mandelliINDUSTRIALE

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1. TECHNICAL DATA

Machining Center Mandelli 5 H (Ref. §3.01)

1.1 LINEAR AXES

Travels

X axis - longitudinal	mm	800
Y axis - vertical	mm	650
Z axis - transversal	mm	750
Max. handling shape		See diagram

Linear axes features

Rapid	mm/min	24.000
Work feed	mm/min	10-24.000
Acceleration	mm/s2	1.500
Max. thrust at 100% cont. (S3/60)	N	12.000 (15.000)
Motor working torque (100% continuous)	Nm	24
Motor power	kW	7,5

Dimensions

Slideways type		Roller sliding block
Ball screw diameter	mm	50
Ball screw pitch	mm	20

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1.2 POSITIONING ACCURACIES X-Y-Z AXES (According to VDI 3441)

Version		Standard
Uncertain positioning P	mm	0,015
Average dispersion of positioning Ps	mm	0,007
Average inversion error U	mm	0,003

1.3 MACHINE SPINDLE

Head type		Horizontal (H)
Spindle motor power at 100% cont.(S3/60)	kW	22 (27,5)
Max. spindle speed	rpm	6.000
Programmable speed	rpm	30-6000
Max. continuat. torque 100%	Nm	650
Max. torque reference revolutions	rpm	326
Speed range	no.	2
Spindle taper DIN 69871		50
Clamping force on tool retention knub	N	14.000
Front bearing internal diameter	mm	100

1.4 ROTARY TABLE

Type		ISO 500 indexed pre-arranged to receive pallet
Min. division angle	degrees	1
Rapid	rpm	12
Rotation time (90°-180°)	s.	5-6
Pallet net load	daN	800
Max. tilting torque	Nm	8.000
Max. twisting torque with table clamped	Nm	4.500
Positioning tolerance	"	+- 3

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1.5 ROTARY TABLE

Type		ISO 500 continuous prearranged to receive pallet
Min. division angle	degrees	0,001
Rapid	rpm	12
Work feed	rpm	0,012-12
Rotation time (90°-180°)	s.	4-5
Pallet net load	daN	800
Max. twisting torque with table clamped	Nm	2.500
Max. contouring torque	Nm	1.000
Positioning accuracies (according to VDI 3441)		
Uncertain positioning P	"	12
Average dispersion of positioning Ps	"	6

1.6 PALLET (DIN 55201)

Dimensions	mm	500x500
Weight	daN	145
Fixing slots	mm	14 H12 (n. 4)
Reference slots	mm	14 H8
T slot pitch	mm	100
Central reference hole	mm	50 H7

1.7 PALLET (DIN 55201)

Dimensions	mm	500x630
Weight	daN	185
Fixing slots	mm	14 H12 (n. 4)
Reference slots	mm	14 H8
T slot pitch	mm	100
Central reference hole	mm	50 H7

1.8 AUTOMATIC PALLET CHANGER

Type		ISO 500 active and translating
Pallet tables	no.	2
Travel	mm	950
Pallet change time (according to VDI 2852)	s	19

1.9 TOOL MAGAZINE

Type		Floor type single chain with tool insert station	
Tool capacity	no.	40	
Max. tool diameter (with all pockets occupied)	mm	125	
Max. tool diameter (with next pockets free)	mm	350	
Max. tool length	mm	450	
Max. tool weight	daN	25	
Max. tool tilting torque	Nm	75	
Tool searching speed	m/min	30	
Tool change time (according to VDI 2852)	s	11	
Tool capacity (optional)	no.	60-80-100 120-160-200	(11)

(11) Tool magazines with more than 100 pockets are double chain type

1.10 TOOL COOLING SYSTEM

Capacity of coolant collection tank	dm3	700

Tool cooling system external/through spindle/to multispindle tool heads

Pump type		Volumetric
Max. delivery (free discharge)	dm3/min	40
Max. pressure (adjustable)	bar	25
Filter capacity	micron	60
Motor power	kW	4

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Component shower washing system

Pump type		Centrifugal
Max. delivery (free discharge)	dm3/min	200
Max. pressure	bar	3
Filter capacity	micron	700
Motor power	kW	2,2

1.11 ELECTRICAL FEATURES

Tension	V	380 +/- 5%
Frequency	Hz	50
Tension to CNM Plasma n. c.	V	220
Tension to solenoid valves	V	24 (d.c.)

1.12 SAFETY PRECAUTIONS

Axes motor	IP	55
Spindle motor	IP	65
Electrical cabinet	IP	54
CNM Plasma n.c.	IP	44
Max. admissible temperature	°C	40
Max. admissible ambient humidity	%	90

1.13 GENERAL INSTALLATION DATA

Occupied surface (M/C basic version+ cabinets+APC+60 pockets tool magazine)	m	6,9x5,9
Max. height	m	3.3
Total weight (M/C basic version+rotary table+APC+60 pockets tool magazine)	daN	15.000 ca.
Cabinet oil tank capacity	dm3	250
Max. noise (accordig to UNI 7712)	dB(A)	80
Foundations		It requires a concrete slob without reinforcement
Installed power	kVA	70

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2. GENERAL FEATURES

Machining Center Mandelli 5 H (Ref. §3.1)

2.1 BASIC STRUCTURE OF THE MACHINING CENTER

The main structures of the machine are made in cast iron. Opportune thermal stabilizations are made to eliminate internal tension.

The internal form of the structures is symmetrical reticular type, so as to guarantee excellent rigidity in the various working conditions.

2.2 LINEAR AXES MOVEMENT

The movement of the 3 linear axes is carried out by means of ball screws with double preloaded lead nuts.

The slideways for axes X-Y-Z are built with roller recirculation preloaded sliding blocks.

The axes are commanded by brushless A.C. motors through a positive cog belt reduction. An electromagnetic brake keyed to the screw guarantees the clamping of the axis in the absence of current.

The measuring system for the axes is by optical scales.

The vertical axis "Y" is balanced by a closed circuit hydraulic system made up of a cylinder and an accumulator.

2.3 HORIZONTAL SPINDLE HEAD (H)

Cast in stabilized cast iron, it runs frontally on the column and is held in check by a system of opposing taper gibs.

The kinematic chain is made up of casehardened and tempered helical spur gears with automatic range change actuated by a hydraulic

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cylinder.

The spindle rotates on two supports with high-precision bearings and with a preload which is rigorously determined in relation to the working conditions, to maintain maximum radial and axial rigidity.

The shape of the head, and in particular the part which supports the spindle, was designed to facilitate machining in the center of the table without using over-long tools.

The spindle unit is lubricated by forced circulation, with continual temperature control by means of the oil cooling cabinet.

The spindle rotation speeds, with continuous variation, are obtained by an A.C. motor.

The angular orientation is obtained by an encoder placed near the spindle.

The flow of coolant through the tool is obtained by a rotary coupling mounted as standard in axis with the spindle.

2.4 TOOL EXCHANGE DEVICE AND TOOL MAGAZINE

Developed to interpret the necessities of absolute reliability, of modularity in the various requests of capacity and connection with other systems, these constitute a high performance unit.

The magazines are free standing chains with pockets for the tool tapers and a clamping device on the pull stud of the tool itself. Their configuration is very compact, even with very high capacities.

The chain is moved by an A.C. motor.

A system for resetting makes it possible to compensate for possible lengthening of the chain.

This is moved by a brushless A.C. motor, managed like an axis, the positioning is guaranteed by an encoder and the bi-directional search can be carried at any moment during machining time.

The management is Random with variable or fixed positions and permits the handling of large tools.

The change arm is attached to the tool magazine. The tool change operation is carried out in a fixed position on axes Y-Z and features 2 distinct phases:

A) Search in the magazine for the next tool which is prepared in an intermediate waiting position, which frees the chain for the following search: this operation can be carried out during machining.

B) Execution of the actual tool change cycle. Before the change, a system of rotary brushes cleans the tool taper.

2.5 MANUAL TOOL INSERT STATION

The manual tool load/unload station is fixed at the back of the tool magazine.

To manually load or unload a tool, it is first necessary to define the operation of the NC console, then request permission for access to the magazine by means of the special bush button panel.

On pressing the electric pedal, the pneumatic actuator is triggered, acting on the clamping pins of the tool and allowing the operator to load/unload it.

The proximity switch detects whether a tool is clamped or unclamped according to the angular position of the arm activated by the cylinder.

The station can be equipped with a device for reading the tool codes.

2.6 CONTINUOUS ROTARY TABLE

This is a fundamental element for the results of precision and performance of the machining center.

The prerogative of this table is in the transmission system, which comprises a worm screw with a helical gear for backlash recuperation.

This gives correct positioning and high rigidity of the axis,

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essential for contouring jobs.

The load is supported by an axial-radial roller bearing and by sliding surfaces for the scope of dampening the vibrations produced by the technology of cutting chips. The retroaction of the measuring system is obtained with a RON encoder.

2.7 ROTARY TABLE WITH 360 POSITIONS

This is a fundamental element for the results of precision and performance of the machining center.

The structure of the rotary table is in cast iron and is fixed directly onto the sliding blocks of the X axis slideways.

The angular position of the rotary plate is detected by an optical encoder, while the precision of angular positioning is obtained by a pair of Hirth rings.

2.8 HYDRAULIC CONTROL SYSTEM

This is formed of a tank with a motor and pump for the machine power facilities, for lubricating the slideways and for the lubrication-feed of the head.

The power facilities of the machine are sub-divided into movements of tool change, traverse of the carriage, pick-up, change and clamping the tool in the spindle, clamping the rotary table, handling the pallets.

The lubrication of the slideways is obtained by a unit complete with tank, pump, timer and pressure control. There is a continuous delivery of oil for the head which, apart from lubricating, removes the heat generated by the kinematics of rotation.

A refrigeration unit removes the oil in the area of the hydraulics cabinet and having cooled it, returns it to the intake area.

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2.9 ELECTRIC CONTROL SYSTEM

Mandelli has always attributed enormous importance to electronics on machining centers for obtaining high performance with greater reliability considering the continual sophistication of manufacturing systems. The project and the execution are carried out within the company.

A medium sized cabinet, completely accessible from one side to facilitate dislocation, contains the various units made of pre-wired panels specialized in their task and mounted on modules which are easily accessible for maintenance.

The main panels are:

Auxiliary power panel: on this depend the power supplies of all the other units connected to it through automatic protection switches.

Axis and spindle drive panel: the drives for the axes and the spindle motor are of commercial type.

Input-Output rack: this contains the various cards for transferring signals from the machine to the CNC both in input and output.

Interface panels which can be programmed for CNC other than PLASMA: This is a microprocessor module and executes the plant management logic and relative diagnostics.

2.10 AUTOMATIC PALLET CHANGER (APC)

To guarantee operative continuity and precision, the machining center can be fitted with an APC which replaces the pallets automatically.

The unit, made up of a structure with 2 exchange posts, is situated in front of the longitudinal axis of the machine.

Each post is fitted with a pallet shifting device which constitutes a "pegged chain" commanded by an A.C. geared motor, and slideways in antifriction plastic.

2.11 MULTIPALLET

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The 6 position circular multipallet is formed of a welded steel structure on which the rotary magazine rests.

The 6 pallet-holder stations are fixed on one side to the central thrust bearing and on the other rested on rollers on the supporting structure.

Each station is fitted with roller slideways for the radial running of the pallets handled by a single central actuator. Loading/unloading is possible in all the radial positions and the rotation drives are controlled like an axis by the CNC.

All the movements are electro-mechanical with A.C. brushless motors.

The multipallet communicates with:
- the machining center (without the interposition of an A.P.C.)
- the load/unload stations
- buffer stations

The rotation speed of the magazine is 5 revolutions per minute and the managing logic follows the shortest route to the required position.

The carriages are fitted with systems for dripproofing.

2.12 POWER MONITOR

The Power Monitor is an instrument which, instant by instant, measures the current and tension absorbed by the spindle motor.

Converted into power, the signal is transmitted to the NC and shown on the LED display beside the machine.

When writing out the program, the value of maximum acceptable power can be associated to each tool: the NC compares this limit value with the power measured, carrying out the following procedures:

- When the measured power is more than the set maximum for over 5 seconds, the feed rate of the axes is reduced by 50% for a period of 5 seconds.

- If after 5 seconds the power absorbed by the spindle is still greater than the set limit, the feed rate of the axes is brought to zero, other wise it is taken up to 100% of the nominal value

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(in steps of 10%).

The device therefore not only functions as an adapting control, modifying the technological parameters according to the amount of stock or wear on the tool, but acts as a safety precaution against possible programming errors.

Thanks to the possibility of using macroinstructions, alternative procedures can be carried out which can be defined by the user with a view to keeping the machine running.

2.13 ELECTRONIC MEASURING PROBE

This is a probe formed from a fixed body and a shaft which is mobile in all directions; the deflection of the shaft activates the on-off type contacts which are used, together with the position of the machine axis, to carry out the following operations and checks:

- Rough workpiece check: for detecting the position and if necessary, moving the machine axes.
- Checking the workpiece being machined: measuring internal and external diameters, centering positions, distances between bores, rims, surfaces, etc.
- Final check: for carrying out a command on the machine for the most critical or significant machining jobs.

The procedures for the use and the available measuring cycles depend on the type and configuration of the numerical control.

The probe is loaded into the tool magazine and inserted into the spindle automatically, the same as any other tool.

The obtainable precision, to add to that of the machining center, varies according to the feedrate of the probe at contact point; at 25 mm./1', it is 0.01 mm. with repeatability equal to 0.005 mm.

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2.14 CNC PLASMA

The CNM PLASMA is born from the experience of Mandelli, leading company in the construction of machining centers and flexible manufacturing systems, intent on coupling their own machines with a modern and flexible numerical control which evolves and develops continually with the ideals of compatibility and standardization.

Plasma is born from three fundamental contributions of skill:

- the technology of machining by cutting chips, to obtain performances of excellence in terms of quality, precision and speed;

- the world of manufacturing, the knowledge of how a modern workshop of machining centers is organized, to fit out the CNC with all the necessary backup for the best utilization of the machine and its integration in the production flow;

- the culture of computer science, which has made it possible to build an avant-garde instrument, based on a multiprocessor structure and a multitasking operative system, easy to integrate into the more widely known market networks.

The integration of these skills has brought two essential aspects to the foreground:

- Facility of use: the ergonomics of the console and the software backup instruments guarantee a simple yet powerful man-machine interface, regarding both machine activities and perfecting programs.

- optimization of use: with both the stand-alone machine, or a machine inserted in systems such as cells or FMS, the Plasma, equipped computerized aids for planning, management and machine logic and with complete and highly developed diagnostics, guarantees the highest yielding productive capacity and the highest machining efficiency.

The programming language embraces all the standard ISO, but also permits the use of variables typical of a high level programming language through which it is possible to carry out operations of mathematics, tests, etc.

A certain number of system variables are also available which contain values within the CNC such as the measurements detected by probes, the

identification of pallets, the results of tests for tool presence etc.

The language permits the use of macro routines which can be nested to several levels for carrying out repetitive program cycles.

Some routines can be carried out directly by the machine after the occurrence of certain events such as for example the breaking of a tool; each of these routines can be written directly by the user or, alternatively, supplied by Mandelli.

Finally, in the Plasma not only are the programs and macro routines managed as files, but also the working offsets and tool compensations, the only limits for the latter being the saturation of the available memory.

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2.15 CNC PLASMA: Configuration of standard version

* 16 bit CPU
* 64 Kb standard memory with battery back-up (autonomy: 1 month)
  Optional: expansion to 256 or 752 Kb
* Highly ergonomical console
* 12" B/W display
* Data support with double 3"1/2 floppy disk unit (256 Kb each)
* Serial line RS232 with XON/XOFF protocol for connection to paper reader and DNC line for loading/unloading programs

OPTIONALS

* Integration in FMS and connection to ETHERNET with DECNET protocol for transmitting programs, machine status and production data
* Further serial line RS232 with XON/XOFF protocol

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2.16 CNC PLASMA: Technical features

AXIS CONTROL

* 12 simultaneously controlled axes
* 10 which can be programmed with a feed
* 5 in independent movement
* 2 in coupled movement (Gantry) (**)
* Linear interpolation on 5 axes
* Circular interpolation on any couple of axes
* Control of acceleration/deceleration and space gain for each single axis with adaptation to the one which is most penalized in interpolation
* Measuring system management with resolver, inductosyn, optical scales and encoder
* Resolution of 1/2048 of a mm or degree
* Accuracy of 1/1024 of a mm or degree
* Axis pursuit up to 57.6 mt/min

(**) optional feature

MACHINE CONTROL

* Integrated PLC
* Independent overrides for work feeds, rapids and spindle rotation speed
* Programmable override inhibition
* Up to 5 different compensations for the same tool
* Automatic length and radius compensation
* Independent clamping commands for each axis

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* Independent mirror image for each axis
* Automatic selection of spindle rotation range
* Direct programming of spindle rotation in rpm.
* Programmable dwell time
* Command for moving absolute zero reference

PROGRAMMING

* High level editing with complex functions
* Retention of several machining programs in memory
* Up to 32767 possible offsets for each axis
* Up to 32767 different tool compensations
* Coding of ISO, ASCII characters with automatic recognition
* Possibility for the use of flexible co-ordinates
* Metric or Imperial programming
* Feed programming in mt/min., mt/rev. or 1/T
* Parametric programming with variables (150 or more than 250 if used as vectors, arithmetical, trigonometrical or algebraic functions)
* Numerical values programmable with 12 digits and optional decimal point
* Instructions for unconditional or conditional jump according to the value of a variable
* Corrections from the program for tool length and radius values and values of offsets inserted in the files
* Up to 20 levels of macro nesting

OPTIONALS

* Helicoidal interpolation on any three axes

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* Guided threading

* 360 position spindle orientation

* Rapid management of measuring probe on two axes simultaneously, with result automatically memorized in variables

* Real tool life management with automatic selection of the available tool

* Management of multiple tool magazines

* Adaptive control system of the power absorbed by the spindle with adaptation of feed and speed and automatic call of a macro in the case of overpower

* Guided management of operations for inserting and extracting tools during machining time

* Tool code management actuated with bar codes and magnetic pads (reading only - BALLUFF)