M3	1.5	1	8.9	6IP	0.92	8.11
M4	2	2.1	19	8IP	2.79	24.7
M5	2.5	4.7	42	10IP	4.47	39.6
M6	3	7.7	68	20IP	13.4	119
M8	4	17.8	158	27IP	28.95	256
M10	5	35	310	40IP	68.4	605
M12	6	57	504	45IP	114.4	1013
M16	8	126	1115	55IP	345.9	3061
M20	10	252	2230	60IP	556.2	4922

Contact an applications specialist for recommended seating torque.

Socket Set Screws - Metric Sizes

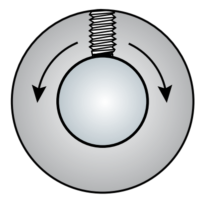
Holding Power: Whereas socket screws rely on tension to create clamping forces, set screws rely on compression to develop holding power, which is the key component in set screw joints. Holding power, typically defined as the amount of force a set-screw joint can withstand without movement, is created by frictional resistance developed when the set screw is tightened. In set screws joints, there are three types of holding power the engineer should be aware of: axial, torsional and dynamic. In some joints, only one type will affect the joint, while in others all three could affect the joint.

Axial holding power is the amount of resistance to lateral movement the set screw can provide. Contact an applications specialist for the maximum amounts of axial holding power a cup point set screw can offer by size. **However, the maximum amounts should never be used,** as over-torquing to develop holding power can cause damage to the set screw and a loss of compressive power.



Axial Holding Power

Torsional holding power is the amount of resistance to rotational movement the set screw can provide. Both axial and torsional holding power are considered static, as they are based upon resistance under load. The approximate amount of torsional holding power a set screw can provide can be determined by multiplying axial holding power by the shaft radius in meters (or T=F x R). For example, a M6 set screw being used on a 0.012 m diameter shaft will provide 4000 N of axial force. Taking 4000 N of axial force (F) times the shaft radius of 0.006 m (R) will net a torsional holding power of 24 Nm.

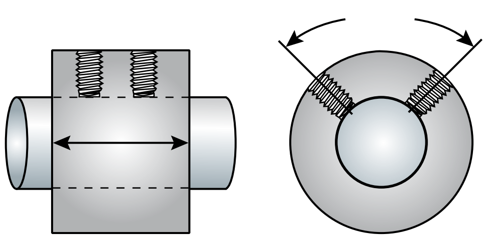


Torsional Holding Power

Dynamic holding power is based upon the set screw's ability to keep the joint fastened under vibration and other dynamic loads. Failure or loosening due to dynamic loading will only occur if the forces acting upon the fastener exceed the axial or torsional holding powers or there is a deformation of the fastener or engagement material.

Holding power can be negatively impacted by such factors as improper hole alignment between the set screw and the axis of the shaft, high lubricity on the mating surface or improper seating torque.

In some instances, more than one set screw will be required to attain the holding power required by the application. If more than one is used, the angle between the screws will most significantly affect the holding power. When the second screw is installed at a 180° angle from the first, holding power is increased by only 30%.



Multiple Set Screws

As the angle between the screws decreases, the overall holding power should increase up to approximately 100%. Actual holding power in your application should be determined through laboratory testing.

Size: For example, a M6 set screw typically provides a maximum of 4000 N holding power, while increasing the diameter to M8 will increase maximum holding power to 6200 N. The diameter of the set screw, in most cases, should be approximately half the diameter of the shaft. For example, when using a 12mm diameter shaft, the set screw should be M6 in diameter.

Seating Torque: Attaining proper seating torque is key in developing the desired axial and/or torsional holding powers. If the set screw is under-torqued, it will not develop enough compressive force to resist lateral and rotational movement. If it is over-torqued, recess and/or thread damage can occur, which will lead to application damage.

Drive System: Most set screw users rely on the hex drive system. However, for high torque set screw applications, or automated assembly situations, the TORX PLUS® Drive System is recommended. Some manufacturers have experienced recess splitting when using hex set screws in high torque applications, causing excessive rework and assembly line downtime. By converting to the TORX PLUS Drive, they are able to drive the set screws at very high torque levels without recess damage. Also, the TORX PLUS Drive allows quicker engagement of the screw on the assembly line for increased production speed.

Other Variables: Other issues to consider include the relative hardness of the set screw point and the shaft; and the frequency of the screws' setting – i.e., are they permanent, semi-permanent or frequently re-set.

Hex Keys and Bits - Metric Sizes

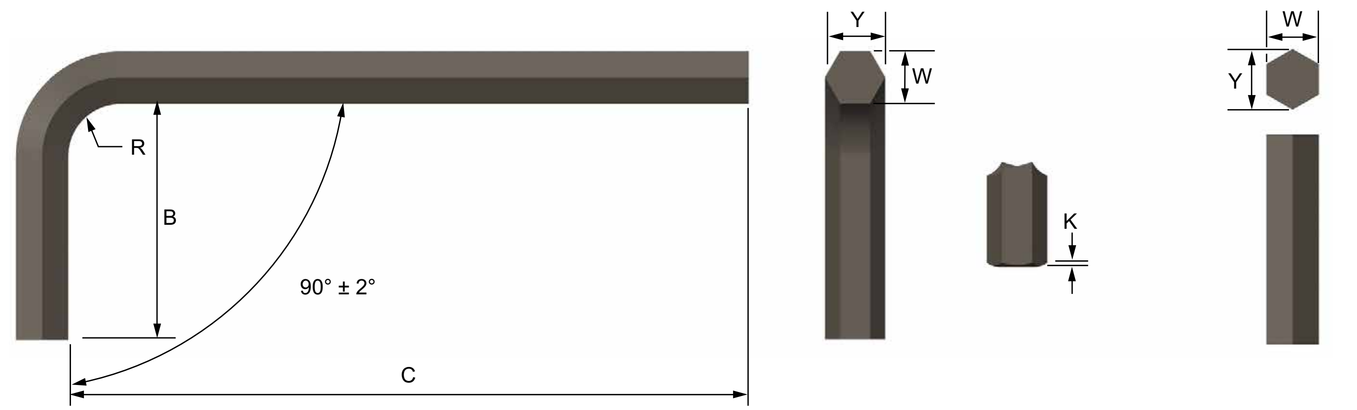


Table M-21: Dimensions of Metric Hex Keys and Bits

Key or Bit Size	W Hexagon Width Across Flats		Y Hexagon Width Across Corners		B Length of Short Arm		C Length of Long Arm				R Radius of Bend	K Chamfer Length
							Short Series		Long Series			
nom.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	min.	max.
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	87	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	25	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	6.328	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	164	206	12.0	0.76
14	14.000	13.930	16.058	15.880	56	53					14.0	0.85
17	17.000	16.930	19.499	19.300	63	60					17.0	1.04
19	19.000	18.930	21.793	21.580	70	67					19.0	1.16

Notes for Metric Hex Keys and Bits

1. Ends: Each end shall be square with the axis of the respective arms of keys and the longitudinal axis of bits within 4°. The edges may be sharp radiused or chamfered at the option of the manufacturer. Where ends are chamfered, the length of the chamfer shall not exceed the values listed for "K" in Table M-21.

2. Truncation of Hex Corners: The truncation or rounding of the hexagon corners within the specified width across corner dimensions shall be evident on all corners.

3. Angle of Bend: The angle of bend between the axis of the short arm and the axis of the long arm on hex keys shall be 90°±2°.

4. Large Keys and Bits: For nominal sizes above 25mm, it is recommended that bits be used in conjunction with standard wrenches or power drives. When the application makes the use of key necessary, the keys should conform to the dimensions specified herein.

5. Plated Keys and Bits: For plated hex keys or bits, all dimensions are before plating.

4. Designation: Hex keys and bits shall be designated by the following data in the sequence shown below.

Nominal key (or bit) size, product name, series (for keys) and protective coating, if required.

Examples:

6mm Hex Key, Short Series

8mm Hex Key, Long Series, Nickel Plated

32mm Hex Bit

Hex Keys and Bits - Metric Sizes

7. **Material:** Hex keys and bits shall be fabricated from an alloy steel having two or more of the following alloying elements: chromium, nickel, molybdenum or vanadium in sufficient quantity to assure that the mechanical and physical requirements specified in ANSI B18.3.2M can be met when the keys and bits are hardened by quenching from the austenitizing temperature and tempered. Metric hex keys and bits will have a hardness range of Rockwell C50 to C57 for nominal sizes up to and including 12mm, and Rockwell C45 to C53 for sizes 13mm and larger. For sizes 2mm and smaller, the microhardness requirement is Knoop 565 to 685 or the Vickers equivalent.
8. **Torsional Strength:** Torsional strength requirements and test procedures are per ASI B18.3.2M. See Table M-22 to the right.

Hardness:

Up to and including 12mm..........Rockwell C50 to C57

13mm and larger...........................Rockwell C45 to 53

Table M-22: Torsional Strength of Metric Hex Keys

Key Size	Minimum Torsional Strength	
mm	Nm	lb.-in.
1.5	1.0	8.9
2	2.1	19.0
2.5	4.7	42.0
3	7.7	68.0
4	17.8	158.0
5	35.0	310.0
6	57.0	504.0
8	126.0	1115.0
10	252.0	2230.0
12	420.0	3780.0
14	670.0	6030.0
17	1180.0	10620.0
19	1670.0	15030.0

Table M-23: Applicability of Metric Keys and Bits

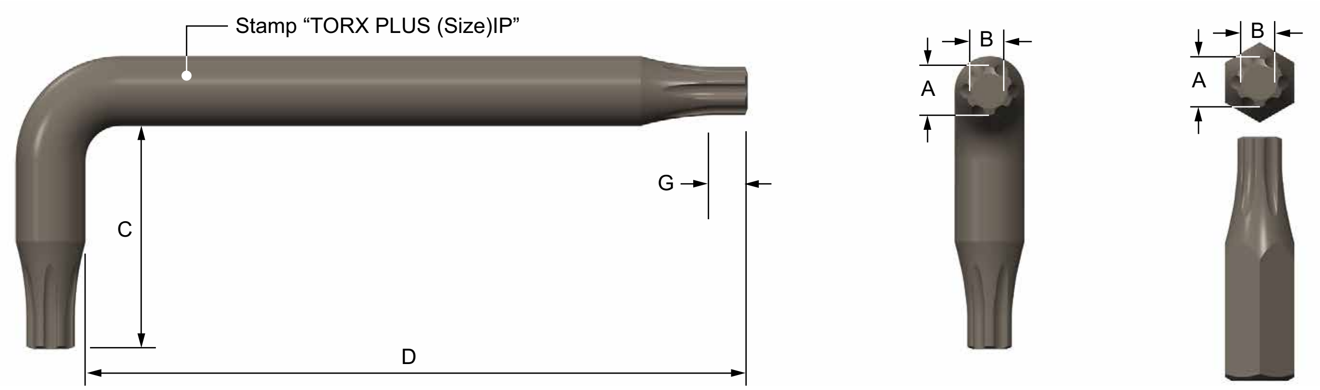
Nom. Key or Bit Size	Nominal Screw Size				
	Cap Screws	Low Head Cap Screws	Flat Countersunk Head Cap Screws	Button Head Cap Screws	Set Screws
1.5	M1.6, M2				M3
2	M2.5		M3	M3	M4
2.5	M3		M4	M4	M5
3	M4	M4	M5	M5	M6
4	M5	M5	M6	M6	M8
5	M6	M6	M8	M8	M10
6	M8	M8	M10	M10	M12
8	M10	M10	M12	M12	M16
10	M12	M12	M14, M16	M16	M20
12	M14	M14	M20		M24
14	M16	M16			
17	M20	M20			
19	M24	M24			

Applications

Metric series keys and bits are primarily intended to be used for tightening and loosening metric series hex socket screw products, but may also be suitable for use on other products having metric hexagon socket wrenching provisions.

For applicability of keys and bits to various socket screw types and sizes, see Table M-23 to the left.

TORX PLUS® Drive Keys and Bits - Metric Sizes



Wrench

Bit

Table M-24: Dimensions of TORX PLUS Metric Keys and Bits

Drive Size	A TORX PLUS Width incl. Lobes ref.	B Width max.	G Length of Configuration min.	C Length of Short Arm nom.	D Length of Long Arm Short Series nom.	Long Series nom.
6IP	1.68	1.31	0.89	15.50	42.16	
7IP	1.98	1.51	1.06	15.50	47.80	
8IP	2.20	1.76	1.22	15.50	47.80	
9IP	2.46	1.90	1.32	15.50	47.80	
10IP	2.72	2.07	1.44	16.80	50.80	85.90
15IP	3.25	2.50	1.71	17.81	54.10	90.41
20IP	3.84	2.98	2.01	19.10	57.20	95.30
25IP	4.39	3.37	2.31	20.30	60.50	100.11
27IP	4.95	3.86	2.59	21.30	63.50	104.90
30IP	5.49	4.27	2.86	23.90	69.90	114.30
40IP	6.60	5.13	3.45	26.20	76.20	124.00
45IP	7.77	6.13	4.04	28.70	82.60	133.40
50IP	8.79	6.83	4.56	31.80	95.30	152.40
55IP	11.18	8.93	5.76	35.10	108.00	171.50
60IP	13.20	10.33	6.86	38.10	120.65	190.55
70IP	15.49	12.21	8.00	41.28	133.35	209.55
80IP	17.51	13.64	9.04	44.45	146.05	228.60
90IP	19.88	15.70	10.28	47.63	158.75	247.65
100IP	22.09	17.42	11.43	53.98	184.15	286.75

Notes for TORX PLUS Metric Keys and Bits:

1. **Ends:** All hand tools (keys) are to have straight end or 5° point chamfer as shown above. No shear tapering or burrs allowed on end.
2. **Dimensions:** All dimensions are before plating. If plating is required, keys will be considered special.

   Dimensions "A" and "B" are to be gaged.
3. **Designation:** TORX PLUS keys shall be designated by the following data in the sequence shown: TORX PLUS drive size, product name, series, and protective coating, if required. Examples:

   8IP, TORX PLUS key, short series

   30IP, TORX PLUS key, long series, nickel-plated
4. **Material:** TORX PLUS keys shall be made of an alloy steel hardened and tempered so as to comply with the physical and mechanical requirements of Federal Specification GGG-K-275 and TORX PLUS Standard TMD-703.
5. **Torsional Strength:** Minimum torsional strength to be tested through fixture per TORX PLUS Standard TMD-703.

TORX PLUS® Keys and Bits - Metric Sizes

Table M-25: Torsional Strength of TORX PLUS Keys

Drive Size	Minimum Torsional Strength Nm	lb.-in.
6IP	0.92	8.11
7IP	1.68	14.9
8IP	2.79	24.7
9IP	3.49	30.9
10IP	4.47	39.6
15IP	8.06	71.4
20IP	13.40	119.0
25IP	19.60	173.0
27IP	28.95	256.0
30IP	39.30	348.0
40IP	68.40	605.0
45IP	114.40	1,013.0
50IP	162.10	1,435.0
55IP	345.90	3,061.0
60IP	556.20	4,922.0
70IP	910.55	8,058.0
80IP	1290.70	11,422.0
90IP	1925.00	17,036.0
100IP	2645.55	23,412.0

Note: When tested to failure, failure should occur with a clean, square shear fracture.

Table M-26: Applicability of Metric TORX PLUS Keys and Bits

Nom. Key or Bit Size	Nom. Screw Size: Socket Head Cap Screws	Low Head Cap Screws	Flat Countersunk Head Cap Screws	Button Head Cap Screws	Set Screws
6IP	M2	M1.8, M2			M3
8IP	M2.5			M3	M4
10IP	M3	M3	M3		M5
15IP				M4	
20IP		M4	M4		M6
25IP	M4	M5	M5	M5	
27IP	M5			M6	M8
30IP	M6	M6	M6		
40IP		M8		M8	M10
45IP	M8		M8	M10	M12
50IP	M10	M10	M10		
55IP	M12	M12	M12	M12	M16
60IP		M14			
70IP	M16	M16	M16		
90IP	M20	M20			
100IP	M24				

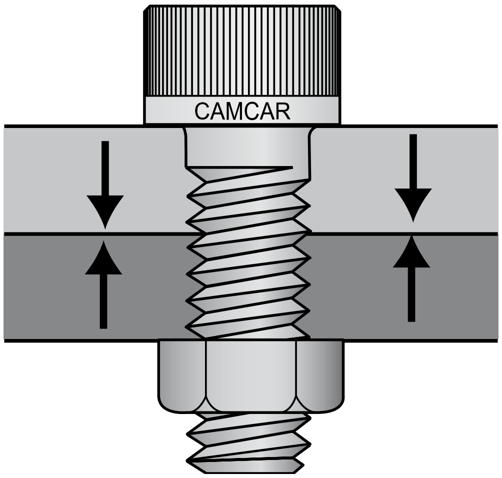
Applications: TORX PLUS keys and bits are intended to be used for tightening and loosening all fasteners incorporating a TORX PLUS Drive recess.

Use With Socket Screws: For applicability of TORX PLUS metric keys to various socket screw types and sizes, see Table M-26 to the left.

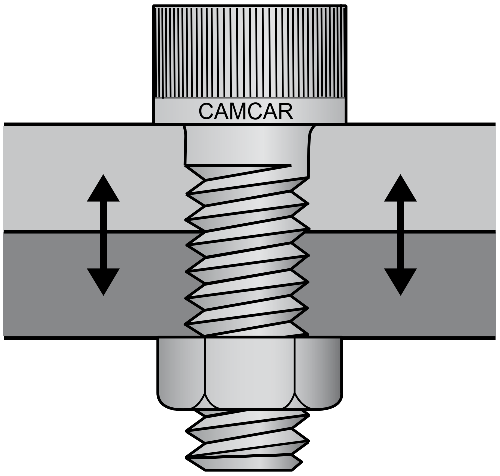
An Overview of Bolted Joint Design

To assure proper bolted joint design, there are many critical factors to consider and steps to take; some are more important than others. The following is designed to provide only a basic discussion of proper joint design. A complete discussion of the topic would be impossible to cover here. If you would like more information on this topic, consult the ASTM International online library at www.astm.org, the most recent *Fastener Standards* by the Industrial Fasteners Institute, or your STANLEY Engineered Fastening applications specialist.

Designing the Joint
Bolt joint design is an iterative process, in that the designer will rely on trial and error, past experience, and their judgement to make some design decisions. As experience and knowledge increases, the designer is able to make better judgements regarding the effect of certain design parameters and decisions. However, regardless of the size, application or operating parameters of a joint, there are some steps which are commonly undertaken.



Clamp



Axial Loading

1. **Define the purpose of the joint:** In this step, define what the joint is designed to do, environmental conditions, cost targets, size and operating parameters, desired life, critical nature, potential failure modes and any other factors involved in the purpose of the joint.
2. **Begin to design the joint:** Determine the layout of the joint, including joint members, size, shape and material.
3. **Estimate service loads:** Estimating service loads is a difficult but very important step, especially in critical joints. The static and dynamic loads to be considered include weight, pressure, shock, inertial effects, thermal effects, etc. Load intensifiers, such as prying and eccentricity, should also be considered.
4. **Define bolts to be used:** With the joint geometry and service loads established, the bolt size, number and strength can be determined. Bolt selection should include material, diameter, thread pitch, length, tensile strength, head style, drive style, thread style, hardness and finish.
5. **Determine required minimum and maximum preload and minimum and maximum clamp load:** The minimum and maximum preload at assembly should be selected to achieve the desired minimum and maximum clamp load for proper function of the joint throughout the life of the product. The minimum clamping force should be great enough to overcome vibration loosening, joint separation, slippage, fatigue, leakage and other similar type failures. Maximum clamp force should not be great enough to cause bolt yielding, joint crushing, stress cracking, fatigue failure, tensile failure or other similar failures in service.

An Overview of Bolted Joint Design

6. Determine tightening methods and assembly line accuracy. During assembly, there are different fastener assembly methods and tightening strategies which must be considered. With these come variances in the accuracy of achieving desired preloads, K factors and the required tightening torque to achive the bolt preload range. Among the potential tightening strategies and their preload accuracy are:

Torque: ±35%
Torque-Angle: ±15%
Torque-to-Yield ±7%

These should be considered before finalizing the joint design, so necessary adjustments can be made to ensure the joint remains reliable during service life.

In determining torque for achieving desired preload, the following equations should be used:

$$T=KDP$$

- P — Tension
- D — Screw Diameter
- K — K Factor (nut factor)
- T — Torque

For example, a 1/4" socket screw with UNRC threads and using a K factor of,0 .21 would have a minimum yield strength of 5,073 lbs. Using 75% of that, 3,805 lbs., gives us the pounds of tension induced in the bolt. Consequently, the formula becomes

T=0.21 lbs x 0.25 in. x 3805 = 200 lb.-in.

7. Finalize joint design: At this point, it may be necessary to make changes in the joint material, bolt preload range, bolt selection, tightening methods, etc., depending upon what was determined during the other steps of the joint design process.

8. Test the application: While joint design continues to become a more exact science as the technical knowledge of fastening increases, there is yet to be a fail-safe method that can eliminate the need for testing in real-world conditions, especially in critical joints. It is highly recommended that testing be performed to prove your joint design and ensure your application achieves the desired level of reliability.

Inch and Metric Size Comparison

Table A-1: Diameter/Thread Pitch Comparison

Inch Sizes		
nom.	Dia. in.	TPI
0	0.0600	80
1	0.0730	64 72
2	0.0860	56 64
3	0.0990	48 56
4	0.1120	40 48
5	0.1250	40 44
6	0.1380	32 40
8	0.1640	32 36
10	0.1900	24 32
1/4	0.2500	20 28
5/16	0.3125	18 24
3/8	0.3750	16 24
7/16	0.4375	14 20
1/2	0.5000	13 20
5/8	0.6250	11 18
3/4	0.7500	10 16
7/8	0.8750	9 14
1	1.000	8 12

Metric Sizes			
nom.	Dia. in.	Pitch mm	TPI (approx.)
M1.4	0.055	0.30 0.20	85 127
M1.6	0.063	0.35 0.20	74 127
M2	0.079	0.40 0.25	64 101
M2.5	0.098	0.45 0.35	56 74
M3	0.118	0.50 0.35	51 74
M4	0.157	0.70 0.50	36 51
M5	0.196	0.80 0.50	32 51
M6	0.236	1.00 0.75	25 34
M8	0.315	1.25 1.00	20 25
M10	0.393	1.50 1.25	17 20
M12	0.472	1.75 1.25	14.5 20
M14	0.551	2.00 1.50	12.5 17
M16	0.630	2.00 1.50	12.5 17
M18	0.709	2.50 1.50	10 17
M20	0.787	2.50 1.50	10 17
M22	0.866	2.50 1.50	10 17
M24	0.945	3.00 2.00	8.5 12.5
M27	1.063	3.00 2.00	8.5 12.5

Tapping Recommendations

Table A-2:
Common Tap Drill Sizes – Inch

Dia.	Pitch UNC	Drill Size in.	Wire, Letter, Fractional	Pitch UNF	Drill Size in.	Wire, Letter, Fractional
0				80	0.0465	#56
1	64	0.0595	#53	72	0.0595	#53
2	56	0.0700	#50	64	0.0700	#50
3	48	0.0785	#47	56	0.0820	#45
4	40	0.0890	#43	48	0.0935	#42
5	40	0.1015	#38	44	0.1040	#37
6	32	0.1065	#36	40	0.1065	#33
8	32	0.1360	#29	36	0.1360	#29
10	24	0.1495	#25	32	0.1590	#21
1/4	20	0.2040	#6	28	0.2187	7/32
5/16	18	0.2610	G	24	0.2720	I
3/8	16	0.3130	5/16	24	0.3320	Q
7/16	14	0.3680	U	20	0.3906	25/64
1/2	13	0.4219	27/64	20	0.4531	29/64
9/16	12	0.4847	31/64	18	0.5120	13mm
5/8	11	0.5469	35/64	18	0.5780	37/64
3/4	10	0.6562	21/32	16	0.6875	11/16
7/8	9	0.7656	49/64	14	0.8125	13/16
1	8	0.8750	7/8	12	0.9219	59/64
1-1/4	7	1.1094	1-7/64	12	1.1719	1-11/64
1-1/2	6	1.3437	1-11/32	12	1.4219	1-43/64

Table A-3:
Common Tap Drill Sizes – Metric

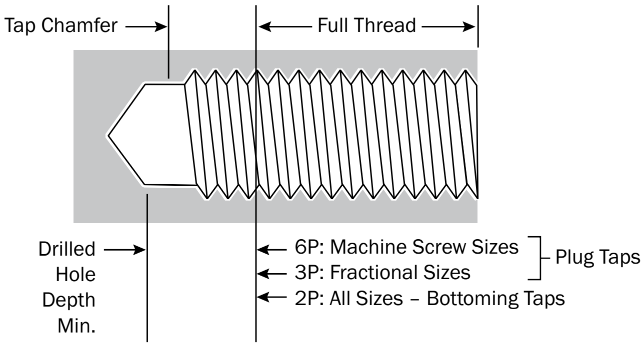
Diameter	Thread Pitch	Drill mm
M3	0.5	2.5
M4	0.7	3.3
M5	0.8	4.2
M6	1.0	5.0
M8	1.25	6.7
M10	1.5	8.5
M12	1.75	10.2
M16	2.0	14.0
M20	2.5	17.5
M24	3.0	21.0

There are two basic factors to consider in tapped hole strength and cost. These are hole depth and tap drill diameters. The deeper the hole, the greater the tapping time and possibility of tool breakage. The smaller the tap drill diameter, the greater the power required to tap and possibility of tool breakage.

Generally, the following minimum engagement lengths are used:

- Hardened steel: 1 diameter
- Soft steel and cast iron: 1.5 diameters
- Aluminum and plastic: 2 diameters

These values vary slightly depending on the percent of thread tapped.



Drilling Depths for Tapping Blind Holes
The minimum depth of a drilled hole for tapping equals the full thread depth plus the number of turns P (pitch) for each style and size of tap.

Hexagon Socket Gaging - Inch

Gaging of Hexagon Sockets (Inch)
Hexagon sockets in screws shall be such as to allow the GO member of the gage to enter freely to the minimum key engagement depths specified in the dimensional tables for the respective screw types.

For hexagon sockets which are not chamfered, the NOT GO gage member shall not enter any of the three across flat dimensions of socket for nominal socket sizes of 1/8" and larger and the hexagonal NOT GO gage member shall not enter the socket for nominal socket sizes smaller than 1/8".

For chamfered hexagon sockets, the NOT GO gage member shall be permitted to enter only to a depth equivalent to 10% of the nominal socket size for nominal socket sizes up to and including 1/16", and to 7.5% of the nominal socket sizes for larger sockets.

Gages
Gages shall be made from gage steel, hardened and tempered to HRC60 minimum. They shall be thermally stabilized and given suitable surface treatment to obtain maximum abrasion resistance.

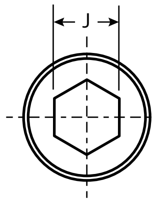
The form of hexagonal gage members shall be within the tolerance zone specified. See American National Standard Engineering Drawing and Related Documentation Practices, Dimensioning and Tolerancing, ANSI Y14.5.

The surface roughness on hexagon flats shall be 8 microinches (mathematical average) maxiumum. See American National Standard, Surface Texture, ANSI B46.1.

The gage handles shall conform with American National Standard, Gage Blanks, ANSI B47.1.

Table A-4: Dimensions of Hexagon Sockets – Inch

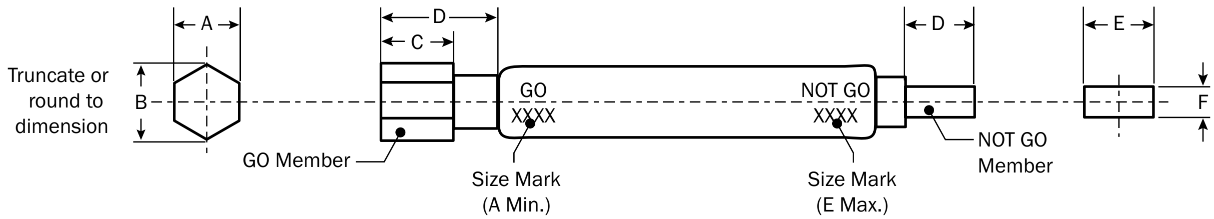
Socket Size		J Socket Width Across Flats		Socket Size		J Socket Width Across Flats		Socket Size		J Socket Width Across Flats	
nom.	dec.	max.	min.	nom.	dec.	max.	min.	nom.	dec.	max.	min.
	0.028	0.0285	0.028	3/16	0.188	0.1900	0.1880	7/8	0.875	0.855	0.875
	0.035	0.0355	0.035	7/32	0.219	0.2217	0.2190	1	1.000	1.020	1.000
	0.050	0.0510	0.050	1/4	0.250	0.2530	0.2500	1-1/4	1.250	1.270	1.250
1/16	0.062	0.0635	0.062	5/16	0.312	0.3160	0.3120	1-1/2	1.500	0.153	1.500
5/64	0.078	0.0791	0.078	3/8	0.375	0.3790	0.3750	1-3/4	1.750	1.785	1.750
3/32	0.094	0.0952	0.094	7/16	0.438	0.4420	0.4380	2	2.000	2.040	2.000
7/64	0.078	0.1111	0.078	1/2	0.500	0.5050	0.5000	2-1/4	2.250	2.295	2.250
1/8	0.125	0.1270	0.125	9/16	0.562	0.5680	0.5620	2-1/2	2.500	2.450	2.500
9/64	0.141	0.1426	0.141	5/8	0.625	0.6310	0.6250	2-3/4	2.750	2.805	2.750
5/32	0.156	0.1587	0.156	3/4	0.750	0.7570	0.7500	3	3.000	3.060	3.000



Notes for Table A-4

1. Applicable socket depths are specified in the dimensional tables and notes for the respective screw types.
2. Sockets up to and including 1" nominal size shall be checked in accordance with the Hexagon Socket Gages and Gaging specified. Suitability of larger sockets shall be determined by means of direct measurement for various technical and economic reasons.
3. For broached sockets that are at or near the maximum limit of size, the overcut resulting from drilling shall not exceed 20 percent of the length of any flat of the socket on sizes up to and including 1" and 30 percent on large sockets.
4. Where hexagon sockets are chamfered, the depth of chamfer shall not exceed 10 percent of the nominal socket size for sizes up to and including 1/16", and 7.5 percent for larger sizes. For chamfered sockets, it is permissible for the NOT GO socket gage to enter the depth of the chamber.

Hexagon Socket Gaging - Inch



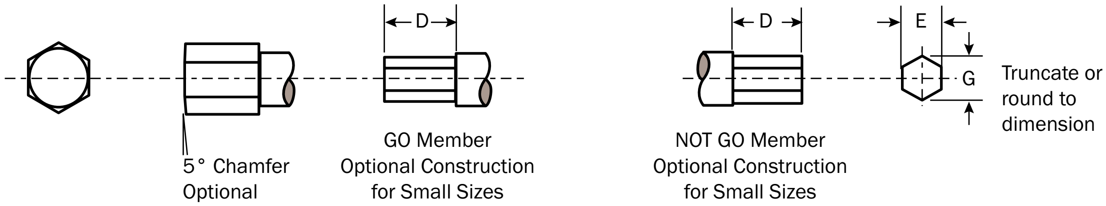


Table A-5: Dimensions of Gages for Hexagon Sockets – Inch

Socket Size		A GO Gage Width Across Flats		B GO Gage Width Across Corners		C GO Gage Length	D Usable Gage Length	E NOT GO Gage Width		F NOT GO Gage Thickness		G NOT GO Gage Width Across Corners	
nom.	dec.	max.	min.	max.	min.	min.	min.	max.	min.	max.	min.	max.	min.
	0.028	0.0281	0.0280	0.0316	0.0314	0.062	0.062	0.0285	0.0284			0.0308	0.0300
	0.035	0.0351	0.0350	0.0395	0.0393	0.093	0.093	0.0355	0.0354			0.0386	0.0381
	0.050	0.0501	0.0500	0.0562	0.0560	0.187	0.187	0.0510	0.0509			0.0550	0.0545
1/16	0.062	0.0626	0.0625	0.0703	0.0701	0.187	0.187	0.0635	0.0634			0.0688	0.0683
5/64	0.078	0.7820	0.0718	0.0882	0.0880	0.187	0.187	0.0791	0.0790			0.0862	0.0857
3/32	0.094	0.0939	0.0937	0.1060	0.1058	0.250	0.250	0.0952	0.0950			0.1036	0.1301
7/64	0.078	0.1096	0.1094	0.1240	0.1238	0.250	0.250	0.1111	0.1109			0.1212	0.1207
1/8	0.125	0.1252	0.1250	0.1420	0.1418	0.250	0.250	0.1270	0.1268	0.057	0.055		
9/64	0.141	0.1408	0.1416	0.1595	0.1593	0.250	0.250	0.1426	0.1424	0.064	0.062		
5/32	0.156	0.1564	0.1562	0.1776	0.1174	0.250	0.250	0.1587	0.1585	0.071	0.069		
3/16	0.188	0.1877	0.1875	0.2137	0.2135	0.250	0.038	0.1900	0.1898	0.088	0.086		
7/32	0.219	0.2189	0.2187	0.2492	0.2490	0.250	0.437	0.2217	0.2215	0.102	0.100		
1/4	0.250	0.2502	0.2500	0.2848	0.2845	0.312	0.500	0.2530	0.2528	0.117	0.115		
5/16	0.312	0.3127	0.3120	0.3573	0.3570	0.312	0.625	0.3160	0.3158	0.150	0.148		
3/8	0.375	0.3752	0.3750	0.4288	0.4285	0.500	0.750	0.3790	0.3788	0.180	0.178		
7/16	0.438	0.4377	0.4375	0.5008	0.5005	0.500	0.875	0.4420	0.4418	0.211	0.209		
1/2	0.500	0.5002	0.5000	0.5718	0.5715	0.500	1.000	0.5050	0.5048	0.241	0.239		
9/16	0.562	0.5677	0.5625	0.6424	0.6420	0.750	1.125	0.5680	0.5678	0.269	0.267		
5/8	0.625	0.6252	0.6250	0.7150	0.7146	0.750	1.250	0.6310	0.6308	0.302	0.300		
3/4	0.750	0.7502	0.7500	0.8585	0.8580	0.750	1.500	0.7570	0.7568	0.364	0.362		
7/8	0.875	0.8752	0.8750	1.0025	1.0020	0.875	1.750	0.8850	0.8848	0.423	0.421		
1	1.000	1.0020	1.0000	1.4750	1.1470	1.000	2.000	1.0100	1.0098	0.489	0.487		

Notes for Table A-5:
The gages specified herein are intended for use in determining the acceptability of sockets up to and including the 1" nominal hexagon socket size. Suitability of hexagon sockets of nominal sizes larger than 1" shall be determined by direct measurement for various technical and economical reasons.

Hexagon Socket Gaging - Metric

Gaging of Metric Sockets
Acceptability of sockets shall be determined by the use of the hexagon socket gages specified. The hexagon sockets shall allow the GO member of the gage to enter freely to the minimum key engagement depth.

The NOT GO gage member shall be permitted to enter only a depth equivalent to 10% of the nominal socket size for nominal socket sizes up to and including 1.5mm, and to 7.5% of the nominal socket sizes for larger sockets.

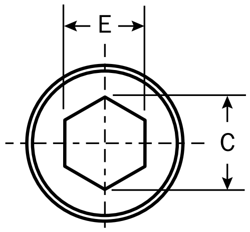
To determine the acceptability of sockets in plated products after plating, a GO gage identical in design and tolerances to that shown except having a width across flats dimension equal to the nominal key size shall be employed.

Edge of Socket
The edge at junction of the socket with the face may be broken (rounded or chamfered) providing the depth of chamfer or rounding will not cause violation of the NOT GO gage penetration limits specified.

Broached Sockets
For hexagon broached sockets at or near the maximum limit of size, the overcut resulting from drilling shall not exceed 20% of the length of any flat of the socket.

Table A-6: Dimensions of Hexagon Sockets – Metric

Nominal Socket Size	E NOT GO Gage Width		C Dimensions Across Corners
	max.	min.	min.
0.7	0.724	0.711	0.803
0.9	0.902	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	1.020	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
14	14.159	14.032	16.090
17	17.216	17.050	19.560
19	19.243	19.605	21.870
22	22.319	22.065	25.310
24	24.319	24.065	27.600
27	27.319	27.065	31.040
32	32.461	32.080	36.800
36	36.461	36.080	41.380



Hexagon Socket Gaging - Metric

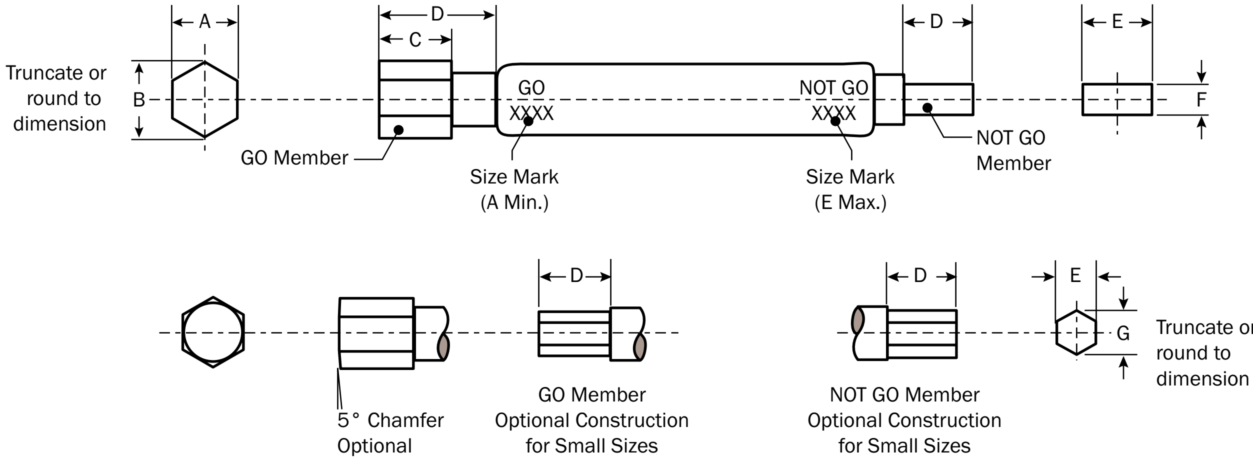


Table A-7: Dimensions of Gages for Hexagon Sockets – Metric

Socket Size		A GO Gage Width Across Flats		B GO Gage Width Across Corners		C GO Gage Length	D Usable Gage Length	E NOT GO Gage Width		F NOT GO Gage Thickness		G NOT GO Gage Width Across Corners	
nom.	dec.	max.	min.	max.	min.	min.	min.	max.	min.	max.	min.	max.	min.
0.7	0.714	0.711	0.711	0.803	0.798	1.5	1.5	0.724	0.721			0.782	0.770
0.9	0.892	0.889	0.889	1.003	0.998	2.4	2.4	0.902	0.899			0.980	0.968
1.3	1.273	1.270	1.270	1.427	1.422	4.7	5.0	1.295	1.293			1.397	1.364
1.5	1.523	1.520	1.520	1.730	1.725	5.0	5.0	1.545	1.543			1.680	1.660
2	2.023	2.020	2.020	2.300	2.295	5.0	7.0	2.045	2.043			2.230	2.210
2.5	2.525	2.520	2.520	2.870	2.865	7.0	7.0	2.560	2.554			2.790	2.770
3	3.025	3.020	3.020	3.440	3.435	7.0	7.0	3.071	3.006			3.350	3.330
4	4.025	4.020	1.020	4.580	4.575	7.0	7.0	4.084	4.079	1.80	1.75		
5	5.025	5.020	5.020	5.720	5.715	7.0	7.0	5.084	5.079	2.30	2.25		
6	6.025	6.020	6.020	6.860	6.855	8.0	12.0	6.095	6.091	2.80	2.75		
8	8.030	8.025	8.025	9.150	9.145	8.0	16.0	8.115	8.109	3.80	3.75		
10	10.030	10.025	10.025	11.500	11.495	12.0	20.0	10.127	10.122	4.80	4.75		
12	12.037	12.032	12.032	13.800	13.795	12.0	24.0	12.146	12.141	5.75	5.70		
14	14.037	14.032	14.032	16.090	16.085	12.0	28.0	14.159	14.154	6.75	6.70		
17	17.055	17.050	17.050	19.560	19.555	19.0	34.0	17.216	17.211	8.10	8.05		
19	19.070	19.065	19.605	21.870	21.865	19.0	38.0	19.243	19.238	9.10	9.05		
22	22.070	22.065	22.065	25.310	25.305	22.0	44.0	22.319	23.314	10.50	10.45		
24	24.070	24.065	24.065	27.600	27.595	25.0	48.0	24.319	24.314	11.50	11.45		

Gages

Gages shall be made from gage steel, hardened and tempered to HRC60 minimum. They shall be thermally stabilized and given suitable surface treatment to obtain maximum abrasion resistance.

The form of hexagonal gage members shall be within the tolerance zone specified. See American National Standard Engineering Drawing and Related Documentation Practices, Dimensioning and Tolerancing, ANSI Y14.5.

The surface roughness on hexagon flats shall be 8 microinches (mathematical average) maximum. See American National Standard, Surface Texture, ANSI B46.1.

The gage handles shall conform with American National Standard, Gage Blanks, ANSI B47.1.

TORX PLUS® Socket Gaging - Inch & Metric

The applicable penetration gaging depths for various sizes and styles of TORX PLUS socket head screws are specified in the dimensional tabulations for the respective screw types and/or the TORX PLUS Engineering Standards.

Tamper-resistant TORX PLUS recesses are available in most head styles. Contact STANLEY Engineered Fastening Decorah Operations for application assistance.

Gaging
Two varieties of penetration gages for acceptance inspection purposes are available. The dial indicating the type as shown in Figure 1, and the hand plug type as depicted in Figure 2. The dial type is preferred, due to its ease of use and broader versatility. Gage members applicable to both types of gages are available.

Gaging Procedure
All penetration gaging shall be performed relative to the top surface of the screw head. In the case of head styles having rounded top corners, measurements shall be taken from the actual intersection of the top surface of the head with the socket counterbore.

Dial Type Gages
The dial penetration gage shall be set at "zero" while the nose surface of gage is pressed flush against a flat surface. The GO gage member shall then be oriented such that it enters freely into the socket and with the nose of gage head pressed against the screw head, the penetration depth read directly on the dial. The gage member shall be rotated with respect to the socket so that a minimum of three adjacent lobes of the socket are engaged by a common lobe on the gage to unsure that all dimensions and radii are checked. All readings so taken shall be equal to or exceed the specified minimum GO gage penetration.

Hand Plug Type Gages
The GO gage member on hand type gages must be etched, step relieved, ground off to length or otherwise processed to properly demark the extent of the specified minimum penetration depth for the respective size and head style of the screw under inspection. Therefore, the hand-type gage members can not be used for various depths and screw head styles. The GO end of the gage shall be inserted, parallel to the axis of the screw, into the socket and shall enter freely to a depth such that the minimum penetration demarcation is flush with or below the top of the screw head. The gage member shall be rotated with respect to the socket so that a minimum of three adjacent lobes of socket are engaged by a common lobe on the gage to insure that all dimensions and radii are checked.

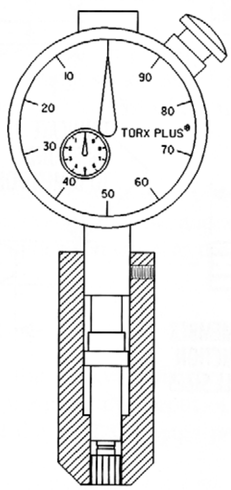


Figure 1

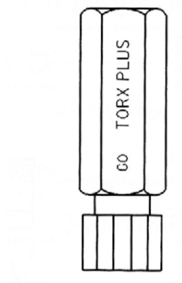


Figure 2

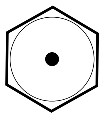
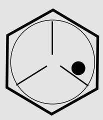
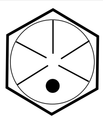
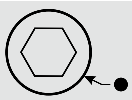
Table A-8:
Dimensions of TORX PLUS Sockets

TORX PLUS Recess Size	A Ref. in.	A Ref. mm
6IP	0.069	1.75
7IP	0.081	2.06
8IP	0.094	2.39
9IP	0.101	2.57
10IP	0.111	2.82
15IP	0.132	3.35
20IP	0.155	3.94
25IP	0.178	4.52
27IP	0.200	5.08
30IP	0.221	5.61
40IP	0.266	6.76
45IP	0.312	7.92
50IP	0.352	8.94
55IP	0.446	11.33
60IP	0.529	13.44
70IP	0.619	15.72
80IP	0.700	17.75
90IP	0.795	20.19
100IP	0.880	22.40

Fastener Strength and Grade Markings

Fastener markings are designed to provide two important pieces of information: the specification to which the fastener was manufactured, and the manufacturer's identification mark. On inch-sized socket screws, STANLEY Engineered Fastening's identification may appear as "Camcar". On metric-sized socket screws, it may appear as "12.9" or "Camcar 12.9". Head markings of registered manufacturers can be found at www.uspto.gov/trademarks/law/fastener/fqa.jsp .

Table A-9: Fastener Strength/Grade Markings – Inch

Fastener Properties					Mechanical Properties		
Identification Grade Mark	Product Specifications	Fastener Description	Nominal Size Range in.	Material	Min. Tensile Strength psi	Min. Yield Strength psi	Proof Load psi
	Grade 2	Bolts, screws, studs	1/4 through 3/4	Low or medium carbon steel	74,000	57,000	55,000
			over 3/4 to 1-1/2		60,000	36,000	33,000
	Grade 5	Bolts, screws, studs	1/4 through 1	Medium carbon steel, quenched and tempered	120,000	92,000	85,000
			1 through 1-1/2		105,000	81,000	74,000
			Over 1-1/2 through 3		90,000	58,000	55,000
	Grade 8	Bolts, screws, studs	1/4 through 1-1/2	Medium carbon steel, quenched and tempered	150,000	130,000	120,000
	Socket Screw	Socket head cap screws	#0 through 1/2	Alloy steel, quenched and tempered	180,000	162,000	140,000
			Over 1/2 through 2		170,000	153,000	135,000

● Denotes location of manufacturer's I.D.

Table A-10: Fastener Strength/Grade Markings – Metric

Identification Grade Mark	Product Specification	Fastener Description	Material	Mechanical Properties Min. Tensile Strength MPa	Min. Yield Strength MPa	Proof Load MPa
	Class 5.8	Bolts, screws, studs	Low or medium carbon steel	520 (75,900 psi)	420	380
	Class 8.8	Bolts, screws, studs	Medium carbon steel, quenched and tempered	830 (120,000 psi)	640	600
	Class 10.9	Bolts, screws, studs	Medium carbon steel, quenched and tempered	1040 (150,000 psi)	1100	920
	Class 12.9	Socket head cap screws	Alloy steel, quenched and tempered	1220	1100	920

● Denotes location of manufacturer's I.D.

Warning: Inch standard and metric Class 12.9 socket head cap screws are considered comparable. However, outside the United States, manufacturing of socket head cap screws to other classes is permitted. If your application requires property class 12.9 socket head cap screws, it is important that you verify with your supplier that what you are buying meets those specifications.

Combining high-stressed socket screws joints with a corrosive environment increases the risk of stress corrosion failure.

Standard Hardness Conversion Tables

Table A-11: Hardened Carbon Steel and Hard Alloys

Rockwell C	Rockwell A	Rockwell 15-N	Rockwell 30-N	Rockwell 45-N	Knoop 500 GR and over	Brinell 3000 KG†	Tensile Strength approx.
71	87.0		86.5	78.5			
70	86.5	94.0	86.0	77.5	972		
69	86.0	93.5	85.0	76.5	946		
68	85.6	93.2	84.4	75.4	920		
67	85.0	92.9	83.6	74.2	895		
66	84.5	92.5	82.8	73.3	870		
65	83.9	92.2	81.9	72.0	846		
64	83.4	91.8	81.1	71.0	822		
63	82.8	91.4	80.1	69.9	799		
62	82.3	91.1	79.3	68.8	776		
61	81.8	90.7	78.4	67.7	754		
60	81.2	90.2	77.5	66.6	732		
59	80.7	89.8	76.6	65.5	710		
58	80.1	89.3	75.7	64.3	690	615	
57	79.6	88.9	74.8	63.2	670	595	
56	79.0	88.3	73.9	62.0	650	577	
55	78.5	87.9	73.0	60.9	630	560	301
54	78.0	87.4	72.0	59.8	612	543	292
53	77.4	86.9	71.2	58.6	594	525	283
52	76.8	86.4	70.2	57.4	576	512	273
51	76.3	85.9	69.4	56.1	558	496	264
50	75.9	85.5	68.5	55.0	542	481	255
49	75.2	85.0	67.6	53.8	526	469	246
48	74.7	84.5	66.7	52.5	510	455	237
47	74.1	83.9	65.8	51.4	495	443	229
46	73.6	83.5	64.8	50.3	480	432	222
45	73.1	83.0	64.0	49.0	466	421	215
44	72.5	82.5	63.1	47.8	452	409	208
43	72.0	82.0	62.2	46.7	438	400	201
42	71.5	81.5	61.3	45.5	426	390	194
41	70.9	80.9	60.4	44.3	414	381	188
40	70.4	80.4	59.5	43.1	402	371	181
39	69.9	79.9	58.6	41.9	391	362	176
38	69.4	79.4	57.7	40.8	380	353	171
37	68.9	78.8	56.8	39.6	370	344	168
36	68.4	78.3	55.9	38.4	360	336	162
35	67.9	77.7	55.0	37.2	351	327	157
34	67.4	77.2	54.2	36.1	342	319	153
33	66.8	76.6	53.3	34.9	334	311	149
32	66.3	76.1	52.1	33.7	326	301	145
31	65.8	75.6	51.3	32.5	318	294	142
30	65.3	75.0	50.4	31.3	311	286	138
29	64.7	74.5	49.5	30.1	304	279	135
28	64.3	73.9	48.6	28.9	297	271	132
27	63.8	73.3	47.7	27.8	290	264	128
26	63.3	72.8	46.8	26.7	284	258	125
25	62.8	72.2	45.9	25.5	278	253	122
24	62.4	71.6	45.0	24.3	272	247	120
23	62.0	71.0	44.0	23.1	266	243	117
22	61.5	70.5	43.2	22.0	261	237	114
21	61.0	69.9	42.3	20.7	256	231	112
20	60.5	69.4	41.5	19.6	251	226	110

Table A-12: Soft Carbon Steel

Rockwell B	Rockwell F	Rockwell 15-T	Rockwell 30-T	Rockwell 45-T	Rockwell A	Knoop 500 GR and over	Brinell 3000 KG†	Tensile* Strength approx.
100		93.1	83.1	72.9	61.5	251	240	116
98		92.5	81.8	70.9	60.2	241	248	109
96		91.8	80.4	68.9	58.9	231	216	103
94		91.2	79.1	66.9	57.6	221	205	98
92		90.5	77.8	64.8	56.4	211	195	93
91		90.2	77.1	63.8	55.8	206	190	91
89		89.5	75.8	61.8	54.6	196	180	87
88		89.2	75.1	60.8	54.0	192	176	85
86		88.6	73.8	58.8	52.8	184	169	83
84		87.9	72.4	56.8	51.7	176	162	78
82		87.3	71.1	54.8	50.6	170	156	76
80		86.6	69.7	52.8	49.5	164	150	73
78		86.0	68.4	50.8	48.4	158	144	
76		85.3	67.1	48.8	47.3	152	139	
75	99.6	85.0	66.4	47.8	46.8	150	137	
74	99.1	84.7	65.7	46.8	46.3	147	135	
72	98.0	84.0	64.4	44.8	45.3	143	130	
70	96.8	83.4	63.1	42.8	44.3	139	125	
68	95.6	82.7	61.7	40.8	43.3	135	121	
66	94.5	82.1	60.4	38.7	42.3	131	117	
64	93.4	81.4	59.0	36.7	41.4	127	114	
62	92.2	80.8	57.7	34.7	40.4	124	110	
60	91.1	80.1	56.4	32.7	39.5	120	107	
58	90.0	79.5	55.0	30.7	38.6	117	104	
56	88.8	78.8	53.7	28.7	37.7	114	101	
54	87.7	78.2	52.4	26.7	36.8	111		
52	86.5	77.5	51.0	24.7	35.9	109		
50	85.4	76.9	49.7	22.7	35.0	107		
49	84.8	76.6	49.0	21.7	34.6	106		
47	83.7	75.9	47.7	19.7	33.7	104		
45	82.6	75.3	46.3	17.7	32.9	102		
43	81.4	74.6	45.0	15.7	32.0	100		
41	80.3	74.0	43.7	13.6	31.2	98		
39	79.1	73.3	42.3	11.6	30.3	96		
37	78.0	72.7	41.0	9.6	29.5	94		
35	76.9	72.0	39.6	7.6	28.7	92		
33	75.7	71.4	38.3	5.6	27.8	90		
31	74.6	70.7	37.0	3.6	27.0	88		
30	74.0	70.4	36.3	2.6	26.6	87		

Reference: ASTM E140

NOTES:

† Tungsten carbide ball

* Tensile strength is psi x 1000. These cross-reference numbers hold for carbon steel only.

Decarburization and Discontinuity Limits - Inch

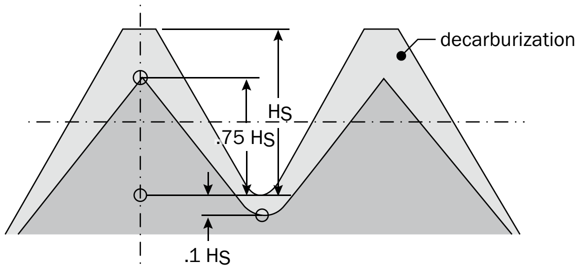


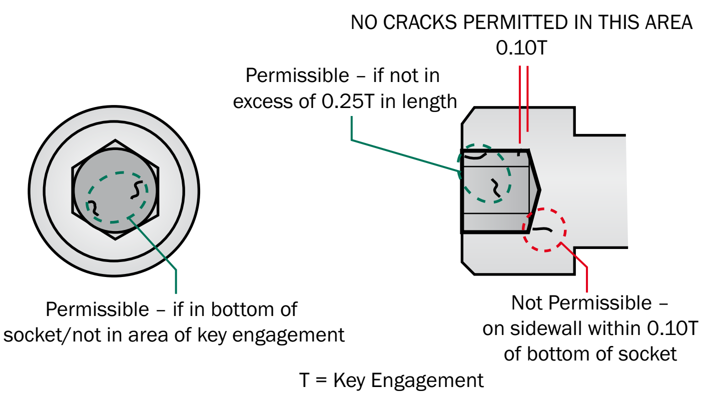
Table A-13: Decarburization Limits – Inch

Threads per in.	Thread Height H5	0.75 H from Root to Crest min.	01 H at Root max.	Threads per in.	Thread Height H5	0.75 H from Root to Crest min.	01 H at Root max.
80	0.008	0.006	0.001	16	0.038	0.029	0.004
72	0.009	0.007	0.001	14	0.044	0.033	0.004
64	0.010	0.008	0.001	13	0.047	0.035	0.005
56	0.011	0.008	0.001	12	0.051	0.038	0.005
48	0.013	0.010	0.001	11	0.056	0.042	0.006
44	0.014	0.011	0.001	10	0.031	0.046	0.006
40	0.015	0.011	0.002	9	0.068	0.051	0.007
36	0.017	0.013	0.002	8	0.077	0.058	0.008
32	0.019	0.014	0.002	7	0.088	0.066	0.009
28	0.022	0.017	0.002	6	0.102	0.077	0.010
24	0.026	0.020	0.003	5	0.123	0.092	0.012
20	0.031	0.023	0.003	4.5	0.136	0.102	0.014
18	0.034	0.026	0.003	4	0.153	0.115	0.015

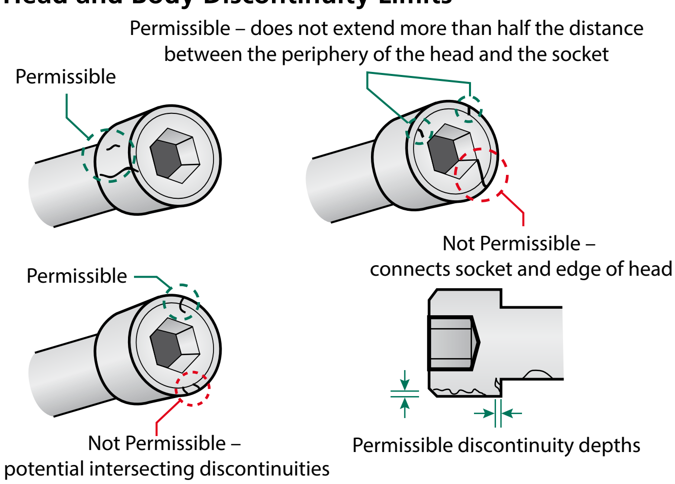
Reference Standard: ASTM A 574

Carburization or Decarburization – Inch
There shall be no evidence of carburization or total decarburization on the surfaces of the heat treated screws when measured using optical or microhardness methods. The depth of partial decarburization shall be limited to the values in Table A-13 when measured as shown in the illustration above Table A-13.

Socket Discontinuity Location and Limits



Head and Body Discontinuity Limits



Discontinuities

Socket
Depth of discontinuities in the socket area are allowed to a maximum depth of 0.03D or 0.005", whichever is greater, providing they do not affect the usability and performance of the screw.

Head and Shank
Discontinuities as defined above are permitted in the locations illustrated to the left to a maximum depth of 0.03D or 0.005", whichever is greater, in the bearing area, fillet and other surfaces. For peripheral discontinuities, a maximum depth of 0.06D, but not over 0.064" is permissible. 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.

Threads
Threads shall have no laps at the root or in the flanks located below the pitch line. Laps are permissible at the thread crest to a depth of 25% of the basic thread height and on the thread flanks beyond the pitch diameter. Longitudinal seams in the threads are acceptable to a maximum depth of 0.03D or 0.005", whichever is greater.

For additional information, reference ASTM A 574.

Decarburization and Discontinuity Limits - Metric

Reference Standard: ASTM A 574M

Carburization or Decarburization – Metric
There shall be no evidence of carburization or total decarburization on the surfaces of the heat treated screws when measured using optical or microhardness methods. The depth of partial decarburization shall be limited to the values in Table A-14 when measured as shown in the illustration above Table A-14.

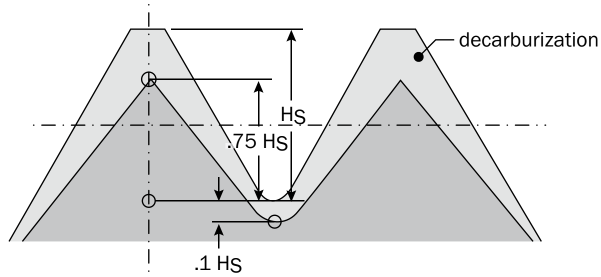


Table A-14: Decarburization Limits – Metric

Thread Pitch mm	Thread Height mm	0.75 H from Root to Crest mm
0.35	0.215	0.161
0.40	0.245	0.184
0.45	0.276	0.207
0.50	0.307	0.230
0.70	0.429	0.322
0.80	0.491	0.368
1.00	0.613	0.460
1.25	0.767	0.575
1.50	0.920	0.690
1.75	1.074	0.806
2.00	1.227	0.920
2.50	1.534	1.151
3.00	1.840	1.380

Discontinuities

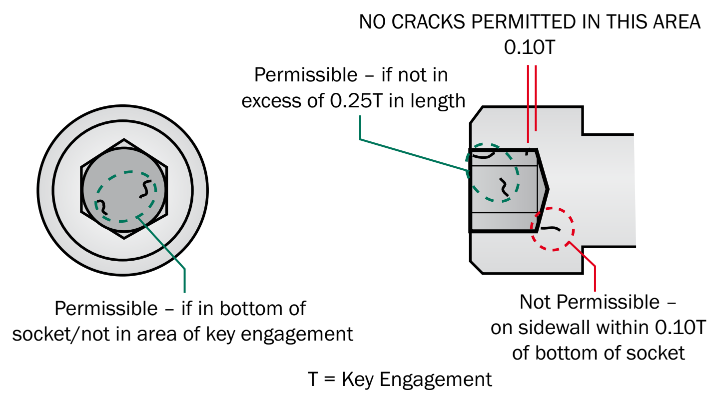
Socket
Forging defects that connect the socket to the periphery of the head are not permissible. Defects originating on the periphery and with a transverse indicating a potential to intersect are not permissible. Other forging defects are permissible, provided those located in the bearing area, fillet and top surfaces to not exceed a depth of 0.03D or 0.13mm, whichever is greater. For peripheral discontinuities, the maximum depth may be 0.06D but not to exceed 1.6mm.

Head and Body
Seams in the shank shall not exceed a depth of 0.03D or 0.2mm, whichever is greater. No transverse discontinuities shall be permitted in the head-to-shank fillet area.

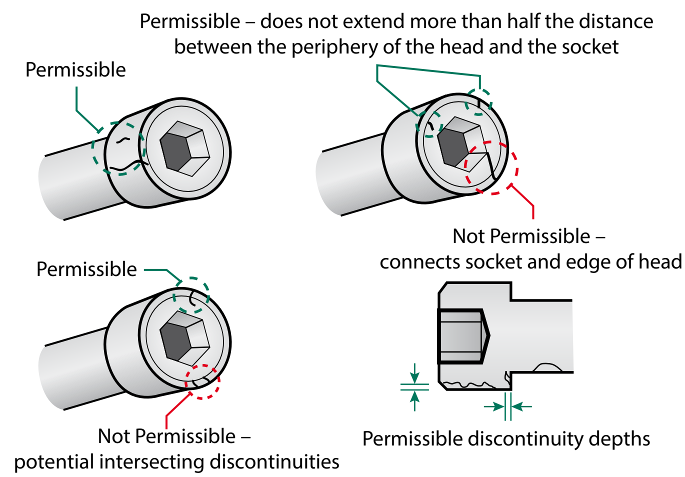
Threads
Threads shall have no laps at the root or in the flanks located below the pitch line. Laps are permissible at the thread crest to a depth of 25% of the basic thread height and on the thread flanks beyond the pitch diameter. Longitudinal seams in the threads are acceptable to a maximum depth of 0.03D or 0.2mm, whichever is greater.

For additional information, reference ASTM A 574M.

Socket Discontinuity Location and Limits



Head and Body Discontinuity Limits



Elements added to Camcar Socket Screws

The steels used to manufacture Camcar socket screw combine carbon, iron and various other elements. These elements are added to improve the fasteners' physical properties and characteristics. Typically, alloying elements are added to perform one or more of the following functions: improve heat response, achieve desired work hardening rate, and/or refine the grain structure. The effects of base elements iron and carbon, as well as the alloying elements added to Camcar socket screws, are outlined below.

Base Elements

Iron (Fe): Iron is the base for carbon and stainless steels. It is typically considered detrimental in aluminum, brass and other similar metals. Because pure iron does not provide sufficient strength or heat treat response and is soft and ductile, alloying elements are necessary.

Carbon (C): The carbon element in steel provides strength, hardness and wear resistance. It is found in both alloys and stainless steels. If the carbon content of stainless steel is too high, it can negatively effect the steel's ability to resist corrosion. Carbon steel fasteners fall into the following groups:

1. **Low carbon:** This material has low carbon content, typically less than 0.3%, and provides poor heat treat response in large diameter parts. Carbon content is sufficient for properly heat treating smaller diameter parts. Typically used in low strength applications.
2. **Medium carbon:** This material has sufficient carbon content, typically over 0.3%, to allow heat treatment for higher tensile strength. However, since it contains no alloying elements, as the size of the fastener increases, the strength of the fastener decreases because it can't be hardened to full depth.
3. **Alloy steel:** Carbon steel fasteners are considered an alloy steel when they contain a specified minimum level of manganese, silicon, copper, aluminum, boron, columbium, molybdenum, chromium, nickel, titanium, vanadium and/or any other element added to achieve a specific effect. Also, the chromium content is less than 4%. If it is more than 4%, then it is stainless steel. The elements following are added to attain specific physical properties.

Alloying Elements

Aluminum (Al): Added to alloy steels, aluminum restricts grain growth and control grain size in non-heat-treatable stainless steels. When used in nitriding steels in amounts of 1 – 1.25%, it produces uniformly hard and strong nitrided case.

Boron (B): Boron is a very effective and economical additive for improving heat treat response in alloy steels. It is added in amounts as small as 0.003%. If boron has been added to the raw material, the letter "B" will appear in the name. For example, 4037 steel is designated 40B37 when it contains boron.

Alloying Elements, continued

Chromium (Cr): Chronium is an alloying element for both alloy and stainless steels. This additive is designed to increase strength, toughness, hardness and wear resistance. At high temperatures, it helps resist corrosion and scaling. If a steel has over 4% chromium content, it may be considered a stainless steel.

Columbium (Cb): Columbium, used in some microalloys, is also called niobium. It refines the grain structure of the material in order to improve heat treat response and work hardening rates.

Copper (Cu): Copper in small amounts is found in materials such as 302HQ stainless steel and is the major element in brass and other similar materials. It is added for increased strength and resistance to corrosion.

Manganese (Mn): Manganese is considered a universal element since it is a key ingredient in virtually all steels. It improves tensile strength, hardness, response to heat treat and surface quality.

Molybdenum (Mo): Molybdenum is added to both alloy and stainless steels. It increases strength, toughness, hardness, response to heat treat, machinability and corrosion resistance. Also, molybdenum enhances the effects of other alloying elements.

Nickel (Ni): Used in alloy and stainless steels, nickel increases strength and hardness and assures more consistent results from heat treat. In high-chromium content stainless steels, it helps to resist corrosion and scaling at high temperatures.

Nitrogen (N): Used in some alloys, microalloys and stainless steels, nitrogen significantly increases work hardening rates. In some alloy steels with aluminum or chromium content, it acts as a nitriding or carbonitriding agent to provide an extremely hard case after heat treat.

Silicon (Si): Like manganese, silicon is a universal element. It increases strength, hardness and formability.

Sulfur (S): Sulfur is added to 430F stainless steel and other steels, with manganese, to approve machinability.

Titanium (Ti): Titanium is used in some microalloys and stainless steels for resistance to carbide precipitation.

Vanadium (V): An additive for some alloys and microalloys, vanadium increases strength and hardness, while improving toughness and high temperature mechanical properties.

Finish Selection

Table A-15: Finish Selection

○ Poor

● (grey) Average

● Good

	Corrosion Resistance	Galvanic Corrosion	Torque-Tension Scatter	Thickness Uniformity	Damage Resistance	Temperature Resistance	Automation Compatibility	Health-problem Avoidance	Appearance	Availability	Cost
Electro-plated zinc with chromate	Average	Poor	Poor	Good	Average	Poor	Good	Average	Average	Good	Average
Electroplated copper, nickel or chrome	Poor	Poor	Poor	Good	Average	Good	Good	Average	Good	Poor	Poor
Zinc phosphate and oil compounds	Average	Poor	Good	Good	Poor	Poor	Poor	Poor	Poor	Good	Good
Macro zinc phosphate and polymer or oil film	Good	Poor	Good	Good	Average	Poor	Poor	Poor	Poor	Poor	Average
Zinc phosphate and organic paints and oils	Average	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Average
Zinc phosphate and zinc-rich and aluminum coats (organic/inorganic and chromates)	Good	Good	Poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor
Mechanically-cleaned steel with aluminum organic/inorganic and chromates	Good	Good	Average	Poor	Good	Good	Average	Average	Average	Good	Poor
Multi-layered electroplate and organic/inorganic cover coats (with or without chormates)	Good	Average	Average	Average	Poor	Average	Average	Average	Average	Poor	Poor

NOTE: Heat treated fasteners with platings such as electroplatings and zinc are susceptible to hydrogen-assisted failures. If your application requires these types of platings, please contact the application specialists at our Decorah Operations to discuss the concerns related to hydrogen failures and thread fit, as well as proper finish selection.

Galvanic Corrosion

Galvanic corrosion occurs when two dissimilar metals are in contact with an electrolyte, which is a medium through which an electrical current can flow. The rate of corrosion depends on the difference in electrical potential, or anodic-cathodic relationship, of the metals in the joint as defined by the Galvanic Series (see table at right). A highly anodic material in contact with a highly cathodic material will corrode much more quickly than two highly cathodic materials or when the materials used are closer together in the Galvanic Series. When corrosion does occur, the anodic material is the most likely to corrode, whereas the cathodic material is the least likely to corrode.

To reduce the likelihood of galvanic corrosion in a fastened joint, it is recommended the designer choose materials that are grouped together in the Galvanic Series chart. If that is not possible, other recommendations are

1. Select materials which are as close together in the chart as possible
2. Provide a barrier between the two metals, such as paint, non-metallic washer or gasket
3. Design the fastener as the cathode so the cathodic area is small compared to the anodic area
4. Use a metallic finish on the fastener that is close on the chart to the mating material.

Galvanic Series

Anodic End (Most likely to corrode)
Magnesium Magnesium alloys Zinc
Aluminum 1100 Aluminum 2024-T4 Steel or Iron Cast Iron Chromium-Iron (active) Ni-Resist Cast Iron
300 Series Stainless Steels (active)
Nickel (active) Inconel Nickel-Chromium Alloy (active) Hastelloy Alloy C (active)
Brasses Copper Bronzes Copper-Nickel Alloys
Nickel (passive) Inconel Nickel-Chromium Alloy (passive)
Chromium-Iron (passive) 300 Series Stainless Steels (passive) Hastelloy Alloy C (passive)
Silver Titanium Gold Platinum
Cathodic End (Least likely to corrode)

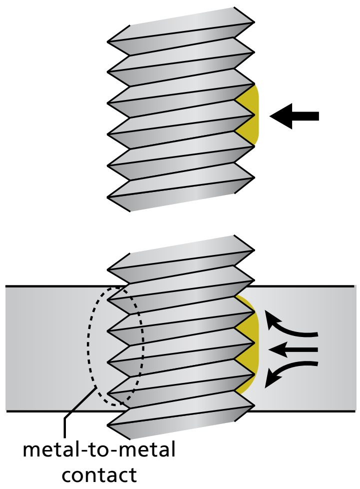
Nylon Locking Elements

The nylon locking method consists of a nylon patch, strip or pellet, permanently bonded onto or embedded into the threads of any fastener.

Whether your application requires patch, pellet or strip, this method provides a degree of holding power not otherwise possible. The principle is the same for all three types. When mating threads are engaged, the tough, resilent nylon element is compressed, and, with all the clearances thereby closed, a strong counterforce is established. This creates a metal-to-metal contact, which not only locks, but also sets up a positive resistance to vibration.

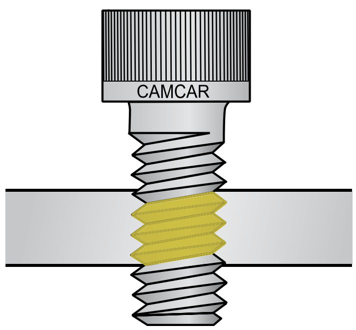
The nylon element allows an excellent degree of re-usability for the system. It retains its high strength properties at temperatures up to 250° F. It is also virtually unaffected by alcohol, gasoline, caustic soda and most commercial solvents. This element can be added to standard parts or built into any special fasteners as needed. STANLEY Engineered Fastening applications specialists can recomment the proper locking method for any specific application, based on such factors as type of material, complexity of the parts, hardness, wall thickness, etc.

How a Nylon Locking Element Works



Lock

- A pellet, strip or patch extends from the fastener thread.
- As the mating threads engage, the element is compressed and a counterforce is generated, which locks the fastener in place.
- The screw will remain locked even after repeated use.



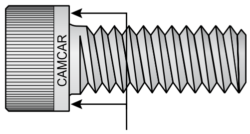
Adjust

- Nylon locking elements keep the fastener in place, whether the screw is seated or not.
- The positive locking action along with the resiliency of the nylon material prevent the fastener from shaking loose or backing out.
- Accurate adjustments are easy to make without sacrificing the nylon element's locking capability.

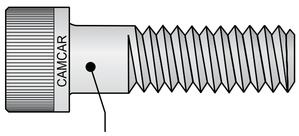
Table A-16: Prevailing Torque Per IFI-124 (External Threads)

Thread Size Inch	Initial Installation max.	First Removal min.	Fifth Removal min.
0	0.75	1.5*	0.5*
2	2	3*	1.5*
4	5	1	0.5
6	8	2	1
8	12	2.5	1.5
10	18	3	2
1/4	40	5	3
5/16	85	8	5
3/8	110	14	9
7/16	150	20	12
1/2	220	26	16
9/16	270	35	22
5/8	350	45	30
3/4	460	60	45
7/8	700	95	65
1	900	100	85

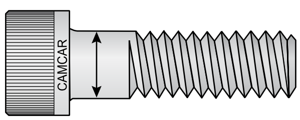
Basic Fastener Terminology



Bearing Surface: Supporting or locating surface of a fastener which seats against the part it is fastening.

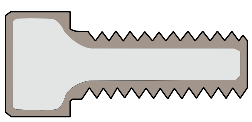


Body: The unthreaded portion of a fastener, also called the shank.

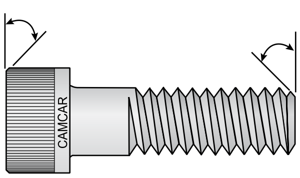


Body Diameter: Width of the unthreaded portion of the shank.

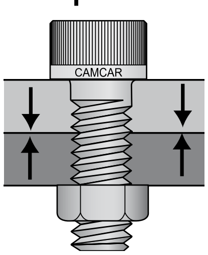
Bolt: Typically, an externally-threaded fastener which requires a nut in order to secure a joint.



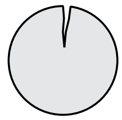
Case Hardened: Heat treated fastener in which the surface is harder than the core.



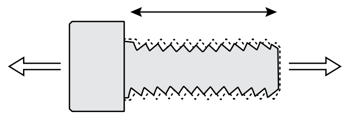
Chamfer Angle: The slope of a beveled edge on the fastener, measured from the normal to the axis of the fastener.



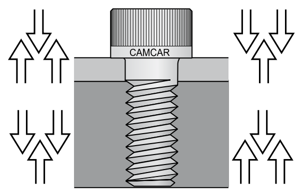
Clamp Load: The amount of pressure in a fastened joint in service. This may vary during service life.



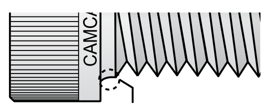
Crack: A clean, crystalline fracture which passes through or across the grain boundaries without inclusion of foreign elements.



Elongation: The stretching of a bolt along its axis during tensile loading.

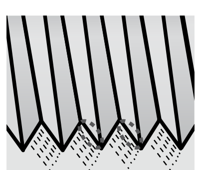


Fatigue Strength: The ability of a fastener to resist fracture when subjected to cyclic variations in stress.

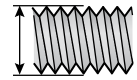


Fillet: The concave junction of two intersecting surfaces of a fastener.

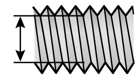
Fit: The resulting range of tightness which may occur due to the application of tolerances and allowances in the mating joint members.



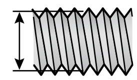
Load Flank: The top portion of each thread which applies the clamp load pressure to the mating threads.



Major Diameter: On external threads, the thread's largest or outside width.



Minor Diameter: On external threads, the thread's smallest or inside width.



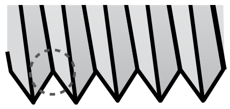
Pitch Diameter: The measurement in which the distance across the grooves is equal to the distance across the threads.

Preload: The amount of force put on a fastener once assembly is complete.

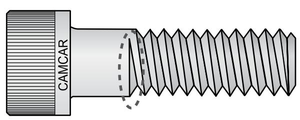
Proof Load: The amount of force a bolt can withstand before permanent plastic deformation will occur.

Rockwell Hardness Test: Procedure designed to measure the hardness of the fastener, given in an alpha-numerical scale. The higher the number, the harder the fastener. Socket screws are typically in the "C" scale, which is the hardest Rockwell designation, but the scale designation is dependent on the size of the socket screw. ASTM standards require socket screws products meet specific Rockwell Hardness standards. Rockwell test are utilized to test for decarburization and carburization and to determine the amount of resistance to permanent deformation during the testing procedure. They also assure that heat treating was performed to the specification.

Basic Fastener Terminology

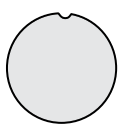


Root: The base of the V thread. This is the weakest point on a fastener, because it has the smallest cross-sectional area.

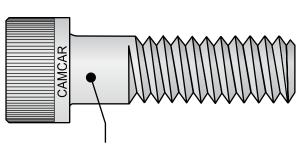


Runout Thread: The thread section that is between the last scratch of the thread and the fillet or body.

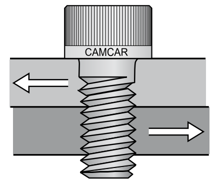
Screw: Typically an externally-threaded fastener which does not require a nut in order to secure a fastened joint.



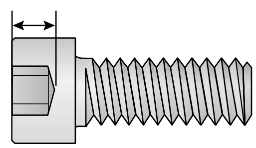
Seam: A narrow, non-crystalline, continuous discontinuity, which is generally inherent in the raw material. Seams are usually straight or smooth-curved line discontinuities running parallel to the product axis.



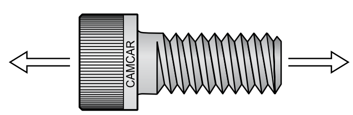
Shank: The unthreaded portion of a fastener, also called the body.



Shear Strength: Resistance to transverse loading. Transverse loads should only be applied to a dowel pin or the unthreaded section of a screw; otherwise, thread deformation will occur. Shear strength is measured in terms of pounds (lb.) or kilonewtons (kN).

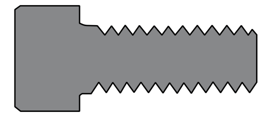


Socket Depth: The distance measured parallel to the fastener axis from the top of the head to the extreme end of the recess.

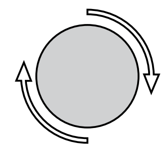


Tensile Strength: The maximum load in tension (stretching) that a part can carry without failure. Expressed in pounds per square inch (psi) or megapascals (MPa).

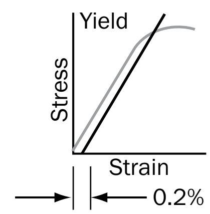
Tensile Stress Area: The selected area or areas used to calculate the tensile strength of an externally threaded fastener, so the fastener strength is consistent with the material strength. It corrects for the notch and helix effect of the threads and is a function of the pitch and minor diameters.



Through Hardened: Heat treated fastener with uniform hardness from the surface to the core.



Torsion: Twisting force applied to a fastener, parallel to the axis.



Yield Strength: Measurement of the resistance of material to plastic deformation. When a bolt is stretched, yield strength is the point where the bolt will not return to its original length following testing. It is measured in pounds per square inch (psi) or megapascals (MPa). Yield strength is often determined by the offset method illustrated above.

List of Tables

Inch Standards

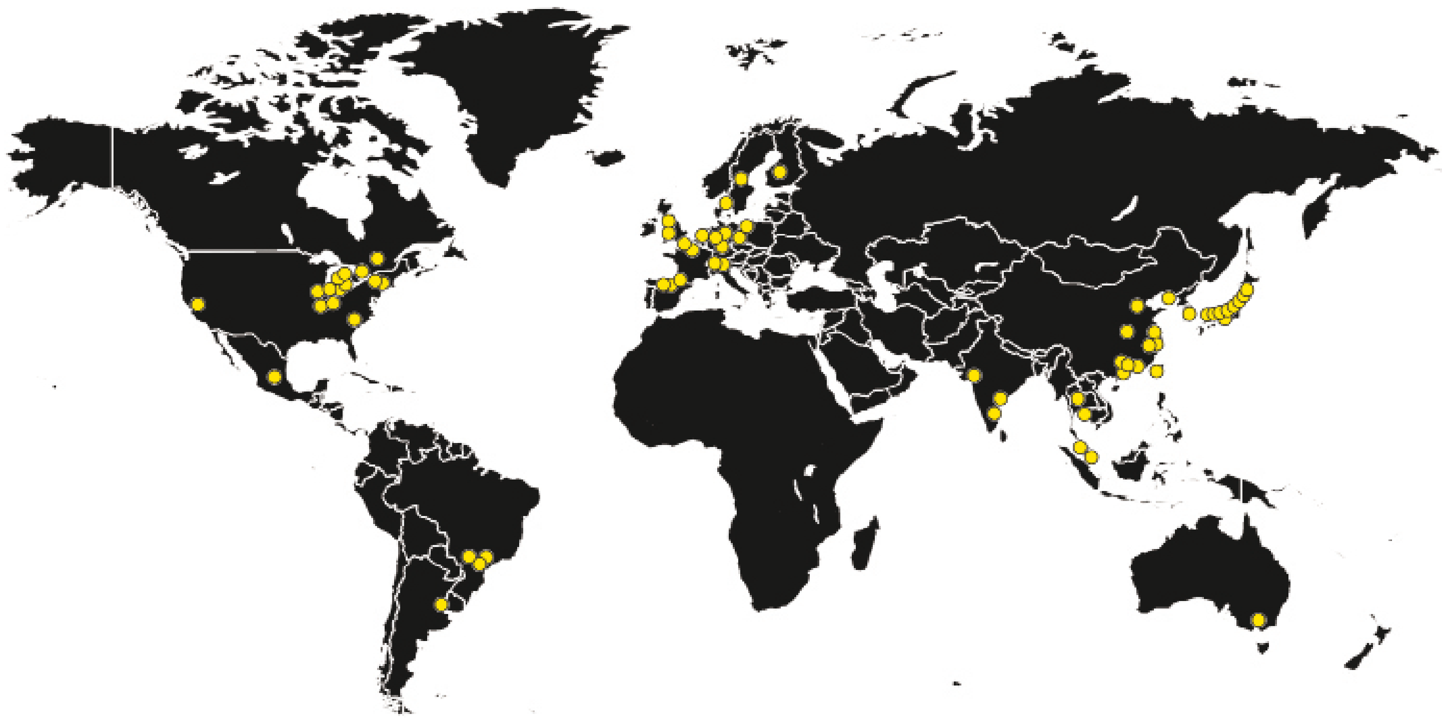
Metric Standards

Appendix

Notes

STANLEY

Engineered Fastening



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