COLIBRI
SPINDLES

PRO Jet Spindle
SPEED and POWER JET

USER MANUAL

CONTENTS

FCC Compliance Statement

This BLE sensor (FCC ID: 2ACJNTJEH-030A) complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Testing confirmed compliance with the limits for a Class A digital device, as defined in FCC Part 15. These limits are designed to provide reasonable protection against harmful interference in a residential environment.
This device generates, uses, and can radiate radio-frequency energy; if not installed and used according to the instructions, it may cause harmful interference to radio or television reception. There is no guarantee that interference will not occur in a particular installation.
If interference does occur—testing by switching the device off and on can help confirm this—the user should consider one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the device and the receiver.
- Connect the device to an outlet on a circuit different from that supplying the receiver.
- Consult the dealer or an experienced radio/TV technician.

This device complies with FCC Rules Part 15:
Operation is subject to two conditions:
1. This device may not cause harmful interference.
2. This device must accept any interference that may be received or that may cause undesired operation.

⚠	**WARNING!** Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

1. General

1.1 Safety First

⚠	**Read the Manual** Safety of the operator is a main concern. This equipment is as safe as we are able to make it. Avoid accidents by reading the safety alerts, investing a few seconds of thought and a careful approach to handling equipment. You, the operator, can avoid many accidents by observing the following precautions. Review the safety instructions of the manufacturer, suppler, owner and all organizations responsible for the prevention of accidents.
⚠	**Ensure the Following:** The work area and the area around the CNC machine are free of obstacles. The work area is properly lit. This equipment is operated only by a responsible adult trained in this operation This equipment is not operated by a person under the influence of drugs or alcohol This equipment is not operated by a person with any illness or physical condition that might reduce reflexes or awareness and increase exposure to risk. Before starting any kind of work, install all of the safety devices prescribed by the builder of the machine or power tool.
⚠	**Warning: Rotating Tools, Entanglement Hazard** To avoid risks associated with the use of rotating tools it is strongly recommended to use the utmost caution and concentration when working.
⚠	**Warning: Rotating Tools, Cut or Severe Hazard** Always wear correctly sized gloves that allow the sensitivity necessary to operate the tool correctly and give adequate protection in the event of the blade being touched during use.
⚠	**Warning:** Always use safety glasses or protective screens to protect your eyes.
⚠	Only install tools in perfect condition that are recommended for the material to be worked and that are suitable for the type of machine used. Do not use cracked or deformed tools. Check that the balancing, keying and centering of rotary tools are carried out correctly. Secure the tool correctly using the proper tightening and adjustment devices. Remove all tightening and adjustment devices before use. Check that the tool rotates in the correct direction. Never exceed the limits of a piece of machinery. If its ability to do a job or to do so safely is in question - DON'T TRY IT.

1.2 Statement of Conformity

The POWER Jet and SPEED Jet Spindles meets the following standards:

European Standards (CE)
- EMC: EN 301489-1/17
- Radio: EN 300328 V 1.8.1
- Safety: EN 61010-1:2010

American Standards (UL)
- EMC: FCC Part 15 B
- Radio: FCC Part 15 C
- Safety: UL 61010-1

International Standards
- Safety: IEC 61010-1:2010

1.3 Introduction

The POWER and SPEED Jet models of the PRO Jet Spindle family, are robust High-Speed Sub-Spindles. It is driven by the CNC machine spindle's coolant-through-flow, at a minimum pressure of 15/20 bar (POWER Jet/ SPEED Jet).
A PRO Jet Spindle does not require any special installation, aside from mounting onto the machine spindle. It operates as any other standard toolholder in the tool magazine using ATC.

1.4 Case Contents

SPEED Jet Spindle box

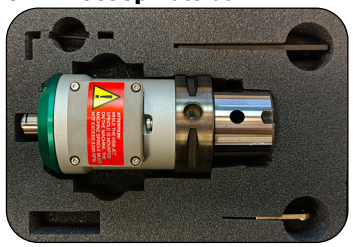


Fig. 1: SPEED Jet case contents

1. SPEED JET Spindle
2. Nut ER11 GHS
3. Wrench ER11 SMS
4. Shaft Lock Flat Key
5. Allen key - Hexagonal 2.0 mm

POWER Jet Spindle box

Fig. 2: POWER Jet case contents

1. POWER JET Spindle
2. Nut ER11 GHS
3. Wrench ER11 SMS
4. Shaft Lock Flat Key
5. Allen key - Hexagonal 2.0 mm

Note: CR2 Battery for Speed Sensor is not included!

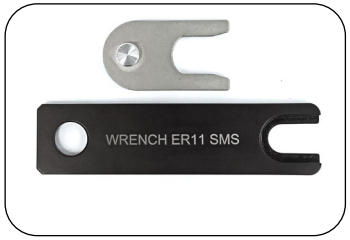


Fig. 3: Shaft lock flat key and wrench

Jet Spindle Monitor App

Download on the App Store

GET IT ON Google Play

1.5 Main Features

The PRO Jet Spindle system uses the machine's existing coolant or cutting fluid supply as a pressurized energy source, rotating a turbine in the range of 20K - 55K RPMs.
It offers an ideal solution for a wide range of semi-finishing and finishing applications such as milling, drilling, thread-milling, engraving, chamfering, deburring, fine radial grinding and more. The Jet Spindle is equipped with real-time wireless RPM transmitting and monitoring; to optimize cutting conditions.

1.5.1 Basic Operation Tables for Spindle Applications

Basic operation table - POWER Jet

JET SPINDLE OPERATING PARAMETERS					POWER JET	
HIGH PRESSURE COOLANT (BAR)	15 BAR	20 BAR	40 BAR	70 BAR	Terms of Use	
Min Coolant Supply Diameter [mm]	4.0				**Collet**	ER11 AA/UP
Min flow rate (L/min)	10	12	16	22	**Runout**	3 Microns
Rotational spindle speed [RPM]*	20,000	25,000	35,000	45,000	**Warranty**	1 Year
Max power (W) / torque (Nmm)	53 / 20	71 / 27	188 / 57	409 / 93		

*** Notes:**
- Rotational spindle speed is based on coolant pressure and flow rate.
- Coolant pressure is measured at the spindle inlet.

Max. Tool Diameter [mm]	Application	P	M	N [Al]	N [Cu]	S [Ti]
	Drilling	3.0		4.0	3.0	
	Slot Milling	6.0	4.0	6.0	4.0	
	Profile Milling	6.0				
	Shoulder Milling					
	Chamfering					
	Deburring					
	Engraving					

Basic operation table - SPEED Jet

JET SPINDLE OPERATING PARAMETERS				SPEED JET	
HIGH PRESSURE COOLANT (BAR)	20 BAR	30 BAR	40 BAR	Terms of Use	
Min Coolant Supply Diameter [mm]	4.0			**Collet**	ER11 AA/UP
Min flow rate (L/min)	10	15	20	**Runout**	3 Microns
Rotational spindle speed [RPM]*	33,000	44,000	55,000	**Warranty**	1 Year
Max power (W) / torque (Nmm)	37 / 12	76 / 18	115 / 25		

*** Notes:**
- Rotational spindle speed is based on coolant pressure and flow rate.
- Coolant pressure is measured at the spindle inlet.

Max. Tool Diameter [mm]	Application	P	M	N [Al]	N [Cu]	S [Ti]
	Drilling	2.0		3.0	2.0	
	Profile Milling	6.0	4.0	6.0	4.0	
	Slot Milling	4.0	3.0	4.0	3.0	
	Shoulder Milling	4.0	6.0			
	Chamfering	6.0				
	Deburring					
	Engraving					

1.5.2 Integrated Coolant Nozzle System

Integrated coolant nozzle system provides direct jet coolant application for fast, powerful cooling and effective chip evacuation.

Fig. 4: Integrated coolant nozzle system

1.5.3 Wireless RPM Mobile App

Fig. 5: Jet Spindle wireless transmitter and Jet Spindle Monitor App

Both, the POWER Jet and SPEED Jet Spindle are equipped with an integrated BLE ("Bluetooth Low Energy") sensor which can automatically connect to the iOS & Android 'Jet Spindle Monitoring" App, allowing real-time monitoring of the rotation speed during machining. The spindle housing is fitted with a wireless transmitter that sends RPM data to the mobile device via BLE technology. The Jet spindle sensor transmitter is powered by a non-rechargeable CR2 lithium battery.

1.5.4 BLE Sensor Transmitter Information

- BLE frequency transmission
- Range up to 10 m
- Internal battery-powered
- Individual ID number for each transmitter unit
- Direct live wireless rotational speed monitoring via Jet Spindle Monitor App

Fig. 6: Jet Spindle with BLE Speed Sensor

1.5.5 Mounting System to CNC Machine Spindle

Both PRO Jet Spindles are available with several mounting adaptation options:

- ER32 collet chuck with a special tightening nut, suitable for all standard toolholders with an ER32 adaptation.
- Integral options for various other adaptations are available upon request.

Fig. 7: SPEED Jet Spindle with mounting adaptation options (for Illustration purposes only)

1.5.6 Tool Clamping

Both PRO Jet Spindles are compatible with ER11 collet chuck. It is recommended to use high-precision ER 11 spring collets.
When longer overhang is required, 10 and 25mm length ER11 thermal shrink collets are available.

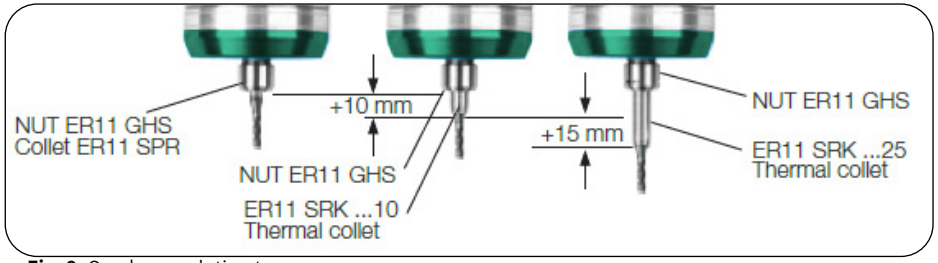


Fig. 8: Overhang solution types

1.5.7 Shaft Lock for Tool Clamping

The shaft lock mechanism provides a simple, easy way to change the cutting tool on the PRO Jet Spindle. For complete tool mounting instructions, see chapter 2.3.5 (page 21).

Fig. 9: PRO Jet Spindle shaft lock mechanism

2. Installation

2.1 Battery Installation Wireless RPM Transmitter

Install battery into the RPM transmitter:

1. Unscrew the 4 battery case cover screws using a hexagonal 2 mm Allen key.
2. Remove the case cover.
3. Make sure the O-ring inside the cover is seated well, and is intact.
4. Insert the CR2 - 3V lithium battery in the correct direction.
5. Replace the battery case cover.
6. Replace the 4 screws to secure the battery case cover.
7. The transmitter is ready for operation.

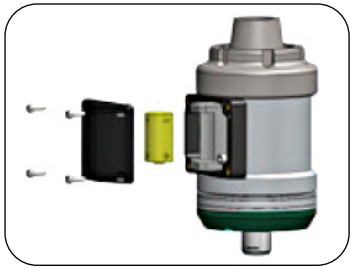


Fig. 10: Battery case opening

2.2 Jet Spindle Monitor App

Every PRO Jet Spindle is equipped with a BLE Speed Sensor. This allows for real-time monitoring of the RPM during machining with a Mobile App, available both for iOS and Android.

2.2.1 Prerequisite for App Installation

Make sure that the following prerequisites are met:

1. iOS or Andriod device
2. Distance from PRO Jet Spindle to mobile device: no more than 10 m.
3. Create space for the mobile device to provide close-up and unobstructed viewing.

2.2.2 Mobile Device Installation and Workspace

1. Download Jet Spindle Monitor
2. Use Jet Spindle Monitor App across all your Jet Spindle devices, FREE of charge.
3. By installing Jet Spindle Monitor, you agree to our Terms & Privacy Policy.
4. Connect Jet Spindle Monitor on Apple or Android devices.

2.2.3 Download Jet Spindle Monitor App

Use Jet Spindle Monitor across all your Jet Spindle devices, FREE of charge.

By installing Jet Spindle Monitor, you agree to our Terms & Privacy Policy.

Connect Jet Spindle Monitor on Apple or Andriod devices

iPhone & iPad

IOS

Requires iPhone 10 or newer. Click on the button below or search “Jet Spindle Monitor” on your device or just scan the QR code.

Download on the App Store

Andriod Phone & Device

Google

Requires Andriod 10 or newer. Click on the button below or search “Jet Spindle Monitor” on your device or just scan the QR code.

GET IT ON Google Play

2.2.4 Connect Jet Spindle to Jet Spindle Monitor App

The Jet Spindle Monitoring App and the PRO Jet Spindle must be connected (paired) immediately after inserting transmitter battery.
How to connect the PRO Jet Spindle to the App on mobile device:

1. Make sure the battery is installed in the BLE Speed Sensor in the Spindle.
2. Make sure your mobile device is ON.
3. The Jet Spindle will appear automatically in the list of connected devices in the App.
4. You have to set the Idle Speed of the Spindle each time you are starting the Spindle again - using the SET button.

Fig. 11: Multiple Spindle connection

2.2.5 App Display Screens

Home Screen

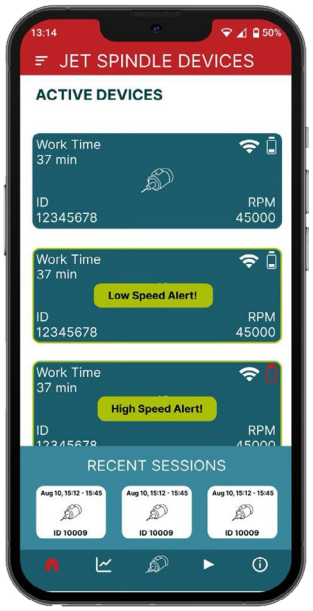


Fig. 12: App - Home Screen

The Jet Spindle Monitor home screen features:

- Tiles for each active device, including:
  - » Device ID
  - » Current work time
  - » RPM of device
  - » Unit bluetooth signal strength
  - » Unit sensor battery level
- Tiles for most recent active devices
- In the footer there are links to:
  - » Real Time RPM graphs for selected active unit
  - » Device List
  - » Video Tutorials
  - » Operating Guide

Real Time RPM

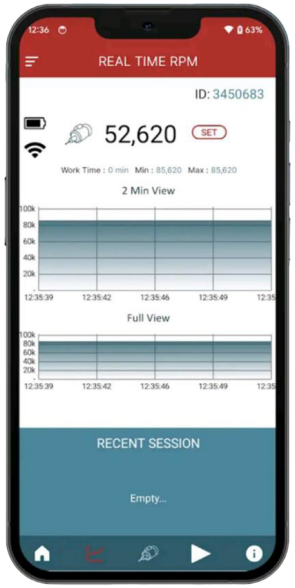


Fig. 13: App - RPM Screen

Detailed screen of selected device:

- Battery (full – empty) indicator icon:

Battery will show as full up to 60% and from 60% until 0% will go down by 10% each time and at 10% full battery icon will blind and be red in color.

- BLE (Bluetooth) signal indicator:

Indicating the strength of signal connection to the selected device.

- Use SET button to automatically manage 10% RULE.
- You have to press the SET button after restarting the Spindle again.
- First table:

2 Min View Graphic presentation of speed in kRPM of last 2 minutes of activity

- Second table:

Full View Graphic presentation of the kRPM of entire current session

Device List

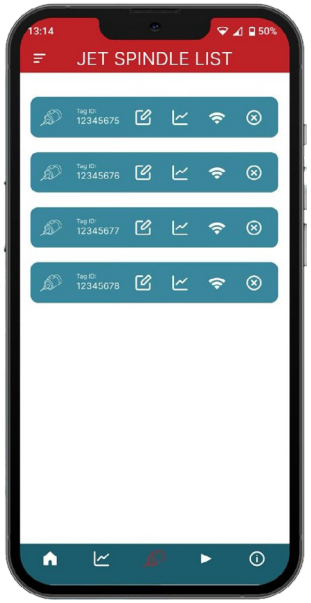


Fig. 14: App - Device List

List of all devices, includes:

- Link to edit devices details
- Link to the device last or current Real Time RPM
- Bluetooth signal strength
- X to delete device from application, until device is active again and will be automatically added to the application.

Edit Device

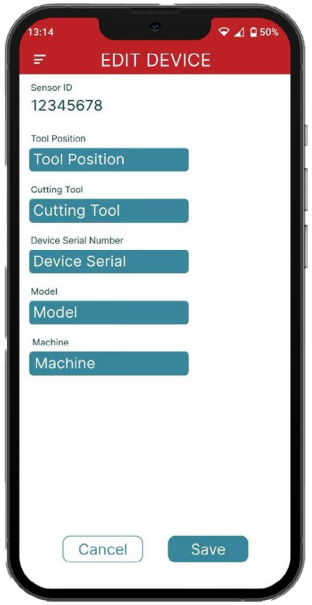


Fig. 15: App - Edit Device

Edit Device screen:

Accessable from the Device List, you can update the following device details:

- Tool position
- Cutting Tool
- Device Serial Number
- Device model
- Machine name

Video Tutorials

Fig. 16: App - Tutorials

Instruction and training videos:

- Link to instruction videos on YouTube to learn how to use the jet spindle and the jet spindle monitoring app.

Operating Guide

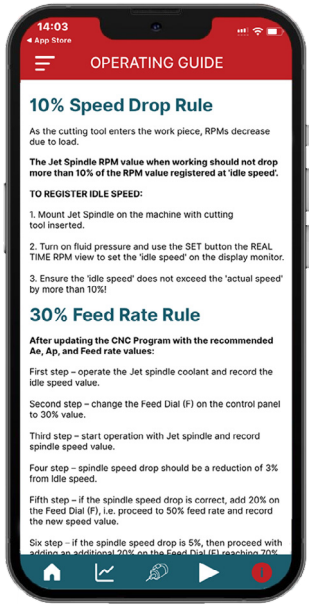


Fig. 17: App - Operating Guide

2 Important rules, you must follow:

- 10% Rule

Set the spindle speed (RPMs) to not less than 10% less than the idle speed, for maximum productivity and product life.

- 30% Rule

Follow the steps of the 30% Rule when setting up the machining on a new process.

2.3 Using PRO Jet Spindle

2.3.1 Prerequisites for CNC Machine

1. Coolant flow through the main CNC machine spindle.
2. Min. coolant pressure, at main spindle outlet: 15 bar (POWER Jet)/ 20 bar (SPEED Jet).
3. Max. coolant pressure, at main spindle outlet: 70 bar (POWER Jet)/ 40 bar (SPEED Jet).
4. Minimum flow rate: 10 L/min.
5. Filter element: Max. 100 µm.
6. Active mist collector.
7. With emulsion coolant, use an anti-foaming agent additive suitable for emulsion.
8. With oil based coolant, high pressure increases the amount of oil fumes:
   a. Use appropriate means of fire protection and fire extinguishing.
   b. Use anti-dissolution additive suitable for the oil.
9. Max. viscosity 15 mm^2/s.

2.3.2 PRO Jet Spindle Installation to CNC Machine

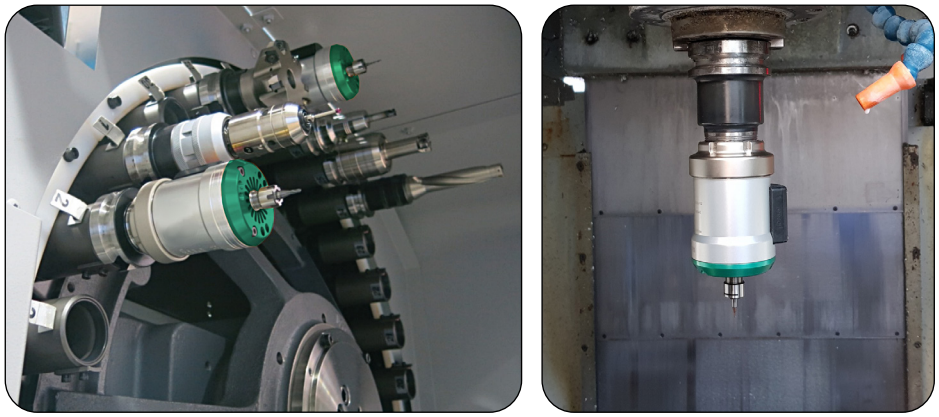


Fig. 18: PRO Jet Spindle on CNC machine

When the PRO Jet Spindle is mounted on the machine, the CNC machine spindle should be stationary, except for tool check procedure or Z-offset measurement. In these cases, tool rotation must not exceed 3,000 RPMs to avoid risk of breakage/injury.

To avoid CNC machine spindle rotation during a PRO Jet Spindle operation, use the correct software M-code to lock the spindle orientation.

For example: “M19” code locks the spindle in a defined angle position.

2.3.3 Placement of PRO Jet Spindle in ER32 Toolholder

Caution: Deviation from these steps may lead to locking of the tightening nut to the PRO Jet Spindle.
The PRO Jet Spindle only operates with a toolholder that has a coolant through channel.
To secure the PRO Jet Spindle in a toolholder: See steps in Figure 19.

Fig. 19: Placement of SPEED Jet Spindle in toolholder (same procedure for POWER Jet)

1. Use a standard toolholder with ER32 collet chuck.
2. Loosen the SPEED/POWER Jet Spindle tightening nut 1.5 turns.
3. Insert built-in ER32 taper shank into ER32 collet chuck until the PRO Jet Spindle tightening nut will be placed on the toolholder.
4. Fasten the PRO Jet Spindle tightening nut onto the toolholder, without turning the Jet Spindle relative to the nut.
5. Fasten the PRO Jet Spindle tightening nut, to clamp the PRO Jet Spindle and the toolholder together with an ER 32 spanner. **Use hand force only.**

⚠	**WARNING!** Using an automatic machine for locking, may cause damage to the Jet Spindle.

Fig. 20: Example of toolholder with a coolant-through hole

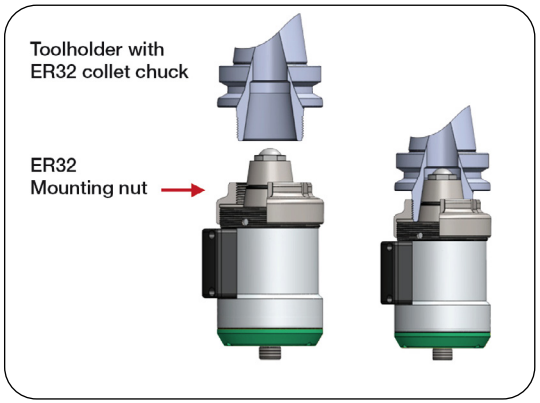


Fig. 21. SPEED Jet Spindle holding ER32 collet chuck

2.3.4 Tool Prerequisites

PRO Jet Spindles should be used in applications with tool shank diameters up to 7 mm!

Recommended max. tool diameter - POWER Jet

Max. Tool Diameter [mm]	Application	P	M	N [Al]	N [Cu]	S [Ti]
	Drilling	3.0		4.0	3.0	
	Slot Milling	6.0	4.0	6.0	4.0	
	Profile Milling	6.0				
	Shoulder Milling					
	Chamfering					
	Deburring					
	Engraving					

Recommended max. tool diameter - SPEED Jet

Max. Tool Diameter [mm]	Application	P	M	N [Al]	N [Cu]	S [Ti]
	Drilling	2.0		3.0	2.0	
	Profile Milling	6.0	4.0	6.0	4.0	
	Slot Milling	4.0	3.0	4.0	3.0	
	Shoulder Milling	4.0	6.0			
	Chamfering	6.0				
	Deburring					
	Engraving					

2.3.5 Tool Installation for the PRO Jet Spindle

Note: Example made here with SPEED JET, but same principle applies for POWER JET!

Assemble the ER 11 AA/UP collet, the cutting tool and ER 11 nut:
Firstly, ensure Jet Spindle cone and collet are thoroughly cleaned.

1. Insert ER11 AA/UP collet and cutting tool into clean Jet Spindle cone. Screw on ER11 nut and tighten by hand.
2. Align shaft lock with the positioning slot on the spindle cover. Raised button fits into the positioning slot.
3. Slide shaft lock flat key to secure it in place.
4. Insert ER11 wrench into the grooves on the ER11 nut. Turn ER11 wrench **clockwise** to tighten (9 Nm)

Fig. 22: Tighten ER 11 nut by hand

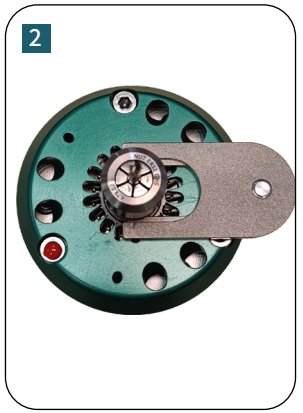


Fig. 23: Position shaft lock key

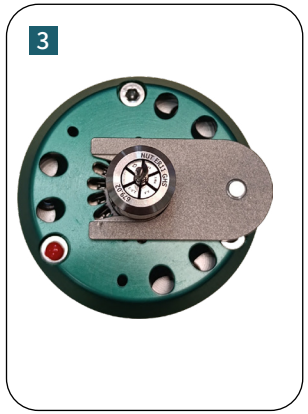


Fig. 24: Slide shaft lock key into place

Fig. 25: Insert wrench into slots on nut – turn **clockwise**

To Remove a Tool:
- Slide the shaft lock flat key into place.
- Insert the wrench and turn **counterclockwise** to loosen the nut (this may take a few turns).
- Keep the shaft lock in the secure position if you wish to insert a new tool.

2.3.6 Tool Clamping and Runout Check (Recommendations)

The POWER Jet and SPEED Jet Spindles are designed to perform high speed operations with small diameter cutting tools for very accurate machining.

It is very important to properly perform the instructions related to cutting tool setup, correct clamping procedure and tool runout.

Standard clamping tools, such as ER11 spring collets and standard clamping accessories are used on a PRO Jet Spindle.

To get a minimum runout value use ER11 SPR...AA or AAA spring collects with exact hole size.

According to ISO 15488, the collet runout tolerances should be checked as shown in the image.

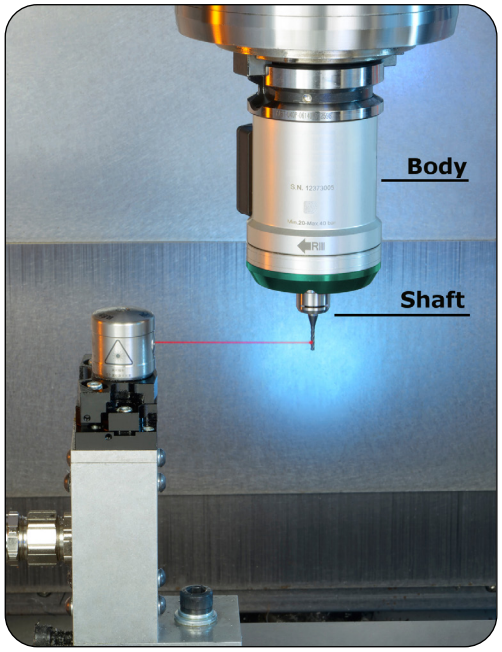


Fig. 26: Optical runout testing

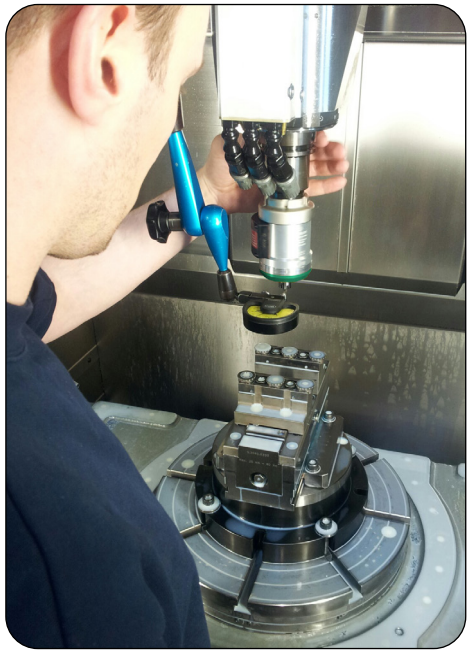


Fig. 27: Manual runout testing

- PRO Jet Spindle body must remain static.
- Runout Is measured by rotating the shaft manually, or running an air supply through the machine spindle.

2.3.7 Cartridge Replacement for PRO Jet Spindle

To replace the cartridge there are two steps, first remove the existing cartridge and then install the new cartridge:

REMOVE CARTRIDGE

1. Remove the sensor cover and sensor base (image 2, 3)
2. Remove the bolts that hold the cartridge in place and remove the cartridge (image 6, 7)

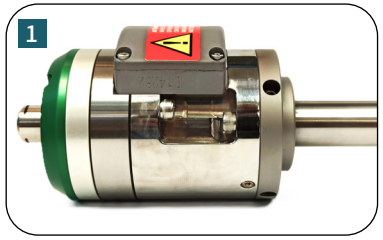


Fig. 28: Place on a Workbench

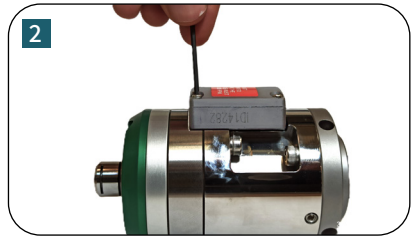


Fig. 29: Remove sensor cover

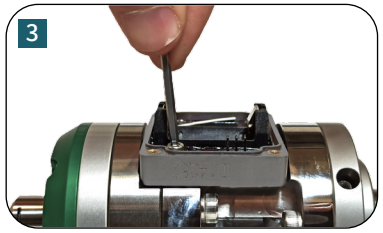


Fig. 30: Remove sensor base

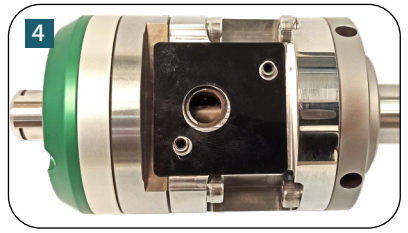


Fig. 31: Sensor removed

Fig. 32: Remove cartridge screws

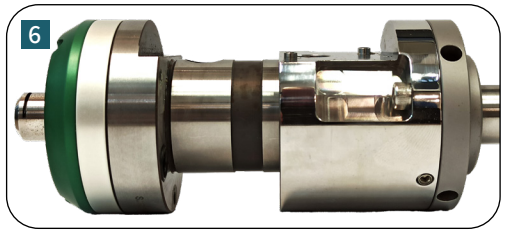


Fig. 33: Remove cartridge

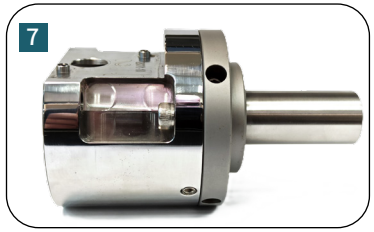


Fig. 34: Cartridge removed

INSTALL CARTRIDGE

1. Insert the cartridge
2. Align the cartridge, while secruing the bolts
3. Assemble the sensor base and sensor cover

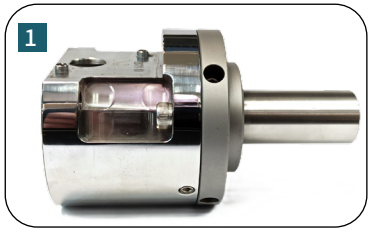


Fig. 35: Place Cartridge on Workbench

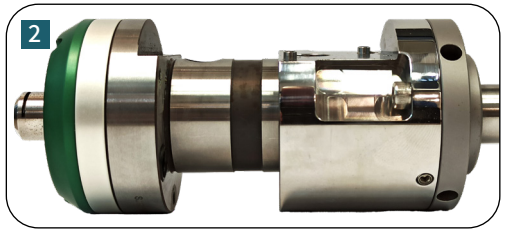


Fig. 36: Insert cartridge

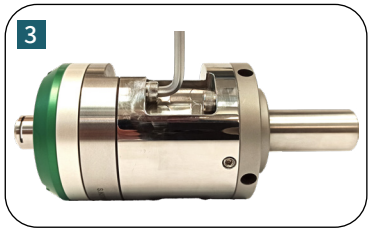


Fig. 37: Screw in cartridge

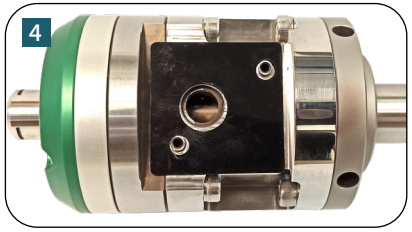


Fig. 38: Place gasket in place

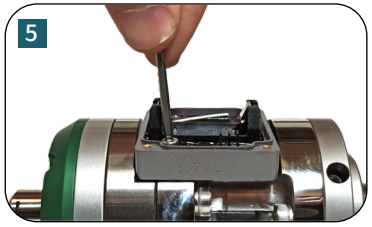


Fig. 39: Screw in sensor base

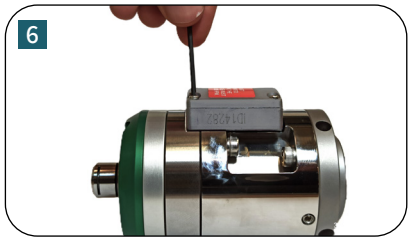


Fig. 40: Screw in sensor cover

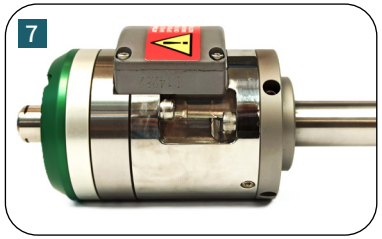


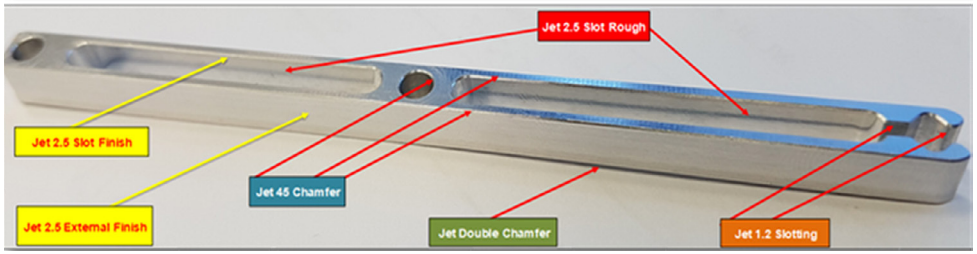
Fig. 41: Cartridge replaced

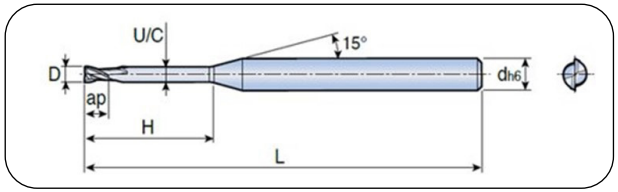
2.3.8 Milling & Drilling with Jet Spindles

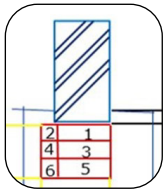
Slot Milling Formula

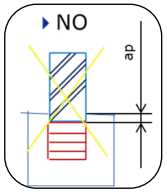
Use a High Speed Slot/Shoulder Milling Strategy as follows:
First step – slot mill with an Ae of 60% of the final slot diameter and an Ap of 30% of end-mill diameter
Second Step – shoulder mill with an Ae of the remaining 40% of final slot diameter and a equivalent Ap of 30% of the end-mill diameter.
Repeat first and second step until you complete the slot.

F(z) according to the "Jet Spindles Cutting Conditions Table", classified by: Tool diameter, Material, Speed



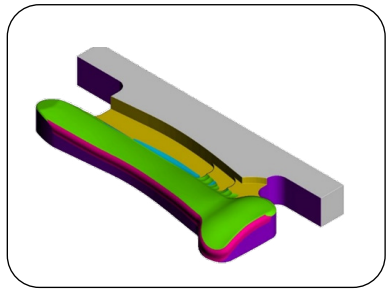


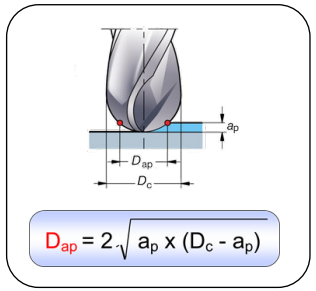




Profile Milling Formula

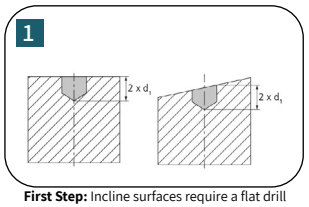
Ball nose geometry and Ap values determined the effective Dap – see equation
Finishing steps cutting conditions are usually correlated:
Ap or Dap = Ae
To achieve better Surface-finish, Ae should be minimum, and Feed will be according to the F(z) "Jet Spindles Cutting Conditions Table" recommendations – Material, Speed, Diameter



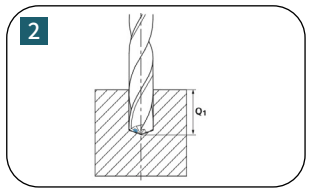


Drilling Formula

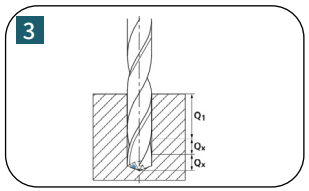
High Speed drill non-ferrous materials with a highly polished spiral tool.
First step – on inclined surfaces preparation with a flat drill or end-mill is mandatory.
Second step – drill until Q1=D according to the F(z) from the "Jet Spindles Operating Data" tables, classified by: Tool diameter, Material, Speed.
Third step - peck drill with Qx = Ap values from the Cutting conditions table. After each peck drill extract to position Q1 for chip evacuation.



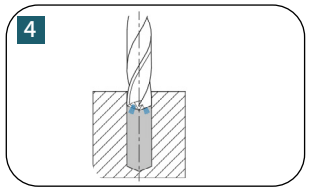
First Step: Incline surfaces require a flat drill



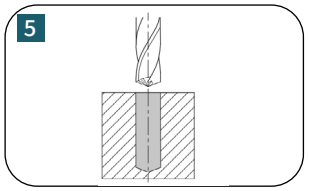
Second Step: Drill until Depth of Q1



Third Step: Pecking steps according to Qx value - extract each time to Q1 to evacuate the chips



Fourth Step: Extract to position 1 x D (Q1) at 500 mm/min or rapid feed. Never extract drill tip from hole



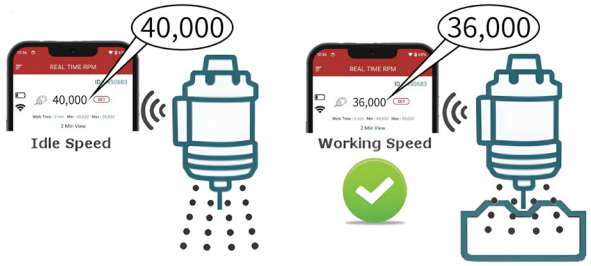
Fith Step: Extract the tip from the hole with vf = 500 mm/min

10% Speed Drop Rule

As the cutting tool enters the work piece, RPMs decrease due to load.
The Jet Spindle RPM value when working should not drop more than 10% of the RPM value registered at 'idle speed'.

TO REGISTER IDLE SPEED

1. Mount Jet Spindle on the machine with cutting tool inserted.
2. Turn on fluid pressure and press SET button in the Jet Spindle App, on Active Device Screen



In the EXAMPLE, following the 10% rule: If idle speed is 40,000 RPM then during machining the jet spindle speed should decrease to a minimum of 36,000 RPM. If however, spindle speed decreases to less than 36,000 RPM, then both depth of cut (Ap) and feed (Fz) need to be reduced. Refer to Operating Data tables below.

2.3.9 Recommended Cutting Conditions

- Monitoring RPMs during Jet Spindle operation is critical, to ensure optimum machining conditions and to avoid damage.
- Cutting speed may be influenced by material hardness, work piece topography and/or cutting tool geometry. Refer to cutting tool manufacturer's documentation.
- Dramatic fluctuations of RPMS during Jet Spindle operation can indicate problems such as inadequate coolant pressure or a broken cutting tool.

2.3.9.1 Jet Spindle Operating Guidelines - POWER JET Tables

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
P	SAE 1.2316 (35 HRC)	Drilling (Drill)	0.3	15	22,000	Pecking steps: 0,25-0,5xD Max length of the hole: 3-4xD		0.002
			0.3	20	25,000			0.002
			0.3	40	35,000			0.002
			0.3	70	45,000			0.002
			0.5	15	22,000			0.004
			0.5	20	25,000			0.004
			0.5	40	35,000			0.004
			0.5	70	45,000			0.004
			0.8	15	22,000			0.006
			0.8	20	25,000			0.006
			0.8	40	35,000			0.006
			0.8	70	45,000			0.006
			1.0	15	22,000			0.006
			1.0	20	25,000			0.006
			1.0	40	35,000			0.006
			1.5	15	22,000			0.006
			1.5	20	25,000			0.006
			1.5	40	35,000			0.006
			2.0	15	22,000			0.008
			2.0	20	25,000			0.008
			2.0	40	35,000			0.008
			2.5	15	22,000			0.008
			2.5	20	25,000			0.008
			3.0	15	22,000			0.008

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
P	SAE 1.2316 (35 HRC)	Profile Milling (Ball-Nose)	0.3	15	22,000	0.005	0.005	0.005
			0.3	20	25,000	0.005	0.005	0.005
			0.3	40	35,000	0.005	0.005	0.005
			0.3	70	45,000	0.005	0.005	0.005
			0.5	15	22,000	0.012	0.010	0.007
			0.5	20	25,000	0.012	0.010	0.007
			0.5	40	35,000	0.012	0.010	0.007
			0.5	70	45,000	0.012	0.010	0.007
			1.0	15	22,000	0.030	0.066	0.012
			1.0	20	25,000	0.030	0.066	0.012
			1.0	40	35,000	0.030	0.066	0.012
			1.0	70	45,000	0.030	0.066	0.012
			1.5	15	22,000	0.046	0.110	0.012
			1.5	20	25,000	0.046	0.110	0.012
			1.5	40	35,000	0.046	0.110	0.012
			1.5	70	45,000	0.046	0.110	0.012
			2.0	15	22,000	0.063	0.153	0.012
			2.0	20	25,000	0.063	0.153	0.012
			2.0	40	35,000	0.063	0.153	0.012
			2.0	70	45,000	0.063	0.153	0.012
			2.5	15	22,000	0.080	0.200	0.012
			2.5	20	25,000	0.080	0.200	0.012
			2.5	40	35,000	0.080	0.200	0.012
			2.5	70	45,000	0.080	0.200	0.012
			3.0	15	22,000	0.100	0.240	0.006
			3.0	20	25,000	0.100	0.240	0.006
			4.0	15	22,000	0.131	0.327	0.006
			4.0	20	25,000	0.131	0.327	0.006
			5.0	15	22,000	0.165	0.414	0.006
			5.0	20	25,000	0.165	0.414	0.006
			6.0	15	22,000	0.200	0.500	0.006
			6.0	20	25,000	0.200	0.500	0.006

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
P	SAE 1.2316 (35 HRC)	Slot Milling (End-Mill)	0.3	15	22,000	0.300	0.005	0.003
			0.3	20	25,000	0.300	0.005	0.003
			0.3	40	35,000	0.300	0.005	0.003
			0.3	70	45,000	0.300	0.005	0.003
			0.5	15	22,000	0.500	0.010	0.005
			0.5	20	25,000	0.500	0.010	0.005
			0.5	40	35,000	0.500	0.010	0.005
			0.5	70	45,000	0.500	0.010	0.005
			0.8	15	22,000	0.800	0.017	0.008
			0.8	20	25,000	0.800	0.017	0.008
			0.8	40	35,000	0.800	0.017	0.008
			0.8	70	45,000	0.800	0.017	0.008
			1.0	15	22,000	1.000	0.022	0.010
			1.0	20	25,000	1.000	0.022	0.010
			1.0	40	35,000	1.000	0.022	0.010
			1.0	70	45,000	1.000	0.022	0.010
			1.5	15	22,000	1.500	0.035	0.015
			1.5	20	25,000	1.500	0.035	0.015
			1.5	40	35,000	1.500	0.035	0.015
			2.0	15	22,000	2.000	0.047	0.020
			2.0	20	25,000	2.000	0.047	0.020
			2.5	15	22,000	2.500	0.060	0.024
			2.5	20	25,000	2.500	0.060	0.024
			3.0	15	22,000	3.000	0.072	0.025
			3.0	20	25,000	3.000	0.072	0.025
			4.0	15	22,000	4.000	0.100	0.025
			4.0	20	25,000	4.000	0.100	0.025
			4.5	15	22,000	4.500	0.110	0.026
			4.5	20	25,000	4.500	0.110	0.026
			5.0	15	22,000	5.000	0.122	0.025
			5.0	20	25,000	5.000	0.122	0.025
			6.0	15	22,000	6.000	0.147	0.025
			6.0	20	25,000	6.000	0.147	0.025
		Shoulder Milling (End-Mill)	0.5	15	22,000	0.050	0.500	0.005
			0.5	20	25,000	0.050	0.500	0.005
			0.5	40	35,000	0.050	0.500	0.005
			0.5	70	45,000	0.050	0.500	0.005
			1.0	15	22,000	0.100	1.000	0.008
			1.0	20	25,000	0.100	1.000	0.008
			1.0	40	35,000	0.100	1.000	0.008
			2.0	15	22,000	0.200	2.000	0.100
			2.0	20	25,000	0.200	2.000	0.100
			3.0	15	22,000	0.300	3.000	0.010
			3.0	20	25,000	0.300	3.000	0.010
			4.0	15	22,000	0.400	4.000	0.010
			4.0	20	25,000	0.400	4.000	0.010
			5.0	15	22,000	0.500	5.000	0.012
			5.0	20	25,000	0.500	5.000	0.012
			6.0	15	22,000	0.500	6.000	0.012

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
M	SS 316 (180-250 HB)	Drilling (Drill)	0.5	15	22,000	Pecking steps: 0,25-0,5xD Max length of the hole: 3-4xD		0.004
			0.5	20	25,000			0.004
			0.5	40	35,000			0.004
			0.8	15	22,000			0.006
			0.8	20	25,000			0.006
			1.0	15	22,000			0.006
			1.0	20	25,000			0.006
			1.5	15	22,000			0.006
			1.5	20	25,000			0.006
			2.0	15	22,000			0.008
			2.0	20	25,000			0.008
			2.5	15	22,000			0.008
			3.0	15	22,000			0.008
		Profile Milling (Ball-Nose)	0.5	15	22,000	0.012	0.010	0.007
			0.5	20	25,000	0.012	0.010	0.007
			0.5	40	35,000	0.012	0.010	0.007
			0.5	70	45,000	0.012	0.010	0.007
			1.0	15	22,000	0.030	0.066	0.012
			1.0	20	25,000	0.030	0.066	0.012
			1.0	40	35,000	0.030	0.066	0.012
			1.5	15	22,000	0.046	0.110	0.012
			1.5	20	25,000	0.046	0.110	0.012
			1.5	40	35,000	0.046	0.110	0.012
			2.0	15	22,000	0.063	0.153	0.012
			2.0	20	25,000	0.063	0.153	0.012
			2.0	40	35,000	0.063	0.153	0.012
			2.5	15	22,000	0.080	0.200	0.012
			2.5	20	25,000	0.080	0.200	0.012
			2.5	40	35,000	0.080	0.200	0.012
			3.0	15	22,000	0.100	0.240	0.006
			3.0	20	25,000	0.100	0.240	0.006
			4.0	15	22,000	0.131	0.327	0.006
			4.0	20	25,000	0.131	0.327	0.006
			5.0	15	22,000	0.165	0.414	0.006
			5.0	20	25,000	0.165	0.414	0.006
			6.0	15	22,000	0.200	0.500	0.006
			6.0	20	25,000	0.200	0.500	0.006

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
M	SS 316 (180-250 HB)	Slot Milling (End-Mill)	0.5	15	22,000	0.500	0.010	0.005
			0.5	20	25,000	0.500	0.010	0.005
			0.5	40	35,000	0.500	0.010	0.005
			0.5	70	45,000	0.500	0.010	0.005
			0.8	15	22,000	0.800	0.017	0.008
			0.8	20	25,000	0.800	0.017	0.008
			0.8	40	35,000	0.800	0.017	0.008
			0.8	70	45,000	0.800	0.017	0.008
			1.0	15	22,000	1.000	0.022	0.010
			1.0	20	25,000	1.000	0.022	0.010
			1.0	40	35,000	1.000	0.022	0.010
			1.0	70	45,000	1.000	0.022	0.010
			1.5	15	22,000	1.500	0.035	0.015
			1.5	20	25,000	1.500	0.035	0.015
			1.5	40	35,000	1.500	0.035	0.015
			2.0	15	22,000	2.000	0.047	0.020
			2.0	20	25,000	2.000	0.047	0.020
			2.0	40	35,000	2.000	0.047	0.020
			2.5	15	22,000	2.500	0.060	0.024
			2.5	20	25,000	2.500	0.060	0.024
			2.5	40	35,000	2.500	0.060	0.024
			3.0	15	22,000	3.000	0.072	0.025
			3.0	20	25,000	3.000	0.072	0.025
			4.0	15	22,000	4.000	0.100	0.025
			4.0	20	25,000	4.000	0.100	0.025
		Shoulder Milling (End-Mill)	1.0	15	22,000	0.100	1.000	0.008
			1.0	20	25,000	0.100	1.000	0.008
			1.0	40	35,000	0.100	1.000	0.008
			1.0	70	45,000	0.100	1.000	0.008
			2.0	15	22,000	0.200	2.000	0.100
			2.0	20	25,000	0.200	2.000	0.100
			2.0	40	35,000	0.200	2.000	0.100
			2.0	70	45,000	0.200	2.000	0.100
			3.0	15	22,000	0.300	3.000	0.010
			3.0	20	25,000	0.300	3.000	0.010
			4.0	15	22,000	0.400	4.000	0.010
			4.0	20	25,000	0.400	4.000	0.010
			5.0	15	22,000	0.500	5.000	0.012
			5.0	20	25,000	0.500	5.000	0.012
			6.0	15	22,000	0.500	6.000	0.012
			6.0	20	25,000	0.500	6.000	0.012

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Al-Si 9% (80-160 HB)	Drilling (Drill)	0.3	15	22,000	Pecking steps: 0,25-0,5xD Max length of the hole: 3-4xD		0.002
			0.3	20	25,000			0.002
			0.3	40	35,000			0.002
			0.3	70	45,000			0.002
			0.5	15	22,000			0.003
			0.5	20	25,000			0.008
			0.5	40	35,000			0.008
			0.5	70	45,000			0.008
			0.8	15	22,000			0.008
			0.8	20	25,000			0.008
			0.8	40	35,000			0.008
			0.8	70	45,000			0.008
			1.0	15	22,000			0.008
			1.0	20	25,000			0.008
			1.0	40	35,000			0.008
			1.0	70	45,000			0.008
			1.5	15	22,000			0.008
			1.5	20	25,000			0.008
			1.5	40	35,000			0.008
			1.5	70	45,000			0.008
			2.0	15	22,000			0.008
			2.0	20	25,000			0.008
			2.0	40	35,000			0.008
			2.0	70	45,000			0.008
			3.0	15	22,000			0.008
			3.0	20	25,000			0.008
			3.0	40	35,000			0.008
			3.0	70	45,000			0.008
			4.0	15	22,000			0.008
			4.0	20	25,000			0.010
			4.0	40	35,000			0.010
			4.0	70	45,000			0.010

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Al-Si 9% (80-160 HB)	Profile Milling (Ball-Nose)	0.5	15	22,000	0.150	0.150	0.005
			0.5	20	25,000	0.150	0.150	0.005
			0.5	40	35,000	0.150	0.150	0.005
			0.5	70	45,000	0.150	0.150	0.005
			0.8	15	22,000	0.240	0.240	0.006
			0.8	20	25,000	0.240	0.240	0.006
			0.8	40	35,000	0.240	0.240	0.006
			0.8	70	45,000	0.240	0.240	0.006
			1.0	15	22,000	0.300	0.300	0.008
			1.0	20	25,000	0.300	0.300	0.008
			1.0	40	35,000	0.300	0.300	0.008
			1.0	70	45,000	0.300	0.300	0.010
			1.5	15	22,000	0.450	0.450	0.010
			1.5	20	25,000	0.450	0.450	0.010
			1.5	40	35,000	0.450	0.450	0.010
			1.5	70	45,000	0.450	0.450	0.010
			2.0	15	22,000	0.600	0.600	0.012
			2.0	20	25,000	0.600	0.600	0.012
			2.0	40	35,000	0.600	0.600	0.012
			2.0	70	45,000	0.600	0.600	0.012
			2.5	15	22,000	0.750	0.750	0.012
			2.5	20	25,000	0.750	0.750	0.012
			2.5	40	35,000	0.750	0.750	0.012
			2.5	70	45,000	0.750	0.750	0.012
			3.0	15	22,000	0.900	0.900	0.012
			3.0	20	25,000	0.900	0.900	0.012
			3.0	40	35,000	0.900	0.900	0.012
			3.0	70	45,000	0.900	0.900	0.012
			4.0	15	22,000	1.200	1.200	0.015
			4.0	20	25,000	1.200	1.200	0.015
			4.0	40	35,000	1.200	1.200	0.015
			4.0	70	45,000	1.200	1.200	0.015
			5.0	15	22,000	1.500	1.500	0.015
			5.0	20	25,000	1.500	1.500	0.015
			5.0	40	35,000	1.500	1.500	0.015
			5.0	70	45,000	1.500	1.500	0.015
			6.0	15	22,000	1.800	1.800	0.020
			6.0	20	25,000	1.800	1.800	0.020
			6.0	40	35,000	1.800	1.800	0.020
			6.0	70	45,000	1.800	1.800	0.020

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Al-Si 9% (80-160 HB)	Slot Milling (End-Mill)	0.5	15	22,000	0.500	0.100	0.008
			0.5	20	25,000	0.500	0.100	0.008
			0.5	40	35,000	0.500	0.100	0.008
			0.5	70	45,000	0.500	0.100	0.008
			0.8	15	22,000	0.800	0.160	0.008
			0.8	20	25,000	0.800	0.160	0.008
			0.8	40	35,000	0.800	0.160	0.008
			0.8	70	45,000	0.800	0.160	0.008
			1.0	15	22,000	1.000	0.200	0.010
			1.0	20	25,000	1.000	0.200	0.010
			1.0	40	35,000	1.000	0.200	0.010
			1.0	70	45,000	1.000	0.200	0.010
			2.0	15	22,000	2.000	0.400	0.015
			2.0	20	25,000	2.000	0.400	0.015
			2.0	40	35,000	2.000	0.400	0.015
			2.0	70	45,000	2.000	0.400	0.015
			3.0	15	22,000	3.000	0.600	0.020
			3.0	20	25,000	3.000	0.600	0.020
			3.0	40	35,000	3.000	0.600	0.020
			3.0	70	45,000	3.000	0.600	0.020
			4.0	15	22,000	4.000	0.800	0.025
			4.0	20	25,000	4.000	0.800	0.025
			4.0	40	35,000	4.000	0.800	0.025
			4.0	70	45,000	4.000	0.800	0.025
			5.0	15	22,000	5.000	1.000	0.025
			5.0	20	25,000	5.000	1.000	0.025
			5.0	40	35,000	5.000	1.000	0.025
			5.0	70	45,000	5.000	1.000	0.025
			5.5	15	22,000	5.500	1.100	0.025
			5.5	20	25,000	5.500	1.100	0.025
			5.5	40	35,000	5.500	1.100	0.025
			5.5	70	45,000	5.500	1.100	0.025
			6.0	15	22,000	6.000	1.200	0.030
			6.0	20	25,000	6.000	1.200	0.030
			6.0	40	35,000	6.000	1.200	0.030
			6.0	70	45,000	6.000	1.200	0.030

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Al-Si 9% (80-160 HB)	Shoulder Milling (End-Mill)	1.0	15	22,000	0.100	1.000	0.010
			1.0	20	25,000	0.100	1.000	0.010
			1.0	40	35,000	0.100	1.000	0.010
			1.0	70	45,000	0.100	1.000	0.010
			2.0	15	22,000	0.200	2.000	0.015
			2.0	20	25,000	0.200	2.000	0.015
			2.0	40	35,000	0.200	2.000	0.015
			2.0	70	45,000	0.200	2.000	0.015
			3.0	15	22,000	0.300	3.000	0.018
			3.0	20	25,000	0.300	3.000	0.018
			3.0	40	35,000	0.300	3.000	0.018
			3.0	70	45,000	0.300	3.000	0.018
			4.0	15	22,000	0.400	4.000	0.020
			4.0	20	25,000	0.400	4.000	0.020
			4.0	40	35,000	0.400	4.000	0.020
			4.0	70	45,000	0.400	4.000	0.020
			5.0	15	22,000	0.500	5.000	0.020
			5.0	20	25,000	0.500	5.000	0.020
			5.0	40	35,000	0.500	5.000	0.020
			5.0	70	45,000	0.500	5.000	0.020
			6.0	15	22,000	0.600	6.000	0.020
			6.0	20	25,000	0.600	6.000	0.020
			6.0	40	35,000	0.600	6.000	0.020
			6.0	70	45,000	0.600	6.000	0.020

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Cu alloys (80-200 HB)	Drilling (Drill)	0.5	15	22,000	Pecking steps: 0,25-0,5xD Max length of the hole: 5xD		0.004
			0.5	20	25,000			0.004
			0.5	40	35,000			0.004
			0.8	15	22,000			0.006
			0.8	20	25,000			0.006
			1.0	15	22,000			0.006
			1.0	20	25,000			0.006
			1.5	15	22,000			0.006
			1.5	20	25,000			0.006
			2.0	15	22,000			0.008
			2.0	20	25,000			0.008
			2.5	15	22,000			0.008
			3.0	15	22,000			0.008
		Profile Milling (Ball-Nose)	0.5	15	22,000	0.012	0.010	0.007
			0.5	20	25,000	0.012	0.010	0.007
			0.5	40	35,000	0.012	0.010	0.007
			0.5	70	45,000	0.012	0.010	0.007
			1.0	15	22,000	0.030	0.066	0.012
			1.0	20	25,000	0.030	0.066	0.012
			1.5	15	22,000	0.046	0.110	0.012
			1.5	20	25,000	0.046	0.110	0.012
			2.0	15	22,000	0.063	0.153	0.012
			2.0	20	25,000	0.063	0.153	0.012
			2.5	15	22,000	0.080	0.200	0.012
			2.5	20	25,000	0.080	0.200	0.012
			3.0	15	22,000	0.100	0.240	0.006
			3.0	20	25,000	0.100	0.240	0.006
			4.0	15	22,000	0.131	0.327	0.006
			5.0	15	22,000	0.165	0.414	0.006
			6.0	15	22,000	0.200	0.500	0.006

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Cu alloys (80-200 HB)	Slot Milling (End-Mill)	0.5	15	22,000	0.500	0.010	0.005
			0.5	20	25,000	0.500	0.010	0.005
			0.5	40	35,000	0.500	0.010	0.005
			0.5	70	45,000	0.500	0.010	0.005
			0.8	15	22,000	0.800	0.017	0.008
			0.8	20	25,000	0.800	0.017	0.008
			0.8	40	35,000	0.800	0.017	0.008
			0.8	70	45,000	0.800	0.017	0.008
			1.0	15	22,000	1.000	0.022	0.010
			1.0	20	25,000	1.000	0.022	0.010
			1.5	15	22,000	1.500	0.035	0.015
			1.5	20	25,000	1.500	0.035	0.015
			2.0	15	22,000	2.000	0.047	0.020
			2.0	20	25,000	2.000	0.047	0.020
			2.5	15	22,000	2.500	0.060	0.024
			2.5	20	25,000	2.500	0.060	0.024
			3.0	15	22,000	3.000	0.072	0.025
			3.0	20	25,000	3.000	0.072	0.025
			4.0	15	22,000	4.000	0.100	0.025
		Shoulder Milling (End-Mill)	1.0	15	22,000	0.100	1.000	0.008
			1.0	20	25,000	0.100	1.000	0.008
			2.0	15	22,000	0.200	2.000	0.100
			2.0	20	25,000	0.200	2.000	0.100
			3.0	15	22,000	0.300	3.000	0.010
			3.0	20	25,000	0.300	3.000	0.010
			4.0	15	22,000	0.400	4.000	0.010
			5.0	15	22,000	0.500	5.000	0.012
			6.0	15	22,000	0.500	6.000	0.012

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
S	Ti alloys (170-250 HB)	Drilling (Drill)	0.5	15	22,000	Pecking steps: 0,25-0,5xD Max length of the hole: 3-4xD		0.004
			0.5	20	25,000			0.004
			0.5	40	35,000			0.004
			0.8	15	22,000			0.006
			0.8	20	25,000			0.006
			1.0	15	22,000			0.006
			1.0	20	25,000			0.006
			1.5	15	22,000			0.006
			1.5	20	25,000			0.006
			2.0	15	22,000			0.008
			2.0	20	25,000			0.008
			2.5	15	22,000			0.008
			3.0	15	22,000			0.008
		Profile Milling (Ball-Nose)	0.5	15	22,000	0.012	0.010	0.007
			0.5	20	25,000	0.012	0.010	0.007
			0.5	40	35,000	0.012	0.010	0.007
			0.5	70	45,000	0.012	0.010	0.007
			1.0	15	22,000	0.030	0.066	0.012
			1.0	20	25,000	0.030	0.066	0.012
			1.0	40	35,000	0.030	0.066	0.012
			1.5	15	22,000	0.046	0.110	0.012
			1.5	20	25,000	0.046	0.110	0.012
			1.5	40	35,000	0.046	0.110	0.012
			2.0	15	22,000	0.063	0.153	0.012
			2.0	20	25,000	0.063	0.153	0.012
			2.0	40	35,000	0.063	0.153	0.012
			2.5	15	22,000	0.080	0.200	0.012
			2.5	20	25,000	0.080	0.200	0.012
			2.5	40	35,000	0.080	0.200	0.012
			3.0	15	22,000	0.100	0.240	0.006
			3.0	20	25,000	0.100	0.240	0.006
			4.0	15	22,000	0.131	0.327	0.006
			4.0	20	25,000	0.131	0.327	0.006
			5.0	15	22,000	0.165	0.414	0.006
			5.0	20	25,000	0.165	0.414	0.006
			6.0	15	22,000	0.200	0.500	0.006
			6.0	20	25,000	0.200	0.500	0.006

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
S	Ti alloys (170-250 HB)	Slot Milling (End-Mill)	0.5	15	22,000	0.500	0.010	0.005
			0.5	20	25,000	0.500	0.010	0.005
			0.5	40	35,000	0.500	0.010	0.005
			0.5	70	45,000	0.500	0.010	0.005
			0.8	15	22,000	0.800	0.017	0.008
			0.8	20	25,000	0.800	0.017	0.008
			0.8	40	35,000	0.800	0.017	0.008
			0.8	70	45,000	0.800	0.017	0.008
			1.0	15	22,000	1.000	0.022	0.010
			1.0	20	25,000	1.000	0.022	0.010
			1.0	40	35,000	1.000	0.022	0.010
			1.0	70	45,000	1.000	0.022	0.010
			1.5	15	22,000	1.500	0.035	0.015
			1.5	20	25,000	1.500	0.035	0.015
			1.5	40	35,000	1.500	0.035	0.015
			2.0	15	22,000	2.000	0.047	0.020
			2.0	20	25,000	2.000	0.047	0.020
			2.0	40	35,000	2.000	0.047	0.020
			2.5	15	22,000	2.500	0.060	0.024
			2.5	20	25,000	2.500	0.060	0.024
			2.5	40	35,000	2.500	0.060	0.024
			3.0	15	22,000	3.000	0.072	0.025
			3.0	20	25,000	3.000	0.072	0.025
			4.0	15	22,000	4.000	0.100	0.025
			4.0	20	25,000	4.000	0.100	0.025
		Shoulder Milling (End-Mill)	1.0	15	22,000	0.100	1.000	0.008
			1.0	20	25,000	0.100	1.000	0.008
			1.0	40	35,000	0.100	1.000	0.008
			1.0	70	45,000	0.100	1.000	0.008
			2.0	15	22,000	0.200	2.000	0.100
			2.0	20	25,000	0.200	2.000	0.100
			2.0	40	35,000	0.200	2.000	0.100
			2.0	70	45,000	0.200	2.000	0.100
			3.0	15	22,000	0.300	3.000	0.010
			3.0	20	25,000	0.300	3.000	0.010
			4.0	15	22,000	0.400	4.000	0.010
			4.0	20	25,000	0.400	4.000	0.010
			5.0	15	22,000	0.500	5.000	0.012
			5.0	20	25,000	0.500	5.000	0.012
			6.0	15	22,000	0.500	6.000	0.012
			6.0	20	25,000	0.500	6.000	0.012

2.3.9.2 Jet Spindle Operating Guidelines - SPEED JET Tables

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
P	SAE 1.2316 (35 HRC)	Drilling (Drill)	0.3	20	33,000	Pecking steps: 0,25-0,5xD Max length of the hole: 3-4xD		0.002
			0.3	30	44,000			0.002
			0.3	40	55,000			0.002
			0.5	20	33,000			0.003
			0.5	30	44,000			0.003
			0.5	40	55,000			0.003
			0.8	20	33,000			0.005
			1.0	20	33,000			0.005
			1.0	30	44,000			0.005
			1.5	20	33,000			0.005
			1.5	30	44,000			0.005
			2.0	20	33,000			0.006
		Profile Milling (Ball-Nose)	0.3	20	33,000	0.004	0.004	0.004
			0.3	30	44,000	0.004	0.004	0.004
			0.3	40	55,000	0.004	0.004	0.004
			0.5	20	33,000	0.010	0.008	0.006
			0.5	30	44,000	0.010	0.008	0.006
			0.5	40	55,000	0.010	0.008	0.006
			1.0	20	33,000	0.024	0.053	0.010
			1.0	30	44,000	0.024	0.053	0.010
			1.0	40	55,000	0.024	0.053	0.010
			1.5	20	33,000	0.037	0.088	0.010
			1.5	30	44,000	0.037	0.088	0.010
			1.5	40	55,000	0.037	0.088	0.010
			2.0	20	33,000	0.050	0.122	0.010
			2.0	30	44,000	0.050	0.122	0.010
			2.0	40	55,000	0.050	0.122	0.010
			2.5	20	33,000	0.064	0.160	0.010
			2.5	30	44,000	0.064	0.160	0.010
			2.5	40	55,000	0.064	0.160	0.010
			3.0	20	33,000	0.080	0.192	0.005
			3.0	30	44,000	0.080	0.192	0.005
			4.0	20	33,000	0.105	0.262	0.005
			4.0	30	44,000	0.105	0.262	0.005
			5.0	20	33,000	0.132	0.331	0.005
			5.0	30	44,000	0.132	0.331	0.005
			6.0	20	33,000	0.160	0.400	0.005

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
P	SAE 1.2316 (35 HRC)	Slot Milling (End-Mill)	0.3	20	33,000	0.300	0.004	0.002
			0.3	30	44,000	0.300	0.004	0.002
			0.3	40	55,000	0.300	0.004	0.002
			0.5	20	33,000	0.500	0.008	0.004
			0.5	30	44,000	0.500	0.008	0.004
			0.5	40	55,000	0.500	0.008	0.004
			0.8	20	33,000	0.800	0.014	0.006
			0.8	30	44,000	0.800	0.014	0.006
			0.8	40	55,000	0.800	0.014	0.006
			1.0	20	33,000	1.000	0.018	0.008
			1.0	30	44,000	1.000	0.018	0.008
			1.0	40	55,000	1.000	0.018	0.008
			1.5	20	33,000	1.500	0.028	0.012
			1.5	30	44,000	1.500	0.028	0.012
			1.5	40	55,000	1.500	0.028	0.012
			2.0	20	33,000	2.000	0.038	0.016
			2.0	30	44,000	2.000	0.038	0.016
			2.0	40	55,000	2.000	0.038	0.016
			2.5	20	33,000	2.500	0.048	0.019
			2.5	30	44,000	2.500	0.048	0.019
			2.5	40	55,000	2.500	0.048	0.019
			3.0	20	33,000	3.000	0.058	0.020
			3.0	30	44,000	3.000	0.058	0.020
			3.0	40	55,000	3.000	0.058	0.020
			4.0	20	33,000	4.000	0.080	0.020
			4.0	30	44,000	4.000	0.080	0.020
			4.0	40	55,000	4.000	0.080	0.020
		Shoulder Milling (End-Mill)	0.5	20	33,000	0.040	0.400	0.004
			0.5	30	44,000	0.040	0.400	0.004
			0.5	40	55,000	0.040	0.400	0.004
			1.0	20	33,000	0.080	0.800	0.006
			1.0	30	44,000	0.080	0.800	0.006
			1.0	40	55,000	0.080	0.800	0.006
			2.0	20	33,000	0.160	1.600	0.080
			2.0	30	44,000	0.160	1.600	0.080
			2.0	40	55,000	0.160	1.600	0.080
			3.0	20	33,000	0.240	2.400	0.008
			3.0	30	44,000	0.240	2.400	0.008
			3.0	40	55,000	0.240	2.400	0.008
			4.0	20	33,000	0.320	3.200	0.008

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
M	SS 316 (180-250 HB)	Drilling (Drill)	0.5	20	33,000	Pecking steps: 0,25-0,5xD Max length of the hole: 3-4xD		0.003
			0.5	30	44,000			0.003
			0.5	40	55,000			0.003
			0.8	20	33,000			0.005
			0.8	30	44,000			0.005
			0.8	40	55,000			0.005
			1.0	20	33,000			0.005
			1.0	30	44,000			0.005
			1.0	40	55,000			0.005
			1.5	20	33,000			0.005
			1.5	30	44,000			0.005
			1.5	40	55,000			0.005
			2.0	20	33,000			0.006
		Profile Milling (Ball-Nose)	0.5	20	33,000	0.010	0.008	0.006
			0.5	30	44,000	0.010	0.008	0.006
			0.5	40	55,000	0.010	0.008	0.006
			1.0	20	33,000	0.024	0.053	0.010
			1.0	30	44,000	0.024	0.053	0.010
			1.0	40	55,000	0.024	0.053	0.010
			1.5	20	33,000	0.037	0.088	0.010
			1.5	30	44,000	0.037	0.088	0.010
			2.0	20	33,000	0.050	0.122	0.010
			2.0	30	44,000	0.050	0.122	0.010
			2.5	20	33,000	0.064	0.160	0.010
			3.0	20	33,000	0.080	0.192	0.005
			4.0	20	33,000	0.105	0.262	0.005
		Slot Milling (End-Mill)	0.5	20	33,000	0.500	0.008	0.004
			0.5	30	44,000	0.500	0.008	0.004
			0.5	40	55,000	0.500	0.008	0.004
			0.8	20	33,000	0.800	0.014	0.006
			0.8	30	44,000	0.800	0.014	0.006
			0.8	40	55,000	0.800	0.014	0.006
			1.0	20	33,000	1.000	0.018	0.008
			1.0	30	44,000	1.000	0.018	0.008
			1.0	40	55,000	1.000	0.018	0.008
			1.5	20	33,000	1.500	0.028	0.012
			1.5	30	44,000	1.500	0.028	0.012
			2.0	20	33,000	2.000	0.038	0.016
			2.5	20	33,000	2.500	0.048	0.019
			2.5	30	44,000	2.500	0.048	0.019
			3.0	20	33,000	3.000	0.058	0.020
		Shoulder Milling (End-Mill)	1.0	20	33,000	0.080	0.800	0.006
			1.0	30	44,000	0.080	0.800	0.006
			1.0	40	55,000	0.080	0.800	0.006
			2.0	20	33,000	0.160	1.600	0.080
			2.0	30	44,000	0.160	1.600	0.080
			3.0	20	33,000	0.240	2.400	0.008
			3.0	30	44,000	0.240	2.400	0.008
			4.0	20	33,000	0.320	3.200	0.008
			5.0	20	33,000	0.400	4.000	0.010
			6.0	20	33,000	0.400	4.800	0.010

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Al-Si 9% (80-160 HB)	Drilling (Drill)	0.3	20	33,000	Pecking steps: 0,25-0,5xD Max length of the hole: 3-4xD		0.002
			0.3	30	44,000			0.002
			0.3	40	55,000			0.002
			0.5	20	33,000			0.006
			0.5	30	44,000			0.006
			0.5	40	55,000			0.006
			0.8	20	33,000			0.006
			0.8	30	44,000			0.006
			0.8	40	55,000			0.006
			1.0	20	33,000			0.006
			1.0	30	44,000			0.006
			1.0	40	55,000			0.006
			1.5	20	33,000			0.006
			1.5	30	44,000			0.006
			1.5	40	55,000			0.006
			2.0	20	33,000			0.006
			2.0	30	44,000			0.006
			2.0	40	55,000			0.006
			3.0	20	33,000			0.006
			3.0	30	44,000			0.006
			3.0	40	55,000			0.006
		Profile Milling (Ball-Nose)	0.5	20	33,000	0.120	0.120	0.004
			0.5	30	44,000	0.120	0.120	0.004
			0.5	40	55,000	0.120	0.120	0.004
			0.8	20	33,000	0.192	0.192	0.005
			0.8	30	44,000	0.192	0.192	0.005
			0.8	40	55,000	0.192	0.192	0.005
			1.0	20	33,000	0.240	0.240	0.006
			1.0	30	44,000	0.240	0.240	0.006
			1.0	40	55,000	0.240	0.240	0.006
			1.5	20	33,000	0.360	0.360	0.008
			1.5	30	44,000	0.360	0.360	0.008
			1.5	40	55,000	0.360	0.360	0.008
			2.0	20	33,000	0.480	0.480	0.010
			2.0	30	44,000	0.480	0.480	0.010
			2.0	40	55,000	0.480	0.480	0.010
			2.5	20	33,000	0.600	0.600	0.010
			2.5	30	44,000	0.600	0.600	0.010
			2.5	40	55,000	0.600	0.600	0.010
			3.0	20	33,000	0.720	0.720	0.010
			3.0	30	44,000	0.720	0.720	0.010
			3.0	40	55,000	0.720	0.720	0.010
			4.0	20	33,000	0.960	0.960	0.012
			4.0	30	44,000	0.960	0.960	0.012
			4.0	40	55,000	0.960	0.960	0.012
			5.0	20	33,000	1.200	1.200	0.012
			5.0	30	44,000	1.200	1.200	0.012
			5.0	40	55,000	1.200	1.200	0.012
			6.0	20	33,000	1.440	1.440	0.016
			6.0	30	44,000	1.440	1.440	0.016
			6.0	40	55,000	1.440	1.440	0.016

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Al-Si 9% (80-160 HB)	Slot Milling (End-Mill)	0.5	20	33,000	0.500	0.080	0.006
			0.5	30	44,000	0.500	0.080	0.006
			0.5	40	55,000	0.500	0.080	0.006
			0.8	20	33,000	0.800	0.128	0.006
			0.8	30	44,000	0.800	0.128	0.006
			0.8	40	55,000	0.800	0.128	0.006
			1.0	20	33,000	1.000	0.160	0.008
			1.0	30	44,000	1.000	0.160	0.008
			1.0	40	55,000	1.000	0.160	0.008
			1.5	20	33,000	1.500	0.240	0.010
			1.5	30	44,000	1.500	0.240	0.010
			1.5	40	55,000	1.500	0.240	0.010
			2.0	20	33,000	2.000	0.320	0.012
			2.0	30	44,000	2.000	0.320	0.012
			2.0	40	55,000	2.000	0.320	0.012
			2.5	20	33,000	2.500	0.400	0.014
			2.5	30	44,000	2.500	0.400	0.014
			2.5	40	55,000	2.500	0.400	0.014
			3.0	20	33,000	3.000	0.480	0.016
			3.0	30	44,000	3.000	0.480	0.016
			3.0	40	55,000	3.000	0.480	0.016
			3.5	20	33,000	3.500	0.560	0.018
			3.5	30	44,000	3.500	0.560	0.018
			3.5	40	55,000	3.500	0.560	0.018
			4.0	20	33,000	4.000	0.640	0.020
			4.0	30	44,000	4.000	0.640	0.020
			4.0	40	55,000	4.000	0.640	0.020
		Shoulder Milling (End-Mill)	1.0	20	33,000	0.080	0.800	0.008
			1.0	30	44,000	0.080	0.800	0.008
			1.0	40	55,000	0.080	0.800	0.008
			2.0	20	33,000	0.160	1.600	0.012
			2.0	30	44,000	0.160	1.600	0.012
			2.0	40	55,000	0.160	1.600	0.012
			3.0	20	33,000	0.240	2.400	0.014
			3.0	30	44,000	0.240	2.400	0.014
			3.0	40	55,000	0.240	2.400	0.014
			4.0	20	33,000	0.320	3.200	0.016
			4.0	30	44,000	0.320	3.200	0.016
			4.0	40	55,000	0.320	3.200	0.016
			5.0	20	33,000	0.400	4.000	0.016
			5.0	30	44,000	0.400	4.000	0.016
			5.0	40	55,000	0.400	4.000	0.016
			6.0	20	33,000	0.480	4.800	0.016
			6.0	30	44,000	0.480	4.800	0.016
			6.0	40	55,000	0.480	4.800	0.016

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
N	Cu alloys (80-200 HB)	Drilling (Drill)	0.5	20	33,000	Pecking steps: 0,25-0,5xD Max length of the hole: 5xD		0.003
			0.5	30	44,000			0.003
			0.5	40	55,000			0.003
			0.8	20	33,000			0.005
			0.8	30	44,000			0.005
			0.8	40	55,000			0.005
			1.0	20	33,000			0.005
			1.0	30	44,000			0.005
			1.0	40	55,000			0.005
			1.5	20	33,000			0.005
			2.0	20	33,000			0.006
		Profile Milling (Ball-Nose)	0.5	20	33,000	0.010	0.008	0.006
			0.5	30	44,000	0.010	0.008	0.006
			0.5	40	55,000	0.010	0.008	0.006
			1.0	20	33,000	0.024	0.053	0.010
			1.5	20	33,000	0.037	0.088	0.010
			2.0	20	33,000	0.050	0.122	0.010
			2.5	20	33,000	0.064	0.160	0.010
			3.0	20	33,000	0.080	0.192	0.005
			4.0	20	33,000	0.105	0.262	0.005
		Slot Milling (End-Mill)	0.5	20	33,000	0.500	0.008	0.004
			0.5	30	44,000	0.500	0.008	0.004
			0.5	40	55,000	0.500	0.008	0.004
			0.8	20	33,000	0.800	0.014	0.006
			0.8	30	44,000	0.800	0.014	0.006
			0.8	40	55,000	0.800	0.014	0.006
			1.0	20	33,000	1.000	0.018	0.008
			1.5	20	33,000	1.500	0.028	0.012
			2.0	20	33,000	2.000	0.038	0.016
			2.5	20	33,000	2.500	0.048	0.019
			3.0	20	33,000	3.000	0.058	0.020
		Shoulder Milling (End-Mill)	1.0	20	33,000	0.080	0.800	0.006
			2.0	20	33,000	0.160	1.600	0.080
			3.0	20	33,000	0.240	2.400	0.008
			4.0	20	33,000	0.320	3.200	0.008
			5.0	20	33,000	0.400	4.000	0.010
			6.0	20	33,000	0.400	4.800	0.010

	Material	Process	Cutting Tool dia. (mm)	Pressure (bar)	Speed (rpm)	Ae (mm)	Ap (mm)	Fz (mm/t)
S	Ti alloys (170-250 HB)	Drilling (Drill)	0.5	20	33,000	Pecking steps: 0,25-0,5xD Max length of the hole: 5xD		0.003
			0.5	30	44,000			0.003
			0.5	40	55,000			0.003
			0.8	20	33,000			0.005
			0.8	30	44,000			0.005
			0.8	40	55,000			0.005
			1.0	20	33,000			0.005
			1.0	30	44,000			0.005
			1.0	40	55,000			0.005
			1.5	20	33,000			0.005
			1.5	30	44,000			0.005
			1.5	40	55,000			0.005
			2.0	20	33,000			0.006
		Profile Milling (Ball-Nose)	0.5	20	33,000	0.010	0.008	0.006
			0.5	30	44,000	0.010	0.008	0.006
			0.5	40	55,000	0.010	0.008	0.006
			1.0	20	33,000	0.024	0.053	0.010
			1.0	30	44,000	0.024	0.053	0.010
			1.0	40	55,000	0.024	0.053	0.010
			1.5	20	33,000	0.037	0.088	0.010
			1.5	30	44,000	0.037	0.088	0.010
			2.0	20	33,000	0.050	0.122	0.010
			2.0	30	44,000	0.050	0.122	0.010
			2.5	20	33,000	0.064	0.160	0.010
			3.0	20	33,000	0.080	0.192	0.005
			4.0	20	33,000	0.105	0.262	0.005
		Slot Milling (End-Mill)	0.5	20	33,000	0.500	0.008	0.004
			0.5	30	44,000	0.500	0.008	0.004
			0.5	40	55,000	0.500	0.008	0.004
			0.8	20	33,000	0.800	0.014	0.006
			0.8	30	44,000	0.800	0.014	0.006
			0.8	40	55,000	0.800	0.014	0.006
			1.0	20	33,000	1.000	0.018	0.008
			1.0	30	44,000	1.000	0.018	0.008
			1.0	40	55,000	1.000	0.018	0.008
			1.5	20	33,000	1.500	0.028	0.012
			1.5	30	44,000	1.500	0.028	0.012
			2.0	20	33,000	2.000	0.038	0.016
			2.5	20	33,000	2.500	0.048	0.019
			2.5	30	44,000	2.500	0.048	0.019
			3.0	20	33,000	3.000	0.058	0.020
		Shoulder Milling (End-Mill)	1.0	20	33,000	0.080	0.800	0.006
			1.0	30	44,000	0.080	0.800	0.006
			1.0	40	55,000	0.080	0.800	0.006
			2.0	20	33,000	0.160	1.600	0.080
			2.0	30	44,000	0.160	1.600	0.080
			3.0	20	33,000	0.240	2.400	0.008
			3.0	30	44,000	0.240	2.400	0.008
			4.0	20	33,000	0.320	3.200	0.008
			5.0	20	33,000	0.400	4.000	0.010
			6.0	20	33,000	0.400	4.800	0.010

3. Maintenance

3.1 Periodic Maintenance

The POWER Jet and SPEED Jet Spindle is free from periodic maintenance.

3.2 Battery Change on RPM Transmitter

The battery (CR2 - 3V) in the RPM transmitter mounted on the PRO Jet Spindle, will lose power over time.
To change the battery, please proceed as in chapter 2 (Installation p.12).

3.3 Recommended Operating Environment

- Temperature range: 15-30° C.
- Max. altitude: 2000 m.

3.4 Steps for Machine Maintenance

To ensure the optimal performance and longevity of your Jet spindle, please follow these professional maintenance guidelines:

- **Removal Prior to Machine Maintenance:** Always **remove the Jet spindle from the machine** before initiating any maintenance procedures on the machine itself.
- **System Flushing Post-Maintenance:** Once machine maintenance is complete, **run the pump for approximately one minute**. This critical step flushes out any residual dirt or debris from the pipes, preventing contamination.
- **Reinstallation:** Only re-install the Jet spindle into the machine **after the pipes have been thoroughly flushed**.

Adhering to these steps will help prevent potential issues and maintain the efficiency of your Jet spindle.

3.5 Spindle Storage

3.5.1 Spindle Pre-Storage

Before storing the PRO Jet Spindle:

- Clean the PRO Jet Spindle by air blowing for 10-15 seconds.
- Max. air pressure for cleaning (2 bar/30 psi) – DO NOT EXCEED 50,000 RPM.
- Place the PRO Jet Spindle back in its case.

3.5.2 Recommended Storage Conditions

The POWER Jet and SPEED Jet Spindle should be stored to meet the following conditions:

- Sheltered from possible adverse weather conditions.
- Ideal Storage Temperature Range: 15° C to 27° C.
- Humidity Range: 30% to 60% relative humidity (RH).

⚠	**WARNING!** It is strictly prohibited immerse a PRO Jet Spindle in a fluid bath. Clean external adaptor and ER11 nut using alcohol and treatment with oil. Clean internal shaft using air pressure only.

Any damage caused by one of the above “Warnings” will not be covered by the warranty.

4. Working with a PRO Jet Spindle

⚠	**WARNING!** Use the utmost caution when working with rotating tools.

The PRO Jet Spindle enables optimal cutting speed conditions for small diameter, solid carbide tools requiring high RPMs.

The Jet Spindle rotates at its rated speed when idle. When the cutting tool enters the work piece, it is expected that the rotation speed might slow down by several thousand RPM.

If the PRO Jet Spindle rotation speed drops by more than several thousand RPM, when the cutting tool enters the work piece: refer to the **10% Rule** (section 2.3.8) to adjust cutting parameters accordingly.

For recommended Cutting Tool Parameters, please consult the chapter 2.3.

In order to take advantage of high speed machining, minimize cutting forces and reduce wear, tool diameter should be selected according to the spindle speed (when possible).
- Always select the smallest tool diameter, according to the application requirements.
- Always select cutting tools in grades that are suitable for high speed machining.

4.1 Recalculation of Table Feed for a PRO Jet Spindle

There are two calculation methods for table feed F [mm / min], with the PRO Jet Spindle:
- Existing machining process (transition from machining with a machine spindle to a PRO Jet Spindle).
- New machining process.

4.1.1 Existing Machining Process

The feed per tooth fz remains constant while the table feed F increases in proportion to the POWER and SPEED Jet Spindle rotation speed.

The feed per tooth fz should remain constant while the table feed F changes.
Calculate the table feed F [mm/min] according to the following formula:
- F ≈ Ratio x F current
- F - New table feed
- Ratio - Ratio between the machine spindle speed and PRO Jet Spindle speed, (new speed divided by the current speed).
- F Current - Current table feed with original machine spindle.

Example:
If using a machine spindle at 8,000 rpm, with a table feed of 160 [mm/min], and the PRO Jet Spindle set to 30,000 rpm, then the new recommended table feed is as follows:
- New table feed = 30,000/8,000 x 160 = 3.75 x 160 = 600 [mm/min].
- In this example, the new table feed should be 600 [mm/min].

4.1.2 New Machining Process

Calculate the table speed, F [mm/min], according to the formula: F = n x z x fz
- Rotation speed – n [rpm] rotation speed for table speed calculation, can be determined only after reading the actual rotation speed obtained when the tool has engaged the material.
- Number of teeth – z.
- Feed per tooth – fz [mm/tooth] , select according to tool vendor's recommendations, taking into consideration the machining material, application and the tool geometry.

Note:
First trial for both machining processes: It is recommended to increase table feed gradually.

5. Troubleshooting

5.1 App Messages

App Messages	Indication	Action Required
No Data Found (IOS), Blank Homescreen (Android)/	Spindle is not in operation/not spinning.	Operate the Spindle with the machines high pressure coolant.
NO SIGNAL		
NO CHART DATA AVAILABLE		
SET	Idle Spindle speed not set.	Press the Set button, while the Spindle is spinning in Idle speed, outside of the material.
Low Speed Alert!	Jet Spindle is rotating to slow, has to handle to much torque.	Check: Jet Spindle, coolant pressure, and cutting parameters.
LOW BATTERY	Battery is low on power.	Replace the battery in the Spindle Speed Sensor.

5.2 Spindle Shaft Does Not Rotate or RPM Not Corresponding to Coolant Pressure

May Result In “Low Speed Alert!” Message.
1. Check coolant pressure in the system.
2. Check spindle inlet is clear.
3. Run coolant through the Jet Spindle for 5 minutes while idle.
4. If issue persists - call for technical assistance.

5.3 Spindle Not Used Within the Past Month

Before working with a PRO Jet Spindle that has not been recently operated, first assemble it on the CNC machine. Then run coolant through the Jet Spindle for 3 to 5 minutes. Ensure that the Jet Spindle reaches a speed corresponding to the coolant pressure being pumped through it.

6. New Unit Warranty Summary

New PRO Jet Spindle Warranty Frame
The manufacturer warrants that its Spindles are to be free from defects in material, design and workmanship under proper use. Maintenance and service, for a period commencing from the date of invoice referenced by the Spindle Serial No., is valid for 300 working hours or until 12 months from the date of invoice (whichever comes first).

Warranty Conditions:
- Warranty does not apply to spindles that have been subject to operator/programmer error (i.e. crashed or improper preventative maintenance, installation errors, and/or contamination).
- Warranty does not apply to spindles that have been repaired, or have attempted to be repaired by anyone other than a manufacturer authorized representative.
- Warranty does not apply to worn-out bearings.
- Claim of defect must be issued by returning the spindle in its original packaging accompanied by a written claim form; with an explanation of the malfunction, inclusion of the spindle serial no. and a copy of the product invoice.

The manufacturer’s liability under this warranty shall be limited to the repair of, or replacement of, at the manufacturer’s discretion, any part determined to the manufacturer’s satisfaction to be defective, and which has not been found to have been misused, abused, abnormally used, or damaged by accident or improper maintenance, altered, or carelessly handled.
Upon determination by the manufacturer that a warranty claim is valid, a refurbished or new spindle will be shipped as a replacement, on a no charge bases. All spindles repaired under warranty will remain under the initial warranty timeframe for the balance of the valid warranty period.
Customer shall pay shipping and handling costs for the spindle’s return to the manufacturer’s premises. Return of the repaired or replacement spindles under warranty shall be sent to the customer’s premises only, at the expense of the manufacturer.
The manufacturer reserves the right to choose the method of shipment on all replacement parts supplied under warranty. The customer shall bear all shipping costs related to spindles which are not under warranty.

Warranty shall not apply to:

- Claims or damage resulting from customer or third party repairs or modifications to the product, or other circumstances beyond the manufacturer's control.
- Claims or damage due to non-compliance with recommended installation, operation and maintenance procedures, as specified by the manufacturer, including, without limitation; abuse, neglect, misuse of the product by the customer, its agents, employees or contractor.
- Damage resulting from operation of product not within the working parameters and working environment it was designed for.
- Claims or damage resulting from the use of third party replacement parts.
- Any direct or indirect loss, consequential loss, personal injury or damage to property, loss arising from interruptions or delays in production.
- Claims or damage resulting from buyer's non-compliance with applicable laws, regulations, codes or by-laws, and standard industry practices.

Transfer of Warranty

Spindles are only covered under warranty to the original buyer of the spindle and this warranty is non-transferable to, and may not be enforced by, any third parties, including, but not limited to; subsequent buyers, users or assignees of the spindle.

6.1 Repaired/Refurbished Unit Warranty Summary

Repaired/Refurbished PRO Jet Spindle Warranty Frame

The manufacturer warrants that its repaired / refurbished Spindles are to be free from defects in material, design and workmanship under proper use. Maintenance and service of repaired or refurbished units are referenced by the Spindle Serial No. and is valid for 200 working hours or until 6 months from the date of invoice (whichever comes first).

Repair and Refurbishment: PRO Jet Spindle Warranty Frame

A Spindle that has undergone repair by the manufacturer not within the warranty cover terms and/or valid timeframe, shall be entitled to a limited warranty period of 6 months from the invoice date; or 200 working hours (whichever comes first) all warranted repairs must be performed by the manufacturer as the sole certified entity. Using any repair service other than a manufacturer authorized rep, will immediately terminate the warranty; validity, scope and terms.

Performance on refurbished units:

- Runout up to 5 µm
- Balancing level up to 3 mm/s

The repaired / refurbished spindle warranty is subject to the same restrictions and conditional terms as equally applied and specified for the "New PRO Jet Spindle Warranty Frame".

This warranty document supersedes all and any previous warrant policy information published by the manufacturer, including warranty assurances and conditions stated in the product User Manuals. The manufacturer reserves the right to make changes in products or specifications at any time, without prior notice.

6.2 Activating Warranty Frame

Activate your warranty instantly online by filling out the registration form on the website: **reg.colibri-jet.com**. Or scan the **QR Code** below.
Make sure you have your invoice information on hand.

Registering your product not only activates the warranty but also allows you to receive many important product support features:

- Product ATP
- Online Training & Documentation
- Product Management Interface
- Help & Technical Support Services

6.3 Customer Service After Purchase

After a PRO Jet Spindle was purchased from an authorized Colibri sales representative: Whenever a malfunction cannot be resolved by the solutions mentioned in the troubleshooting section, you are requested to consult your authorized sales representative for further assistance or instructions.

The unit should not be returned before receiving written approval from your authorized sales representative. The serial number for the unit must be indicated on your claim form (you can find this information on the spindle housing).

We hope this information will be helpful. Our goal is to provide the best possible service to our customers.

PARTNERS

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