XEBEC Back Burr Cutter＆ Deburring Tool Path™
For Machining Center

Instruction Manual

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XEBEC XEBEC Back Burr Cutter & Deburring Tool Path™ Instruction Manual (For Machining Center)

Notes for Using XEBEC Deburring Tool Path
XEBEC Deburring Tool Path may be used only by those customers who agree to the terms of use at the time of purchase. Under these terms, it is prohibited to use XEBEC Deburring Tool Path with any tool other than XEBEC Back Burr Cutter. Transfer or provision of XEBEC Deburring Tool Path to any third party is also prohibited.
Make sure to comply with the terms of use.

For Your Safety

Safety Precautions (P.5)

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Safety Precautions

Warning and Caution Logos

The meanings of the indications and symbols related to matters which must be observed in order to ensure the safety of this product are as detailed below.

Warning and Caution Logos

⚠ WARNING	**WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury**
⚠ CAUTION	**CAUTION indicates practices that may cause injuries and damages**

Symbols

Obey all safety messages that follow this symbol to avoid possible injury or death.

This is the safety alert symbol. It is used to alert you to potential physical injury hazards.

Operator Safety Protection

	⚠ WARNING
	**Make sure that the product is free of any visible damage prior to use** The product may break, and fragments may scatter if the product is used with any damage or excessive tool wear.
	**Do not touch the product while it is in motion** Make sure to isolate this product while in use by taking measures such as closing the door of the machine tool.
	**If vibrations or any other abnormality occurs, discontinue use immediately.** If the use of the product is continued with any abnormality, the product may break or fall off, possibly causing injury or loss of sight.
	**Wear protective gloves and gears when touching the product** If the cutting blades is touched with bare hands, there is risk of injury or burns.

Wear protective gears

Wear protective gears such as goggles, face mask, gloves, and earmuff when using this product. Furthermore, make sure to cover your skin with clothing.

Attention to the Work Area

- Install an enclosure so that persons other than the operator do not enter the work area, and ensure that all persons, if any, in the work area are wearing protective gears.
- In particular be careful that children do not enter the work area.
- Keep the floor of the work area clean at all times to prevent the risk of slipping or tripping on chips, dust, cutting fluids, coolant, or other substances.
- There is the risk of fire caused by heating, sparks, or other factor resulting from use of the product. Do not use the product close to a flammable liquid or in an explosive atmosphere. Also be sure to enact fire prevention measures.

Chips and Dust

Make sure to use a dust collector or other means to collect chips, dust, and other substances to prevent them from scattering into the surrounding.

Precautions for Setup and Installation

	WARNING
	Select the appropriate tool size. Select the appropriate tool size and set the projection length appropriately to avoid damages to the product, jig or the machine tool.
	During use, this product must be clamped firmly to the machine tool and the workpiece must be fixtured securely. If the workpiece moves during machining, the workpiece or this product may break, causing fragments to scatter.
	Before use, preform test with air cutting or simulation software to make sure there is no error with the Path. It there is any error, this product or the workpiece may break.
	Make sure to set the tool length offset at the tip of this product when using XEBEC Path. Setting the tool length offset at any point other than the tip of this product is dangerous as it may result in tool collision and accident.
	Minimize positional error and dimensional variance of holes to be deburred and make sure to position this product correctly. If the max allowed accumulated variance is exceeded, the edge quality after deburring will be affected. If this product is not positioned correctly, it may break.
	Make sure the tool runout is less than 0.01mm after the tool is clamped in the tool holder. If the tool runout is greater, this product may break when it is rotated or applied to the workpiece.
	Make sure that the positioning format (incremental or absolute) of the Path matches that of the machine tool. If the incorrect positioning format is used, this product, the machine tool and the fixture may break.

Pre-Use Inspection

	WARNING
	Select and use coolant or cutting fluid that is suitable for the purpose. Depending on the type of coolant or cutting fluid, there is a risk of fire caused by overheating, sparks, or other problem. If there is any risk of overheating or sparks, be sure to implement fire prevention measures.

	CAUTION
	Prior to the use of this product, make sure that there will be no tool collision. Select the appropriate tool size and set the projection length appropriately by taking into consideration the movement and the tool path of this product in use.
	Adjust the direction of cutting fluid or coolant to ensure that it is applied to the cutting blades. If the cutting fluid or coolant is not applied sufficiently, the cutting blades may become overheated, and the tool life may be shortened.
	Minimize the burr size generated during the previous machining process. If the root thickness of the burrs is greater than the deburring amount (edge break length) of the Path, it may not be possible to remove the burrs completely.

Precautions for Use

	⚠ WARNING
	**DO NOT use at excessive rotational speeds.** The use of this product at any excessive rotational speed may cause it to break. Refer to the standard machining parameters for each tool size.
	**DO NOT use this product in counterclockwise (CCW) rotation.** This product must be used in clockwise (CW) rotation. Using this product in CCW rotation will result in damages.
	**DO NOT use this product with hand tools.** This product must be used with CNC machines. If used with any hand tool, it may break and cause injuries.
	**DO NOT use this product for any purpose other than deburring or chamfering.** This product is designed for deburring and chamfering. It may break if used for any other purpose.

	⚠ CAUTION
	**Edges with gaps and openings** If there is any gap or opening on the edge to be deburred, the cutting edge is more prone to chipping, and the tool life may be shortened.

Regular Maintenance

When replacing this product, remove any dirt from the tool holder and the shank, and keep them clean.

Introduction

Product Overview (P.10)

Contents of the Product (P.11)

Features (P.12)

Applicable Equipment (P.13)

Target Edges to Deburr (P.14)

Product Overview

XEBEC Back Burr Cutter and XEBEC Deburring Tool Path are a dedicated cutter and customized path specifically for the purpose of removing burrs from cross hole edges that are generated by hole drilling.

Contents of the Product

The followings will be provided when you purchase XEBEC Back Burr Cutter and Deburring Tool Path.

- XEBEC Back Burr Cutter

- XEBEC Deburring Tool Path (Provided in a text file format)
- XEBEC Tool Path Code Sheet

Features

XEBECBack Burr Cutter

- Made of micro-grain cemented carbide
  High cutting performance and long tool life
- Available in 2 variants: Heat-resistant AlTiCrN coated variant and sharp-edged uncoated variant
  AlTiCrN coated variant is suitable for difficult-to-cut materials such as medium tensile steel (S45C, AISI1045, C45), stainless steel, titanium and Inconel alloys.
  Uncoated variant features sharp cutting edges that are effective in preventing built-up edges and formation of secondary burrs, and it is suitable for plastics and aluminum (uncoated variant is available only in Regular Type).
- Blade shape is optimized for deburring
  Helical cutting edges for optimal cutting performance and prevention of secondary burrs
- 3 types of neck lengths
  Available in three types of neck lengths: Short Type, Regular Type, and Straight Type, making this tool suitable for wide range of edges.
  Short Type features 3 blades and a short neck length (only 3 times the Cutter diameter), enabling high feed rate and long tool life.
  Regular Type and Straight Type feature long neck lengths that enable long reach, making deburring of deep holes possible. Regular Type has the neck length 5 times of the Cutter diameter, and Straight Type 15 times of the Cutter diameter.

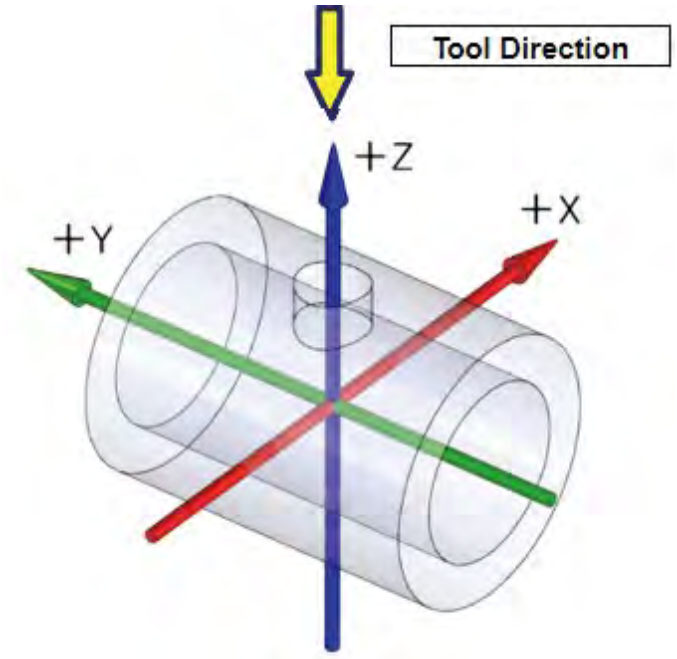
XEBEC Deburring Tool Path

- **Optimal tool paths for deburring**
  Achieves uniform edge break without formation of secondary burrs. Achieves uniform edge break without formation of secondary burrs.
- **Supports deburring of various types of drilled holes such as orthogonal and off-center cross holes**
  Target Edges to Deburr) which were previously difficult to deburr.
- **Longer tool life for lower running costs**
  The optimal tool path enables deburring with the minimum amount of cutting, thereby reducing tool wear caused by heat. Furthermore, the contact point of the cutting blades with the workpiece changes constantly during deburring, achieving long tool life.
- **Quick deburring with minimum tool movement**
  Enables deburring in 1/5 - 1/10 the machining time required with a spring-loaded deburring tools.
- **Enables deburring of multiple holes**
  The long neck length enables deburring of multiple holes with one Cutter.

Applicable Equipment

Applicable with CNC machines that are capable of simultaneous 3-axis (XYZ) control.

Axis configuration of applicable machining centers
The tool direction must be via Z-axis as shown in Figure 1.
For turn-mill machines, refer to the dedicated instruction manual.



Target Edges to Deburr

The red lines in Figures 1 and 2 are examples of the edges to be deburred.

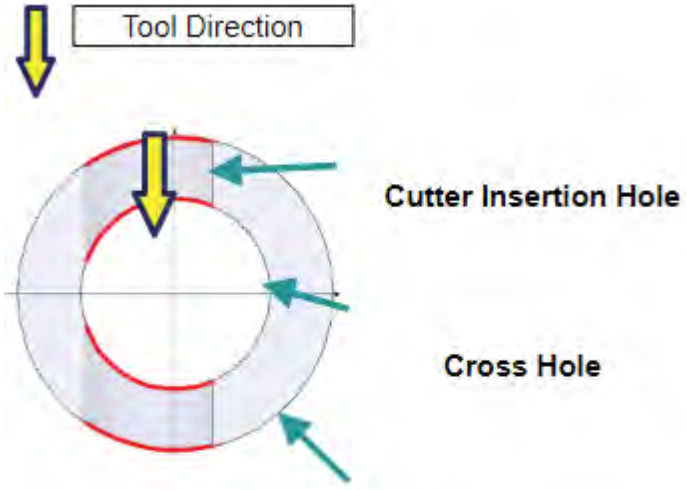


Figure1

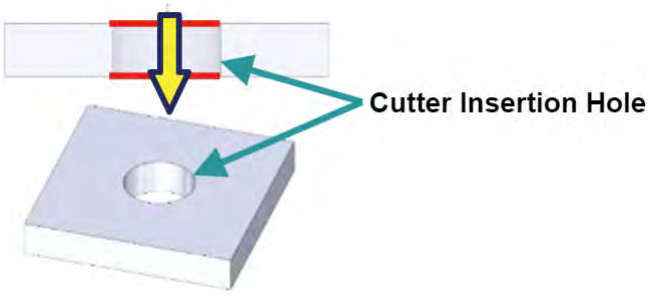


Figure2

Depending on the configuration of cross holes, it may not be possible to create a Deburring Tool Path.
For more information, please refer to the Tool Path Code Sheet to be provided.

Product Specifications

XEBEC Back Burr Cutter Specifications (P.16)

XEBEC Back Burr Cutter Standard Machining Parameters (P.20)

XEBEC Deburring Tool Path Data Format (P.24)

Tool Length Offset (P.26)

Max Allowed Accumulated Variance (mm) (P.27)

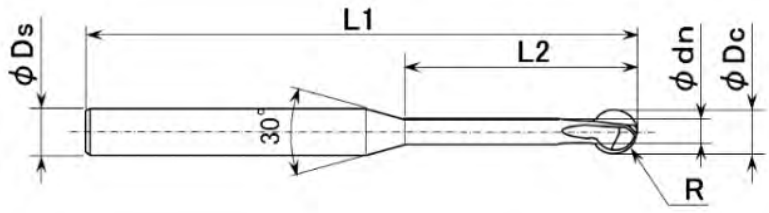
Start Point (P.28)

XEBEC Back Burr Cutter Specifications

AlTiCrN Coated

Steel P | Stainless Steel M | Cast Iron K | Superalloys S | Non-ferrous Metals N

[Short / Regular Type]



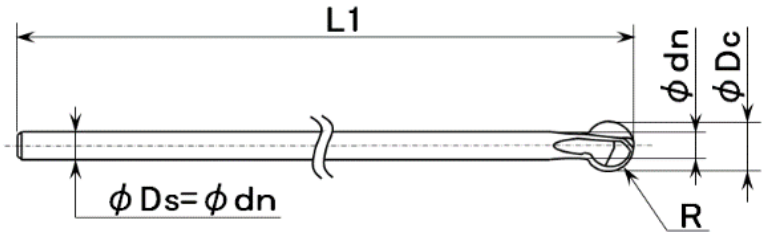
	Product Code	Cutter Radius R(mm)	Cutter Diameter ΦDc(mm)	Neck Diameter Φdn (mm)	Neck Length L2(mm)	Allover Length L1(mm)	Shank Diameter ΦDs(mm)	Number of blades
Short Type	XC-08-AS-3F	0.4	0.8	0.48	3	60	3	3
	XC-13-AS-3F	0.65	1.3	0.78	5	60	3	3
	XC-18-AS-3F	0.9	1.8	1.1	6	60	3	3
	XC-23-AS-3F	1.15	2.3	1.4	7.5	70	3	3
	XC-28-AS-3F	1.4	2.8	1.7	9	70	4	3
	XC-33-AS-3F	1.65	3.3	2.0	10.5	70	4	3
	XC-38-AS-3F	1.9	3.8	2.4	12	70	4	3
	XC-48-AS-3F	2.4	4.8	3.0	15	70	6	3
	XC-58-AS-3F	2.9	5.8	3.5	18	70	6	3
	XC-78-AS-3F	3.9	7.8	4.7	24	100	8	3
	XC-98-AS-3F	4.9	9.8	5.9	30	120	10	3

	Product Code	Cutter Radius R(mm)	Cutter Diameter ΦDc(mm)	Neck Diameter Φdn(mm)	Neck Length L2(mm)	Allover Length L1(mm)	Shank Diameter ΦDs(mm)	Number of blades
Regular Type	XC-08-A	0.4	0.8	0.48	5	60	3	2
	XC-13-A	0.65	1.3	0.78	8	60	3	2
	XC-18-A	0.9	1.8	1.1	10	60	3	2
	XC-23-A	1.15	2.3	1.4	12.5	70	3	2
	XC-28-A	1.4	2.8	1.7	15	70	4	2
	XC-33-A	1.65	3.3	2.0	17.5	70	4	2
	XC-38-A	1.9	3.8	2.4	20	70	4	2
	XC-48-A	2.4	4.8	3.0	25	70	6	2
	XC-58-A	2.9	5.8	3.5	30	70	6	2
	XC-78-A	3.9	7.8	4.7	40	100	8	3
	XC-98-A	4.9	9.8	5.9	50	120	10	3

AlTiCrN Coated

Steel P | Stainless Steel M | Cast Iron K | Superalloys S | Non-ferrous Metals N

[Straight Type]

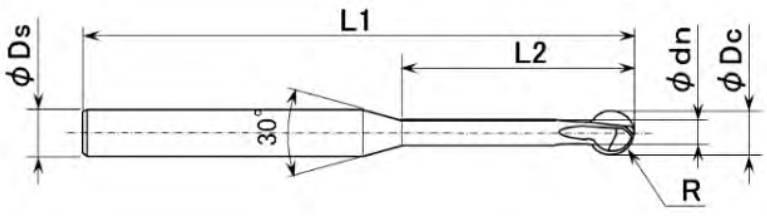


	Product Code	Cutter Radius R(mm)	Cutter Diameter ΦDc(mm)	Neck Diameter Φdn (mm)	Neck Length L2(mm)	Allover Length L1(mm)	Shank Diameter ΦDs(mm)	Number of blades
Straight Type	XC-18-B	0.9	1.8	1.1	-	50	1.1	2
	XC-23-B	1.15	2.3	1.4	-	60	1.4	2
	XC-28-B	1.4	2.8	1.7	-	70	1.7	2
	XC-33-B	1.65	3.3	2.0	-	80	2.0	2
	XC-38-B	1.9	3.8	2.4	-	85	2.4	2
	XC-48-B	2.4	4.8	3.0	-	105	3.0	2
	XC-58-B	2.9	5.8	3.5	-	120	3.5	2
	XC-78-B	3.9	7.8	4.7	-	150	4.7	3
	XC-98-B	4.9	9.8	5.9	-	180	5.9	3

Uncoated

Non-ferrous Metals N | Plastics O

[Regular Type]



	Product Code	Cutter Radius R(mm)	Cutter Diameter ΦDc(mm)	Neck Diameter Φdn(mm)	Neck Length L2(mm)	Allover Length L1(mm)	Shank Diameter ΦDs(mm)	Number of blades
Regular Type	XC-08-A-N	0.4	0.8	0.48	5	60	3	2
	XC-13-A-N	0.65	1.3	0.78	8	60	3	2
	XC-18-A-N	0.9	1.8	1.1	10	60	3	2
	XC-23-A-N	1.15	2.3	1.4	12.5	70	3	2
	XC-28-A-N	1.4	2.8	1.7	15	70	4	2
	XC-33-A-N	1.65	3.3	2.0	17.5	70	4	2
	XC-38-A-N	1.9	3.8	2.4	20	70	4	2
	XC-48-A-N	2.4	4.8	3.0	25	70	6	2
	XC-58-A-N	2.9	5.8	3.5	30	70	6	2
	XC-78-A-N	3.9	7.8	4.7	40	100	8	3
	XC-98-A-N	**4.9**	**9.8**	**5.9**	**50**	**120**	10	3

⚠CAUTION	**XEBECCautions Regarding the Settings of XEBEC Back Burr Cutter** ● If this product is used without considering the risk of tool collision or if a wrong size tool is used, the product, jig, and machine may be damaged. Therefore, make sure to check the dimensions before use. ● Make sure to set the tool projection length appropriately for the workpiece when clamping this product with a tool holder. ● Clamp this product firmly with the tool holder so that it does not move during use. ● Make sure the tool runout is less than 0.01mm after the tool is clamped in the tool holder. ● Set the tool length offset at the tip of this product to ensure that Deburring Tool Path works as it is designed to. ▶ Tool Length Offset ● To prevent tool collision, minimize positional error and dimensional variance of holes to be deburred and make sure to position this product correctly.

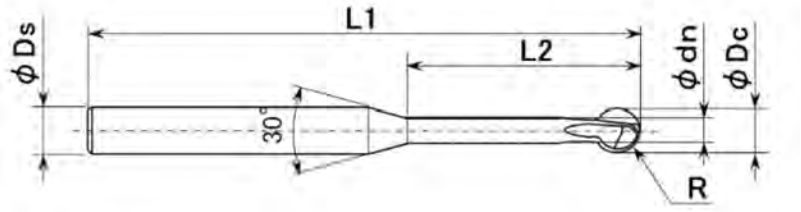
XEBEC Back Burr Cutter Standard Machining Parameters

MEMO

- Rotational speed and feed rate are a guide for initial use.
- To improve the machining result, take steps such as adjusting the rotational speed and feed rate, or select another Tool Path for a different deburring amount (edge break length).
- If vibration or abnormal noise is detected, or if the max rotational speed or feed rate of the machine is below the parameters listed in the table, lower them both at the same rate to be within the machine's capability.
- Different types of cross holes are defined according to their configurations. Please refer to the page below for the appropriate settings for each cross hole type.
  ▶ **Cross Hole Types**
- The uniformity of the edge break improves by turning on Advanced Preview Control of the machine tool.
- **Machining Parameters**
  To minimize the risk of secondary burrs, keep the tool projection length as short as possible. To minimize this risk, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).

AlTiCrN Coated

[Short / Regular Type]

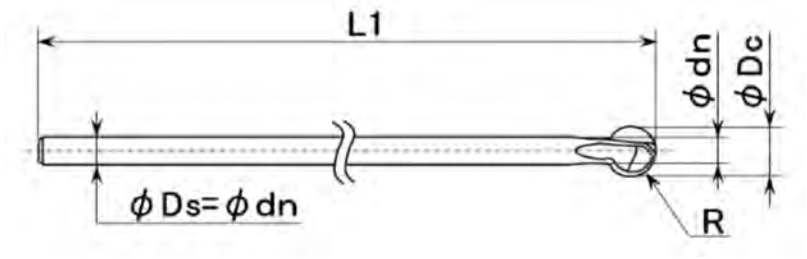


				Steel P Stainless Steel M Cast Iron K Superalloys S		Non-ferrous Metals N	
	Product Code	Cutter Diameter ΦDc(mm)	Tool Protruding Length (mm)	Rotational Speed n (min-1)	Feed Rate Vf(mm/min)	Rotational Speed n (min-1)	Feed Rate Vf(mm/min)
Short Type	XC-08-AS-3F	0.8	3Dc	20000	1080	20000	1170
	XC-13-AS-3F	1.3	3Dc	20000	1080	20000	1170
	XC-18-AS-3F	1.8	3Dc	20000	1080	20000	1170
	XC-23-AS-3F	2.3	3Dc	15000	1350	18000	1710
	XC-28-AS-3F	2.8	3Dc	12500	1800	15000	2520
	XC-33-AS-3F	3.3	3Dc	10600	1890	12700	2250
	XC-38-AS-3F	3.8	3Dc	9200	2160	11000	2880
	XC-48-AS-3F	4.8	3Dc	7200	1980	8500	2880
	XC-58-AS-3F	5.8	3Dc	6000	1620	7000	2160
	XC-78-AS-3F	7.8	3Dc	4500	1620	5400	1920
	XC-98-AS-3F	9.8	3Dc	3600	1320	4300	1560

				Steel P Stainless Steel M Cast Iron K Superalloys S		Non-ferrous Metals N	
	Product Code	**Cutter Diameter ΦDc(mm)**	**Tool Protruding Length (mm)**	**Rotational Speed n (min-1)**	**Feed Rate Vf(mm/min)**	**Rotational Speed n (min-1)**	**Feed Rate Vf(mm/min)**
Regular Type	**XC-08-A**	0.8	**5Dc**	20000	**600**	20000	**650**
	XC-13-A	1.3	**5Dc**	20000	**600**	20000	**650**
	XC-18-A	1.8	**5Dc**	20000	**600**	20000	**650**
	XC-23-A	2.3	**5Dc**	15000	**750**	18000	**950**
	XC-28-A	2.8	**5Dc**	12500	**1000**	15000	**1400**
	XC-33-A	3.3	**5Dc**	10600	**1050**	12700	**1250**
	XC-38-A	3.8	**5Dc**	9200	**1200**	11000	**1600**
	XC-48-A	4.8	**5Dc**	7200	**1100**	8500	**1600**
	XC-58-A	5.8	**5Dc**	6000	**900**	7000	**1200**
	XC-78-A	7.8	**5Dc**	4500	**1350**	5400	**1600**
	XC-98-A	9.8	**5Dc**	3600	**1100**	4300	**1300**

AlTiCrN Coated

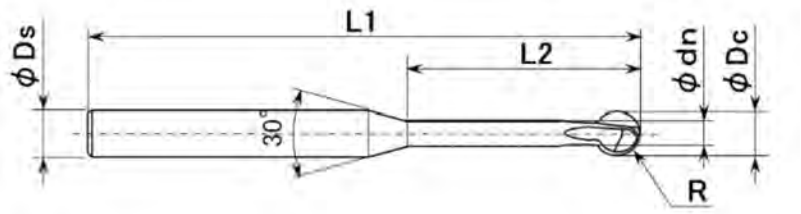
[Straight Type]



				Steel P Stainless Steel M Cast Iron K Superalloys S		Non-ferrous Metals N	
	Product Code	Cutter Diameter ΦDc(mm)	Tool Protruding Length (mm)	Rotational Speed n (min-1)	Feed Rate Vf (mm/min)	Rotational Speed n (min-1)	Feed Rate Vf (mm/min)
Straight Type	XC-18-B	1.8	6Dc	9700	480	9700	480
			10Dc	4400	220	4400	220
			15Dc	2200	110	2200	110
	XC-23-B	2.3	6Dc	7900	480	7900	480
			10Dc	3500	220	3500	220
			15Dc	2200	110	2200	110
	XC-28-B	2.8	6Dc	6200	620	6200	620
			10Dc	2800	220	2800	220
			15Dc	2200	110	2200	110
	XC-33-B	3.3	6Dc	5400	460	5400	460
			10Dc	2400	190	2400	190
			15Dc	1900	95	1900	95
	XC-38-B	3.8	6Dc	4600	460	4600	460
			10Dc	2000	160	2000	160
			15Dc	1600	80	1600	80
	XC-48-B	4.8	6Dc	3600	360	3600	360
			10Dc	1600	120	1600	120
			15Dc	1300	60	1300	60
	XC-58-B	5.8	6Dc	3000	300	3000	300
			10Dc	1300	100	1300	100
			15Dc	1000	50	1000	50
	XC-78-B	7.8	6Dc	1600	240	1600	240
			10Dc	650	70	650	70
			15Dc	200	10	200	10
	XC-98-B	9.8	6Dc	1300	200	1300	200
			10Dc	500	50	500	50
			15Dc	200	10	200	10

Uncoated

[Regular Type]



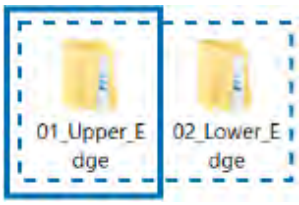
				Non-ferrous Metals N Plastics O	
	Product Code	**Cutter Diameter ΦDc(mm)**	**Tool Protruding Length (mm)**	**Rotational Speed n (min-1)**	**Feed Rate Vf(mm/min)**
Regular Type	**XC-08-A-N**	0.8	**5Dc**	20000	**650**
	XC-13-A-N	1.3	**5Dc**	20000	**650**
	XC-18-A-N	1.8	**5Dc**	20000	**650**
	XC-23-A-N	2.3	**5Dc**	18000	**950**
	XC-28-A-N	2.8	**5Dc**	15000	**1400**
	XC-33-A-N	3.3	**5Dc**	12700	**1250**
	XC-38-A-N	3.8	**5Dc**	11000	**1600**
	XC-48-A-N	4.8	**5Dc**	8500	**1600**
	XC-58-A-N	5.8	**5Dc**	7000	**1200**
	XC-78-A-N	7.8	**5Dc**	5400	**1600**
	XC-98-A-N	9.8	**5Dc**	4300	**1300**

XEBEC Deburring Tool Path Data Format

XEBEC Deburring Tool Path data is stored in separate folders as shown below.

■First Folder Level

- Contains folders for each target edge (Upper Edge / Lower Edge) to be deburred



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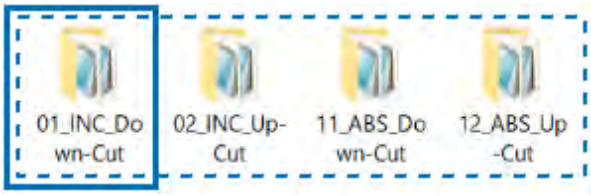
■Second Folder Level

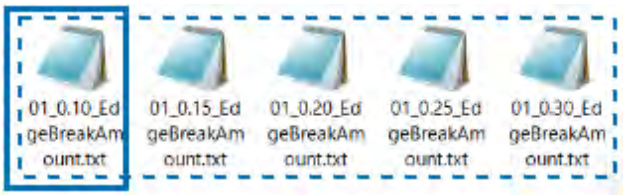
- Incremental (INC) Down Cut
- Absolute (ABS) Down Cut
- Incremental (INC) Up Cut
- Absolute (ABS) Up Cut



▼

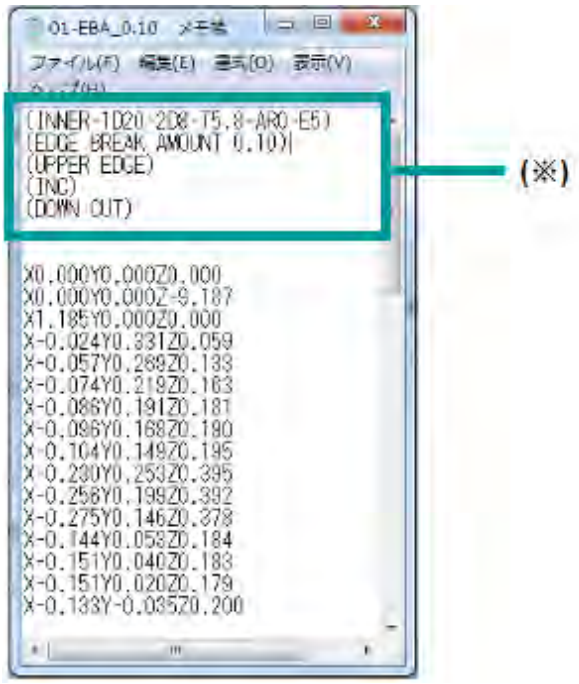
■Third Folder Level

- Contains a set of five XEBEC Deburring Tool Paths in .txt format, each corresponding to a specific deburring amount (edge break length)
- Example: 01_0.10_EdgeBreakAmount.txt
  The second number in the file name "0.10" indicates that the tool path is for deburring amount of 0.10mm



▼

■Text File (.txt)
Specifications are listed at the top in parentheses ( )
Check to make sure that the Deburring Tool Path data is correct for the target edge to deburr.
Check to make sure that the Path data is correct for the target edge to deburr.



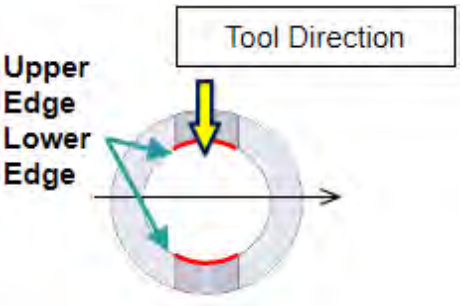
MEMO

Depending on the edge configuration, the data set exist only for the Upper Edge.
In that case, a total of 20 text files is provided.

Data Example

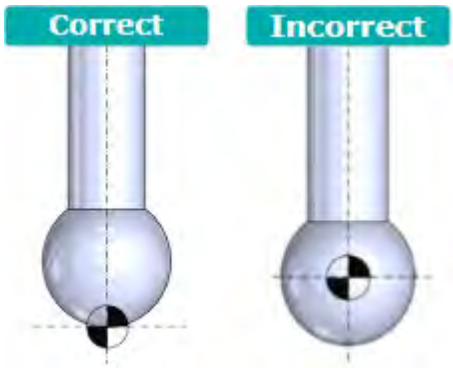
For example, a total of 40 text files are included for an Inner Diameter cross hole.

- **First Folder Level**(2 Folders)
  Upper Edge and Lower Edge
- **Second Folder Level**(4 Folders)
  Incremental (INC) Up Cut / Down Cut
  Absolute (ABS) Up Cut / Down Cut
- **Third Folder Level**(5 Text Files)
  Each text file corresponds to a specific deburring amount (edge break length)



Tool Length Offset

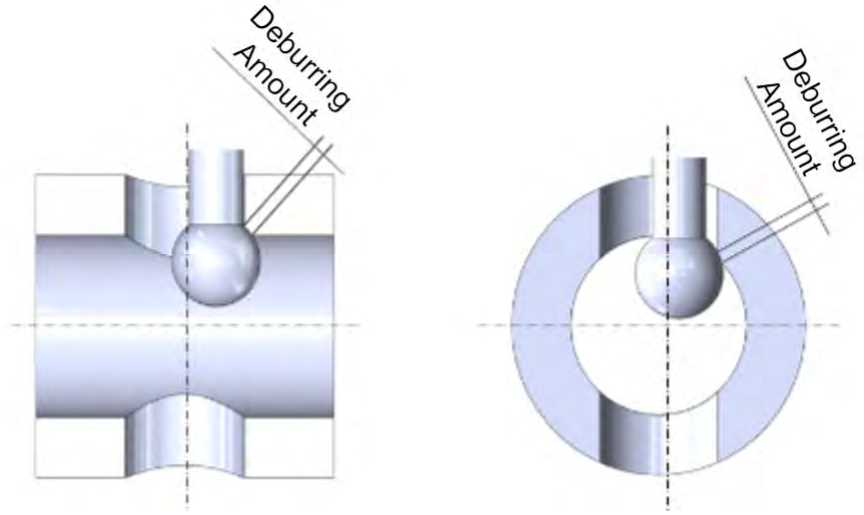
Set the tool length offset at the tip of this product to ensure that Deburring Tool Path works as it is designed to.



⚠CAUTION	**Make sure to set the tool length offset at the tip of this product when using XEBEC Deburring Tool Path** Setting the tool length offset at any point other than the tip of this product is dangerous as it may result in tool collision and accident.

Max Allowed Accumulated Variance (mm)

Make sure to take into consideration the tolerance build up and the total of positional and dimensional variance when selecting the deburring amount (edge break length) from the set of five that provided.



- If the actual hole diameter is large due to dimensional variance or if there is the positional variance, the Cutter may not contact the edge. In that case, try Deburring Tool Path data for a larger deburring amount.
- If the actual hole diameter is small due to dimensional variance, the deburring amount may become excessive. In that case, try Deburring Tool Path data for a smaller deburring amount.

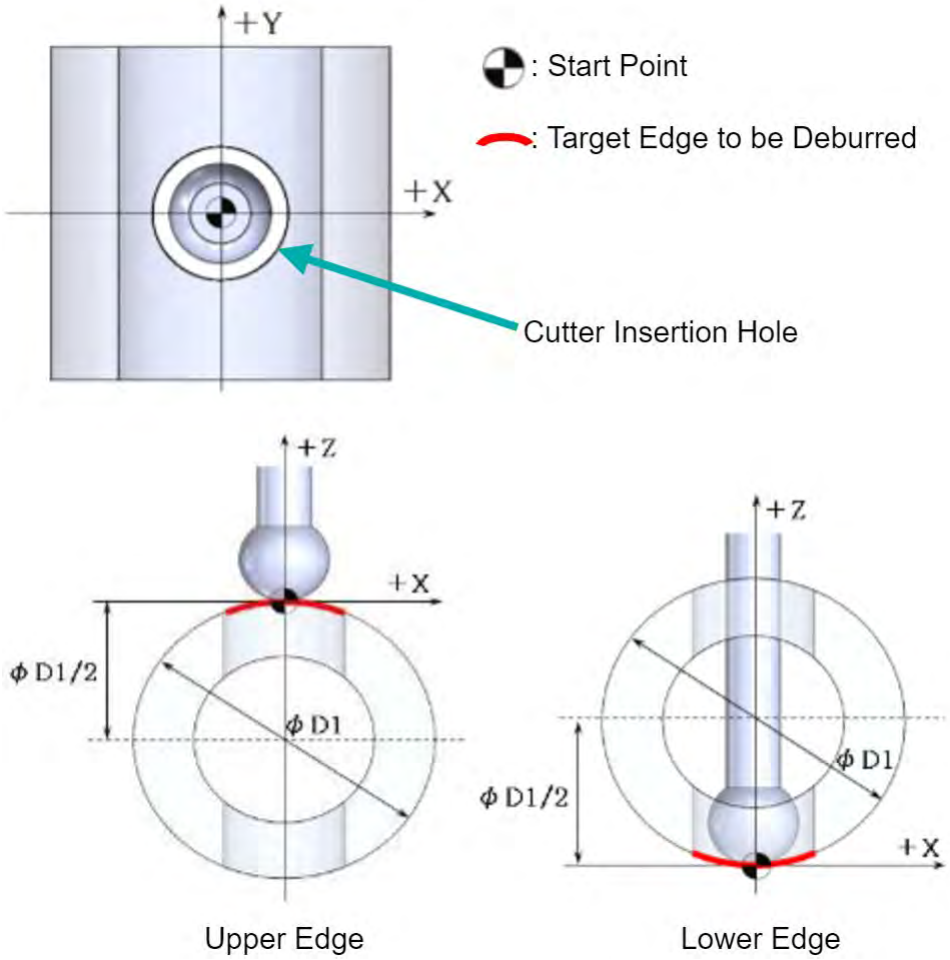
Product Code	Cutter Diameter ΦDc (mm)	Deburring Amount (mm)					Max Allowed Accumulated Variance (mm)
		①	②	③	④	⑤	
XC-08-A	0.8	0.02	0.04	0.06	0.08	0.10	**0.03**
XC-13-A	1.3	0.04	0.06	0.08	0.10	0.12	**0.05**
XC-18-A, XC-18-B	1.8	0.07	0.09	0.11	0.13	0.15	**0.08**
XC-23-A, XC-23-B	2.3	0.07	0.09	0.11	0.13	0.15	**0.09**
XC-28-A, XC-28-B	2.8	0.08	0.11	0.14	0.17	0.20	**0.10**
XC-33-A, XC-33-B	3.3	0.08	0.11	0.14	0.17	0.20	**0.11**
XC-38-A, XC-38-B	3.8	0.09	0.13	0.17	0.21	0.25	**0.12**
XC-48-A, XC-48-B	4.8	0.10	0.15	0.20	0.25	0.30	**0.15**
XC-58-A, XC-58-B	5.8	0.10	0.15	0.20	0.25	0.30	**0.18**
XC-78-A, XC-78-B	7.8	0.10	0.15	0.20	0.25	0.30	**0.24**
XC-98-A, XC-98-B	9.8	0.10	0.15	0.20	0.25	0.30	**0.34**

Start Point

Start Point refers to the initial tool position from which XEBEC Back Burr Cutter and Deburring Tool Path is to begin the deburring operation. Program the tool position so that the centerline and the tip of the Cutter is precisely aligned with the Start Point that we specify. XEBEC Deburring Tool Path should run once the Cutter is brought precisely at this position. The Start Point is at the center of the Cross Hole in the XC plane.

In both examples below, the Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at an offset poistion away from the centerline by one half the diameter D1.

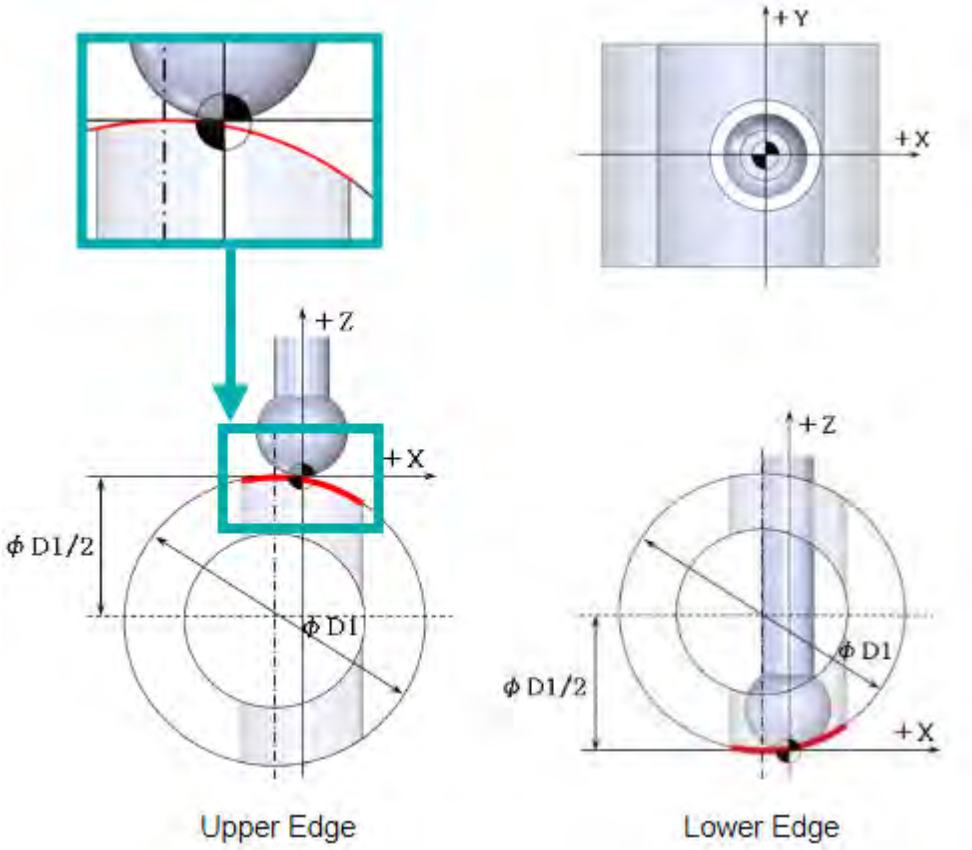
Example: On-Center Cross Hole



Upper Edge

Lower Edge

Example: Off-Center Cross Hole



Upper Edge

Lower Edge

How to Implement XEBEC Deburring Tool Path

Incremental (INC) Positioning Format (P.31)

Absolute Positioning (ABS) Format (P.35)

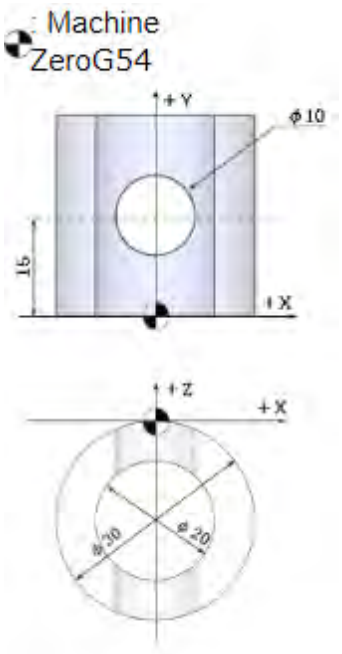
Incremental (INC) Positioning Format

This section offers an example of implementing XEBEC Deburring Tool Path into the machining program in incremental positional format.
G-codes and all other details are based on FANUC controls. Make sure to use appropriate codes for your machine tool.

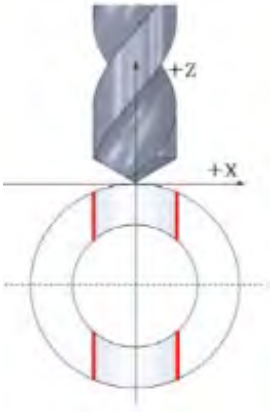
Machining Operations

- **Workpiece Shape**
  Outer Diameter Φ30mm x Inner Diameter Φ20mm
- **Previous Operation**
  Drilled a Φ10mm hole that crosses orthogonally and on-center with the centerline of the workpiece
- **Target Edge to be Deburred**
  Upper and Lower edges of the inner diameter at the intersection of the Φ10 hole and the Φ20 hole

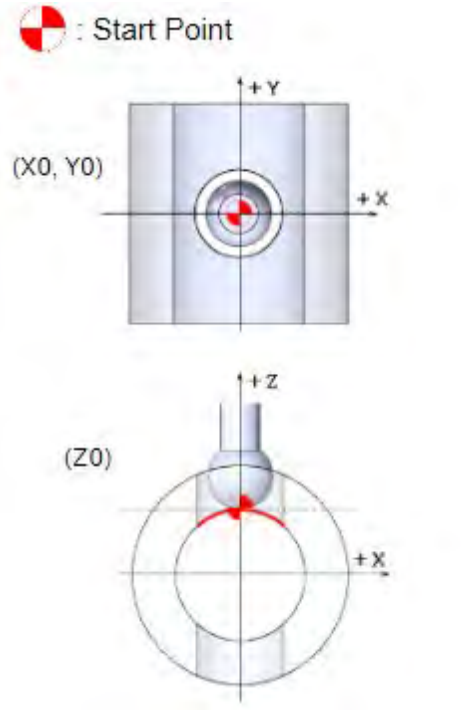
[Workpiece]



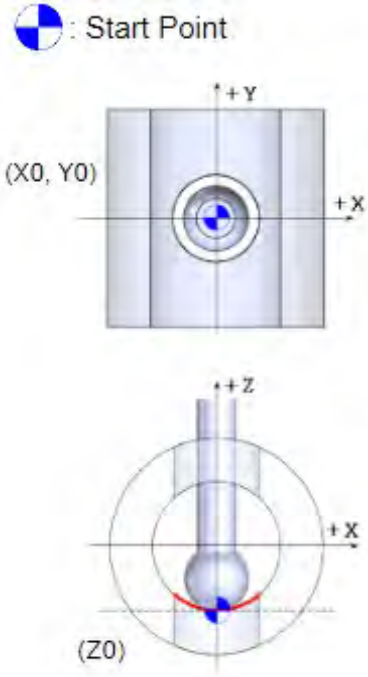
OP 1: Drilling



OP 2: Deburring Upper Edge



OP 3: Deburring Lower Edge



Program Overview

Main Program	
O0001 (MAIN PROG);	
G17G40G49G80;	Select XY plane
N1(10DRILL/T1H1);	**Drilling the Φ10 hole**
T01;	Call the drill
G91G28Z0.0M05	Zero return the drill to the zero position

Main Program	
M06;	Tool change
S5000M03;	Turn the spindle on in the CW rotation
G00G90G54X0.0Y15.0;	Position XY axes at the hole center
G43Z50.0H01M08;	Select H01 Tool Length Offset
G98G81Z-35.0R3.0F500;	Spot drilling cycle
G80;	Cancel drilling cycle
G00Z100.0M09;	
G91G28Z0.0M05;	Zero return the drill to the zero position
M01;	
N2(5.8BURRS CUTTER/T2H2);	**Deburring operation**
T02;	Call XEBEC Back Burr Cutter
G91G28Z0.0M05;	Zero return the drill to the zero position
M06;	Tool change
S6000M03;	Turn the spindle on in the CW rotation
G00G90G54X0.0Y15.0;	Position XY axes at the Start Point
G43Z50.0H02M08;	Select H02 Tool Length Offset
Z3.0;	
G1Z-5.0F3000;	Position Z-axis at the Start Point for Upper Edge
F1000;	Set feed rate for the deburring operation
M98P0002;	Call subprogram O0002 (XEBEC Deburring Tool Path for Upper Edge)
G01G90X0.0Y15.0F3000;	Position XY axes at the Start Point
Z-25.0;	Position Z-axis at the Start Point for Lower Edge
F1000;	Set feed rate for the deburring operation
M98P0003;	Call subprogram O0003 (XEBEC Deburring Tool Path for Upper Edge)
G00G90Z100.0M09;	
G91G28Z0.0M05;	Zero return the drill to the zero position
M01;	
M30;	Program end

Upper Edge Deburring Subprogram	
O0002(UPPER EDGE SUB PROG);	
G91;	Incremental Positioning (*1)
N1(XEBEC PATH);	XEBEC Deburring Tool Path
X0.000Y0.000Z0.000;	
X0.000Y0.000Z-5.675;	
X2.514Y0.000Z0.000;	
X-0.022Y0.385Z0.013;	
X-0.063Y0.367Z0.036;	
X-0.098Y0.343Z0.055;	
X-0.128Y0.315Z0.068;	

Upper Edge Deburring Subprogram	
X0.135Y0.322Z-0.071;	
X0.105Y0.357Z-0.059;	
X0.066Y0.374Z-0.038;	
X0.023Y0.394Z-0.014;	
X-2.514Y-0.000Z0.000;	
X0.000Y0.000Z5.675;	
X0.000Y0.000Z0.000;	
G90;	Absolute Positioning (*2)
M99;	Return to main program

Lower Edge Deburring Subprogram	
O0003(LOWER EDGE SUB PROG);	
G91;	Incremental Positioning (*1)
N2(XEBEC PATH);	XEBEC Deburring Tool Path
X0.000Y0.000Z0.000;	
X0.000Y0.000Z-0.139;	
X2.539Y0.000Z0.000;	
X-0.022Y0.387Z-0.013;	
X-0.063Y0.369Z-0.037;	
X-0.098Y0.345Z-0.056;	
X-0.128Y0.317Z-0.069;	
X0.135Y0.325Z0.073;	
X0.105Y0.359Z0.060;	
X0.066Y0.377Z0.038;	
X0.023Y0.396Z0.014;	
X-2.539Y-0.000Z0.000;	
X0.000Y0.000Z0.139;	
X0.000Y0.000Z0.000;	
G90;	Absolute Positioning (*2)
M99;	Return to main program

*1 This example shows how to implement XEBEC Deburring Tool Path in incremental positioning. This code is not included in XEBEC Deburring Tool Path.
*2 This example shows how to switch back to the absolute positioning after running XEBEC Deburring Tool Path in incremental positioning. This code is not included in XEBEC Deburring Tool Path.

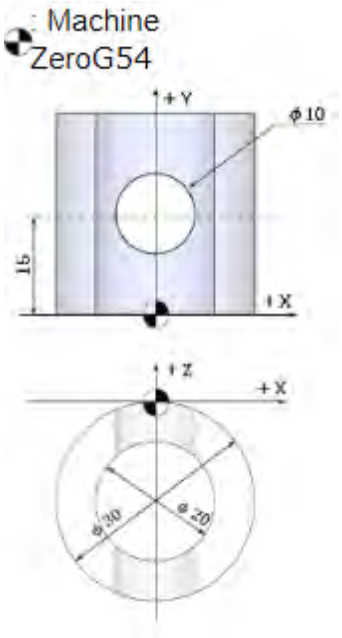
Absolute Positioning (ABS) Format

This section offers an example of implementing XEBEC Deburring Tool Path into the machining program in absolute positional format.
G-codes and all other details are based on FANUC controls. Make sure to use appropriate codes for your machine tool.

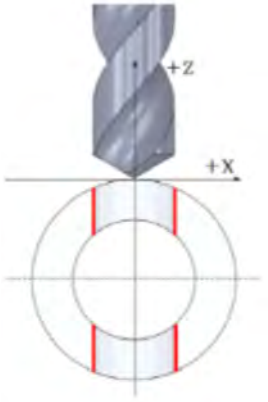
Machining Operations

- **Workpiece Shape**
  Outer Diameter Φ30mm x Inner Diameter Φ20mm
- **Previous Operation**
  Drilled a Φ10mm hole that crosses orthogonally and on-center with the centerline of the workpiece
- **Target Edge to be Deburred**
  Upper and Lower edges of the inner diameter at the intersection of the Φ10 hole and the Φ20 hole

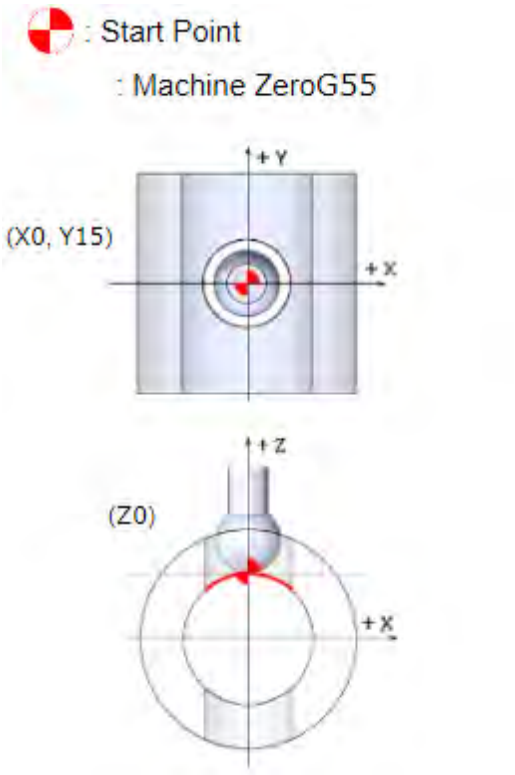
[Workpiece]



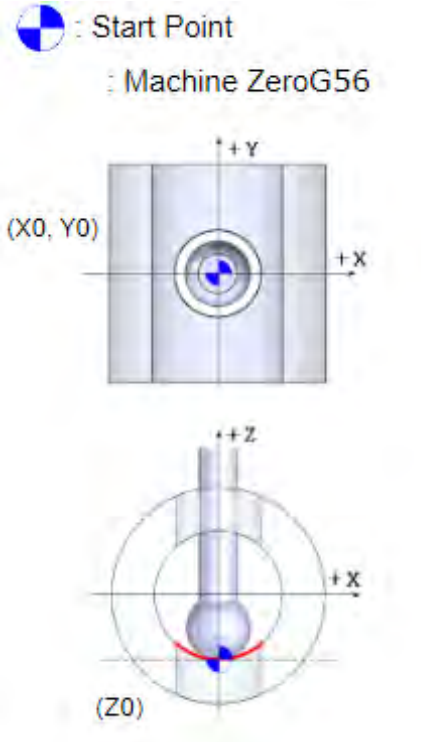
OP 1: Drilling



OP 2: Deburring Upper Edge



OP 3: Deburring Lower Edge



Program Overview

Main Program	
O0001 (MAIN PROG);	
G17G40G49G80;	Select XY plane
N1(10DRILL/T1H1);	**Drilling the Φ10 hole**

Main Program	
T01;	Call the drill
G91G28Z0.0M05	Zero return the drill to the zero position
M06;	Tool change
S5000M03;	Turn the spindle on in the CW rotation
G00G90G54X0.0Y15.0;	Position XY axes at the hole center
G43Z50.0H01M08;	Select H01 Tool Length Offset
G98G81Z-35.0R3.0F500;	Spot drilling cycle
G80;	Cancel drilling cycle
G00Z100.0M09;	
G91G28Z0.0M05;	Zero return the drill to the zero position
M01;	
N2(5.8BURRS CUTTER/T2H2);	**Deburring operation**
T02;	Call XEBEC Back Burr Cutter
G91G28Z0.0M05;	Zero return the drill to the zero position
M06;	Tool change
S6000M03;	Turn the spindle on in the CW rotation
G00G90G55X0.0Y0.0;	Position XY axes at the Start Point G55 (*1)
G43Z55.0H02M08;	Select H02 Tool Length Offset
Z8.0;	
G1Z0.0F3000;	Position Z-axis at the Start Point for Upper Edge
F1000;	Set feed rate for the deburring operation
M98P0002;	Call subprogram O0002 (XEBEC Deburring Tool Path for Upper Edge)
G01G90G56X0.0Y0.0F3000;	Position XY axes at the Start Point G56 (*1)
Z0.0;	Position Z-axis at the Start Point for Lower Edge
F1000;	Set feed rate for the deburring operation
M98P0003;	Call subprogram O0003 (XEBEC Deburring Tool Path for Upper Edge)
G00G90Z125.0M09;	
G91G28Z0.0M05;	Zero return the drill to the zero position
M01;	
M30;	Program end

XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0). Therefore, G55 and G56 are used in this example to set the machine zero point at different positions.

Upper Edge Deburring Subprogram	
O0002(UPPER EDGE SUB PROG);	
N1(XEBEC PATH);	
X0.000Y0.000Z0.000;	XEBEC Deburring Tool Path
X0.000Y0.000Z-5.646;	
X2.564Y0.000Z-5.646;	
X2.535Y0.447Z-5.629;	
X2.450Y0.881Z-5.578;	

Upper Edge Deburring Subprogram	
X2.313Y1.290Z-5.501;	
X2.133Y1.665Z-5.405;	
X2.133Y-1.665Z-5.405;	
X2.313Y-1.290Z-5.501;	
X2.450Y-0.881Z-5.578;	
X2.535Y-0.447Z-5.629;	
X2.564Y-0.000Z-5.646;	
X0.000Y0.000Z-5.646;	
X0.000Y0.000Z0.000;	
M99;	Return to main program

Lower Edge Deburring Subprogram	
O0003(LOWER EDGE SUB PROG);	
N2(XEBEC PATH);	
X0.000Y0.000Z0.000;	
X0.000Y0.000Z-0.154;	
X2.564Y0.000Z-0.154;	
X2.535Y0.447Z-0.171;	
X2.450Y0.881Z-0.222;	
X2.313Y1.290Z-0.299;	
X2.133Y1.665Z-0.395;	
	XEBEC Deburring Tool Path
X2.133Y-1.665Z-0.395;	
X2.313Y-1.290Z-0.299;	
X2.450Y-0.881Z-0.222;	
X2.535Y-0.447Z-0.171;	
X2.564Y-0.000Z-0.154;	
X0.000Y0.000Z-0.154;	
X0.000Y0.000Z0.000;	
M99;	Return to main program

Specifications of Cross Hole Types

Cross Hole Types (P.40)

Type A: Orthogonal Cross Hole - Outer Diameter (Cutter Insertion Hole < Outer Diameter) (P.43)

Type B: Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole) (P.45)

Type C: Flat Surface Hole (P.47)

Type D and E: Angled Cross Hole (On-center) - Outer/Inner Diameter (P.50)

Type D and E: Angled Cross Hole (Off-center) - Outer/Inner Diameter (P.52)

Type F: Angled Surface Hole (P.54)

Type G and H: Slotted Hole Parallel with Cross Hole Axis (On-center) - Outer/Inner Diameter (ar=0°) (P.56)

Type G and H: Slotted Hole Parallel with Cross Hole Axis (Off-center) - Outer/Inner Diameter (ar=0°) (P.58)

Type G and H: Slotted Hole Parallel with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°) (P.60)

Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (On-center) - Outer/Inner Diameter (P.62)

Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (Off-center) - Outer/Inner Diameter (P.64)

Type I and J: Slotted Hole Perpendicular with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°) (P.66)

Type K: Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole > Cross Hole) (P.68)

Type K: Orthogonal Cross Hole Aligned with X-axis (ar＝90°/-90°) (P.70)

Type L: Broken Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole) (P.72)

Type M: Broken Hole - Inner Diameter (Cutter Insertion Hole ＞ Cross Hole) (P.74)

Type N: Angled Cross Hole Inner Diameter (On-center) - (Cutter Insertion Hole > Cross Hole) (P.76)

Type N: Angled Cross Hole Inner Diamater (Off-center) - (Cutter Insertion Hole > Cross Hole) (P.78)

Type P: Tapped Orthogonal Cross Hole (Cutter Insertion Hole ≦ Cross Hole) (P.80)

Type Q: Tapped Flat Surface Hole (P.82)

Type R: Tapped Angled Surface Hole (P.84)

Cross Hole Types

The cross hole type of your workpiece is indicated in the Tool Path Code Sheet to be provided separately.

Type	Description	Product Specifications	Edge Configuration	Example
A	Orthogonal Cross Hole - Outer Diameter (Cutter Insertion Hole < Outer Diameter)	On-center Off-center	Upper/Lower	Type A: Orthogonal Cross Hole - Outer Diameter (Cutter Insertion Hole < Outer Diameter)
B	Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole)	On-center Off-center	Upper/Lower	Type B: Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole)
C	Flat Surface Hole	-	Front/Back	Type C: Flat Surface Hole
D	Angled Cross Hole - Outer Diameter	On-center Off-center	Upper	Type D and E: Angled Cross Hole (On-center) - Outer/Inner Diameter Type D and E: Angled Cross Hole (Off-center) - Outer/Inner Diameter
E	Angled Cross Hole - Inner Diameter	On-center Off-center	Upper	Type D and E: Angled Cross Hole (On-center) - Outer/Inner Diameter Type D and E: Angled Cross Hole (Off-center) - Outer/Inner Diameter
F	Angled Surface Hole	-	Front/Back	Type F: Angled Surface Hole
G	Slotted Hole Parallel with Cross Hole Axis - Outer Diameter	On-center Off-center	Upper	Type G and H: Slotted Hole Parallel with Cross Hole Axis (On-center) - Outer/Inner Diameter (ar=0°) Type G and H: Slotted Hole Parallel with Cross Hole Axis (Off-center) - Outer/Inner Diameter (ar=0°) Type G and H: Slotted Hole Parallel with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°)
H	Slotted Hole Parallel with Cross Hole Axis - Inner Diameter	On-center Off-center	Upper	Type G and H: Slotted Hole Parallel with Cross Hole Axis (On-center) - Outer/Inner Diameter (ar=0°) Type G and H: Slotted Hole Parallel with Cross Hole Axis (Off-center) - Outer/Inner Diameter (ar=0°) Type G and H: Slotted Hole Parallel with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°)
I	Slotted Hole Perpendicular with Cross Hole Axis - Outer Diameter	On-center Off-center	Upper	Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (On-center) - Outer/Inner Diameter Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (Off-center) - Outer/Inner Diameter Type I and J: Slotted Hole Perpendicular with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°)

J	Slotted Hole Perpendicular with Cross Hole Axis - Inner Diameter	On-center Off-center	Upper	Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (On-center) - Outer/Inner Diameter Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (Off-center) - Outer/Inner Diameter Type I and J: Slotted Hole Perpendicular with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°)
K	Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole > Cross Hole)	On-center Off-center	Front/Rear	Type K: Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole > Cross Hole) Type K: Orthogonal Cross Hole Aligned with X-axis (ar＝90°/-90°)
L	Broken Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole)	Off-center	-	Type L: Broken Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole)
M	Broken Hole - Inner Diameter (Cutter Insertion Hole > Cross Hole)	Off-center	-	Type M: Broken Hole - Inner Diameter (Cutter Insertion Hole ＞ Cross Hole)
N	Angled Cross Hole - Inner Diameter (Cutter Insertion Hole > Cross Hole)	On-center Off-center	Front/Rear	Type N: Angled Cross Hole Inner Diameter (On-center) - (Cutter Insertion Hole > Cross Hole) Type N: Angled Cross Hole Inner Diamater (Off-center) - (Cutter Insertion Hole > Cross Hole)

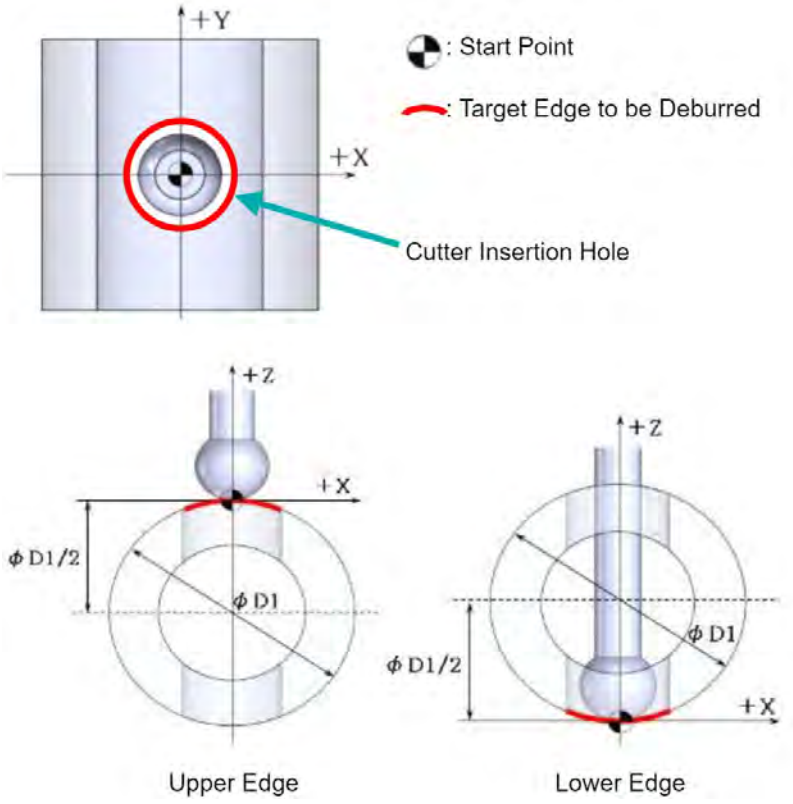
Tapped Hole Tool Path

Type	Description	Product Specifications	Edge Configuration	Example
P	Tapped Orthogonal Cross Hole - Inner diameter (Cutter Insertion Hole ≦ Cross Hole)	On-center Off-center	Upper	Type P: Tapped Orthogonal Cross Hole (Cutter Insertion Hole ≦ Cross Hole)
Q	Tapped Flat Surface Hole	-	Back Edge	Type Q: Tapped Flat Surface Hole
R	Tapped Angled Surface Hole	**-**	Back Edge	Type R: Tapped Angled Surface Hole

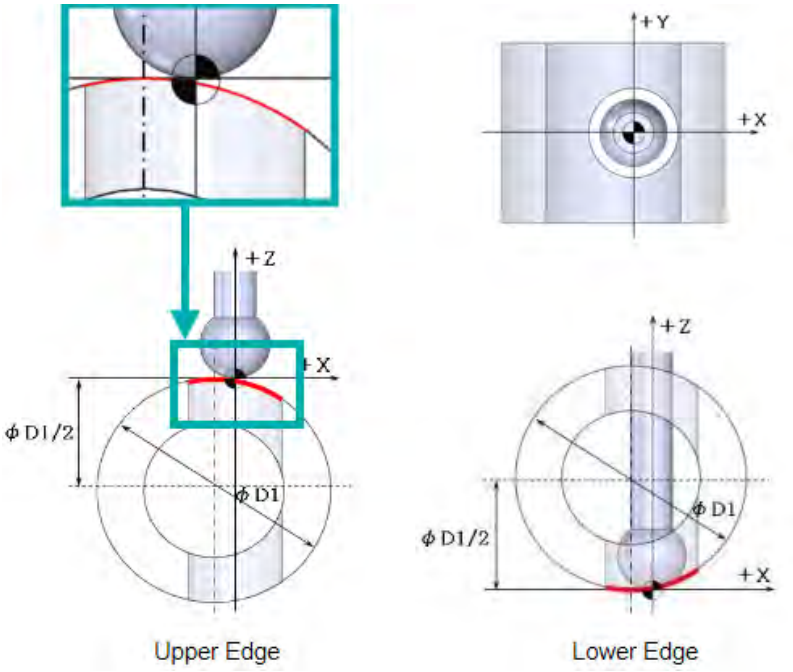
Type A: Orthogonal Cross Hole - Outer Diameter (Cutter Insertion Hole < Outer Diameter)

The Start Point is at the center of the Cutter Insertion Hole in the XY plane.
Along the Z-axis, it is at an offset position away from the centerline by one half the diameter D1.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

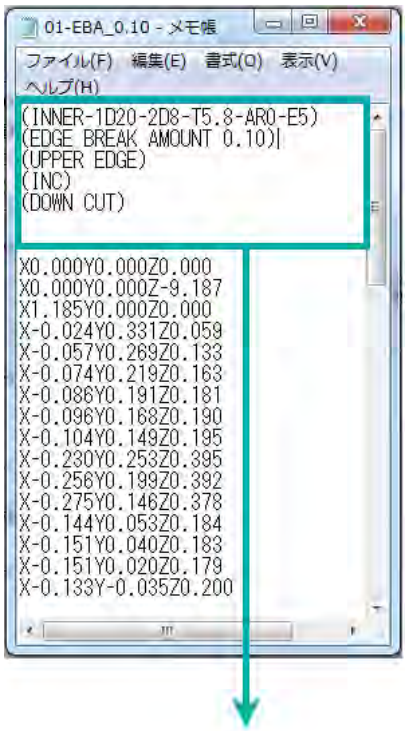
Example: On-Center Cross Hole



Example: Off-Center Cross Hole



XEBEC Deburring Tool Path Specifications



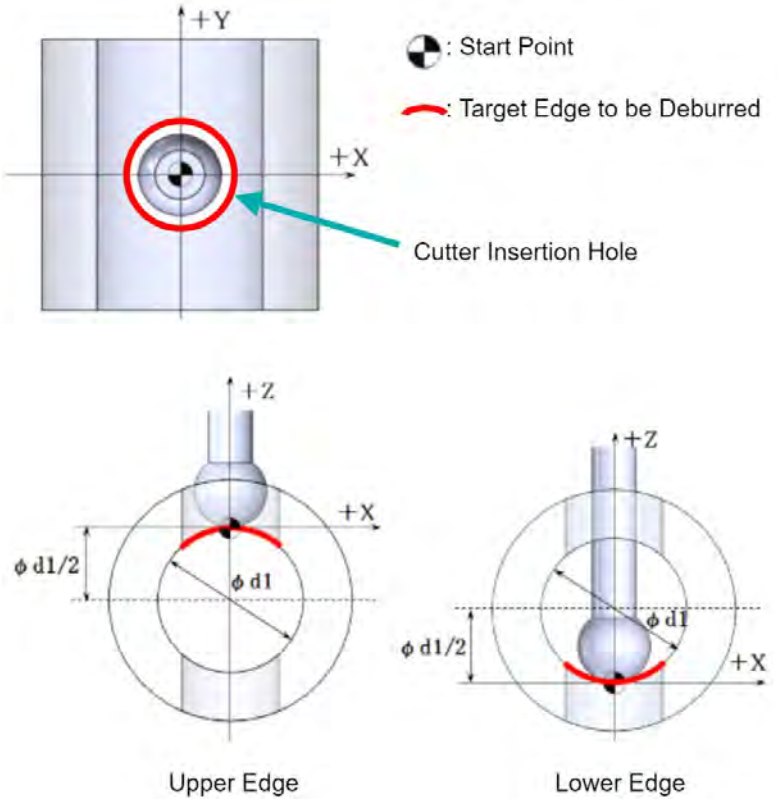
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D10-T5.8-AR0-E5)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D10: Cutter Insertion Hole 2D Diameter Φ10mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° E5: Offset +5mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(UPPER EDGE)	Upper Edge [LOWER: Lower Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type B: Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole)

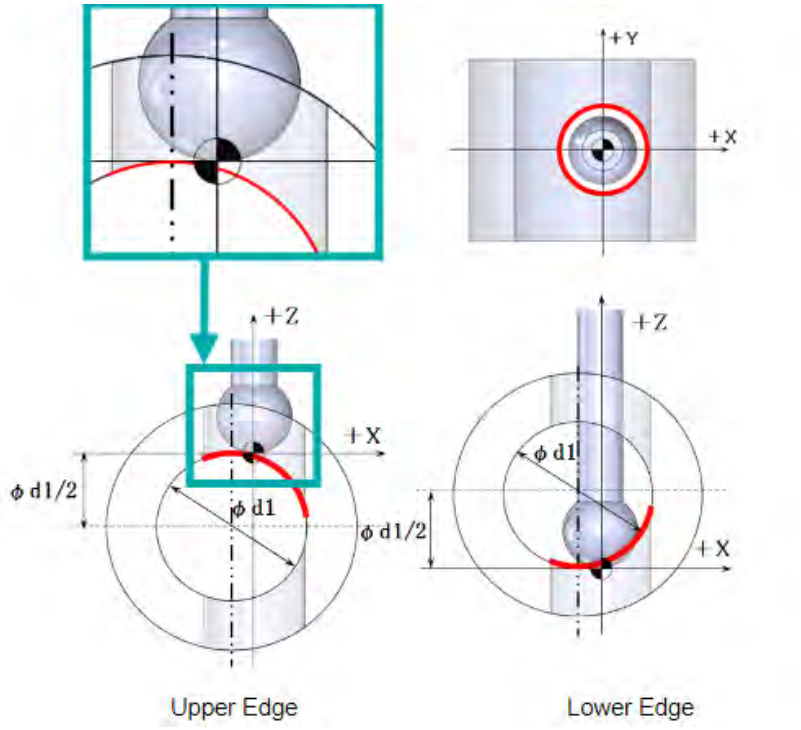
The Start Point is at the center of the Cutter Insertion Hole in the XY plane.
Along the Z-axis, it is at an offset position away from the centerline by one half the diameter D1.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: On-Center Cross Hole

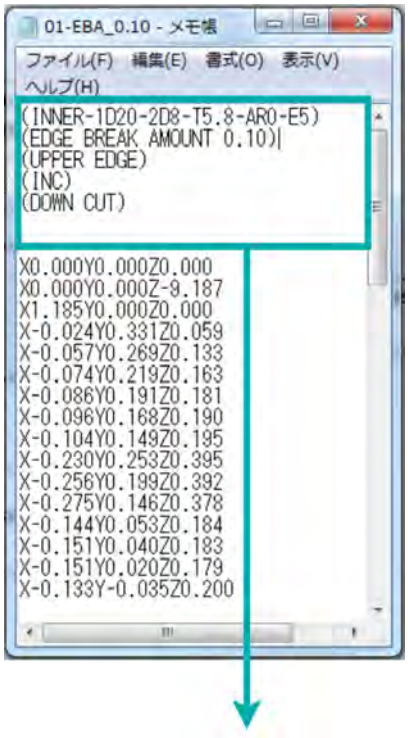


Example: Off-Center Cross Hole

Specifications of Cross Hole Types



XEBEC Deburring Tool Path Specifications



Specifications are indicated at the top of the text file in parentheses ( )

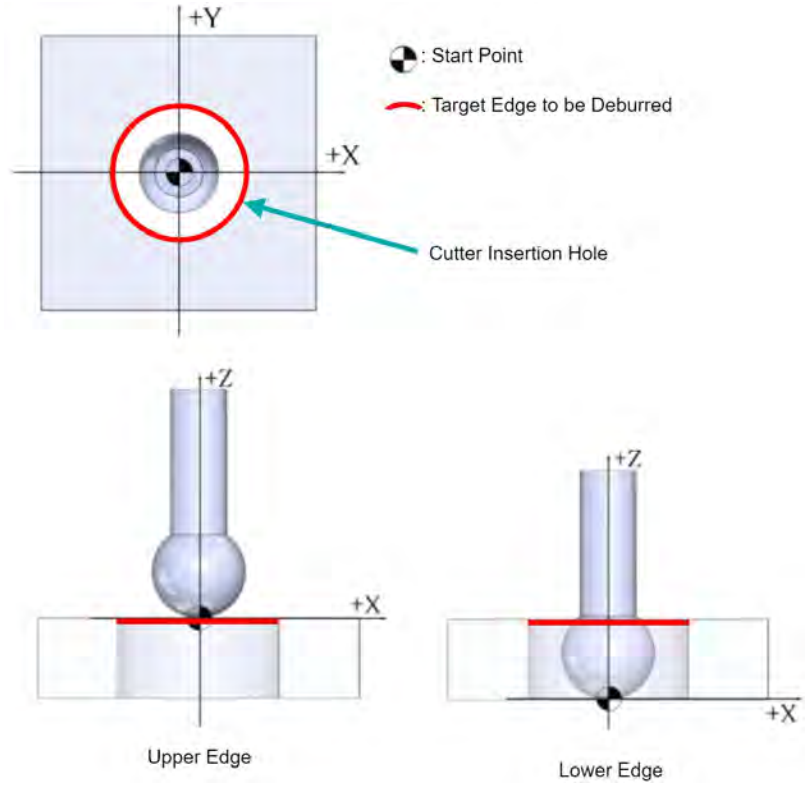
Specifications	Descriptions
(INNER-1D20-2D10-T5.8-AR0-E5)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D10: Cutter Insertion Hole 2D Diameter Φ10mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° E5: Offset +5mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(UPPER EDGE)	Upper Edge [LOWER: Lower Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]

Specifications	Descriptions
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

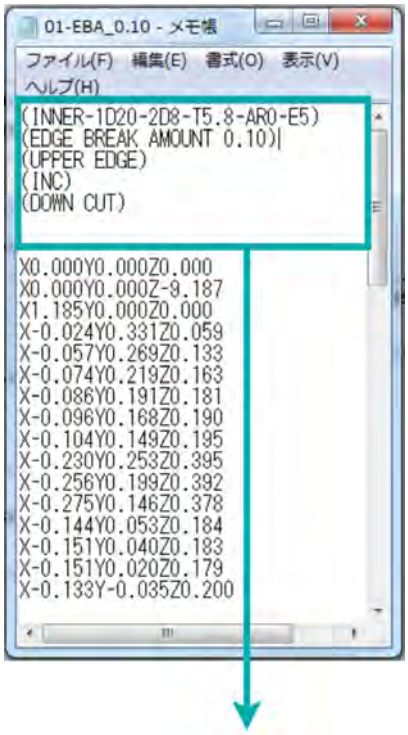
Type C: Flat Surface Hole

The Start Point is at the center of the Cutter Insertion Hole in the XY plane.
For Upper Edge, the Z coordinate is aligned with the top surface (for Lower Edge, with the back surface).
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Flat Surface Hole



XEBEC Deburring Tool Path Specifications



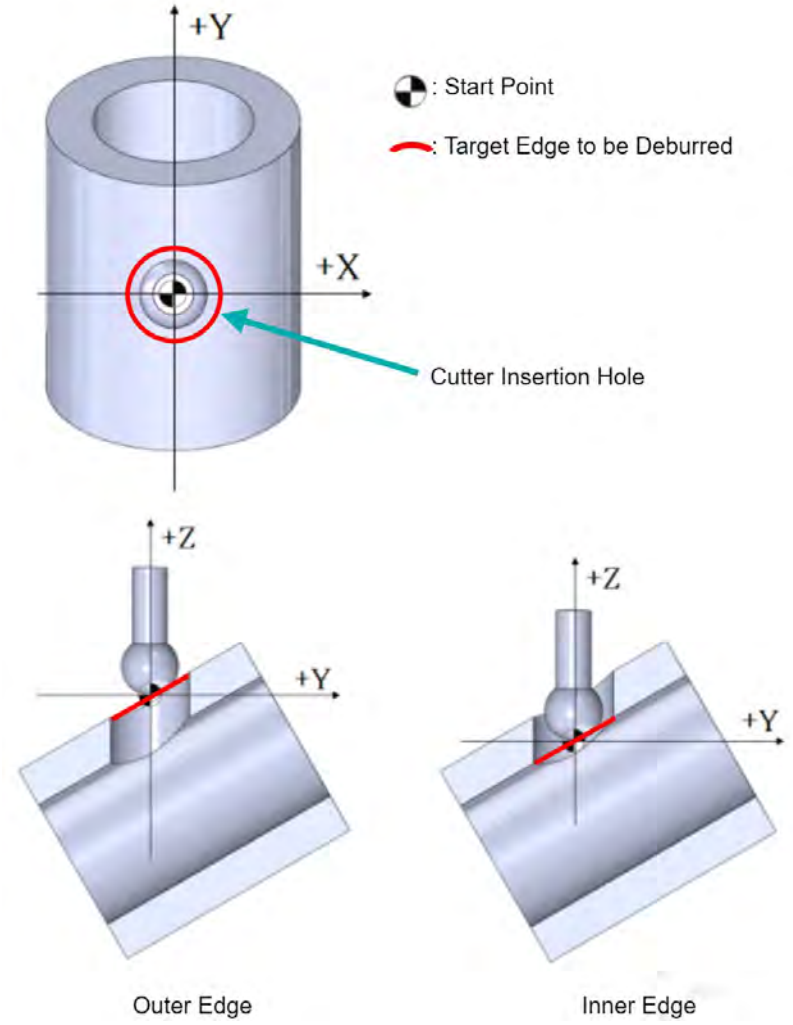
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(2D10-T5.8);	2D10: Cutter Insertion Hole 2D Diameter Φ10mm T5.8: Cutter Diameter Φ5.8mm
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(BACK EDGE)	The Edge at the Backside [FRONT: The Edge at the Front Side]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type D and E: Angled Cross Hole (On-center) - Outer/Inner Diameter

The Start Point is at the center of the Cutter Insertion Hole in the XY plane.
Along the Z-axis, it is at the intersection of the Cutter Insertion Hole axis and the outer/inner diameter.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

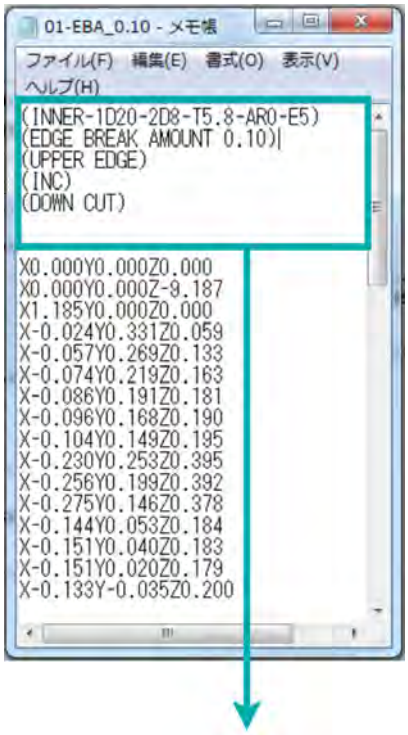
Example: Angled Cross Hole (On-center)



MEMO

Machining Parameters
To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).

XEBEC Deburring Tool Path Specifications



Specifications	Descriptions
(INNER-1D20-2D10-T5.8-AR0-E0-AA60.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D10: Cutter Insertion Hole 2D Diameter Φ10mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° AA60: Inclination Angle +60° E0: Offset 0mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(UPPER EDGE)	Type D Upper Edge [LOWER: Type E Lower Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type D and E: Angled Cross Hole (Off-center) - Outer/Inner Diameter

The Start Point is at the center of the Cutter Insertion Hole in the XY plane.
Along the Z-axis, it is at the intersection of the Cutter Insertion Hole axis and the outer/inner diameter.
XEBEC Debutting Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Angled Cross Hole (Off-center)

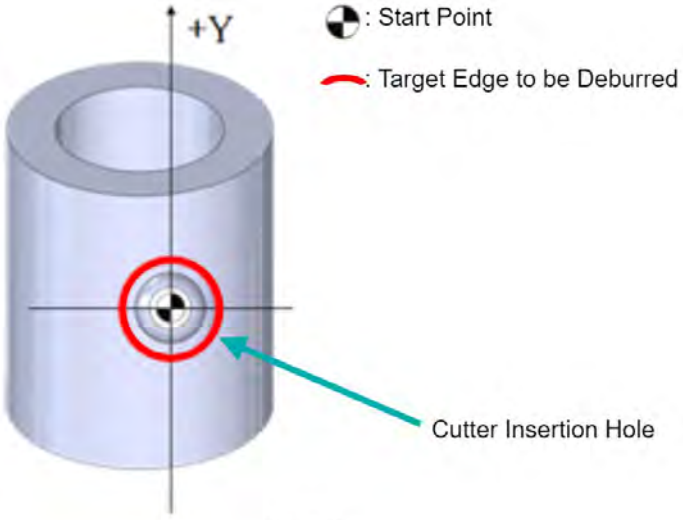


Figure1

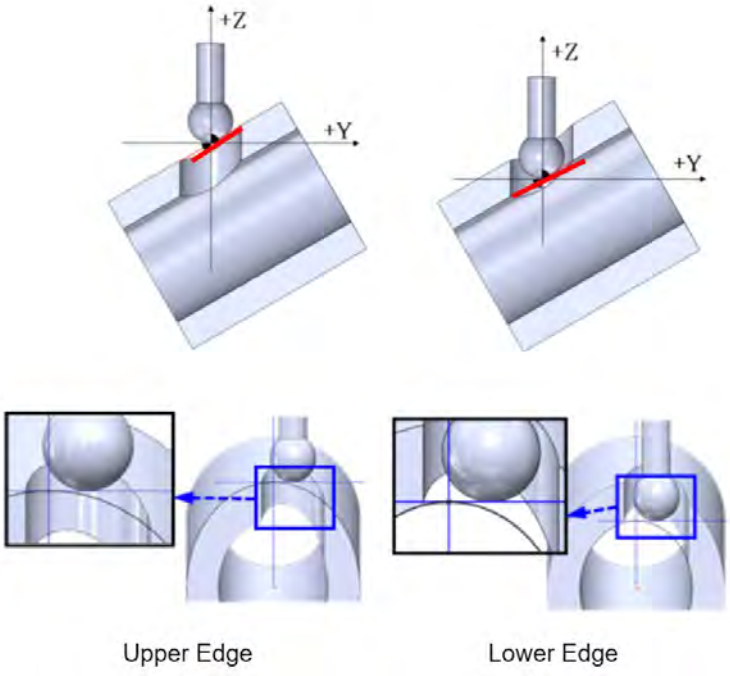
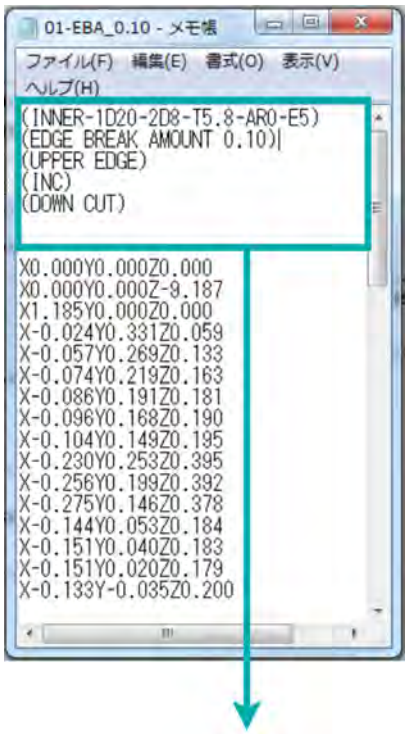


Figure2

Machining Parameters
To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).

XEBEC Deburring Tool Path Specifications



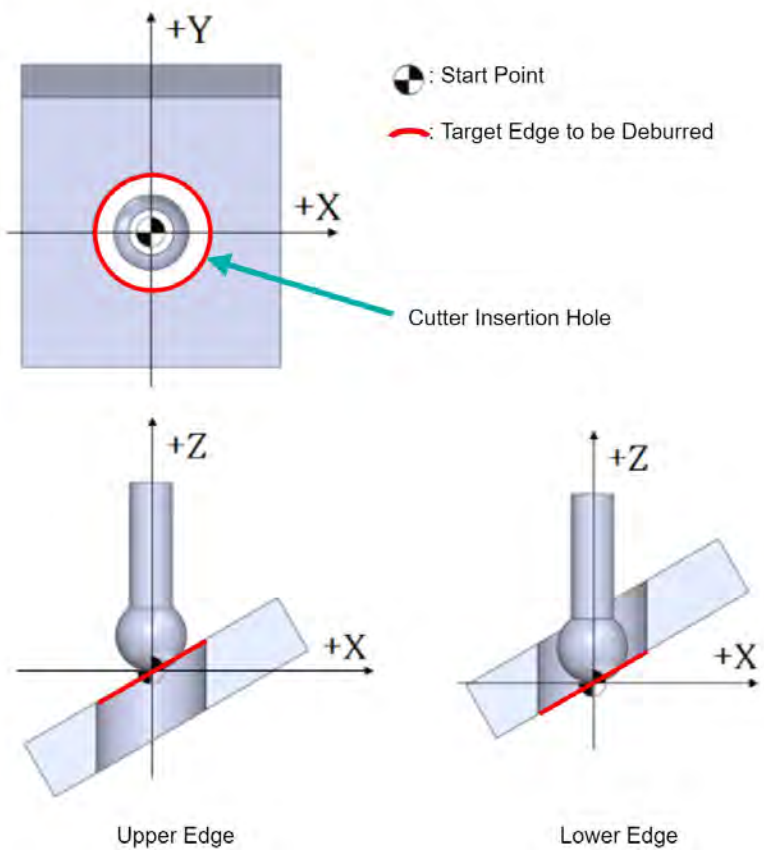
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D10-T5.8-AR0-E0-AA60.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D10: Cutter Insertion Hole 2D Diameter Φ10mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° AA60: Inclination Angle +60° E0: Offset 0mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(UPPER EDGE)	Upper Edge [LOWER: Lower Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type F: Angled Surface Hole

The Start Point is at the center of the Cutter Insertion Hole in the XY plane.
Along the Z-axis, it is at the intersection of the Cutter Insertion Hole axis and the upper/lower angled surface.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

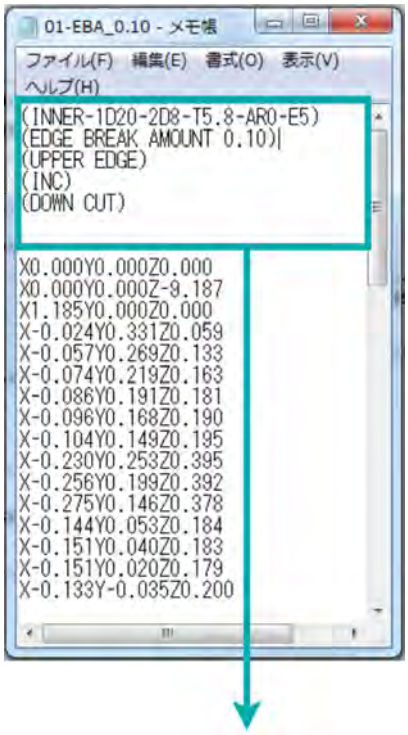
Example: Tapped Angled Surface Hole



MEMO

Machining Parameters
To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).

XEBEC Deburring Tool Path Specifications



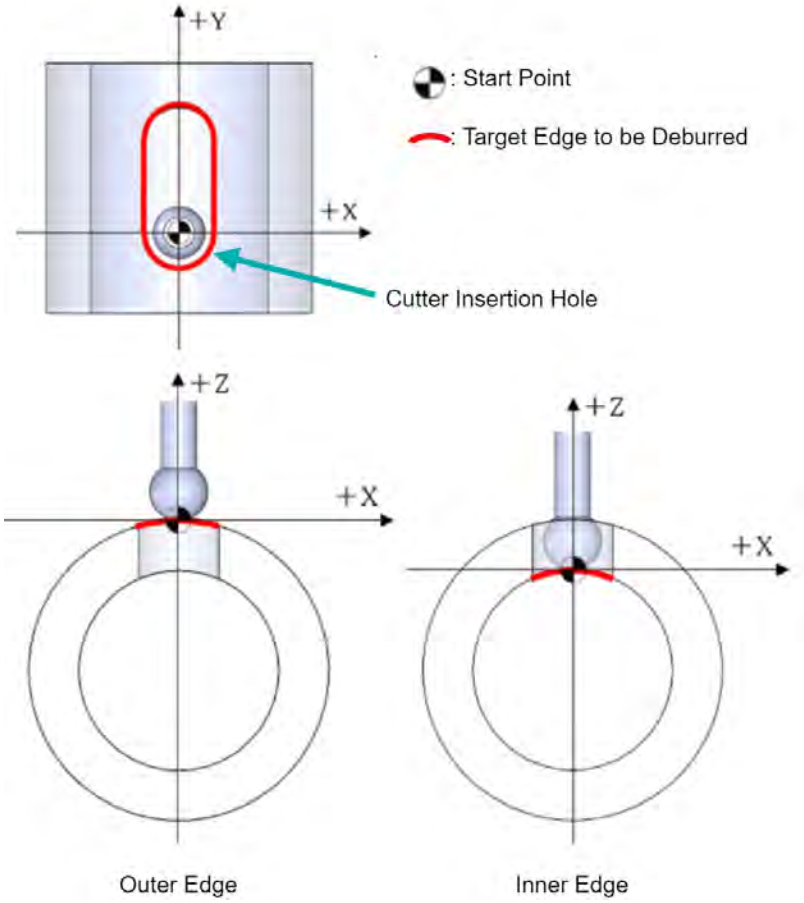
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(2D10.-T5.8-AR0-AA60.)	2D10: Cutter Insertion Hole 2D Diameter Φ10mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° AA60: Inclination Angle +60°
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(BACK EDGE)	The Edge at the Backside [FRONT: The Edge at the Front Side]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

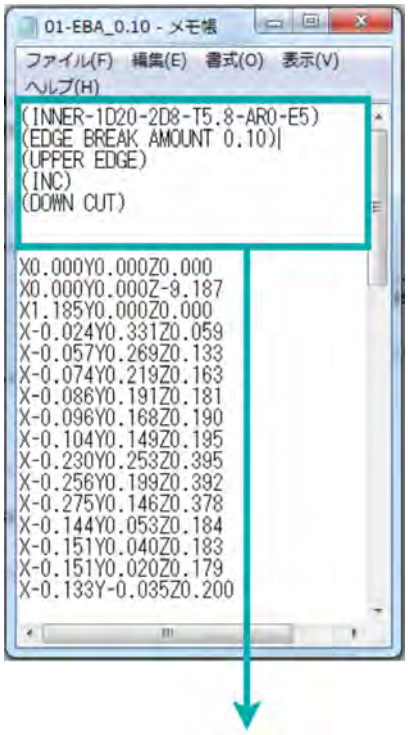
Type G and H: Slotted Hole Parallel with Cross Hole Axis (On-center) - Outer/Inner Diameter (ar=0°)

When the orientation angle (ar) is 0°, the Start Point is at the center of the Radius R in the XY plane at the -Y side. The Z coordinate is at the highest point of the Outer/Inner Diameter.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Slotted Hole Parallel with Cross Hole Axis (On-center)



XEBEC Deburring Tool Path Specifications



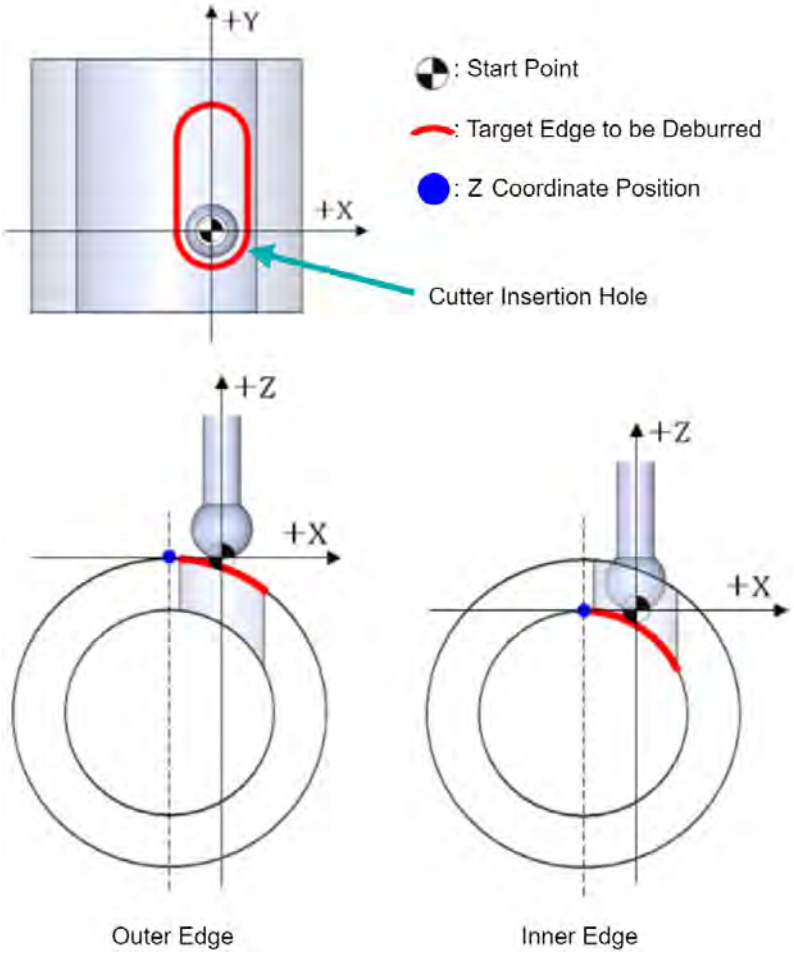
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D8-T5.8-AR90-E3-L10.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D8: Cutter Insertion Hole 2D Diameter Φ8mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E3: Offset +3mm from the Cross Hole Axis L10: Length Between R Centers 10mm
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(UPPER EDGE)	Upper Edge [Lower Edge not applicable with Types G & H]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

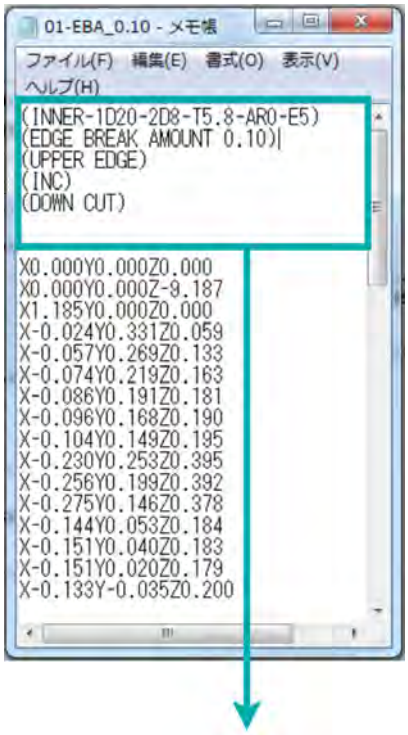
Type G and H: Slotted Hole Parallel with Cross Hole Axis (Off-center) - Outer/Inner Diameter (ar=0°)

When the orientation angle (ar) is 0°, the Start Point is at the center of the Radius R in the XY plane at the -Y side. The Z coordinate is at the highest point of the Outer/Inner Diameter.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Slotted Hole Parallel with Cross Hole Axis (Off-center)



XEBEC Deburring Tool Path Specifications



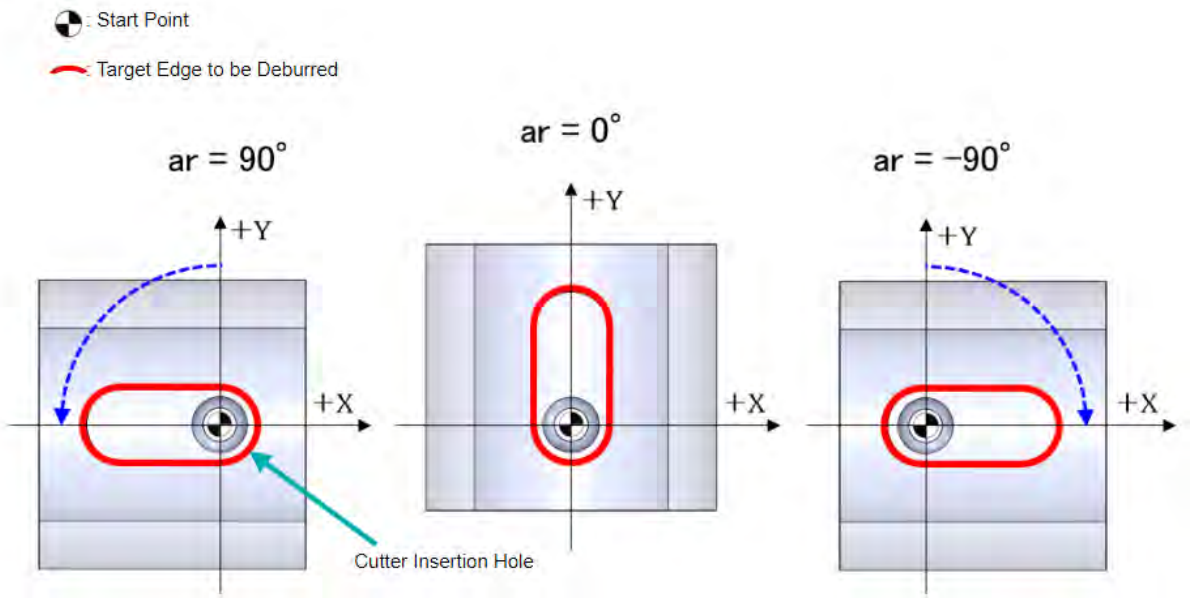
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D8-T5.8-AR90-E3-L10.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D8: Cutter Insertion Hole 2D Diameter Φ8mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E3: Offset +3mm from the Cross Hole Axis L10: Length Between R Centers 10mm
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(UPPER EDGE)	Upper Edge [Lower Edge not applicable with Types G & H]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

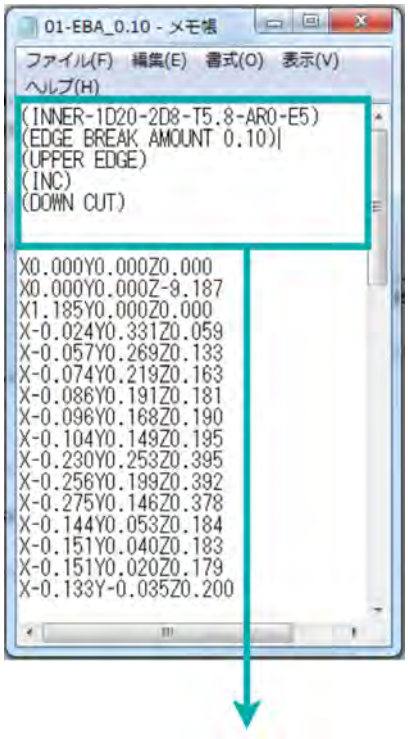
Type G and H: Slotted Hole Parallel with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°)

Described in this section is an example in which the cross hole axis is aligned with the X-axis (ar=90° and -90°).
When the orientation angle (ar) is 90°, the Start Point is at the center of the Radius R in the XY plane at the +X side. When the orientation angle (ar) is -90°, the Start Point is at the -X side. The Z coordinate is at the highest point of the Outer/Inner Diameter. .
These apply regardless of whether the Slotted Hole is On-center or Off-center.

Example: Cross Hole Axis Aligned with X-axis



XEBEC Deburring Tool Path Specifications



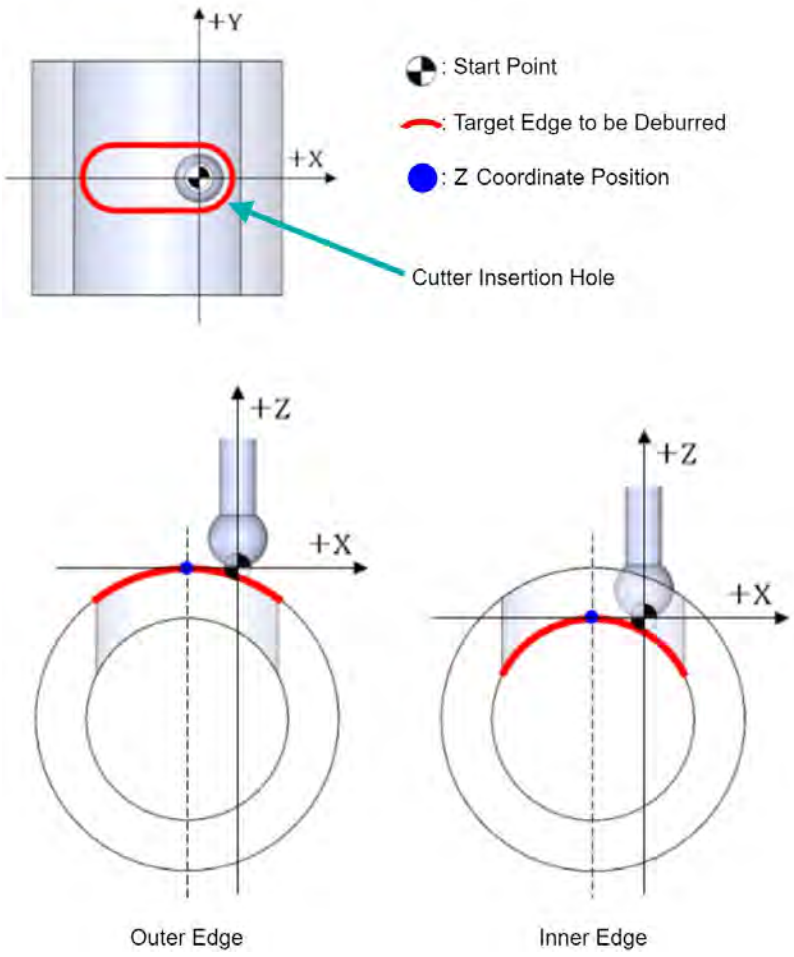
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D8-T5.8-AR90-E3-L10.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D8: Cutter Insertion Hole 2D Diameter Φ8mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E3: Offset +3mm from the Cross Hole Axis L10: Length Between R Centers 10mm
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(UPPER EDGE)	Upper Edge [Lower Edge not applicable with Types G & H]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

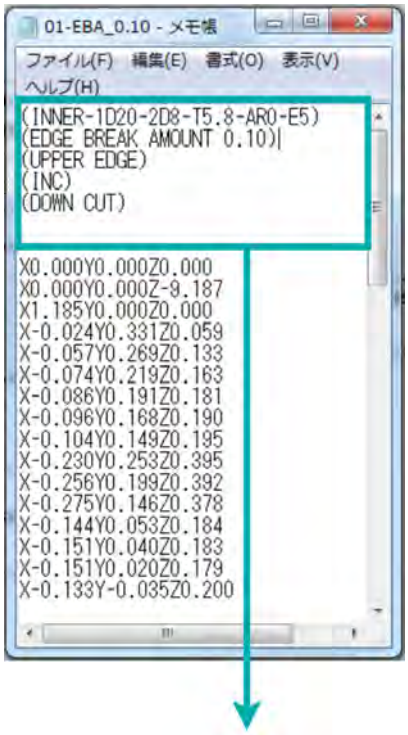
Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (On-center) - Outer/Inner Diameter

When the orientation angle (ar) is 0°, the Start Point is at the center of the Radius R in the XY plane at the +X side. The Z coordinate is at the highest point of the Outer/Inner Diameter.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Slotted Hole Perpendicular with Cross Hole Axis (On-center)



XEBEC Deburring Tool Path Specifications



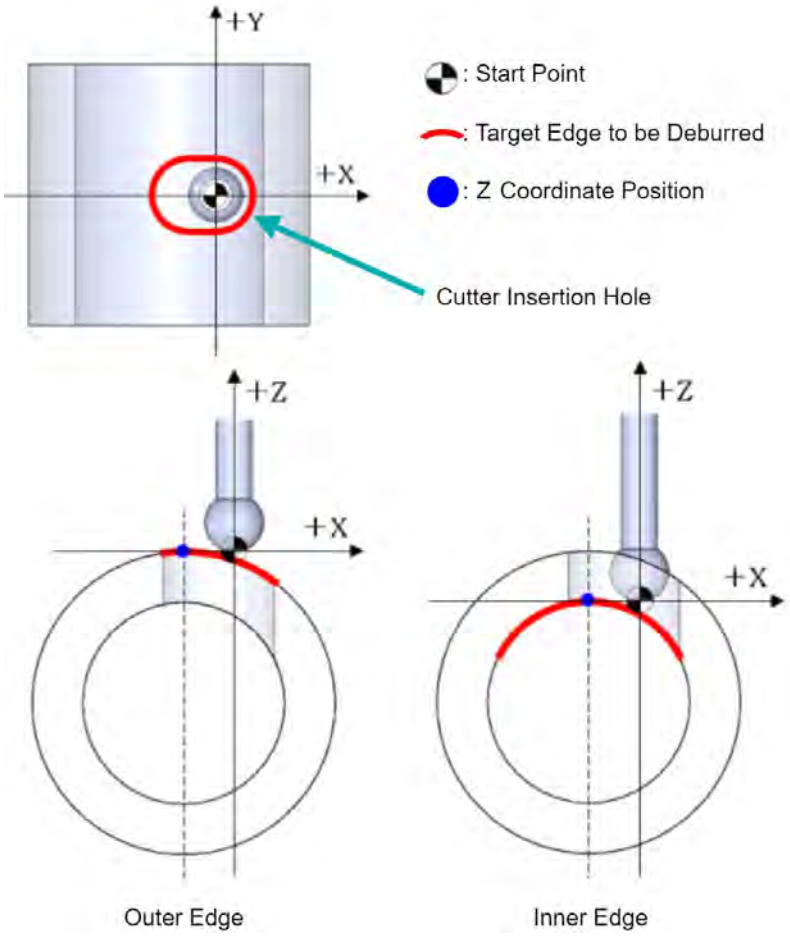
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D8-T5.8-AR90-E1-L10.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D8: Cutter Insertion Hole 2D 8mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E1: Offset +1mm from the Cross Hole Axis L10: Length Between R Centers 10mm
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(UPPER EDGE)	Upper Edge
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

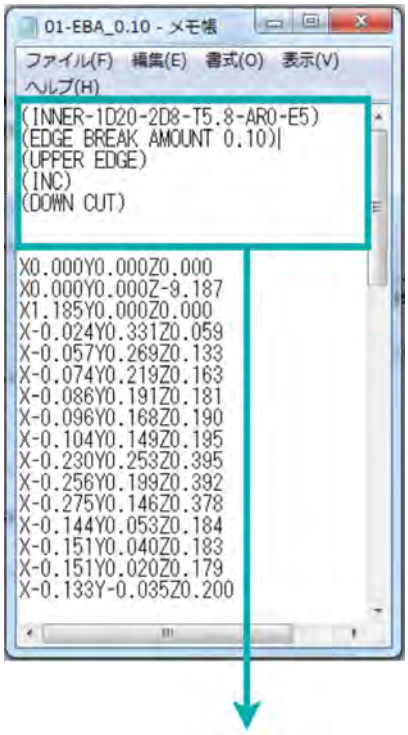
Type I and J: Slotted Hole Perpendicular with Cross Hole Axis (Off-center) - Outer/Inner Diameter

When the orientation angle (ar) is 0°, the Start Point is at the center of the Radius R in the XY plane at the +X side. The Z coordinate is at the highest point of the Outer/Inner Diameter.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Slotted Hole Perpendicular with Cross Hole Axis (Off-center)



XEBEC Deburring Tool Path Specifications



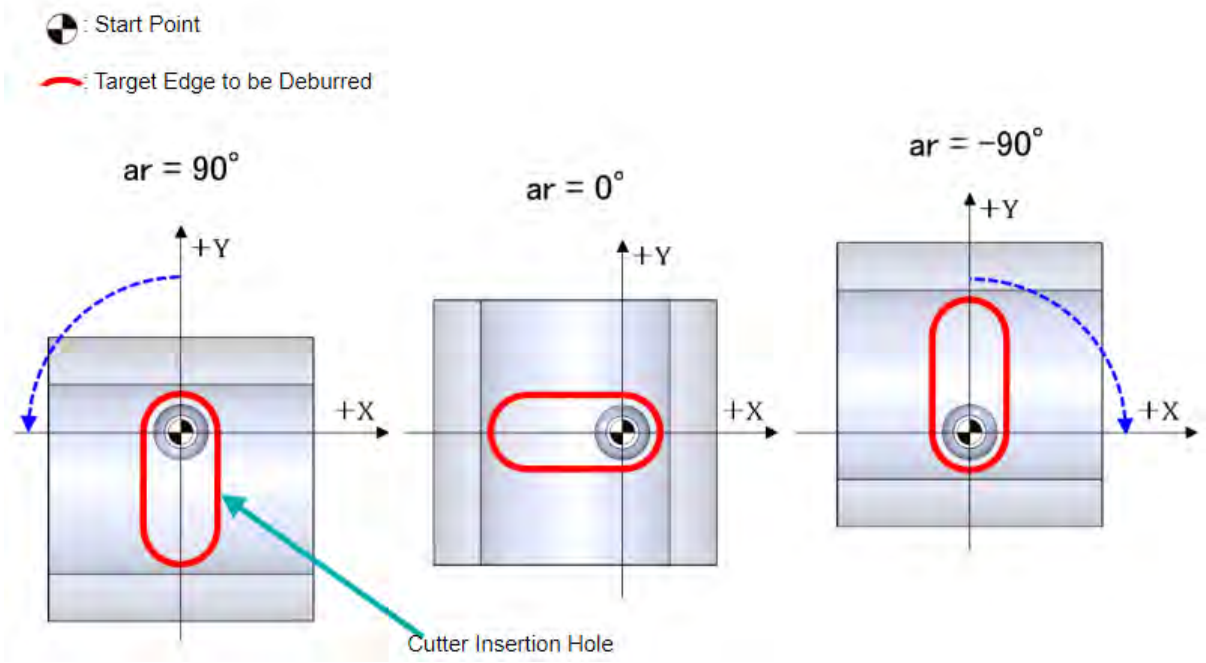
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D8-T5.8-AR90-E1-L10.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D8: Cutter Insertion Hole 2D 8mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E1: Offset +1mm from the Cross Hole Axis L10: Length Between R Centers 10mm
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(UPPER EDGE)	Upper Edge
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

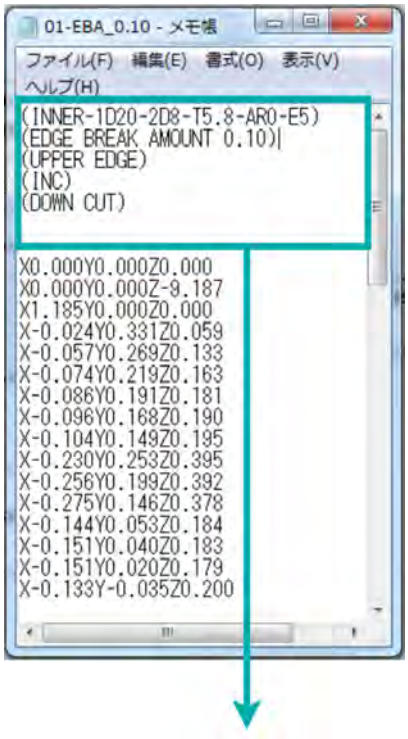
Type I and J: Slotted Hole Perpendicular with Cross Hole Axis Aligned with X-axis (ar＝90°/-90°)

When the orientation angle (ar) is 90°, the Start Point is at the center of the Radius R in the XY plane at the +Y side. When the orientation angle (ar) is -90°, the Start Point is at the -Y side. The Z coordinate is at the highest point of the Outer/Inner Diameter.
These apply regardless of whether the Slotted Hole is On-center or Off-center.

Example: Cross Hole Axis Aligned with X-axis



XEBEC Deburring Tool Path Specifications



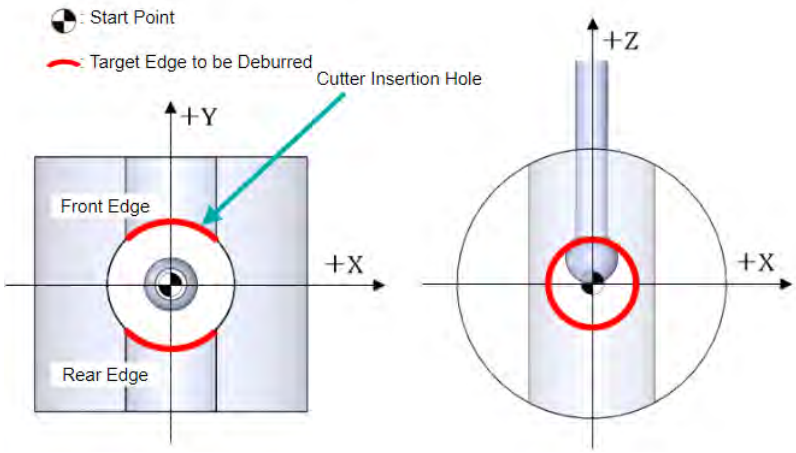
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D20-2D8-T5.8-AR90-E1-L10.)	INNER: Inner Edge [OUTER: Outer Edge] 1D20: Cross Hole 1D Diameter Φ20mm 2D8: Cutter Insertion Hole 2D 8mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E1: Offset +1mm from the Cross Hole Axis L10: Length Between R Centers 10mm
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(UPPER EDGE)	Upper Edge
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type K: Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole > Cross Hole)

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at the center of the Cross Hole.Along the Z-axis, it is at the center of the Cross Hole.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

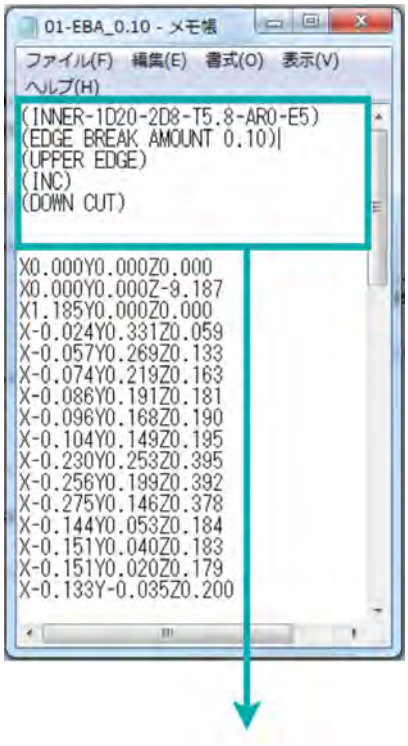
Example: Orthogonal Cross Hole - Inner Diameter (Cutter Insertion Hole > Cross Hole)



MEMO

Machining Parameters
To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).

XEBEC Deburring Tool Path Specifications



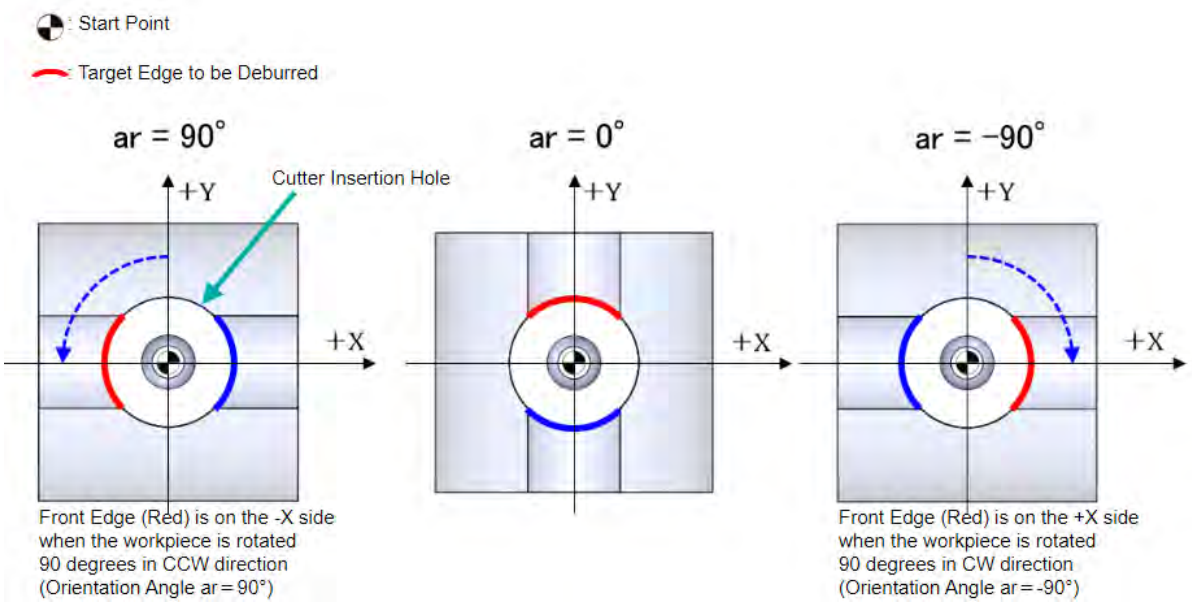
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D8.-2D20.-T5.8.-AR90.-E3.)	INNER: Inner Edge [OUTER: Outer Edge] 1D8: Cross Hole 1D Diameter Φ8mm 2D20: Cutter Insertion Hole 2D Diameter Φ20mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E3: Offset +3mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(FRONT EDGE)	Front Edge [REAR EDGE: Rear Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

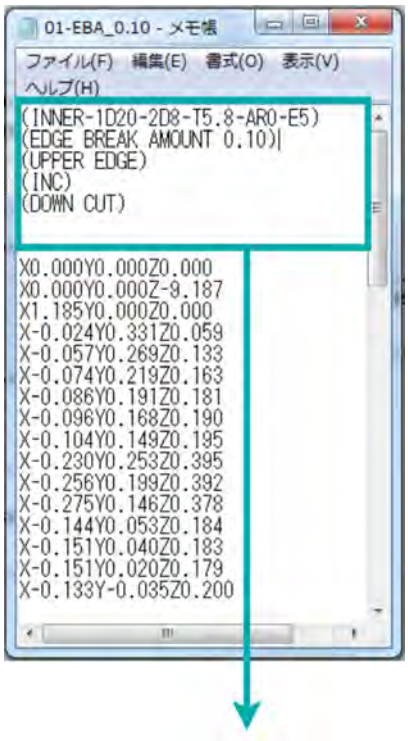
Type K: Orthogonal Cross Hole Aligned with X-axis (ar＝90°/-90°)

Assuming that the cross hole is aligned with the Y-axis (Orientation Angle ar=0°), Front Edge (Red) is defined as the edge that is on the +Y side and Rear Edge (Blue) is the edge on the -Y side as shown in the example below.
The relationship between Front (Red) /Rear (Blue) Edges and the orientation angle are also shown.

Example: Cross Hole Axis Aligned with X-axis



XEBEC Deburring Tool Path Specifications



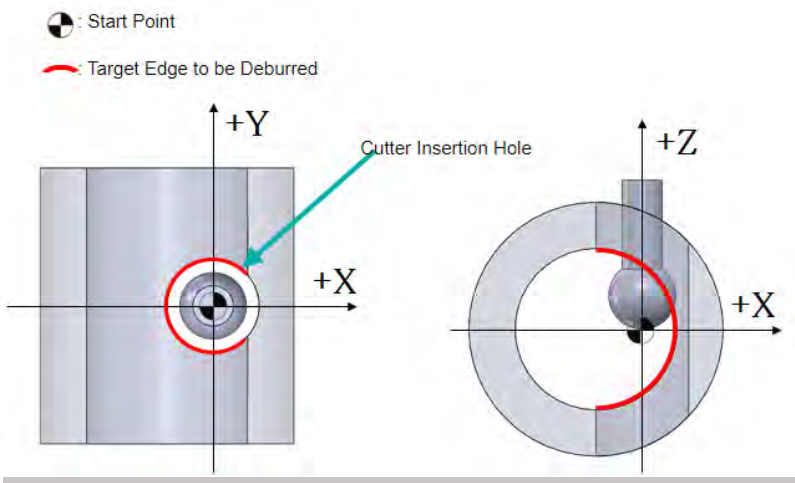
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D8.-2D20.-T5.8.-AR90.-E3.)	INNER: Inner Edge [OUTER: Outer Edge] 1D8: Cross Hole 1D Diameter Φ8mm 2D20: Cutter Insertion Hole 2D Diameter Φ20mm T5.8: Cutter Diameter Φ5.8mm AR90: Cross Hole Orientation Angle 90° E3: Offset +3mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.30)	Deburring Amount 0.30mm
(FRONT EDGE)	Front Edge [REAR EDGE: Rear Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type L: Broken Hole - Inner Diameter (Cutter Insertion Hole ≦ Cross Hole)

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at the center of the Cross Hole.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

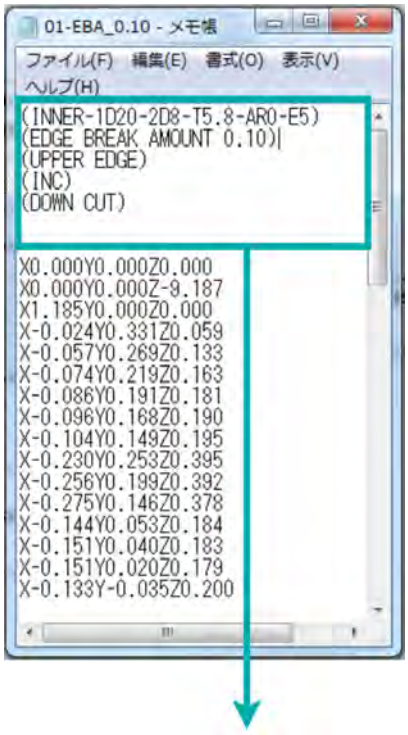
Example: Broken Hole - Inner Diameter



MEMO

Machining Parameters
To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).

XEBEC Deburring Tool Path Specifications



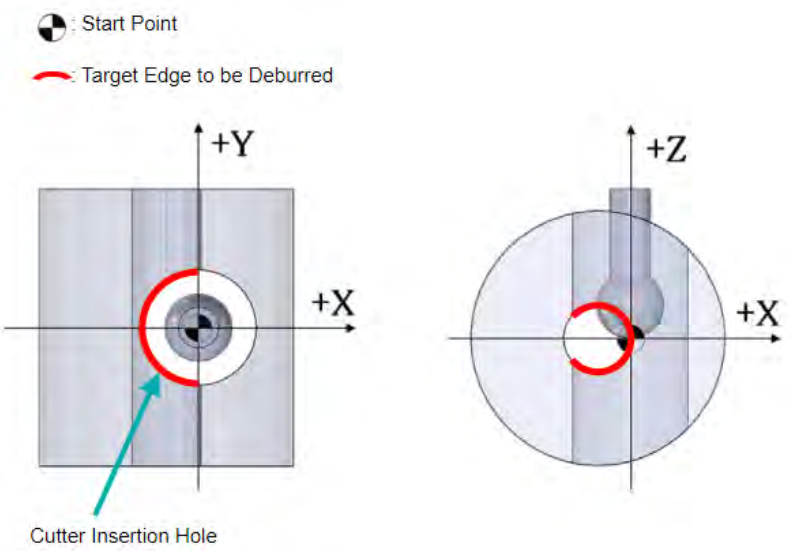
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D14.-2D9.-T5.8-AR0-E4.5)	INNER: Inner Edge 1D14: Cross Hole Diameter Φ14mm 2D9: Cutter Insertion Diameter Φ9mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° E4.5: Offset +4.5mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(UPPER EDGE)	Upper Edge [Lower Edge not applicable with Type L]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type M: Broken Hole - Inner Diameter (Cutter Insertion Hole ＞ Cross Hole)

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at the center of the Cross Hole.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

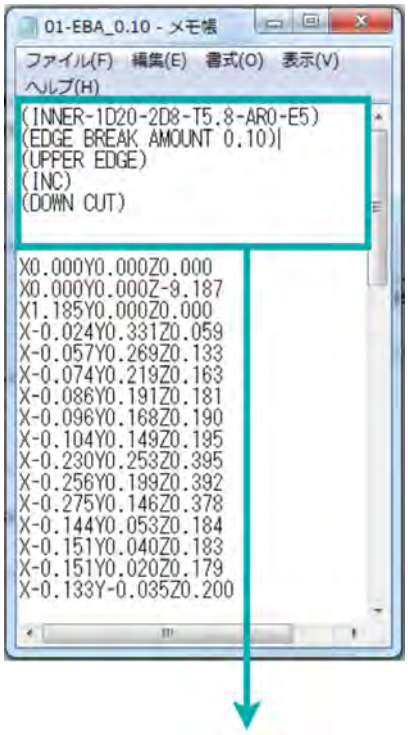
Example: Broken Hole - Inner Diameter



MEMO

Machining Parameters
To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).

XEBEC Deburring Tool Path Specifications



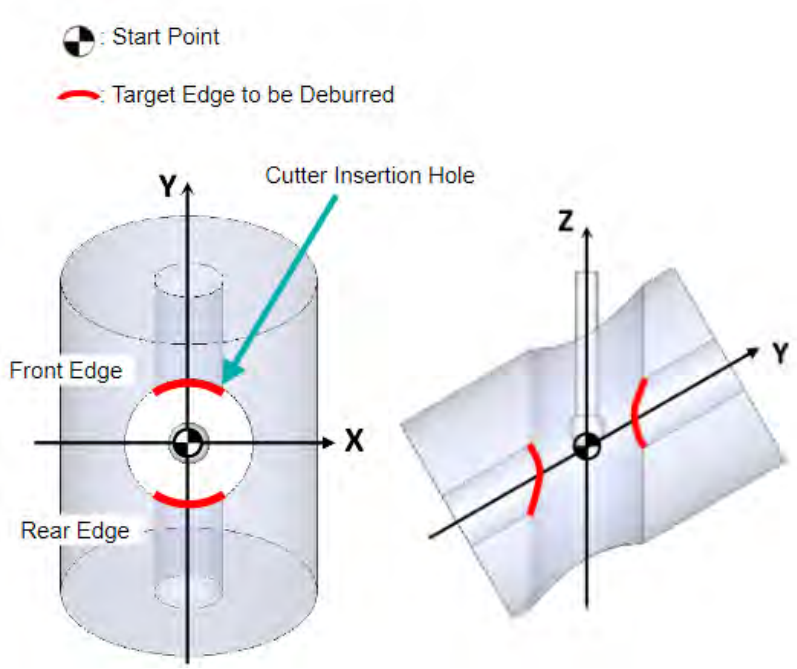
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D8.-2D9.-T5.8-AR0-E3.5)	INNER: Inner Edge 1D8: Cross Hole Diameter Φ8mm 2D9: Cutter Insertion Diameter Φ9mm T5.8: Cutter Diameter 5.8mm AR0: Cross Hole Orientation Angle 0° E3.5: Offset +3.5mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(UPPER EDGE)	Upper Edge [Lower Edge not applicable with Type M]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type N: Angled Cross Hole Inner Diameter (On-center) - (Cutter Insertion Hole > Cross Hole)

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at the intersection of the axes of Cutter Insertion Hole and the Cross Hole.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

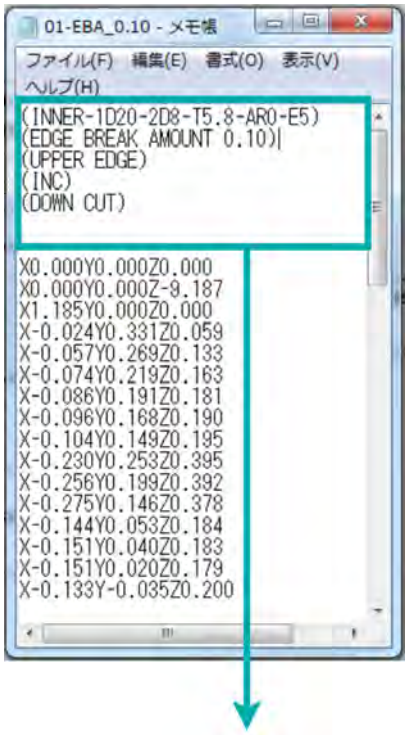
Example: Angled Cross Hole - Inner Diameter



MEMO

- **Machining Parameters**
  To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).
- **Front Edge, Rear Edge**
  Refer to the link below for definitions of Front Edge and Rear Edge.
  ▶Type K: Orthogonal Cross Hole Aligned with X-axis (ar=90°/-90°)

XEBEC Deburring Tool Path Specifications



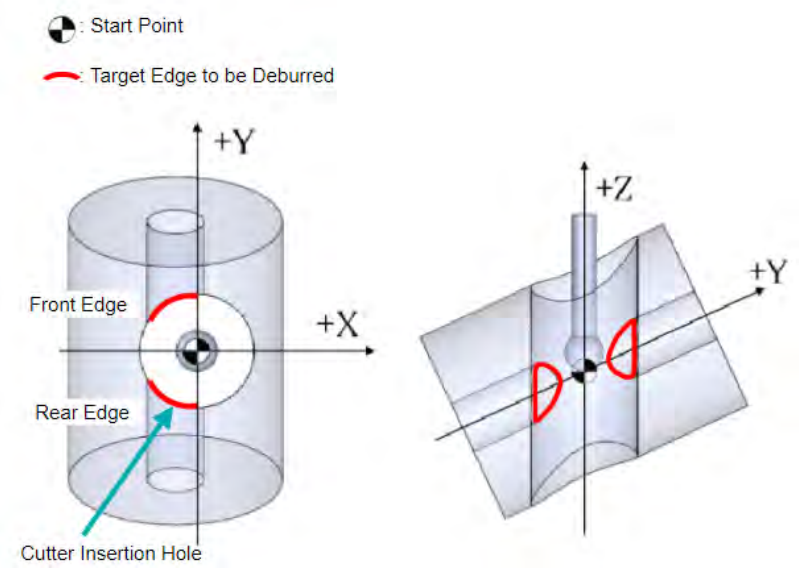
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D8-2D20-T5.8-AR0-E0-AA60.)	INNER: Inner Edge 1D20: Cross Hole 1D Diameter Φ8mm 2D10: Cutter Insertion Hole 2D Diameter Φ20mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° AA60: Inclination Angle +60° E0: Offset 0mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(FRONT EDGE)	Front Edge [REAR EDGE: Rear Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type N: Angled Cross Hole Inner Diamater (Off-center) - (Cutter Insertion Hole > Cross Hole)

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is it is at the intersection of the axes of Cutter Insertion Hole and the Cross Hole.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

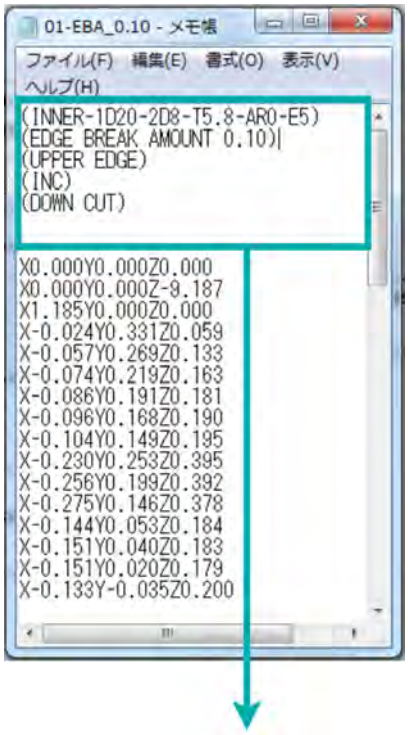
Example: Angled Cross Hole (Off-Center) - Inner Diameter



MEMO

- **Machining Parameters**
  To minimize the risk of secondary burrs, keep the tool projection length as short as possible. In case secondary burrs form, reduce the feed rate to 50% of the standard machining parameter and work with the smallest deburring amount (edge break length).
- **Front Edge, Rear Edge**
  Refer to the link below for definitions of Front Edge and Rear Edge.
  ▶Type K: Orthogonal Cross Hole Aligned with X-axis (ar＝90°/-90°)

XEBEC Deburring Tool Path Specifications



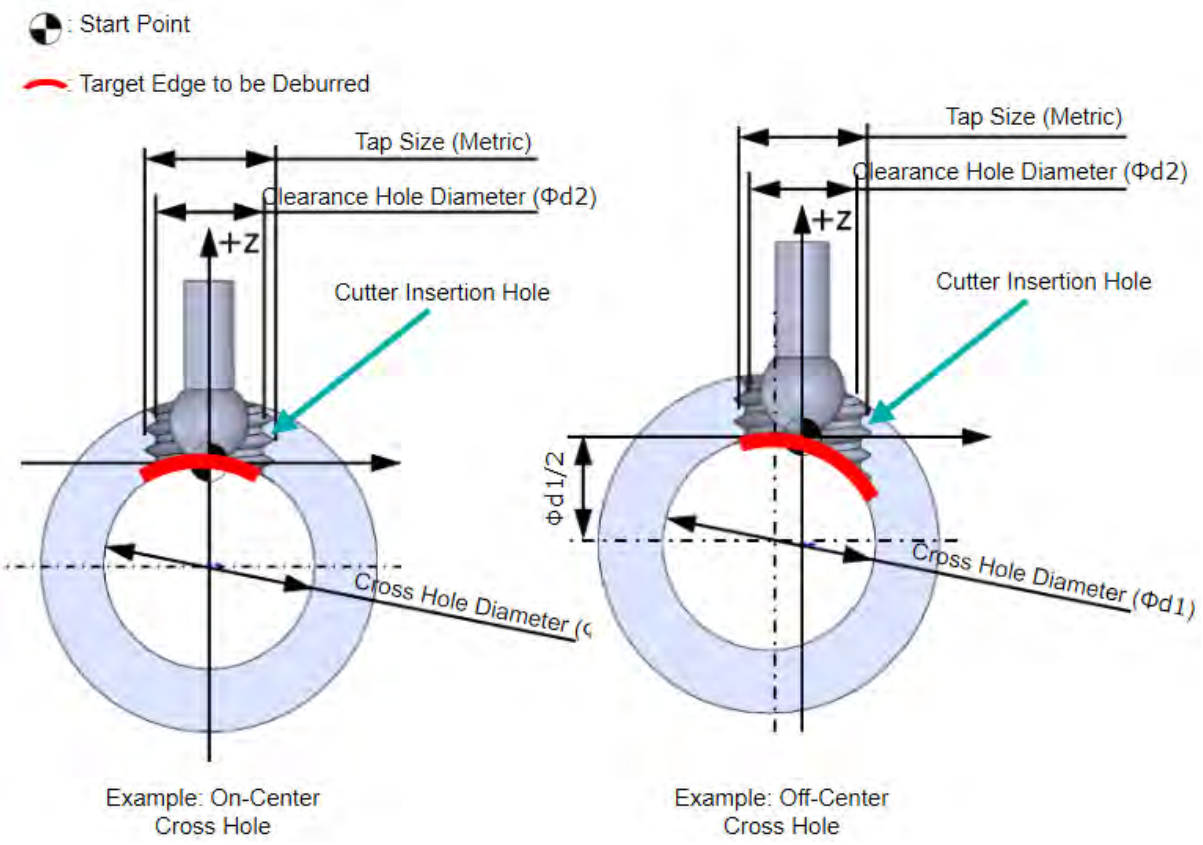
Specifications are indicated at the top of the text file in parentheses ( )

Specifications	Descriptions
(INNER-1D8-2D20-T5.8-AR0-E4.5-AA60.)	INNER: Inner Edge 1D20: Cross Hole 1D Diameter Φ8mm 2D10: Cutter Insertion Hole 2D Diameter Φ20mm T5.8: Cutter Diameter Φ5.8mm AR0: Cross Hole Orientation Angle 0° AA60: Inclination Angle +60° E4.5: Offset +4.5mm from the Cross Hole Axis
(EDGE BREAK AMOUNT 0.10)	Deburring Amount 0.10mm
(FRONT EDGE)	Front Edge [REAR EDGE: Rear Edge]
(INC)	Positioning Format: Incremental [ABS: Absolute]
(DOWN CUT)	Down Cut Machining [UP CUT: Up Cut Machining]

Type P: Tapped Orthogonal Cross Hole (Cutter Insertion Hole ≦ Cross Hole)

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at the highest position of the Cross Hole.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Tapped Orthogonal Cross Hole



Content of XEBEC Tapped Hole Tool Path (Pre & Fin)

Pre Path: to be used on the clearance hole prior to tapping

- Pre Path forms a large edge break at the exit of the clearance hole, to suppress formation of burrs during tapping
- It performs edge breaking in three passes rather than in a single pass to reduce cutting resistance.

Fin (Finish) Path: to be used after tapping to finish

- Fin Path forms edge break length of 0.02mm after tapping.
- It removes burrs that are generated during the tapping operation.

⚠CAUTION	**Do not use Fin Path if you are using a roll tap** There is a risk of tool collision if Fin Path is used on an inner thread created by a roll tap, due to the deformation of the inner diameter resulting from roll tapping.

Steps to Use XEBEC Tapped Hole Tool Path

1. Drill the clearance hole
2. Use Pre Path to break edge
3. Tapping
4. Use Fin Path to finish

Alternative Steps to Shorten the Cycle Time

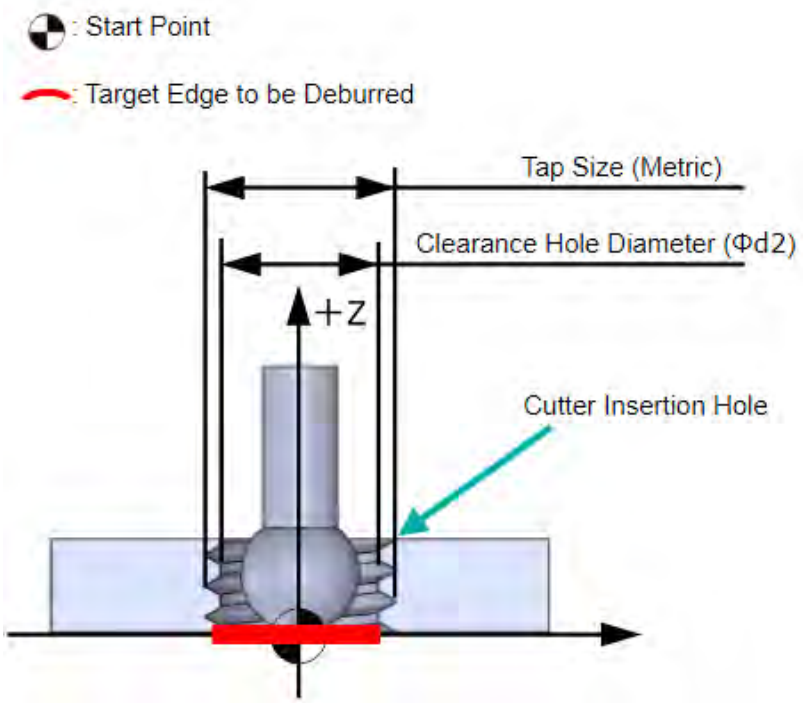
1. Drill the clearance hole
2. Use Fin Path to break edge
3. Tapping

When omitting Pre Path and using Fin Path only, the Cutter will need to remove a greater amount of material as it travels in the radial direction initially from the Start Point, prior to breaking the edge. For safety, reduce the initial feed rate in the radial direction. After that, continue at the recommended feed rate.

Type Q: Tapped Flat Surface Hole

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at the position of the lower edge.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Tapped Flat Surface Hole



Content of XEBEC Tapped Hole Tool Path (Pre & Fin)

Pre Path: to be used on the clearance hole prior to tapping

- Pre Path forms a large edge break at the exit of the clearance hole, to suppress formation of burrs during tapping
- It performs edge breaking in three passes rather than in a single pass to reduce cutting resistance.

Fin (Finish) Path: to be used after tapping to finish

- Fin Path forms edge break length of 0.02mm after tapping.
- It removes burrs that are generated during the tapping operation.

⚠CAUTION	**Do not use Fin Path if you are using a roll tap** There is a risk of tool collision if Fin Path is used on an inner thread created by a roll tap, due to the deformation of the inner diameter resulting from roll tapping.

Steps to Use XEBEC Tapped Hole Tool Path

1. Drill the clearance hole
2. Use Pre Path to break edge
3. Tapping
4. Use Fin Path to finish

Alternative Steps to Shorten the Cycle Time

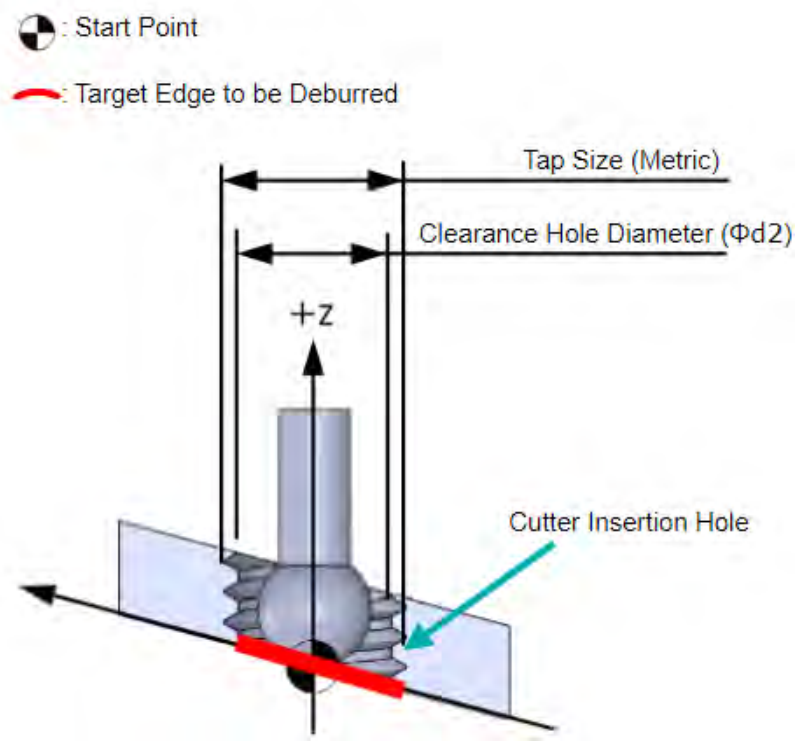
1. Drill the clearance hole
2. Use Fin Path to break edge
3. Tapping

When omitting Pre Path and using Fin Path only, the Cutter will need to remove a greater amount of material as it travels in the radial direction initially from the Start Point, prior to breaking the edge. For safety, reduce the initial feed rate in the radial direction. After that, continue at the recommended feed rate.

Type R: Tapped Angled Surface Hole

The Start Point is at the center of the Cutter Insertion Hole in the XY plane. Along the Z-axis, it is at the intersection of the Cutter Insertion Hole axis and the angled surface.
XEBEC Deburring Tool Path for absolute positioning (ABS) is generated with the Start Point position as the machine zero point (X0Y0Z0).

Example: Tapped Angled Surface Hole



Content of XEBEC Tapped Hole Tool Path (Pre & Fin)

Pre Path: to be used on the clearance hole prior to tapping

- Pre Path forms a large edge break at the exit of the clearance hole, to suppress formation of burrs during tapping
- It performs edge breaking in three passes rather than in a single pass to reduce cutting resistance.

Fin (Finish) Path: to be used after tapping to finish

- Fin Path forms edge break length of 0.02mm after tapping.
- It removes burrs that are generated during the tapping operation.

⚠CAUTION	**Do not use Fin Path if you are using a roll tap** There is a risk of tool collision if Fin Path is used on an inner thread created by a roll tap, due to the deformation of the inner diameter resulting from roll tapping.

Steps to Use XEBEC Tapped Hole Tool Path

1. Drill the clearance hole
2. Use Pre Path to break edge
3. Tapping
4. Use Fin Path to finish

Alternative Steps to Shorten the Cycle Time

1. Drill the clearance hole
2. Use Fin Path to break edge
3. Tapping

When omitting Pre Path and using Fin Path only, the Cutter will need to remove a greater amount of material as it travels in the radial direction initially from the Start Point, prior to breaking the edge. For safety, reduce the initial feed rate in the radial direction. After that, continue at the recommended feed rate.

XEBEC Back Burr Cutter＆ Deburring Tool Path™ For Machining Center Instruction Manual Ver1.03

March 2025

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