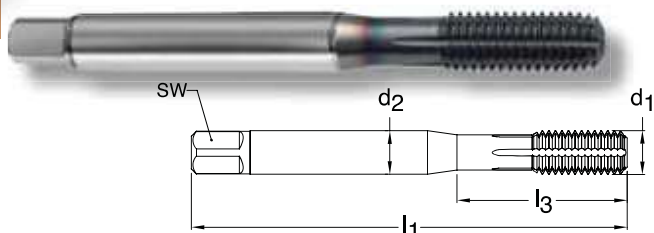


## UNC



Through holes



Blind holes



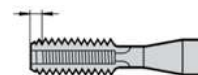
TiCN coated



External cooling

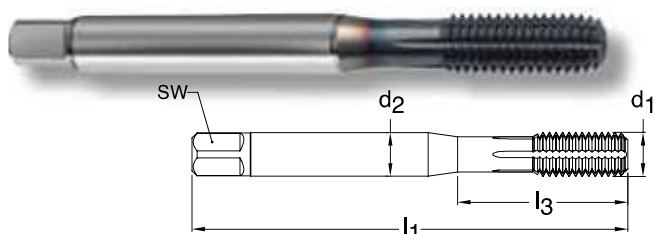
Series **4377**Standard **DIN/ANSI**Tool Material **HSS-E-PM**Flute **Oil grooves**

Chamfer Form C • 2-3

Class of Fit **2BX**

| d1 - P  | H Limits | Tap Drill Range inch | Number of Flutes | d2 inch | SW inch | l1 inch | l3 inch | Order Code | EDP Number    | Stock |
|---------|----------|----------------------|------------------|---------|---------|---------|---------|------------|---------------|-------|
| 2-56    | H3/H4    | 0.077 - 0.079        | 3                | 0.141   | 0.110   | 1.772   | 0.441   | 2.184      | 9043770021840 | ●     |
| 3-48    | H3/H4    | 0.089 - 0.913        | 3                | 0.141   | 0.110   | 1.969   | 0.500   | 2.515      | 9043770025150 | ●     |
| 4-40    | H4/H5    | 0.100 - 0.102        | 4                | 0.141   | 0.110   | 2.205   | 0.709   | 2.845      | 9043770028450 | ●     |
| 5-40    | H4/H5    | 0.114 - 0.116        | 4                | 0.141   | 0.110   | 2.205   | 0.709   | 3.175      | 9043770031750 | ●     |
| 6-32    | H5/H6    | 0.124 - 0.126        | 4                | 0.141   | 0.110   | 2.205   | 0.709   | 3.505      | 9043770035050 | ●     |
| 8-32    | H5/H6    | 0.149 - 0.150        | 4                | 0.168   | 0.131   | 2.480   | 0.827   | 4.166      | 9043770041660 | ●     |
| 10-24   | H6/H7    | 0.171 - 0.173        | 4                | 0.194   | 0.152   | 2.756   | 0.945   | 4.826      | 9043770048260 | ●     |
| 12-24   | H6/H7    | 0.196 - 0.198        | 4                | 0.220   | 0.165   | 3.150   | 1.024   | 5.486      | 9043770054860 | ●     |
| 1/4-20  | H7/H8    | 0.225 - 0.228        | 5                | 0.255   | 0.191   | 3.150   | 1.181   | 6.350      | 9043770063500 | ●     |
| 5/16-18 | H8/H9    | 0.286 - 0.290        | 5                | 0.318   | 0.238   | 3.543   | 1.377   | 7.938      | 9043770079380 | ●     |
| 3/8-16  | H8/H9    | 0.345 - 0.350        | 5                | 0.381   | 0.286   | 3.937   | 1.456   | 9.525      | 9043770095250 | ●     |
| 7/16-14 | H9/H10   | 0.404 - 0.408        | 5                | 0.323   | 0.242   | 3.937   | N/A     | 11.113     | 9043770111130 | ●     |
| 1/2-13  | H10/H11  | 0.463 - 0.468        | 5                | 0.367   | 0.275   | 4.331   | N/A     | 12.700     | 9043770127000 | ●     |
| 9/16-12 | H10/H11  | 0.523 - 0.527        | 6                | 0.429   | 0.322   | 4.331   | N/A     | 14.288     | 9043770142880 | ●     |
| 5/8-11  | H11/H12  | 0.582 - 0.587        | 6                | 0.480   | 0.360   | 4.331   | N/A     | 15.875     | 9043770158750 | ●     |
| 3/4-10  | H12/H13  | 0.703 - 0.708        | 6                | 0.590   | 0.442   | 4.921   | N/A     | 19.050     | 9043770190500 | ●     |
| 7/8-9   | H12/H13  | 0.825 - 0.831        | 7                | 0.697   | 0.523   | 5.512   | N/A     | 22.225     | 9043770222250 | ●     |
| 1-8     | H13/H14  | 0.943 - 0.950        | 7                | 0.800   | 0.600   | 6.299   | N/A     | 25.400     | 9043770254000 | ●     |

## UNF



Through holes



Blind holes



TiCN coated



External cooling

Series **4378**Standard **DIN/ANSI**Tool Material **HSS-E-PM**Flute **Oil grooves**

Chamfer Form C • 2-3

Class of Fit **2BX**

| d1 - P  | H Limits | Tap Drill Range inch | Number of Flutes | d2 inch | SW inch | l1 inch | l3 inch | Order Code | EDP Number    | Stock |
|---------|----------|----------------------|------------------|---------|---------|---------|---------|------------|---------------|-------|
| 2-64    | H3/H4    | 0.078 - 0.080        | 3                | 0.141   | 0.110   | 1.772   | 0.441   | 2.184      | 9043780021840 | ●     |
| 3-56    | H3/H4    | 0.090 - 0.092        | 3                | 0.141   | 0.110   | 1.969   | 0.500   | 2.515      | 9043780025150 | ●     |
| 4-48    | H4/H5    | 0.102 - 0.103        | 4                | 0.141   | 0.110   | 2.205   | 0.709   | 2.845      | 9043780028450 | ●     |
| 5-44    | H4/H5    | 0.114 - 0.115        | 4                | 0.141   | 0.110   | 2.205   | 0.709   | 3.175      | 9043780031750 | ●     |
| 6-40    | H5/H6    | 0.126 - 0.128        | 4                | 0.141   | 0.110   | 2.205   | 0.748   | 3.505      | 9043780035050 | ●     |
| 8-36    | H4/H5    | 0.151 - 0.153        | 4                | 0.168   | 0.131   | 2.480   | 0.827   | 4.166      | 9043780041660 | ●     |
| 10-32   | H5/H6    | 0.174 - 0.178        | 4                | 0.194   | 0.152   | 2.756   | 0.945   | 4.826      | 9043780048260 | ●     |
| 12-28   | H6/H7    | 0.198 - 0.202        | 4                | 0.220   | 0.165   | 3.150   | 1.024   | 5.486      | 9043780054860 | ●     |
| 1/4-28  | H6/H7    | 0.233 - 0.236        | 5                | 0.255   | 0.191   | 3.150   | 1.181   | 6.350      | 9043780063500 | ●     |
| 5/16-24 | H7/H8    | 0.292 - 0.295        | 5                | 0.318   | 0.238   | 3.543   | 1.377   | 7.938      | 9043780079380 | ●     |
| 3/8-24  | H7/H8    | 0.355 - 0.358        | 5                | 0.381   | 0.286   | 3.543   | 1.456   | 9.525      | 9043780095250 | ●     |
| 7/16-20 | H8/H9    | 0.413 - 0.417        | 5                | 0.323   | 0.242   | 3.937   | N/A     | 11.113     | 9043780111130 | ●     |
| 1/2-20  | H8/H9    | 0.476 - 0.480        | 6                | 0.367   | 0.275   | 3.937   | N/A     | 12.700     | 9043780127000 | ●     |
| 9/16-18 | H8/H9    | 0.535 - 0.540        | 6                | 0.429   | 0.322   | 3.937   | N/A     | 14.288     | 9043780142880 | ●     |
| 5/8-18  | H9/H10   | 0.599 - 0.603        | 6                | 0.480   | 0.360   | 3.937   | N/A     | 15.875     | 9043780158750 | ●     |
| 3/4-16  | H10/H11  | 0.719 - 0.727        | 7                | 0.590   | 0.442   | 4.331   | N/A     | 19.050     | 9043780190500 | ●     |
| 7/8-14  | H10/H11  | 0.840 - 0.846        | 8                | 0.697   | 0.523   | 4.921   | N/A     | 22.225     | 9043780222250 | ●     |
| 1-12    | H11/H12  | 0.961 - 0.966        | 9                | 0.800   | 0.600   | 5.512   | N/A     | 25.400     | 9043780254000 | ●     |

# Technical Information

## Cutting Rate recommendations for **FORM/FLUTELESS** taps

Thanks to the development of modern tool materials, geometries, coatings and recently the Guhring developed improved tool surface the scope of malleable materials able to be fluteless tapped is expanding. The table "Cutting rate recommendations" below provides an overview of materials that can be machined with Guhring's "Profile" fluteless taps. In many cases, a test in

harder or more brittle materials is worth while in order to benefit from the advantages of fluteless tapping in these materials. Please contact our technical specialists for advice.

### Cutting rate recommendations

| Material group                                                                     |                                                 | Approximate<br>Rc  | Approximate<br>HB   | Recommended SFM |          |               |
|------------------------------------------------------------------------------------|-------------------------------------------------|--------------------|---------------------|-----------------|----------|---------------|
|                                                                                    |                                                 |                    |                     | HSS-E           | HSS-E-PM | Solid carbide |
|    | Structural steels, free-cutting steels          |                    | <180                | 45-70           | 60-90    | 90-120        |
|                                                                                    | Unalloyed case hardened steels                  | <20                | <230                | 40-65           | 55-80    | 75-100        |
|                                                                                    | Unalloyed heat-treatable steels                 | <25                | <250                | 30-55           | 50-75    | 65-95         |
|    | Structural steels, free-cutting steels          | <20                | <230                | 40-65           | 55-80    | 75-100        |
|                                                                                    | Case hardened steels, heat-treatable steels     | <25                | <250                | 30-55           | 50-75    | 65-95         |
|                                                                                    | Nitriding steels, spheroidal graphite iron      | <30                | <280                | 25-45           | 40-70    | 60-85         |
|                                                                                    |                                                 | <35                | <320                | 20-35           | 35-60    | 50-75         |
|                                                                                    |                                                 | <38                | <380                | -               | -        | -             |
|    | Stainless- and acid-resistant steels, sulphured |                    | <180                | 40-50           | 45-60    | 50-70         |
|                                                                                    | austenitic                                      | <25                | <250                | 35-50           | 40-55    | 45-60         |
|                                                                                    | martensitic                                     | <30                | <280                | 25-40           | 35-50    | 40-55         |
|                                                                                    |                                                 | <35                | <320                | -               | 25-40    | 30-45         |
|  | Alloyed case hardened steels                    | <25                | <250                | 25-45           | 40-60    | 55-80         |
|                                                                                    | Alloyed heat-treatable steels                   | <30                | <280                | 20-40           | 35-55    | 50-70         |
|                                                                                    | Alloyed tool steels                             | <35                | <320                | 15-30           | 30-50    | 40-60         |
|                                                                                    | High speed tool steels                          | <38                | <380                | -               | -        | -             |
|                                                                                    |                                                 | <44                | <415                | -               | -        | -             |
|                                                                                    |                                                 | <60                |                     | -               | -        | -             |
|  | Cast iron                                       |                    | <180                | -               | -        | -             |
|                                                                                    | Spheroidal graphite iron                        | <25                | <250                | 40-65           | 60-80    | 75-130        |
|                                                                                    | Malleable cast iron                             | <35                | <320                | 40-65           | 60-80    | 75-130        |
|  | Aluminum and Al-alloys                          | SILICON<br>CONTENT | WROUGHT<br>ALUMINUM |                 |          |               |
|                                                                                    | Al cast alloys                                  | <10%               | n/a                 | 60-75           | 70-140   | 100-165       |
|                                                                                    |                                                 | >10%               | n/a                 | -               | -        | -             |
|                                                                                    | Al wrought alloys                               | n/a                | 30-80               | 80-100          | 100-150  | 150-200       |
|                                                                                    |                                                 | n/a                | 75-150              | 80-100          | 100-150  | 150-200       |
|  | Titanium and Ti-alloys                          |                    | <320                | 7-26            | 7-26     | 20-35         |
|                                                                                    |                                                 |                    | >320                | -               | -        | -             |
|  | Nickel and Ni-alloys                            |                    | <320                | 7-26            | 7-26     | 20-35         |
|                                                                                    |                                                 |                    | >320                | -               | -        | -             |
|  | Plastics                                        |                    |                     | -               | -        | -             |
|  | Magnesium-alloys                                |                    |                     | -               | -        | -             |
|  | Brass, short-chipping                           |                    | <180                | 35-50           | 50-65    | 75-100        |
|                                                                                    | long-chipping                                   |                    | <180                | 40-65           | 60-80    | 80-120        |

# Technical Information

## DRILL SIZE FOR THREAD FORMING @ 55% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.91          | M 10           | 0.75     | 9.72          | 2                 | 56  | 2.01          |
| M 1.1          | 0.25     | 1.01          | M 10           | 1.00     | 9.63          | 2                 | 64  | 2.04          |
| M 1.2          | 0.25     | 1.11          | M 10           | 1.25     | 9.53          | 3                 | 48  | 2.32          |
| M 1.4          | 0.30     | 1.29          | M 10           | 1.50     | 9.44          | 3                 | 56  | 2.34          |
| M 1.6          | 0.35     | 1.47          | M 11           | 0.75     | 10.72         | 4                 | 40  | 2.61          |
| M 1.7          | 0.35     | 1.57          | M 11           | 1.00     | 10.63         | 4                 | 48  | 2.65          |
| M 1.8          | 0.35     | 1.67          | M 11           | 1.50     | 10.44         | 5                 | 40  | 2.94          |
| M 2            | 0.40     | 1.85          | M 12           | 1.00     | 11.63         | 5                 | 44  | 2.96          |
| M 2.2          | 0.45     | 2.03          | M 12           | 1.25     | 11.53         | 6                 | 32  | 3.21          |
| M 2.3          | 0.40     | 2.15          | M 12           | 1.50     | 11.44         | 6                 | 40  | 3.27          |
| M 2.5          | 0.45     | 2.33          | M 12           | 1.75     | 11.35         | 8                 | 32  | 3.87          |
| M 2.6          | 0.45     | 2.43          | M 14           | 1.00     | 13.63         | 8                 | 36  | 3.90          |
| M 3            | 0.50     | 2.81          | M 14           | 1.25     | 13.53         | 10                | 24  | 4.43          |
| M 3.5          | 0.60     | 3.28          | M 14           | 1.50     | 13.44         | 10                | 32  | 4.53          |
| M 4            | 0.70     | 3.74          | M 14           | 2.00     | 13.25         | 12                | 24  | 5.09          |
| M 4.5          | 0.75     | 4.22          | M 15           | 1.00     | 14.63         | 12                | 28  | 5.15          |
| M 5            | 0.50     | 4.81          | M 15           | 1.50     | 14.44         | 1/4               | 20  | 5.88          |
| M 5            | 0.80     | 4.70          | M 16           | 1.00     | 15.63         | 1/4               | 28  | 6.01          |
| M 5.5          | 0.50     | 5.31          | M 16           | 1.50     | 15.44         | 5/16              | 18  | 7.41          |
| M 6            | 0.75     | 5.72          | M 16           | 2.00     | 15.25         | 5/16              | 24  | 7.54          |
| M 6            | 1.00     | 5.63          | M 17           | 1.00     | 16.63         | 3/8               | 16  | 8.93          |
| M 7            | 0.75     | 6.72          | M 17           | 1.50     | 16.44         | 3/8               | 24  | 9.13          |
| M 7            | 1.00     | 6.63          | M 18           | 1.00     | 17.63         | 7/16              | 14  | 10.43         |
| M 8            | 0.75     | 7.72          | M 18           | 1.50     | 17.44         | 7/16              | 20  | 10.64         |
| M 8            | 1.00     | 7.63          | M 18           | 2.00     | 17.25         | 1/2               | 13  | 11.97         |
| M 8            | 1.25     | 7.53          | M 18           | 2.50     | 17.07         | 1/2               | 20  | 12.23         |
| M 9            | 0.75     | 8.72          | M 20           | 1.00     | 19.63         | 9/16              | 12  | 13.50         |
| M 9            | 1.00     | 8.63          | M 20           | 2.50     | 19.07         | 9/16              | 18  | 13.76         |
| M 9            | 1.25     | 8.53          |                |          |               | 5/8               | 11  | 15.01         |
|                |          |               |                |          |               | 5/8               | 18  | 15.35         |
|                |          |               |                |          |               | 3/4               | 10  | 18.10         |
|                |          |               |                |          |               | 3/4               | 16  | 18.46         |
|                |          |               |                |          |               | 7/8               | 9   | 21.17         |
|                |          |               |                |          |               | 7/8               | 14  | 21.55         |
|                |          |               |                |          |               | 1                 | 8   | 24.21         |
|                |          |               |                |          |               | 1                 | 12  | 24.61         |

## DRILL SIZE FOR THREAD FORMING @ 57.5% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.90          | M 10           | 0.75     | 9.71          | 2                 | 56  | 2.01          |
| M 1.1          | 0.25     | 1.00          | M 10           | 1.00     | 9.61          | 2                 | 64  | 2.03          |
| M 1.2          | 0.25     | 1.10          | M 10           | 1.25     | 9.51          | 3                 | 48  | 2.31          |
| M 1.4          | 0.30     | 1.28          | M 10           | 1.50     | 9.41          | 3                 | 56  | 2.34          |
| M 1.6          | 0.35     | 1.46          | M 11           | 0.75     | 10.71         | 4                 | 40  | 2.60          |
| M 1.7          | 0.35     | 1.56          | M 11           | 1.00     | 10.61         | 4                 | 48  | 2.64          |
| M 1.8          | 0.35     | 1.66          | M 11           | 1.50     | 10.41         | 5                 | 40  | 2.93          |
| M 2            | 0.40     | 1.84          | M 12           | 1.00     | 11.61         | 5                 | 44  | 2.95          |
| M 2.2          | 0.45     | 2.02          | M 12           | 1.25     | 11.51         | 6                 | 32  | 3.19          |
| M 2.3          | 0.40     | 2.14          | M 12           | 1.50     | 11.41         | 6                 | 40  | 3.26          |
| M 2.5          | 0.45     | 2.32          | M 12           | 1.75     | 11.32         | 8                 | 32  | 3.86          |
| M 2.6          | 0.45     | 2.42          | M 14           | 1.00     | 13.61         | 8                 | 36  | 3.89          |
| M 3            | 0.50     | 2.80          | M 14           | 1.25     | 13.51         | 10                | 24  | 4.41          |
| M 3.5          | 0.60     | 3.27          | M 14           | 1.50     | 13.41         | 10                | 32  | 4.52          |
| M 4            | 0.70     | 3.73          | M 14           | 2.00     | 13.22         | 12                | 24  | 5.07          |
| M 4.5          | 0.75     | 4.21          | M 15           | 1.00     | 14.61         | 12                | 28  | 5.13          |
| M 5            | 0.50     | 4.80          | M 15           | 1.50     | 14.41         | 1/4               | 20  | 5.85          |
| M 5            | 0.80     | 4.69          | M 16           | 1.00     | 15.61         | 1/4               | 28  | 6.00          |
| M 5.5          | 0.50     | 5.30          | M 16           | 1.50     | 15.41         | 5/16              | 18  | 7.39          |
| M 6            | 0.75     | 5.71          | M 16           | 2.00     | 15.22         | 5/16              | 24  | 7.52          |
| M 6            | 1.00     | 5.61          | M 17           | 1.00     | 16.61         | 3/8               | 16  | 8.90          |
| M 7            | 0.75     | 6.71          | M 17           | 1.50     | 16.41         | 3/8               | 24  | 9.11          |
| M 7            | 1.00     | 6.61          | M 18           | 1.00     | 17.61         | 7/16              | 14  | 10.40         |
| M 8            | 0.75     | 7.71          | M 18           | 1.50     | 17.41         | 7/16              | 20  | 10.62         |
| M 8            | 1.00     | 7.61          | M 18           | 2.00     | 17.22         | 1/2               | 13  | 11.94         |
| M 8            | 1.25     | 7.51          | M 18           | 2.50     | 17.02         | 1/2               | 20  | 12.20         |
| M 9            | 0.75     | 8.71          | M 20           | 1.00     | 19.61         | 9/16              | 12  | 13.46         |
| M 9            | 1.00     | 8.61          | M 20           | 2.50     | 19.02         | 9/16              | 18  | 13.74         |
| M 9            | 1.25     | 8.51          |                |          |               | 5/8               | 11  | 14.97         |
|                |          |               |                |          |               | 5/8               | 18  | 15.32         |
|                |          |               |                |          |               | 3/4               | 10  | 18.06         |
|                |          |               |                |          |               | 3/4               | 16  | 18.43         |
|                |          |               |                |          |               | 7/8               | 9   | 21.12         |
|                |          |               |                |          |               | 7/8               | 14  | 21.52         |
|                |          |               |                |          |               | 1                 | 8   | 24.16         |
|                |          |               |                |          |               | 1                 | 12  | 24.57         |

## DRILL SIZE FOR THREAD FORMING @ 60% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.90          | M 10           | 0.75     | 9.69          | 2                 | 56  | 2.00          |
| M 1.1          | 0.25     | 1.00          | M 10           | 1.00     | 9.59          | 2                 | 64  | 2.02          |
| M 1.2          | 0.25     | 1.10          | M 10           | 1.25     | 9.49          | 3                 | 48  | 2.30          |
| M 1.4          | 0.30     | 1.28          | M 10           | 1.50     | 9.39          | 3                 | 56  | 2.33          |
| M 1.6          | 0.35     | 1.46          | M 11           | 0.75     | 10.69         | 4                 | 40  | 2.59          |
| M 1.7          | 0.35     | 1.56          | M 11           | 1.00     | 10.59         | 4                 | 48  | 2.63          |
| M 1.8          | 0.35     | 1.66          | M 11           | 1.50     | 10.39         | 5                 | 40  | 2.92          |
| M 2            | 0.40     | 1.84          | M 12           | 1.00     | 11.59         | 5                 | 44  | 2.94          |
| M 2.2          | 0.45     | 2.02          | M 12           | 1.25     | 11.49         | 6                 | 32  | 3.18          |
| M 2.3          | 0.40     | 2.14          | M 12           | 1.50     | 11.39         | 6                 | 40  | 3.25          |
| M 2.5          | 0.45     | 2.32          | M 12           | 1.75     | 11.29         | 8                 | 32  | 3.84          |
| M 2.6          | 0.45     | 2.42          | M 14           | 1.00     | 13.59         | 8                 | 36  | 3.88          |
| M 3            | 0.50     | 2.80          | M 14           | 1.25     | 13.49         | 10                | 24  | 4.39          |
| M 3.5          | 0.60     | 3.26          | M 14           | 1.50     | 13.39         | 10                | 32  | 4.50          |
| M 4            | 0.70     | 3.71          | M 14           | 2.00     | 13.18         | 12                | 24  | 5.05          |
| M 4.5          | 0.75     | 4.19          | M 15           | 1.00     | 14.59         | 12                | 28  | 5.12          |
| M 5            | 0.50     | 4.80          | M 15           | 1.50     | 14.39         | 1/4               | 20  | 5.83          |
| M 5            | 0.80     | 4.67          | M 16           | 1.00     | 15.59         | 1/4               | 28  | 5.98          |
| M 5.5          | 0.50     | 5.30          | M 16           | 1.50     | 15.39         | 5/16              | 18  | 7.36          |
| M 6            | 0.75     | 5.69          | M 16           | 2.00     | 15.18         | 5/16              | 24  | 7.51          |
| M 6            | 1.00     | 5.59          | M 17           | 1.00     | 16.59         | 3/8               | 16  | 8.88          |
| M 7            | 0.75     | 6.69          | M 17           | 1.50     | 16.39         | 3/8               | 24  | 9.09          |
| M 7            | 1.00     | 6.59          | M 18           | 1.00     | 17.59         | 7/16              | 14  | 10.37         |
| M 8            | 0.75     | 7.69          | M 18           | 1.50     | 17.39         | 7/16              | 20  | 10.59         |
| M 8            | 1.00     | 7.59          | M 18           | 2.00     | 17.18         | 1/2               | 13  | 11.90         |
| M 8            | 1.25     | 7.49          | M 18           | 2.50     | 16.98         | 1/2               | 20  | 12.18         |
| M 9            | 0.75     | 8.69          | M 20           | 1.00     | 19.59         | 9/16              | 12  | 13.42         |
| M 9            | 1.00     | 8.59          | M 20           | 2.50     | 18.98         | 9/16              | 18  | 13.71         |
| M 9            | 1.25     | 8.49          |                |          |               | 5/8               | 11  | 14.93         |
|                |          |               |                |          |               | 5/8               | 18  | 15.30         |
|                |          |               |                |          |               | 3/4               | 10  | 18.01         |
|                |          |               |                |          |               | 3/4               | 16  | 18.40         |
|                |          |               |                |          |               | 7/8               | 9   | 21.07         |
|                |          |               |                |          |               | 7/8               | 14  | 21.48         |
|                |          |               |                |          |               | 1                 | 8   | 24.10         |
|                |          |               |                |          |               | 1                 | 12  | 24.54         |

## DRILL SIZE FOR THREAD FORMING @ 62.5% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.89          | M 10           | 0.75     | 9.68          | 2                 | 56  | 1.99          |
| M 1.1          | 0.25     | 0.99          | M 10           | 1.00     | 9.58          | 2                 | 64  | 2.02          |
| M 1.2          | 0.25     | 1.09          | M 10           | 1.25     | 9.47          | 3                 | 48  | 2.29          |
| M 1.4          | 0.30     | 1.27          | M 10           | 1.50     | 9.36          | 3                 | 56  | 2.32          |
| M 1.6          | 0.35     | 1.45          | M 11           | 0.75     | 10.68         | 4                 | 40  | 2.57          |
| M 1.7          | 0.35     | 1.55          | M 11           | 1.00     | 10.58         | 4                 | 48  | 2.62          |
| M 1.8          | 0.35     | 1.65          | M 11           | 1.50     | 10.36         | 5                 | 40  | 2.91          |
| M 2            | 0.40     | 1.83          | M 12           | 1.00     | 11.58         | 5                 | 44  | 2.93          |
| M 2.2          | 0.45     | 2.01          | M 12           | 1.25     | 11.47         | 6                 | 32  | 3.17          |
| M 2.3          | 0.40     | 2.13          | M 12           | 1.50     | 11.36         | 6                 | 40  | 3.24          |
| M 2.5          | 0.45     | 2.31          | M 12           | 1.75     | 11.26         | 8                 | 32  | 3.83          |
| M 2.6          | 0.45     | 2.41          | M 14           | 1.00     | 13.58         | 8                 | 36  | 3.87          |
| M 3            | 0.50     | 2.79          | M 14           | 1.25     | 13.47         | 10                | 24  | 4.38          |
| M 3.5          | 0.60     | 3.25          | M 14           | 1.50     | 13.36         | 10                | 32  | 4.49          |
| M 4            | 0.70     | 3.70          | M 14           | 2.00     | 13.15         | 12                | 24  | 5.04          |
| M 4.5          | 0.75     | 4.18          | M 15           | 1.00     | 14.58         | 12                | 28  | 5.10          |
| M 5            | 0.50     | 4.79          | M 15           | 1.50     | 14.36         | 1/4               | 20  | 5.81          |
| M 5            | 0.80     | 4.66          | M 16           | 1.00     | 15.58         | 1/4               | 28  | 5.96          |
| M 5.5          | 0.50     | 5.29          | M 16           | 1.50     | 15.36         | 5/16              | 18  | 7.34          |
| M 6            | 0.75     | 5.68          | M 16           | 2.00     | 15.15         | 5/16              | 24  | 7.49          |
| M 6            | 1.00     | 5.58          | M 17           | 1.00     | 16.58         | 3/8               | 16  | 8.85          |
| M 7            | 0.75     | 6.68          | M 17           | 1.50     | 16.36         | 3/8               | 24  | 9.08          |
| M 7            | 1.00     | 6.58          | M 18           | 1.00     | 17.58         | 7/16              | 14  | 10.34         |
| M 8            | 0.75     | 7.68          | M 18           | 1.50     | 17.36         | 7/16              | 20  | 10.57         |
| M 8            | 1.00     | 7.58          | M 18           | 2.00     | 17.15         | 1/2               | 13  | 11.87         |
| M 8            | 1.25     | 7.47          | M 18           | 2.50     | 16.94         | 1/2               | 20  | 12.16         |
| M 9            | 0.75     | 8.68          | M 20           | 1.00     | 19.58         | 9/16              | 12  | 13.39         |
| M 9            | 1.00     | 8.58          | M 20           | 2.50     | 18.94         | 9/16              | 18  | 13.69         |
| M 9            | 1.25     | 8.47          |                |          |               | 5/8               | 11  | 14.89         |
|                |          |               |                |          |               | 5/8               | 18  | 15.28         |
|                |          |               |                |          |               | 3/4               | 10  | 17.97         |
|                |          |               |                |          |               | 3/4               | 16  | 18.38         |
|                |          |               |                |          |               | 7/8               | 9   | 21.03         |
|                |          |               |                |          |               | 7/8               | 14  | 21.45         |
|                |          |               |                |          |               | 1                 | 8   | 24.05         |
|                |          |               |                |          |               | 1                 | 12  | 24.50         |

# Technical Information

## DRILL SIZE FOR THREAD FORMING @ 65% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.89          | M 10           | 0.75     | 9.67          | 2                 | 56  | 1.98          |
| M 1.1          | 0.25     | 0.99          | M 10           | 1.00     | 9.56          | 2                 | 64  | 2.01          |
| M 1.2          | 0.25     | 1.09          | M 10           | 1.25     | 9.45          | 3                 | 48  | 2.28          |
| M 1.4          | 0.30     | 1.27          | M 10           | 1.50     | 9.34          | 3                 | 56  | 2.31          |
| M 1.6          | 0.35     | 1.45          | M 11           | 0.75     | 10.67         | 4                 | 40  | 2.56          |
| M 1.7          | 0.35     | 1.55          | M 11           | 1.00     | 10.56         | 4                 | 48  | 2.61          |
| M 1.8          | 0.35     | 1.65          | M 11           | 1.50     | 10.34         | 5                 | 40  | 2.89          |
| M 2            | 0.40     | 1.82          | M 12           | 1.00     | 11.56         | 5                 | 44  | 2.92          |
| M 2.2          | 0.45     | 2.00          | M 12           | 1.25     | 11.45         | 6                 | 32  | 3.15          |
| M 2.3          | 0.40     | 2.12          | M 12           | 1.50     | 11.34         | 6                 | 40  | 3.22          |
| M 2.5          | 0.45     | 2.30          | M 12           | 1.75     | 11.23         | 8                 | 32  | 3.81          |
| M 2.6          | 0.45     | 2.40          | M 14           | 1.00     | 13.56         | 8                 | 36  | 3.85          |
| M 3            | 0.50     | 2.78          | M 14           | 1.25     | 13.45         | 10                | 24  | 4.36          |
| M 3.5          | 0.60     | 3.23          | M 14           | 1.50     | 13.34         | 10                | 32  | 4.48          |
| M 4            | 0.70     | 3.69          | M 14           | 2.00     | 13.12         | 12                | 24  | 5.02          |
| M 4.5          | 0.75     | 4.17          | M 15           | 1.00     | 14.56         | 12                | 28  | 5.09          |
| M 5            | 0.50     | 4.78          | M 15           | 1.50     | 14.34         | 1/4               | 20  | 5.79          |
| M 5            | 0.80     | 4.65          | M 16           | 1.00     | 15.56         | 1/4               | 28  | 5.95          |
| M 5.5          | 0.50     | 5.28          | M 16           | 1.50     | 15.34         | 5/16              | 18  | 7.31          |
| M 6            | 0.75     | 5.67          | M 16           | 2.00     | 15.12         | 5/16              | 24  | 7.47          |
| M 6            | 1.00     | 5.56          | M 17           | 1.00     | 16.56         | 3/8               | 16  | 8.82          |
| M 7            | 0.75     | 6.67          | M 17           | 1.50     | 16.34         | 3/8               | 24  | 9.06          |
| M 7            | 1.00     | 6.56          | M 18           | 1.00     | 17.56         | 7/16              | 14  | 10.31         |
| M 8            | 0.75     | 7.67          | M 18           | 1.50     | 17.34         | 7/16              | 20  | 10.55         |
| M 8            | 1.00     | 7.56          | M 18           | 2.00     | 17.12         | 1/2               | 13  | 11.84         |
| M 8            | 1.25     | 7.45          | M 18           | 2.50     | 16.90         | 1/2               | 20  | 12.14         |
| M 9            | 0.75     | 8.67          | M 20           | 1.00     | 19.56         | 9/16              | 12  | 13.35         |
| M 9            | 1.00     | 8.56          | M 20           | 2.50     | 18.90         | 9/16              | 18  | 13.66         |
| M 9            | 1.25     | 8.45          |                |          |               | 5/8               | 11  | 14.85         |
|                |          |               |                |          |               | 5/8               | 18  | 15.25         |
|                |          |               |                |          |               | 3/4               | 10  | 17.93         |
|                |          |               |                |          |               | 3/4               | 16  | 18.35         |
|                |          |               |                |          |               | 7/8               | 9   | 20.98         |
|                |          |               |                |          |               | 7/8               | 14  | 21.42         |
|                |          |               |                |          |               | 1                 | 8   | 24.00         |
|                |          |               |                |          |               | 1                 | 12  | 24.46         |

## DRILL SIZE FOR THREAD FORMING @ 67.5% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.89          | M 10           | 0.75     | 9.66          | 2                 | 56  | 1.98          |
| M 1.1          | 0.25     | 0.99          | M 10           | 1.00     | 9.54          | 2                 | 64  | 2.00          |
| M 1.2          | 0.25     | 1.09          | M 10           | 1.25     | 9.43          | 3                 | 48  | 2.27          |
| M 1.4          | 0.30     | 1.26          | M 10           | 1.50     | 9.31          | 3                 | 56  | 2.31          |
| M 1.6          | 0.35     | 1.44          | M 11           | 0.75     | 10.66         | 4                 | 40  | 2.55          |
| M 1.7          | 0.35     | 1.54          | M 11           | 1.00     | 10.54         | 4                 | 48  | 2.60          |
| M 1.8          | 0.35     | 1.64          | M 11           | 1.50     | 10.31         | 5                 | 40  | 2.88          |
| M 2            | 0.40     | 1.82          | M 12           | 1.00     | 11.54         | 5                 | 44  | 2.91          |
| M 2.2          | 0.45     | 1.99          | M 12           | 1.25     | 11.43         | 6                 | 32  | 3.14          |
| M 2.3          | 0.40     | 2.12          | M 12           | 1.50     | 11.31         | 6                 | 40  | 3.21          |
| M 2.5          | 0.45     | 2.29          | M 12           | 1.75     | 11.20         | 8                 | 32  | 3.80          |
| M 2.6          | 0.45     | 2.39          | M 14           | 1.00     | 13.54         | 8                 | 36  | 3.84          |
| M 3            | 0.50     | 2.77          | M 14           | 1.25     | 13.43         | 10                | 24  | 4.34          |
| M 3.5          | 0.60     | 3.22          | M 14           | 1.50     | 13.31         | 10                | 32  | 4.46          |
| M 4            | 0.70     | 3.68          | M 14           | 2.00     | 13.08         | 12                | 24  | 5.00          |
| M 4.5          | 0.75     | 4.16          | M 15           | 1.00     | 14.54         | 12                | 28  | 5.07          |
| M 5            | 0.50     | 4.77          | M 15           | 1.50     | 14.31         | 1/4               | 20  | 5.77          |
| M 5            | 0.80     | 4.63          | M 16           | 1.00     | 15.54         | 1/4               | 28  | 5.93          |
| M 5.5          | 0.50     | 5.27          | M 16           | 1.50     | 15.31         | 5/16              | 18  | 7.29          |
| M 6            | 0.75     | 5.66          | M 16           | 2.00     | 15.08         | 5/16              | 24  | 7.45          |
| M 6            | 1.00     | 5.54          | M 17           | 1.00     | 16.54         | 3/8               | 16  | 8.80          |
| M 7            | 0.75     | 6.66          | M 17           | 1.50     | 16.31         | 3/8               | 24  | 9.04          |
| M 7            | 1.00     | 6.54          | M 18           | 1.00     | 17.54         | 7/16              | 14  | 10.28         |
| M 8            | 0.75     | 7.66          | M 18           | 1.50     | 17.31         | 7/16              | 20  | 10.53         |
| M 8            | 1.00     | 7.54          | M 18           | 2.00     | 17.08         | 1/2               | 13  | 11.80         |
| M 8            | 1.25     | 7.43          | M 18           | 2.50     | 16.85         | 1/2               | 20  | 12.12         |
| M 9            | 0.75     | 8.66          | M 20           | 1.00     | 19.54         | 9/16              | 12  | 13.32         |
| M 9            | 1.00     | 8.54          | M 20           | 2.50     | 18.85         | 9/16              | 18  | 13.64         |
| M 9            | 1.25     | 8.43          |                |          |               | 5/8               | 11  | 14.82         |
|                |          |               |                |          |               | 5/8               | 18  | 15.23         |
|                |          |               |                |          |               | 3/4               | 10  | 17.88         |
|                |          |               |                |          |               | 3/4               | 16  | 18.32         |
|                |          |               |                |          |               | 7/8               | 9   | 20.93         |
|                |          |               |                |          |               | 7/8               | 14  | 21.39         |
|                |          |               |                |          |               | 1                 | 8   | 23.94         |
|                |          |               |                |          |               | 1                 | 12  | 24.43         |

## DRILL SIZE FOR THREAD FORMING @ 70% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.88          | M 10           | 0.75     | 9.64          | 2                 | 56  | 1.97          |
| M 1.1          | 0.25     | 0.98          | M 10           | 1.00     | 9.52          | 2                 | 64  | 2.00          |
| M 1.2          | 0.25     | 1.08          | M 10           | 1.25     | 9.41          | 3                 | 48  | 2.26          |
| M 1.4          | 0.30     | 1.26          | M 10           | 1.50     | 9.29          | 3                 | 56  | 2.30          |
| M 1.6          | 0.35     | 1.43          | M 11           | 0.75     | 10.64         | 4                 | 40  | 2.54          |
| M 1.7          | 0.35     | 1.53          | M 11           | 1.00     | 10.52         | 4                 | 48  | 2.59          |
| M 1.8          | 0.35     | 1.63          | M 11           | 1.50     | 10.29         | 5                 | 40  | 2.87          |
| M 2            | 0.40     | 1.81          | M 12           | 1.00     | 11.52         | 5                 | 44  | 2.90          |
| M 2.2          | 0.45     | 1.99          | M 12           | 1.25     | 11.41         | 6                 | 32  | 3.13          |
| M 2.3          | 0.40     | 2.11          | M 12           | 1.50     | 11.29         | 6                 | 40  | 3.20          |
| M 2.5          | 0.45     | 2.29          | M 12           | 1.75     | 11.17         | 8                 | 32  | 3.79          |
| M 2.6          | 0.45     | 2.39          | M 14           | 1.00     | 13.52         | 8                 | 36  | 3.83          |
| M 3            | 0.50     | 2.76          | M 14           | 1.25     | 13.41         | 10                | 24  | 4.32          |
| M 3.5          | 0.60     | 3.21          | M 14           | 1.50     | 13.29         | 10                | 32  | 4.45          |
| M 4            | 0.70     | 3.67          | M 14           | 2.00     | 13.05         | 12                | 24  | 4.98          |
| M 4.5          | 0.75     | 4.14          | M 15           | 1.00     | 14.52         | 12                | 28  | 5.05          |
| M 5            | 0.50     | 4.76          | M 15           | 1.50     | 14.29         | 1/4               | 20  | 5.75          |
| M 5            | 0.80     | 4.62          | M 16           | 1.00     | 15.52         | 1/4               | 28  | 5.92          |
| M 5.5          | 0.50     | 5.26          | M 16           | 1.50     | 15.29         | 5/16              | 18  | 7.27          |
| M 6            | 0.75     | 5.64          | M 16           | 2.00     | 15.05         | 5/16              | 24  | 7.43          |
| M 6            | 1.00     | 5.52          | M 17           | 1.00     | 16.52         | 3/8               | 16  | 8.77          |
| M 7            | 0.75     | 6.64          | M 17           | 1.50     | 16.29         | 3/8               | 24  | 9.02          |
| M 7            | 1.00     | 6.52          | M 18           | 1.00     | 17.52         | 7/16              | 14  | 10.25         |
| M 8            | 0.75     | 7.64          | M 18           | 1.50     | 17.29         | 7/16              | 20  | 10.51         |
| M 8            | 1.00     | 7.52          | M 18           | 2.00     | 17.05         | 1/2               | 13  | 11.77         |
| M 8            | 1.25     | 7.41          | M 18           | 2.50     | 16.81         | 1/2               | 20  | 12.10         |
| M 9            | 0.75     | 8.64          | M 20           | 1.00     | 19.52         | 9/16              | 12  | 13.28         |
| M 9            | 1.00     | 8.52          | M 20           | 2.50     | 18.81         | 9/16              | 18  | 13.62         |
| M 9            | 1.25     | 8.41          |                |          |               | 5/8               | 11  | 14.78         |
|                |          |               |                |          |               | 5/8               | 18  | 15.20         |
|                |          |               |                |          |               | 3/4               | 10  | 17.84         |
|                |          |               |                |          |               | 3/4               | 16  | 18.29         |
|                |          |               |                |          |               | 7/8               | 9   | 20.88         |
|                |          |               |                |          |               | 7/8               | 14  | 21.36         |
|                |          |               |                |          |               | 1                 | 8   | 23.89         |
|                |          |               |                |          |               | 1                 | 12  | 24.39         |

## DRILL SIZE FOR THREAD FORMING @ 72.5% THREAD

| Metric Threads |          |               | Metric Threads |          |               | UNC / UNF Threads |     |               |
|----------------|----------|---------------|----------------|----------|---------------|-------------------|-----|---------------|
| Tap Dia.       | Pitch mm | Drill size mm | Tap Dia.       | Pitch mm | Drill size mm | Tap Size          | TPI | Drill size mm |
| M 1            | 0.25     | 0.88          | M 10           | 0.75     | 9.63          | 2                 | 56  | 1.96          |
| M 1.1          | 0.25     | 0.98          | M 10           | 1.00     | 9.51          | 2                 | 64  | 1.99          |
| M 1.2          | 0.25     | 1.08          | M 10           | 1.25     | 9.38          | 3                 | 48  | 2.25          |
| M 1.4          | 0.30     | 1.25          | M 10           | 1.50     | 9.26          | 3                 | 56  | 2.29          |
| M 1.6          | 0.35     | 1.43          | M 11           | 0.75     | 10.63         | 4                 | 40  | 2.53          |
| M 1.7          | 0.35     | 1.53          | M 11           | 1.00     | 10.51         | 4                 | 48  | 2.58          |
| M 1.8          | 0.35     | 1.63          | M 11           | 1.50     | 10.26         | 5                 | 40  | 2.86          |
| M 2            | 0.40     | 1.80          | M 12           | 1.00     | 11.51         | 5                 | 44  | 2.89          |
| M 2.2          | 0.45     | 1.98          | M 12           | 1.25     | 11.38         | 6                 | 32  | 3.11          |
| M 2.3          | 0.40     | 2.10          | M 12           | 1.50     | 11.26         | 6                 | 40  | 3.19          |
| M 2.5          | 0.45     | 2.28          | M 12           | 1.75     | 11.14         | 8                 | 32  | 3.77          |
| M 2.6          | 0.45     | 2.38          | M 14           | 1.00     | 13.51         | 8                 | 36  | 3.82          |
| M 3            | 0.50     | 2.75          | M 14           | 1.25     | 13.38         | 10                | 24  | 4.30          |
| M 3.5          | 0.60     | 3.20          | M 14           | 1.50     | 13.26         | 10                | 32  | 4.43          |
| M 4            | 0.70     | 3.65          | M 14           | 2.00     | 13.01         | 12                | 24  | 4.96          |
| M 4.5          | 0.75     | 4.13          | M 15           | 1.00     | 14.51         | 12                | 28  | 5.04          |
| M 5            | 0.50     | 4.75          | M 15           | 1.50     | 14.26         | 1/4               | 20  | 5.72          |
| M 5            | 0.80     | 4.61          | M 16           | 1.00     | 15.51         | 1/4               | 28  | 5.90          |
| M 5.5          | 0.50     | 5.25          | M 16           | 1.50     | 15.26         | 5/16              | 18  | 7.24          |
| M 6            | 0.75     | 5.63          | M 16           | 2.00     | 15.01         | 5/16              | 24  | 7.42          |
| M 6            | 1.00     | 5.51          | M 17           | 1.00     | 16.51         | 3/8               | 16  | 8.74          |
| M 7            | 0.75     | 6.63          | M 17           | 1.50     | 16.26         | 3/8               | 24  | 9.00          |
| M 7            | 1.00     | 6.51          | M 18           | 1.00     | 17.51         | 7/16              | 14  | 10.22         |
| M 8            | 0.75     | 7.63          | M 18           | 1.50     | 17.26         | 7/16              | 20  | 10.49         |
| M 8            | 1.00     | 7.51          | M 18           | 2.00     | 17.01         | 1/2               | 13  | 11.74         |
| M 8            | 1.25     | 7.38          | M 18           | 2.50     | 16.77         | 1/2               | 20  | 12.07         |
| M 9            | 0.75     | 8.63          | M 20           | 1.00     | 19.51         | 9/16              | 12  | 13.24         |
| M 9            | 1.00     | 8.51          | M 20           | 2.50     | 18.77         | 9/16              | 18  | 13.59         |
| M 9            | 1.25     | 8.38          |                |          |               | 5/8               | 11  | 14.74         |
|                |          |               |                |          |               | 5/8               | 18  | 15.18         |
|                |          |               |                |          |               | 3/4               | 10  | 17.80         |
|                |          |               |                |          |               | 3/4               | 16  | 18.27         |
|                |          |               |                |          |               | 7/8               | 9   | 20.83         |
|                |          |               |                |          |               | 7/8               | 14  | 21.33         |
|                |          |               |                |          |               | 1                 | 8   | 23.84         |
|                |          |               |                |          |               | 1                 | 12  | 24.36         |

# FORM TAPS

| Material group                                  | Approximate Rc  | Approximate HB   | Recommended SFM |          |               |
|-------------------------------------------------|-----------------|------------------|-----------------|----------|---------------|
|                                                 |                 |                  | HSS-E           | HSS-E-PM | Solid carbide |
| Structural steels, free-cutting steels          |                 | <180             | 45-70           | 60-90    | 90-120        |
| Unalloyed case hardened steels                  | <20             | <230             | 40-65           | 55-80    | 75-100        |
| Unalloyed heat-treatable steels                 | <25             | <250             | 30-55           | 50-75    | 65-95         |
| Structural steels, free-cutting steels          | <20             | <230             | 40-65           | 55-80    | 75-100        |
| Case hardened steels, heat-treatable steels     | <25             | <250             | 30-55           | 50-75    | 65-95         |
| Nitriding steels, spheroidal graphite iron      | <30             | <280             | 25-45           | 40-70    | 60-85         |
|                                                 | <35             | <320             | 20-35           | 35-60    | 50-75         |
|                                                 | <38             | <380             | -               | -        | -             |
| Stainless- and acid-resistant steels, sulphured |                 | <180             | 40-50           | 45-60    | 50-70         |
| austenitic                                      | <25             | <250             | 35-50           | 40-55    | 45-60         |
| martensitic                                     | <30             | <280             | 25-40           | 35-50    | 40-55         |
|                                                 | <35             | <320             | -               | 25-40    | 30-45         |
| Alloyed case hardened steels                    | <25             | <250             | 25-45           | 40-60    | 55-80         |
| Alloyed heat-treatable steels                   | <30             | <280             | 20-40           | 35-55    | 50-70         |
| Alloyed tool steels                             | <35             | <320             | 15-30           | 30-50    | 40-60         |
| High speed tool steels                          | <38             | <380             | -               | -        | -             |
|                                                 | <44             | <415             | -               | -        | -             |
|                                                 | <60             |                  | -               | -        | -             |
| Cast iron                                       |                 | <180             | -               | -        | -             |
| Spheroidal graphite iron                        | <25             | <250             | 40-65           | 60-80    | 75-130        |
| Malleable cast iron                             | <35             | <320             | 40-65           | 60-80    | 75-130        |
| Aluminium and Al-alloys                         | Silicon Content | Wrought Aluminum |                 |          |               |
| Al cast alloys                                  | <10%            | n/a              | 60-75           | 70-140   | 100-165       |
|                                                 | >10%            | n/a              | -               | -        | -             |
| Al wrought alloys                               | n/a             | 30-80            | 80-100          | 100-150  | 150-200       |
|                                                 | n/a             | 75-150           | 80-100          | 100-150  | 150-200       |
| Titanium and Ti-alloys                          |                 | <320             | 7-26            | 7-26     | 20-35         |
|                                                 |                 | >320             | -               | -        | -             |
| Nickel and Ni-alloys                            |                 | <320             | 7-26            | 7-26     | 20-35         |
|                                                 |                 | >320             | -               | -        | -             |
| Plastics                                        |                 |                  | -               | -        | -             |
| Magnesium-alloys                                |                 |                  | -               | -        | -             |
| Brass, short-chipping                           |                 | <180             | 35-50           | 50-65    | 75-100        |
| long-chipping                                   |                 | <180             | 40-65           | 60-80    | 80-120        |



# Fluteless taps and thread forming

Fluteless taps are used for the forming of internal threads without chip removal. In contrast to conventional tapping where material is cut from the workpiece, thread forming is a pressure deformation process without chip removal for the production of internal threads. During the process the material is cold formed without interrupting the grain flow.

According to DIN 8583, thread forming is described as “pressing the thread into the workpiece with a tool possessing a spiral working area”. The spiral threaded, polygonal portion of the fluteless tap is “screwed” into the pre-drilled workpiece with an appropriate constant feed rate equal to the thread pitch. The thread profile is pressed gradually via the forming lead into the material of the workpiece so to speak. Subsequently, the pressure in the deformation zone exceeds the compression limit, the workpiece becomes ductile and is deformed. The material yields radially, “flows” along the thread profile in the unoccupied base of the tool and forms the minor diameter of the nut thread. The flow process creates the process specific form pockets (claws).

The tapping size hole diameter is heavily dependent on the formability of the material, the workpiece geometry and the required effective depth of the thread. In comparison to conventional tapping, a larger diameter tapping size hole should be selected. With a larger diameter tapping size hole the load on the tool is reduced while increasing the tool life. Thanks to the uninterrupted grain flow, the loading capacity of the thread remains sufficient with a 50% effective thread depth.

The partially formed crests of the thread with decreasing effective thread depth are a typical characteristic of threads produced by the thread forming process. With the flanks of the thread fully

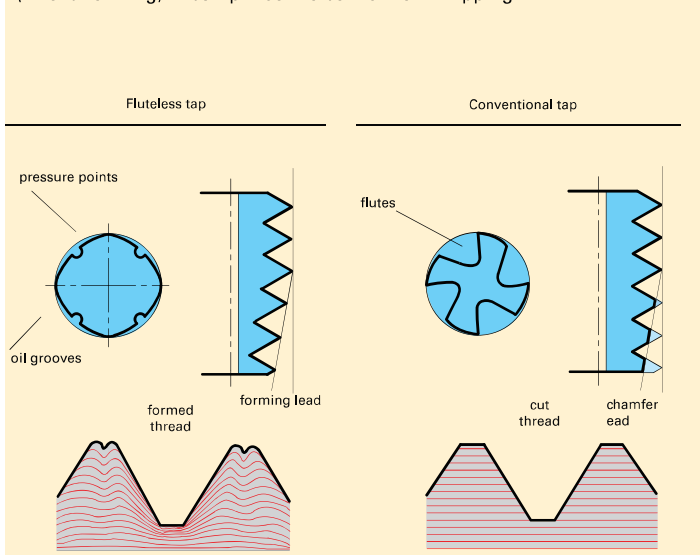
formed, they have no influence on the tensile strength of the thread. If necessary, the required deformation level of the thread should be determined by performing a test.

Lubrication is of significant importance. The lubrication prevents material from building up on the thread flanks and ensures that the necessary torque for the forming process is not too high. Therefore, under no circumstances should there ever be a breakdown in lubrication! Preference should be given to lubricants such as cooling agents or oils containing graphite such as those used in rolling processes. Always follow the rule: “The better the lubrication the easier the thread forming process.”

It offers the following advantages:

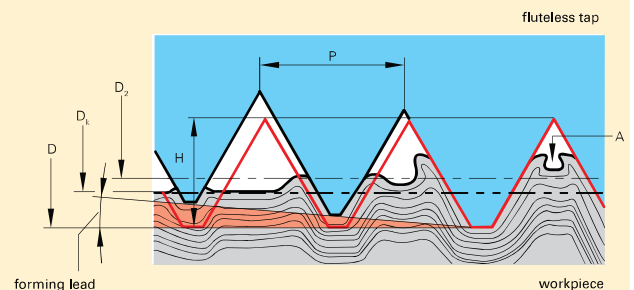
- no chip formation.
- one tool for the production of threads in through and blind holes.
- application in wide range of materials.
- no cutting errors.
- pitch and angle of thread errors that can occur with thread cutting are eliminated.
- internal threads produced by thread forming possess a higher tensile strength particularly at the thread flanks thanks to the so-called “uninterrupted grain flow” and the cold forming process.
- the surface of the thread is improved.
- fluteless taps can be applied at higher speeds because the formability of many materials increases with the forming speed. This does not have a negative effect on the tool life.
- reduced danger of breakage through rigid design

**Process**  
The production of internal threads without chip removal (thread forming) in comparison to conventional tapping



Flow characteristics of the material during thread forming and the deformation process

D = nom.-Ø  
D<sub>2</sub> = flank-Ø  
D<sub>k</sub> = hole-Ø  
H = profile height  
P = pitch  
A = form pocket (claw)  
— finished nut thread



# Guhring's fluteless taps - Characteristics and advantages

Conventional fluteless taps, produced by a grinding process only, show traces of microscopic, very fine grinding marks on the surface of the tool. This also applies to the threaded portion of the tool required to perform the thread forming operation.

This surface topography (structure) has a negative effect on the friction between the tool and the material to be re-formed as well as on the herewith associated heat development, on the necessary torque and last but not least on the wear of the pressure points of the fluteless tap. In addition, the "grinding marks" encourage the build-up of the material to be re-formed in the thread flanks of the fluteless tap. This is also called cold welding.

Thanks to a special process to improve the surface topography (structure), Guhring's new Profile fluteless taps no longer possess these "grinding marks". This has been confirmed in research and tool life studies in varying materials under production conditions.

For the user, a longer tool life and increased cutting speeds are the benefits of this special process. The tool life can be increased considerably depending on the material to be machined and the application conditions. A 100% increase in tool life is not unusual.

The improved surface topography is not only of benefit to tools with bright finish. Particularly coated tools also benefit from the new process. Outer contour and forming lead greatly determine the performance of the fluteless tap. Numerous tests have shown that fluteless taps with optimal pressure point geometry and quantity achieve increased tool life and dimensional accuracy.

Further improvements in quality are achieved when the fluteless tap is produced completely in one setting and with one grinding wheel - set-up with a special roll. Pitch errors between the thread crests and former lead transition area do not occur as with the conventional grinding process.

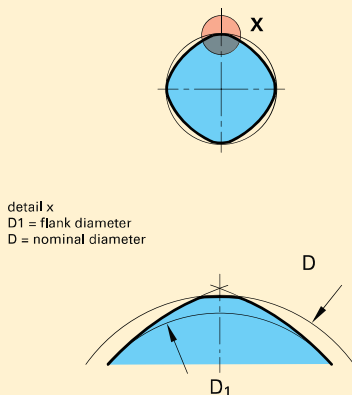


Surface of a conventional fluteless tap

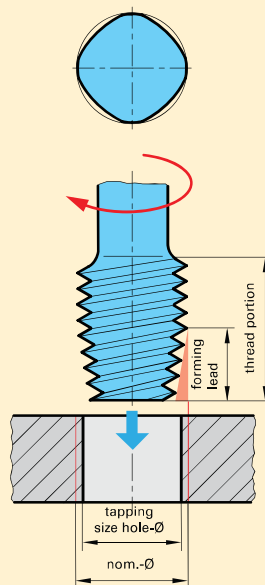


Optimized surface of a Guhring Profile fluteless tap

Cross section of fluteless tap



The principle



Types of tapping size hole

with fluteless taps without oil grooves  
for thread depth  $\leq 1 \times D$



for thread depth  $\geq 1 \times D$

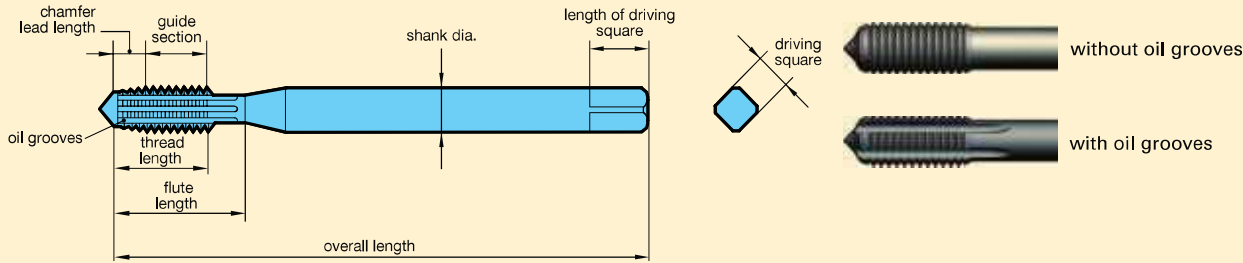


with fluteless taps with oil grooves  
for all thread depths

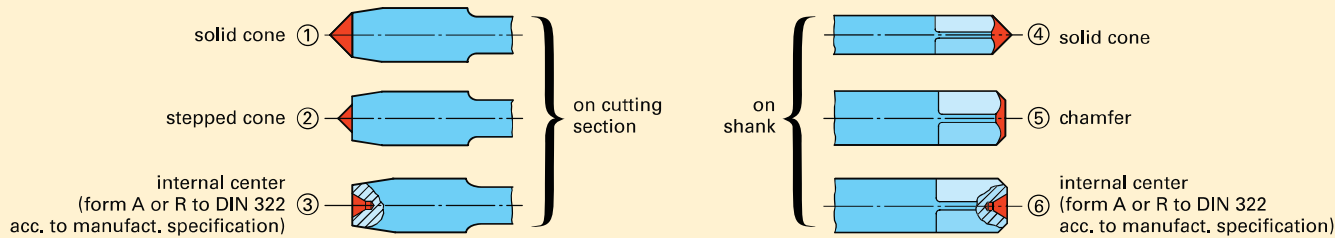


# Definitions, angles, centers, thread tolerances and fits

## Thread portion



## Types of centres (standard, to DIN 2197/DIN 2175)



| Center on cutting section |                               |                     |                 |
|---------------------------|-------------------------------|---------------------|-----------------|
| Thread dia. range mm      | with chamfer forms A, C, D, E | with chamfer form B | Center on shank |
| ≤ 5.6                     | ①                             | ①                   | ④ ⑤ ⑥           |
| > 5.6 ... 12.8            | ① ② ③                         | ① ② ③               | ④ ⑤ ⑥           |
| > 12.8                    | ③                             | ③                   | ⑥               |

## Thread tolerances and fits

Fits between internal and external threads are separated by a diagonal stroke, as for example 6H/6g (internal/external thread). The fit has to be selected in conjunction with the appropriate thread connection.

The tolerance zones of the tolerance classes fine, medium and coarse are allocated to three screw-in lengths short (S), normal (N) and long (L). Generally, the following rules apply for selecting a tolerance class:

### Fine tolerance zone (S):

For precision threads, when only a small variation in the fit is permitted.

### Screw-in lengths:

The quality of thread connection is also affected by the screw-in length. The ISO tolerance system was, especially as regards the pitch diameter, divided into three groups, i.e.

### Medium tolerance zone (N):

General application

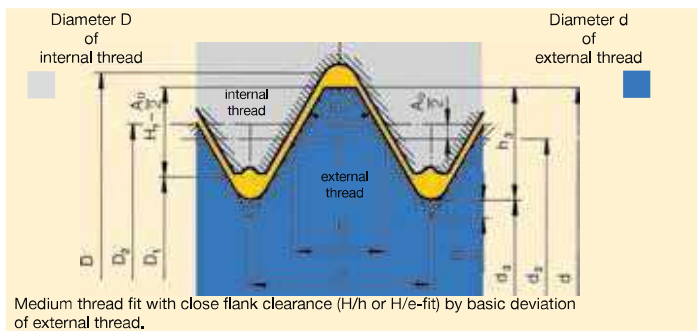
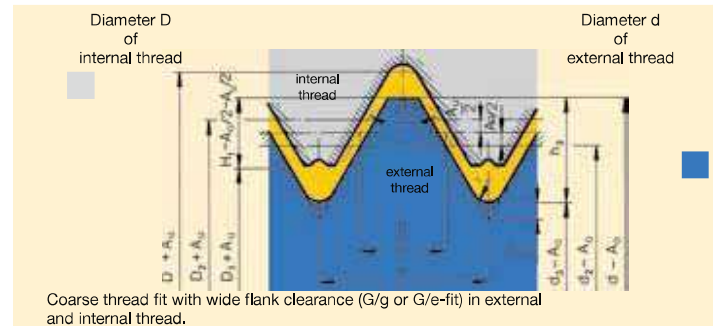
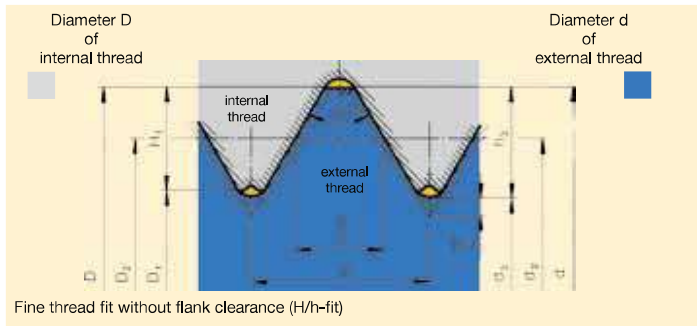
### Coarse tolerance zone (L):

There are no special precision requirements and in cases where production difficulties may occur, e.g. thread production in hot-rolled rods, deep blind holes or plastic components.

The following fit should be selected for normal screw-in length N: To ensure a tighter fit of thread connections, we recommend for short screw-in lengths a narrower fit.



## Thread fit with varying flank clearance



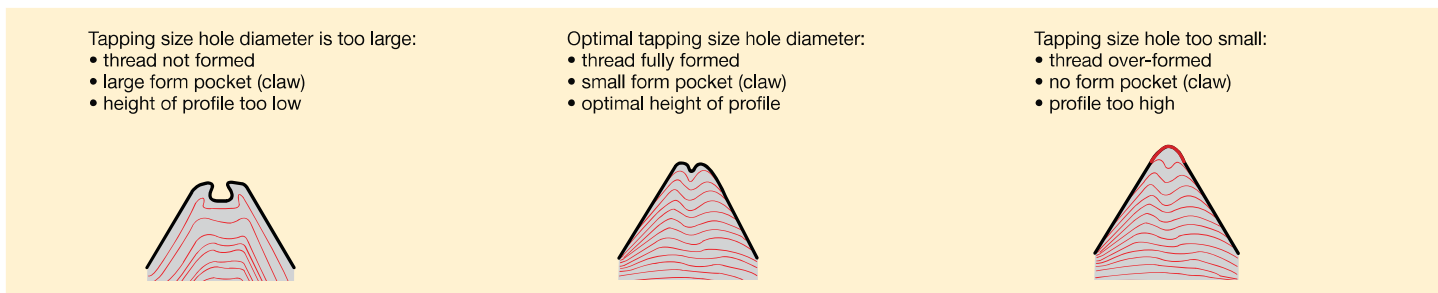
### Explanation of symbols

- $D$  = major diameter of internal thread
- $D_1$  = nominal diameter of tapping size hole
- $D_2$  = effective diameter of internal thread
- $d$  = major diameter of external thread
- $d_2$  = effective diameter of external thread
- $d_3$  = root diameter of external thread
- $P$  = pitch
- $s$  = pitch angle
- $H$  = peak to valley height of thread profile
- $A_o$  = positive tolerance
- $A_u$  = negative tolerance

### Tapping size hole diameter

With fluteless tapping, the tapping size hole diameter influences the distinction of the formed thread. A too small tapping size hole diameter results in an over-forming of the thread which must definitely be prevented because this can lead to tool breakage. A

too large tapping size hole is acceptable with certain tolerances because formed threads have a sufficient loading capacity from a 50% bearing depth.



### Cooling lubricants with fluteless taps

With fluteless taps the main task of the coolant is lubrication. The better the lubrication with the maximum concentration, the longer the tool life.

There are two different types of lubricant:

#### Oil based lubricants

These are mineral oils with the best lubricating characteristics. They reduce friction and achieve optimal life.

#### Soluble lubricants

Soluble, or emulsion, lubricants are concentrates mixed with water. Where a 6% emulsion is typically fine for most cutting processes, a higher level of lubricity is needed for thread forming. A content of 12% is ideal for forming threads. It should be noted that 50% of the success of thread forming is based on proper lubrication.

