

Cooling






Tolerance

h6

Coating

AlphaSlide Rainbow

Strategy

ETC

Application





Features

HA

≠



3xD



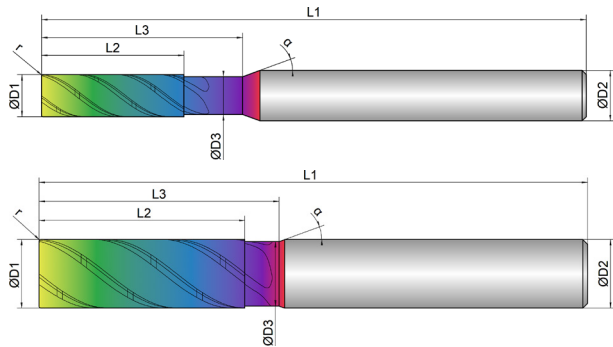





- Chip breaker for short, defined chip length
- Unequal tooth pitch combined with variable helical pitch for smooth running
- Reinforced face with 2 cutting edges to the center

- For roughing and finishing under ETC conditions
- For process reliable, helical diving and immersion

- Ideal chip evacuation, even with high radial depth of cutting



| Roughing                                                           |                                               |                                               |                                         |                                         | Finishing                                                          |                                               |                                       |                                        |                          |                                       |    |
|--------------------------------------------------------------------|-----------------------------------------------|-----------------------------------------------|-----------------------------------------|-----------------------------------------|--------------------------------------------------------------------|-----------------------------------------------|---------------------------------------|----------------------------------------|--------------------------|---------------------------------------|----|
| <div><div></div><div></div><div></div><div></div><div></div></div> |                                               |                                               |                                         |                                         | <div><div></div><div></div><div></div><div></div><div></div></div> |                                               |                                       |                                        |                          |                                       |    |
| inappropriate                                                      |                                               |                                               |                                         |                                         | optimal                                                            |                                               |                                       |                                        |                          |                                       |    |
| inappropriate                                                      |                                               |                                               |                                         |                                         | optimal                                                            |                                               |                                       |                                        |                          |                                       |    |
| EXN1-M03-0033                                                      | <div>D1</div> <div></div> <div>mm<br/>ø</div> | <div>D3</div> <div></div> <div>mm<br/>ø</div> | <div>L2</div> <div></div> <div>mm</div> | <div>L3</div> <div></div> <div>mm</div> | <div>L1</div> <div></div> <div>mm</div>                            | <div>D2</div> <div></div> <div>mm<br/>ø</div> | <div>z</div> <div></div> <div>#</div> | <div>r</div> <div></div> <div>mm</div> | <div></div> <div>°</div> | <div>α</div> <div></div> <div>°</div> |    |
|                                                                    | 5                                             | 5.0                                           | 4.5                                     | 17.0                                    | 24.0                                                               | 65.0                                          | 6.0                                   | 4                                      | 0.15                     | 38                                    | 20 |
|                                                                    | 6                                             | 6.0                                           | 5.5                                     | 18.0                                    | 25.0                                                               | 65.0                                          | 6.0                                   | 4                                      | 0.15                     | 38                                    | 20 |
|                                                                    | 8                                             | 8.0                                           | 7.5                                     | 24.0                                    | 30.0                                                               | 70.0                                          | 8.0                                   | 4                                      | 0.20                     | 38                                    | 20 |
|                                                                    | 10                                            | 10.0                                          | 9.4                                     | 30.0                                    | 35.0                                                               | 80.0                                          | 10.0                                  | 4                                      | 0.20                     | 38                                    | 20 |
|                                                                    | 12                                            | 12.0                                          | 11.4                                    | 36.0                                    | 45.0                                                               | 93.0                                          | 12.0                                  | 4                                      | 0.20                     | 38                                    | 20 |
|                                                                    | 16                                            | 16.0                                          | 15.4                                    | 48.0                                    | 55.0                                                               | 110.0                                         | 16.0                                  | 4                                      | 0.30                     | 38                                    | 20 |
|                                                                    | 20                                            | 20.0                                          | 19.4                                    | 60.0                                    | 70.0                                                               | 125.0                                         | 20.0                                  | 4                                      | 0.30                     | 38                                    | 20 |



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|          |                          |      | ETC                                                                               | Finishing                                                                         | Materialgroup<br>Factor<br>fz / a | Materialgroup<br>Factor<br>ae ETC |
|----------|--------------------------|------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------|-----------------------------------|
|          |                          |      |  |  |                                   |                                   |
| Material | Strength<br>(N/mm²)      |      | Vc = m/min                                                                        | Vc = m/min                                                                        |                                   |                                   |
| N        | NON-FERROUS              |      |                                                                                   |                                                                                   |                                   |                                   |
| 1.1      | ALUMINIUM   alloyed      | <500 | 520                                                                               | 380                                                                               | 1                                 | 1                                 |
| 1.2      | ALUMINIUM   alloyed      | <600 | 500                                                                               | 360                                                                               | 1                                 | 1                                 |
| 2.1-2.3  | ALUMINIUM   casted       | <600 | 480                                                                               | 320                                                                               | 0.9                               | 0.8                               |
| 3.1-3.3  | COPPER   alloyed         | <650 | 220                                                                               | 160                                                                               | 0.8                               | 0.7                               |
| 4.1      | MAGNESIUM   alloyed      | <250 | 520                                                                               | 350                                                                               | 1                                 | 1                                 |
| 5.1      | PLASTICS   Thermoplastic | <100 |                                                                                   |                                                                                   |                                   |                                   |
| 5.2      | PLASTICS   Duroplastic   | <150 |                                                                                   |                                                                                   |                                   |                                   |

**ADVICE |** All fz/a values in the table for material group 1.1, consider factors for the other groups!  
Depending on the material, it may be necessary to change the Vc or Fz value.  
When helical and ramping reduce fz by 50 %.  
The specified values represent starting values for a solid clamping situation.  
To determine the hmax values, please use the provided calculator.  
The use of cooling lubricant is recommended for high process reliability.  
For coarser roughing operations we recommend a Weldon in conjunction with a Weldon chuck.

Material N 1.1

|  |  | Immersion<br>Angle<br> | ETC<br>high dynamic<br> |                     |            |              | ETC<br>low dynamic<br> |                    |            |              | Finishing<br> |            |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------|------------|--------------|-------------------------------------------------------------------------------------------------------------|--------------------|------------|--------------|----------------------------------------------------------------------------------------------------|------------|
|                                                                                     |                                                                                     |                                                                                                           | fz<br>(mm/Z)                                                                                               | ae = 0.15xD<br>(mm) | ap<br>(mm) | hmax<br>(mm) | fz<br>(mm/Z)                                                                                                | ae = 0.3xD<br>(mm) | ap<br>(mm) | hmax<br>(mm) | fz<br>(mm/Z)                                                                                       | ae<br>(mm) |
| 5                                                                                   | 17                                                                                  | 1°                                                                                                        | 0.07                                                                                                       | 0.75                | L2max      | 0.05         | 0.043                                                                                                       | 1.5                | L2max      | 0.0394       | 0.028                                                                                              | 0.2        |
| 6                                                                                   | 18                                                                                  | 1°                                                                                                        | 0.09                                                                                                       | 0.9                 | L2max      | 0.0643       | 0.056                                                                                                       | 1.8                | L2max      | 0.0513       | 0.03                                                                                               | 0.2        |
| 8                                                                                   | 24                                                                                  | 1.2°                                                                                                      | 0.11                                                                                                       | 1.2                 | L2max      | 0.0786       | 0.068                                                                                                       | 2.4                | L2max      | 0.0623       | 0.032                                                                                              | 0.2        |
| 10                                                                                  | 30                                                                                  | 1.5°                                                                                                      | 0.13                                                                                                       | 1.5                 | L2max      | 0.0928       | 0.081                                                                                                       | 3                  | L2max      | 0.0742       | 0.034                                                                                              | 0.2        |
| 12                                                                                  | 36                                                                                  | 1.5°                                                                                                      | 0.15                                                                                                       | 1.8                 | L2max      | 0.1071       | 0.093                                                                                                       | 3.6                | L2max      | 0.0852       | 0.036                                                                                              | 0.2        |
| 16                                                                                  | 48                                                                                  | 2°                                                                                                        | 0.18                                                                                                       | 2.4                 | L2max      | 0.1285       | 0.112                                                                                                       | 4.8                | L2max      | 0.1026       | 0.038                                                                                              | 0.2        |
| 20                                                                                  | 60                                                                                  | 3°                                                                                                        | 0.21                                                                                                       | 3                   | L2max      | 0.15         | 0.130                                                                                                       | 6                  | L2max      | 0.1191       | 0.04                                                                                               | 0.2        |

# EXPLANATION

## APPLICATIONS

|                                                                                                     |                                                                                                     |                                                                                                                  |                                                                                               |
|-----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
|  Multipass milling |  Trimming          |  Deburring                      |  Engraving |
|  Corner rounding   |  Full slot milling |  Forward and backward deburring |                                                                                               |

## COOLINGS

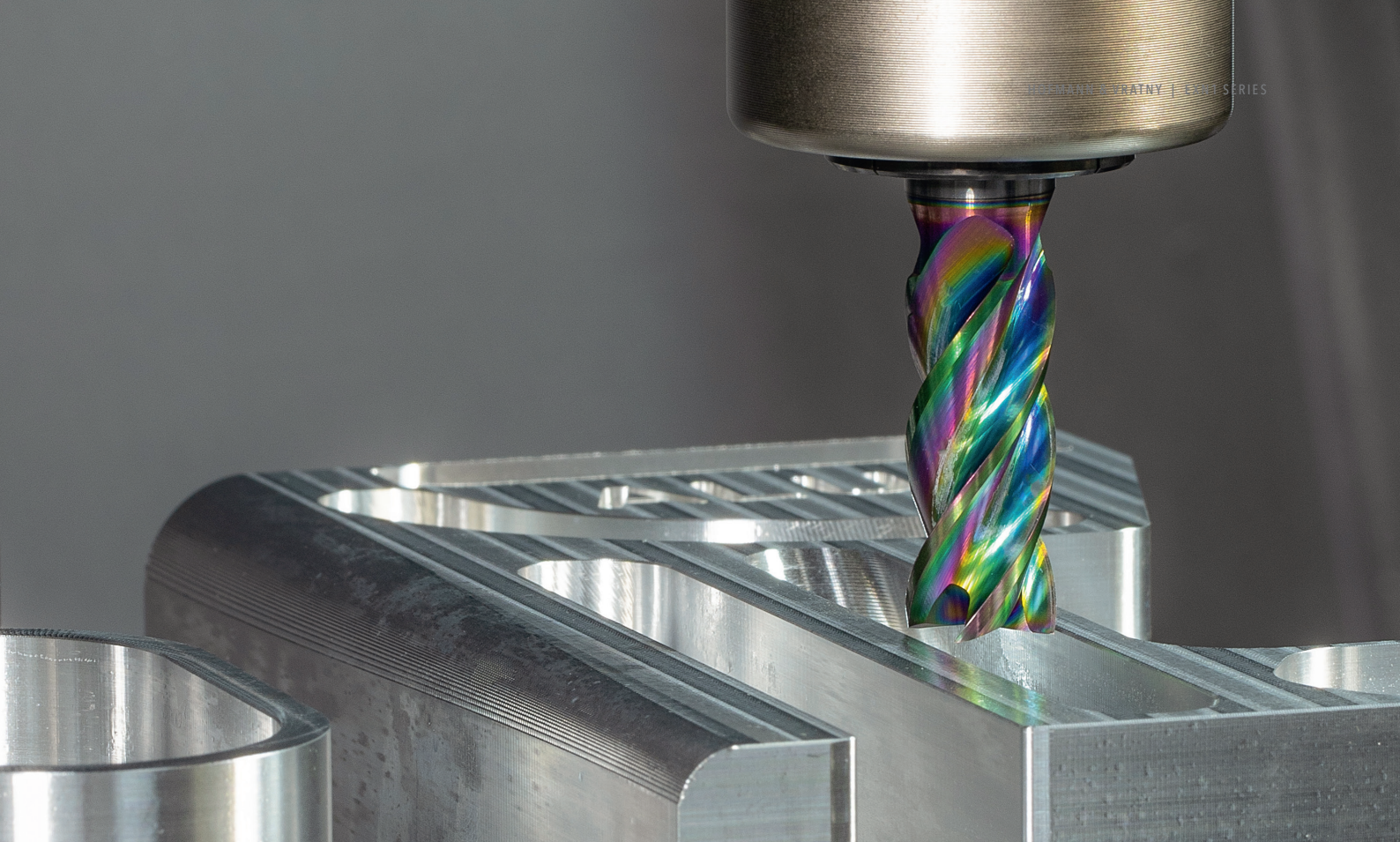
|                                                                                                                  |                                                                                                   |                                                                                                 |                                                                                                         |
|------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
|  Air-cooling                  |  Dry machining |  Oil cooling |  Cooling Lubricant |
|  Minimum quantity lubrication |                                                                                                   |                                                                                                 |                                                                                                         |

## FEATURES

|                                                                                                             |                                                                                                               |                                                                                                           |                                                                                                           |
|-------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|  0,5xD                   |  1xD                       |  1,5xD                 |  2xD                 |
|  2,5xD                   |  3xD                       |  3,5xD                 |  4xD                 |
|  5xD                     |  Center cutting            |  Non-center cutting    |  Without Weldon      |
|  With Weldon             |  Internal cooling          |  Dynamic helical pitch |  Chip breaker        |
|  Unequal tooth pitch     |  Roughing teeth            |  Helical immersion     |  Feed directions x,y |
|  Feed directions x, y, z |  Feed directions x, y, (z) |  Corner radius         |  Corner bevel        |
|  Sharp edged             |                                                                                                               |                                                                                                           |                                                                                                           |

## STRATEGY

|                                                                                                                 |                                                                                                              |                                                                                                        |                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
|  Extended Trochoidal Cutting |  High Performance Cutting |  High Speed Cutting |  Multi Task Cutting |
|  Universal Machining         |                                                                                                              |                                                                                                        |                                                                                                          |



## PROPERTIES

|                                                                                                        |                                                                                                            |                                                                                                            |                                                                                                         |
|--------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
|  Cutting diameter   |  Small cutting diameter |  Large cutting diameter |  Undercut diameter |
|  Cutting length     |  Total bevel length     |  Undercut length        |  Total length      |
|  Shank diameter     |  Number of teeth        |  Corner radius          |  Corner bevel      |
|  Programming radius |  Maximum cutting depth  |  Helical angle          |  Alpha angle       |

## APPLICATION TABLE

The values given in the application table are only guidelines. These values are largely dependent on the machining situation and application.

## FIGURES

All technical drawings and photographs are given as an example. The product may deviate from the original in terms of colour and dimensions.

N 1.1 **ALUMINIUM** | alloyed <500 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN      | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI       | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|--------------------|-------------|----------------|--------------------|-------------------|--------------|-------------|-------------|------------|
| 3.0205         | Al99               | AW-1200     | A 4            | 1 C                | P-Al99.0          | 4010         | L-3001      | A1200       | AA1200     |
| 3.0250         | Al99.5H            |             | A 59050 C      | L 31               |                   |              |             |             | AA1000     |
| 3.0255         | Al99.5             | AW-1050 A   | A 5            | L 31               | P-AlP99.5         | 4007         | L-3051      | A1050       | AA1050 A   |
| 3.0275         | Al99.7             | AW-1070 A   | A 7            | 2L 48              | P-AlP99.7         | 4005         | L-3071      | A1070       | AA1070 A   |
| 3.0280         | Al99.8             |             |                |                    |                   |              |             |             |            |
| 3.0285         | Al99.8             | AW-1080 A   | A 8            | 1A                 | P-Al99.8          | 4004         | L-3081      | A1080       | AA1080 A   |
| 3.0305         | Al99.9             | AW-1090     |                |                    |                   |              |             |             |            |
| 3.0505         | AlMn 0.5 Mg 0.5    | AW-3105     |                | N 31               |                   |              |             | A3105       | AA3105     |
| 3.0506         | AlMn 0.6           | AW-3207     |                |                    |                   |              |             |             |            |
| 3.0515         | AlMn 1             | AW-3103     |                | N 3                | P-AlMn 1.2        | 4067         | L-3811      | A3103       | AA3103     |
| 3.0517         | AlMn 1 Cu          | AW-3003     | A-M1           |                    | P-AlMn 1.2 Cu     |              | L-3810      | A3003       | AA3003     |
| 3.0525         | AlMn 1 Mg 0.5      | AW-3005     | A-MG0,5        |                    |                   |              |             | A3005       | AA3005     |
| 3.0526         | AlMn 1 Mg 1        | AW-3004     | A-M1G          |                    | P-AlMn 1.2 Mg     | GA/6511      | L-3820      | A3004       | AA3004     |
| 3.0915         | AlFeSi             | AW-8011A    |                |                    |                   |              |             |             |            |
| 3.1255         | AlCu 4 SiMg        | AW-2014     | A-U4SG         | H 15               | P-AlCu 4.4 SiMnMg |              | L-3130      | A2014       | AA2014     |
| 3.1305         | AlCu 2.5 Mg        | AW-2117     | A-U2G          | L 86               | P-AlCu 2.5 MgSi   |              | L-3180      | A2117       | AA2117     |
| 3.1324         | AlCu 4 MgSi        | AW-2017 A   |                |                    |                   |              |             |             |            |
| 3.1325         | AlCuMg1            | AW-2017 A   | A-U4G          | H 14               | P-AlCu 4.5 MgMn   | GA631        | L-3120      | A2017       | AA2017 A   |
| 3.1355         | AlCuMg2            | AW-2024     | A-U4G1         | L 97 / L 98        | P-AlCu 4.5 MgMn   | 5            | L-3140      | A2024       | AA2024     |
| 3.1371         | G-AlCu 4 TiMg      | AC-21000    |                |                    |                   |              |             |             |            |
| 3.1841         | G-AlCu 4 Ti        | AC-21100    |                |                    |                   |              |             |             |            |
| 3.2134         | G-AlSi 5 Cu 1,3 Mg | AC-45300    |                |                    |                   |              |             |             |            |
| 3.2307         | Al99.85 MgSi       |             |                |                    |                   |              |             |             |            |
| 3.2315         | AlMgSi 1           | AW-6082     | A-SGM0,7       | H 30               | P-AlMgSi          | 4212         | L-3453      |             | AA6082     |
| 3.3206         | AlMgSi 0.5         | AW-6060     | A-GS           | H 9                | P-AlMgSi          | 4140         | L-3442      |             | AA6060     |
| 3.3208         | Al99.9 MgSi        | AW-6401     |                |                    |                   |              |             |             |            |
| 3.3210         | AlMgSi 0.7         | AW-6005 A   |                |                    |                   |              |             |             |            |
| 3.3211         | AlMg 1 SiCu        | AW-6061     | A-GSUC         | H 20               | P-AlMg 1 SiCu     |              | L-3420      | A6061       | AA6061     |
| 3.3241         | G-AlMg 3 Si        |             |                |                    |                   |              |             |             |            |
| 3.3261         | G-AlMg 5 Si        | AC-51400    |                |                    |                   |              |             |             |            |
| 3.3292         | GD-AlMg 9          | AC-51200    |                |                    |                   |              |             |             |            |
| 3.3307         | Al99.85 Mg 0.5     | AW-5110     |                |                    |                   |              |             |             |            |
| 3.3308         | Al99.9 Mg 0.5      | AW-5210     |                |                    |                   |              |             |             |            |
| 3.3315         | AlMg1              | AW-5005 A   | A-G0,6         | N 41               | P-AlMg 0.9        | 4106         | L-3350      | A5005       | AA5005 A   |
| 3.3316         | AlMg 1.5           | AW-5050     | A-G1,5         | 3L 44              | P-AlMg 1.5        |              | L-3380      |             | AA5050 B   |
| 3.3317         | Al99.85 Mg 1       | AW-5305     |                |                    |                   |              |             |             |            |
| 3.3318         | Al99.9 Mg 1        | AW-5505     |                |                    |                   |              |             |             |            |
| 3.3326         | AlMg 1.8           | AW-5051 A   |                |                    |                   |              |             |             |            |
| 3.3345         | AlMg 4.5           | AW-5082     | A-G4,5         |                    | P-AlMg 4.4        |              |             | A5082       | AA5082     |
| 3.3523         | AlMg 2.5           | AW-5052     | A-G2,5C        | L 80 / L 81        | P-AlMg 2.5        | 4120         | L-3360      | A5052       | AA5052     |
| 3.3525         | AlMg 2 Mn 0.3      | AW-5251     | A-G2M          | N4                 | P-AlMg 2 Mn       |              | L-3361      |             | AA5251     |
| 3.3527         | AlMg 2 Mn 0.8      | AW-5049     | A-G2,5MC       |                    |                   |              |             | A5049       | AA5049     |
| 3.3535         | AlMg 3             | AW-5754     | A-G3M          |                    | P-AlMg 3.5        | 4130         | L-3390      |             | AA5754     |
| 3.3537         | AlMg 2.7 Mn        | AW-5454     | A-G2,5MC       |                    | P-AlMg 2.7 Mn     | 4130         | L-3391      |             | AA5454     |
| 3.3541         | G-AlMg 3           | AC-51100    |                |                    |                   |              |             |             |            |
| 3.3545         | AlMg 4 Mn          | AW-5086     | A-G4MC         |                    | P-AlMg 4.4        |              | L-3382      |             | AA5086     |
| 3.3547         | AlMg 4,5 Mn        | AW-5083     | A-G4,5MC       | N 8                | P-AlMg 4.5        | 4140         | L-3321      | A5083       | AA5083     |
| 3.3549         | AlMg 5 Mn          | AW-5182     |                |                    |                   |              |             |             |            |
| 3.3555         | AlMg 5             | AW-5019     |                |                    |                   |              |             |             |            |
| 3.3561         | G-AlMg 5           | AC-51300    |                |                    |                   |              |             |             |            |

N 1.2 **ALUMINIUM** | alloyed <600 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI     | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|---------------|-------------|----------------|--------------------|-----------------|--------------|-------------|-------------|------------|
| 3.0615         | AlMgSiPb      | AW-6012     | A-SGPb         |                    | P-AlSiMgMn      |              | L-3452      |             | AA6012     |
| 3.1645         | AlCu 4 PbMgMn | AW-2007     |                |                    |                 | 4355         | L-3121      | A2007       | AA2007     |
| 3.1655         | AlCu 6 BiPb   | AW-2011     | A-U5PbBi       | FC 1               | P-AlCu 5.5 PbBi | 4338         | L-3192      | A2011       | AA2011     |
| 3.4335         | AlZn 4.5 Mg 1 | AW-7020     | A-Z5G          | H 17               |                 | 4425         | L-3741      |             | AA7020     |
| 3.4345         | AlZnMgCu 0.5  | AW-7022     | A-Z4GU         |                    |                 |              |             |             | AA7022     |
| 3.4365         | AlZnMgCu 1.5  | AW-7075     | A-Z5GU         | 2L 95              | P-AlZn 5.8 MgCu |              | L-3710      | A7075       | AA7075     |

**N 2.1 - N 2.3** **ALUMINIUM** | casted <600 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN    | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|------------------|-------------|----------------|--------------------|-------------|--------------|-------------|-------------|------------|
| <b>3.1841</b>  | G-AlCu 4 Ti      |             |                |                    |             |              |             | AC1A        | A 295.0    |
| <b>3.1871</b>  | G-AlCu 4 TiMg    |             |                |                    |             |              |             |             |            |
| <b>3.2131</b>  | G-AlSiCu1        |             |                |                    |             |              |             |             |            |
| <b>3.2151</b>  | G-AlSi 6 Cu 4    | AC-45000    | A-S5UZ         | LM 4               |             |              |             | AC4B        | A 319.0    |
| <b>3.2161</b>  | G-AlSi 8 Cu 3    | AC-46200    | A-S9U3A-Y4     | LM 24              | 5075        |              |             | AC4D        | A 328.0    |
| <b>3.2163</b>  | GD-AlSi 9 Cu 3   |             |                |                    |             |              |             |             |            |
| <b>3.2211</b>  | G-AlSi 11        |             |                |                    |             |              |             |             |            |
| <b>3.2341</b>  | G-AlSi 5 Mg      |             |                |                    |             |              |             |             |            |
| <b>3.2371</b>  | G-AlSi 7 Mg 0,3  | AC-42100    |                |                    |             |              |             | AC4CH       | A 356.0    |
| <b>3.2373</b>  | G-AlSi 9 Mg      | AC-43300    |                |                    |             |              |             |             |            |
| <b>3.2381</b>  | G-AlSi 10 Mg     | AC-43100    |                |                    |             |              |             |             |            |
| <b>3.2382</b>  | GD-AlSi 10 Mg    |             |                |                    |             |              |             |             |            |
| <b>3.2383</b>  | G-AlSi 10 Mg(Cu) | AC-43400    | A-S10G         | LM 9               | 3049        | 4253         |             | ADC3        | A 360.2    |
| <b>3.2581</b>  | G-AlSi 12        | AC-47100    | A-S13          | LM 6               | 4514        | 4261         |             | AC3A        | A 413.2    |
| <b>3.2582</b>  | GD-AlSi 12       |             |                |                    |             | 4247         |             | ADC1        | A 413.0    |
| <b>3.2583</b>  | G-AlSi 12 Cu     | AC-44300    | A-S12-Y4       | LM 20              | 5079        | 4260         |             | ADC1        | A 413.1    |
| <b>3.2585</b>  | SG-AlSi12        |             |                |                    |             |              |             |             |            |
| <b>3.2982</b>  | GD-AlSi 12 Cu    |             |                |                    |             |              |             |             |            |
| <b>3.3241</b>  | G-AlMg 3 Si      |             |                |                    |             |              |             |             |            |
| <b>3.3261</b>  | G-AlMg 5 Si      |             |                |                    |             |              |             |             |            |
| <b>3.3561</b>  | G-AlMg 5         |             |                |                    |             |              |             | AC7A        | A 514.0    |

**N 3.1** **COPPER** | alloyed <600 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN     | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|-------------------|-------------|----------------|--------------------|-------------|--------------|-------------|-------------|------------|
| <b>2.0060</b>  | E-Cu 57           | CW-004A     |                |                    |             |              |             |             | B-120      |
| <b>2.0065</b>  | E-Cu 58           | CW-004A     | Sn-a2          | C 101              |             |              |             |             | C 11000    |
| <b>2.0070</b>  | SE-Cu             | CW-020A     | Cu-c1          | C 101              |             |              |             |             | C 10300    |
| <b>2.0082</b>  | G-Cu L 45         |             |                | HCC 1              |             |              |             |             | C 81100    |
| <b>2.0085</b>  | G-Cu L 50         | CC-040A     |                | HCC 1              |             |              |             |             | C 81100    |
| <b>2.0240</b>  | CuZn 15           | CW-502L     | CuZn 15        | CZ 102             |             |              |             | C 2300      | C 23000    |
| <b>2.0265</b>  | CuZn 30           | CW-505L     | CuZn 30        | CZ 102             |             |              |             | C 2600      | C 26000    |
| <b>2.0321</b>  | CuZn 37           | CW-508L     | CuZn 37        | CZ 180             | C 2720      |              |             |             | C 27200    |
| <b>2.0340</b>  | G-CuZn 37 Pb      | CC-754S-GM  |                |                    |             |              |             |             |            |
| <b>2.0492</b>  | G-CuZn 15 Si 4    | CC-761S-GS  |                |                    |             |              |             |             | B-198      |
| <b>2.0592</b>  | G-CuZn 35 Al 1    | CC-765S     | U-Z 36 N 3     | HTB 1              |             |              |             |             | C 86500    |
| <b>2.0595</b>  | G-KCuZn 37 Al 1   | CC-766S     |                |                    |             |              |             |             |            |
| <b>2.0596</b>  | G-CuZn 34 Al 2    | CC-764S     | U-Z 36 N 3     |                    |             |              |             |             |            |
| <b>2.0857</b>  | CuNi 3 Si         | CW-112C     |                |                    |             |              |             |             |            |
| <b>2.0916</b>  | CuAl 5            |             |                |                    |             |              |             |             |            |
| <b>2.0927</b>  | SG-CuAl 9 Ni 5 Fe |             |                |                    |             |              |             |             |            |
| <b>2.0936</b>  | CuAl 10 Fe 3 Mn 2 | CW-306G     | U-A 10 Fe      | CA 103             |             |              |             |             |            |
| <b>2.0966</b>  | CuAl 10 Ni 5 Fe 4 | CW-307G     | U-A 10 N       | CA 104             |             |              |             |             | C 63000    |
| <b>2.1006</b>  | SG-CuSn           |             |                |                    |             |              |             |             |            |
| <b>2.1050</b>  | G-CuSn 10         | CC-480K-GS  |                | CT 1               |             |              |             |             | C 90700    |
| <b>2.1052</b>  | G-CuSn 12         | CC-483K-GS  | UE 12 P        | Pb 2               |             |              |             |             | C 91700    |
| <b>2.1060</b>  | G-CuSn 12 Ni 2    | CC-484K-GS  |                |                    |             |              |             |             | C 91700    |
| <b>2.1090</b>  | G-CuSn 7 ZnPb     |             | UE 7 Z5 Pb 4   |                    |             |              |             |             | C 93200    |
| <b>2.1093</b>  | G-CuSn 6 ZnNi     |             |                | LG 4               |             |              |             |             |            |
| <b>2.1096</b>  | G-CuSn 5 ZnPb     |             | UE 5 Pb 5 Z 5  | LG 2               |             |              |             |             | C 83600    |
| <b>2.1176</b>  | G-CuPb 10 Sn      | CC-495K-GS  | UE 10 Pb 10    | LB 2               |             |              |             |             | C 93700    |
| <b>2.1182</b>  | G-CuPb 15 Sn      | CC-496K-GS  | U-Pb 15 E 8    | LB 1               |             |              |             |             | C 93800    |
| <b>2.1188</b>  | G-CuPb 20 Sn      | CC-497K-GS  | U-Pb 20        | LB 5               |             |              |             |             | C 94100    |
| <b>2.1266</b>  | CuCd 1            |             |                |                    |             |              |             |             |            |
| <b>2.1292</b>  | G-CuCrF 35        | CC-140C     |                | CC1-FF             |             |              |             |             | C 81500    |
| <b>2.1293</b>  | CuCrZr            | CW-106C     | U-Cr 0.8 Zr    | CC 102             |             |              |             |             | C 81500    |
| <b>2.1322</b>  | CuMg 0.4          |             |                |                    |             |              |             |             |            |
| <b>2.1355</b>  | CuMn 2            |             |                |                    |             |              |             |             |            |
| <b>2.1461</b>  | SG-CuSi 3         | CW-116C     |                |                    |             |              |             |             |            |

**N 4.1** **MAGNESIUM** | alloyed <200 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN     | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|-------------------|-------------|----------------|--------------------|-------------|--------------|-------------|-------------|------------|
| 3.5101         | G-MgZn 4 SE1 Zr 1 | MC-35110    | G-Z 4 Tr       | MAG-5              |             |              |             |             | ZE 41      |
| 3.5102         | G-MgZn 5 Th2 Zr1  |             |                |                    |             |              |             |             |            |
| 3.5103         | MgSE 3 Zn2 Zr1    | MC-65120    | G-Tr 3 Z 2     | MAG-6              |             |              |             |             | EZ 33      |
| 3.5105         | G-MgTh 3 Zn2 Zr1  |             |                |                    |             |              |             |             | QE 22      |
| 3.5106         | G-MgAg 3 SE2 Zr1  | MC-65210    | G-Ag 22.5      | MAG-12             |             |              |             |             |            |
| 3.5200         | G-MgAl 8 Zn 1     | MA-40020    |                |                    |             |              |             |             |            |
| 3.5312         | MgAl 3 Zn         | MA-21130    |                |                    |             |              |             |             |            |
| 3.5314         | MgAl 3 Zn         |             | G-A3 Z1        | MAG-E-111          |             |              |             |             | AZ 31 B    |
| 3.5470         | GD-MgAl 4 Si 1    | MC-21320    |                |                    |             |              |             |             |            |
| 3.5612         | GD-MgAl 6 Zn 3    | MC-21140    |                |                    |             |              |             |             |            |
| 3.5614         | MgAl 6 Zn         |             | G-A6 Z1        | MAG-E-121          |             |              |             |             | AZ 61 A    |
| 3.5662         | GD-MgAl 6         |             |                |                    |             |              |             |             |            |
| 3.5812         | G-MgAl 8 Zn 1     | MC-21110    | G-A9           |                    |             |              |             |             | AZ 81      |
| 3.5912         | G-MgAl 9 Zn 1     | MC-21120    | G-A 9 Z 1      |                    |             |              |             |             | AZ 91      |

**N 5.1** **PLASTICS** | thermoplastics <100 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN               | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI    |
|----------------|-----------------------------|-------------|----------------|--------------------|-------------|--------------|-------------|-------------|---------------|
| PC             | Makralon                    |             | Orgalan        | Sinvet             |             |              |             |             | Lexan         |
| PC             | Nuclon                      |             |                |                    |             |              |             |             | Merlon        |
| PC             | Plastocarbon                |             |                |                    |             |              |             |             |               |
| PE             | Baylon                      |             |                | Fertene            | Carlona     |              |             |             | Althon        |
| PE             | Dekalen                     |             |                | Eraclene           | Escorene    |              |             |             | Bakellite     |
| PE             | Lupolen                     |             |                |                    |             |              |             |             | Chemplex      |
| PE             | Hostalen                    |             |                |                    |             |              |             |             | Dylan         |
| PF             | Alberit                     |             |                | Fenachem           |             |              |             |             | Biralit       |
| PF             | Bakelit                     |             |                | Moldesile          |             |              |             |             | Biratex       |
| PF             | Bulitol                     |             |                |                    |             |              |             |             | Birax         |
| PF             | Durax                       |             |                |                    |             |              |             |             |               |
| PF             | Harex                       |             |                |                    |             |              |             |             |               |
| PF             | Resinol                     |             |                |                    |             |              |             |             |               |
| PFTE           | Hostaflon                   |             | Soreflon       |                    |             |              |             |             | Halon; Teflon |
| PP             | Vestolen PP                 |             | Eitex P        | Moplen             | Carola P    |              |             |             | Profax        |
| PP             | Synalen PP                  |             | Napryl         | Kastilen           | Procom      |              |             |             | Rexene        |
| PP             | Novolen                     |             |                |                    |             |              |             |             | Tenite        |
| PP             | Hostalen PP                 |             |                |                    |             |              |             |             |               |
| PS             | Hostylon                    |             |                | Sdistir            | Lustrex     |              |             |             | Carinex       |
| PS             | Lorkalen                    |             |                | Lastinol           |             |              |             |             | Dylene        |
| PS             | Polystyrol                  |             |                |                    |             |              |             |             | Toporex       |
| PS             | Styropor                    |             |                |                    |             |              |             |             |               |
| PVC            | Coroplast                   |             |                |                    |             |              |             |             |               |
| PVC            | Hostalit                    |             |                |                    |             |              |             |             |               |
| PVC            | Mipolam                     |             |                |                    |             |              |             |             |               |
| PVC            | Opalon                      |             |                |                    |             |              |             |             |               |
| PVC            | Solvec                      |             |                |                    |             |              |             |             |               |
| PVC            | Vinoflex                    |             |                |                    |             |              |             |             |               |
| PP-H           | Homopolymer                 |             |                |                    |             |              |             |             |               |
| PP-C           | Copolymer                   |             |                |                    |             |              |             |             |               |
| ABS            | Acrylnitrid Butadien Styrol |             |                |                    |             |              |             |             |               |
| PMMA           | Polymethyl metha Crylat     |             |                |                    |             |              |             |             |               |
| PMMA           | Plexiglas; Resarit; Degluan |             |                |                    |             |              |             |             |               |
| POMC           | Polyoxymethylen             |             |                |                    |             |              |             |             |               |
| POMC           | Hostaform; ultraform        |             |                |                    |             |              |             |             |               |
| PI             | Polymid                     |             |                |                    |             |              |             |             |               |
| PEI            | Polytherimid                |             |                |                    |             |              |             |             |               |
| PVC-H          | Polyvinylchlorid (hard)     |             |                |                    |             |              |             |             |               |
| PA             | Polyamide                   |             |                |                    |             |              |             |             |               |

## N 5.2 PLASTICS | duroplastics <150 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|---------------|-------------|----------------|--------------------|-------------|--------------|-------------|-------------|------------|
| PUR 5220       |               |             |                |                    |             |              |             |             |            |
| PF 31          |               |             |                |                    |             |              |             |             |            |
| MP 183         |               |             |                |                    |             |              |             |             |            |

### Technical formulas

Calculate cutting  
speed (m/min)

$$V_c = \frac{D \cdot \pi \cdot n}{1000}$$

Calculate  
rotational speed (rpm)

$$n = \frac{V_c \cdot 1000}{D \cdot \pi}$$

Calculate feed rate  
(mm/min)

$$V_f = n \cdot z \cdot f_z$$

Calculate feed per tooth  
(mm/number of teeth)

$$f_z = \frac{V_f}{n \cdot z}$$

Calculate chip removal rate  
(cm<sup>3</sup>/min)

$$Q = \frac{a_p \cdot a_e \cdot V_f}{1000}$$

Calculate average  
chip thickness (mm)

$$h_m = f_z \cdot \frac{\sqrt{a_e}}{D}$$

#### Explanation of terms

|                      |                           |                         |
|----------------------|---------------------------|-------------------------|
| <b>V<sub>c</sub></b> | Cutting speed             | in m/min                |
| <b>n</b>             | Rotational speed          | in rpm                  |
| <b>V<sub>f</sub></b> | Feed rate                 | in mm/min               |
| <b>F<sub>z</sub></b> | Feed per tooth            | in mm/number of teeth   |
| <b>z</b>             | Number of teeth (cutting) |                         |
| <b>a<sub>p</sub></b> | Depth of cut              | in mm                   |
| <b>a<sub>e</sub></b> | Width of cut              | in mm                   |
| <b>h<sub>m</sub></b> | Average chip thickness    | in mm                   |
| <b>Q</b>             | Chip removal rate         | in cm <sup>3</sup> /min |
| <b>D</b>             | Diameter of tool          | in mm                   |

# EXPLANATION OF CUTTING DATA

## EXAMPLE FOR SIDE MILLING OF 3.2151 WITH Ø10:

### N 2.1 - N 2.3 ALUMINIUM | casted <600 N/mm<sup>2</sup>

| Materialnumber | Germany   DIN | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|---------------|-------------|----------------|--------------------|-------------|--------------|-------------|-------------|------------|
| 3.1841         | G-AlCu 4 Ti   |             |                |                    |             |              |             | AC1A        | A 295.0    |
| 3.1871         | G-AlCu 4 TiMg |             |                |                    |             |              |             |             |            |
| 3.2131         | G-AlSiCu1     |             |                |                    |             |              |             |             |            |
| 3.2151         | G-AlSi & Cu 4 | AC-45000    | A-SSUZ         | LM 4               |             |              |             | AC4B        | A 319.0    |
| 3.2161         | G-AlSi & Cu 3 | AC-46200    | A-S9U3A-Y4     | LM 24              | 5075        |              |             | AC4D        | A 328.0    |

THE MATERIAL KEY WITH DETAILED BREAKDOWN OF MATERIALS BY MATERIAL GROUP CAN BE FOUND AT THE END OF THE CATALOGUE.

| N       | Material                 | Strength<br>(N/mm <sup>2</sup> ) | Full Slot  | Side Milling | Finishing  | ETC        | Materialgroup<br>Factor<br>fz / a | Materialgroup<br>Factor<br>ae ETC |
|---------|--------------------------|----------------------------------|------------|--------------|------------|------------|-----------------------------------|-----------------------------------|
|         |                          |                                  | Vc = m/min | Vc = m/min   | Vc = m/min | Vc = m/min |                                   |                                   |
| 1.1     | ALUMINIUM   alloyed      | <500                             | 500        | 500          | 500        | 560        | 1                                 | 1                                 |
| 1.2     | ALUMINIUM   alloyed      | <600                             | 480        | 480          | 480        | 540        | 1                                 | 1                                 |
| 2.1-2.3 | ALUMINIUM   casted       | <600                             | 450        | 450          | 450        | 510        | 0.9                               | 0.8                               |
| 3.1-3.3 | COPPER   alloyed         | <650                             | 200        | 200          | 200        | 260        | 0.8                               | 0.7                               |
| 4.1     | MAGNESIUM   alloyed      | <250                             | 500        | 500          | 500        | 560        | 1                                 | 1                                 |
| 5.1     | PLASTICS   Thermoplastic | <100                             | 400        | 400          | 400        | 460        | 0.7                               | 0.8                               |
| 5.2     | PLASTICS   Duroplastic   | <150                             | 350        | 350          | 350        | 410        | 0.6                               | 0.7                               |

OVERVIEW OF THE DIFFERENT MATERIAL GROUPS FOR THIS TOOL INCLUDING FACTORS

### Material N 1.1

| D1 | L2 | Immersion<br>Angle | Full Slot    |                  |                  | Side Milling |                    |            | Finishing    |            |            | ETC          |                     |            |              |
|----|----|--------------------|--------------|------------------|------------------|--------------|--------------------|------------|--------------|------------|------------|--------------|---------------------|------------|--------------|
|    |    |                    | fz<br>(mm/Z) | ae = 1xD<br>(mm) | ap = 1xD<br>(mm) | fz<br>(mm/Z) | ae = 0.3xD<br>(mm) | ap<br>(mm) | fz<br>(mm/Z) | ae<br>(mm) | ap<br>(mm) | fz<br>(mm/Z) | ae = 0.25xD<br>(mm) | ap<br>(mm) | hmax<br>(mm) |
| 2  | 6  | 1°                 | 0.02         | 2                | 2                | 0.03         | 0.6                | L2max      | 0.018        | 0.2        | L2max      | 0.045        | 0.5                 | L2max      | 0.039        |
| 3  | 10 | 1°                 | 0.03         | 3                | 3                | 0.04         | 0.9                | L2max      | 0.02         | 0.2        | L2max      | 0.055        | 0.75                | L2max      | 0.0476       |
| 4  | 13 | 1.2°               | 0.04         | 4                | 4                | 0.05         | 1.2                | L2max      | 0.021        | 0.2        | L2max      | 0.07         | 1                   | L2max      | 0.0606       |
| 5  | 14 | 1.2°               | 0.045        | 5                | 5                | 0.065        | 1.5                | L2max      | 0.023        | 0.2        | L2max      | 0.08         | 1.25                | L2max      | 0.0693       |
| 6  | 16 | 1.5°               | 0.05         | 6                | 6                | 0.07         | 1.8                | L2max      | 0.025        | 0.2        | L2max      | 0.1          | 1.5                 | L2max      | 0.0866       |
| 8  | 22 | 2°                 | 0.07         | 8                | 8                | 0.09         | 2.4                | L2max      | 0.03         | 0.2        | L2max      | 0.12         | 2                   | L2max      | 0.1039       |
| 10 | 25 | 2.5°               | 0.09         | 10               | 10               | 0.1          | 3                  | L2max      | 0.035        | 0.2        | L2max      | 0.14         | 2.5                 | L2max      | 0.1212       |
| 12 | 28 | 3°                 | 0.1          | 12               | 12               | 0.13         | 3.6                | L2max      | 0.04         | 0.2        | L2max      | 0.16         | 3                   | L2max      | 0.1386       |
| 16 | 36 | 4°                 | 0.12         | 16               | 16               | 0.15         | 4.8                | L2max      | 0.045        | 0.2        | L2max      | 0.18         | 4                   | L2max      | 0.1559       |
| 20 | 41 | 5°                 | 0.15         | 20               | 20               | 0.18         | 6                  | L2max      | 0.05         | 0.2        | L2max      | 0.22         | 5                   | L2max      | 0.1905       |

ALL DATA GIVEN HERE IS FOR THE FIRST GROUP N1.1 IN THE MATERIAL GROUP OVERVIEW

### DETERMINATION OF CUTTING DATA:

From the material key results: **material group N2.1-2.3**

Vc = 450 m/min (as indicated in the table)

fz = 0.1 mm/Z (as indicated in the table) x Factor fz 0.9 = **fz 0.09 mm/Z**



VIDEO EXPLANATION

## EXAMPLE FOR ETC MILLING OF PE WITH Ø10:

### N 5.1 PLASTICS | thermoplastics <100 N/mm²

| Materialnumber | Germany   DIN | Europe   EN | France   AFNOR | Great Britain   BS | Italy   UNI | Sweden   SIS | Spain   UNE | Japan   JIS | USA   AISI |
|----------------|---------------|-------------|----------------|--------------------|-------------|--------------|-------------|-------------|------------|
| PC             | Makralon      |             | Orgalan        | Sinvet             |             |              |             |             | Lexan      |
| PC             | Nuclon        |             |                |                    |             |              |             |             | Merlon     |
| PC             | Plastocarbon  |             |                |                    |             |              |             |             |            |
| PE             | Baylon        |             | Fertene        | Carlona            |             |              |             |             | Althion    |
| PE             | Dekalen       |             | Eraclene       | Escorene           |             |              |             |             | Bakelite   |

THE MATERIAL KEY WITH DETAILED BREAKDOWN OF MATERIALS BY MATERIAL GROUP CAN BE FOUND AT THE END OF THE CATALOGUE.

| N       | Material                 | Strength<br>(N/mm²) | Full Slot  | Side Milling | Finishing  | ETC        | Materialgroup<br>Factor<br>fz / a | Materialgroup<br>Factor<br>ae ETC |
|---------|--------------------------|---------------------|------------|--------------|------------|------------|-----------------------------------|-----------------------------------|
|         |                          |                     | Vc = m/min | Vc = m/min   | Vc = m/min | Vc = m/min |                                   |                                   |
| 1.1     | ALUMINIUM   alloyed      | <500                | 500        | 500          | 500        | 560        | 1                                 | 1                                 |
| 1.2     | ALUMINIUM   alloyed      | <600                | 480        | 480          | 480        | 540        | 1                                 | 1                                 |
| 2.1-2.3 | ALUMINIUM   casted       | <600                | 450        | 450          | 450        | 510        | 0.9                               | 0.8                               |
| 3.1-3.3 | COPPER   alloyed         | <650                | 200        | 200          | 200        | 260        | 0.8                               | 0.7                               |
| 4.1     | MAGNESIUM   alloyed      | <250                | 500        | 500          | 500        | 560        | 1                                 | 1                                 |
| 5.1     | PLASTICS   Thermoplastic | <100                | 400        | 400          | 400        | 460        | 0.7                               | 0.8                               |
| 5.2     | PLASTICS   Duroplastic   | <150                | 350        | 350          | 350        | 410        | 0.6                               | 0.7                               |

OVERVIEW OF THE DIFFERENT MATERIAL GROUPS FOR THIS TOOL INCLUDING FACTORS

#### Material N 1.1

| D1 | L2 | Immersion<br>Angle | Full Slot    |                  |                  | Side Milling |                    |            | Finishing    |            |            | ETC          |                     |            |              |
|----|----|--------------------|--------------|------------------|------------------|--------------|--------------------|------------|--------------|------------|------------|--------------|---------------------|------------|--------------|
|    |    |                    | fz<br>(mm/Z) | ae = 1xD<br>(mm) | ap = 1xD<br>(mm) | fz<br>(mm/Z) | ae = 0.3xD<br>(mm) | ap<br>(mm) | fz<br>(mm/Z) | ae<br>(mm) | ap<br>(mm) | fz<br>(mm/Z) | ae = 0.25xD<br>(mm) | ap<br>(mm) | hmax<br>(mm) |
| 2  | 6  | 1°                 | 0.02         | 2                | 2                | 0.03         | 0.6                | L2max      | 0.018        | 0.2        | L2max      | 0.045        | 0.5                 | L2max      | 0.039        |
| 3  | 10 | 1°                 | 0.03         | 3                | 3                | 0.04         | 0.9                | L2max      | 0.02         | 0.2        | L2max      | 0.055        | 0.75                | L2max      | 0.0476       |
| 4  | 13 | 1.2°               | 0.04         | 4                | 4                | 0.05         | 1.2                | L2max      | 0.021        | 0.2        | L2max      | 0.07         | 1                   | L2max      | 0.0606       |
| 5  | 14 | 1.2°               | 0.045        | 5                | 5                | 0.065        | 1.5                | L2max      | 0.023        | 0.2        | L2max      | 0.08         | 1.25                | L2max      | 0.0693       |
| 6  | 16 | 1.5°               | 0.05         | 6                | 6                | 0.07         | 1.8                | L2max      | 0.025        | 0.2        | L2max      | 0.1          | 1.5                 | L2max      | 0.0866       |
| 8  | 22 | 2°                 | 0.07         | 8                | 8                | 0.09         | 2.4                | L2max      | 0.03         | 0.2        | L2max      | 0.12         | 2                   | L2max      | 0.1039       |
| 10 | 25 | 2.5°               | 0.09         | 10               | 10               | 0.1          | 3                  | L2max      | 0.035        | 0.2        | L2max      | 0.14         | 2.5                 | L2max      | 0.1212       |
| 12 | 28 | 3°                 | 0.1          | 12               | 12               | 0.13         | 3.6                | L2max      | 0.04         | 0.2        | L2max      | 0.16         | 3                   | L2max      | 0.1386       |
| 16 | 36 | 4°                 | 0.12         | 16               | 16               | 0.15         | 4.8                | L2max      | 0.045        | 0.2        | L2max      | 0.18         | 4                   | L2max      | 0.1559       |
| 20 | 41 | 5°                 | 0.15         | 20               | 20               | 0.18         | 6                  | L2max      | 0.05         | 0.2        | L2max      | 0.22         | 5                   | L2max      | 0.1905       |

ALL DATA GIVEN HERE IS FOR THE FIRST GROUP N1.1 IN THE MATERIAL GROUP OVERVIEW

#### DETERMINATION OF CUTTING DATA:

From the material key results: **material group N5.1**

Vc= 460 m/min (as indicated in the table)

fz= 0.14 mm/Z (as indicated in the table) x Factor fz 0.7 = **fz 0.098 mm/Z**

ae= 2.5 mm (as indicated in the table) x Factor ae 0.8 = **2.0 mm ae**