Unbrako

# Engineering Guide

# Socket Products

# TABLE OF CONTENTS

**UNBRAKO® Socket Screw Products**



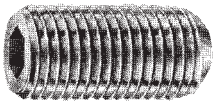
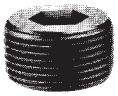
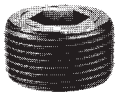
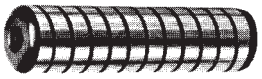
**NOTE:** The proper tightening of threaded fasteners can have a significant effect on their performance.

Many application problems such as self-loosening and fatigue can be minimized by adequate tightening.

The recommended seating torques listed in the catalog tables serve as guidelines only.

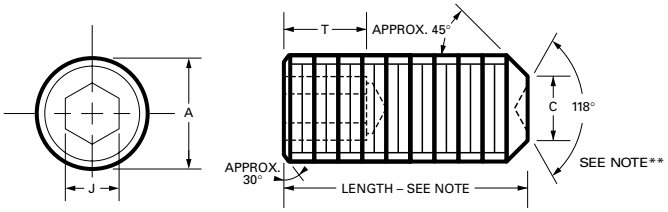
Even when using the recommended seating torques, the induced loads obtained may vary as much as ±25% depending upon the uncontrolled variables such as mating material, lubrication, surface finish, hardness, bolt/joint compliance, etc.

# INCH QUICK SELECTOR GUIDE

| TYPES | | APPLICATIONS/FEATURES | PERFORMANCE (See Note 1) | | | page |
|---|---|---|---|---|---|---|
| | | | hardness | operating temperatures (unplated) | | |
| **Square Head Set Screws** |  | Half-dog or self-locking cup points only. Use where maximum tightening torques are required | Rc 45 (min.) | 450° F | | 17 |
| **Socket Set Screws Alloy Steel** |  | Fasten collars, sheaves, gears, knobs on shafts. Locate machine parts. Cone, half-dog, flat, oval, cup and self-locking cup points standard | Rc 45-53 | 450°F | | 18–23 |
| **Socket Set Screws Stainless Steel** |  | Use stainless for corrosive, cryogenic or elevated temperatures environments. Plain cup point standard. Other styles on special order | Rb96-Rc33 | 800°F | | 18–23 |
| **Pressure Plugs 3/4" Taper Dryseal** |  | Features common to 3/4" and 7/8" tapers: Dryseal threads for positive seal without sealing compound; controlled chamfer for faster starting | Rc 34-40<br><br>Rb 82 Typical | 550°F<br>800°F<br>400°F Brass | | 24, 26 |
| **7/8" Taper LEVL-SEAL® Pressure Plug** |  | LEVL-SEAL® plug features: controlled 7/8" tape in 3/4" taper hole seats plug level, flush with surface within 1/2 pitch. LEVL-SEAL plug is an UNBRAKO original | Rc 35-40<br><br>Rb 82 Typical | 550°F<br><br>400°F Brass | | 25–27 |
| **PTFE/ TEFLON** Coated** |  | PTFE/TEFLON coated plugs seal at 60% lower seating torques without tape or compound; install faster at lower cost; smaller sizes can be power installed; LEVL-SEAL plug type for 100% flush seating | Rc 35-40 | 450°F (uncoated) | | 26–27 |
| **Hex Keys** |  | Tough, ductile, for high torquing; accurate fit in all types socket screws; size marked for quick identity | Rc 47-57 | torsional shear in-lb. min. 1.2 to 276.000 | | 32–33 |
| **Dowel Pins (Standard)** |  | Formed ends, controlled heat treat; close tolerances; standard for die work; also used as bearings, gages, precision parts, etc. | core: Rc 50-58 | calculated shear psi<br>150,000 | surface<br>8 micro-inch (max) | 28–29 |
| **Dowel Pins Pull-Out Type** |  | For use in blind holes. Easily removed without special tools. Reusable, Save money. No need for knock-out holes. Same physicals, finish, accuracy and tolerances as standard UNBRAKO dowel pins. | surface: Rc 60 (min.) | 150,000 | 8 micro-inch (max) | 30–31 |

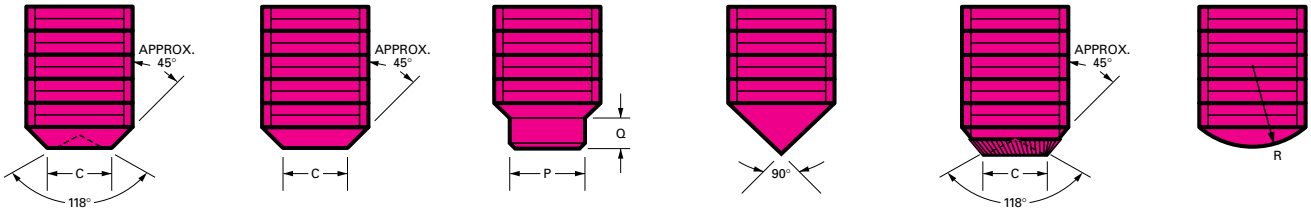
**NOTE 1:** Performance data listed are for standard production items only. Non-stock items may vary due to variables in methods of manufacture. It is suggested that the user verify performance on any non-standard parts for critical applications.

## SOCKET SET SCREWS ■ Dimensions ■ Application Data ■ Seating Torques




### LENGTH TOLERANCE

| Diameter | .63 and under | over .63 to 2″ | over 2″ to 6″ | over 6″ |
|---|---|---|---|---|
| All | ±.01 | ±.02 | ±.03 | ±.06 |



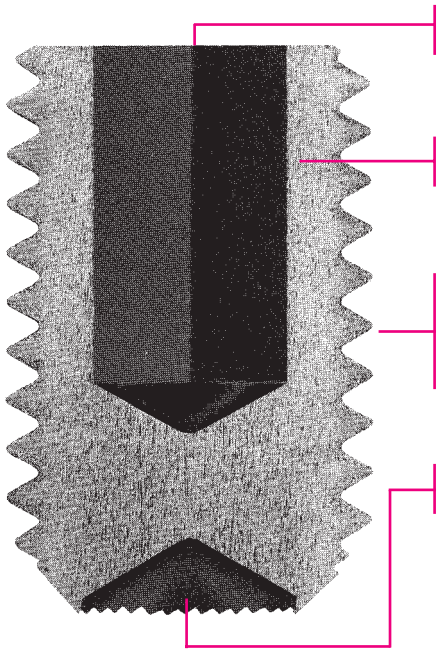

### DIMENSIONS

| nom. size | basic screw diameter | threads per inch | | A | | | C | | P | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | UNRC | UNRF | max. | UNRC | UNRF | max. | min. | max. | min. |
| #0 | .060 | – | 80 | .0600 | – | .0568 | .033 | .027 | .040 | .037 |
| #1 | .073 | 64 | 72 | .0730 | .0692 | .0695 | .040 | .033 | .049 | .045 |
| #2 | .086 | 56 | 64 | .0860 | .0819 | .0822 | .047 | .039 | .057 | .053 |
| #3 | .099 | 48 | 56 | .0990 | .0945 | .0949 | .054 | .045 | .066 | .062 |
| #4 | .112 | 40 | 48 | .1120 | .1069 | .1075 | .061 | .051 | .075 | .070 |
| #5 | .125 | 40 | 44 | .1250 | .1199 | .1202 | .067 | .057 | .083 | .078 |
| #6 | .138 | 32 | 40 | .1380 | .1320 | .1329 | .074 | .064 | .092 | .087 |
| #8 | .164 | 32 | 36 | .1640 | .1580 | .1585 | .087 | .076 | .109 | .103 |
| #10 | .190 | 24 | 32 | .1900 | .1825 | .1840 | .102 | .088 | .127 | .120 |
| 1/4 | .250 | 20 | 28 | .2500 | .2419 | .2435 | .132 | .118 | .156 | .149 |
| 5/16 | .312 | 18 | 24 | .3125 | .3038 | .3053 | .172 | .156 | .203 | .195 |
| 3/8 | .375 | 16 | 24 | .3750 | .3656 | .3678 | .212 | .194 | .250 | .241 |
| 7/16 | .437 | 14 | 20 | .4375 | .4272 | .4294 | .252 | .232 | .297 | .287 |
| 1/2 | .500 | 13 | 20 | .5000 | .4891 | .4919 | .291 | .207 | .344 | .334 |
| 9/16 | .562 | 12 | 18 | .5625 | .5511 | .5538 | .332 | .309 | .390 | .379 |
| 5/8 | .625 | 11 | 18 | .6250 | .6129 | .6163 | .371 | .347 | .469 | .456 |
| 3/4 | .750 | 10 | 16 | .7500 | .7371 | .7406 | .450 | .425 | .562 | .549 |
| 7/8 | .875 | 9 | 14 | .8750 | .8611 | .8647 | .530 | .502 | .656 | .642 |
| 1 | 1.000 | 8 | 12 | 1.0000 | .9850 | .9886 | .609 | .579 | .750 | .734 |
| 1 1/8 | 1.125 | 7 | 12 | 1.1250 | 1.1086 | 1.1136 | .689 | .655 | .844 | .826 |
| 1 1/4 | 1.250 | 7 | 12 | 1.2500 | 1.2336 | 1.2386 | .767 | .733 | .938 | .920 |
| 1 3/8 | 1.375 | 6 | 12 | 1.3750 | 1.3568 | 1.3636 | .848 | .808 | 1.031 | 1.011 |
| 1 1/2 | 1.500 | 6 | 12 | 1.5000 | 1.4818 | 1.4886 | .926 | .886 | 1.125 | 1.105 |

**NOTE:** Performance data listed are for standard production items only. Non-stock items may vary due to variables in methods of manufacture. It is suggested that the user verify performance on any non-standard parts for critical applications.

# SOCKET SET SCREWS

**Dimensions ■ Application Data ■ Seating Torques**



Deep socket – Key fits deeply into socket to provide extra wrenching area for tighter tightening without reaming the socket or rounding off corners of key

Continuous grain flow – Flow lines of rolled threads follow closely the contour of the screw

Fully formed threads – are rolled, not cut or ground. Metal is compressed, making it extra strong. Threads resist shearing, withstand higher tightening torques

Class 3A threads – Formed with closest interchangeable fit for maximum cross-section with smooth assembly. Assure better mating of parts

Counterbored knurled cup point

**NOTES**

**Material:** ASTM F912 – alloy steel
ASTM F880 – stainless steel

**Dimensions:** ASME/ANSI B18.3

**Hardness:** Rc 45-53 (alloy steel only), Rb 96-Rc 33 (stainless steel)

**Thread class:** 3A

1. When length equals nominal diameter or less, included angle is 118°. (#4 x 1/8 and #8 x 3/16 also have 118 angle)
2. When length equals nominal diameter or less, included angle is 130°.

**DIMENSIONS**

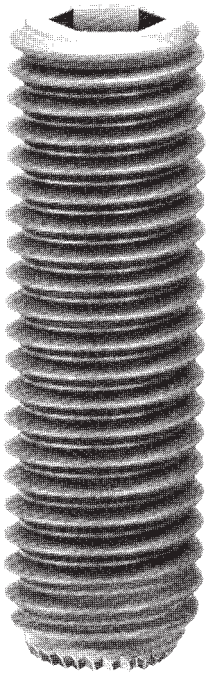
**RECOMMENDED SEATING TORQUES – INCH-LBS.****

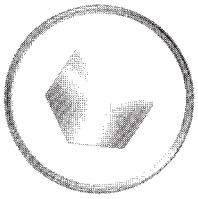
| Q | | T* | J | R | Applicable only to nominal minimum lengths shown or longer | | | |
|---|---|---|---|---|---|---|---|---|
| max. | min. | min. | nom. | basic | alloy steel | stainless | nom. min. screw length | min. key engagement |
| .017 | .013 | .035 | .028 | .045 | 1.0 | .4 | 3/32 | .050 |
| .021 | .017 | .035 | .035 | .055 | 1.8 | 1.2 | 1/8 | .060 |
| .024 | .020 | .035 | .035 | .064 | 1.8 | 1.2 | 1/8 | .060 |
| .027 | .023 | .060 | .050 | .074 | 5 | 4 | 5/32 | .070 |
| .030 | .026 | .075 | .050 | .084 | 5 | 4 | 5/32 | .070 |
| .033 | .027 | .075 | .0625 | .094 | 10 | 7 | 5/32 | .080 |
| .038 | .032 | .075 | .0625 | .104 | 10 | 7 | 3/16 | .080 |
| .043 | .037 | .075 | .0781 | .123 | 20 | 16 | 3/16 | .090 |
| .049 | .041 | .105 | .0937 | .142 | 36 | 26 | 3/16 | .100 |
| .067 | .059 | .105 | .125 | .188 | 87 | 70 | 5/16 | .125 |
| .082 | .074 | .140 | .1562 | .234 | 165 | 130 | 3/8 | .156 |
| .099 | .089 | .140 | .1875 | .281 | 290 | 230 | 7/16 | .188 |
| .114 | .104 | .190 | .2187 | .328 | 430 | 340 | 1/2 | .219 |
| .130 | .120 | .210 | .250 | .375 | 620 | 500 | 9/16 | .250 |
| .146 | .136 | .265 | .250 | .422 | 620 | 500 | 5/8 | .250 |
| .164 | .148 | .265 | .3125 | .469 | 1,325 | 980 | 11/16 | .312 |
| .196 | .180 | .330 | .375 | .562 | 2,400 | 1,700 | 3/4 | .375 |
| .227 | .211 | .450 | .500 | .656 | 3,600 | 3,000 | 3/4 | .500 |
| .260 | .240 | .550 | .5625 | .750 | 5,000 | 4,000 | 7/8 | .562 |
| .291 | .271 | .650 | .5625 | .844 | 7,200 | 5,600 | 1 | .562 |
| .323 | .303 | .700 | .625 | .938 | 9,600 | 7,700 | 1 1/8 | .625 |
| .354 | .334 | .700 | .625 | 1.031 | 9,600 | 7,700 | 1 1/4 | .625 |
| .385 | .365 | .750 | .750 | 1.125 | 11,320 | 9,100 | 1 1/4 | .750 |

***CAUTION:** Values shown in column T are for minimum stock length cup point screws. Screws shorter than nominal minimum length shown do not have sockets deep enough to utilize full key capability which can result in failure of socket, key or mating threads.

**See Note, page 1.

## SOCKET SET SCREWS ■ Point Selection According to Application





Socket set screws offer three types of holding power: torsional (resistance to rotation); axial (resistance to lateral movement); and vibrational.

**Size selection** is an important factor in holding power. The screw diameter should be roughly 1/2 that of the shaft as a rule-of-thumb. (For more specific size data see pages 18–19.) Additional design considerations appear below.

**Holding power** is almost directly proportional to seating torque in a cup, flat, and oval point screws. Holding power can be increased by increasing seating torque. Greater holding power reduces the number of screws required and the assembled cost of the application.

By its penetration, the set screw point can add as a much as 15% to total holding power. Cone points, with deepest penetration, give the greatest increase; oval points, with minimum penetration, the least. Making 1 the index for cup point, holding power values from tables on pages 22 and 23 can be multiplied by 1.07 for cone point, 0.92 for flat or dog points, and 0.90 for oval point.

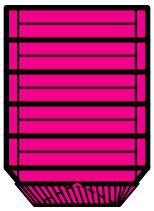
**Relative hardness** between set screw and shaft is also a factor. A 10-point differential between the screw's normal Rockwell C 50 and shaft should be maintained for full holding power. As much as 15% loss in holding power can result from a lower differential.

**Vibration resistance** can be achieved by correct size and proper tightening. The UNBRAKO knurl cup set screw offers additional mechanical locking resistance when required.

### POINT SELECTION

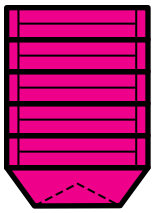
#### According to Application

Point selection is normally determined by the nature of the application – materials, their relative hardness, frequency of assembly and re-assembly and other factors. Reviewed here are standard point types, their general features and most frequent areas of application of each type.



**knurled cup**

For quick and permanent location of gears, collars, pulleys or knobs on shafts. Exclusive counterclockwise locking knurls resist screw loosening, even in poorly tapped holes. Resists most severe vibration.



**plain cup**

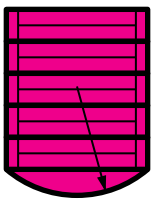
Use against hardened shafts, in zinc, die castings and other soft materials where high tightening torques are impractical.

### STAINLESS STEEL ADVANTAGES

- Corrosion resistance, Wide temperature range (–300° F to +800° F), Freedom from scaling or oxidation.
- Non-magnetic, a valuable property in certain electrical and electronic applications. (Maximum permeability is 1.2 and can be reduced to 1.02 by bright annealing.) Corrosion-resistance useful where cleanliness is important.
- Standard processing of these socket set screws includes a passivation treatment which neutralizes surface contamination.

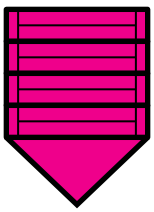
**flat**

Use where parts must be frequently re-set, as it causes little or no damage to part it bears against. Can be used against hardened shafts (usually with ground flat for better contact) and as adjusting screw. Preferred for thin wall thickness and on soft plugs.



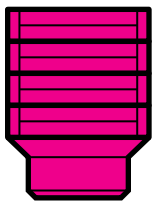
**oval**

Use for frequent adjustment without deformation of part it bears against, also for seating against an angular surface. Circular U-grooves or axial V-grooves sometimes put in shaft to permit rotational or longitudinal adjustment.



**cone**

For permanent location of parts. Deep penetration gives highest axial and holding power. In material over Rockwell C15 point is spotted to half its length to develop shear strength across point. Used for pivots and fine adjustment.



**half dog**

Used for 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.

## SOCKET SET SCREWS ■ Torsional and Axial Holding Power

### SIZE SELECTION OF SOCKET SET SCREWS

The user of a set-screw-fastened assembly is primarily buying static holding power. The data in this chart offers a simplified means for selecting diameter and seating torque of a set screw on a given diameter shaft.

Torsional holding power in inch-pounds and axial holding power in pounds are tabulated for various cup point socket screws, seated at recommended installation torques. Shafting used was hardened to Rockwell C15. Test involved Class 3A screw threads in Class 2B tapped holes. Data was determined experimentally in a long series of tests in which holding power was defined as the minimum load to produce 0.010 inch relative movement of shaft and collar.

From this basic chart, values can be modified by percentage factors to yield suitable design data for almost any standard set screw application.

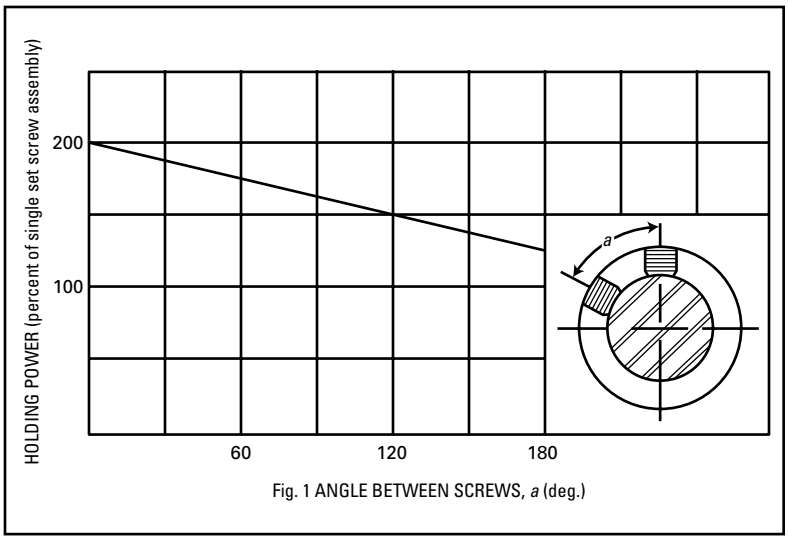


Fig. 1 ANGLE BETWEEN SCREWS, *a* (deg.)

### NOTES

Tabulated axial and torsional holding powers are typical strengths and should be used accordingly, with specific safety factors appropriate to the given application and load conditions. Good results have been obtained with a factor of 1.5-2.0 under static load conditions (i.e., where a collar is supporting a vertical load on a post) and of 4.0-8.0 for various dynamic situations.

Values in bold type in the chart indicate recommended set screw sizes on the basis that screw diameter should be roughly one-half shaft diameter.

### TORSIONAL and AXIAL HOLDING POWER (Based on Recommended Seating Torques – Inch-Lbs.)

| nom. size | seating torque inch-lbs. | axial holding power (pounds) | shaft diameter (shaft hardness Rc 15 to Rc 35) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1/16 | 3/32 | 1/8 | 5/32 | 3/16 | 7/32 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 |
| | | | torsional holding power inch-lbs. | | | | | | | | | | | |
| #0 | 1.0 | 50 | **1.5** | 2.3 | 3.1 | 3.9 | 4.7 | 5.4 | 6.2 | | | | | |
| #1 | 1.8 | 65 | 2.0 | **3.0** | 4.0 | 5.0 | 6.1 | 7.1 | 8.1 | 10.0 | | | | |
| #2 | 1.8 | 85 | 2.6 | 4.0 | **5.3** | 6.6 | 8.0 | 9.3 | 10.6 | 13.2 | 16.0 | | | |
| #3 | 5 | 120 | 3.2 | 5.6 | 7.5 | **9.3** | 11.3 | 13.0 | 15.0 | 18.7 | 22.5 | 26.3 | | |
| #4 | 5 | 160 | | 7.5 | 10.0 | 12.5 | **15.0** | 17.5 | 20.0 | 25.0 | 30.0 | 35.0 | 40.0 | |
| #5 | 10 | 200 | | | 12.5 | 15.6 | 18.7 | **21.8** | **25.0** | 31.2 | 37.5 | 43.7 | 50.0 | 56.2 |
| #6 | 10 | 250 | | | | 19 | 23 | 27 | 31 | **39** | 47 | 55 | 62 | 70 |
| #8 | 20 | 385 | | | | 30 | 36 | 42 | 48 | 60 | **72** | 84 | 96 | 108 |
| #10 | 36 | 540 | | | | | 51 | 59 | 68 | 84 | 101 | **118** | 135 | 152 |
| 1/4 | 87 | 1,000 | | | | | | | 125 | 156 | 187 | 218 | **250** | **281** |
| 5/16 | 165 | 1,500 | | | | | | | | 234 | 280 | 327 | 375 | 421 |
| 3/8 | 290 | 2,000 | | | | | | | | | 375 | 437 | 500 | 562 |
| 7/16 | 430 | 2,500 | | | | | | | | | | 545 | 625 | 702 |
| 1/2 | 620 | 3,000 | | | | | | | | | | | 750 | 843 |
| 9/16 | 620 | 3,500 | | | | | | | | | | | | 985 |
| 5/8 | 1,325 | 4,000 | | | | | | | | | | | | |
| 3/4 | 2,400 | 5,000 | | | | | | | | | | | | |
| 7/8 | 3,600 | 5,600 | | | | | | | | | | | | |
| 1 | 5,000 | 6,500 | | | | | | | | | | | | |

If you know set screws, you know that the tighter you can tighten them, the better they hold and the more they resist loosening from vibration. But there's a limit to how much you can tighten the average socket set screw. If you're not careful, you can ream or crack the socket, and in some cases, even strip the threads. So you're never quite sure whether or not it will actually stay tight.

With UNBRAKO set screws it's a different story. A unique combination of design and carefully controlled manufacturing and heat treating gives these screws extra strength that permits you to tighten them appreciably tighter than ordinary screws with minimal fear of reaming or cracking the socket. this extra strength represents a substantial bonus of extra holding power and the additional safety and reliability that goes with it.

**Design** – Deeper UNBRAKO sockets give more key engagement to let you seat the screws tighter. Corners are radiused to safeguard against reaming or cracking the socket when the extra tightening torque is applied. The sharp corners of other set screws create high stress concentrations and can cause cracking, even at lower tightening torques. By eliminating the corners, the radii distribute tightening stresses to reduce the chance of splitting to a minimum.

**Controlled Manufacturing** – The fully-formed threads of UNBRAKO set screws are rolled under extreme pressure to minimize stripping and handle the higher tightening torques. Also, with rolled threads, tolerances can be more closely maintained. UNBRAKO set screws have Class 3A threads, closest interchangeable fit, giving maximum cross-section with smooth assembly. The thread form itself has the radiused root that increases the strength of the threads and resistance to shear.

**Controlled Heat Treatment** – This is the third element of the combination. Too little carbon in the furnace atmosphere (decarburization) makes screws soft, causing reamed sockets, stripped threads and sheared points when screws are tightened. Too much carbon (carburization) makes screws brittle and liable to crack or fracture. The heat treatment is literally tailored to each "heat" of UNBRAKO screws, maintaining the necessary controlled Rc 45-53 hardness for maximum strength.

Finally, point style affects holding power. As much as 15% more can be contributed, depending on the depth of penetration. The cone point (when used without a spotting hole in the shaft) gives greatest increase because of its greater penetration. The oval point, with the least contact area, affords the least. The cup point lies in between, but is by far the most commonly used, because of the wide range of applications to which it is adaptable.

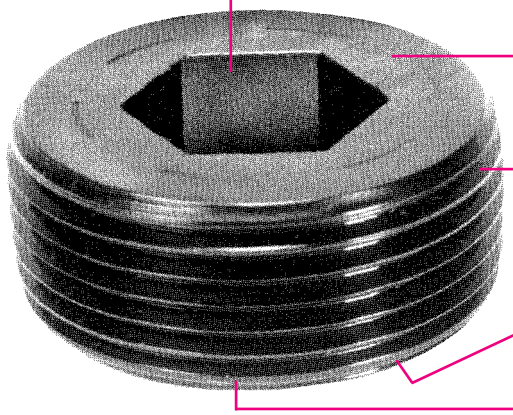
However, there is one cup point that can give you both a maximum of holding power and of resistance to vibration. It is the exclusive UNBRAKO knurled cup point, whose locking knurls bite into the shaft and resist the tendency of the screw to back out of the tapped hole. The chart on this page shows clearly how much better the UNBRAKO set screws resist vibration in comparison with plain cup point set screws. UNBRAKO knurled cup point self-locking set screws give you excellent performance under conditions of extreme vibration.

**UNBRAKO SOCKET SET SCREWS – UNRC or UNRF Thread – Seated Against Steel Shaft**

| nom. size | seating torque inch-lbs. | axial holding power (pounds) | shaft diameter (shaft hardness Rc 15 to Rc 35) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5/8 | 3/4 | 7/8 | 1 | 1 1/4 | 1 1/2 | 1 3/4 | 2 | 2 1/2 | 3 | 3 1/2 | 4 |
| | | | torsional holding power inch-lbs. | | | | | | | | | | | |
| #0 | 1.0 | 50 | | | | | | | | | | | | |
| #1 | 1.8 | 65 | | | | | | | | | | | | |
| #2 | 1.8 | 85 | | | | | | | | | | | | |
| #3 | 5 | 120 | | | | | | | | | | | | |
| #4 | 5 | 160 | | | | | | | | | | | | |
| #5 | 10 | 200 | 62 | | | | | | | | | | | |
| #6 | 10 | 250 | 78 | 94 | 109 | | | | | | | | | |
| #8 | 20 | 385 | 120 | 144 | 168 | 192 | | | | | | | | |
| #10 | 36 | 540 | 169 | 202 | 236 | 270 | 338 | | | | | | | |
| 1/4 | 87 | 1,000 | 312 | 357 | 437 | 500 | 625 | 750 | | | | | | |
| 5/16 | 165 | 1,500 | **468** | **562** | 656 | 750 | 937 | 1125 | 1310 | 1500 | | | | |
| 3/8 | 290 | 2,000 | 625 | 750 | **875** | **1000** | 1250 | 1500 | 1750 | 2000 | | | | |
| 7/16 | 430 | 2,500 | 780 | 937 | 1095 | 1250 | 1560 | 1875 | 2210 | 2500 | 3125 | | | |
| 1/2 | 620 | 3,000 | 937 | 1125 | 1310 | 1500 | **1875** | **2250** | 2620 | 3000 | 3750 | 4500 | | |
| 9/16 | 620 | 3,500 | 1090 | 1310 | 1530 | 1750 | 2190 | 2620 | **3030** | 3500 | 4370 | 5250 | 6120 | |
| 5/8 | 1,325 | 4,000 | 1250 | 1500 | 1750 | 2000 | 2500 | 3000 | 3750 | **4000** | 5000 | 6000 | 7000 | 8000 |
| 3/4 | 2,400 | 5,000 | | 1875 | 2190 | 2500 | 3125 | 3750 | 4500 | 5000 | **6250** | **7500** | 8750 | 10000 |
| 7/8 | 3,600 | 5,600 | | | 2620 | 3000 | 3750 | 4500 | 5250 | 6000 | 7500 | 9000 | **10500** | 12000 |
| 1 | 5,000 | 6,500 | | | | 3500 | 4375 | 5250 | 6120 | 7000 | 8750 | 10500 | 12250 | **14000** |

# PRESSURE PLUGS

## LEVL SEAL® TYPE Dryseal Thread Form with 7/8-inch per foot



Precision hex socket with maximum depth for positive wrenching at higher seating torques

Heat treated alloy steel for strength
Roundness closely controlled for better sealing

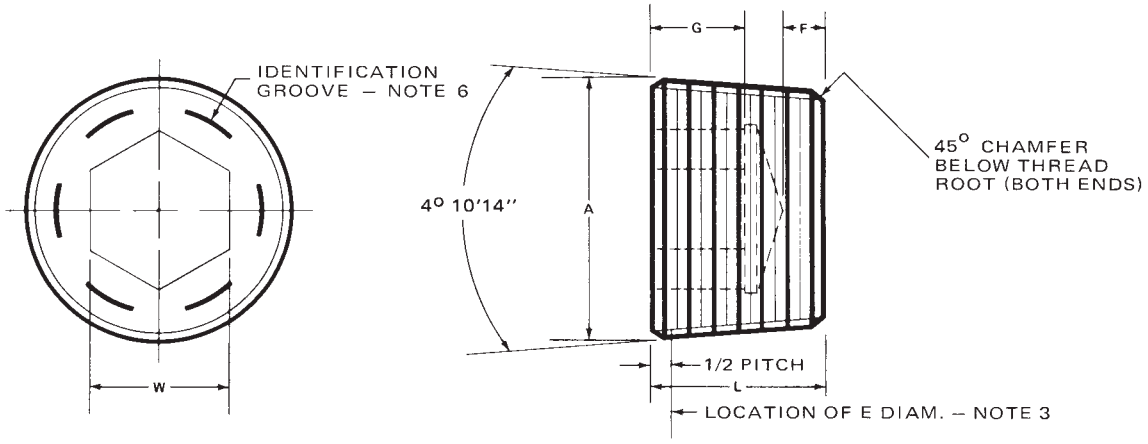
High pressure is developed through a deliberate difference of taper between the plug and the tapped hole having standard 3/4" taper

Flush seating is achieved through closer control of thread forms, sizes and taper-improves safety and appearance.

Fully formed PTF dryseal threads for better sealing without the use of a compound

Controlled chamfer for faster

See Application Data on page 27




### DIMENSIONS*

| nominal thread size | | A ref. | F min. | G min. | L +.000 –.015 | E note 3 ref. |
|---|---|---|---|---|---|---|
| 1/16 | .062 | .307 | .052 | .141 | .250 | .28118 |
| 1/8 | .125 | .401 | .049 | .141 | .250 | .37360 |
| 1/4 | .250 | .529 | .045 | .266 | .406 | .49163 |
| 3/8 | .375 | .667 | .040 | .266 | .406 | .62701 |
| 1/2 | .500 | .830 | .067 | .329 | .531 | .77843 |
| 3/4 | .750 | 1.041 | .054 | .329 | .531 | .98887 |
| 1 | 1.000 | 1.302 | .112 | .360 | .656 | 1.23863 |
| 1 1/4 | 1.250 | 1.647 | .102 | .360 | .656 | 1.58338 |
| 1 1/2 | 1.500 | 1.885 | .102 | .360 | .656 | 1.82234 |
| 2 | 2.000 | 2.360 | .084 | .360 | .656 | 2.29627 |

See page 24 for threads per inch, w nom., and X.
*Dimensions before coating for PTFE/TEFLON-coated LEVL-SEAL pressure plugs.

**NOTES**

1. **Material:** ASTM A574 alloy steel, austenitic stainless steel or brass.
2. **Hardness:** Rc 35-40 for steel.
3. **Basic pitch diameter:** E-pitch dia. at a distance of one-half pitch from large end of plug.
   PTF thread from 7/8-inch taper per foot.
   E0 – pitch diameter at small end of plug;
   E1 – pitch diameter at L1 distance from end of plug;
   L1 – length of hand-tight engagement.
4. Bottom of plug to be flat within "X" T.I.R.

DRY-SEAL and LEVL-SEAL: Small end of plug to be flush with face of standard NPTF ring gages within one thread (L1, L2 and tapered ring).

Large end of plug to be flush with face of special 7/8 taper ring gages within one-half thread.

5. Undercut in socket at mfrs. option
6. Six equally spaced identification grooves (1/16-27 plug to have 3 identification grooves) on alloy steel plugs. (LEVL-SEAL)
7. Dimensions apply before plating and/or coating.

## PRESSURE PLUGS ■ Application Data

Pressure plugs are not pipe plugs. Pipe plugs (plumber's fittings) are limited to pressures of 600 psi, are sealed with a compound, and are made of cast iron with cut threads and protruding square drive.

Pressure plugs are made to closer tolerances, are generally of higher quality, and almost all have taper threads. Properly made and used, they will seal at pressures to 5000 psi and without a sealing compound (pressure tests are usually at 20,000 psi.) they are often used in hydraulic and pneumatic designs.

**Performance Requirements**

Pressure plugs used in industrial applications should:

- not leak at pressures to 5000 psi
- need no sealing compounds
- be reusable without seizure
- give a good seal when reused
- seal low viscosity fluids
- require minimum seating torque
- require minimum re-tooling or special tools.

For a satisfactory seal, the threads of the plug and those in the mating hole must not gall or seize up to maximum possible tightening torque. Galling and seizure are caused by metal pickup on the mating surfaces and are directly related to force on the surface, material hardness, lubrication used, and thread finish.

**How Pressure Plugs Seal**

Sealing is achieved by crushing the crest of one thread against the root of the mating thread. If too much of compressive force is required to torque the plug, it will tend to gall in the hole. Too little force will not deform the crest of threads enough to produce a seal. Increasing the hardness of the material will reduce galling but will also increase the required sealing force. Generally a hardness range of Rc 30 to 40 will meet most requirements. The tightening force must be low enough to cause no galling in this range.

**Cost Considerations**

Dryseal plugs are more frequently used, especially where reuse is frequent. Reason: more threads are engaged and they therefore resist leakage better. They are also preferred in soft metals to reduce of over-torquing.

### TYPES OF PRESSURE PLUG THREADS

Three thread forms are commonly used for pipe plugs and pressure plugs:

**NPT:** National Pipe thread, Tapered. This is the thread form commonly used for commercial pipe and fittings for low pressure applications. A lubricant and sealer are generally used.

**ANPT:** Aeronautical National Pipe thread, Tapered. Covered by MIL-S-7105, this thread form was developed for aircraft use. It is basically the same as the NPT thread except that tolerances have been reduced about 50 percent. Plugs made with this thread should be used with lubricants and sealers. They are not to be used for hydraulic applications.

**NPTF:** National Pipe thread, Tapered, Fuel. This is the standard thread for pressure plugs. They make pressure-tight joints without a sealant. Tolerances are about 1/4 those for NPT threads. The standard which applies is ANSI B1.20.3. Applicable for fluid power applications.

**APPLICATION DATA – DRYSEAL TYPE**

| nom. size | threads per inch | tap drill size+ | tap drill size ++ | recommended torque in.-lbs* |
|---|---|---|---|---|
| 1/16 | 27 | 15/64 | 1/4 | 150 |
| 1/8 | 27 | 21/64 | 11/32 | 250 |
| 1/4 | 18 | 27/64 | 7/16 | 600 |
| 3/8 | 18 | 9/16 | 37/64 | 1200 |
| 1/2 | 14 | 11/16 | 23/32 | 1800 |
| 3/4 | 14 | 57/64 | 59/64 | 3000 |
| 1 | 11 1/2 | 1 1/8 | 1 5/32 | 4200 |
| 1 1/4 | 11 1/2 | 37.5mm | – | 5400 |
| 1 1/2 | 11 1/2 | 43.5mm | – | 6900 |
| 2 | 11 1/2 | 2 3/16 | – | 8500 |

Unbrako recommends using a tapered reamer with corresponding size tap drill (see page 27).

+With use of reamer (taper thread).

++Without use of tapered reamer.

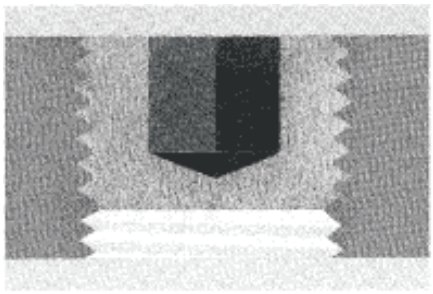
*Recommended torques for alloy steel only. Multiply by .65 for stainless steel and .50 for brass.

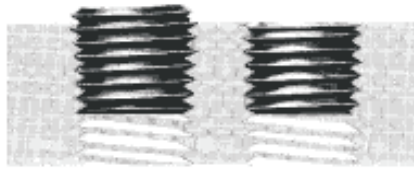
NPTF fully formed Dryseal threads achieve seal in tapped holes without need for sealing compounds.

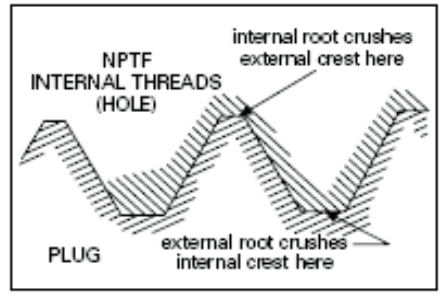
# PRESSURE PLUGS

## PTFE/TEFLON-Coated LEVL-SEAL Type Dryseal Thread Form with 7/8-inch Taper per Foot

Deliberate difference in taper between the plug and the tapped hole. Idealfor use in assemblies where clearanceis limited and in hydraulic lines near moving parts. Designed for use in hard materials and in thick-walled sections as well as for normal plug applications.








High pressure seal– Achieved through metal-to-metal contact at the large end of the plug. High load placed on the few mating threads near the top of the hole.

**Flush seating–** Design of LEVL-SEAL plug permits seating within half a pitch in a normally tapped hole. Conventional plugs have the greater tolerance of a full pitch and usually protrude above the surface.

PTF fully formed Dryseal threads designed to achieve seal in tapped holes without need for sealing com-pounds.

### PTFE/TEFLON CoatedLEVL-SEAL Type

Typical thickness is 0.0005-inchLEVL-SEAL precision coated with tough, corrosion-resistantPTFE/TEFLON. Installation of the new plugs is faster with the coating of PTFE/TEFLON which acts as a lubricant as well as seal. Power equipment can be used to install the smaller sizes instead of the manual wrenching required by higher torques of uncoated plugs. Suited for in assembly line production.

Higher hydraulic and pneumatic working pressures can be effectively sealed. Seal is effective without use of tapes or sealing compounds, even with liquids of very low viscosity. Unbrako Laboratories have tested these plugs with surges up to 13,500 psi 8times in 5 minutes, then held peak pressure for 6 full hours without trace of leakage.

Flush seating improves appear-ance and adds safety. LEVL-SEAL plugs seat flush because of a combi-nation of (1) gaging procedures, and (2) a deliberate difference in taper between the plug and a normally tapped NPTF hole. (The taper of the plug is 7/8” per foot , while that of the hole is 3/4” per foot.)

PTFE/TEFLON was selected for the coating material because of its combination of extra hardness and abrasion resistance which permit reuse up to 5 times without apprecia-ble loss of seal.

The coating is serviceable to +450°F without deterioration.

Temperatures lower than –100° F require the use of stainless steel plugs. These are available in the same range of sizes as the alloy steel plugs.

With no tape or sealing compound involved, there is no danger of foreign matter entering and contaminating the system or equipment. The coating reduces any tendency of the plug to“freeze” in the hole because of rustor corrosion.

### APPLICATION DATA – LEVL-SEAL and LEVL-SEAL with PTFE/TEFLON

| nom. size | threads per inch | recommended hole diameter | | tapping information tap projection thru $L_1$ ring | | Imperfect threads allowable | tap* drill size | recommended torque (inch-lbs.) alloy steel |
|---|---|---|---|---|---|---|---|---|
| | | max. | min. | max. | min. | | | |
| 1/16 | 27 | .2374 | .2334 | .375 | .250 | 4 | 15/64 | 150 |
| 1/8 | 27 | .3271 | .3271 | .375 | .250 | 4 | 21/64 | 250 |
| 1/4 | 18 | .4249 | .4209 | .521 | .397 | 4 | 27/64 | 600 |
| 3/8 | 18 | .5655 | .5615 | .516 | .392 | 4 | 9/16 | 1200 |
| ½ | 14 | .6905 | .6865 | .641 | .517 | 4 | 11/16 | 1800 |
| 3/4 | 14 | .8836 | .8896 | .627 | .503 | 4 | 57/64 | 3000 |
| 1 | 11 ½ | 1.280 | 1.1240 | .772 | .584 | 4 | 1 1/8 | 4200 |
| 1 1/4 | 11 ½ | 1.4794 | 1.4754 | .780 | .592 | 4 | 37.5mm | 5400 |
| 1 ½ | 11 ½ | 1.7165 | 1.7116 | .793 | .605 | 4 | 43.5mm | 6900 |
| 2 | 11 ½ | 2.1905 | 2.8165 | .761 | .573 | 4 | 2 3/16 | 8500 |

*For taper thread (using tapered reamer). For tap drill size (without using tapered reamer) see table and corresponding comment on page 26.

**Maximum for PTFE/TEFLON-coated but can be reduced as much as 60% in most applications.

Unbrako

## ENGINEERING PART NUMBERS – INCH

Unbrako provides a stock number for every standard, stocked item in its price list. However, there may be particular sizes or optional features the user may desire. The following part numbering system allows the engineer or designer to record a particular description for ordering.

| Alloy Steel | Drilled Head (3) | #4 | UNRC | 1 1/2" | Cadmium Plate |
|---|---|---|---|---|---|
| 20097 | H3 | -94 | C | -24 | C |

**FINISH**

B – Chemical Black Oxide
C – Cadmium Plate – Silver
D – Cadmium Plate – Yellow
S – Silver Plate
U – Zinc Plate – Silver
Z – Zinc Plate – Yellow

No letter indicates standard black finish (Thermal Oxide) for alloy steel and passivation for stainless steel.

**LENGTH in 16ths**

**THREAD TYPE C – coarse, F – fine**

**DIAMETER***

| DIA. | #0 | #1 | #2 | #3 | #4 | #5 | #6 | #8 | #10 | 1/4 | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DASH NO. | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 98 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |

| DIA. | 5/8 | 3/4 | 7/8 | 1 | 1 1/8 | 1 1/4 | 1 3/8 | 1 1/2 | 1 3/4 | 2 | 2 1/4 | 2 1/2 | 2 3/4 | 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DASH NO. | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 28 | 32 | 36 | 40 | 44 | 48 |

**OPTIONAL FEATURES**

Cross Drilled Heads:
H1 – 1 Hole Thru
H2 – 2 Hole2 Thru
H3 – 3 Holes Thru

Self-Locking:
E – LOC-WEL to MIL-DTL18240
L – LOC-WEL (Commercial)
P – Nylon Plug
TF – TRU-FLEX
K – Nylon Plug to MIL-DTL18240

**BASE NUMBER**

20097 – socket head cap screw – alloy steel
20098 – socket head cap screw – stainless steel
72531 – low head cap screw
12705 – shoulder screw
16990 – flat head cap screw – alloy steel
16991 – flat head cap screw – stainless steel
38030 – button head cap screw – alloy
38031 – button head cap screw – stainless steel
05455 – square head cap screw – knurled cup
05456 – square head cap screw – half dog

**Set Screws**

| Alloy Steel | Stainless Steel | |
|---|---|---|
| 28700 | 28707 | flat point |
| 28701 | 28708 | cup point |
| 28704 | 28709 | knurled cup point |
| 28702 | 28710 | cone point |
| 28705 | 28711 | oval point |
| 28706 | 28713 | half dog point |

* Shoulder screws are designated by shoulder diameter

# OPTIONAL PART NUMBERING SYSTEM

## PRESSURE PLUG PART NUMBERS

| Basic Part No. | Material | 1/4" | Finish |
|---|---|---|---|
| 29466 | A | -4 | C |

**FINISH**
B – Chemical Black Oxide
C – Cadmium Plate-Silver
D – Cadmium Plate-Yellow
S – Silver Plate
U – Zinc Plate – Silver
Z – Zinc Plate – Yellow

**NOMINAL SIZE IN 16ths**

**OPTIONAL FEATURES**
A – Austenitic Stainless
D – Aluminum
E – Brass
No letter – alloy steel

**BASIC PART NUMBER**
29466 – dry seal
*38194 – LEVEL-SEAL
**69188 – PTFE/TEFLON coated

* Standard stock available in austenitic stainless steel, brass, and alloy only
** Standard stock available in austenitic stainless steel, and alloy only

## DOWEL PINS PART NUMBERS

The Part number consists of (1) a basic part number describing the item; (2) a dash number and letter designating diameter and oversize dimension; (3) a dash number designating length.

| dowel pin | 1/4" | .001 oversize | 1/2" |
|---|---|---|---|
| 28420 | –250 | B | –8 |

**LENGTH in 16ths**

**OVERSIZE A-.0002, B-.001, C-.002 (see below)**

**DIAMETER in thousandths**

**BASIC PART NUMBER**
28420 – Standard Dowel Pins
69382 – Pull-Out Dowel Pins

## HEX KEYS PART NUMBERS

The Part number consists of (1) a basic part number describing the item; (2) a dash number designating size and a letter denoting finish.

| long arm | 1/4" |
|---|---|
| 05854 | –13 |

**FINISH** Standard Black Finish (Thermal Oxide)

See dash number in dimension table page 32

**BASIC PART NUMBER**
05853 – short arm wrench
05854 – long arm wrench
78950-6" – long arm wrench

## ENGINEERING PART NUMBERS – METRIC

| Alloy Steel | Drilled Head (3) | 4MM Dia. | Thread Pitch | Length | Cadmium Plate |
|---|---|---|---|---|---|
| 76000 | H3 | -M4 | -0.7 | -12 | C |

**FINISH**

B – Chemical Black Oxide
C – Cadmium Plate – Silver
D – Cadmium Plate – Yellow
S – Silver Plate
U – Zinc Plate – Silver
Z – Zinc Plate – Yellow

No letter indicates standard black finish (Thermal Oxide) for alloy steel and passivation for stainless steel.

**LENGTH in mm**

**THREAD TYPE STATE THREAD PITCH**

**DIAMETER in mm***

**OPTIONAL FEATURES**

Cross Drilled Heads:
H1 – 1 Hole Thru
H2 – 2 Hole2 Thru
H3 – 3 Holes Thru

Self-Locking:
E – LOC-WEL to MIL-DTL-18240
L – LOC-WEL (Commercial)
P – Nylon Plug
TF – TRU-FLEX
K – Nylon Plug to MIL-DTL-18240

**BASE NUMBER**

76000 – metric socket head cap screw – alloy steel
76001 – metric socket head cap screw – stainless steel
76002 – metric low head cap screw – alloy
76032 – metric low head cap screw – stainless steel
76005 – metric flat head cap screw – alloy steel
76006 – metric flat head cap screw – stainless steel
76003 – metric button head cap screw – alloy
76004 – metric button head cap screw – stainless steel
76007 – metric shoulder screw – alloy

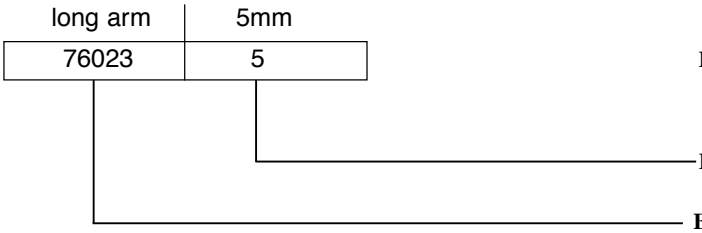
**Metric Set Screws**

| Alloy Steel | Stainless Steel | |
|---|---|---|
| 76010 | 76016 | flat point |
| 76011 | 76017 | cup point |
| 76012 | 76018 | knurled cup point |
| 76013 | 76019 | cone point |
| 76014 | 76020 | oval point |
| 76015 | 76021 | half dog point |

* Shoulder screws are designated by shoulder diameter

## HEX KEYS PART NUMBERS (METRIC)

The Part number consists of (1) a basic part number describing the item; (2) a dash number designating size.



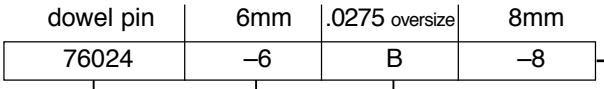

**FINISH** Standard Black Finish (Thermal Oxide)

**Key size in mm**

**BASIC PART NUMBER**
76022 – short arm wrench
76023 – long arm wrench

## DOWEL PINS PART NUMBERS (METRIC)

The Part number consists of (1) a basic part number describing the item; (2) a dash number and letter designating diameter and oversize dimension; (3) a dash number designating length.




**LENGTH in mm**

**OVERSIZE A-.0055, B-.0275mm**

**DIAMETER in mm**

**BASIC PART NUMBER**
76024 – Standard Dowel Pins
76035 – Pull-Out Dowel Pins