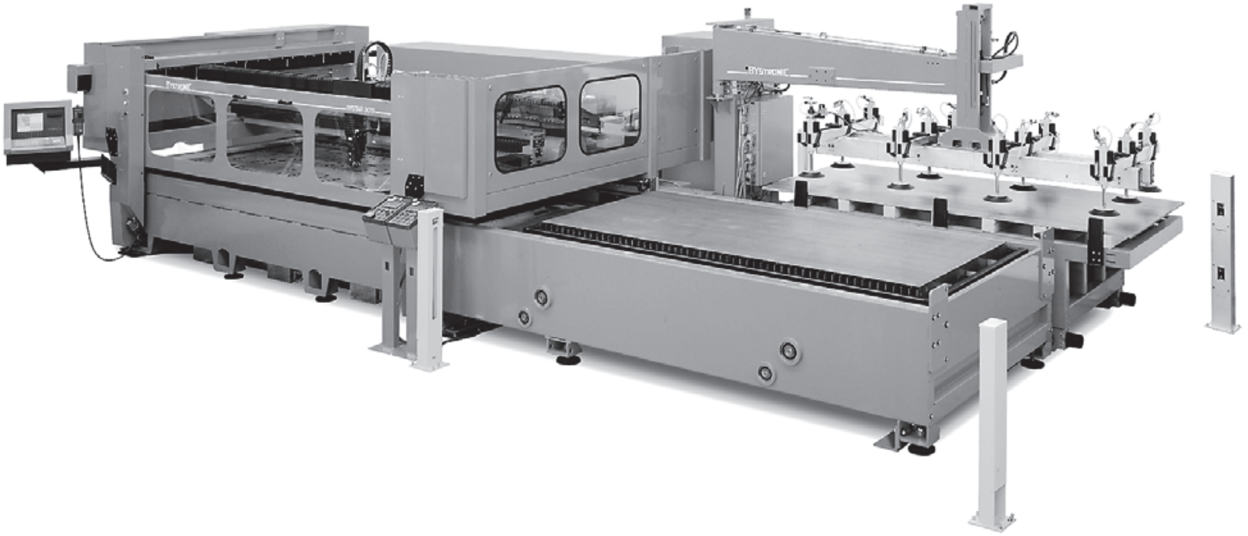
Operator’s Manual

BYSTAR



Bystronic Laser AG
Industriestr. 21
CH - 3362 Niederönz
Telefon + 41 62 956 33 33
Telefax + 41 62 956 33 80

Issue 05.2002

Order description: **Operator's Manual BYSTAR, Issue 05.2002, English**
Order number: **STBINH34.WEN**

Index of changes

	Chapter	Pages	Issue	File name
	Table of Contents	5	05.2002	STBINH34.WEN
1	Product description	17	05.2002	STBPBS06.WEN
2	Safety	10	08.96	LMBSIH03.WEN
3	Laser Series BTL	38	05.2002	LMBLAS08.WEN
4	Gas control	18	06.2000	LMBGAS04.WEN
5	Starting the Machine, MMC-Help & Parameters	23	01.2001	LMBHLP05.WEN
6	Beam path	27	07.2000	STBSTF13.WEN
7	Machining area	28	01.2001	LMBBER_05_V01_EN.FM
8				
9	Transport and Installation	9	02.98	LMBTRI05.WEN
10	Machining	48	07.2000	LMBLBE03.WEN
11	Appendix	5	07.2000	LMBANH02.WEN
12	Glossary	2	11.96	LMBGLO01.WEN
	Alphabetical Index	4	01.2001	STBINX33.WEN

Table of Contents

Operator’s Manual

BYSTAR

Product Description

Issue 05.2002

Table of contents

Introduction

Purpose

This operator's manual has been worked out to enable the users to get to know the machine, in order to best exploit its features in compliance with the specifications.

The enclosed manual also provides important information and supply the necessary instructions for an economic, competent and safe use of the machine.

We recommend to pay close attention to these instructions to avoid accidents, to reduce the cost of repair work and time loss, and extend the life of the machine.

Safekeeping of the machine documents

The operator's manual must be made available at all times at the site where the machine is operated.

Training

This manual was written for operators who have attended an operator training course at Bystronic or an introductory course at the customer site following the installation of a machine.

All persons entrusted to work on the machine must read these instructions before any activity, and thoroughly fulfill all safety regulations herein contained.

Working on the machine involves for example:

– the use of the machine, including commissioning, the repair work during operation, disposal of production-dross, maintenance, disposal of auxiliary and worned-out material;
– maintenance (up-keep, inspections, repairs);
– Transport

The analytical table of contents at the end of this manual will make it easy for the operator to find the desired information.

1 Product description

Documentation

The acceptance documents of the Bystar Laser Machine includes this operating manual and the following documents:

This manual was written for operators who have attended an operator training course at Bystronic or an introductory course at the customer site following the installation of a machine.

1 User Manual

This user manual describes the control and use of the machine and its components, and the safety devices, which are essential for the correct, economic and safe running of the machine.

Maintenance

The maintenance manual describes all the necessary operations for the maintenance, inspection and resetting of the machine.

Machine Documentation

The machine documentation contains the data that identifies the customer's specific product, the declaration of compliance and test documentation.

Machine logbook

All maintenance work, repairs, trouble-shooting and possible set-ups of the machine must be recorded In the logbook

Another empty directory may be used for inserting lists of parameters of your choice.

Spare parts catalogue

The spare parts catalogue contains views of the machine units and the list of their spare parts, as well as the address of all Bystronic branches.

Electrical equipment

This volume contains the circuit diagrams, the lay-out diagrams and the list of all the electric equipment.

Equipment Layout

This volume contains the diagrams, the storage plans and lists of the pneumatic and hydraulic devices.

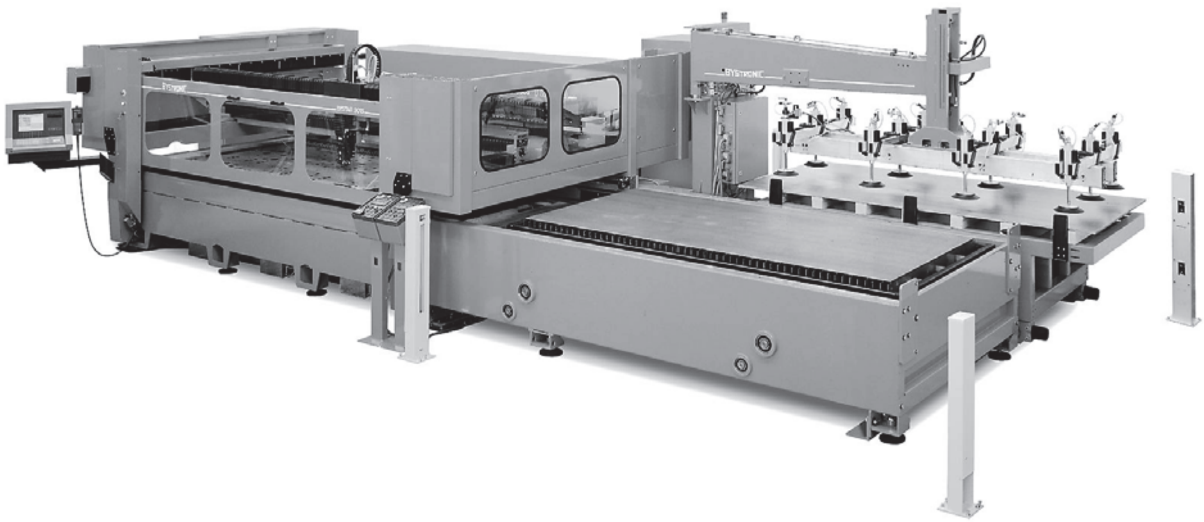
1.1 Construction principles

The tool of the Bystronic laser machines is the laser beam, the laser is fixedly fitted. The laser beam is guided to the workpiece through deflecting mirrors, by the principle of the "floating optical" system. The deflecting mirrors are all fixedly fitted on the axis of the machine. This ensures that the beam path from the resonator to the working head is well set. In case of operating errors, the beam is therefore prevented from dangerously hitting any of the surrounding areas.

The BYSTAR Laser machine is distinguished by the following characteristics:

- Highly dynamic operation due to the new CNC activation and control principle
- Versatility due to its modular design (shuttle table, sheet feed, integrated CNC rotary axis, loading and unloading device)
- Low running cost due to the use of the modern Turbo DC resonators
- Extremely simple programming of parts and cutting plans with the **Bysoft** software package
- Free access to the cutting area for machining flat sheets and tubes
- Servicing and supply worldwide by Bystronic

Overview of the machine in its standard configuration with a rotating loader



The following paragraph will give a brief description of the functions of the main components.

1.2 Machine components

1.2.1 Standard equipment

Machine Frame

The machine's robust chassis consists of a structure made of steel sheets and tubes. The machine frame supports the entire beam path which holds the carriage, the crossbar and the machining head. It was built with specific antivibration characteristics in consideration of the high accelerations of the machining axes.

The bottom part of the machine frame is divided into extraction chambers. In the extraction chamber in which the machining head is positioned, the valves are opened and the air containing impurities is extracted.

A conveyor carries the slag that fall through the rack supports of the grid to the disposal tray.

Machining table

The table with a built-in grid is used for supporting the workpieces during flat machining.

Grates

The grates may be made of various metals. Copper bars offer the greatest resistance to the effects of heat in time. Slag is easily removed. Nevertheless, the high reflectivity of copper may have a detrimental effect on thin sheets with small holes (the holes become imprecise) or when cutting with oxide (formation of plasma, interruption of beam). Bars made of steel and V_2A can be cut by the customer himself. The cutting plans are present on the hard disk of the PC-Panel. The life of these bars depends on the Laser power used for the cut.

Crossbar

The crossbar supports the carriage. The mirror in the crossbar deflects the laser beam in the direction of the axis of the crossbar.

Carriage

The carriage supports the Z axis. The mirror in the carriage deflects the laser beam vertically downwards in the direction of the machining head.

Z Axis

The Z axis moves the machining head in a vertical direction. It lifts the machining head above the workpiece to enable positioning on the various templates and keeps the distance from the nozzle constant even if the workpiece has an irregular shape.

Sensing

Optimum machining quality is dependent upon a constant distance between the nozzle and the workpiece. There are two ways of measuring this distance:

– By sensing (mechanical) in contact with the workpiece, the distance of all materials can be measured. Sensing is, however, used mainly for machining tubes and materials with no electrical conductivity. The distance is measured using a high-resolution potentiometer.
– Capacitive sensing is used for measuring the electrical capacitance between the nozzle and the workpiece. Capacitive sensing can therefore only be used with flat materials that conduct electricity.

By moving the Z axis, the distance between the nozzle and the workpiece is regulated to a preset value.

Machining Head

The machining head represents the last component on the beam path. Its built-in lens brings the laser beam into focus and enables it to reach the necessary density of power on the workpiece. The standard supply comprises 2 cutting heads with focal distances of 5“ and 7½“.

The process gas is fed in the machining head:

- During cutting, the gas pushes the fused material out of the cutting slot and prevents the focusing lens from being damaged by slag.
- During welding, the process gas prevents the oxygen in the air from reading the bead.

The process gas flow is modelled by the nozzle so that

- during the cut, as much gas flows through the cutting slot as possible
- during welding, the entire length of the bead is protected against reaction with the oxygen in the air

A more detailed description of machining head control is provided in the "Beam path" chapter.

Control Box and Panel PC

The control box comprises:

- Power supply
- ON/OFF switch
- Power distribution
- Safety circuits
- Programmable controller (PLC)
- Modules for driving the main axes

The PLC system checks the safety functions and the safety door. In addition, it controls the “optional“ components, if installed on the machine in question (see section “0)

The CNC system transforms the plans (nested part contours) and process parameters into axis movements, determining the path of the Laser beam on the workpiece by combining the movements of the crossbar, the carriage and the tool (and the rotary axis, if installed). In addition, it automatically adapts the speed of movement, process gas and Laser power to the geometric contour of the part to be produced.

The machine processes the programs irrespective of their order of entry. The system PC may therefore be used for creating or editing contours, while the machine is executing another program at the same time.

The CNC communicates with the machine operator by means of the MMC Software. The MMC Software is installed on the Panel PC. The MMC control instructions are described in the "Help and MMC Parameters" chapter of the manual. The help system may be accessed directly from the MMC Software by pressing the <Shift> and <F1> keys.

Control Panel

There may be up to two control panels present on the machine. On the shuttle table control panel or the Bytrans control panel there is an emergency button and keys for controlling the safety door. In addition, the control panel comprises keys for controlling the shuttle table, the rotary axis and the small parts conveyor, if installed on the machine in question. The second control panel controls feed by means of the rotating loader or the Bytrans.

A more detailed description of the control panel and its functions is provided in the “Machining arear“ chapter.

Laser Control Box

The Laser control box comprises:

- Gas control
- Laser control
- High-voltage device for generating the Laser beam

The gas control reduces the pressure of the Laser gases to the specified level, mixes them and supplies them to the Laser.

Using the Laser control, the laser device is activated automatically or manually in step mode. It controls the operation of the Laser and provides indications on the text display about the system pressure, power, line current, any faults present and the operating mode of the Laser device itself.

The gas control is described in the chapter entitled “Gas Control”.

Laser

The heart of the laser is the resonator, where the laser beam is generated. The laser gas consists of a mixture of carbon dioxide, nitrogen and helium. The turbocompressor produces a fast movement of gas along the axis of the resonator. The gas is cooled in the precooler and postcooler, so as to optimize the transfer of energy from the high voltage unit adjacent to the laser gas.

A complete section is dedicated to the laser.

Cooling Device

A large part of the electrical power absorbed is converted by the laser into heat. This heat is eliminated by means of the cooling device. The resonator, the laser gas and the entire optical system of the laser beam path are cooled by the cooling fluid circuit.

A description of the cooling device is provided in the documentation supplied by the manufacturers of the device (see the "Maintenance" section).

Operator Safety

Operator safety is ensured by the safety doors and the fixed guard panels, which are regulated according to the specific arrangement of the customer's machine.

If the non-linear or linear loading unit or the tube handling device is installed, user safety is also ensured by their light barriers.

During the cutting process, the safety door is always closed and protects the operator from:

- direct exposure to laser radiation
- reflected laser radiation
- slag expelled during machining
- risk of injury during crossbar motion

The light barriers protect the operator from the risk of injury during loading

1.2.2 Modular Structure

Interchange Table System

The interchange table system consists of an additional frame (loading frame) and two blades, which run above one another. By exchanging these blades, the machined workpieces can be removed and the next workpiece can be set in position while the machine is processing a program.

The functions of the shuttle table system are described in the "machining area" chapter of the manual.

Rotating Loader

The rotating loader is used for automatically loading the loading table once the machined workpieces have been cleared.

The functions and commands are described in the "loading unit" chapter of the manual. Respect the maintenance frequencies indicated in the maintenance manual and the "automation modules" chapter.

BYTRANS automatic loading / unloading system

The automatic loading and unloading system is used for automatically loading and unloading the loading table. The system enables a greater degree of machining automation with respect to the non-linear loader as the table can be cleared by the automatic loading and unloading system at any time (e.g. a cut lasting several work shifts, clearing during day shift).

The functions and commands are described in the "BYTRANS" chapter of the manual. Respect the maintenance frequencies indicated in the maintenance manual and the "Automation Modules" chapter.

Rotary axis

The rotary axis with the interchangeable spindle is used for machining tubes and profiles.

Spindle

The manual spindle control may be replaced with a pneumatic control system.

Tail stock

The tail stock is used to centre and support the workpiece while machining tubes.

The functions of the rotary axis and its options are described in the "Workstation" section of the instructions booklet. Make sure you respect the maintenance schedule indicated in the maintenance manual and in the "Workstation" section.

1.2.3 Optional Supply Package

Exhaust Air Filter

The exhaust air filter blocks most of the particles that are emitted during machining and can be extracted.
A description of the exhaust air filter is provided in the documentation supplied by the manufacturer of the device (see the "Maintenance“ booklet).

Additional Machining Heads

To obtain the best machining quality, some materials require the use of a cutting head with a focus length of 3 ¾“ in addition to the basic cutting heads supplied. A special welding head is available for welding operations.

Reflection Absorber

When machining materials with a high reflectivity, such as aluminium and copper, reflections may cause damage to the resonator. The reflection absorber absorbs the reflections so that they may not return to the resonator.

BYPOS Flying Optics

For machines with flying optics, the focus point changes over the working range of the plant. The greater the distance between the exit window and the lens, the deeper the focus point lies. The reason for this is a natural divergence of the laser beam. Due to this, different qualities of cutting arise for large working ranges.

With the use of adaptive optics (BYPOS), the focus parameters, independent of environmental influences such as the variable distance of the focussing optic, can be held constant by the laser in plants with "flying" optics, or even controlled to suit the process and workpiece.

Crossjet

The Crossjet system is equipped with a nozzle for oil mist which may also be used to direct a jet of compressed air without oil onto the workpiece.

- By applying a thin coat of oil on the area before carrying out the piercing operation, you can stop splashed material sticking to it.
- The compressed air jet is used to expel splashed material during piercing operations.

A more detailed description of how to use the scan, the machining head and the Crossjet system is provided in the “Beam Guide“ chapter.

Cut Control

The Cut Control checks the cutting process by using stainless steel fusion. The process control is based on the light given out by the piece being processed and regulates the feed or stops the cutting process.

The Cut Control is fitted inside the machining head. The cutting heads with integrated Cut Control are identified by an adhesive label.

For a detailed description, see the chapter "Beam path".

1.2.4 Programming software **Bysoft**

Using the **Bysoft** software module, a wide variety of geometrical forms and finished cutting plans may be obtained. The software module may be activated from either the Panel PC or an external station. A description of the **Bysoft** programming software is available in an additional manual or via the Online-Help service.

1.3 Power supply and process materials

1.3.1 Electric diagrams and energy connections

The diagrams of the electrical, gas, hydraulic, pneumatic and coolant systems are in the “Equipment Diagrams“ and “Electrical Equipment“ booklets. This volume also contains the signal exchange, travel end, cable connection and installation diagrams.

1.3.2 Type and usage

Pneumatic Unit

The supply unit conditions the compressed air coming from the compressor.

- The supply unit is used to supply the pneumatic cylinders and valves with compressed air.
- Purified air is fed into the beam path. The overpressure created in this way in the beam tube prevents the penetration of vapour and particles of dirt.
- The exhaust filter has a separate air supply!

Hydraulic Unit

(only for machines with a BYTRANS rotating loader. Also for repositioning machines and BYLAS machines)

The hydraulic control unit provides the hydraulic pressure required by the following circuits:

Cooling water

A stable working temperature of the laser beam is obtained by cooling. Presetting the temperature for the gas allows an ideal energy transmission to the laser.
Also the laser control cabinet and the CNC control cabinet, the machine mirrors and the working head are water-cooled.

Energy supply

The machine is provided with a central energy intake port. The cooling device and the air exhaust filter are separately connected to the power line.

Gas

The storage of the necessary gas, according to the specific needs of the customer, will be in cylinders, in bundles, and also partially in tanks.
The process gases will influence the quality of machining. The laser gases are decisive for the correct functioning of the laser. It is therefore recommended to respect the requested gas characteristics.

Other process materials

Trade name	Use
Anticorit BW 366	Anticorrosion wax
Motorex Gearsynt 220	Gear oil
Chain lubricant WKS	Chain lubricant
Molykote DX Pasta	Rack grease
Motorex Universal Grease EP 190	Guide grease
Motorex Proweld 264	Welding protection for Crossjet
Acteon	Lens cleaner
Motorex Renolin MR 15	Hydraulic oil
Oil turbo blower pump F12	Oil for resonator turbines
Compressor Oil G32	Oil for vacuum pump resonator

1.4 Appropriate use

The machine is a state-of-the-art product, as well as meeting all safety regulations and satisfying EEC rules for machines tools. It is equipped with safety panels, light barriers, safety doors, safety switches and emergency stop switches in order to ensure the highest degree of safety.

However, the machine can still cause danger to the life of the user or third parties, if incorrect operations are attempted or operations for tasks the machine was not designed for. The safety of the machine will be guaranteed only if:

- due attention is given to instructions and the working cycles are respected.
- the operator has been trained and fully briefed for the work on the machine;
- the range of responsibilities of each person is clearly defined and respected if more than one operator will be running the machine;
- all persons not directly involved with the process are not allowed to atted the premises
- the operator does not attempt any operation that may endanger safety
- all errors and troubles, that may endanger safety are promptly eliminated.
- the user strictly respects all conditions of inspection and maintenance,

The machine is destined to the cutting, welding, industrial hardening of flat materials, round tubes and profiles.

The machine and discharge air purification are designed for: ferrous metals, aluminium, titanium, brass and their alloys.

***Materials**, which develop poisonous gases with evaporation, require special withdrawal systems, or auxiliary filters in the withdrawal systems.*

Changes made to the application and/or auxiliary conditions without the written authorization of the manufacturers are made at one's own risk.

1.5 Identification

Identification plates

The plates are fitted

- on the STL cabinet, above the main switch
- on the laser, under the laser output
- on the Cross Bar
- on the machine frame
- Rotating loader / BYTRANS (on request)

The data to be found on the plate depend on the type of the specific machine. They can be found on the order confirmation in the volume “Machine documentation”.

Conformity

The declaration of conformity is in the volume “Machine documentation”.

1.6 Technical data

For the technical data of the rotating loader and BYTRANS loader, see the relevant chapter of the manual.

Machning Centre

Work range:			
X Axis	BYSTAR 3015	mm	3’000
	BYSTAR 4020	mm	4’000
	BYSTAR 4025	mm	4’250
Y Axis	BYSTAR 3015	mm	1’500
	BYSTAR 4020	mm	2’000
	BYSTAR 4025	mm	2’500
Z lifting axis		mm	170
Standard chuck		mm	10-340
Locking length	BYSTAR 3015	mm	2’700
	BYSTAR 4020	mm	3’700
	BYSTAR 4025	mm	3’700
Machining precision:			
Machining tolerance VDI 3441		mm/m	±0.1
Repeatability tolerance		mm	±0.05
Positioning tolerance U Axis		°	0.03
Measuring edge precision:			
Measurement tolerance (well formed edge)		mm	±0.5
Repeatability tolerance		mm	±0.2
Speed:			
Position simultaneous axis movement		$^{m}/_{min}$	max 169
Of cutting		$^{m}/_{min}$	≤50
Of exchange tables (slow / fast)		$^{m}/_{min}$	5.5/35

Supports capacity load:			
Lifting table interchange	BYSTAR 3015	kg	890
	BYSTAR 4020	kg	1’580
	BYSTAR 4025	kg	1’980
Fixed table panel		kg	3’500
Carriage, Cross Bar, Z axis motors:			
Direct current without reduction			
Standard colour:			RAL 2004

The speed of machining, the workable thickness of the piece and the consumption of gas depends most of all on the power of the laser, the material, the kind of machining and the quality of machining required.

More detailed information is given in the chapter “Gas Control”, “Machining”.

Power Supply and Connections

Electrical power supply:			
Three-phase electrical connection, +PE		Hz	50/60
Machine: cos 0.91, 100 AT, 4-pole		V	3x480/400
Exhaust air filter: cos 0.91, 25 AT, 4-pole		V	230/400
Oscillations *)[1]		%	+6, -10
Free of faults (spot welding system)			
Connection values:			
Machine/laser /cooling device	Laser 30	kVA	54.0
	Laser 40	kVA	70.0
	Laser 22	kVA	40.0
Non-linear loading		kVA	2.5
Loading and unloading system		kVA	4.5
Exhaust air filter (Herding)		kVA	5.2
Cooling water:			
Closed circuit with cooling device			
Water flow rate		$^{l}/_{min}$	75
Water starting temperature *)[2]		°C	19
Water temperature constant		K	± 1
Impurities		µm	< 50
Maximum conductivity allowed		$^{\mu S}/_{cm}$	< 6000

Without flux. Ideal pH value		-	7
Cooling water pressure		bar	4-5
Connection piece		Zoll	1"
Machine air:			
Minimum input pressure		bar	6
Maximum machine air consumption		Nm3/h	20
Maximum air consumption of chuck locking device		Nm3/h	5
Maximum diameter of particles		µm	5
Maximum density of particles		mg/m^3	5
Maximum residual oil content		mg/m^3	0.1
Condensation point under pressure (class 4 or better)		°C	3
free of solvent vapours			
Connection piece		Zoll	1/2"
Exhaust air filter air:			
Minimum input pressure		bar	6
Maximum filter cleaning consumption		Nm3/h	10
On the avarage filter cleaning consumption		Nm3/h	0.2
Quality: free of water; max. residual oil content		mg/m^3	0.1
Connection piece		Zoll	1/2
Process gas:			
Diameter of pipe: dependent on length			
Quality of pipe: copper/VA, non-oxidized			
Outer diameter of connection piece		mm	12
Dynamic N_2 primary pressure 1100 l/min		bar	25
Dynamic O_2 primary pressure 400 l/min		bar	18

The client shall provide the necessary connections for power, water, gas and compressed air to the machine.

*)[1] If the input voltage is too low the pulse peaks cannot be guaranteed.
*)[2] In case of high humidity in the air, the water input temperature can be raised to 5 °C, to avoid the forming of dew

Diagrams concerning the process gas consumption in relation to gas pressure and nozzle diameter are in the chapter "Gas control".

Environment Conditions

Thickness of concrete foundation	mm	300
Concrete type B 300/DIN 4225	$^{N}/_{cm^2}$	0,8-1,0
Floor load		
Floor evenness over 5 m	mm	± 5
Ambient air quality:		
Absence of solvent substances		
Min. permissible ambient temp.	°C	15
Max. permissible ambient temp.	°C	35
Dew point	°C	< 10
Relative humidity in the air	%	< 70

It is important to make sure that the laser and the machining centre are placed on the same foundation (same vibration transmission). The other components of the system can be placed on separate foundations. We recommend having the foundation checked by a skilled technician.

Weight and Dimensions

		L x W x H [m]	Weight [kg]
Base frame with table	BYSTAR 3015	4.6 x 2.2 x 1.1	4’800
	BYSTAR 4020	5.8 x 3.9 x 1.2	8’770
	BYSTAR 4025	6.4 x 4.5 x 1.2	9'850
Carriage and Cross Bar	BYSTAR 3015	5.1 x 0.8 x 1.3	800
	BYSTAR 4020	6.1 x 0.8 x 1.3	900
	BYSTAR 4025	6.1 x 0.8 x 1.3	900
Safety door	BYSTAR 3015	4.0 x 2.0 x 0.3	250
	BYSTAR 4020	5.0 x 2.0 x 0.3	310
	BYSTAR 4025	5.0 x 2.0 x 0.3	310
Laser	Laser 30	3.2 x 0.95 x 1.8	1'600
	Laser 40	2.5 x 0.80 x 1.7	1'600
	Laser 22	1.95 x 0.90 x 1.9	1'400
Cooling device (Furrer)	WKL 400	2.2 x 1.0 x 2.0	970
Cooling device (Hyfra Pedia)	HT 50	1.2 x 0.9 x 2.0	450
Cooling device (KLH)	SC 31	2.0 x 0.9 x 1.95	880
STL,CNC Cabinet		1.8 x 0.5 x 1.9	600
LAS Cabinet		0.9 x 0.85 x 1.9	200
Modular extension:			
Shuttle table			
intermediate frame			500
lifting unit			1’000
Drive unit			800
2 tables per			400
Rot. axis (with tailstock)		0.8 x 0.5 x 0.5	170
Additional equipment:			
Exhaust air filter system			1'400

Laser

Beam characteristics:		Unit	Value
Wave length		µm	10,6
Guaranteed output power	Laser 30	Watt	3’000
	Laser 40	Watt	4'000
	Laser 22	Watt	2'200
Power adjustment	Laser 30	Watt	150-3’000
	Laser 40	Watt	150-4’000
	Laser 22	Watt	150-2'200
Power stability (24 h)		%	± 1,5
Beam quality:			
Diameter (de-coupling, $1/e^2$)		mm	12
Divergence (semi-angle,Laser)		mrad	< 1.2
Divergence (semi-angle, widening)		mrad	< 0.8
Directional stability		mrad	< 0,1
Power distribution TEM		-	00/01*
Beam quality factor M^2		-	1.9
Polarization			zirkular
Pulse characteristics:			
Pulse frequency		Hz	1 bis 2500
Normal pulse width		µs	10-1500
Max. pulse peak (accordingly to width)		kW	3.8
Reflected radiation protection:			
Direct Radiation, Safety Class DIN L5A	Laser 30	W/cm^2	2650
	Laser 40	W/cm^2	3030
	Laser 22	W/cm^2	
Reflective Radiation:			
Safety door window, polycarbonate		mm	4

Laser gas consumption (minimum values.):			
Laser gas input pressure		bar	5
Helium min. purity: 99,996%	Laser 30	$^{Nl}/_{h}$	35.0
	Laser 40	$^{Nl}/_{h}$	36.0
	Laser 22	$^{Nl}/_{h}$	25.0
Nitrogen min. purity: 99,999%	Laser 30	$^{Nl}/_{h}$	18.5
	Laser 40	$^{Nl}/_{h}$	28.0
	Laser 22	$^{Nl}/_{h}$	12.0
Carbon dioxide min. purity: 99,995%	Laser 30	$^{Nl}/_{h}$	1.5
	Laser 40	$^{Nl}/_{h}$	2.0
	Laser 22	$^{Nl}/_{h}$	1.2

For information on the power of the laser cutting machine, see the Laser Parameters chapter of the manual.

1.7 Necessary space for control and maintenance

The necessary minimum space for the laser machine can be calculated from the lay-out diagrams in the volume "Machine documentation". To ensure the operation of the machine without any hindance, please allow for the necessary space for the following:

Loading: Manual loading, through crane/lifting fork.

Disposal: Removal of scraps from machining of tube and templates.

Unloading: Possible storage of workpieces.

Gas Feeding: Access to the gas cabinet with the appropriate transport equipment.

Maintenance: Free access for replacement of components, possible with auxiliary means.

Operator’s Manual

Laser Machine

Safety

Issue 08.96

Table of contents

2 Safety Warnings

Safekeeping

Keep these operating instructions at hand near the machine at all times.

Training

All persons entrusted to work on the machine must read and thoroughly follow these instructions before beginning any activity. In particular all safety regulations herein contained, must be respected.
The machine can be operated and serviced by trained personnel only. Also the minimum age limit for machine operators must be absolutely respected.

Supplementary instructions

Besides all use and maintenance instructions, and the accident-preventing rules enforced in the country where the machine is operated and on the work location, also the specific regulations concerning the safety on the job and the qualification of the personnel must be complied with.

Warranty

During the warranty period, possible faults will be dealt with by the warranty conditions of Bystronic. Any consequence of modifications or variations arbitrarily carried out will be considered as user's responsibility. This is particularly valid for those modifications compromising the safety of the machine.

Technical modifications

The builder reserves the right to modify the specifics of the machine in order to improve its performances even if they might differ from informations and descriptions contained in this manual.

2.1 Warning notes and symbols

In the operating instructions the following symbols will be used:

Danger:

Imminent hazard possibly causing severe injuries or death.

Warning:

Possible hazardous situation with potential injuries or death.

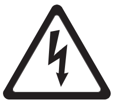
Caution:

Possible hazardous situation with potential light bodily damage or damages to objects.

Notice:

Operating precautions not related to hazardous situations.

Imminent hazard from **overhung loads** with possible severe injuries or death. Observe all prescribed instructions for handling overhung loads.



Imminent hazard from **high voltage**, with possible severe injuries or death.

Imminent hazard from **laser radiation** with possible severe injuries or death. Avoid contact of skin and eyes with direct and indirect radiation. Wear protective laser glasses.

2.2 Organisational precautions

Company directive

These instructions should always be kept at hand in the compartment provided for this purpose.
Observe and enforce all statutory or otherwise applicable accident prevention rules that may have to be fulfilled in addition to the provisions contained herein!
Such rules may concern the handling of hazardous substances or the use of personal protection equipment.
These operating instructions should be completed with all other relevant company's directives, including supervision and reporting requirements. (E.g. with respect to labour organisation, job procedures, personnel).
All personnel using the machine must first read these operating instructions, and specifically the chapter entitled "Safety Instructions" before commencing work. Once the machine is in operation it will be too late.
Perform at least occasional checks to ensure that all personnel using the machine is aware of the relevant safety and hazard instructions and observes the necessary precautions!
Where necessary or required by applicable regulations, provide personal protection equipment. (shoes and goggles for laser class 4) and enforce its use!
Make sure that the safety and hazard warnings affixed to the machine are duly observed. Keep warning labels in a perfectly legible condition at all times!
Immediately switch-off the machine if unusual noise or vibrations are observed and report this condition to the responsible supervisor.
Don not perform modifications to this machine without prior consultation with Bystronic.
Observe the prescribed frequency for periodical checks indicated in the operation instructions.
Inform all personnel about the location and proper use of the fire-extinguishers!
Observe fire reporting and fire fighting regulations!

Personnel qualification

Only reliable personnel must be allowed to work on or with the laser machine. Observe the statutory minimum age limits!
Use only trained and appropriately instructed operators. Ensure that all personnel responsibilities concerning the operation maintenance and repair of the machine are clearly defined!
Ensure that the machine cannot be run by unauthorised personnel!
Provide an appropriate definition of operator responsibilities and allow operators to refuse third party instructions if these are not in accordance with applicable safety rules.
Apprentices, trainees and other personnel not fully qualified for using this machine must only use it under the supervision of an experienced staff member!
All work on electrical systems shall be restricted to qualified electricians observing applicable regulations and codes of practice.
Personnel working on gas-carrying systems (gas consuming system) must be duly trained for these functions.
Hydraulic system work must be carried out by personnel possessing the necessary knowledge and specific experience in the filed of hydraulics.

2.3 Safety instructions for specific operating phases

Normal functioning mode

The Normal Functioning mode is the mode of the intended use of the machine as cutting and welding.
Avoid all unsafe operating conditions!
Adopt measures for the safe and proper functioning of the machine!
Do not start the machine unless all protective features and safety devices (e.g. removable protection systems, emergency shutdown features, soundproofing, extraction devices) are in place and fully operable!
Check the machine for visually detectable damages or faults at least once per shift! Immediately report changes (including operating changes) to the responsible supervisor/unit! When such condition should be detected immediately stop the machine and make it safe through the appropriate safety devices!
When detecting any malfunction immediately stop and secure the machine! Provide immediate intervention for the removal of the fault!
Observe the start-up and shutdown procedures as well as the control messages as described in the Operating Instructions Manual!
Before starting the machine make sure that that does not cause hazard for anyone!
Keep shut all guards and enclosures!
Do not stop or remove extraction and ventilation systems while the machine is in operation!

Special functioning mode: (special machining)

The Special Functioning mode is the mode to allow the normal functioning of the machine, such as the manual functioning while carrying out set-up operations, maintenance interventions inspections or adjustments of the working head.
Observe all prescribed interventions as well as the prescribed intervals in between of adjusting, maintenance and inspection of the machine. Also observe all instructions concerning replacing of spare units or partial set ups. These operations are exclusive competence of qualified personnel.

Supplementary warnings for maintenance and repair

All operations of maintenance and repair must be carried out after shutdown of the machine, unless these operations require special functioning. All interventions are exclusive competence of qualified personnel.

2.4 Information about specific hazard types

A detailed description of the risks due to radiation and electricity is provided in the documentation distributed at the Bystronic accident-prevention course. Bystronic laser machines should only be serviced and repaired by staff instructed and informed as indicated in the documentation distributed at the accident-prevention course.

2.4.1 Radiation

In the normal operation the machine meets Laser Class 1 with fully enclosed laser beam. All enclosures must be in place. The exclusion of blocks by electrical jumper settings is prohibited.
The protective door provides protection against diffuse and reflected radiation. It is not necessary to wear protective glasses against diffuse and reflected radiation. We recommend, however, that you wear antiglare glasses if you have to observe radiation for a long time during machining. (Level 1.7-4)

Special mode

In special mode, the machine belongs to laser class 4. The direct and reflected laser beam and diffuse radiation can cause damage to the eyes and skin. Mark the laser operating area clearly! Cover reflecting objects or move them aside. Keep inflammable objects away and make sure that no explosive solvent vapours may form.

Direct laser beam

The direct laser beam may cause severe injury to any part of the body!
Never expose yourself to direct laser radiation!
From the design point of view, protection against direct laser radiation is obtained by assembling all the optical elements in a fixed position and allowing movement along the axes only. The optical elements are fixed so that the laser beam moves on a horizontal plane and is deflected for machining vertically downwards.
Do not alter the way in which the optical elements are fixed!
Further protection is provided by the size of the elements and control procedures. The working procedure for special mode is described step by step in a preset sequence. In special mode, the laser beam is not produced until the pulse key on the manual control device is pressed.
Follow the indications given in the operator's manual to protect yourself against direct laser radiation!

Reflected and Diffuse Radiation

Avoid exposing your eyes and skin to reflected and diffuse radiation. When working in special mode, wear laser safety glasses.
Use laser safety glasses which are in accordance with DIN 58215 safety class L5A standards. These type of safety glasses are available in speciality stores or Bystronic Laser, part no. 8701016.
These safety glasses provide sufficient protection against reflected and diffuse radiation emitted by Bystronic CO_2 laser machines. These glasses absorb reflected and diffuse radiation with a wavelength of 10.6 μm.

2.4.2 Electrical hazards

Use original fuses only, suitable for the prescribed amperage! In case of malfunction, switch the machine off immediately!
Work on electrical systems or equipment must be carried out by a qualified electrician or appropriately trained personnel supervised by a qualified electrician, in compliance with the rules of electrotechnical practice.
All parts on which inspection, maintenance or repair work is performed must be de-energized where indicated. Check that the disconnected parts are in fact at zero-voltage, earth them and short-circuit them as well as insulate the adjacents parts with tension!
Periodically inspect the electrical equipment. All defects, such as charred cables and loose cables, must be immediately repaired.
In case of interventions on parts with tension, call a second person who can, if necessary, operate the emergency shut down or the main switch. Mark off the area with a red-and-white safety chain and a warning sign. Use electrically insulated tools only!

Before working on high voltage assemblies, de-energise the system, and connect the power supply cable to earth and short-circuit the components (e.g. with an earth-rod)!

2.4.3 Hydraulic and Pneumatic systems

Work on hydraulic systems must only be performed by specially trained and experienced personnel!
Check all pipework, tubes and screw-fittings for visible damage! Eliminate defects immediately! Oil leaking can cause injury or fire. Before opening assemblies and pressure lines (hydraulic, compressed air) to do repair work, de-pressurise according to the instructions in the operating instructions volume!
Hydraulic and pneumatic tubes must be set and fitted accurately. Do not confuse connections.
The valves, as well as length and quality of flexible tubes must meet the specific requirements.
Never perform assembly or disassembly work while the system is still under pressure (including tightening or slackening of screw fittings), to avoid bursting parts or gas leaks that may cause injury.

2.4.4 Gas, Dust, Vapour, Fumes

Works such as welding, flame cutting or grinding require approval as they may cause fire or explosion hazard!
Before commencing welding, flame cutting or grinding work, clean the machine and its surroundings of dust and inflammable materials and provide sufficient ventilation (explosion hazards!).
Provide adequate ventilation when working in small rooms! (Observe national regulations where applicable)!

2.4.5 Hazards due to materials and products

Product interaction hazards

Before exposing any chemical to intensive laser radiation, make sure that possible evaporation, combustion, chemical reaction or fumes formations can not cause concentrations of fumes gases, dusts or even explosive mixtures, that could be dangerous for health or human lives.

Fundamentals

In the machining of materials with the laser beam, the emissions of the the workpiece material or auxiliary agents, material residue, slag, dust, fumes or gas/vapours. The emission levels and the slag concentration will vary according to the machining process and the material. While metal cutting results mainly in slag formation processes, plastic welding tend to release fumes and gases.

- Auxiliary materials warranting particular attention are mainly aggressive oils. Use protective gloves and glasses.
- Please note local regulations on the disposal of metals and special waste.
- The fumes may pose a health hazard due to absorption via the skin or respiratory tract. A distinction must be made between sensitzing, toxic and carcinogenic effects.

The hazard levels are expressed in terms of a maximum allowable concentration (MAK, maximum concentration at a given place of work). These threshold figures are derived from comparative studies, experiments and theoretical comparisons. Where no such basic research is available, an TRK (engineering guideline concentration) is adopted.
For applicable MAK and TRK levels please consult your local regulations. The values quoted herein (Swiss SUVA level) can only provide a rough outline.

- Emissions levels are generally minimum if an optimum parameters setting is used.
- The increase of cutting speed, due to the increment of the laser power, will diminish the quantity of emissions for every meter cut.
- Galvanised steel and chrome-nickel steel will produce more emissions for every meter cut if compared to steel not alloyed, even in the case of optimum parameters and equal thickness of the panel.
- The particle size distribution may vary. Approx. 80% of particles released into the air are respirable (0.3-5μm).

- The generating process, the nature and the effects of polluting substances going through lungs can be compared to polluting substances emitted when thermical cuttings, such as gas, plasma or arc cutting are performed.
- Metals, alloys and relative oxides are considered solid polluting materials.
- Toxic gases from the process or material used include ozone, nitricoxides and carbon monoxides.

Notice:

See also the attached list of possible emissions!

Safety measures

Occupational safety

Material analysis including coatings, films or paintwork (see above notes).

Metal working

- Thanks to the technical characteristics of the equipment studied by Bystronic, the compliance with the MAK values prescribed for metal machining has been certified in the cutting of structural steels, and of CrNi steels of average alloy.
- Measurements showing compliance with applicable threshold levels (including for carbon, sulfur, nitric oxide and ozone) of comparable exhaust are also available for AL_2O_{3-} ceramics, anticorodal and oiled steel and aluminium plates (Swiss Control Institute for Work-Safety).

Where more stringent local MAK levels are imposed or emission thresholds are enforced for other metals, alloys or plastics, the specified maximum levels must be determined by the customer. Systematic emission measurements are currently beeing conducted within EUREKA project n. EU 643. This research is coordinated by the Laser Zentrum of Hannover.
The exhaust extraction system must be switched on as soon as the machining process begins.

Environment protection

Plastic machining applications require the use of multi-stage mechanical filters and activated charcoal filtering systems. In some cases, electrostatic precipitators or wet filters may have to be added.
With regard to slag and filter residues , observe rules and regulations concerning the disposal of special waste.
The emissions released into the air during the laser machining process must be vacuum-extracted. A two-chamber extraction system is provided on the machine. Compliance with Bystronic’s technical data is mandatory. An extraction and filter system meeting these requirements can be ordered as an option.
In case of machining pieces that do not cover the entire surface on the chamber extraction system, it is advisable to cover the remaining surface with other materials. In this way the efficiency of the extraction system will increase.

2.4.6 Noise

The sound-proofing systems provided for the machine must be fitted while the machine is in operation.

2.4.7 Lubricants, cooling, cleaning agents

Always observe the applicable safety regulations when handling oil, greases or other chemical substances!
Avoid any prolonged skin contact with the above mentioned substances. If necessary use protective gloves, goggles or aprons. Apply suitable skin protection ointment before commencing work.
Change oil-soaked clothing immediately. Do not carry oily rags in the pockets of your clothing. Avoid inhaling oil-mist or vapours.
Avoid the contact of aerosol cans with hot objects, gases or vapour. Such containers are explosion hazards!

Caution:

Danger of fire and explosion
laser radiation

The proper disposal of lubricants, cooling fluids or cleaning agents is the responsibility of the machine user.

2.4.8 Injures caused by machine movement

Before entering a dangerous area, cut off the machine power to avoid bodily harm.

2.5 Safety and Protection Features

In accordance to the applicable machine safety regulations, precautions have been taken to safeguard the danger areas.
It is the responsibility of the machine user, to mount the planned barriers and to periodically check their function.
Protection and safety components can be removed, modified, or in abled only if absolutely necessary for transport and repair, and only when all due precautions have been taken to prevent hazards to life and health of persons as well as actions taken to prevent any damage and breakage of machine components.
Before commissioning the machine, it must be ensured that all safety components are in place as well as all hazard points are safeguarded in compliance with local safety regulations.

To the safety components belong:

- safety door
- cabinet doors
- high voltage covering laser cabinet
- Plexiglas covering upper part of the laser
- service tube shutter
- wing doors upper part of the laser
- service covering lower part of the laser
- protection fence

modular expansion:

- light barrier

2.6 Emergency Measures

The cabinets for the machine control and the high voltage supply are equipped with emergency stop buttons, which will shut off the machine in case of an emergency.
By activating the emergency button the laser stimulator (high voltage supply) and all axis drives are shut off. The machine control system remains active so that process sequence data are preserved and that a quick re-start is possible. System messages will give information to the cause that lead up to the emergency stop.

Emergency stop buttons are mounted on:

- CNC cabinet
- PLC cabinet
- laser cabinet
- hand terminal
- operator console

2.7 Information signs

All the warning signs must be affixed and legible. In case of a substitution of a sign, the new sign must be fitted on the same point. The precise location of all signs is contained in the appropriate chapter of the operating instructions.

Hazard signal for laser radiation

- on the beam protection tubes
- on the laser door close to the beam output
- on the expansion lens system
- on the tool enclosure
- on the cutting head

High Voltage warning signs

- on the plexiglas cover on the resonator
- on the resonator
- on the turbo
- on the frequency converter
- on the enclosures of the high voltage panel in the laser cabinet

Operator's Manual

Laser Cut

Laser 30 / Laser 40

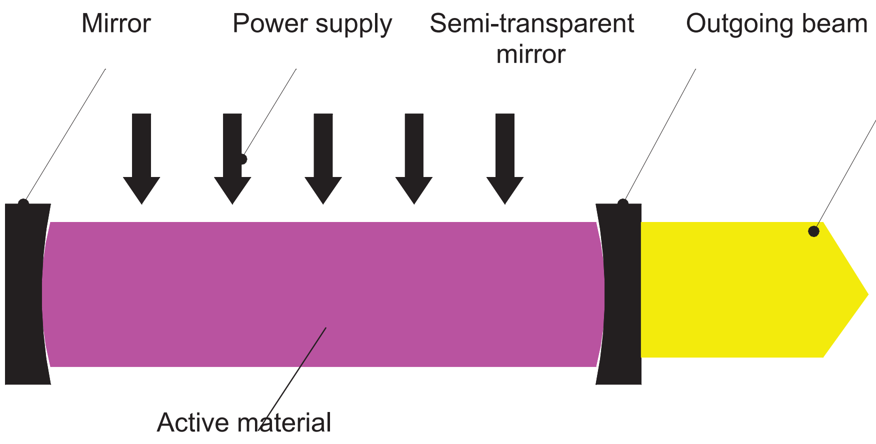
Issue 05.2002

Table of contents

3 Laser

3.1 General description

Operation



Laser machines are light-generating systems. The laser beam is comparable to traditional light sources:

- parallel (minimum divergence)
- coherent (the waves are in phase)
- monochromatic (narrow spectrum of wavelengths).

A laser system essentially consists of three components:

- **The energy source**, that gives the power supply to an
- **active material (light amplifier)**, which absorbs the power supply and is enclosed in a
- **resonator**, consisting of (at least) two mirrors, placed at a fixed distance from one another.

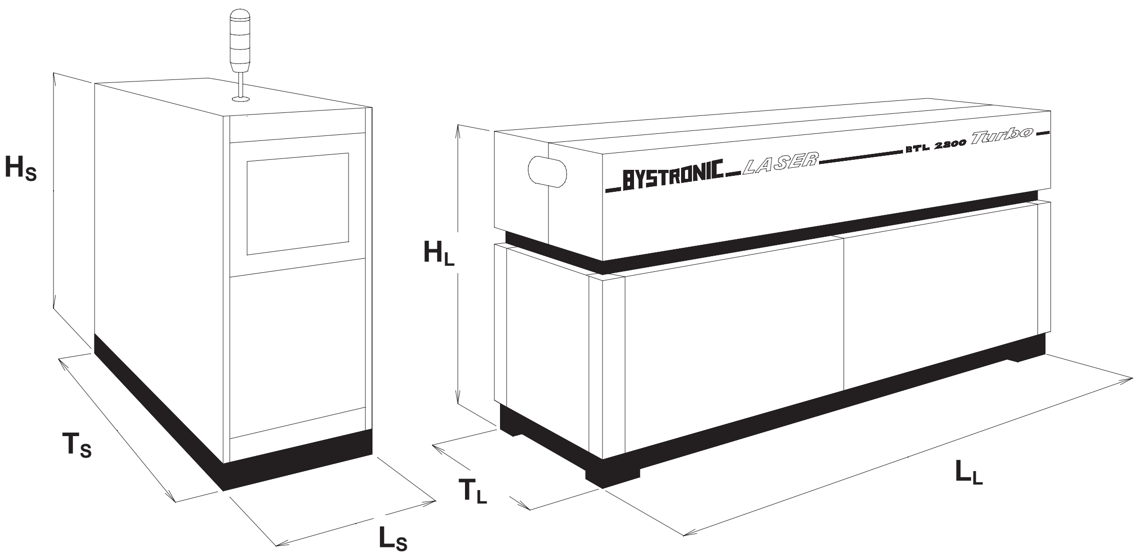
The Bystronic lasers of the BTL series have been designed as industrial tools for the machining of materials.

The active material used is a gas mixture composed of carbon dioxide, nitrogen and helium. The construction principle is based on the speed of the gas on a direction axial to the resonator. The speed of the axial gas flow allows an effective cooling of the gas and therefore a good transmission of energy to the resonator.

The axial flow of the gas is generated by a fast vibration-free radial turbine, which allows a large gas circulation with few pulses.

The radial turbine is water-cooled. The cooling down of the gas is ensured by a chiller placed in the gas return tubing and by two chillers placed in the gas supply tubing, allowing a high efficiency of the laser beam. The gas chillers are equipped with cooling coils and a water cooling jacket. These prevent the radiant heat in the upper part of the laser from compromising the positional stability of the beam.

3.1.1 Lay out and dimensions



Overall dimensions of laser control cabinet and the laser

Control Cabinet		Laser	
Laser 30	**Laser 40**	**Laser 30**	**Laser 40**
L_S 850 mm	L_S 1050 mm	L_L 3150 mm	L_L 2450 mm
T_S 900 mm		T_L 800 mm	T_L 800 mm
H_S 2000 mm		H_L 1700 mm	H_L 1700 mm

3.1.2 Laser

The laser series are all built using a chassis of the same width and height. Lengths of the construction differ based on the power classification. Production of the laser beam takes place in the upper part of the laser. The Laser30 work with a level of deflection and using a low number of mirrors. On the Laser 40, two levels of deflection are necessary with a total of three folds. The kinematic suspension of the resonator allows a maximum position and mode stability in cold and hot operating conditions.

The gas supply and gas exhaust systems are symmetrically arranged. This layout differs from conventional systems since it ensures a compensation of the vacuum forces influencing the resonator.

This well studied resonator design will generally allow a replacement of lens systems without further readjustments. All optical system components are electrically grounded, easily accessible, and clearly arranged. Several fans in the top part of the resonator unit provide an adequate air circulation. A water heat exchanger keeps the air at the ideal working temperature.

3.1.3 Excitation

The laser is operated through the electric excitation of the active gas mixture. This function is performed by a d.c. excitation.
At full load, voltage on the discharge paths is about 17kV for Laser 30 and Laser40. According to the

size of the laser, the maximum current flow is between 70 and 85 mA. On standby, the current flow is around 10 mA.

The laser power can be adjusted between approx. 100 W and a maximum output by varying the path current.

All system components carrying a high-voltage are covered by a safety device.

The laser unit and control cabinet are connected by cables to allow free lay-out of both cabinets.

3.1.4 Control cabinet

The control cabinet contains the electrical power supply, the laser gas mixing unit and the microprocessor control system (MCS). The microprocessor control system controls and monitors all laser functions and provides all necessary operating current status information

The **high-voltage section** is located in the lower half of the cabinet and is sealed off. The heat developing in this section is dispersed in the water cooling circuit through an air heat exchanger.

In the control gas module the **laser gases** are brought to the required pressure and mixed. The gas mixing values are factory preset for optimum results.

The **type of process gas** and **gas pressure** are manually set with the rotary handles on the control panel, or automatically controlled by the CNC controls of the machine.

The MCS module contains the **laser control**. The operating and display controls are located on the front panel. From the display the operator can follow the machining progression and relevant information such as the system pressure, power and operating current. Safety status and error messages are shown in clear text. This allows to start up the laser independently of the laser machine, so that the laser unit and the machine can be put contemporarily into operation at different times and places.

3.1.5 Laser operating modes

The laser can be used in any of these operating modes:

CW	=	Continuous mode
MD	=	Modulation mode
NP	=	Pulse mode

Each of the operating modes can be selected on the laser control unit or the CNC control of the machine (with the exception of the modulation mode that is automatically selected according to the requirements of the control unit itself). This allows the user to select the optimum operating mode for a given material or application.

3.1.6 Laser type

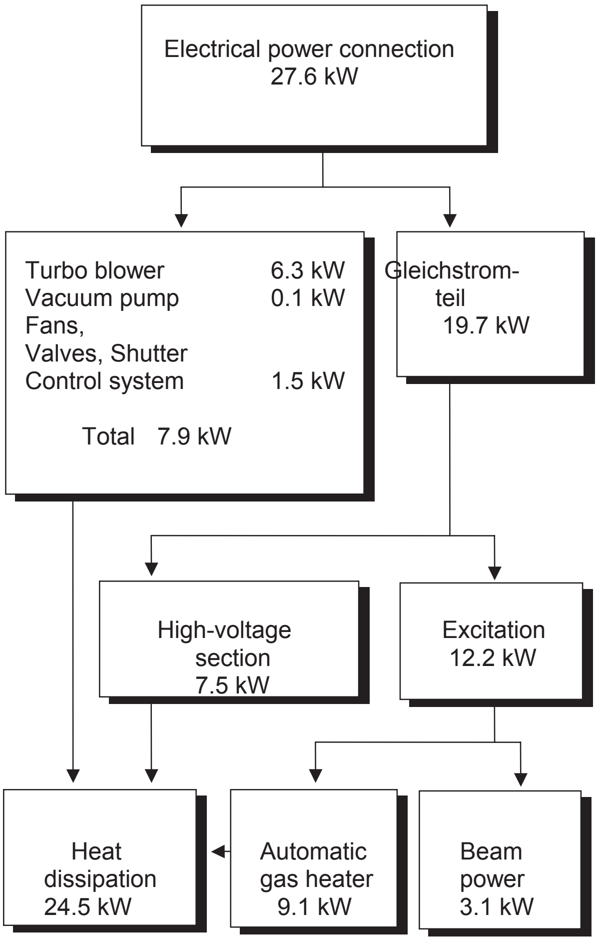
The laser series consist of Laser 30 and Laser 40. The configurations of these lasers are as follows:

- Concerning the operation they differ in the nominal power of 3000 W to 4000 W.
- From a construction point of view the main difference is in the number of the discharge paths in the resonator: the Laser 30 have twelve paths. The Laser 40 requires 16 paths and two levels of deflection.

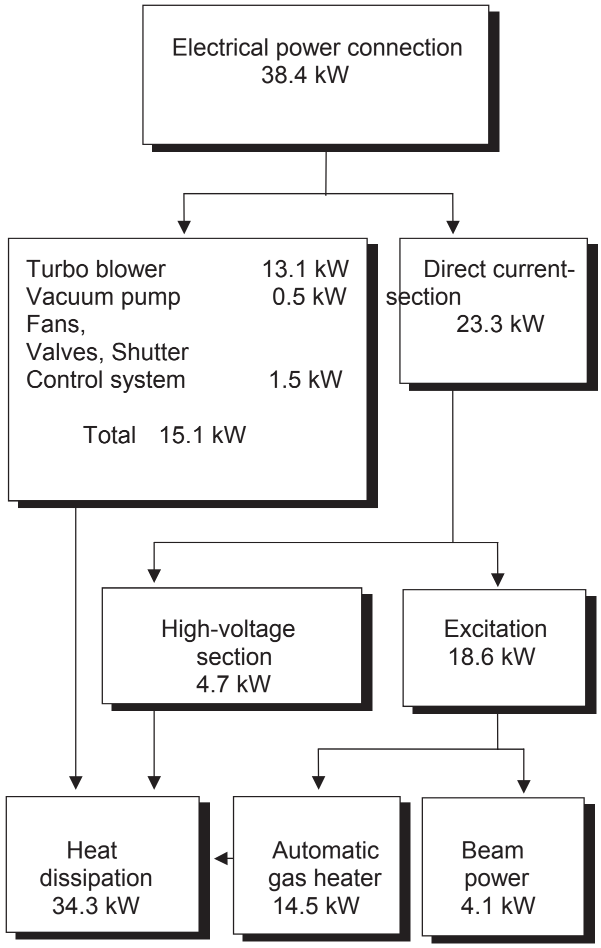
You can see the type of laser for which this Operator’s Manual is written looking at the script on the doors hinged on the upper part of the laser or at the order confirmation, which is part of the chapter “Machine documentation”.

3.1.7 Power consumption graph and power diagram

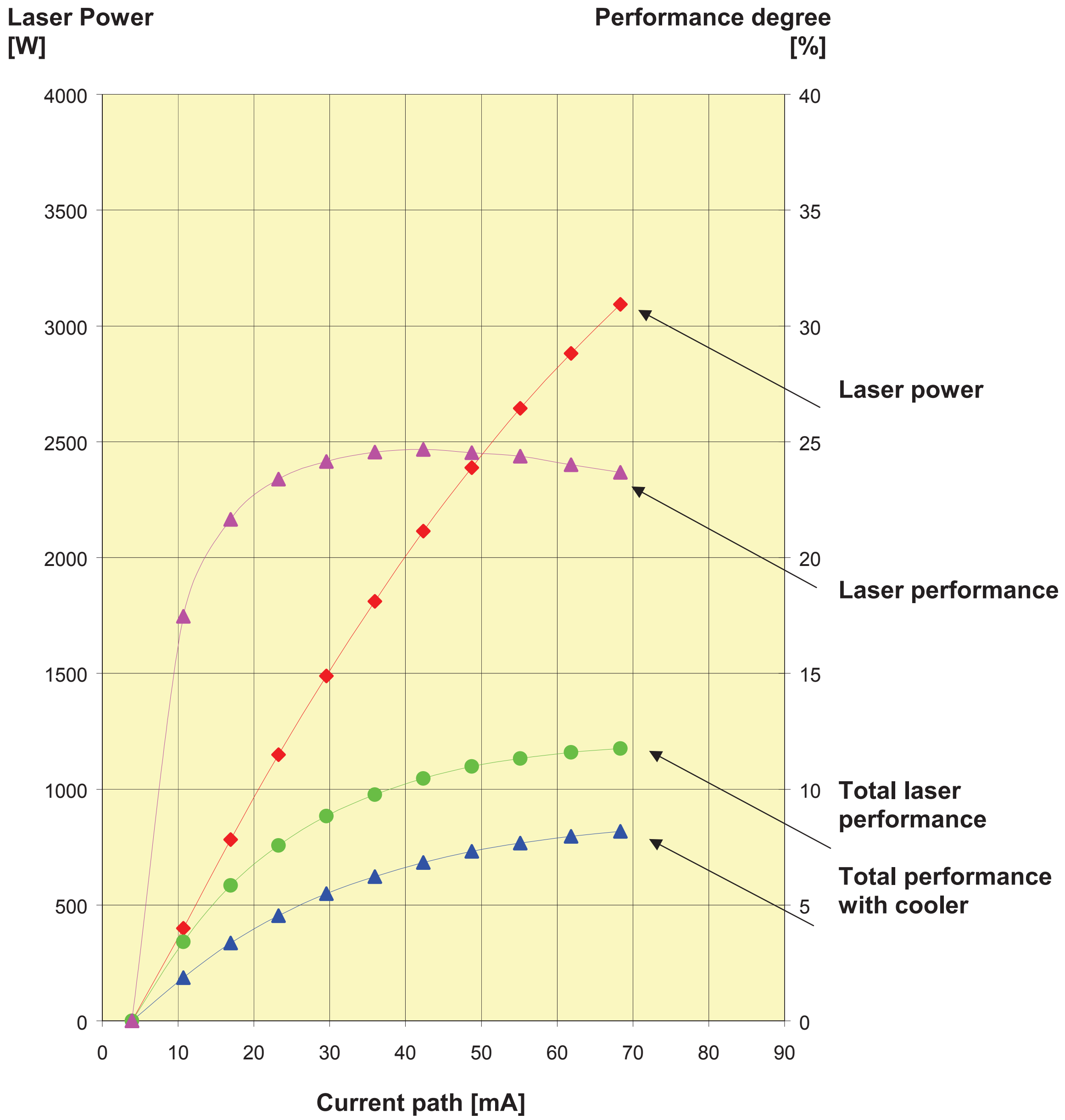
Laser 30



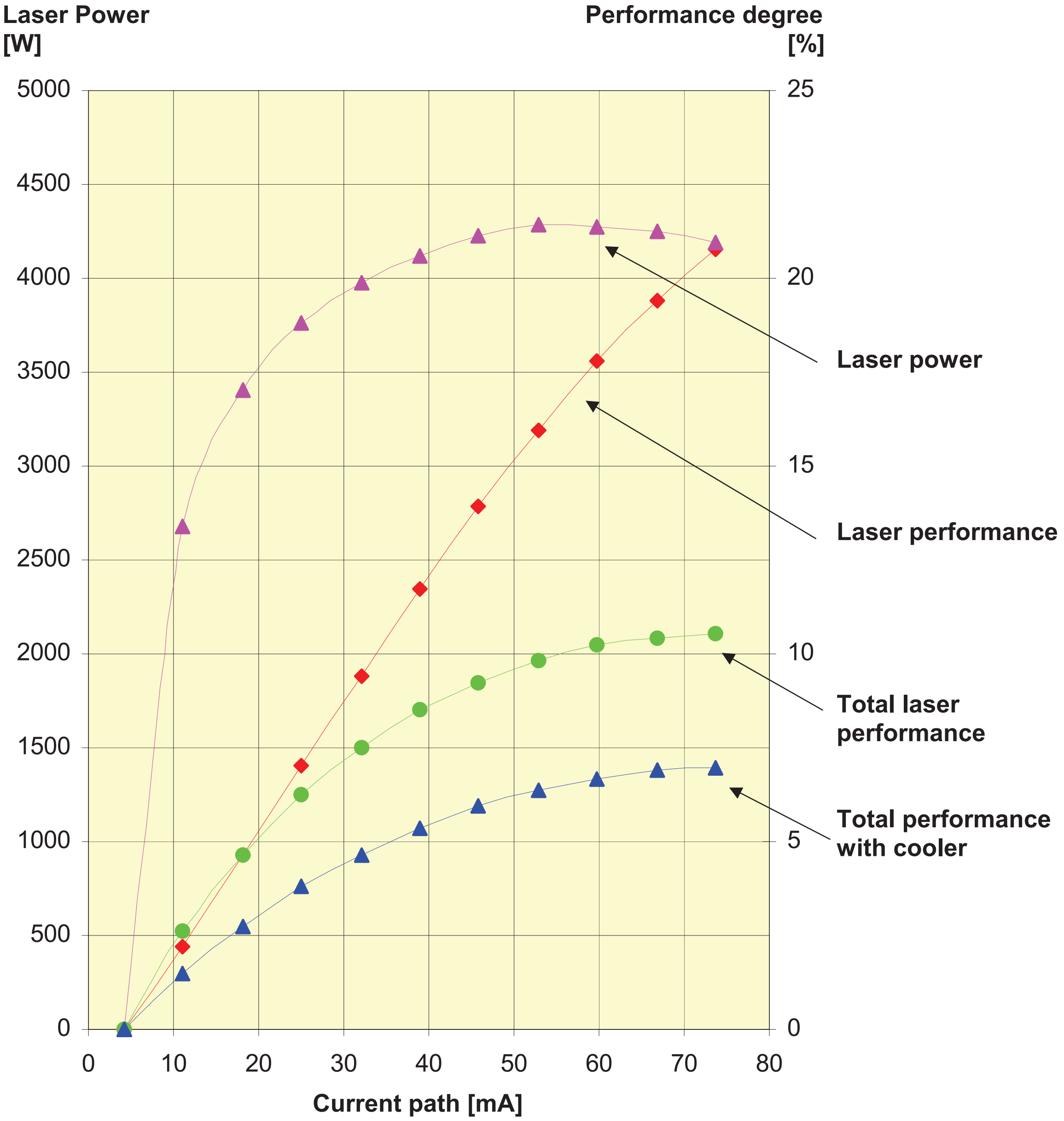
Laser 40



Power diagram of the Laser 30



Power diagram of the Laser 40



3.2 Safety warnings

3.2.1 Intended use

The Bystronic laser is intended for industrial use as a tool in the following applications:

– Cutting
– Welding
– Marking

Any other use shall be deemed not in compliance with the intended use and the manufacturer shall not be held responsible for any damage to the machine. All responsibility shall rest with the user.

3.2.2 Radiation

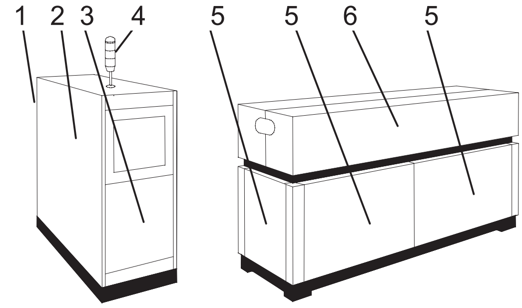
In the normal mode the laser unit meets laser class 1 which means fully enclosed laser beams. All enclosures and covers must be in place. Do not overrule locks!

Where prolonged viewing of the radiation produced when the machine is working is required, eye protection must be used!

In the special mode, the laser conforms to the laser class 4. When this mode is selected, the following precautions should be taken:

– Mark off the area of the laser beam!
– Cover or remove high-reflectance objects.
– Remove inflammable objects. Wear eye protection.

3.2.3 Protection and safety devices

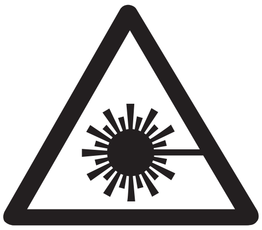


1 Laser cabinet rear door
2 Two fixed laser cabinet covers (same on the right side)
3 Laser cabinet front doors
4 Warning lights
5 Six protection enclosures with sound-proofing matting (same on rear side of the laser)
6 Two wing doors with key-lock on upper part of resonator (same on rear side of laser)

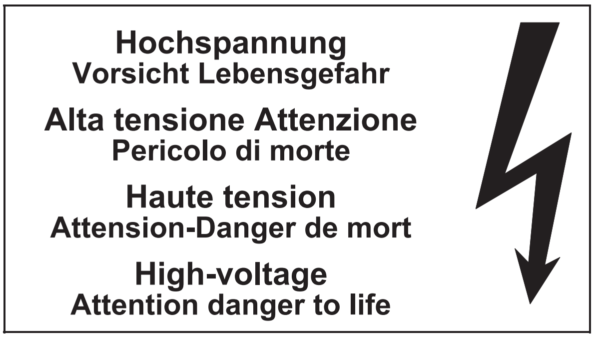
Make sure that the wing doors of the upper part of the resonator are closed with the keys. Remove the keys.

3.2.4 Info-plates types

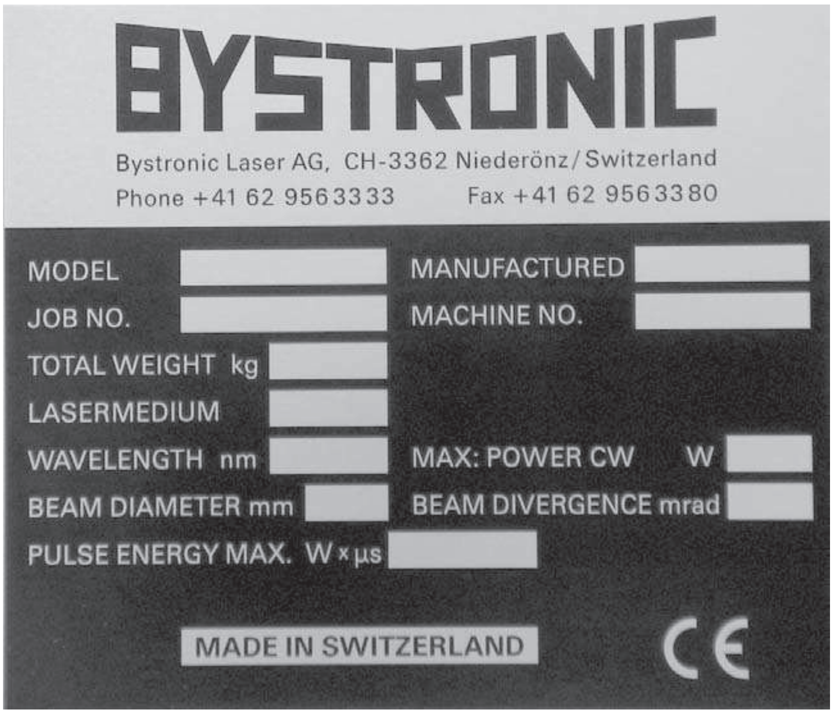
Info-plate 1 : 26 x 52 mm
Info-plate 2 : 52 x 105 mm
Info-plate 3 : 130 x 190 mm



Info-plate 4 : 25 x 18 mm
Info-plate 5 : 35 x 50 mm
Info-plate 6:70 x 100 mm



Info-plate 7 : 26 x 52 mm
Info-plate 8 : 52 x 105 mm



Info-plate 9

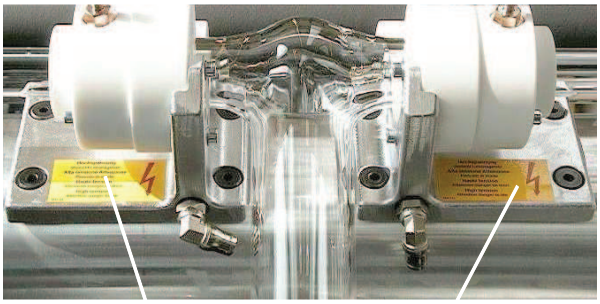
3.2.5 Position of Labels

The numbers refer to the list of labels given in the previous section.

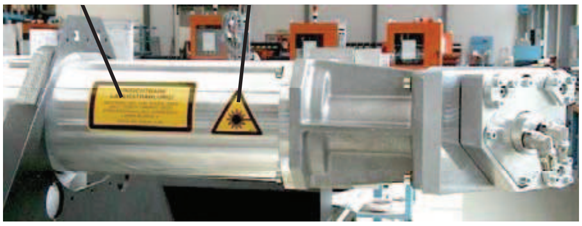
Resonator

Resonator with open swing doors, without a cover made of Plexiglas

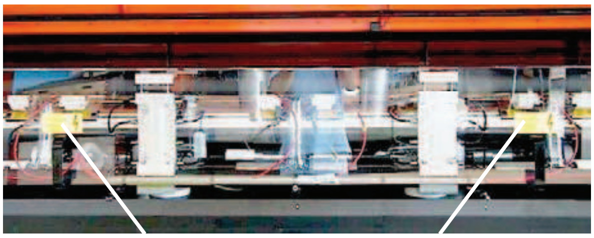
The same for the rear of the resonator



Beam expander

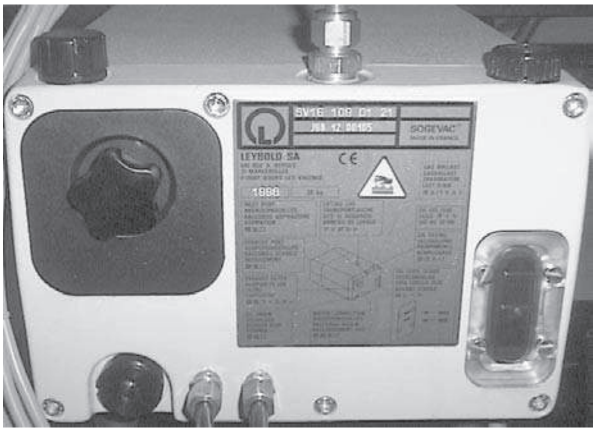


Plexiglass cover

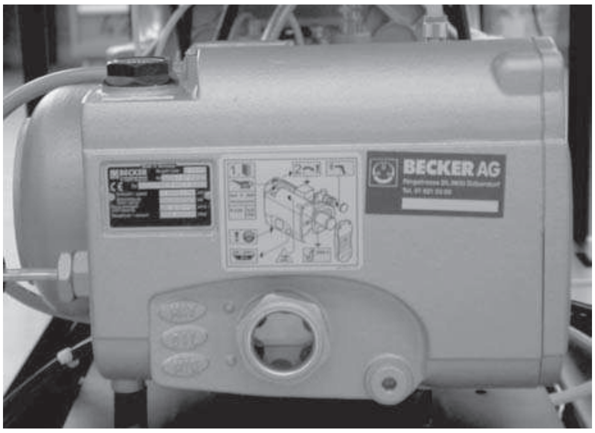


Laser 30 turbo blowers typ "Leybold"

Vacuum pump



Vacuum pump maintenance information plate Laser 30



Vacuum pump maintenance information plate Laser 40

3.2.6 Emergency measures

The cabinets for the laser controls and the high-voltage supply are equipped with emergency stop keys to de-energize the machine in case of an emergency.

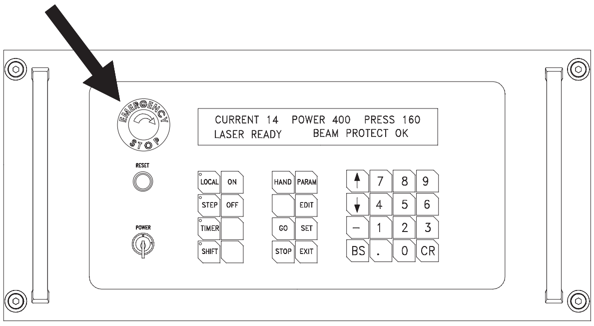
Pressing the emergency stop key de-energizes:

– the high-voltage supply
– the turbine motor for the gas circulation
– the vacuum pump motor

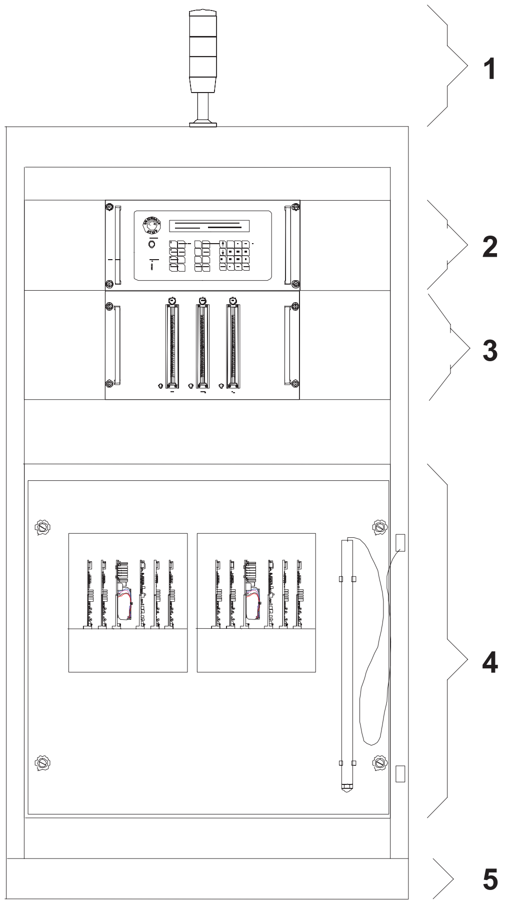
The laser control remains energized for:

– the system messages indicating that the machine stop was caused by an emergency stop
– a quick start up after the trouble-shooting, since all process information are still stored.

The following drawing shows the position of the emergency stop button on the laser control panel:



3.3 Construction and operation characteristics

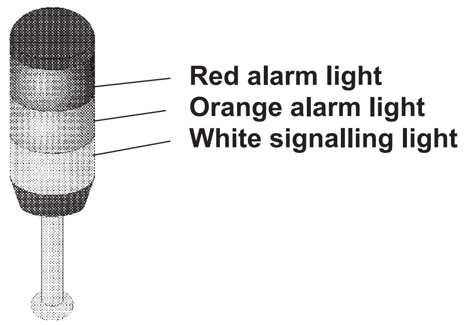


Laser control cabinet with open doors and safety covers in place!

1 Alarm lights
2 Laser control (MCS)
3 Gas control (Laser gas and process gas)
4 High-voltage supply
  for Laser30, one HV chassis
  for Laser40, two HV chassis'
5 Skirting

The laser control cabinet is basically divided into three sections. The lower section houses the high-voltage supply, the centre section is the gas control systems and in the upper section houses the laser control. The cables input and output are located in the skirting.

3.3.1 Alarm and warning lights



The alarm lights are fitted on the upper side of the laser control cabinet and signal (visible from afar) the currently selected laser. These lights have the following functions:

Red alarm light

When the red alarm LED lights up, this means that the shutter is open and the laser beam may be emitted by the laser device. When the red LED is off, the shutter is closed.

If this light is blinking the laser is working in a special mode (laser class 4).

The special mode is active when the laser cover is open. The special mode is described in the beam path chapter.

Orange alarm light

When the orange LED lights up, the high-voltage on the laser device is connected and the laser is operating.

White signalling light

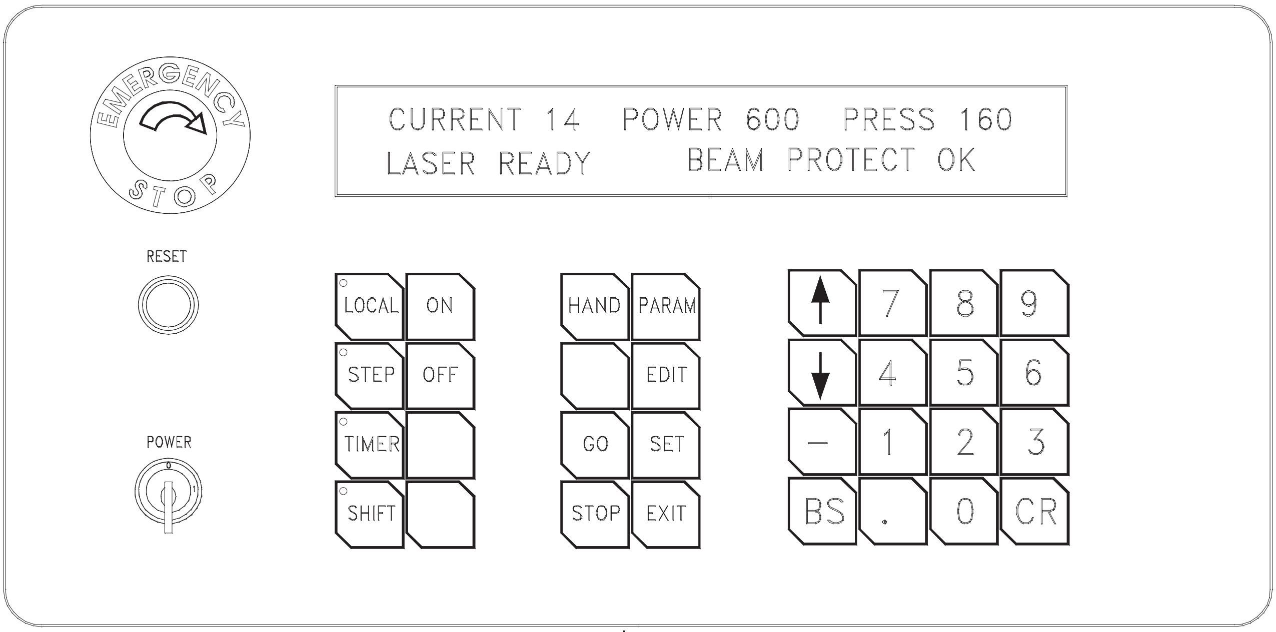
The white signalling light indicates insufficient pressure in the gas supply. This signal allows the user to commute the gas supply to the reserve tank, before the control system automatically cuts off the machining because of the lack of gas. To find out which gas caused the signalling of the white lamp, just look at the gas control system: the relative green indicator light is off.

3.3.2 Laser control system (MCS)

All laser functions can be controlled directly from the laser control system.

The control system can be integrated, together with the laser, in a higher-order machine control.
On the laser control panel are located:

- Display with 2 lines x 40 characters.
- Emergency stop key (mushroom-shaped)
- Reset button
- Key-operated POWER ON / OFF switch
- Keyboard with 32 keys



Display

In standard operating mode (no special functions active) the display is divided into three areas:

OPERATING DATA	
SYSTEM STATUS	**RADIATION PROTECTION**

When the `h`, `p` or `e` function is activated, the standard operating data remain active in the background. Once this function is de-activated, the data can be re-displayed. If an error occurs while the system is in special mode, this condition is indicated by a flashing display field.

OPERATING DATA

The process data line continuously shows the following values:

- Path current [mA]
- System pressure [mbar]
- Laser power [W]

SYSTEM STATUS

System status messages are divided into two groups: SYSTEM MESSAGES and ERROR MESSAGES. System messages are overwritten by error messages. Confirm the message after the elimination of the error pressing `r`.

OPERATING DATA
HIGH-VOLTAGE PROTECT. RADIATION PROT.

The two safety circuits, HIGH-VOLTAGE PROTECTION and RADIATION PROTECTION, monitor the system components and enclosures of the machine which may jeopardize personal safety. If a safety circuit is activated, the appropriate message will appear on the display. After eliminating the cause of the error, depress the `r` key to restore a safe system condition. A list of possible error messages is reported at pages 23 and following.

Safety circuit RADIATION PROTECTION

If a beam protection switch is triggered, two different situations must be distinguished:

- if the shutter is open, the high-voltage system will be switched off
- if the shutter is closed, it will be locked

Safety circuit HIGH-VOLTAGE PROTECTION

When the high-voltage protection switch is triggered, the high-voltage supply gets cut off.

Emergency stop

The activation of the emergency stop will disconnect the power supply circuit. The high-voltage supply, the turbo blower, the vacuum pump and the fans will be cut off from the power supply.

The emergency stop can be activated:

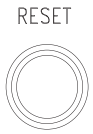
- manually, depressing the key EMERGENCY STOP
- from the machine itself, in case of activation of one of the emergency stops.

The display shows the following message:

CURRENT 0 POWER 0 PRESS 160
EMERGENCY STOP SHUTTER UNLOCKED

In case of a manually triggered emergency stop, the operator must enable the relative key, depressing the `r` key which will enable the emergency stop safety circuit, causing the start message to appear.

Initialization RESET key



The RESET function will put the safety circuits into a defined state. Keep the r key depressed for at least 3 seconds so that the control system has time to check all safety functions.

The control system will check if the system parameters are within their range (see page 19):

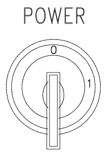
– If the parameters are found to be outside the admissible tolerances, the operator is prompted to depress the p key.
– If the parameters are within the admissible tolerances, the system displays the start-up message. The initialization is completed.

Example of a start-up message:

CURRENT 0 POWER 0 PRESS 1000
VACUUM ON? SHUTTER
UNLOCKED

Important: Confirm every error message by depressing the r key

Key-operated switch POWER



The key can be removed in its vertical (“0”) position to prevent unauthorised persons to start up the laser system. Turning the key clockwise into its horizontal position it shows “1”. In this position the electronic control circuits will be energized. The initialisation text will appear with the request r. (The P..-0.. text depends on the customer specific program installed).

Example of a display with Laser 30

XXXXXX LASER DC BTL 3000 XXXXXX
XXX BYSTRONIC AG P02-03B XXX→
RESET

To start-up the laser, depress the r key and proceed as described in the chapter “Start-up and shut-down”.

Brief description of the key functions on the laser control keyboard

The illuminated buttons are activated when the light is on and de-activated when the light is off.

`l`...... ....Active: Internal power control (MCS). Not active: external (CNC).

`s`...... ....Active: start-up and cut-off in step mode. Inter-connected with the keys `o` and `f`.
Not active: automatic start-up and cut-off.

`t`...... ....No assigned functions (reserve key currently free)

`i`...... ....No assigned functions (reserve key free)

`o`. . . ..Laser start-up

`f`. . . ..Laser cut-off

`h`...... ....Access to operating data and input of the shutter opening time

`g`. . . ..Activation of the preset data with the function `h`

`p`...... ....SYSTEM PARAMETERS, LIMIT TUBEOUT, TUBE CURRENT, WATER FLOW

`e`...... ....Function Editing MCS. Editing the data records for each operation mode

`a`...... ....Hour counter function assigned

`z`...... ....Cut-off HV, turbo blower, vacuum pump and frequency converter
Error message: STOP INTERN ACTIVE. Confirm with `r`
Important: This software STOP is not an emergency stop!

`x`...... ....Abort functions, previously called with the function key.

`u`...... ....Commutation between data groups in the laser control editor

`d`...... ....Commutation between data groups in the laser control editor

`b`...... ....Cancellation of a character during input.

`c`...... ....End of input and commutation to next parameter.

h

Activating the key h on the laser control panel allows access to the functions:

– LASER POWER (laser power)
– SHUTTER TIME (shutter opening time)

To select the desired function with u or d confirm the selection with c. With x abort HAND option.

LASER POWER

This function is described in the paragraph "Operating modes".

SHUTTER TIME

To set the shutter opening time and preset the maximum opening time of the shutter, depress the key g.

For security reasons the shutter will remain open only as long as the key is depressed. This means that the preset opening time will be achieved only if the key will be kept depressed the entire time.

This function is used when starting up the laser, independently from a higher-order machine control.

=========== MANUAL INPUT ===========
SHUTTER TIME ### ### ### **### ### EXIT CR**

h is available only if the option l is activated. x aborts h.

p

Activating the key pon the laser control panel allows access to the functions

– SYSTEM PARAMETER
– LIMIT TUBEOUT
– TUBE CURRENT
– WATER FLOW

Select the desired function with u or d and confirm the selection with c. x aborts the option PARAM.

SYSTEM PARAMETERS

System parameters	Range	Standard
OPERATING PRESSURE	[mbar] 120-190	[mbar] 185 (Laser30) 180 (Laser40)
RUN BLOWER (starting new gas flood and run blower)	[mbar] 0-20	[mbar] 5
HIGH-VOLTAGE ON (high-voltage cut-in)	[mbar] According to operating pressure	[mbar] 175 (Laser30) 170 (Laser40)
TIME FASTMIX (quick gas filling)	[min] According to inactive time	[min] Standard set-up 30
LIMIT FLOOD (gas flood pressure according to sea level height)	[mbar] 900-1200	[mbar] See acceptance report

Caution:

Factory presettings! The optimum values for the system adjusting are preset at the moment of start-up at Bystronc plants. Possible parameter modifications can be carried out only after consulting Bystronic.

For the system parameter modification, always remember that the new inputs will be stored only if carried out in the right order.

After having stored the input values, depressing the key c, the system checks the input.

- If the input value is within the preset adjusting range, the control commutes to the next parameter input
- If the input value is not within such range, the system will make an admissible input.

If you do not want to modify the parameter on display, commute with the key c to the next parameter.

General conditions to be remembered as far as the parameters are concerned:

- the preset value in LIMIT FASTMIX must be lower than the one in HIGH-VOLTAGE ON.
- The value in HIGH-VOLTAGE ON can be lower but not higher than the one OPERATING PRESSURE.

Application: Optimizing of new types of laser after technical modifications are carried out in the plant.

TUBE OUT

The parameter TUBE OUT monitors the minimum current for each path. If the current is lower than the preset value, the control cuts-off the high-voltage supply.

This parameter can be modified in the same way as the system parameters.

The value range for the minimum current is between 0.1 and 9 mA. With an input of 0 mA, the minimum current will no longer be monitored.

Application: Optimizing of new types of laser after technical modifications are carried out in the plant.

TUBE CURRENT

Indication of the tube current of each path currently adopted. To abort the function TUBE CURRENT activate c.

Application: If after the error message “Tube out“ the laser re-start is possible, check if the current is equal in all paths. This check enables to define the origin of the error message.

WATER FLOW

Visualization of the water flow. The indicated value for WATER FLOW is updated every 60 seconds (Laser30 and Laser40 = 80 ml/s). To abort the function WATER FLOW activate c.

Application: As “TUBE CURRENT“ (Single out the origin of the error message “Water error“).

e

Activating the key e on the laser control panel allows access to the editing functions of the laser control. The editing functions allow to edit 50 data records for each mode.

(The editing function is also available in the option h, without having to select e. However, in the option h the columns titles from SNR to SP are not displayed.

Each data record contains the following data:

SNR	CW	GW	F	NP
	(%)	(%)	(Hz)	(ms)

SNR: Record No.
CW: Direct laser power in %
GW: Basic power in %
F: Pulses in Hertz
NP: Normal pulse width in milliseconds

The record numbers are preset and cannot be modified. Digiting a record number the cursor will go to that number.

The data records can not be cancelled, only overwritten.

In case of input errors the editor will go to the laser selected data record.

For the editing function, the keys `b`, `c`, `ud` and the numeric keys are available.

Having selected the editing function with `e`, the data record can not be activated, as opposed to the option HAND, where the editing function is available together with the activation of the data records.

For example, the laser can find itself in operation with a data record activated in HAND with the key `g`. To modify or generate a new data record during the laser operation, select `e`, (on the display, it is not shown which of the data records is currently being processed by the laser).

The key `x` aborts the EDIT function. Select `h` to activate the desired data record.

3.3.3 Laser control system status messages

Message	Meaning	STEP- mode operating procedures	Automatic operating procedures
RUNNING FLOOD	Laser is flooded with nitrogen	During shutdown, wait for VACUUM ON ? message to appear on the display before switching off the laser system	During shutdown, wait for VACUUM ON ? message to appear on the display before switching off the laser system
VACUUM ON ?	Gas circuit is ready for extraction	Vacuum pump is ready to start	This message is omitted
RUNNING VACUUM	Vacuum pump is running	Wait for the message BLOWER ON? If after the emergency stop message the laser is still hot (pressure between 199 and 60 mbar), a direct re-start-up is possible	This message is informative only
BLOWER ON ?	Underpressure level preset in the system parameters LIMIT FASTMIX	Blower ready for start-up	This message is omitted
RUNNING BLOWER	Blower is running	Wait for HIGH-VOLTAGE ON ?	This message is informative only
HIGH-VOLTAGE ON ?	Pressure available to system parameter HIGH-VOLTAGE ON	High-voltage system is ready to be switched on	This message is omitted
LASER READY	Laser start-up completed	Before working, wait for the correct working temperature to be reached (steady power message)	Before working, wait for the correct working temperature to be reached (steady power message)
LASER OFF EXTERN	Automatic shutdown is active; laser will switch off automatically after extended stop time of the reference point	Selector switch above machine main switch is set to "Automatic". In the standard configuration the switch is set to “Manual”	Selector switch above machine main switch is set to "Automatic”. In the standard configuration the switch is set to “Manual”.

Message	Meaning	Mode STEP and Automatic mode procedures
SHUTTER UNLOCKED	All radiation protection covers closed	
SHUTTER LOCKED	Safety door of machining table not closed	Safety door not closed: close the safety door
SHUTTER LOCKED	Customer option for further access control	Close doors/gates/covers applied by the customer
** LASER CLASS IV	The wing doors of the resonator are open	Close the wing doors of the resonator
HV PROTECT LASER	Resonator cover in plexiglas not assembled	Assemble the safety covers and close the swing doors

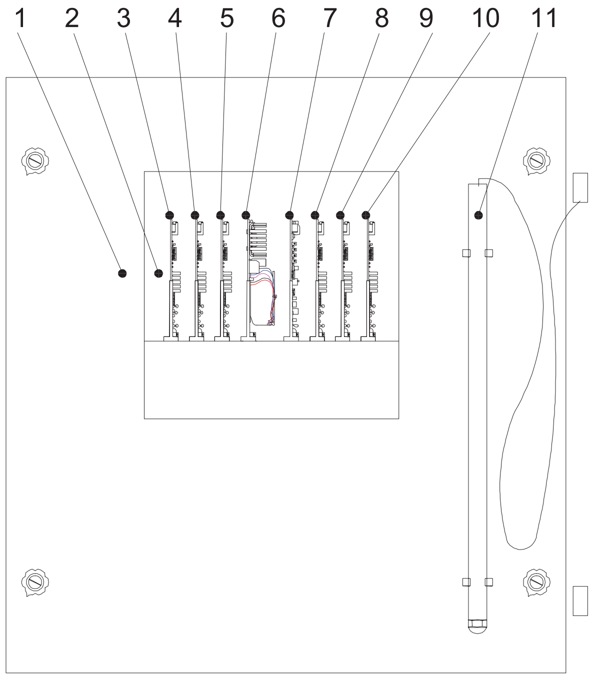
3.3.4 Laser control system error messages

Message	Meaning	Remedy
TUBE OUT NR. xx	Path current in this plasma tube has fallen below prescribed minimum value	– See Acceptance report: system parameters OPERATING PRESSURE – See ”Maintenance manual", "Laser”: vacuum test – See Acceptance report: laser gas pressure indication – Otherwise call Bystronic customer service
OVERCURRENT DESK	Maximum current on HV-rectifier card (stabilizer card)	– See acceptance report: laser gas flow rate indication – See maintenance manual chapter “Laser”: vacuum test – Otherwise call Bystronic customer service
OVERTEMP HV	Over temperature in the high-voltage section of the HV cabinet. Alarm activated by built-in thermostat	– See acceptance report: Cooling water – See maintenance manual chapter “Laser”: cleaning fans and the heat exchangers in the high-voltage cabinets – Otherwise call Bystronic customer service
THERMO ISOL. TRAFO	Maximum current switch cut-off	– Check if maximum current switch is on – Otherwise call Bystronic customer service

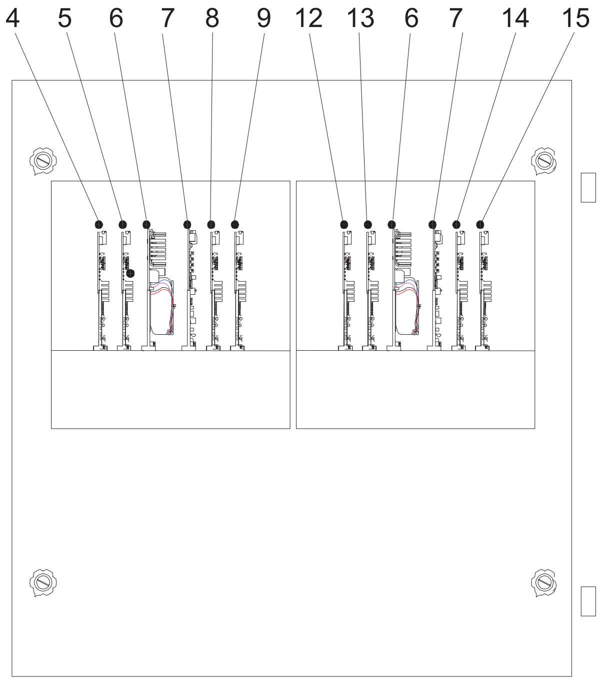
Message	Meaning	Remedy
THERMO HV TRAFO	Maximum current switch cut-off	– See maintenance manual chapter “Laser”: Clean the fans in the high-voltage cabinet – Check if the maximum current switch is on – Otherwise call Bystronic customer service
THERMO VACUUMPUMP	Maximum current switch cut off (vacuum pump has stopped)	– Check if maximum current switch is on – See supplier’s documentation “vacuum pump”: check the oil level – Otherwise call Bystronic customer service
DOOR CONTROLDESK	Protective enclosures of the high-voltage power supply system are not active	– Install protective enclosures – Otherwise call Bystronic customer service
HV PROTECT LASER	– High-voltage enclosures on the laser are inoperative. – Beam protection tube connection in the is not active	– Install protective enclosures – Otherwise call Bystronic customer service
SHUTTERERROR	A laser door has been opened while the shutter was open	– Close laser door, activate Reset – (Finish the machining process before opening the laser door!)
WATERERROR	Low water flow in the shutter.	– See supplier’s documentation “Cooling device” : - Cooling device error messages - Switch on cooling system - Set temperature - input/output valves open - Water flow rate – Otherwise call Bystronic customer service
OVERCURRENT TUBE xx	– Overcurrent in the corresponding path section – Punching of the path in the resonator or defective electronic circuit in the HV cabinet	– Call Bystronic customer service
LIMIT BLOWER	Operating pressure is too high or too low	– See Laser operating manual chapter “Laser”: Setting the operating pressure – See maintenance manual chapter “Laser”: gas circuit sealing
CONVERTER ERROR	– The frequency converter is faulty – Power supply failure	– See documentation for suppliers : Converter error messages – Otherwise call Bystronic customer service
AIR PRESSURE	Insufficient or no air pressure	– Ensure 6 bar air inlet pressure

Message	Meaning	Remedy
TIME OUT SHUTTER	– Internal control monitoring has closed the shutter due to MCS / SPC program execution error – Shutter blocked	– Compile error: activate the Reset key, continue program execution (if error occurs repeatedly call Bystronic customer service) – Shutter blocked: call Bystronic customer service
GAS JET ERROR	Process gas pressure in supply has fallen below preset value	– See operating instruction chapter “Gas control”: check the process gas pressure reducer
GASMIX ERROR	Insufficient pressure in one or more laser gases supply	– See operating instruction chapter “Gas control”: inspect laser gas pressure reduction valves
STOP INTERN AKTIV	STOP key on laser control is active	– Reset
EMERGENCY STOP	One of the emergency stop keys of shuttle table, CNC or laser control system is active	– Reset the activated key, to release it rotate it, then press RESET
OVERTEMP. BEARING	Air circulation blower bearing temperature above 80°C	– Check Becker air circulation blower bearings (if necessary replace the bearings) – Check BTC control electronics
SERVICE BEARING	Circulation blower operating mode active	– At the end of the maintenance operations on the circulation blower, turn the function switch for the BTC control electronics to the "Auto" position.

3.3.5 High-voltage supply



Shown in figure above the high-voltage of a 12 section laser



Shown in figure above the high-voltage of a 16 section laser

1 Outer cover of the high-voltage section! Do not remove this cover!

2 Inner transparent cover of the high-voltage section. Do not remove this cover!

	Laser30	Laser40
3. Current control card for paths (energy source for paths):	1 und 2	
4. Current control card for paths (energy source for paths):	3 and 4	1 and 2
5. Current control card for paths (energy source for paths):	5 and 6	3 and 4
6. Power supply card (Power-Supply)		
7. High-voltage card (HV-Control)		
8. Current control card for paths (energy source for paths):	7 and 8	5 and 6
9. Current control card for paths (energy source for paths):	9 and 10	7 and 8
10. Current control card for paths (energy source for paths):	11 and 12	
11. HV Discharge rod for maintenance use		
12. Current control card for paths (energy source for paths):		9 and 10
13. Current control card for paths (energy source for paths):		11 and 12
14. Current control card for paths (energy source for paths):		13 and 14
15. Current control card for paths (energy source for paths):		15 and 16

3.3.6 Chiller

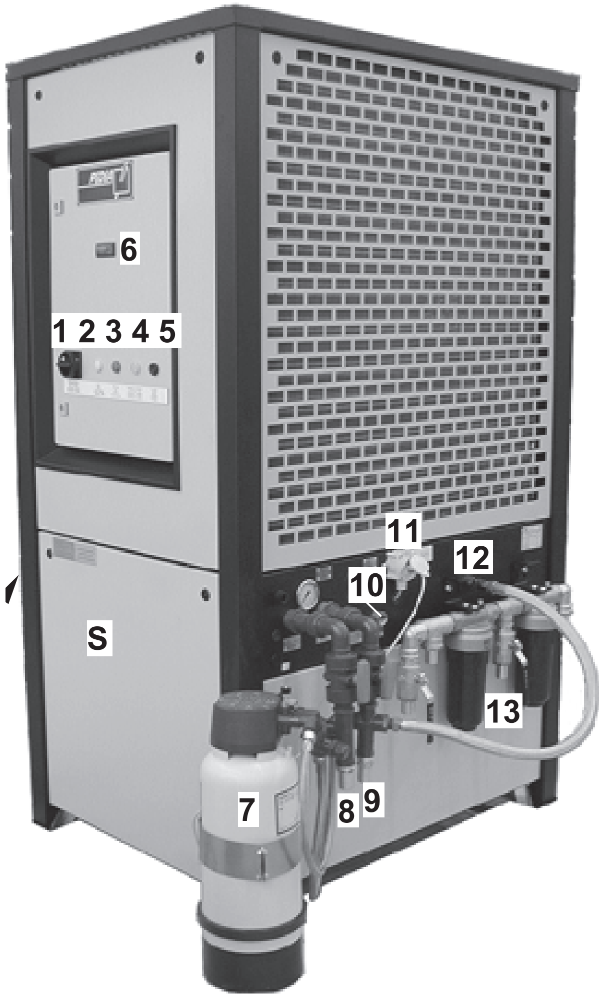


Figure Cooling unit HT series

Figure Cooling unit WKL series

1. Power switch
2. Indicator light, cooling unit on
3. Fault warning lamp (red)
4. Warning lamp liquefier soiled (yellow)
5. Key (manual operation pump)
6. Programming unit cooling control
7. Demineralization unit "MINISTIL"
8. Cooling water supply
9. Cooling water return
10. Connection return Bypos (option)
11. Power connection demineralization unit
12. Mains water supply
13. Secondary flow filter (60µm and140µm)

1.
2. Power switch
3. Fault indicator 1
4. Fault indicator 2
5. Indicator light, cooling unit ON
6. Reset button
7. Programming unit 1st cooling circuit (20°C)
8. Programming unit 2nd cooling circuit (30 – 42°C)
9. Air suction (filter pads)
10. Fans
11. Cooling water 1st cooling circuit supply
12. Cooling water 1st cooling circuit return
13. Supply/return 2nd cooling circuit (option)
14. Supply/return Bypos cooling circuit (option)
15. Mains water supply

Figure Cooling unit KLH series

1. Power switch
2. Programming unit SP circuit - option
3. Programming unit ND circuit
4. Fault indicator display
5. ND circuit (supply and return)
6. SP circuit (supply and return) - option
7. HD circuit (supply and return) - option
8. Mains water supply
9. Tank overflow
10. Drainage
11. Pressure and water level indicator
12. Air suction (filter pad)
13. Fans

The heat developed in the laser gas is removed via a heat exchanger into the water circuit of the cooling unit. The cooling water is stabilized at a constant temperature of 20°C in the cooling unit. The cooling unit essentially comprises the following main components: compressor, condenser, evaporator, manifold and the associated connections and control system. The cooling units are supplied with electrical power from the STL cabinet. The water circuit is run with demineralized water. If possible the water circuit should be filled directly with demineralized water. If demineralized water is not available, the circuit can be connected to the local water supply, although this does considerably reduce the lifetime of the built-in MINISTIL demineralization cartridge. A sensor in the demineralization unit indicates whether the conductance of the water lies below the permitted limit of < 20 μS/cm. An insert (MINISTIL output) limits the volume flow rate to max. 5 l/min. The chapter on maintenance describes when the resin has to be replaced.

A second water circuit and a Bypos circuit are available as options.
This 2nd circuit (mirror cooling circuit) cools all the deflection mirrors in the laser machine and the optical beam expansion system in the laser source. This option is particularly recommended for laser cutting machines being operated in an environment of high air humidity.

The Bypos circuit is an extra circuit that supplies the Bypos unit on the z-axis with a constant water pressure of 14bar. The specific operation of the Bypos system is explained in the chapter on this system.

3.4 Start-up and shut-down

Power control in LOCAL or CNC mode

The difference between LOCAL mode and CNC mode lies in the power control method: in the LOCAL mode the power setpoint is provided by the laser control, while in the CNC mode it is provided by the CNC control:

– stand-by power
– laser power percentage value from the parameter lists
– power values preset on the regulators (see chapter CNC 90)

The LOCAL mode allows the laser to run independently of any higher-order machine control system (this mode is used for instance when the laser is first started in the factory).

The LOCAL mode can be activated at any moment, it can be de-activated only after the function <HAND> has been de-activated.

As a start-up in the LOCAL mode will always take place with appropriate power, the LOCAL mode is frequently used for starting the laser for production. Production start-up is also possible in the CNC mode. In this case care must be taken to ensure that the laser will not be started during the CNC system initialization cycle.

Control

The start-up and shut-down procedures are divided into seperate steps:

– Start-up: gas circuit extraction, build-up of laser gas mixture operating pressure, switching on the high-voltage
– Shut-down: deenerginzing of the high-voltage, stopping the gas circulation, switching off the vacuum pump, flooding

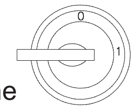
Start-up and shut-down can be performed manually in the above sequence (or going back to any previous step) (STEP mode). It is possible to insert extended dwell time between steps; for example, to check for possible resonator leaks.

During production an automatic switching between these individual steps (Automatic mode) is often preferred.

If during start-up or shut-down an error message appears, see the chapter “laser control error messages” for trouble shooting.

3.4.1 Start-up and Shut-down steps (STEP Mode)

Preliminary operations



Before starting up the laser, carry out the following checks:

1. Ensure that all protective devices, emergency stop key and sound-proofing protection are in place and fully enabled!
2. Check for laser damage or externally visible defects!
3. Check that maintenance work has been performed as specified in the maintenance program.
4. Check if the compressed air supply is properly connected and provides the pressure specified in the chapter “Product description”
5. Check if the laser gas cylinders are properly connected, that the reduction valves are open and supply the pressure as specified in the chapter “Product description”, in the paragraph “Laser Technical Data”.
6. Check if the process gas cylinder is properly connected and that the reduction valve is open. The secondary pressure must be in compliance with the specifications of the chapter “Product description” in the paragraph “Machine Technical Data”. In case there is no process gas in the gas control, it would not be possible to switch on the high-voltage.
7. Check that the parameter “Time Fastmix“ is set on a reasonable value:
   - Start-up after overnight pause (12 h): 20 minutes
   - Start-up after the week-end (60 h): 30 minutes
   - Start-up when the machine is warmed-up: 5 minutes

Switching on

1. Activate the main switch on the left side of the control cabinet:
2. Depress the Reset key below the “emergency stop” key on the SPC control cabinet. If the light of the Reset key is not on, one of the emergency stop keys (see the layout design) is then still active. In this case release the key in question.
3. Turn the key-operated switch located on the laser control panel clockwise to position 1.

On the control key `l`, `s`, `t` and `i` the light will turn on.

The initialization script with the request `r` (the script 'P..-0..' varies depending on the user’s program version) must appear on the display.

Example with Laser 30

XXXXXX LASER DC BTL 3000 XXXXXX
XXX BYSTRONIC AG P00-01B XXX RESET

4. Depress `r` for about 3 seconds (depressing the key briefly, an error message could appear even though no error is present).

For example the following could appear:

CURRENT 0 POWER 0 PRESS 990
VACUUM ON ? SHUTTER UNLOCKED

CURRENT:	Path current
POWER:	Laser power
PRESS:	The pressure reading depends on the laser activation time and will be different if it is taken after the flooding or after an emergency stop at operating values.

The LEDs in the `l`, `s`, `t`, `i` keys have gone out.

Step mode start up

LIS

1. Depress l, if you wish to use the power setting of the laser control. l is activated when the red LED is on. If l is not activated, the preset power is measured by the CNC control.
2. Depress s, if the red LED has not yet lit up. The STEP function is used for instance for a rapid laser re-start-up after an emergency stop, without having to evacuate it completely.

Extraction of the gas circuit

3. Select o

For example, the following indication could appear:

CURRENT 0 POWER 0 PRESS 35
RUNNING VACUUM SHUTTER UNLOCKED

On the display the pressure value shown in the parameter “PRESS” keeps decreasing. The gas circuit is being extracted. Once the system parameter for the “Run Blower” has been reached, the “Blower on ” question will appear on the display.

The following drawing illustrates the cold start-up display and the start up in case the system parameter “Blower on” has been set at an absolute de-pression of 10 mbar.

CURRENT 0 POWER 0 PRESS 10
BLOWER ON ? SHUTTER UNLOCKED

Setting of the laser gas mixture at the working pressure

4. Depress o again

For example, the following message could appear:

CURRENT 0 POWER 0 PRESS
24
RUNNING BLOWER SHUTTER UNLOCKED

The pressure value of the “Press” parameter on the display keeps decreasing. The laser system is filled with the laser gas mixture until it reaches the de-pression value preset in the system parameter: ”Working Pressure“

When the working pressure is reached, the laser is ready for the high-voltage energizing and the display will give the following message (the example is referred to the case where the system parameter “Working Pressure” is set on an absolute de-pression value of 160 mbar):

CURRENT 0 POWER 0 PRESS 160
HIGH-VOLTAGE ON ? SHUTTER
UNLOCKED

Energizing the high-voltage

5. Again depress o.

The high-voltage power supply is energized. The display shows the stand-by power:

Laser 30

CURRENT 14 POWER 560 PRESS 185
LASER READY SHUTTER
UNLOCKED

Laser 40

CURRENT 14 POWER 560 PRESS 180
LASER READY SHUTTER UNLOCKED

Notice:

Allow the laser to warm up to the working pressure before starting the cutting process. The laser has reached its appropriate temperature when the power indication stops rising. The warm up time is approx. 3 to 15 minutes.

Step mode de-energizing

Before executing the de-energizing sequence, at the end of the production cycle, the laser should be allowed to briefly run on its stand-by power level. The cool-down time should be at least 1 minute.

Activate `l` and `s`, if the relative LEDs are not yet lit up.

De-energizing the high-voltage

1. Depress `f`.

The high-voltage is de-energized.

```
CURRENT  0      POWER  0      PRESS  160
HIGH-VOLTAGE ON ?   SHUTTER UNLOCKED
```

Stopping the gas circulation

2. Again depress `f`.

The gas circulation is stopped.

```
CURRENT  0      POWER  0      PRESS  130
BLOWER ON ?                SHUTTER UNLOCKED
```

De-energizing the vacuum pump

3. Again depress `f`.

The vacuum pump is de-energized. The parameter indicator “PRESS” must remain on the value at which the `f` key was pressed, for example:

```
CURRENT  0      POWER  0      PRESS  105
VACUUM ON ?                SHUTTER UNLOCKED
```

Flooding

4. Again depress `f`.

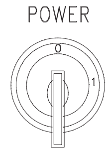
The system will be flooded with nitrogen and the system pressure will rise:

```
CURRENT  0      POWER  0      PRESS  155
RUNNING FLOOD         SHUTTER UNLOCKED
```

When the flooding is over and ambient pressure is reached, the following indication will appear:

```
CURRENT  0      POWER  0  PRESS  990
VACUUM ON ?     SHUTTER UNLOCKED
```

De-energizing



5. Turn the key-operated switch counterclockwise to position zero. Remove the key.

The LEDs have gone out. The laser is disconnected.

Shut-down operations

1. Switch off the main switch on the left-hand side of the control cabinet.
2. Close the compressed air supply.
3. Close the reduction valves in the laser gas supply lines.
4. Close the reduction valves in the process gas supply line.

3.4.2 Automatic Start-up and Shut-down (Automatic mode)

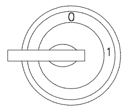
Preliminary operations

Before starting up the laser, check the following:

1. Ensure that all protective devices, emergency stop keys and sound-proofing protections are in place and fully operable.
2. Check for laser damage or external visible defects
3. Check that the maintenance work has been carried out as per the maintenance program
4. Check that the compressed air cylinders are properly connected and supply the pressure specified in the chapter “Product description”
5. Check if the laser gas cylinders are properly connected, that the reduction valves are open and supply the pressure as specified in the chapter “Product description”
6. Check if the process gas cylinder is properly connected with reduction valve open. The process gas must conform to the specifications listed in chapter “Product description” or as appropriate for the cutting parameters, according to the information in the machine logbook. In case no process gas is present, the high-voltage cannot be energized.
7. Check that the parameter “Time Fastmix” is set at a reasonable value:
   - Start-up after overnight pause (12 h): 20 minutes
   - Start-up after the week-end (60 h): 30 minutes
   - Start-up when the machine is warmed up: 5 minutes

Energizing

1. Turn on the main switch on the left side of the control cabinet:
2. Press the Reset key located under the emergency stop button on the control panel. If the Reset key does not light up, it means that one of the emergency stop keys (see layout drawing) is still active. Reset the key.
3. Turn the key-operated switch on the laser control clockwise to position 1.



On the control keys `l`, `s`, `t`, `i` the LED will light up.

The initialization script with the prompt `r` ('P..-0..' changes accordingly to the program version of the user) must appear on the display.

Example of a display with Laser 30

```
XXXXXX LASER DC BTL 3000 XXXXXX
XXX  BYSTRONIC AG  P00-01B  XXX  RESET
```

4. Depress `r` for about 3 seconds (when pressing the key only briefly, an error message could appear even though no error is present).

For example the following indication could appear:

```
CURRENT   0     POWER   0     PRESS 990
VACUUM ON ?             SHUTTER UNLOCKED
```

CURRENT: Path current
POWER: Laser power
PRESS: Pressure in the gas circulation system (the current pressure will depend on the laser activation point, if after the flooding or after an emergency stop).

The lights of the keys `l`, `s`, `t` and `i` are off.

Automatic start-up

1. Depress l, if you wish to measure the laser control power. l is activated when the red LED is on. L l

   If l is not activated, the preset power is measured by the CNC control.

2. De-activate s, if the red LED is still on. s

The laser control is now automatically following the steps described in the chapter “Step mode start-up”.

- Extraction
- Setting of the laser gas mixture at the working pressure
- Activation of the high-voltage

CURRENT 0	POWER 0	PRESS 35
RUNNING VACUUM		SHUTTER UNLOCKED

The laser is ready when the message changes from “Running Vacuum“ to “Laser Ready“:

CURRENT 14	POWER 560	PRESS 160
LASER READY		SHUTTER UNLOCKED

Automatic shut-down

Starting position: the laser is on. Message:

CURRENT 14	POWER 560	PRESS 160
LASER READY		SHUTTER UNLOCKED

1. Depress f.

The high-voltage, the turbo blower and the vacuum pump are shut-down.

The system is flooded with nitrogen, about up to atmospheric pressure.

CURRENT 0	POWER 0	PRESS 155
RUNNING FLOO		SHUTTER UNLOCKED

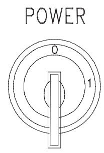
The flooding phase takes a few minutes. At the end of the phase the following message appears on the display:

CURRENT 0	POWER 0	PRESS 990
VACUUM ON ?		SHUTTER UNLOCKED

You can now continue the shut-down procedure (also a new start up cycle would now be possible).

Shut-down

2. Turn the key-operated switch counterclockwise to position zero. Take the key out.



The LEDs are off. The laser is disconnected.

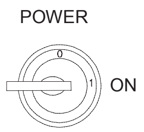
Switching off the machine

1. Turn off the main switch on the left side of the control cabinet.
2. Close the compressed air supply.
3. Close the reduction valves of the laser gas supply.
4. Close the reduction valves of the process gas supply.

3.4.3 Automatic startup and shutdown via the CNC

Switching on

1. Switch on the power switch on the left-hand side of the STL control cabinet.
2. Press the reset button above the power switch on the STL control cabinet **within the next 5 seconds until it lights up**. If this button does not light up, then one of the Emergency-Stop buttons is still actuated. Release the button concerned.
3. Turn the key-operated switch on the laser control to the right to the ON position.
This action is only required the first time the laser is started up. The laser can be automatically started up in future via the panel PC. The user does not need to make use of the MCS control.



4. If the variable <3> is entered under “Setup laser” in the CNC setup, the laser automatically starts up.
The controller type 2=MCS/SSI must, however, be set under "Configuration laser controller“!
Cutting can begin as soon as the orange light on the MCS cabinet illuminates. During the startup process the current status of the laser is displayed on the yellow information line of the MMC. When the laser is ready, then nothing is shown in the display.

Shutting down

Initial situation: The laser is running. The orange light on the MCS cabinet is illuminated.

1. Enter the value <0> under Setup laser in the CNC setup. The laser will now be shut down.
2. After the message “Laser status: Laser off" appears on the PPC, the shutdown process of the entire laser system can be continued.
3. Switch off the power switch on the STL cabinet and close the gas valves.

The key-operated switch on the MCS cabinet should not be turned to more than 0. This enables the system to be switched on again directly from the PPC! The user does not need to make use of the laser control.

3.4.4 Automatic Shut-down of the non-assisted operation

Shut-down

Set the selector above the main switch on "Auto" during the last cutting program. One minute after the end of the cutting of the last plate the laser will be flooded.

The high-voltage supply, the chiller, the aspiration are stopped, the laser and CNC control remain active.

In case of a machine error or with an unsufficient pressure in the compressed air supply the laser is flooded as well. The high-voltage supply, the chiller and the aspiration are stopped, the laser and the CNC control remain active.

Re-start

Reset the selector on “Hand”. Then start the laser as described above.

3.4.5 Restart after extended down-time

After an extended down-time (for example for a company holiday) perform the following checks in addition to what prescribed in the paragraph “Preliminary Operations”:

- Restrictions or obstacles in the laser area
- Water level and quality in the chiller
- Oil level in the turbo blower and in the vacuum pump
- Emergency stop
- Warning light and LED in the gas control
- Water flow rate
- Absence of moist in the gas circuit
- Resonator tightness (vacuum leak test)

3.5 Operation modes

Laser systems are frequently operated in continuous (CW) mode. For optimum cutting results, it is necessary to adjust the feeding speed to the desired template, for example during acceleration, deceleration and dwell times over corners.

The laser power must be adapted to feeding speed.

For these reasons it will not be sufficient to reduce the laser power in the CW mode, but its power must be modulated by varying the pulse duty factor.

For complex machining tasks in difficult materials the pulse mode, super pulse mode, and even combination pulse mode are available.

The following modes are available also on the CO_2 laser by Bystronic:

CW	=	Continuous wave mode (Continuous wave)
MD	=	Modulation mode
NP	=	Normal pulse mode

Transmission of stored records

1. Activate `l`, if the LED is not on
2. Select `h`
3. If the display does not give the message “Laser Power“ select the function “Laser Power” by using `d`
4. Select `c`. The message could be the following:

```
MANUAL  LASER  POWER   1000  GO
EXIT
  3        30        0      0    0
```

3:	Record No.
30:	Continuous laser power in %
0:	Basic power in %
0:	Pulse frequency in Hertz
0:	Normal pulse width in milliseconds

5. Select the desired record no. by using `d`
6. Depress `g`. The system will activate the values of the selected record.
7. Depress `x` to abort the entry of the laser power data. Select again `x` to abort `h` and go back to the initial position.

Checking the laser power selected on the CNC

Select "continuous laser power" as opposed to "pulse mode laser power" on the "Param" menu on the CNC control unit.

Press `d`. When <F1> is pressed, the "cutting laser power" value is displayed, when <F2> is pressed, the "piercing laser power" value is displayed.

3.5.1 Continuous CW mode

Operating principle

A laser is said to operate in continuous mode if its preset power remains unchanged for the duration of the entire cutting process.

CW mode

Control

1. Activate `l`, if the LED is not on
2. Select `h`
3. If the display does not give the message “Laser Power“ select the function “Laser Power” by using `d`
4. Select `c`. The following message may appear:

MANUAL	LASER	POWER	1000	GO	EXIT
3	30	0	0	0	

3: Record No.
30: Continuous laser power in %
0: Basic power in %
0: Pulse frequency in Hertz
0: Normal pulse width in milliseconds

5. Enter for the following position the desired values (go to the next box by depressing CR):
   - Record number, for example 10 instead of the displayed 3
   - Laser power CW in %, for example 100 instead of the 30 displayed
   - Check that the residual positions are at 0
6. Depress `g`. The preset values are activated, the laser is operating at its 100% power. Message:

Example of a display with Laser 30

MANUAL	LASER	POWER	1000	GO	EXIT
3	30	0	0	0	

7. Depress `x` twice to go back to the initial position.

3.5.2 MD modulation mode

The modulation mode can only be activated when the CNC machine control is switched on. The laser will receive the data supplied by the CNC control as soon as the l key is switched off.

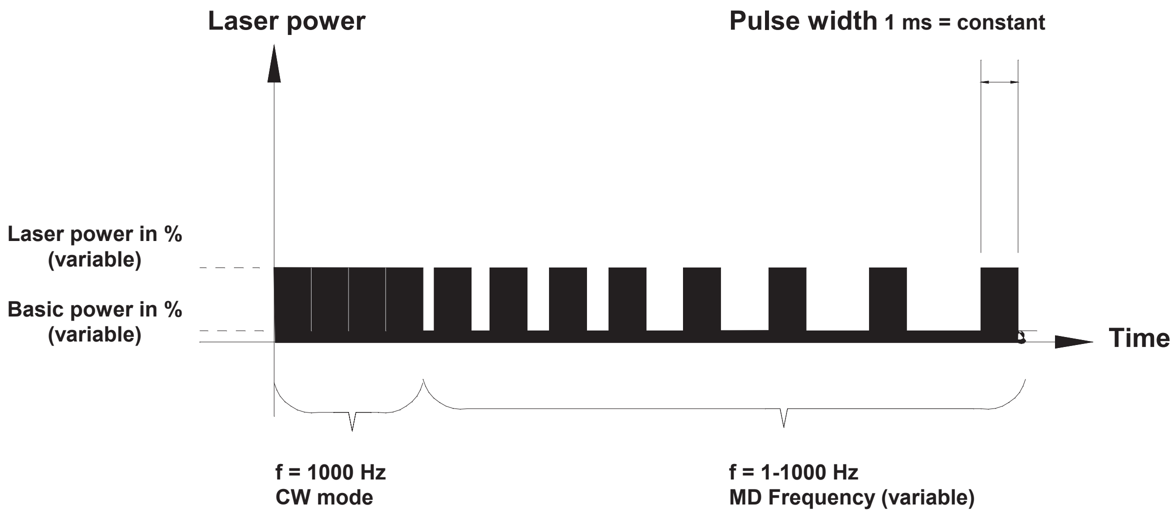
The control modulates the laser power accordingly to the variations of the axis feed (acceleration or decrease of speed)

The laser power modulation prevents the machined material from overheating on the corners and sharp edges.

In the frequency modulation mode, the system changes the frequency (keeping the same pulse width of 1 millisecond) from 1 to 1000 Hertz according to the feeding speed, and the laser power is adjusted to the feeding speed currently adopted. At a pulse width of 1 millisecond, and a pulse frequency of 1000 Hertz, the pulses are adjacent, and the resulting mode is a CW mode, meaning that the preset laser power is reached.

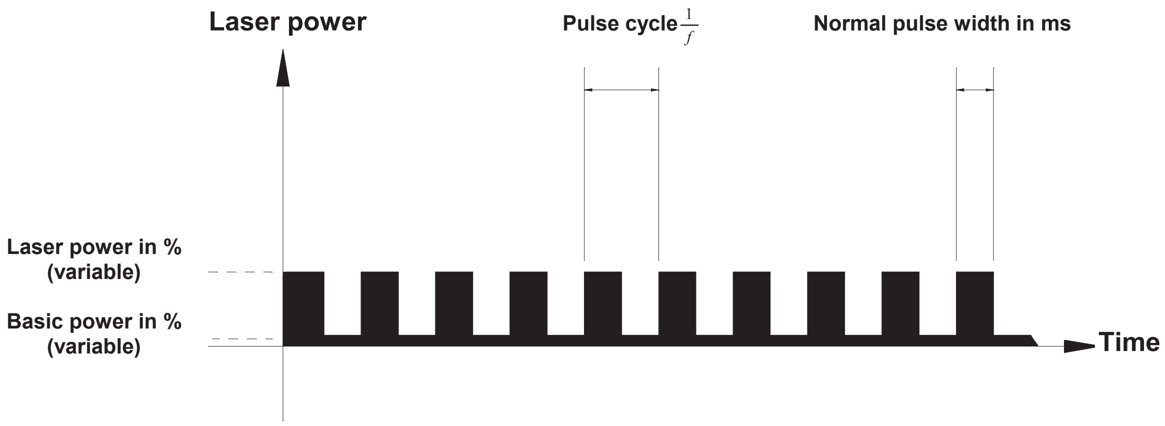
The basic power represents the minimum value in the power regulation range of values. In fact, below a certain value, the cutting quality does not meet the standards. A basic power of 5% is generally preset.

Notice:
Select a high laser power than the basic power for cutting. If the laser power is equal or lower than the basic power, the laser power will not be modulated.



3.5.3 NP normal pulse mode

Operation principles



NP mode

Pulse selector	1	
CW Power	0-100 %	
GW Basic power	0-100 %	(practically min. 5%)
Pulse frequency	1-2'500 Hz	(practically 1-1'500 Hz)
Pulse width	0.2-2.5 ms	
Restrictions	none	

Control

1. Activate `l`, if the LED is not on
2. Select `h`
3. If the display does not give the message “Laser Power“ select the function “Laser Power” by using the keys `d`
4. Select `c`. The following message may appear

MANUAL	LASER	POWER	1000	GO	EXIT
12	80	5	0	1	

12: Record no.
80: Continuous laser power in %
5: Basic power in %
0: Pulse frequency in Hertz
1: Normal pulse width in milliseconds

5. Enter for the following positions the desired values; (go to the next box by depressing <CR>):
   - Record number, for example 10
   - CW Laser power, for example 100
   - Basic power, for example 5
   - Pulse frequency, for example 250
   - Normal pulse width, for example 1
   - Check that the superpulse width is at 0
6. Depress `g`. The preset values will be activated.
7. Select twice `x` to go back to the initial position.

Operator’s Manual

Laser Machine

Gas Control

Issue 06.2000

Table of contents

4 Gas control

4.1 General description

Laser- and process-gases are differentiated.

The process-gases include both cutting-gas and protection-gas, and their composition is generally a mixture of oxygen, nitrogen, helium, argon and compressed air.

Even gas mixtures should be used for some applications to attain optimal machining quality.

4.1.1 Laser gas

The laser-gas mixture is composed of nitrogen, carbon dioxide and helium.
In the laser, the CO_2 (carbon dioxide) is the active means. It is excited by an electric discharge, and turns the electric energy into infra-red rays.

To increase the power of the laser output, nitrogen is added. The nitrogen transfers the power generated by the electric discharge to the CO_2

The third gas of the laser is helium. Helium helps keeping the electrical discharge in the gas mixture and eases the cooling of CO_2.

4.1.2 Gas mixture

In the gas control system the laser gases helium, nitrogen and carbon dioxide are mixed in a specified ratio. This ratio is preset by the factory to guarantee optimum performance and should not be modified. Still, a different gas mixture may be desired for certain types of laser machining. In this case the gas mixture new ratios must be set by specially trained personnel.

⚠ **Attention:**

Improper modifications of the laser gas mix may lead to defects of the laser system and compromise the high-voltage supply!

4.1.3 Process gas

The process gases are used for the following purposes:

– Cutting process: to force the molten material out of the kerf (cutting gas)
– Cutting process: to accelerate the cutting process thanks to the chemical reaction with oxygen (cutting gas, oxidation)
– Cutting, engraving, welding, hardening: to prevent undesirable chemical reactions during the laser machining process by shielding the machining area with inert gases (protection gas)

The suitable gases, gas pressures, nozzle diameters and nozzle heights for the individual applications are shown in the parameter list in the appendix of the MMC Onlinehelp chapter.

4.2 Safety warnings

Danger:

Chemical reactions with other gases may result in injury or death of the operator or third parties, also serious difficulties in breathing and/or heart disfunctions may be experienced in case of pipe leaks, tanks leaks or blowing-up of the gas tanks caused by a fire.

4.2.1 General precautions for the use of gases

1. In re-circulated air premises, thoroughly ventilate after each shift. Prevent gas from accumulating in closed spaces accessible to personnel (for example wells or ducts).
2. Fire-extinguishers available in the rooms must be suited for the flammable materials present on the location. Identify extinguishers location and escape routes with appropriate warning signs.
3. During the operation keep equipment closed. Check on a regular basis for leaks in the tank. In case of a major leak or equipment failure, leave the room immediately and do not re-enter it, unless wearing self-contained breathing apparatus. Maintenance work must be carried out by at least two individuals.
4. Keep cylinders away from open fire and heat sources. If stored outdoors, they must be protected against the effects of direct sun-rays.
5. When transporting the cylinders, ensure that the protective cap is in place. Secure cylinders against falling (AGA). When storing or using gas cylinders, beware of leaks and place cylinders in a well-ventilated place away from easily flammable substances. Never store cylinders in escape routes, offices or workshops or their direct vicinity. Never fill or re-fill cylinders in storage areas.
6. During transport, ensure that the caps and blank nuts are screwed-down tight. Shutdown valves must be opened slowly. Observe national regulations on cylinder approval and inspection intervals.
7. Use only original parts (AGA). Use fittings with approved thread only (see the table on the next page). Close cylinder valves before handling. When replacing check valves of full and empty cylinders for leaks. Never modify the safety valves adjustments. Do not vent gases in closed rooms. Check the status of the hoses at least once a year. All materials must be sufficiently resistant to all mechanical, chemical and thermal loads. Never use grease or oil (AGA). Repair work must be performed by authorized technician (AGA).
8. Avoid eating, drinking and storage of foodstuffs at the work station.
9. Wear protective overalls and gloves made of leather or thick textile fabric. In case of gas escapes in a closed room, wear self-contained breathing apparatus.
10. Observe additional national regulations, for example regarding transport vehicle identification, regular personnel training, work bans, etc.

4.2.2 Use of process gas

1. In the case of small rooms, ensure that they are adequately ventilated, simple air re-circulation systems may be insufficient. In case of large amounts of gas emission during machining at high pressure (up to 50 m³/h depending on nozzle diameter) the composition of breathed air is significantly modified. During high pressure machining with nitrogen the oxygen will deplete, while high pressure machining with oxygen causes an oxygen enrichment.
2. When machining aluminium parts, ensure that the exhaust air system can extract a sufficient quantity of air from the room. Excessively high concentration of protection gas may prevent the oxidation of aluminium slag and lead to any explosion of the dust in the filter.

4.2.3 Use of helium

Warnings about the chemical and physical behaviour and the use of helium:

Helium is a noble gas which does not compound with other chemicals. It is also used as protection gas in electric-arc welding of steel, aluminium, magnesium and titanium, as it prevents oxidation and nitride formation. It has a low solubility in water and organic solvents.

Warnings in case of fire or accidents:

1. Helium is not flammable. In case of fire use gas or powder-type fire extinguishers. Keep your back to the wind. Cool nearby containers and cylinders thoroughly with plenty of water, as heat results in pressure increase which may cause an explosion hazard.
2. Wear self-contained breathing apparatus.
3. Helium is not water-contaminant.

Health protection warnings:

1. Effects and toxicity : Insufficient oxygen, depending on the duration of exposure, may cause fatigue, indisposition, increased blood pressure, shortness of breath. The speed of sound in helium differs from that of air, so that the inhalation of helium in low breathable concentrations can be detected by the breathing noise and the alteration of voice frequencies. A pure helium conditions will cause loss of consciousness and suffocating without noticeable symptoms. Because of its low solubility in the blood, the forced inhalation of helium is less hazardous than nitrogen.
2. First aid: If helium is inhaled, remove the victim from the hazard area. Provide sufficient fresh air. In closed rooms, the first aid personnel must wear self-contained breathing apparatus. Victims need rest, warmth and possibly artificial respiration. Keep respiratory passages clear and monitor the blood circulation and administer cardiac massage if necessary. If victim looses consciousness, put him into a stable lateral position for transportation.
3. Physician: Symptomatic treatment.

4.2.4 Use of nitrogen

Warnings about the chemical and physical behaviour and the use of nitrogen:

Nitrogen reacts only with very few elements at room temperature, for example with lithium and calcium, with formation of nitrides. Even at high temperatures nitrogen does not react easily. It is therefore used as a protection gas in technical processes and to convey or store flammable liquids

Warnings in case of fire and/or accidents:

1. Nitrogen is not flammable. In case of fire, use water-spray or fire-extinguishers of the gas or chemical powder type. In case of large leaks, the gas, mixed with humid air, forms cold fogs heavier than air. Keep your back to the wind, Cool down the nearby nitrogen tanks with plenty of water as overheating increases pressure and may cause an explosion hazard.
2. Wear self-contained breathing apparatus and full protective overalls.
3. Nitrogen is not water-contaminant.

Health warnings:

1. Effects and toxicity: Nitrogen is not physiologically effective, but will prevent, in concentration exceeding 88% vital oxygen intake, thereby leading to suffocation. It does not produce irritation or warning symptoms.
2. First aid: If nitrogen has been inhaled, remove victim from the hazard area. Provide sufficient fresh-air supply In closed rooms first aid personnel must wear self-contained breathing apparatus. Victim must rest and be kept warm. Provide artificial respiration, if necessary. Keep respiratory passages clear and monitor the blood circulation, administer cardiac massage only if necessary. If victim turns unconscious, put him into a stable lateral position before transporting.
3. Physician: Symptomatic treatment

4.2.5 Use of carbon dioxide

Warnings about the chemical and physical behaviour and the use of carbon dioxide:

Carbon dioxide can react violently with a wide range of chemicals, particularly at high temperatures, therefore it cannot represent a universal extinguisher. Its mixture with ammonia, methylamine, ethylamine, dimethylamine, trimethylamine, can also cause very dangerous reactions. In case of quick relieving at standard pressure the liquid carbon dioxide cools down, solidifying, up to 79°C, forming dry-ice which quickly evaporates, with no melting.

Warnings in case of fire and/or accidents:

1. Carbon dioxide is not flammable. Adapt the fire extinguishing measures to the requirement of the premises. Cool down nearby tanks and cylinders of carbon dioxide with plenty of water. Overheating can cause an increase of pressure and an imminent danger of explosions. Breathing hazards, particularly in closed rooms, at floor level. Keep upwind. Beware of congelation of your body, wearing protective overalls.
2. Wear self contained breathing apparatus and a total protection overall.
3. Carbon dioxide is not water-contaminant.

Health protection warnings:

1. Effects and toxicity: in high concentration carbon dioxide has a paralyzing effect on the breathing system . At low concentration rates, the lacking or sufficient pressure of oxygen is decisive to determine the process of CO_2 intoxication. Accordingly with the length of the inhalation without the sufficient oxygen admix, approximately at 8-10% vol., it causes headaches, ear-humming, vertigo, blood-pressure increase, tachycardia, tachypnoe, dyspnoe, state of excitation, nausea. At a concentration rate of more than 10% byvol., it causes ataxia, occasionally even epileptiform cramps, fainting fall of blood-pressure. In all cases provide prompt measures allowing the breathing of fresh air and fast recover otherwise risk of suffocation! At a concentration rate of more than 18-20% byvol., it causes apoplectic-like symptoms. In case of contact of the liquid or dry-iced carbon dioxide with skin, you can experience reddening and swelling with possible blistering. Also possible destruction at different depths of skin texture, heavy pains.
2. First aid: if carbon dioxide has been inhaled, remove the victim from the hazard area and provide a sufficient supply of fresh air. In closed rooms, first aid personnel must wear self-contained breathing apparatus. Victim needs rest, warmth and possibly artificial respiration. Keep respiratory passages clear and monitor the blood circulation. Administer cardiac massage only when necessary. Turn unconscious victims into a stable lateral position, if they need resting before transportation.
3. Physician: If carbon dioxide has been inhaled administer artificial respiration enriched with oxygen (cave-aspiration if the victim has vomited). Intubation and monitoring of gas concentrations in the blood (or acid-alkali balance) may be necessary. Appropriate therapy: infusion of hydroxymethylaminomethane or similar. Continue according to symptoms. In case of severe skin pains, provide an injection of 1 ampoule of hydromorphonehydrochloride. Check respiration and blood circulation. Two ampoules of methylprednisolone 2 by intramuscular injection can be administered.

4.3 Gas characteristics

4.3.1 Laser gas characteristics

Laser gas must be highly pure. The required titres are as follows:

N_2 99.999% (5.0)
He 99.996% (4.6)
CO_2 99.995% (4.5) poss. 99.990 (4.0)

The gas humidity contents must be very low, because the molecules present in the water will weaken the energy of the laser beam. The required laser gas characteristics are reported in the following tables:

Helium laser gas

Denomination and titre by volume	Contents of other gases by volume	Gas content by m^3	Cylinder type/ approx. volume in liters
Helium 4.6 He ### 99.996 %	H_2O ### 5 ppm N_2 ### 20 ppm O_2 ### 5 ppm Ne ### 10 ppm C_nH_m ### 1 ppm	3.7 5.5 9.2 Bundle 110.4	20 40 50 Bundle 12x50
General information	Maximum permissible cylinder pressure at 15°C: 200 Cylinder identification: grey shoulder Cylinder connection: DIN 477, Nr. 6, W21,80 x $^1/_{14}$" right hand Recommended material: Ms/Cu		

Carbon-dioxide laser gas

Denomination and titre by volume	Contents of other gases by volume	Gas content by m^3	Cylinder type/ approx. volume in liters
Carbon dioxide 4.5 CO_2 ### 99.995 %	N_2 ### 30 ppm H_2O ### 5 ppm O_2 ### 10 ppm C_nH_m + CO ### 1 ppm	10 25 30 37.5	13.4 33.4 40 50
General information	Gas with liquid phase Steam pressure at 15°C: 50 bar Cylinder identification: grey shoulder Cylinder connection: DIN 477, Nr. 6, W21,80 x $^1/_{14}$" right hand Recommended material: Ms/Cu		

Nitrogen laser gas

Denomination and titre by vol	Contents of other gases by vol	Gas contents by m^3	Cylinder type/ approx. volume in liters
Nitrogen 5.0 N_2 + noble gasi ### 99.999 %	H_2O ### 5 ppm O_2 ### 3 ppm H_2 ### 2 ppm	10	50
General information	Maximum permissible cylinder pressure at 15°C: 200 bar Cylinder identification: green shoulder Cylinder connection: DIN 477, Nr. 10, W24,32 x $^{1}/_{14}$" right hand Recommended material: Ms/Cu		

4.3.2 Laser gas summary

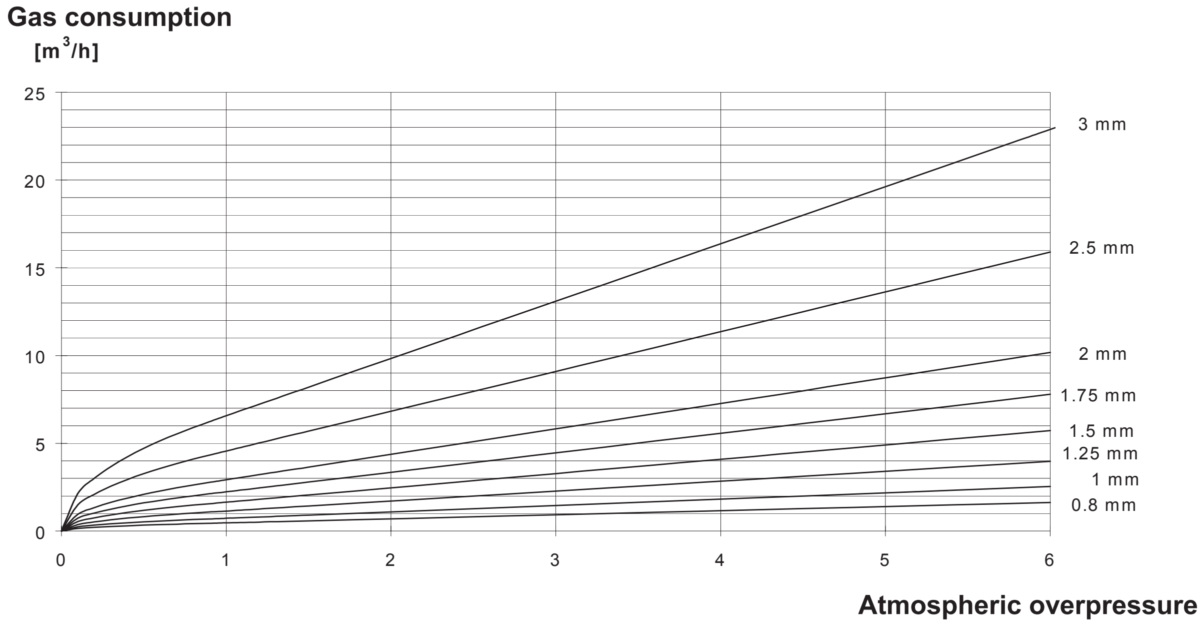
Type of gas		Class	Titre [% Vol.]	Contents of (H_2O) [ppm]	Contents of (O_2) [ppm]	Percentage in the gas mixture [%]
Helium	He	4.6	≥ 99.996	≤ 5	≤ 5	63.1
Carbon dioxide	CO_2	4.5	≥ 99.995	≤ 5	≤ 10	3.4
Nitrogen	N_2	5.0	≥ 99.999	≤ 5	≤ 3	33.5
	Total					100

4.3.3 Process gas characteristics

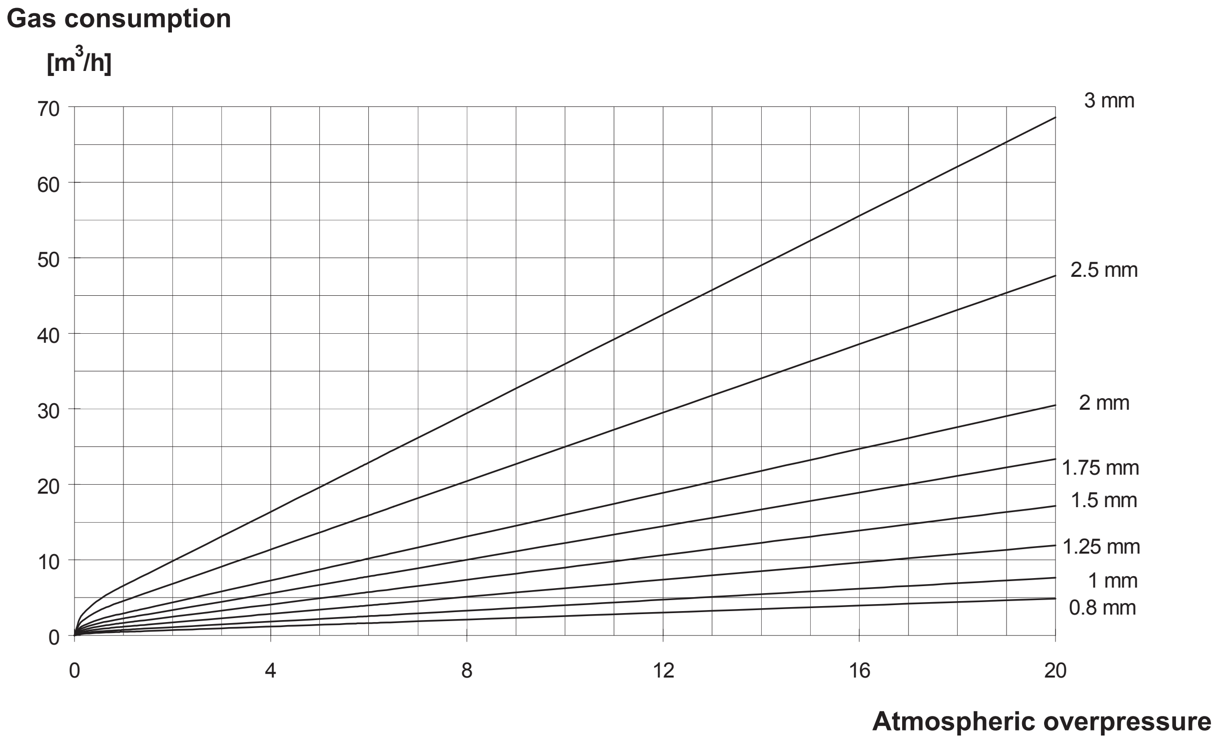
Type of gas		Class	Titre [%Vol.]	Nitrogen contents above (N_2+Ar) [ppm]	Water contents (H_2O) [ppm]	Cutting surface
Oxygen	O_2	3.5	≥ 99.95	≤ 500	≤ 5	Oxidization
				Contents of (O_2) [ppm]	Contents of (H_2O) [ppm]	
Nitrogen	N_2	2.8	≥ 99.8	≤ 500	≤ 20	oxide-free, slightly yellow
Nitrogen	N_2	3.5	≥ 99.95	≤ 100	≤ 10	oxide-free, not necessarily shiny
Nitrogen	N_2	4.5	≥ 99.995	≤ 10	≤ 5	oxide-free, guaranteed shiny
Nitrogen	N_2	5.0	≥ 99.999	≤ 3	≤ 5	absolutely oxide-free, guaranteed shiny

4.3.4 Process gas consumption: oxygen with K nozzles (low pressure cut)

Graph with 0-6 bar resolution

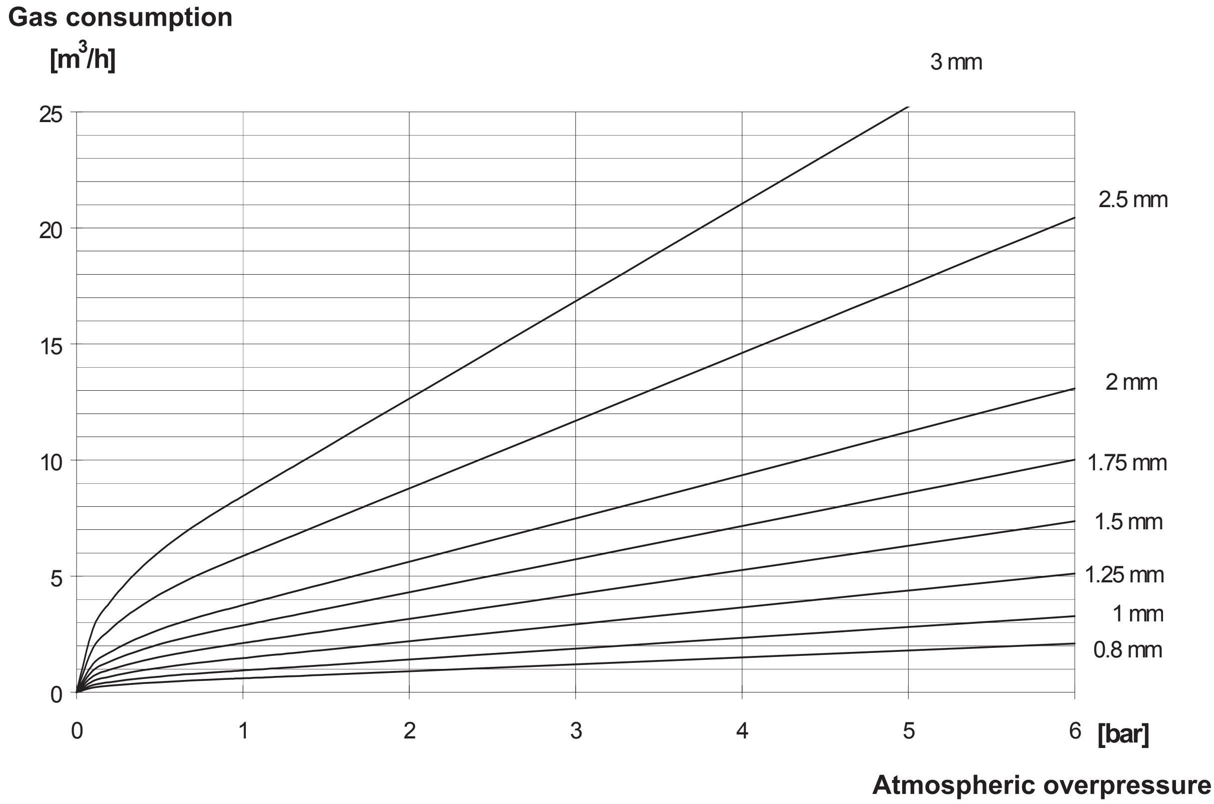


Graph with 0-20 bar resolution

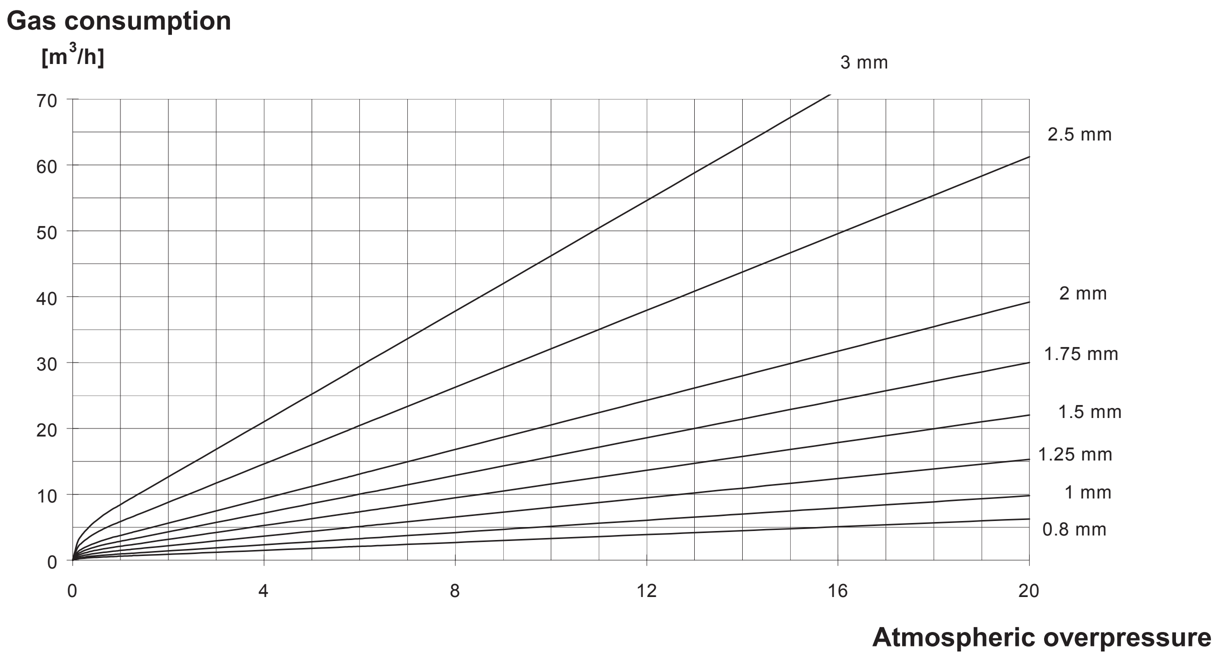


4.3.5 Process gas consumption: oxygen with HK nozzles (high-pressure cut)

Graph with 0-6 bar resolution

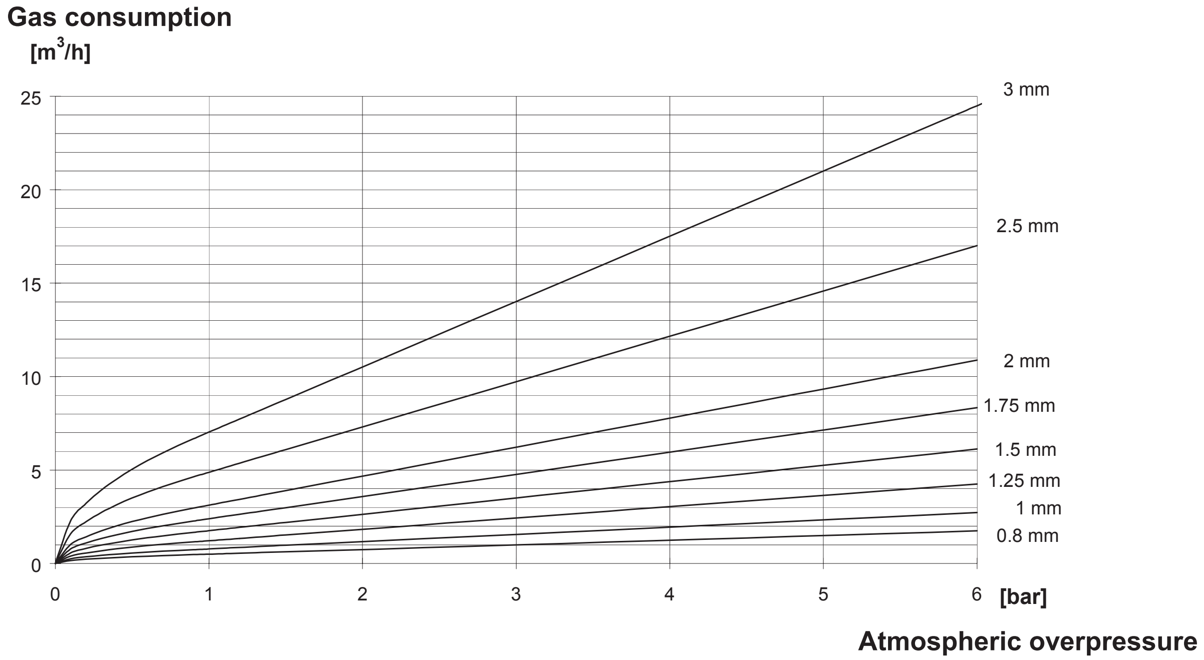


Graph with 0-20 bar resolution

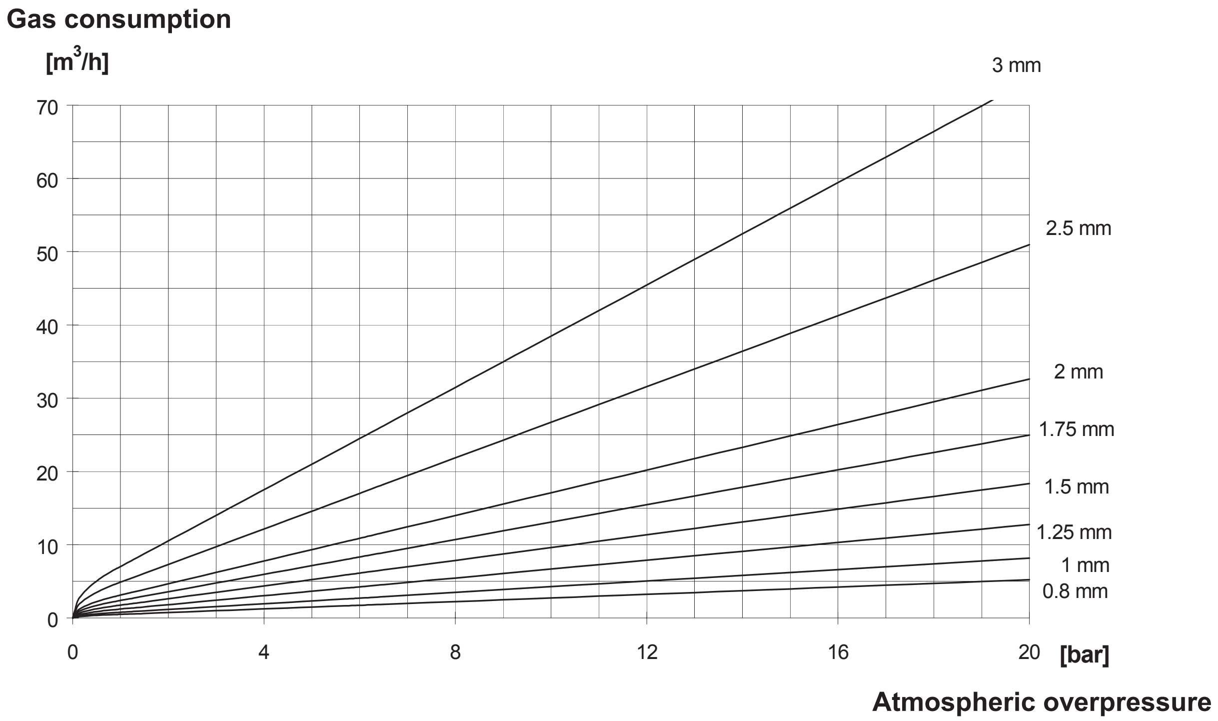


4.3.6 Process gas consumption: Nitrogen with K nozzles (low pressure gas)

Graph with 0-6 bar resolution

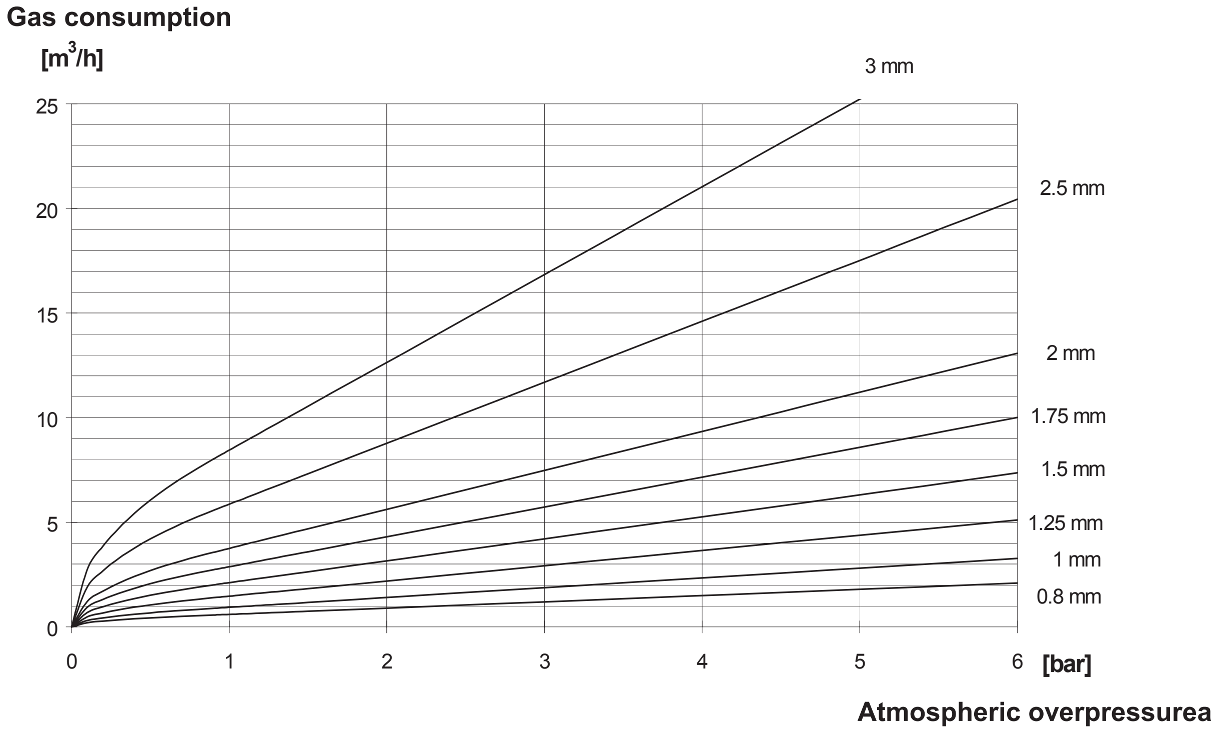


Graph with 0-20 bar resolution

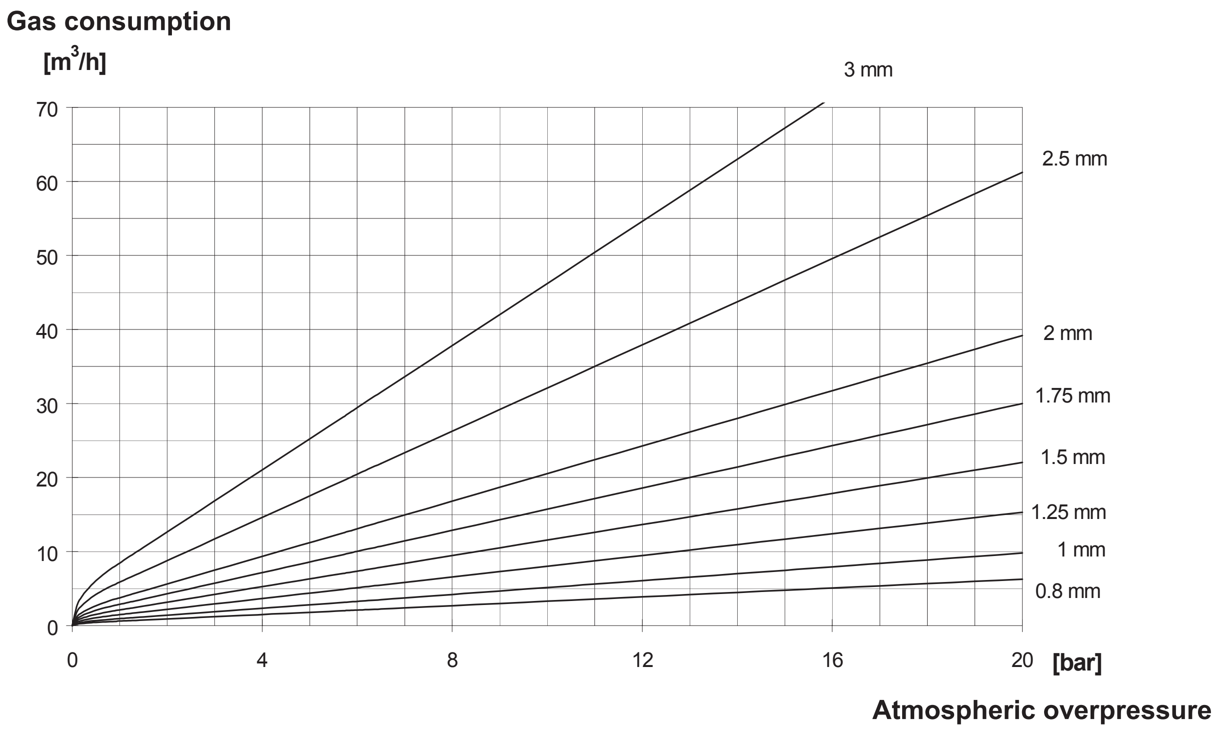


4.3.7 Process gas consumption: nitrogen with HK nozzles (high pressure cut)

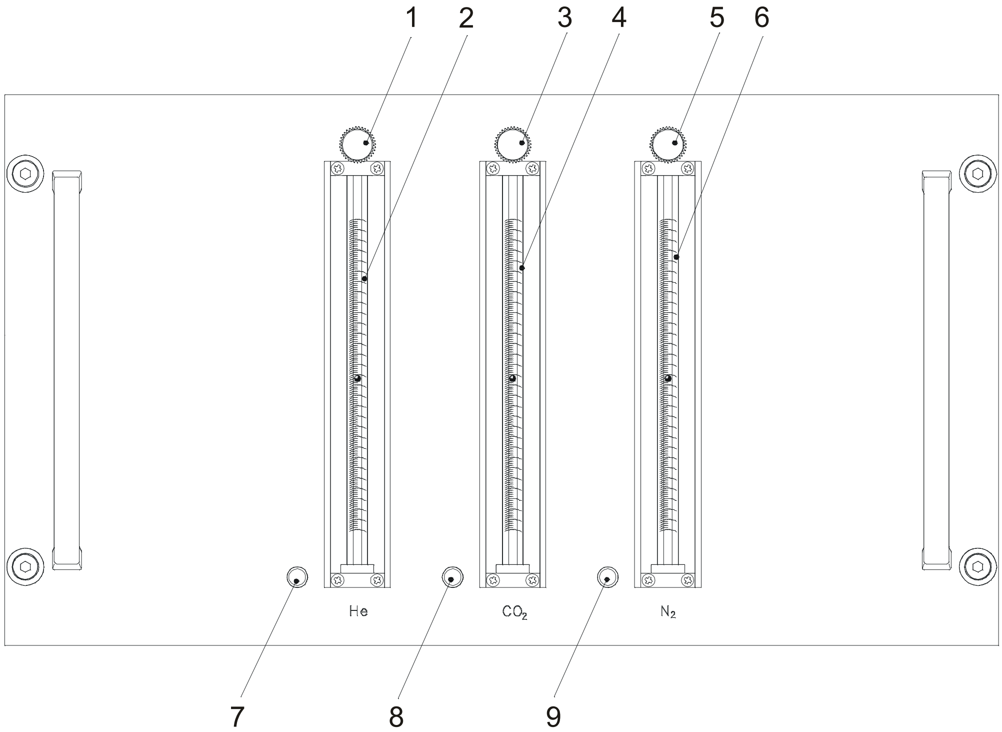
Graph with 0-6 bar resolution



Graph with 0-20 bar resolution



4.4 Control board



Attention:

An unsuitable change of the gas mixture for laser can cause troubles in the operation and damage the high-voltage supply!

1.	He needle valve	Needle valve for adjusting the helium laser gas flow rate
2.	He flow meter	Indicates the preset helium laser gas flow rate
3.	CO_2 needle valve	Needle valve for adjusting the carbon dioxide laser gas flow rate
4.	CO_2 flow meter	Indicates the preset carbon dioxide laser gas flow
5.	Needle valve N_2	Needle valve for adjusting the nitrogen laser gas flow
6.	N_2 Flow meter	Indicates the preset nitrogen laser gas flow rate
7.	He indicator light	When this light is on the supply of the laser gas is sufficient. This means the helium supply pressure exceeds the nominal pressure. The indicator light goes off when the gas pressure drops below 3 bar, for example because the laser gas cylinder is almost empty. If the gas pressure falls below 1 bar, the laser is de-energized (this is valid for CO_2 and N_2).
8.	CO_2 Indicator light	As long as this indicator light is on, the laser gas pressure is sufficient.
9.	N_2 Indicator light	As long as this indicator light is on, the laser gas pressure is sufficient.

4.5 Set-up and operation

Various types of gas supply units are available:

- One-bin gas cabinet
- Two-bins gas cabinet
- Gas cabinet combined with a liquid gas tank

The one-bin gas cabinet is used when the process gases supply to the machine is set directly from a cylinder bundle or a liquid gas tank.

The one-bin gas cabinet can contain:

- 3 laser gas cylinders
- 3 spare cylinders

The two-bins gas cabinet is used when the process gases supply to the machine, both for the laser and for the process comes from single cylinders.

The two-bins gas cabinet can contain:

- 3 laser gas cylinders
- 3 process gas cylinders
- A spare cylinder right besides each of the above mentioned cylinders.

The gas cylinders are not included in the supply from Bystronic.

Safety warnings

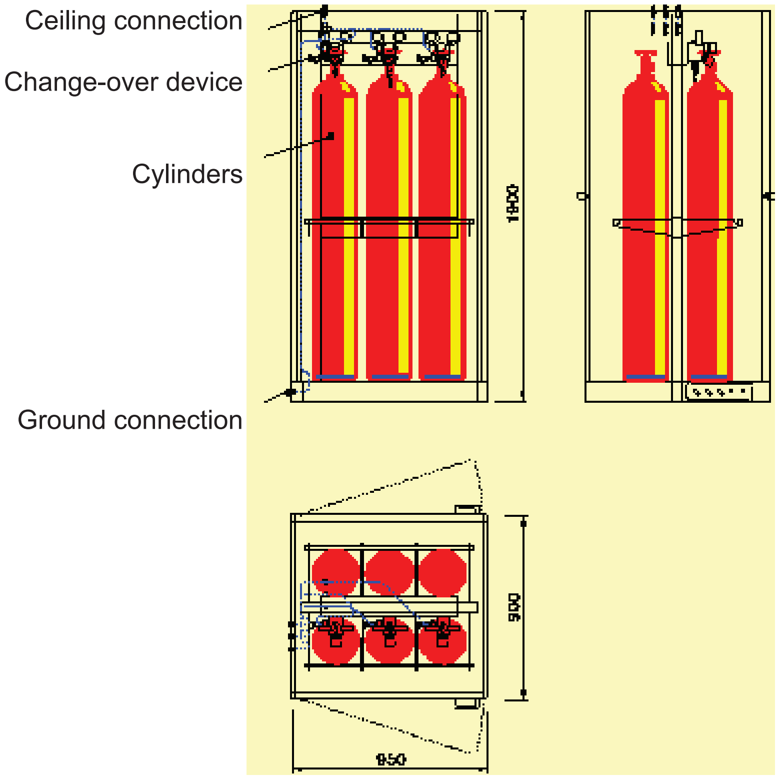
Danger:

Injures and death hazard for operator and third parties caused by:

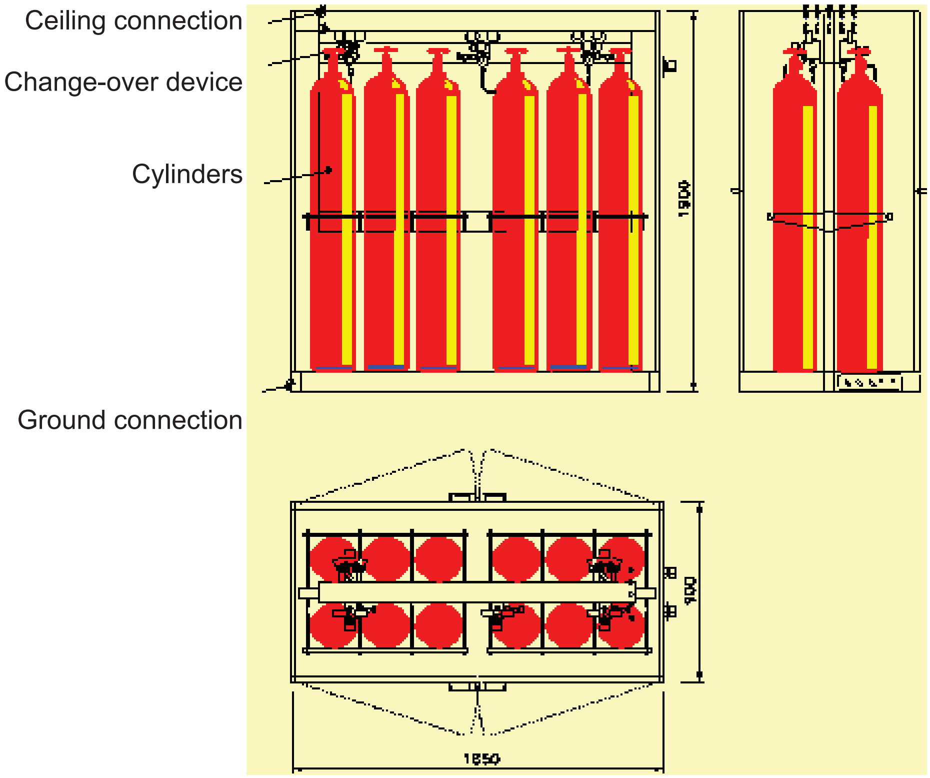
- chemical reaction with other gases
- harmful effects on respiration and cardiac functions in case of pipe or tank leaks
- explosion of gas tanks in case of fire

For safety warnings about each different gas see page 2.

One-bin gas cabinet



Two-bins gas cabinet



4.5.1 Gas tubes

The nitrogen for the laser and for the process differ in their respective titre (see technical data). Therefore all laser gases are put through separate pipes.

Two distinct types of pipings are available for process gases. When, for the different processes, more than two gases should be required, the process change over will also involve a pipe change over. In case of pipe change over make sure that the pipe iswashed, after connecting the required type of gas.

4.5.2 Changing cylinders

⚠ **Caution:**

Secure cylinders in their position! Cylinders not connected should be closed with their protective cap!

Process gas cylinders can be changed during the machining process or with the machine switched off. Pay attention in both cases and carry out the job with accuracy and cleanliness to avoid that dirt particles enter the gas circuits.

Warnings of general nature

Do not allow cylinders to become completely empty. Return them with a minimum residual overpressure of 1 atmosphere as indicated by the manufacturer.

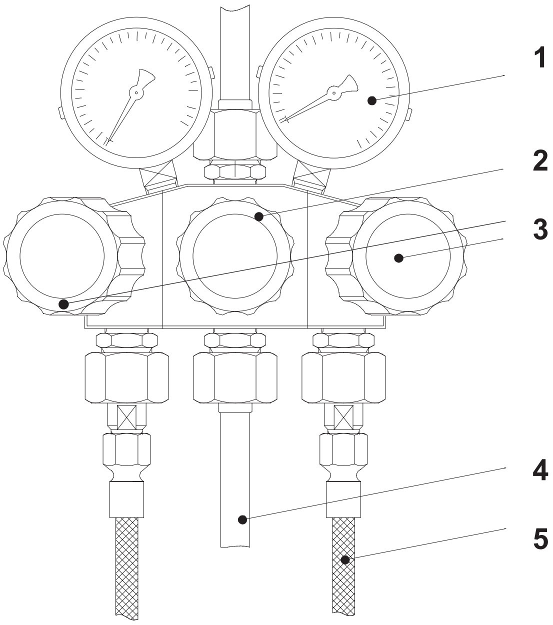
When changing the cylinders pay close attention to the type of gas used. The titre must never be lower than the recommended one.

In case of an insufficient process gas supply, the machine stops and on the laser control display the error message GASJET ERROR will appear, while on the CNC control display the message LASER ERROR will appear.

In case of an insufficient laser gas supply, the machine stops, the laser is de-energized and on the laser displays the error message GAS MIX ERROR will appear, while on the CNC control display the message LASER ERROR will appear.

Once the cause of a fault has been eliminated, clear the error messages on the laser control unit by pressing <RESET>, and on the CNC control by pressing <ABORT>.

Process Gas Fittings

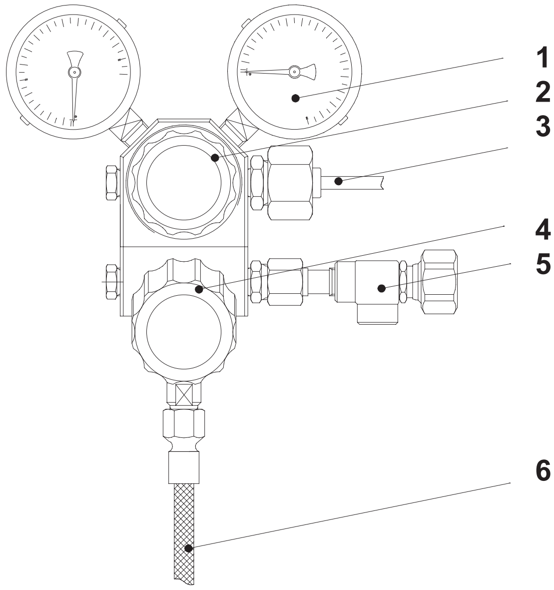


1 Pressure gauge
2 Reducing valve
3 Shutoff valve
4 Ground out gas control connection
5 Bottle connection

Changing the process gas bottles during operation

1. Check that the shutoff valve (3) for the full bottle is closed.
2. Close the reducing valve (2), 0 bar, counter clockwise.
3. Slowly open the valve of the full bottle.
4. Close the shutoff valve (3) of the empty bottle and open the shutoff valve (3) of the full bottle.
5. Adjust the reducing valve (2) to 15 bar (for oxygen) or 25 bar oxide free cutting. (max 28 bar)
6. Close the valve of the empty bottle.
7. Remove the empty bottle and place the protective cap on it. Place a full bottle and secure it properly.
8. Briefly open the valve of the full bottle to blow out any dirt accumulated during shipping. Warning: 200 bar pressure! (eye protection) Connect full bottle.

Laser Gas Fittings



1 Pressure gauge
2 Reducing valve
3 Machine connection
4 Shutoff valve
5 Rinsing valve
6 Gas bottle connection

Changing of laser gas bottles

Switch the laser off to change the bottles.

Notice:

Do not change the gas bottle during operation, because the rinse procedure is not possible. The line fitting (air and humidity) of the full bottle affects the optimal laser performance.

1. Switch off the high-voltage, gas circulation and vacuum pump. (See chapter “Laser”).
2. Close the shutoff valve (4) and the reduction valve (2).
3. Remove the empty bottle and place the protective cap on it. Place a full bottle and secure it properly.
4. Open the full bottle valve, leaving the shutoff valve (4) closed.

5. Close the bottle valve. Open the rinsing valve (5) until the pressure gauge reading has dropped to zero (gas bottles shall always be rinsed at gas bottle replacement).
6. Close the rinsing valve.
7. Repeat steps 4 to 6 three times.
8. Open the full bottle valve.
9. Open the high-pressure shutoff valve (4).
10. Adjust reducing valve (2) to a pressure of 5 bar.
11. Switch on high-voltage, gas circulation and vacuum pump.

Note:

If the machine is out of operation for a longer time period (over 8 hours), the bottle valves must be closed. Otherwise a static pressure can build up at a valve with a leak, which can lead to the destruction of the pressure valve in the cutting cartage.

Operator`s Manuel

Laser Machine

Starting the Machine, MMC-Help

& Parameters

Issue 01.2001

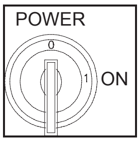
Table of Contents

5 Starting the Machine, MMC-Help and Parameters

5.1 Starting and Stopping the System

5.1.1 Starting the System

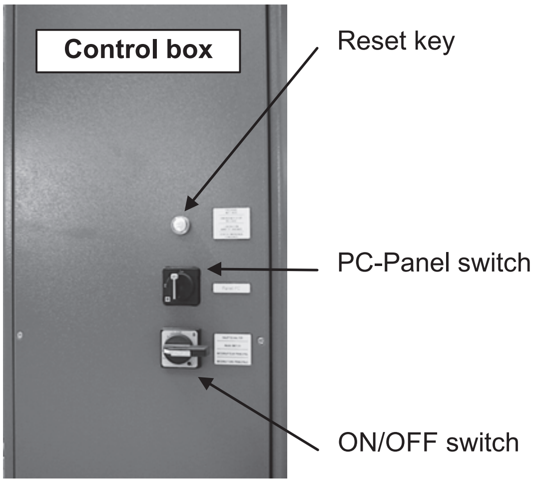
1. Turning on the Gas Supply



Open the reduction valves of the bottles of process gas (O_2, N_2), Laser gas (He, O_2, N_2) and compressed air supply. The minimum pressure in the bottles of process gas must never drop below 5 bars, while for the Laser gas it must not drop below 2 bars.

2. Turning on the Electrical Power Supply of the Resonator and the Machine

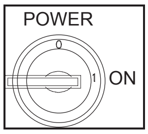
The electrical power supply of the entire system (except for the PC-Panel) is turned on using the ON/OFF switch on the left panel of the electrical control box. This switch can be locked in the <OFF> position and has to be turned to the <ON> position to put the system into operation. The power supply of all the high voltage control systems and the Laser, as well as all the motors, is controlled using this system ON/OFF switch.



3. Using the Reset Key

Before pressing the electrical control box reset button, turn the key-operated switch on the MCS control box (Laser) to the <POWER> position (position 0). If the switch is not in this position, the system cannot be reset ! Then use this reset key to start the machine. It also has to be pressed after an emergency stop. The reset key restores the safety circuits to a defined condition, and activates them.

4. Turning on the Resonator



To start the resonator, the key-operated switch on the MCS control box (Laser) has to be moved to the <ON> position (position 1). The display shows the prompt xxx->RESET.
(The BTL xxxx and Pxxx-0xxx text may vary according to the specific version of the Laser and the programs used by the customer)

```
XXXXXX LASER DC BTL 3000 XXXXXX
XXX   BYSTRONIC AG   P02-03B   XXX   → RESET
```

Now press the reset key situated above the key-operated switch. The <RESET> function restores the safety circuits to a defined condition. Keep the reset key pressed for at least three seconds, so that the control system can check all the safety functions. Having started the machine, after the restart, the <VACUUM ON?> prompt appears on the display.

```
CURRENT    0        POWER    0          PRESS   1000
VACUUM ON?                    SHUTTER  UNLOCKED
```

The resonator can be started in step mode or in automatic mode. To turn it on in automatic mode, press the <ON> key on the keyboard. The <Step> key must be disabled. At this point, the resonator is started automatically. At the end of the startup, the following message appears on the display

```
CURRENT   14      POWER  400         PRESS  160
LASER READY                   SHUTTER UNLOCKED
```

Caution:

The Laser must reach the working temperature before the machining process is started. The working temperature has been reached when the power display (**POWER** xxxx) remains constant on the power value set.

(Further details on how to start the resonator can be found in section 3.4 Turning on and off.)

PC-Panel Switch

The key-operated switch situated between the reset key and the system ON/OFF switch is used for turning on and off the power supply for the PC-Panel irrespective of the position of the system ON/OFF switch. If the switch is on, the PC-Panel automatically starts the operating system and the MMC software. Once started, the main screen (MAIN) of the MMC software will appear on the display.

Peripheral devices:

- The chiller is also connected via the main ON/OFF switch
- The exhaust filter has it own power supply
- When the orange LED on the MCS control box lights up, the machine is ready for operation.

5.1.2 Turning off the System Manually

1. Turning off the Resonator

Press the <OFF> key on the MCS control box keyboard (Laser). At this point, the high voltage, turbo fan and vacuum pump are turned off. The system is flooded with nitrogen until atmospheric pressure is almost reached.

```
CURRENT    0POWER    0 PRESS  155
RUNNING FLOOD   SHUTTER UNLOCKED
```

The flooding process lasts for a few minutes. At the end, the following message appears on the display:

```
CURRENT     0POWER     0PRESS  990
VACUUM ON ?  SHUTTER UNLOCKED
```

Do not continue the power off procedure until this message has been displayed! (at this point, a new startup cycle could be performed).

Turn the key to the left, to position 0. Remove the key. All the displays are off. The entire Laser system is cut off from the power supply.

2. Turning off Peripheral Devices

- Turn off the ON/OFF switch on the left-hand side of the electrical control box
- Turn off the compressed air supply
- Close the reduction valves of the process and Laser gases

3. Turning off the PC-Panel

By pressing the <MAIN> key on the MMC keyboard activate the initial page of the MMC software and press <Shut down> at the bottom of the menu, to turn off the MMC and the computer.

Do not turn off the PC- Panel power supply until the "It's now safe to turn off your computer" message appears on the display.

(Further details on how to turn off the resonator can be found in the "3.4 Turning on and off section".)

5.1.3 Turning off the System Automatically

Generally speaking, the following is true:

The "automatic power off" function enables the system to be turned off automatically when the joblist has been executed in automatic mode.

There are two ways of automatically turning off the system:

1. Power off after a preset timeout ("power off after" parameter in the MMC setup)
2. Power off after a fault has occurred

Power off after a preset timeout

The system is turned off:

– After the Joblist has been executed

– After the cutting head has returned to the reference point

– After the deactivation timeout set in the MMC setup.

The STL control system powers off the following components in the order given.

Without a delay:	– High voltage of Laser
	– Laser Blower
	– The Laser system is flooded with nitrogen
	– Crossjet oil pump
After 1 minute:	– Discharge air filter
After 5 minutes:	– Cutting gas
	– Compressed air
After 10 minutes:	– Compressor chiller
	– Chiller fan

Turning off after a breakdown

The system is automatically turned off following the faults listed below:

– Machine error

– System error

– Loading process not terminated

– Unloading process not terminated

– Light barrier crossed

After 60 minutes, the STL control system automatically turns off the plant. This may be avoided by eliminating the fault within this period of time. The power-off procedure is as described under the item “powering off after a preset time period“.

5.1.4 Starting after an Automatic Power-Off

Important:

Before starting the machine, the time parameter must be restored to zero in the MMC setup.

After the automatic power off, the resonator must be restarted manually.

To restart the resonator, press the reset key situated above the key-operated switch. The <RESET> function restores the safety circuits to a defined status. Keep the reset key pressed for at least three seconds so that the system can check all the safety functions. The first message that appears on the display after the restarts is the prompt <VACUUM ON?>.

```
CURRENT    0      POWER    0         PRESS   1000
VACUUM ON?                 SHUTTER  UNLOCKED
```

The resonator can be started in step mode or automatic mode. The <Step> key must be disabled. Now the resonator is started automatically. At the end of the startup, the following message appears on the display:

```
CURRENT   14      POWER  400        PRESS  160
LASER READY                SHUTTER UNLOCKED
```

Caution:

The Laser must reach the working temperature before the machining process is started. The working temperature has been reached when the power display (**POWER** ...) remains constant on the power value set.

5.2 Configuring the CNC

Introduction

The operator may control the cutting system by means of a PC installed directly on the machine frame. This PV is known as the <Panel PC> or, by its abbreviated name, PPC.
The MMC (Man- Machine- Communication) panel provides the operator with the following functions:

– Control of system (CNC) by means of an optical fibre cable
– Creation, processing, graphic representation, editing and printing of work plans (NC plans)
– Creation, processing, editing and printing of process parameters
– Monitoring of the machining process and procedure in case of faults

The CNC control system is housed in the right-hand area of the control cabinet, on a special rack. The CNC comprises the following boards:

– **ROM/RAM:** This board contains the working memory of the CNC (RAM). The working memory contains the last work plan with its machine parameters and process parameters. The CNC software is located in the ROM on the board.
– Computer (CPU), which processes the sequences of commands according to the signals provided by the switches, the gas and laser control system, the keyboard etc. The computer sends signals for coordinating the gas and laser control with the movements of the axes.
– **Lascon 3:** (Memory and communication board for the laser machine via the RS 422 interface)
– **Sercom:** (Interface board e.g. Diehl optics control)
– **Poscon:** (Board for controlling the position of the X,Y,U axes)
– **2W-Con:** (Board for controlling the position of the ZW axis)
– **Impgen:** (Feed encoder card)
– **Diocom:** (Interface board for serial communication)

Geometrical and process data input and output are carried out by a Personal Computer with an MMC operator panel, connected to the CNC system by an optical cable. The Panel-PC has a keyboard, mouse, monitor, 3 ½ disk drive, ZIP drive and hard disk.

By using the PC- or the machine keyboard, the operator will prepare the machining process to be carried out and regulate the process, when the need arises.

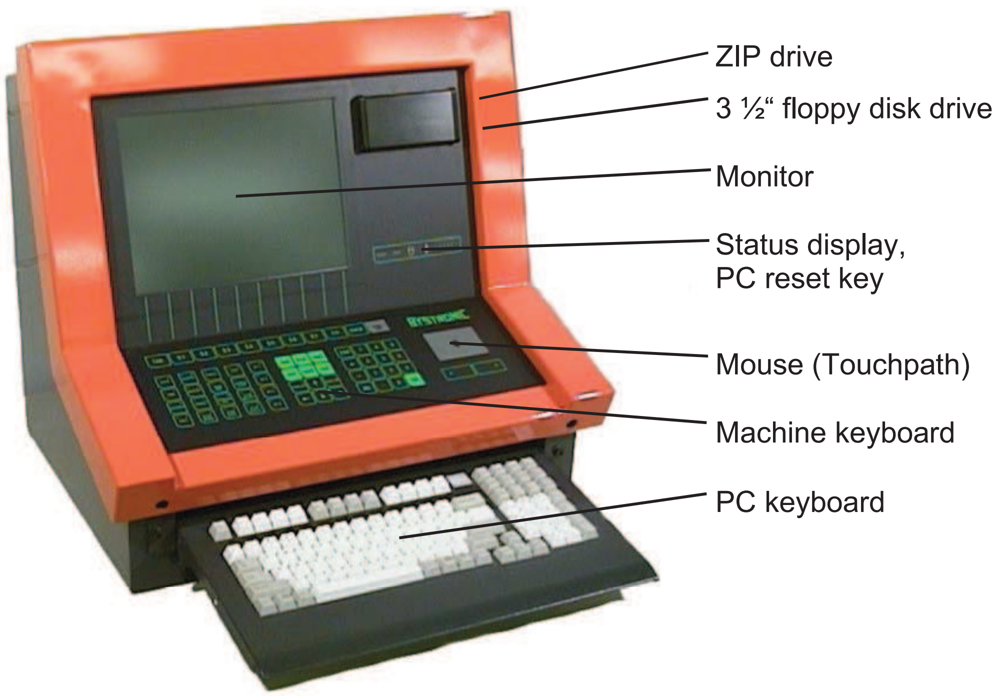
5.2.1 Variants

The following functions described in the present user manual are not part of the standard supply and are therefore not available on all machines:

– Rotating axis (U axis)
– Flying optics (Bypos-W / Diehl optics)
– Cross-Jet
– Exchange of shuttle table
– Loading / unloading system
– Retractable grids

You will find a list of the options installed on your machine on the order confirmation in the “Machine Documentation” folder.

5.2.2 The Panel-PC



5.2.3 PPC Functions

The PC panel works with the Windows 95 operating system. Immediately after turning on the Panel-PC at the switch located in the electrical control box, the operator’s control panel (MMC) is automatically turned on. If the main switch has been turned on, communication with the CNC is activated by means of the optical fibre cable. At this point, the operator can control the machine.

The following programs are available:

WIN 95: Complete version of the Microsoft Windows 95 operating system.

MMC: Man-Machine-Communication. Means of communication between the operator and the machine. Used for controlling and managing the machining process, displaying information about the operating status and system messages, inputting and outputting data on data storage media, etc.

Bysoft: Bystronic programming software for processing geometrical data. To use the operator panel, familiarity with the Windows 95 operating system is essential.

The explanations given in the following sections refer to MMC mode.

5.2.4 Data Types and Flow MMC

The data required to manage the machining process are divided into two types of files:

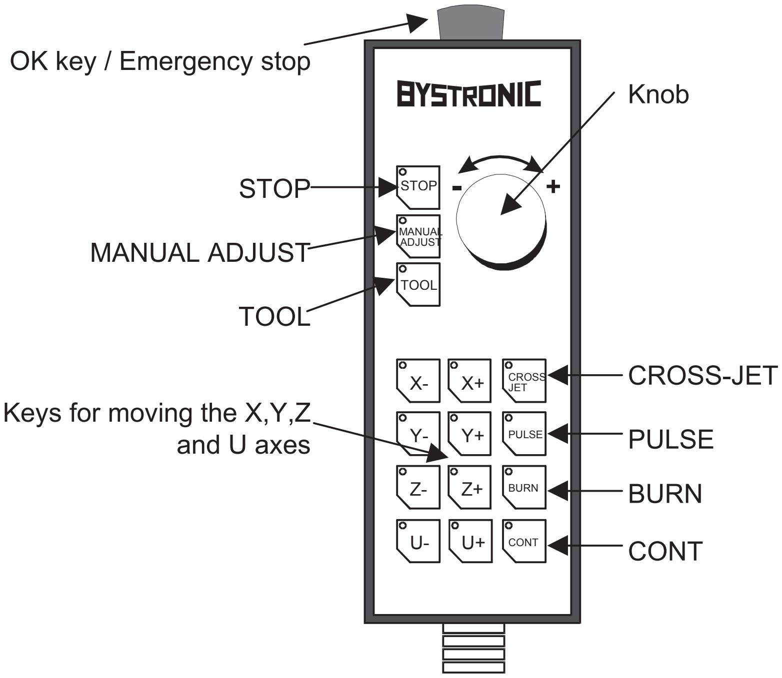
	Files with machining plans	**Files with process parameters**
Contents of files	Definitions of the contour by means of straight and curved elements ("G" functions), and information about the machining technology ("M" functions)	Parameters for feed, gas, laser etc. (see the "Param" section and the list of parameters in the annexed documentation)
Creating files	In the CNC editor using the machine or PC keyboard (see the "Data" section) With the Bystronic BYSOFT software locally on the PC or externally (see the separate documentation "BYSOFT User Manual") With BYSOFT CAD and data conversion system (see the "BYSOFT User Manual")	In the parameter editor using the machine keyboard (see the <Data> section) On the <Work> menu- "active param.", using the machine keyboard (see the "Work" section.)
Data transmission	on hard disk from PC on removable data storage media (3½" / ZIP disk drive) via the network via a data line (on-line transmission from external computer)	on hard disk from PC on removable data storage media (3½" / ZIP disk drive) via the network via a data line (on-line transmission from external computer)

When read from the hard disk, floppy disk or other higher-level computer, the machining plans and files with process parameters are loaded into the main memory of the PC. When the machining process is started, the files are copied to the working memory of the CNC.

This two-phase data flow was chosen to enable the next plan to be created, checked and modified on the PC, while the machine is carrying out the current plan present in the memory of the CNC.

The machining plan together with its process parameters is called the "machining plan" (or job, for short).

5.2.5 CNC Manual Mode



Manual control is used for set-up and regulation, for cutting off plate rejects and test cuts to determine the parameters.

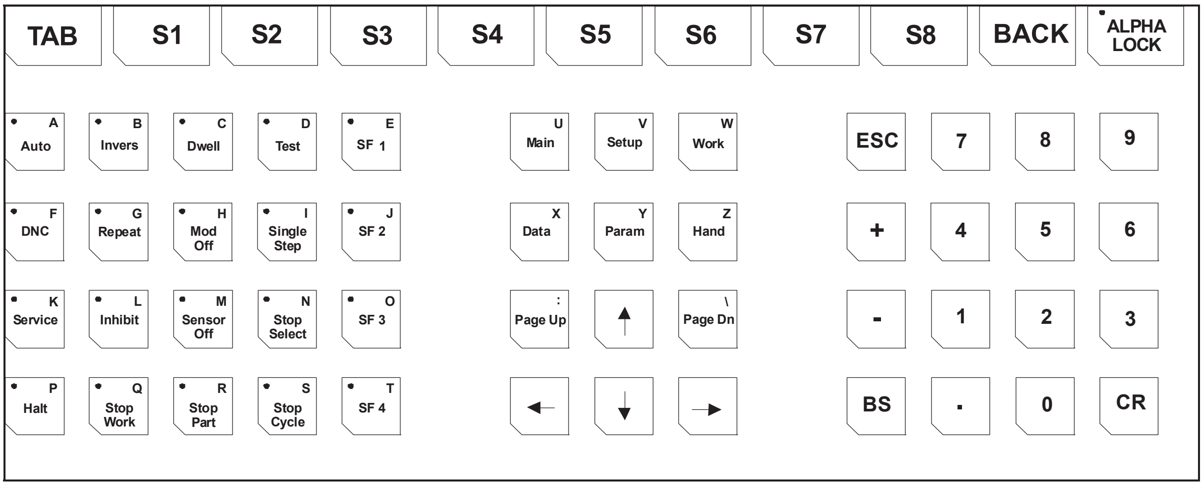
Choose <HAND> “Manual mode“ or “Automatic set up“, to activate manual control.

The emergency stop button, <STOP> and <CONT> are always active, irrespective of whether the <Hand> menu is activated or not.

Brief description of manual control keys

<BURN> .... Opens the shutter and keeps it open until the key is released.
<CONT> .... Confirmation key (continue)
<CROSSJET> .... Cross-Jet functions
<MANUAL ADJUST> ..... Precision positioning with knob activated until the key is released
<PULSE>.... .... Single pulse: Opens the shutter for the preset time
<STOP>...... .... Stops Software. Stops the drives of all the axes. It is not an emergency stop!
<U +>.......... .... Turns the rotating axis anticlockwise, manual feed
<U -> .... Turns the rotating axis clockwise, manual feed
<X +> .... Moves along the X axis away from its 0 point, manual feed
<X -> .... Moves along the X axis towards its 0 point, manual feed
<Y +> .... Moves along the Y axis away from its 0 point, manual feed
<Y -> .... Moves along the Y axis towards its 0 point, manual feed
<TOOL> activated .... (LED on)
<Z +> .... Lifts tools, with tracer point activated, and closes process gas valve
<Z -> .... Lowers tool, with tracer point activated and opens process gas valve
<TOOL> deactivated ...... (LED off)
<Z +> .... Lifts tool, with tracer point deactivated
<Z -> .... Lowers tool, with tracer point deactivated
Knob .... For precision positioning of axes

5.2.6 MMC Key Layout



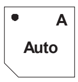
Status

– When the red LED of a key is on, the key is activated.

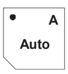
– When the red LED of a key is off, the key is deactivated.

Key Names

In the text of this manual, the keys are indicated in capital letters and in angular bracket < > , e.g. <AUTO> indicates the key:



In operating procedures, an indication given in < > means: press this key (e.g. <AUTO>: press the key:



Automatically activating functions

When a cutting plan is started, the following keys are activated automatically:
– <DWELL>
– <STOP SELECT>
– <SENSOR OFF> (only if it was active during the last process)
– <STOP CYCLE>

When the MMC is started, depending on the machine equipment (e.g. Cross-Jet) and settings on the SETUP menu, the corresponding function keys SF1 to SF4 are activated.

Self-Retaining Functions

– When one of the keys from <AUTO> to <STOP CYCLE> is pressed, its function remains active until the key is pressed a second time to deactivate it.

– When one of these keys is deactivated, its function remains inactive until the key is pressed again to reactivate it.

– The keys are automatically deactivated at the end of the cutting plan

Groups of keys

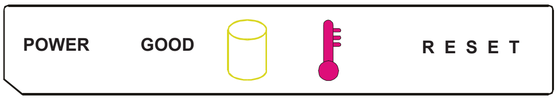
In the description of common features <HALT>, <STOP CYCLE>, <STOP WORK>, <STOP PART> and <STOP SELECT> are grouped under the name <STOP xxxx>

Brief description of the PPC Keyboard

The keys perform different tasks for each individual function. In the index, below the name of the key, an indication is given of all the sections in which this key is described in detail.

< . > ....Decimal point
< - > .... negative numbers
<←> ....Left arrow key. Moves the cursor to the left on the monitor
<↑> ....Up arrow key. Moves the cursor up on the monitor
<→> ....Right arrow key. Moves the cursor to the right on the monitor
<↓> ....Down arrow key. Moves the cursor down on the monitor
<A> ... <Z>.. ....Enters the character indicated on the key
<ALPHA LOCK>... ....Switches to the second function of the key (letter characters)
<AUTO>...... ....Automatic reading of work plans and process parameters
<BACK>...... ....Returns to the previous menu
<BS> ....(Back Space) Deletes the last character entered
<CR> ....(Carriage Return) Confirms the data entered
<DATA>...... ....Editor for work plans and process parameters
<DNC>........ ....Activates the connection with a PPS on a higher level
<DWELL> ... .Acceleration and deceleration, active in the machining of angles
<ESC> ....Exits from a polling/question box without acquiring data
<HALT> ....Stops machining
<HAND> ....Manual mode and diagnosis
<INHIBIT >.. ....Move to the programmed reference point (see <INHIBIT REF>)
<INVERS> . ...Process the main program in reverse
<MAIN>....... ....MMC main menu
<MODE OFF>....... ....Deactivates modulation
<PAGE DN> ....Next page / Skips to end of record
<PAGE UP> ....Previous page / Skips to start of record
<PARAM>... ....Edit the active programs on the <Work> menu
<REPEAT> . ...Process the engraving parameters and then the process parameters (Pre-engraving function)
<SENSOR OFF> .. ..Disable detection in the <Sensor OFF> field
<SERVICE> ....Move to the Service position
<SETUP>.... ....Machine setup values
<SF 1 - 4>... ....Function keys (assigned on the basis of the MMC menu)
<SINGLE STEP> .. ..The plan is executed in single steps (geometrical elements)
<STOP SELECT>. ....Programmed stop of machining sequence (M01)
<STOP CYCLE>... ....Stop before machining a new work plan
<STOP PART> ....Stops before a subprogram
<STOP WORK>.... ....Stops before and after a step (before and after piercing)
<TAB>......... ....Tabulation key used for moving from one dialog box to another
<TEST> ....Moves axes with the machining head raised
<WORK> ....Machining

5.2.7 PPC Status Display



POWER

– Shows electrical power supply to PPC (85-263 VAC)

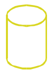
GOOD

Shows secondary PPC power supply voltage monitor switch (voltage: 5V / 12 V). It guarantees correct PPC operation in special cases, such as::

– Slow switch-on/off
– Switching on/off at short intervals
– Voltage oscillation

- Internal PPC temperature indicator.

The symbol lights up if temperature is above 45°C.



– Hard disk operation indicator

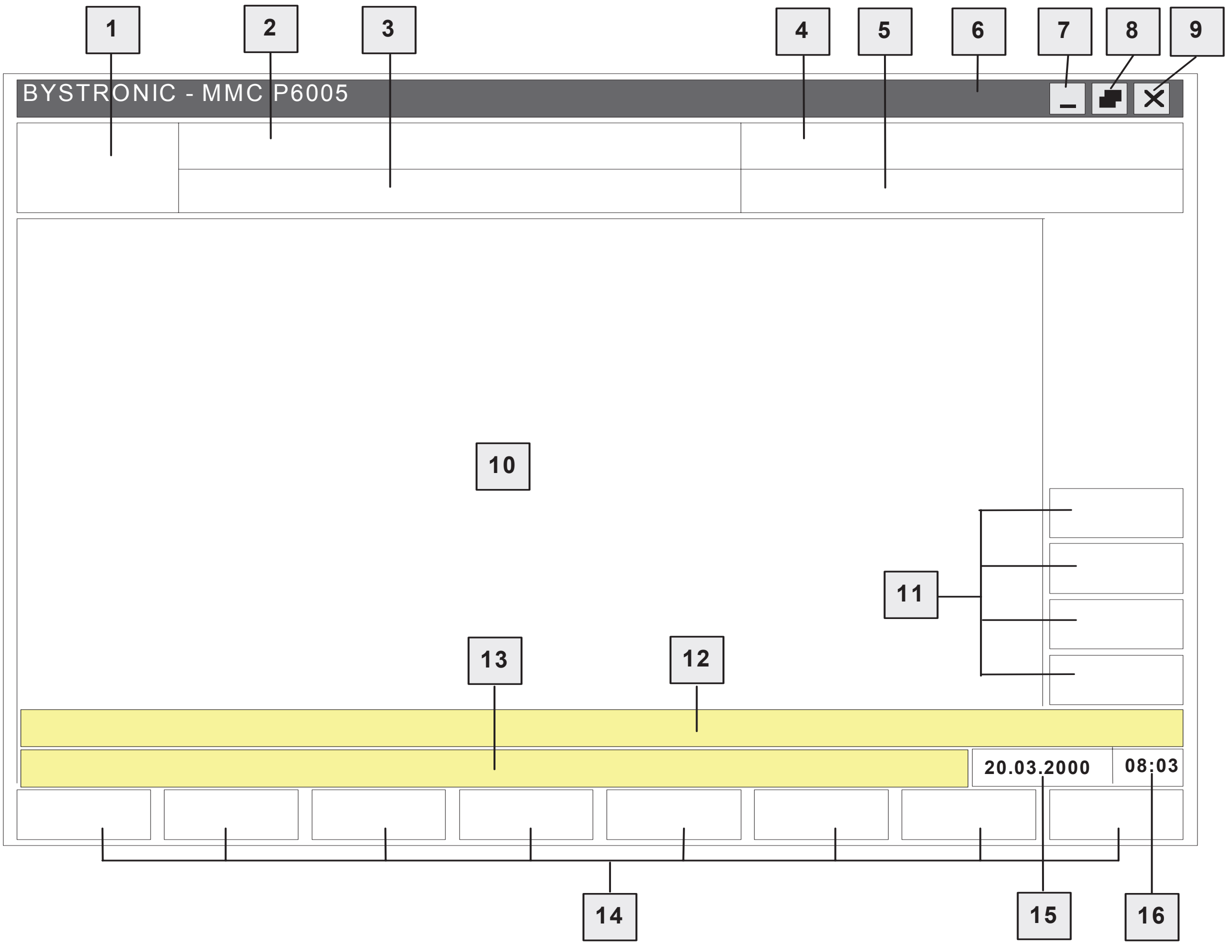
RESET

– Starts up the calculator again

To avoid switching on the PPC accidentally, two keys have been placed under the protection film. Both keys must be pressed at the same time if you wish to switch on the PPC.

5.2.8 MMC Display

All the MMC screens appear in the same form, with windows divided up as follows:



	MMC Screen Overview	
1	**Menu**	From this field, the operator can find out which menu he is on. The definitions correspond to the abbreviations on the machine keyboard: **<MAIN>, <WORK>, <HAND>, <PARAM>, <DATA>, <SETUP>**
2	**CNC mode**	This field indicates the machine's current operating mode (e.g. single job, automatic mode, manual mode, test mode...)
3	**Material name**	Name of current material and size of plate along X/Y axes
4	**NC program**	File name of current cutting plan
5	**Parameter file**	File name of current process parameters
6	**Header**	The header shows the name of the active Windows application and active document.
7	**Minimize**	The "Minimize" command reduces the application to the size of an icon.

8	**Restore**	The “Restore” command restores the current window to its original size and position.
9	**Close application**	This command enables you to close the active document, the active application or an open dialog box field.
10	**Application window**	Vary according to the menu
11	**Function keys with LEDs**	Name of function keys with LED's SF1 - SF4 on the machine keyboard, active in WORK and HAND
12	**Comment line**	The comments of the NC program are displayed for the operator's information.
13	**System messages**	Machine status and error messages
14	**Function keys**	Definition of function keys S1 - S8 on the machine keyboard. The assignment depends on the menu.
15	**Date**	Indicates the current date
16	**Time**	Indicates the current time

Using the Display Menus

To enter and edit numeric values, addresses, paths and file names, select:

4	the number keys for numeric values
-	The "-“ sign for negative values
.	The decimal point ".“ for decimal values
BS	the <BS> (Back Space) key to delete the last digit or character during entry
ALPHA LOCK L Inhibit	The <ALPHA LOCK> key together with letter keys for entering addresses, file names and directories. The < ALPHA LOCK> key must then be deactivated again!
CR	The <CR> (Carriage Return) key to terminate an entry

Data may be entered on the machine keyboard or the PC keyboard. In addition, there is a mouse on the right-hand side of the machine keyboard.

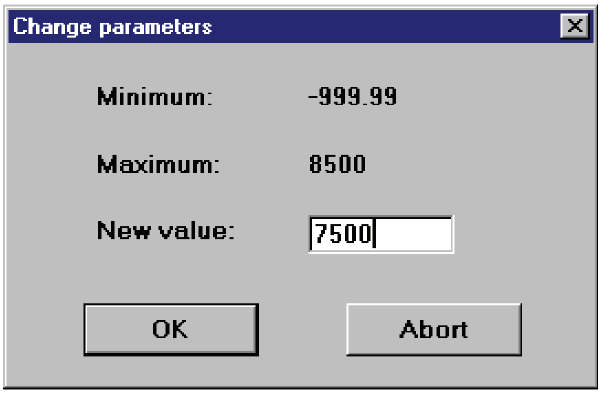
Appearance of the displays in the description of the functions

The screens depend

- on the customer's specific machine configuration (with or without rotating axis etc.)
- on various factors introduced in creating the plans (name of plan, number of plan, programmed number of passes etc.)
- on the current processing status (number of passes carried out, current position of axes etc.)

All the screens shown in this document are therefore to be considered as examples showing the configuration of operator help on the function described, while the text may change.

5.3 Change parameters



When you press a number on the PPC keyboard on the menus <Setup> and <Hand Param>, the "Modify parameters" dialog box is displayed. Enter a value between the max. and min. indicated in the "new value" entry field of the "Modify parameters" dialog box.

5.4 MMC Main Menus

The machine is used by means of one of the following six main menus, which may be retrieved by pressing the keys on the MMC machine keyboard bearing the same name:

MAIN

Initial screen that appears when the MMC is started. It is used for opening and closing operator work sessions, starting the Windows 95 operating system and setting up the machine.

WORK

This menu is used for selecting the NC programs, loading the cutting parameters, machining the plans and displaying the system messages.

HAND

This menu enables the machine to be controlled manually. A diagnostic test is also run to detect any faults that may occur.

PARAM

This menu is used for loading the active process parameters. In addition, changes can be made and data can be saved with its current name or under a different name.

DATA

This menu is used for creating, editing and graphically representing an NC program in the Din editor. In addition, new process parameters can be edited or created in the parameter editor.

SETUP

This menu is used for regulating the setting parameters. This data may only be accessed from the <EXPERT> access level.

5.5 Using the MMC Online-Help

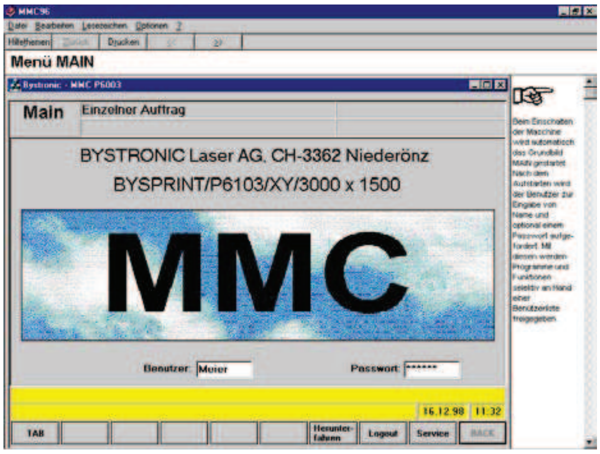
General indications:

The software releases MMC 6003 and later have a preinstalled Online-Help. This help describes the single functions of the MMC and their meanings. It is in the same language as the MMC. The help files are in the contents of the MMC. The name of the file is "HELPLCC_*.hlp” where the asterisk * is the selected language.

5.5.1 Getting help

The help is accessed from the user console by pressing the <SHIFT-F1> key combination and is designed on a contextual basis. According to the active menu page or the dialog box on the MMC, the <SHIFT-F1> keys display the corresponding help topic. The display shows a graphic symbol identical to the pages of the menu with the help text. If the text or graphic indicated does not fit into the relevant area of the screen, it can be consulted by moving the scroll bar to the right or downwards.

The help may also be accessed by clicking on the file on the Windows screen.



Help window, MAIN menu page;
the corresponding text on the right-hand side.

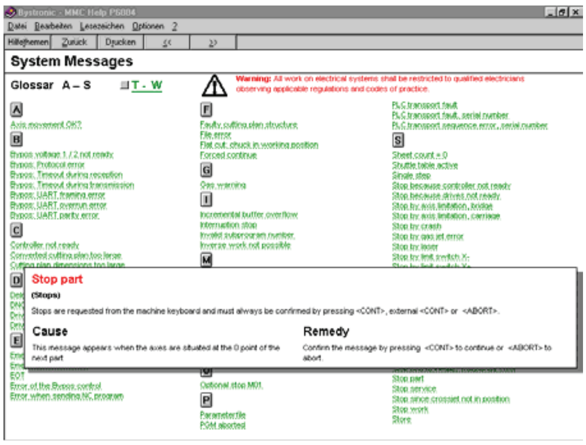
5.5.2 User help

Most graphics have "Hot-spots". A hot-spot means an active element on the screen. By moving the mouse onto an area that contains a "Hot-Spot" the cursor turns into a hand. When the mouse button is clicked, the relevant help text is invoked and the machine switches to the corresponding help page.

When the background of the screen is green, this means there is a link or a "Hot-Spot".

When you click on "related topics”, a dialog box with similar terms is displayed.

5.5.3 System messages



Explanations concerning the <System messages & error messages> are displayed in the status line of the MMC and can be retrieved by pressing the push-button <System Message> in the six main menus of the Online-Help. By pressing this pushbutton a glossary with the messages is displayed. By clicking on one of these messages the pertaining information is retrieved.

5.5.4 Searching for terms

There are 3 ways of locating topics and terms within the help. When you click on the <Help Topics> key, a dialog box is displayed with the cards <contents, index, find>.

Contents:

The <Contents> page is a table of contents. When you click on the main topics, a sublist is displayed thus enabling you to move to the specific help topics.

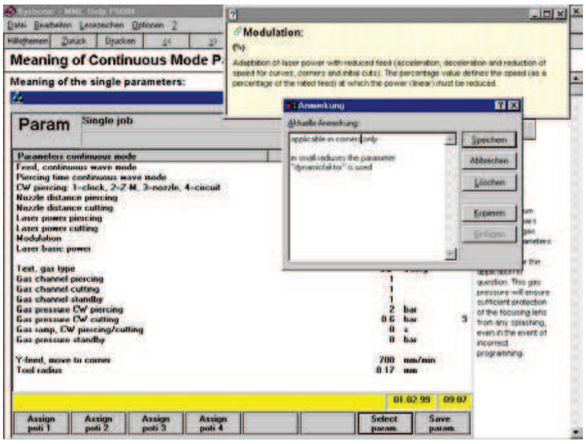
Index:

By entering the desired term on the first line and clicking on the topic found, you gain access to the desired specific topic.

Search:

The <Find> function enables you to locate words or terms anywhere in the entire help file.

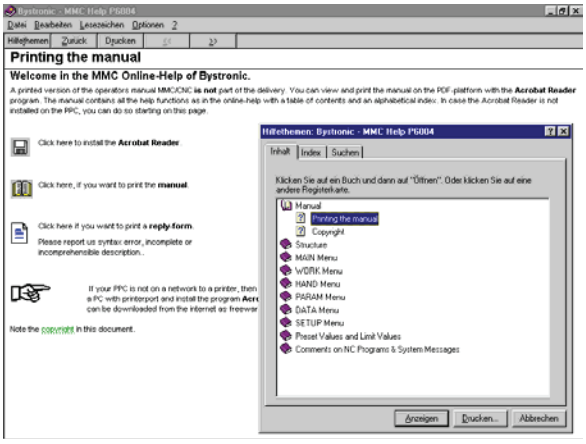
5.5.5 Advisory function of the Online-Help



The Online-Help allows the operator to store additional information or advices of personal nature pertaining to certain help-entries. The operator shall retrieve the help-entry to be associated with a certain information notice. By pressing the right key of the mouse a “drop-down“ will appear. Click on the entry <Annotate>. A dialogue box will open where information or advices referring to the selected help-entry can be stored. A clip will appear before the Help Topic warning that an information notice is available on this topic.

5.5.6 Printing the manual

You may print a complete manual directly from the Online-Help. Start the helpmenu on the PPC with <SHIFT+F1> and click the button <Help Topics>.
In the dialogue menu <Help Topics> click *Contents* => *Manual* => *Print the manual*. Follow the description on the help page „Print the manual“.



5.5.7 DIN-EDITOR menu page limitation

The help may be invoked by pressing the <SHIFT-F1> keys only in the MMC program. The DIN-EDITOR is to be considered as a program in its own right. When you are in DIN-EDITOR, you cannot invoke the help by pressing <SHIFT-F1>. The <DIN-EDITOR> specific topic is accessed quickly by clicking the <EDITOR> key, on the <DATA Menu> specific topic.

5.6 Parameters

Process parameters optimized for the actual application are prerequisites to obtain the required machining quality.

Process parameters for the most frequently machined materials are made available to you on the harddisk of the machine control system or on a diskette. The actual parameters are copied onto the panel PC according to the version of the CNC with the delivery of the machine.

The process parameters for a given mode of operation are listed in a file with a characteristic file name.

Load the process parameters by first pressing the <WORK> key. Then select the “Job List” key or <S1>. Activate key <S2> or the “select Param” function. The parameter required can now be selected and saved using the “open” function.

The parameters provided by Bystronic should be considered as being indicative values. In chapter 10 of the user’s manual, entitled “machining”, there is a list of conditions with which to obtain optimum machining results.

5.6.1 Conventions for data names

Parameters considered in data names:

– Material reference number according to DIN
– Workpiece thickness
– Surface treatment
– Machine model
– Optics (focus length)
– Process or process gas

The file name consists of 5 parts:

WWWWWSSS.TOP

The fist part (5 characters) refers to the material identification according to DIN.

WWWWWSSS.TOP

The second part (3 characters) designates the material thickness.

WWWWWSSS.TOP

The third part (1 character) designates the machine type.

WWWWWSSS.TOP

The fourth part (1 character) designates the optical system.

WWWWWSSS.TOP

The fifth part (1 character) designates the process and the process gas.

Material identification according to DIN

Systematic identification of materials by numbers according to DIN 17007.

The seven digit material number comprises:

– Material main group
– Grade number
– Supplementary number.

Material main groups

0	Pig iron, iron alloys, cast iron
1	Steel and cast steel
2	Heavy metals without iron
3	Light alloys
4-8	Nonmetallic materials
9	Free characteristic number

Grade numbers

For the grade numbers for the main groups 0 and 1, the first two digits stand for the grade classes. The two next digits of the grade numbers are counting numbers. In principle the grade numbers are formed according to the chemical composition of the materials or according to their origin.

Supplementary numbers

The supplementary numbers stand for special characteristics such as type of melting or casting, heat treatment and cold forming.

The supplementary number could not be considered for the Bystronic file name. Only the first five digits are used for the material identification.

5.6.2 Bystronic material identification following DIN

WWWWWSSS.TOP

The letters "W W W W W " stand for the first five digits of the material identification according to DIN.

Main group 1: Steel and cast steel

All steels including cast steel are listed here. The first two digits of the grade numbers characterize the grade classes. The next two digits of the grade numbers are the counting numbers which do not allow to draw any conclusion on the carbon content or alloy content.

Ordinary steels and high-grade steels		Alloyed special steels	
1.00	Merchantable and basis grades	1.20-1.28	Tool steels
1.01-1.02	General structural steels	1.32,1.33	High-speed steels
1.03-1.07	High-grade steels, unalloyed	1.34	Wear-resistant steels
1.08, 1.09	High-grade steels, unalloyed	1.35	Roller bearing steels
1.90-1.99	Special grades	1.36-1.39	Ferrous materials with special physical properties
Unalloyed special steels		1.40-1.45	Stainless steels
1.10	Steels with special physical properties	1.47, 1.48	Heat resisting steels
1.11-1.12	Structural steels	1.49	High-temperature materials
1.15-1.18	Tool steels	1.50-1.84	Structural steels
		1.85	Nitriding steels
		1.88	Hard alloys

Main group 2: Heavy metals and their alloys			
2.000-2.1799	Copper and copper alloys	1.20-1.28	Tin and tin alloys
2.1800-2.1999	Reserved numbers	1.32,1.33	Nickel, cobalt and alloys
2.200-2.2499	Zinc, cadmium and alloys	1.34	Noble metals
2.2500-2.2999	Reserved numbers	1.35	HMP metals
2.3000-3.3499	Lead and lead numbers	1.36-1.39	Reserved numbers
Main group 3: Light metals and their alloys			
3.0000-2.4999	Aluminum and alloys	3.7000-3.7999	Titanium and alloys
3.5000-3.5999	Magnesium and alloys	3.8000-3.9999	Reserved numbers
3.6000-3.6999	Reserved numbers		

In the main groups 2 and 3, the four-digit grade numbers identify the composition, divided in base metals, type and quantity of alloying additions.

5.6.3 Piece thickness

WWWWWWSSS.TOP

Material thickness in tenth of millimeters

The machining quality may suffer as a result of specific finishing methods (paint components or thickness of the coating). It may therefore be necessary to adjust the parameter settings accordingly.

If the workpiece thickness is below 10 mm, therefore the first digit "S" may designate the surface finishing:

E = anodised
F = hot-galvanised
K = laminated with plastic (film)
L = enamelled
V = galvanised
R = flying piercing (rapid piercing)
X = flying piercing with film laminated in plastic
Y = flying piercing with hot-galvanised sheet
Z = flying piercing with electrogalvanised sheet

(Example „SSS“ = E09: workpiece thickness 0.9 mm, anodized).

5.6.4 Machine type, piece support, laser type

WWWWWWSSS.TOP

Code	Machine type	Laser type	Size
A	BYSTAR	BTL 3000	2512 & 3015
B	BYSTAR	BTL 3000	4020 & 4025
C	BYSTAR	BTL 3500	2512 & 3015
D	BYSTAR	BTL 3500	4020 & 4025
H	BYSPRINT	BTL 2200	2512 & 3015
U	BYSPRINT	BTL 2400	2512 & 3015
S	BYSPRINT BYSTAR	BTL 1800	2512 & 3015
T	BYSTAR	BTL 1800	4020 & 4025
W	BYSPRINT	BTL 3000	2512 & 3015
X	BYSTAR	BTL 4000	2512 & 3015
Y	BYSTAR	BTL 4000	4020 & 4025

5.6.5 Optical system

WWWWWWSSS.TOP

Code	Focal length
3	3.75“
5	5“
7	7.5“
0	10“

5.6.6 Process and process gas

WWWWWWSSS.TOP

Code	Process
O	Oxygen cutting
N	Cutting with nitrogen
A	Cutting with argon
L	Cutting with compressed air
P	Spot welding

5.6.7 Parameter list for laser types BTL series

DIN name	Designation	DIN number
St 1203	Deep drawing sheet	1.0330
St W 22	Steel sheet	1.0332
St W 23	Steel sheet	1.0334
St W 24	Steel sheet	1.0335
St 34 - 2		1.0151
St 37 - 2	Structural steel	1.0161
St 42 - 2		1.0181
St 50 - 2		1.0570
St 52 - 3	Structural steel	1.0570
St 60 - 2		1.0533
St 70 - 2		1.0543
C18		1.0405
Ck 15	Case-hardening steel	1.1141
Ck 45	Hardening/tempering	1.1191
Ck 75	Spring steel	1.1248
QST 37-2	Cold forming	1.0221
X5CrNi 18 10	V2A	1.4301
X6CrNiMoTi17-12-2	V4A	1.4571

DIN name	Designation	DIN number
Al 99	High-grade alu	3.025
Al 99.9		3.0305
Al 99.98		3.0385
AlMn	Aluman - 100	3.0515
AlMgSi1Mn	AC 110 Anticorodal	3.2315
AlMg 1	Peraluman - 100	3.3315
AlMg 3	Peraluman - 300	3.3535
Cu	Copper	2.0000
CuZn40	Brass	2.1000
Ti	Titanium	3.7000
Wood	Novopan	9.1100
Wood	Plywood	9.1200
Wood	Structural timber	9.1300
PVC	Polyvinylchloride	1.16927
PMMA	Acrylic glass (Plexiglas)	9.500

Breakdown of file names

Example:1 0 3 3 2 1 5 0 . A 5 O

Process gas: O = Oxygen, L = Compressed air, N = Nitrogen, A = Argon, P = Pulsed cutting

Cutting head: 3 = 3.75“, 7 = 7.5“, 5 = 5“, 0 = 10“

Laser:

A	=	BYSTAR 2512, 3015	BYLAS 6020, 6025	BTL 3000
B	=	BYSTAR 4020, 4025		BTL 3000
C	=	BYSTAR 2512, 3015	BYLAS 6020, 6025	BTL 3500
D	=	BYSTAR 4020, 4025		BTL 3500
H	=	BYSPRINT 2512, 3015		BTL 2200
U	=	BYSPRINT 2512, 3015		BTL 2400
S	=	BYSPRINT 2512, 3015	BYSTAR 2512, 3015	BTL 1800
T	=	BYSTAR 4020, 4025		BTL 1800
W	=	BYSPRINT 2512, 3015		BTL 3000
X	=	BYSTAR 2512, 3015	BYLAS 6020, 6025	BTL 4000
Y	=	BYSTAR 4020, 4025		BTL 4000

Sheet gauge Sheet gaugees in 1/10 mm (z.B. 150 = 15 mm)

Type of surface and machining process: With sheets less than 10 mm thick, a letter defines the type of surface treatment and machining process to be performed

E = anodised
F = hot-galvanised
K = laminated with plastic (film)
L = enamelled
R = Flying piercing (rapid piercing)
V = galvanised
X = Flying piercing with film laminated in plastic
Y = Flying piercing with hot-galvanised sheet

Material: DIN – number of material

5.6.8 Marginal conditions

Transferability of parameters between laser machine tools of the same type

Pre-conditions for the transfer of these parameters found at Bystronic:

- Machine well adjusted
- Beam quality same as when putting into operation
- Focal length and nozzle according to parameter lists
- Machine optical system and focusing optical system in proper condition
- Laser gas qualities corresponding to specifications
- Metal sheet surface free from scale (descaled, pickled or ground)

Influence of contour geometry

The parameters apply for double sheet gauge (example: for sheet gauge 3 mm the parameters apply from 6 mm hole diameter, tooth length etc.).

For complicated and compact contours adaptations of various parameters are necessary. The identification of the parameters authoritative for adaptations presupposes experience of the machine operator in laser machining of simple and large contours.

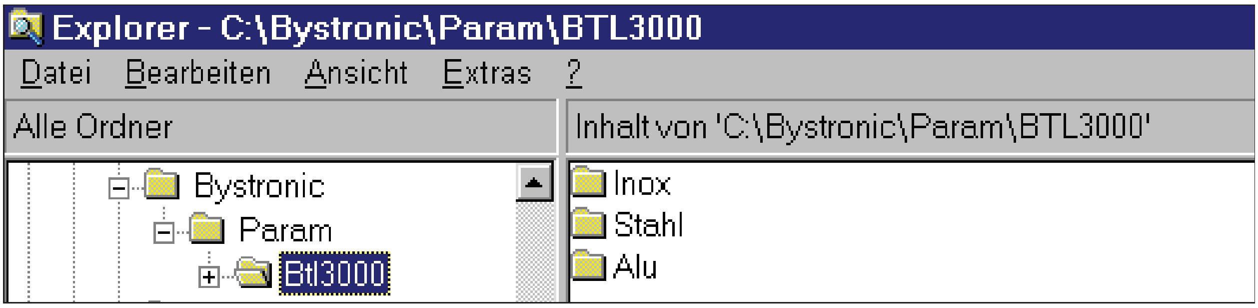
Optimizing the parameters

The parameters provided by BYSTRONIC are approximate values. Also materials of same designation still differ within some tolerances in their composition. Additional differences result from the type of casting, heat treatment and cold forming (see above suffix).

The parameters are selected so that in spite of these differences a machining of the material should be possible in principle. With steady material quality and constant ambient conditions these parameters may be still optimized. An optimization may be desired to increase the quality or economic efficiency of the machining process.

5.6.9 Storage system

No conditions are laid down in the control for the organization to store the parameters. Thus the storage may be adapted to the company-specific requirements. If however also the customer has no demands on the parameter storage, we propose the following file structure:



1. Save the personalised parameters. One possibility for saving lies in renaming the existing directory. It is advisable to use the last date of the parameter saving as the new name for the directory, e.g. 30_09_98.
2. Create a new path called PARAM.
3. Give the DOS command „XCOPY A:*.* C:\BYSTRONIC\PARAM /S“ , which copies all the parameters complete with paths from the floppy disk to the hard disk.
4. Erase unnecessary parameter files from the hard disk. (For example, erase the directory BTL3000 with the subdirectory if working with BTL 3500 Laser systems only).

5.7 Appendix

5.7.1 Deviation of cutting parameters

For the reasons indicated below, the cutting speeds must always be considered as ideal and, during production, must be set on the machine accordingly.

- Production cut or quality
- Plate thickness tolerance limits
- Different alloys, e.g. aluminium alloys
- Components of the alloys due to differences in charge.
- Different surfaces
- Status of installation (new, used)
- Different machine adjustments on the operator side

For these reasons, an exact value cannot be specified and, in practice, the following deviations are acceptable:

Material	**Thickness (mm)**	**Optical system (Inches)**	**Cutting gas**	**Maximum deviation from the straightening speed**
Steel	1-5	5	O_2	-30%
	1-3	7.5	O_2	-30%
	4-20	7.5	O_2	-25%
Aluminium	1-8	5, 7.5	N_2	-30%
Stainless steel	1-3	5, 7.5	N_2	-30%
	4-12	7.5	N_2	-25%
	1-12	5, 7.5	O_2	-30%
Copper	1-4	5	O_2	-25%
Titanium	1-4	5	Ar / N_2	-30%
Brass	1-6	5, 7.5	N_2	-35%
Plexiglas	1-30	7.5, 10	N_2	-50%
Wood	1-30	7.5, 10	N_2	-30%

All the parameters stored in the machine are indicated below. The cutting speeds indicated correspond to about 90% of the max. speed at which a material can be cut off without a break in the laser beam. To set the lower limit of the cutting speed, the percentages indicated above must be subtracted.

The parameters not indicated on the list below must be calculated using a percentage of -30%.

The percentage values are valid for all the laser machines with the CNC 96 control with ROM/RAM 6100 and later releases.

5.7.2 Indicative values

The following pages are a composition of indicative values for BYSTRONIC laser cutting.

Straightening speed for:

- St37-2
- X5CrNi 1810
- AlMgSi 1 Mn

Indicative values with consumption values:

- St37-2
- Stw 22
- X5CrNi 1810
- AlMgSi 1 Mn

Indicative values for piercing times:

- steel
- stainless steel
- aluminium

Introductory training MMC

MMC P6006 / CNC P6111

Bystronic

Introductory training MMC

Document identification: **MMCP6006_EN**

Version: **01**

Please always quote the above product identification and version number when reordering this manual.

Please notify us of any errors or any suggestions for changes, at:

Bystronic Laser AG

Technische Dokumentation

Industriestrasse 21

CH-3362 Niederönz

Tel. +4162-9563333

Fax. +4162-9563380

Trademarks:

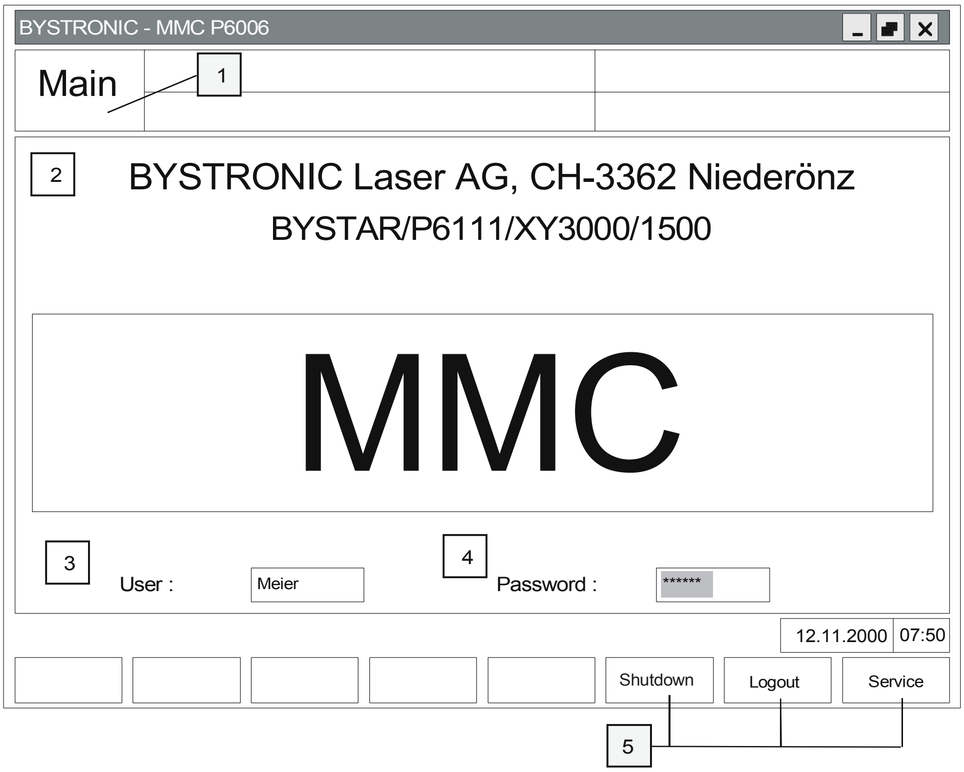
Bystronic would like to point out that the company names, trademarks and product names cited may be subject to patent or trademark protection.

Table of contents

1. MAIN Menu

After the MMC software has been automatically started, the <Main> menu appears on the display.

After the start, the operator is prompted to enter his name and, optionally, a password. In this way, programs and functions are enabled selectively on the basis of the list of users.



	Overview of MAIN operator panel	
1	Menu	This field tells you which menu you are on.
2	Application window	Company address, type of machine, CNC software version number, axes present and size of work area.
3	User	The operator is prompted to enter a user name.
4	Password	The operator is prompted to enter a password.
5	Function keys	Select the menu directly on the machine keyboard using the relevant key <S6 - S8>

1.1 Shut Down

The MMC operator area is closed and the Windows 95 system deactivated.

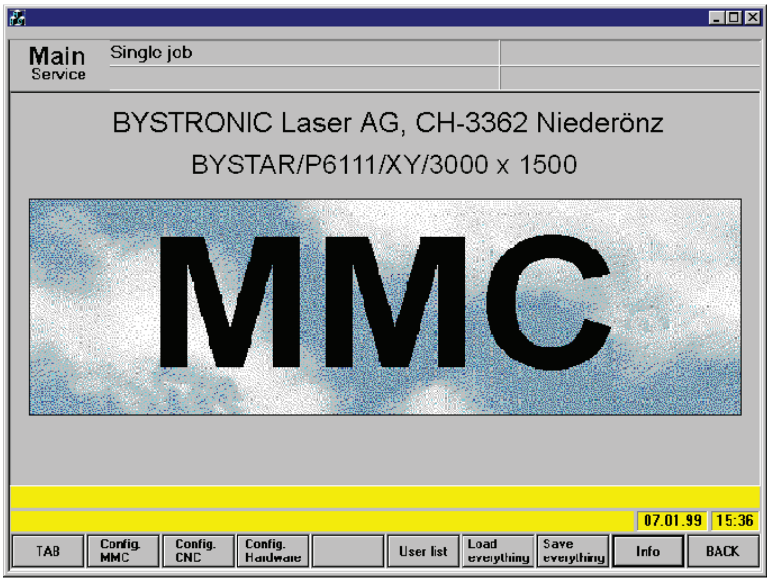
This function must be performed whenever you have to turn off the PPC, as otherwise the Windows 95 operating system is not closed correctly. Do not turn off the PC until the "It's now safe to turn off your computer" message appears on the display.

1.2 Logout

This function enables a user who logged in previously to terminate his work session on the system. The system then prepares for entry of a new user name.

1.3 Service

The Service function allows a user identified by a password (as a Manager) to access the user list and the <Config MMC>. The user can also load and store the current set-up parameters.

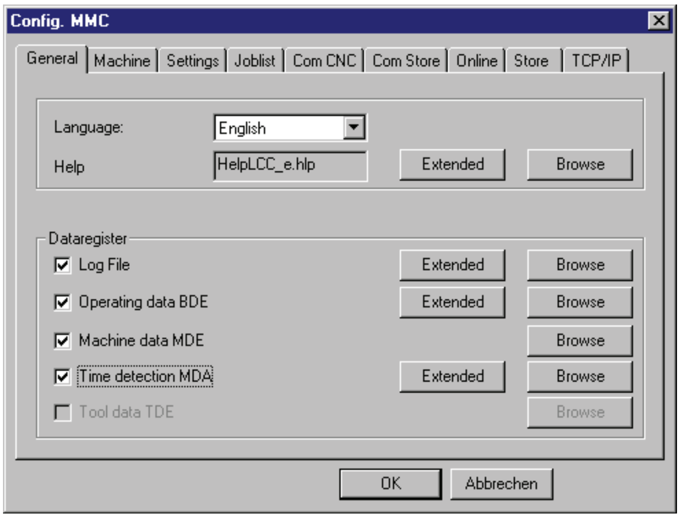


Using a special password, the Bystronic technician can access the <Config. MMC>, <Config. CNC> and <Config. Hardware> configuration menus.

The user can return to the previous menu by pressing <BACK>.

1.3.1 Config MMC

General



This dialog box is used for setting the following characteristics:

Language: German, English, French, Italian >

Default setting: **German**

Help: Used to set the path for activating the Help file.

Default setting: **MMC directory**

Log File: A Logfile containing machine data and specific activities may be activated. It can be used to diagnose errors. This function is not significant for the user.

Default setting: **ON**

BDE: Used for activating a working data read operation

Default setting: **OFF**

MDE: Used for activating a machine data read operation.

Default setting: **OFF**

Time recording MDE: If this option is enabled, the MMC writes the operating times into a file for each day. This data can be analysed on the ByTeam master computer.

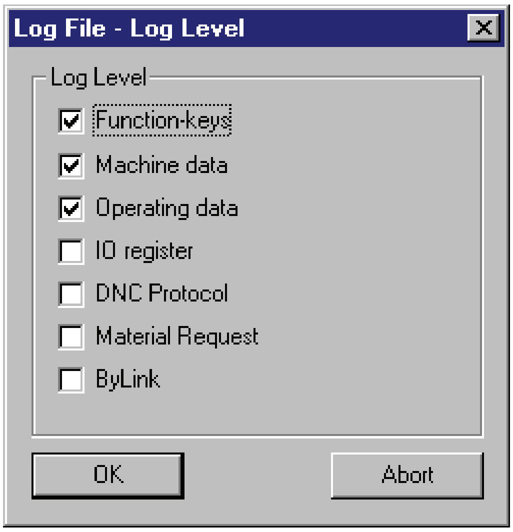
Default setting: **ON**

Time recording is always enabled. The current meter readings can be looked at under Advanced.

Using the <BROWSE> function, the path can be adapted to the corresponding file. It does not, however, allow the file name to be changed. By default, the data read files are stored in MMC\Log\ .

Using the <EXTENDED> function you can display an additional dialog box with options available for the corresponding menu item.

Options Log File



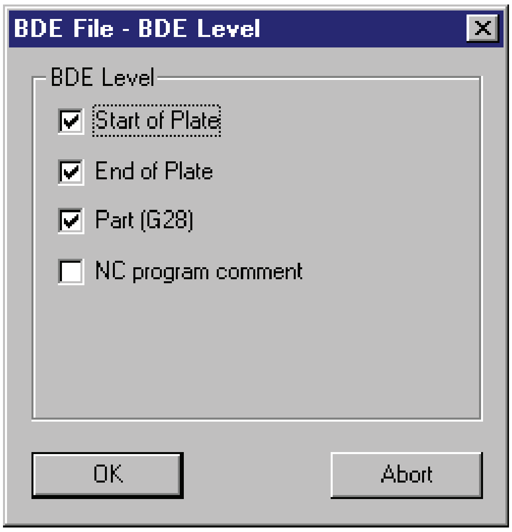
This dialog box is used for setting the following characteristics:

By pressing the <EXTENDED> key in the Log File, you can display a dialog box which is used for inserting options for the LogLevel. By default, the first three options are enabled.

The greater the number of options selected, the larger the amount of data is loaded into the LogFile. This may affect the performance of the PC-Panel. We therefore recommend you do not leave too many options enabled, limiting your selection to those that ensure a precise troubleshooting feature.

Function-keys:	Machine status / data changes from the machine keyboard in accordance with the DNC specifications.
Machine data:	Changes of machine datas in accordance with the DNC specifikations.
Operating data:	Product of machine data in accordance with the DNC specifications.
IO register:	IO register in accordance with the DNC specification. The IO register should only be used when the axes or the IO register have to be used for troubleshooting. Immediately afterwards, the option must be disabled in that it slows down the operation of the MMC considerably.
DNC Protocol:	Accurate analysis of routines that detect or cause a given DNC error.
Material Request:	Data sent to the storage system /CNC.
ByLink	Messages of a connected ByLink.

Options BDE File

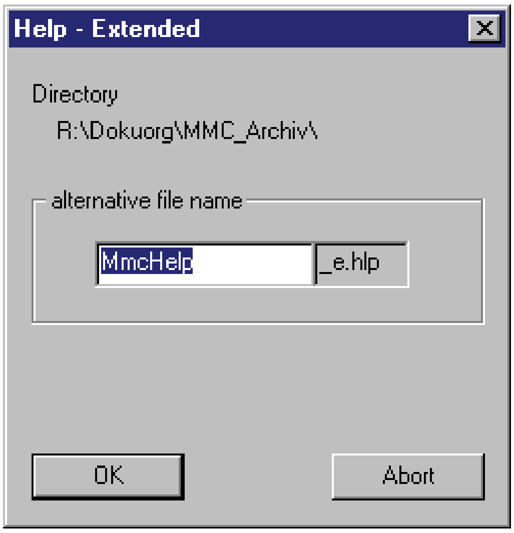


This dialog box is used for setting the following characteristics:

By pressing the <EXTENDED> key in the <BDE operation data> function, you can display a dialog box which is used for entering <LogLevel> options. By default the first three options are enabled

Start of Plate:	Data record is loaded into the BDE-File at the start of the disk.
End of Plate:	Data record is loaded in the BDE-File at the end of the disk.
Part (G28):	Data record is loaded in the BDE-File after a part has been machined
NC program comment:	A data record with a comment is loaded into the Nc-Prog.

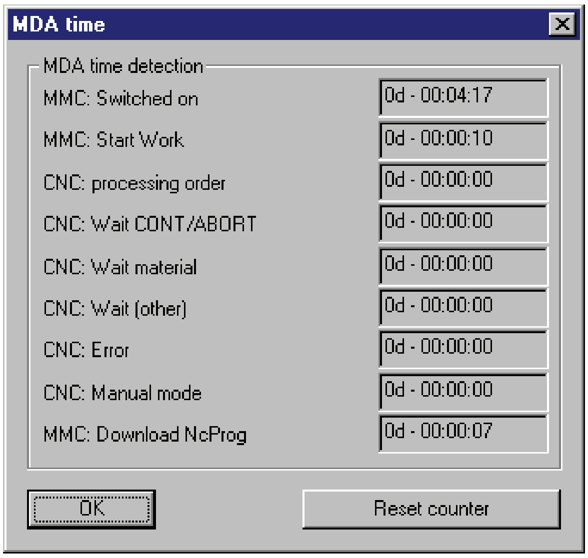
Extension of Help



Alternative file name: If another help has to be used, another help name may be selected from Erweitert. The file is defined according to the language set. The MMC looks for the help under this setting if the automatically generated help name is not found.

This help file is used if the automatically selected help file is not present!

MDE Time



Clicking on the MDE / EXTENDED button opens a dialog box displaying the current meter readings. These meter readings are saved at close of operation, and loaded again when operation is restarted.Beenden gesichert und beim Aufstarten wieder übernommen.

Bystronic

The meter reading format is: Days - Hours:Minutes:Seconds.

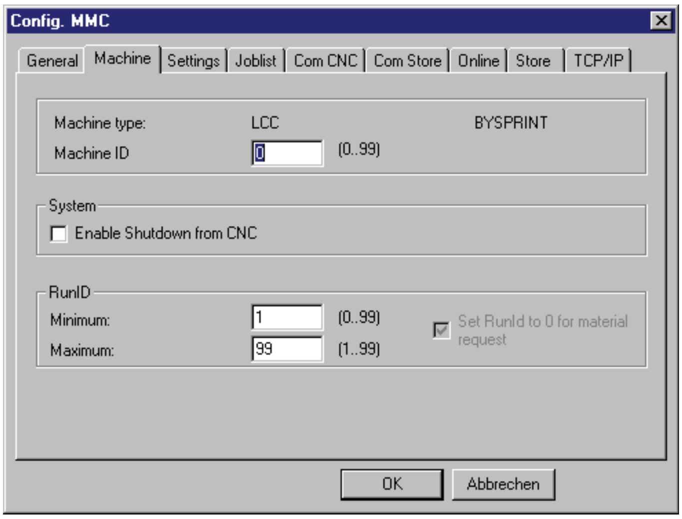
The meter readings are incremented irrespective of the MDE time recording setting, but if this option is not enabled then no file is generated containing the daily readings.

The meter readings can be reset to 0 with the <Reset counter> button. Previous settings are lost irretrievably. This button is only enabled if the user has MANAGER rights.

The MMC records the times for the following MDE meter readings:

MMC: Switched on	Total time that the MMC was switched on
MMC: Start Work	Total time spent by MMC processing jobs
CNC: processing order	Total time spent by CNC machining jobs
CNC: Wait CONT/ABORT	Total time spent by CNC waiting for user input
CNC: Wait material	Total time spent by CNC waiting for material
CNC: Wait (other)	Total time spent waiting by CNC (positioning axes, converting data)
CNC: Error	Total time spent by CNC in error mode
CNC: Manuel mode	Total time spent by CNC in manual mode
MMC: Download NcProg	Total time spent by MMC downloading an NcProg to the CNC

1.3.2 Machine



This dialog box is used for setting the following characteristics:

Machine ID: If a number greater than 0 is set in this position, the task bar of the MMC will show the model and ID of the machine, after the version number, e.g. in the case of an LCC with machine ID = 3, the following data is displayed:

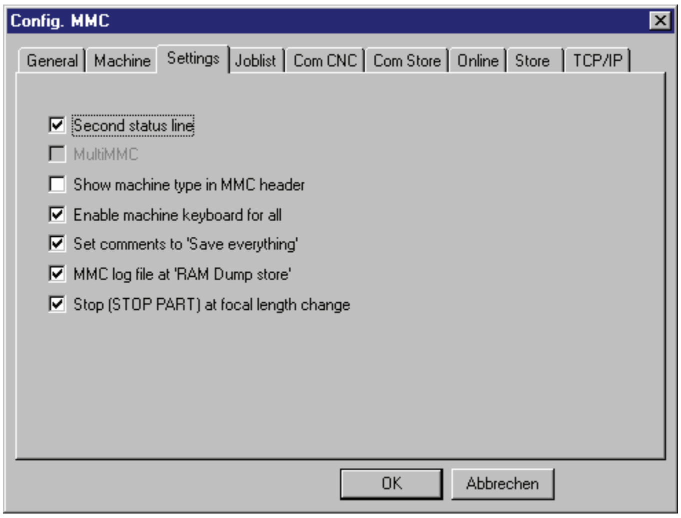
Bystronic - MMC P6006 - LCC3

Power off: This option enables the CNC to close the MMC and power off the PC.

Progressive number: Only used for machines used in an "island" configuration. In this case, the MMC attributes a progressive number to each panel. The range of numbers may be from 1 to 99, bearing in mind that the maximum value must necessarily be greater than the minimum value. The change comes into effect immediately without the MMC having to be restarted.

for material request: It is only used for machines that operate in an island configuration. This option is only enabled if the storage system is active in that configuration. When the option is active, the progressive number 0 is assigned to the CNC and the storage system. In this way, the CNC/storage system cannot check the progressive number. For commissioning only. A change comes into effect immediately without the MMC having to be restarted.

1.3.3 Settings



Second status line: This option is enabled with a monitor having a resolution of 800 x 600 Pixels. In this case, the 2nd status line can be disabled. In the case of a monitor with a resolution of 640 x 480 Pixels, this option is disabled. If the option is changed, the MMC has to be restarted for the change to come into effect.

Multi MMC: This option is enabled if the MMC is started in a directory other than "C:\MMC\Mmc.exe« . If this option is enabled, the MMC will be started, the next time, as MultiMMC, that is, it will use a local initialization file and the ByTif machine keyboard control. When this option is changed, the MMC must be restarted for the change to come into effect.

Show machine type...: If this option is enabled, the type of machine (LCC) is displayed in the top left-hand corner of all menus. This option is set by default in the MutliMMC. Otherwise it is disabled. If this option is changed, the MMC must be restarted for the change to come into effect.

Enable machine..: If this option is active, the machine keyboard can be used to control another application (for example, line command, explorer etc.). This option is active by defulat. It must be enabled when the W.Althaus AG line control is installed on the Panel-PC. A change to this option becomes active immediately.

Set comments...: If this option is enabled, the <Save everything> command associates the note for a given number or N value to it, indicating it in brakkets in the CNC files, for example. N1R12000 (Feed with manual control, head up). A change to this option comes into effect immediately.

MMC Log file at ‚RAM-Dump store

'When this option is active (Standard), by activating <RAM-Dump> (Hand/Diagnosis) both LogFiles "Log-File.log" and "LogFile.bak" are compressed from the Log-Directory and copied on the floppy disc.

NOTE

When LogFile size has been changed, this option can generate an error due to insufficient space for all files on the floppy disc.

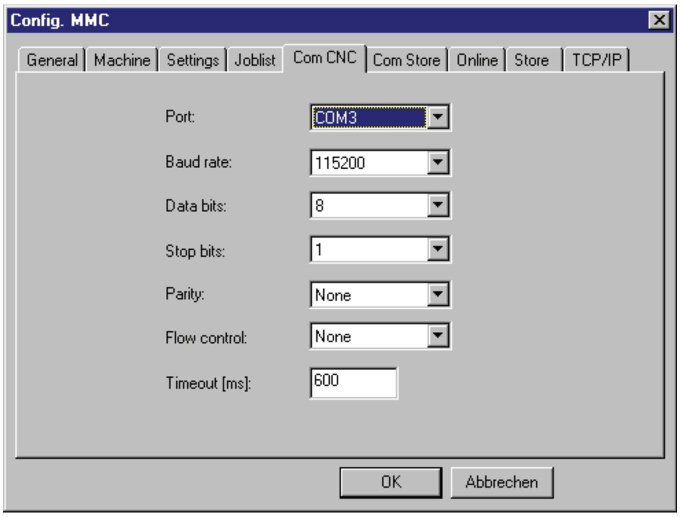
Any modifications are immediately active without MMC re-start.

Stop (STOP PART) at focal length change

When this option is active (Standard), the machine maintains the CNC in <AUTO-SETUP> through <STOP PART> before cutting and displays the WorkInfo window when focus length changes from one to another order.

Any modifications are immediately active without MMC re-start.

1.3.4 Com CNC

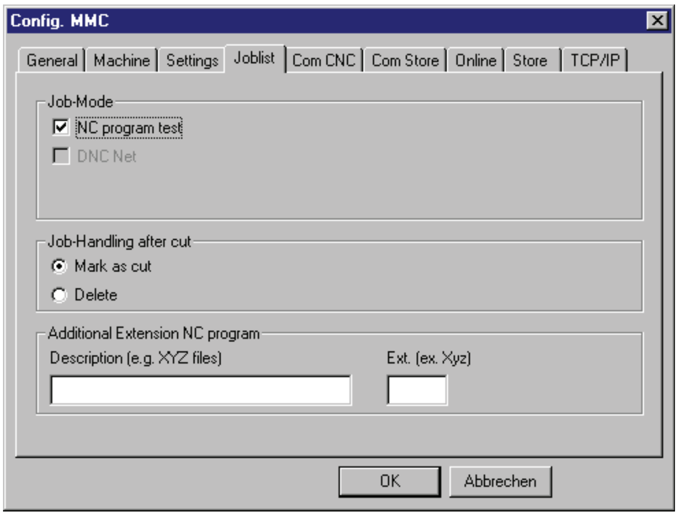


This dialog box is used for defining the serial interface that connects the MMC to the CNC system.

Time-Out: This item is used for defining how long the MMC has to wait for the connection / a signal from the CNC system.

Meaning: To establish communication via an ENQ command, the MMC waits five times the preset time-out, before retrying to connect with ENQ. If the CNC system answers the ENQ with a DLE signal, after sending a data block, the MMC will wait to receive an answer from the CNC system for a period of 10 times the time-out, before signalling the Time-out error.

1.3.5 Joblist



This dialog box only appears on a machine operating in an island configuration and is used for making the following settings:

DNC Net: By activating DNC Net, the MMC can receive jobs to be added to the Joblist and process them via this network. If this option is activated, the MMC must be closed before the DNC Net may be activated. By default, this option is disabled.

NcProg Test: To test a cutting plan after the start and end signal, before it is added to the job list. It works when the job is entered manually, in the case of DNC Net and Online, or transmission using an editor. This option may be enabled/disabled while the MMC is operating. This option is enabled by default.

Job management: Used for choosing, once the cut has been made successfully, whether a "job« is to be removed from the job list or is to remain on the list with the "cut" attribute. By default, the job is marked.

Marked as cut: the cutting job carried out is marked as terminated (grey colour)

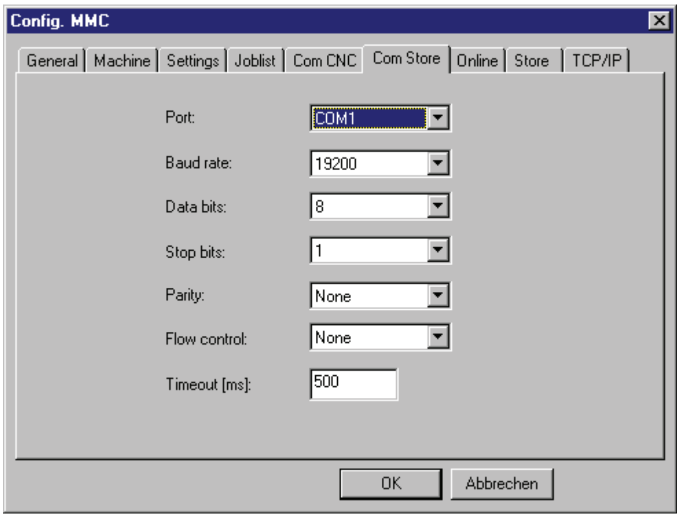
Delete: the cutting job is removed from the list

Extension: Used for selecting a "file filter" function for the dialog box for selecting files from the job list. When the file selection dialog box is opened, the file type filter function may be performed according to the selected extension.

<Description:> = Specific extension

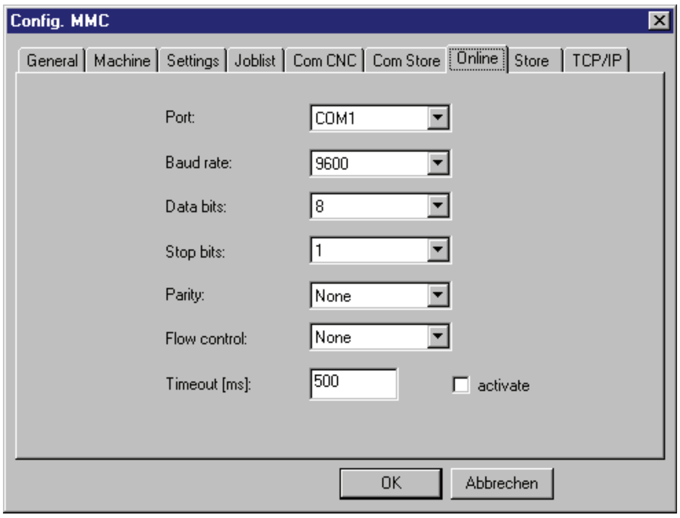
<Extension:>= abc

1.3.6 Com Store



This dialog box is used for defining the serial interface that connects the MMC to the storage system.

1.3.7 Online

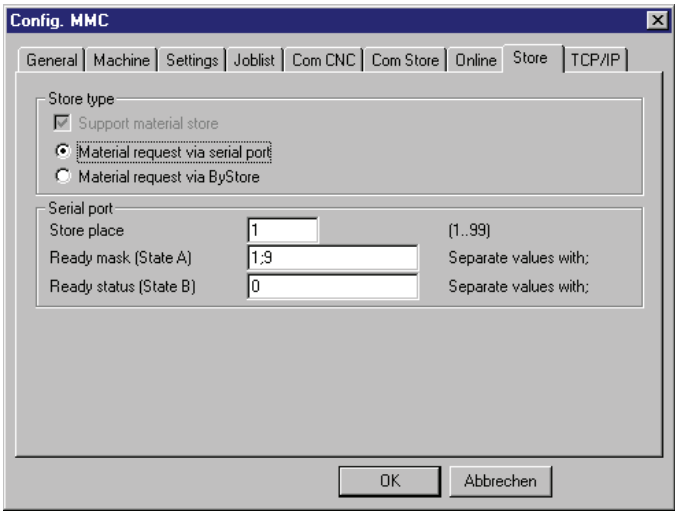


This dialog box is used for defining the serial interface that enables NC programs to be received with the XON / XOFF protocol.

aktivate This checkbox is used for activating Online operation via the MMC. When this option is changed, the MMC must be turned off and on again for the change to come into effect.

1.3.8 Store

This dialog box is used for making specific settings on the sheet storage system. Modifications are immediately accepted without MMC re-start.



Store type:

Support material store	A storage system shall be configured in <Config. CNC> to run a laser machine. For this reason the checkbox is not enabled.
Material request via serial port	A request for material is sent through the serial interface with DNC 90 / 2 protocol. The interface is selected in MMC Config. under COM Storage.
Material request via ByStore	A request for material is sent through a TCP/IP WinSock link to ByStore Application.

Serial port

This section is only available on a laser machine when material storage is controlled through the serial interface. Specific information for sheet storage may be obtained through this section. Any modifications are made without MMC re-start.

Store place:	It is sent to the storage system when the connection is made. According to this number, the storage system may, among other things, define the addressee of the material. As each machine communicates with the storage system via its own interface, this selection is not important and may be left at 1.

"Ready" screen A Values valid for the status of storage system A are provided. Various values can be entered. These values must be separated by a semicolon ";". Values other than digits and ";" are not allowed. The values entered must be DECIMAL.

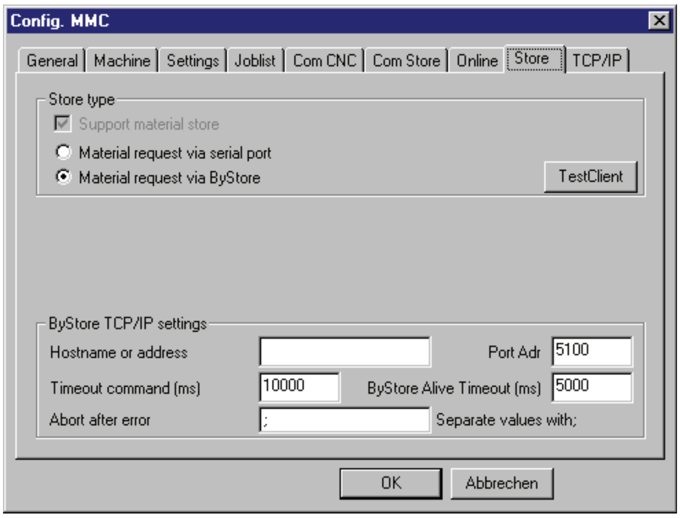
The values of status A define storage system statuses that inform the MMC that the storage system is ready to fulfil a request.

"Ready" screen B Values valid for the status of storage system B are provided. Several values can be entered. These values must be separated by a semicolon ";". Signs other than digits and ";" are not allowed. The values entered must be DECIMAL.

The values of status B define storage system statuses that inform the MMC that the storage system is ready to fulfil a request.

ByStore TCP/IP settings

This section is only available on a laser machine when material storage is controlled through a ByStore. Specific information for material storage may be obtained through this section. Modifications are made without MMC re-start.



Hostname or Address: Indication of a computer name or TCP/IP address, on which ByStore application is reachable.

Standard entry: **blank**

Port Adr.: Port on which ByStore application is reachable as a server.

Standard value:**5100**

ByStore Alive Timeout: Time delay within which ByStore must cyclically announce its availability to MMC through an Alive Message. If this time elapses without any message from ByStore, MMC displays this message on system line: "No answer from ByStore".

Standard value:**5000**

Timeout: Time delay within which ByStore must reply to a request for material by MMC. Otherwise the following message is displayed on system line "ByStore- request for materials: no answer" and send back the error to the caller.

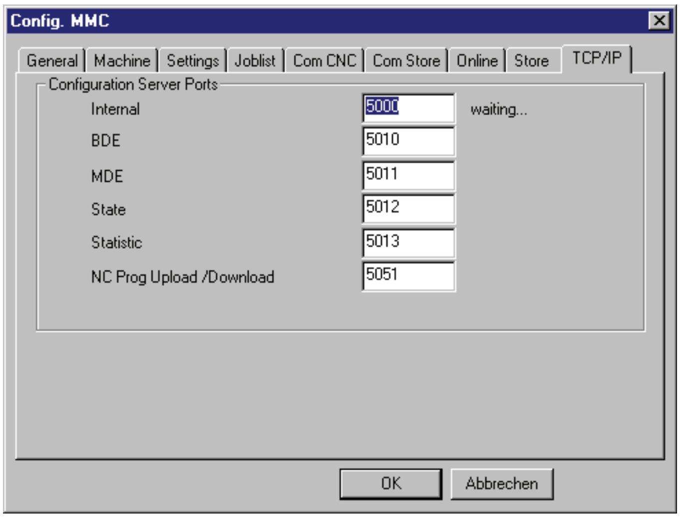
Standard value:**10000**

Abort after error: When a request for material is not acknowledged, ByStore application signals the fault cause through an error code. You can enter here the error codes, which, at the response by ByStore, abort such request for material and also the sheet involved. MMC will no longer cut this sheet and calls for the next sheet. Should any fault occur that cannot be entered here, MMC generates a request for material to ByStore until either storage mode is aborted by MMC or ByStore application acknowledges the request . Several error codes may be entered, provided that they are separated through ;

Not abort is generated after error 86 (ERR_ORDER_ALREADY_EXIST), when the same material is ordered twice to the storage system.

Standard entry: **";"** (No abort)

1.3.9 TCP/IP



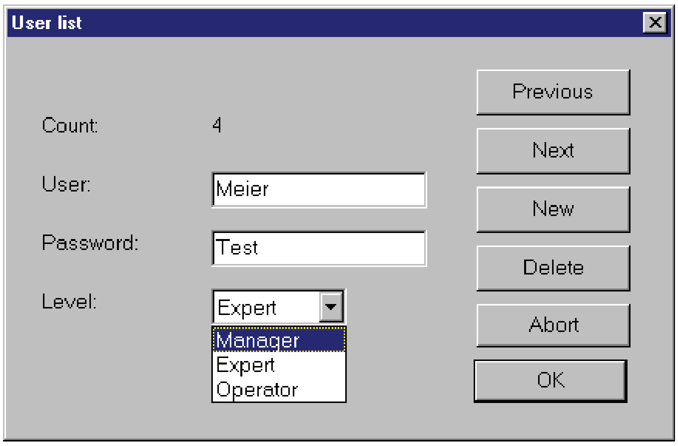
In this dialog box one can define the settings for DNC Link / VSG support. DNC Link can be enabled in Config.CNC.

Link status:

If DNC Link mode or VSG visualization is enabled, a status message is displayed to the right of Internal. The "Internal" socket provides information on the status of the link:

waiting...:	Internal enabled, but link not established yet.
connected:	Link established
timeout:	Existing link broken
error:	Error in link

1.3.10 User List



Users may be divided into the following categories:

– **Operator:** The user has access to the MAIN, WORK, PARAM, HAND and DATA menus. He can therefore create and modify parameters and create plans.

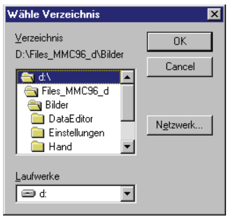
– **Expert:** The user has the same rights as the operator, plus access to the SETUP to set up the machine.

– **Manager:** This user has the same privileges as a user with Expert privileges. What's more, he also has access to Service, where he can assign access privileges (Manager, Expert, Operator) to individual users and can modify users' passwords. A Manager can also modify the Joblists, and load or store anything desired (including the current set-up configuration) using the various functions in MMC Config.

1.3.11 Load everything

The set-up values and the configurations of the machine, the axes and the Hardware are read from their files in drive A and then transferred to the CNC system. If there is no disk in drive A, the path may be indicated subsequently. This procedure is used to reconstruct the status if the information in the RAM on the ROM/RAM board is lost.

1.3.12 Save everything



The MMC enables the machine configuration (Setup, Config, Param, MMC.INI) to be stored. This action may be activated under <Main, Service> using the <Save everything> command. This procedure is to be carried out to save the configurations, and always before changing the ROM/RAM. In this case, the MMC first searches for a disk in drive A. If no diskette is present, the configuration may be saved to a different path.

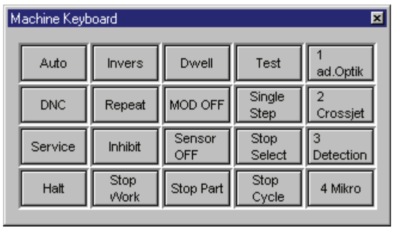
NOTE

When you execute the <Save everything> function, a backup copy is also loaded into the C:\MMC\DIAG directory. If the data on the diskette is lost, the configuration files may be reloaded from this directory using the <Load everything> function.

1.3.13 Info

Contains information about the current MMC version.

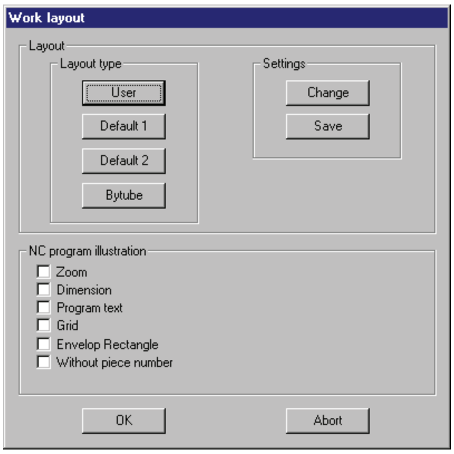
1.3.14 Virtual Machine Keyboard



By pressing the key combination <**SHIFT**+**CTRL**+**K**> you can display or clear the virtual machine keyboard from the monitor. This window lies on top of all the other windows of the MMC application. It indicates the direct CNC keys and is used mainly for remote diagnosis. When a button appears with a light background, this means that its LED is on. Buttons may be pressed using the mouse or the relevant commands (see "Simulating the Machine Keyboard«). The active function is indicated by a light background.

1.3.15 Work Layout

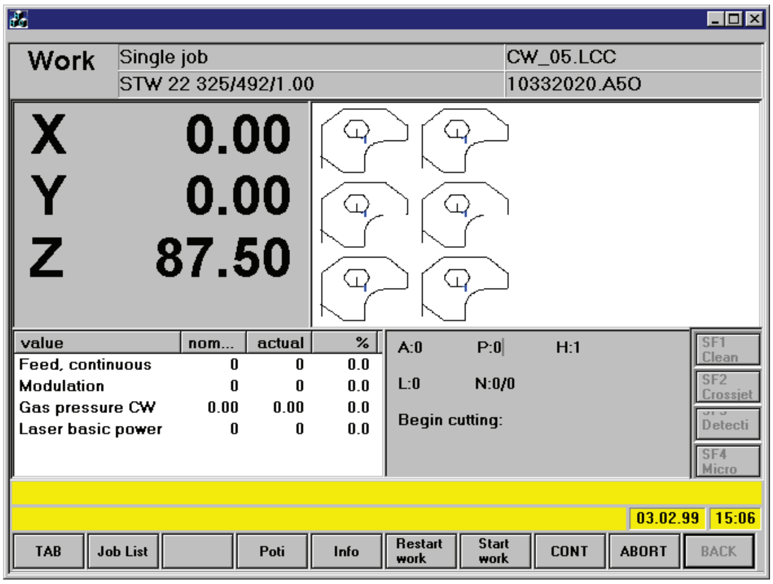
Representation of the Work Layout screen:



This menu can be accessed by pressing <**F10**> if the operator has at least the MMC manager rights and is on the <Work> menu. This menu can be used to select various kinds of layouts for the <Work> menu. The <Change> and <Save> functions may be used to define and save the <User> type of lay-out using the mouse function.

Under <NC-program illustration>, the display of the work plan may be adapted to one's needs.

2. WORK Menu



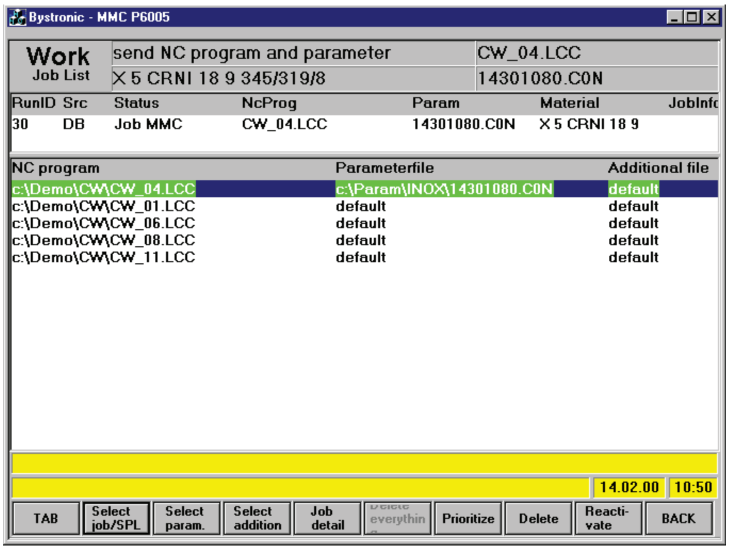
	Overview of WORK operator area	
1	CNC mode	This field indicates the current operating mode of the CNC: <not activated>, <single job>, <automatic mode>, <DNC mode> or <Test mode>
2	NC program	This field indicates the NC program currently running or which is present on the Job-List and will therefore be the next to be processed
3	Material	This field indicates the material and size of the cutting plan along the X/Y axes. If the Job-List is empty, this field also remains empty.
4	Parameter file	Name of file with the process parameters used and active at a given time, or present on the job list or to be used for the next machining process.
5	Actual position values	X, Y, Z, U
6	Graphics	Graphical representation of the job being machined
7	Potentiometer values	This field indicates the current values of the potentiometers.

	Overview of WORK operator area	
8	Information about NC program	A: Job number, P: Program number, L: Subprogram number H: Number of passes, N: current record (Main program / Subprogram) etc.
SF1	Clean	Activation/deactivation of automatic nozzle cleaning. If nozzle cleaning has been deactivated in the setup parameters, the key will have no effect when pressed.
SF2	Cross-Jet	Activates/deactivates the oil mist before and cross blowing after piercing. If the Cross-Jet is deactivated in the set-up values, this key has no effect.
SF3	Detection	Activates / deactivates detection of the edges of the plate. The type of detection specified in the setup is activated. If edge detection is deactivated in the setup values, this key has no effect.
SF4	Microbars	Microwebs on/off. The criteria selected in the values to be set for the microwebs and the width of the web are activated under <Param>. If the microbars are deactivated in the set-up values, this key has no effect.
9	Function keys	Job List, potentiometers, Info, Restart Work, Start Work, Cont, Abort

NOTE

The appearance of the Work menu can be defined by the user. The displayed menue corresponds to <default 1>. The user/system interface can be changed only by a user with Manager privileges.

2.1 Job List



This function activates a list of "jobs" with the NC programs and the process parameter files to be executed. Plans from different directories or drives may be combined on the same job list. In addition, on the job list, each plan may be assigned the corresponding process parameter file.

The job-list only contains file names and paths. The corresponding files are loaded immediately before machining, one by one, into the working memory of the CNC. It is therefore necessary to check that, while the file list is processed, the disks containing their plans and parameters are inserted in the drives, if the list includes files stored on a floppy disk.

You can scroll through the list using the arrow keys and the "page" keys.

The status of each individual job is indicated by means of the following colours:

black	job to be executed
green	job active, in cutting phase
grey	job completed
red	job interrupted but not terminated
light blue	The NC program has already been sent for the next job on the CNC (automatic mode only)
dark blue	The request for material for the next job has been fulfilled successfully by the storage system (automatic mode only)

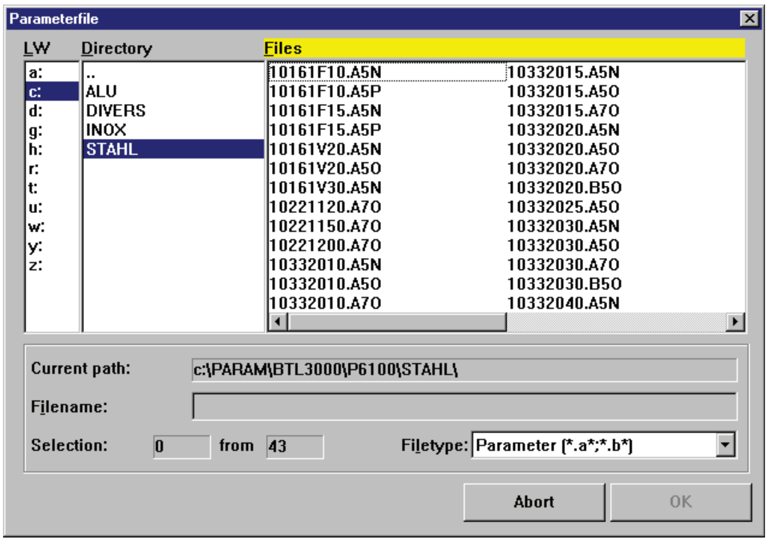
If the "default" item appears in the parameter column of a job, the last parameter used is automatically acquired.

2.1.1 Order queue

The order queue (order list) is displayed on the top, the job list is displayed below. The order queue cannot undergo any processing; it's a mere display of the work flow by CMC and available stocks, if any. Except for "**Delete all**" menu command, all the other menu commands may be only used on the job list. "**Delete all**" can be only entered when no orders are being processed and AUTO is disabled.

RunID:	Progressive number of this sheet	
Src:	Order source. DBàof Job list, DNCàOrder from main processor (DNC LINK)	
Status:	Order MMC:	MMC has already collected data of this sheet
	Material storage:	Request for material from storage executed.
	Material CNC:	Request for material from CNC executed.
	Transfer:	NcProgram sent to CNC.
	Under machining process:	CNC begins machining after table change has been made.
NcProg:	Filename NcProg	
Param:	Filename Parameter (default à Parameter from previous one).	
Material:	Material info from Parameter	
JobInfo:	Comments on NcProgramm.	

2.1.2 Selecting a Job/SPL



A new job is added to the Joblist. To enable the selection to be made, a window appears providing access to all drives, directories and files. The files to be displayed can be selected in the "File type" field.

The job files (*.job) comprise all the job indications, including the parameter file name, and are added directly to the list.

The parameter file name "default" is assigned provisionally to the new jobs added using the NC program file (*.LCC). The "Parameter selection" function can be used to assign parameters to a cutting plan. The plans may also include a reference to the parameter file, as a comment (#FILE#C:\PARAM\14301020.C5N) to be searched for and acquired (for further details, see the BYSOFT programming instructions)

Transferring single file names onto the job list

Position the cursor on the desired file name and confirm by clicking the left mouse button. The file name will be highlighted with a "blue" bar. Several file names can be highlighted by clicking on them. Once all the file names to be transferred to the job list have been highlighted, click on the OK icon, or press the <CR> key on the machine keyboard. The file names are placed on the job list in the order in which they were highlighted. All file names onto the job list.

All file names onto the job list

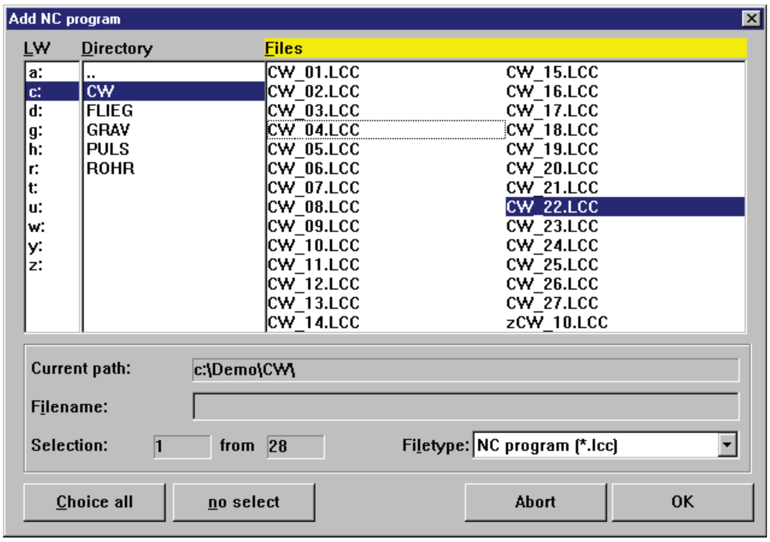
The <Choice all> control file transfers all the file names in the currently selected directory onto the job list.

Number of files in the selection dialog box

By default, the file selection dialog box displays up to a maximum of 1000 files. If there are even more than 1000 files, we recommend you divide them into subdirectories.

Even if the directory contains a larger number of files, the dialog box will only contain the maximum number indicated (1000). In this case, a warning will appear in the top right-hand corner of the screen.

2.1.3 Select param.



– If a process parameter file has been assigned to the plan during creation by BYSOFT, this file is loaded automatically together with the plan.

– If no file has been assigned to the plan and the process parameters have not been loaded, they must be selected now.

A parameter file can be assigned to a job. The selection is made in the same way as for NC programs. One of the following extensions, which are specific for the machines, may be chosen.

., *.a*, *.b*, *.c*, *.d*, *.s*

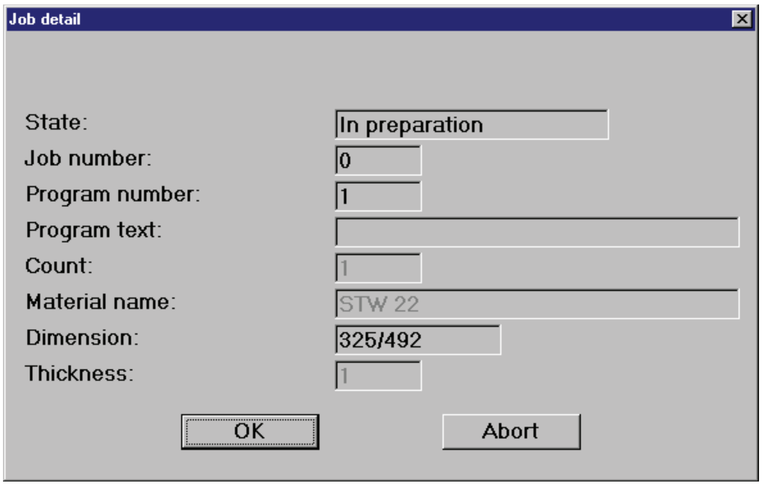
If the <default> indication appears in the parameter column for a specific job, the last valid process parameter used will be adopted automatically.

The machining plan and the process parameters now form the machining program.

2.1.4 Select addition

This function is only used with Bysort (files with stacking information). If an addition is not selected, it is set automatically to <Default>.

2.1.5 Job Detail



Number of runs: Progressive job identification number

Status: Order progress status

Job number: Address A, Order number

Programm number: Address P, Program number

Program text: Text that accompanies the program

Count: Address H, Number of passes (it may no longer be changed during the machining of the last sheet in a job)

Material name: DIN code (of material) from parameter

Dimension: Size of cutting plan

Thickness: Thickness of material from parameter

2.1.6 Total deletion

Deletes all orders in the joblist with a single command.

2.1.7 Setting priority

If you wish to process the plans in a different order from that in which they were inserted, you can set a priority order.

Position the cursor bar on the desired file. If you select "Priority", this file will move to the top of the list. Priority may only be given to files that are still to be executed (shown in black)

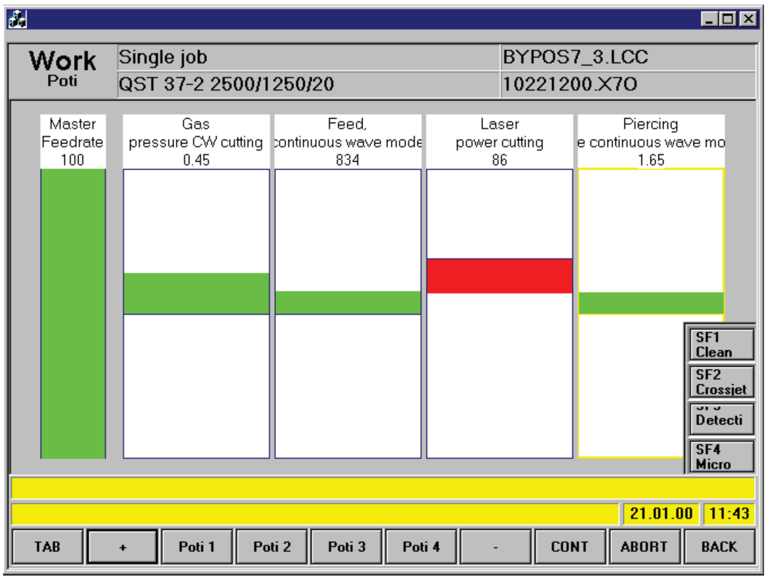
2.1.8 Delete

The job selected by means of the cursor is deleted

2.1.9 Repeat

A job highlighted in red or grey and thus considered as executed, can be repeated and reinserted at the bottom of the list as "not executed".

2.2 Potentiometers



The "potentiometers" function is used for changing single parameters that you selected and that are used by the CNC. For this purpose there are four symbol potentiometers which may be selected using the function keys and changed using the arrow keys or function keys S1 and S6. Any change made to the potentiometer is calculated cyclically as a percentage of the basic value of the parameter, its plausibility is checked and then it is sent directly to the CNC system. During the machining of test parts, the parameters can be changed continuously using the scrolling adjustment keys, and the effect of the change of the parameters on machining quality can be evaluated.

<START WORK> returns the scrolling adjustment keys to their original position.

<RESTART WORK> reactivates the last changes made.

The changes made using the scrolling adjustment keys have a direct effect on the parameters specified in the process parameter file. If you want to keep the adjustments made using the scroll keys for future applications, these parameters can be saved using the "Saving parameters" function.

Master- Feedrate to (%)

<Master- Feedrate> potentiometer ensures quick reduction of the whole cutting process feed rate. This parameter can be associated to a potentiometer. Any value change becomes effective in either static and flying mode within 1 second. When a new parameter record is loaded, the value is set to 100% by default.

⚠	**⚠ CAUTION**
	Error source, particularly when storing a current record with reduced <Master- Feedrate>.

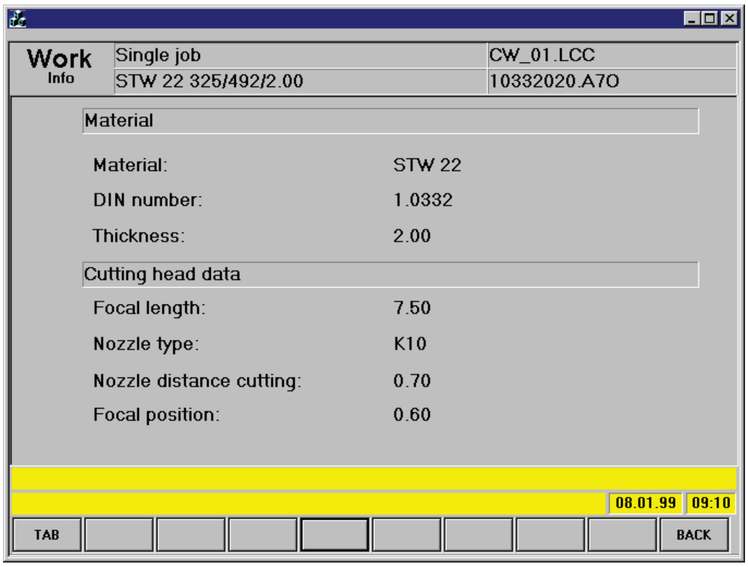
Potentiometers <S1>,<S 2>,<S3>,<S4> or < ⇦ >< ⇨ >

These keys are used for selecting the potentiometer to be changed.

<+> <-> or < ⇩ >< ⇧ >

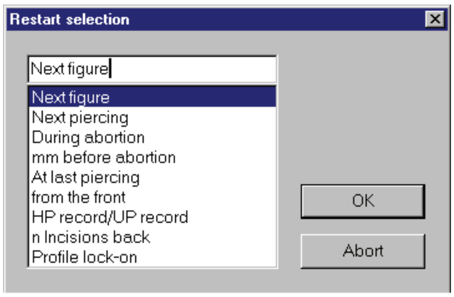
These machine keys are used for changing the value of the selected potentiometer.

2.3 Info



The "Info" function provides an overview of the most important information for setting up the plant. During cutting, the information is taken from the current parameter file, or from the next one.

2.4 Restart Work



Restart the last job stopped. This function creates the window from which the operator may choose how to resume the machining of a job after a stop. According to the status of the stop, several types of restart may be chosen.

In principle, a Restart Work command can be issued after any Stop Part, Stop Work, Abort or Halt command. Then instead of moving to the reference position at restart, the machine positions itself directly at the restart point.

By means of the restart, the status of all function keys active when the stop took place may be restored, except for <AUTO> ,<DNC> ,<SERVICE> and <HALT> which remain cancelled for safety reasons and which must be activated by selecting them one by one after the restart.

Restart selection	Describtion
Next figure	Start machining from the next figure
Next piercing	Start machining from the next piercing point
During abortion	Start machining from machining stop point
mm before abortion	Start machining 1-999mm before the machining stop point (required distance must be entered) All the program steps needed to machine this distance may no longer be stored in the internal memory. If this is the case then machinng restarts at the first program step still stored. If 0 is entered for the distance then this is equiavlent to "Restart at stop point". If the machine stops during cut out at the end of the cut, cut out is repeated (even if unnecessary).
At last piercing	Start machining at the last piercing point, without carrying out piercing. The piercing time is not taken into account
from the front	Start machining from the beginning of the cutting plan (G51)

Restart selection	Describtion
HP-record / UP-record	By entering the block number within the main program and sub program the restart can take place at any point in the cutting plan This means it is possible to skip contours, contour sections or even complete figures that have not yet been cut.
n Incisions back	Start machining at the given number of piercing points before the machining stop point.
Profile lock-on	Start machining after positioning the cutting head in manual mode. On selecting the Contour lock-on option the machine moves into the waiting position. The operator must then position the cutting head in manual mode as close as possible to the required restart point for resumption of cutting After acknowledgement with Cont, the controller moves at right angles to the next contour and continues working through the cutting plan from this point onwards.

Limitations to Restart Work

All restart options:

– A restart is only practical up to the last cutting plan displacement of a figure. For figures prior to this displacement an offset results or the wrong restart point or no restart point is found.

– A restart is only possible in the same cutting process; it cannot extend into another process. Thus for instance a restart can only be performed within the Cutting or Preburning process. It is not possible to switch to preburn from cutting using a restart function.

Contour lock-on:

– When restarting in the contour, the Sensor off field around the cut out point is ignored

– Floating cut start and end is only possible again from the next contour onwards.

– It can take an extremely large amount of computing time to lock onto the contour in large cutting plans or for imprecise restart positions.

Further details about the restart function are provided in section "Restarting After a Stop'

2.5 Start Work

To start a cutting job. <START WORK> sends the next NC program on the Job-List to the CNC system.

If the corresponding parameter file is not "default", the CNC system is sent the corresponding parameters and the values of the potentiometers set to 0. Incorrect NC programs or parameter files interrupt the starting process and cause an appropriate system message to be displayed.

The axes move to the reference point so as to provide the CNC system with a defined position of the axes.

If the <reference point> calibration position has been chosen, the machine control system now carries out the calibration.

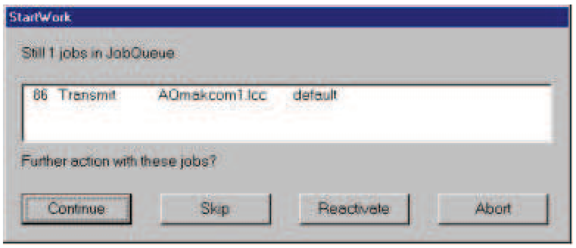
The position of the part to be machined is defined below:

In manual positioning, the part must be pushed against the stop gauges until it is parallel to the machine axes. Using edge detection, the current position of the part is detected and the control system adapts the cutting plan to this new position.

As the machining quality depends to a considerable degree on whether or not the correct parameters have been chosen, the <STOP CYCLE> function is activated automatically before the first pass, so that the parameters can be checked before starting the actual machining process by pressing <CONT>.

2.6 Start Work after Abort

Dialog window at <StartWork> when the order queue is not empty.



Continue — Existing orders left queued: re-run occurs with already ordered material. The subsequent sheets from the job list are queued after these orders t **Normal case**

Skip — Still available sheets are deleted from the order queue and marked as an error on the job list. A re-start with no orders already in use will be generated. The user must manually erase any already ordered materials.

Reactivate — The existing sheets are cancelled and re-activated in the job list. A re-start with the orders already in use is generated. The user must manually erase any already ordered materials.

Abort <StartWork> operation is aborted

2.7 Cont

Confirms termination of dwell states on the basis of system messages. The function is highlighted and activated only if confirmation is requested by the CNC system, e.g. after a stop (STOP ...) or a halt (HALT). The same function is performed by the CONT keys on the HAND menu and POTI, as well as by the key on the manual control and on the control panel.

2.8 Abort

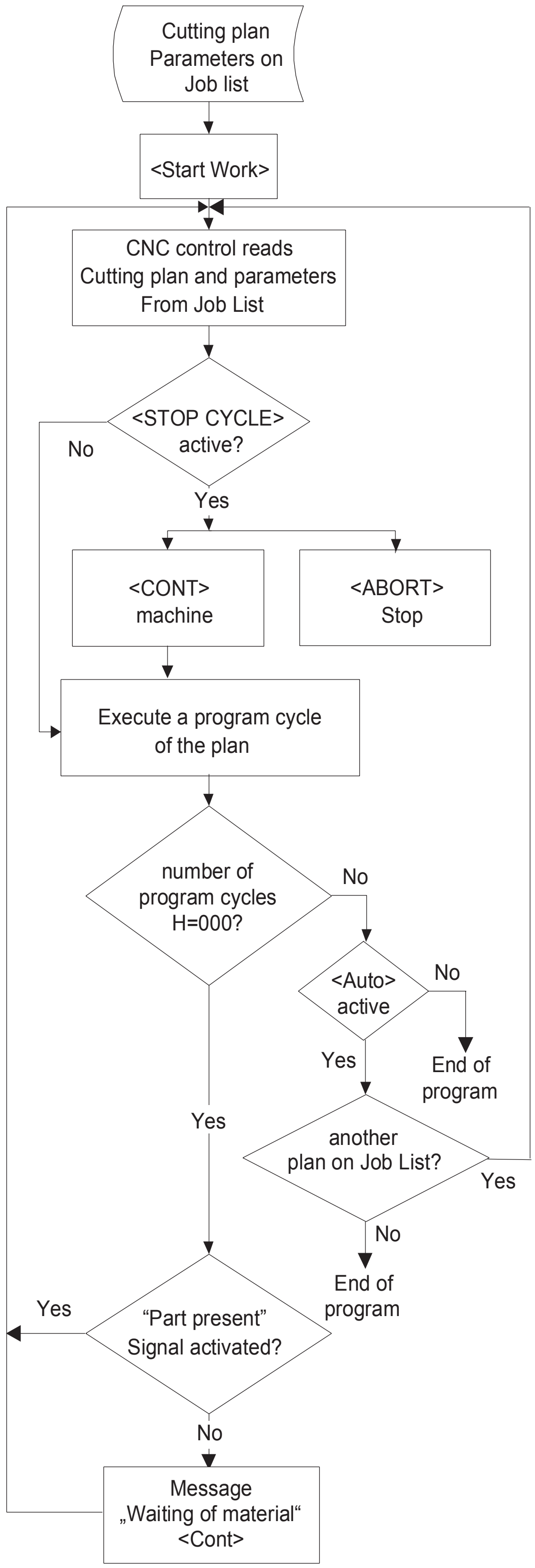
Negative confirmation to terminate dwell states (abort). The cutting process is aborted. The function is highlighted and activated only if confirmation is requested by the CNC system.

2.9 Start of Machining Options

The positions of the keys listed in the table below have an effect on the start of machining. The position of these keys must therefore be selected before activating <START WORK> .

Key	LED on	LED off
<AUTO>	Automatically read plans on the list	Read with <START WORK>
<DNC>	DNC machine control system	Local machine control

2.9.1 Overview of a machining cycle



2.9.2 AUTO

Automatic processing of the job list (<AUTO> activated) means that the entry memory is managed by the CNC system.

– After <START WORK>, the CNC system reads the first of the plans on the list highlighted in black and transfers it to the main memory of the CNC.

– If the list contains no other plans to be processed, after <START WORK>, the "no job present" system message appears.

– If <STOP CYCLE> is left activated, after each program cycle, the machine waits for <CONT> to be pressed before starting the next cycle.

Use:

For rationalizing the order of jobs when similar sets of plans are repeated frequently on the same material (mass production).

Manual processing (<AUTO> deactivated) means that each plan must be sent to the CNC individually by pressing <START WORK>.

Use:

For executing single plans in a loose order.

2.9.3 DNC

Main computer (<DNC> activated) means that the plans are transferred from the main computer to the input memory or are transferred back from the memory to the main computer.

2.10 Machining Sequence Options

Key	LED on	LED off
<DWELL>	Corners starting from the critical angle, with deceleration and acceleration	Corners machined with rated feed
<DNC>	DNC machine control	Local machine control
<INHIBIT REF>	Move to middle position for part change	Move to reference position for part change
<INVERS>	Machine the subprogram in the main program in reverse order	Standard machining
<MOD OFF>	Modulation disabled. Laser power is not adapted to feed.	Modulation enabled. Laser power is adapted to feed
<REPEAT>	The plan is executed first with the engraving parameters and then with the cutting parameters.	The cutting plan is processed normally
<SENSOR OFF>	Disable capacitive height sensing by means of the <SENSOR OFF> field	Tracer point enabled (nozzle distance adjustment)
<TEST>	Test cycle with head raised and no laser beam	Normal work with laser beam

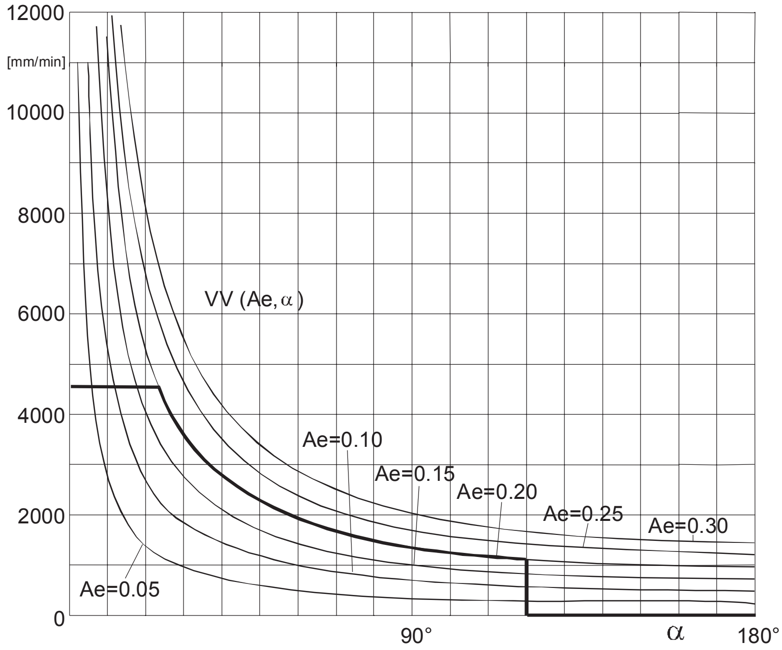
The <DWELL>, <STOP SELECT> and <STOP CYCLE> functions are activated automatically after <START WORK>. If you do not want to keep this function active, you must disable the function after <START WORK>.

2.10.1 DWELL

The special parameters <Dwell time> and <Angle tolerance> are enabled (see the <Special Parameters> section).

"Slow-down speed as a function of the angle of the change in direction" diagram

VV(Ae,α) : Slow-down speed as a function of the angular tolerance and critical angle



Example (in the diagram shown in bold):

Feed = 4500 mm/min; angular tolerance (Ae) = 0.2 mm; critical angle for slow-down time = 120°

Slow-down speed with any angle of change in direction (α):

α = 20°	Feed in the corner = 4500 mm/min
	(without reduction in speed)
α = 90°	Feed in corner= 1300 mm/min
α > 120°	slow-down time activated

Rated feed in the corners (<DWELL> deactivated) means that all the corners are machined with the rated feed speed.

Use:

High feed rates cause considerable vibrations. For this reason, the rated speed is not generally used.

2.10.2 INHIBIT REF

Preset rest position (<INHIBIT REF> activated) means that the axes reach a rest position defined in the plan (even when there is a rotating axis and a tube-handling device).

This rest position may coincide with the position of the last end of cut. In this case the head is simply lifted off the part. We recommend point outside the contour be chosen if you want to be able to pick up the machined part.

At the end of the program, the control system does not emit the "shuttle table exchange" signal. Loading and unloading must therefore be performed manually. If the key sequence <CONT> <CONT> is activated, the program is processed again (condition: the number of H program cycles is not yet zero)

The preset rest position can be activated by pressing <INHIBIT REF> only if it has previously been programmed in the plan using the G0 command (before G99).

If you want to use the <INHIBIT REF> function with round tubes, you must also use the G23 command (G23 "machine tubes with a rectangular section", as with G20 "machine tubes with a circular section", the Y axis cannot make programmed movements) Command sequence for inversion:

(e.g. movement of 200 mm along the X and Y axes, the U axis rotates by 45°)

G23

G0 X200 Y200 U45

G99

Use:

– To resume single parts

– Sequence of plans in machining with a rotating axis

With the preset rest position, the calibration is disabled. In general, tubes with a quadrangular cross section (G23) are cut without microwebs as the webs are difficult to calculate when there are angles. If microwebs are required, they must therefore be programmed in the cutting plan.

2.10.3 INVERS

When the inverse sequence of images (<INVERS> on) is active, the subroutines of a working plan run inversely.

The <Invers> function is activated after <Start Work>, but before <Move to zero point> of the first image.

Use:

If the program restart cannot be carried out, it is possible to remove the working plan by using the <Invers> function. The inverse sequence of images is activated only if each image is recalled as sub-routine.

	CAUTION
	– The sheet edge detection must be deactivated.
	– The operator should be present during the processing.

2.10.4 MOD OFF

Modulation deactivated (MOD OFF enabled) means that the laser power is not adapted to the feed.

Modulation activated (MOD OFF disabled) means that the control system adapts the laser power to the reduced feed (acceleration, deceleration, radii, angles and initial cuts). In this way, you can prevent the material overheating in the corners and in narrow contours.

2.10.5 REPEAT

Repeat program (<REPEAT> activated) means that the program is processed twice consecutively, first with the engraving process parameters and then with the cutting parameters.

Irrespective of the specification made, the control system uses fixed values for the following special parameters:

Critical angle slow-down time	**175**
Angular tolerance	**0.08**
Acceleration factor	**1**
Acceleration factor, initial cut	**1**

Use:

for cutting plates that are painted or covered in foil with a burnt off mark.

Process program once (<REPEAT> deactivated) means that the program is processed once only. This is the standard adjustment.

2.10.6 SENSOR OFF

If the <SENSOR OFF> function is enabled, the special parameter <Sensor Off Feldgrösse> is activated after piercing.

Application:

Using <SENSOR OFF> you can prevent the crater caused by piercing plates from changing the height. With flying piercing, the Sensor Off function is not activated (height detection remains active).

Exception:

Stops in height detection may be programmed by means of the "M10« command (detection off) and the "M11« command (detection on) for example, to pass above grooves that have already been cut. In this case, an absence condition is programmed instead of a field. The default <SENSOR OFF> setting is disabled.

2.10.7 SINGLE STEP

Executing the program in single step mode (<SINGLE STEP> on) means that machining is stopped after each NC block (line). By default, the <SINGLE STEP> function is not enabled.

2.10.8 TEST

<TEST> active means that the job is carried out with the head up and without the laser beam. Both piercing operations and tool change requests are ignored.

<TEST> deactivated means that the plan is executed with all the selected axis and laser functions. This is the standard adjustment.

Use:

It is used to scroll through a cutting plan with a view to checking the paths or passing over parts of a program that have already been executed.

2.11 Stopping the Machining Process

Stops may be divided into two types:

1. Spontaneous Stop

(Stop with the purpose of protecting persons and things)

The most important stops are:

<Emergency off external>

– The red emergency button has been pressed.

<Emergency off internal>

– Red <Stop> button on CNC handheld controller has been pressed (stops CNC drive software).

<Stop by axis limitation>

– The CNC drives have been conducted to the emergency switch by means of path limiters.

<Interruption stop>

– The <Halt> key has been activated. The machining process was stopped immediately.

– When the input air pressure is less than 4.5 bars, the <Halt> function is activated automatically.

<Stop by Crash>

– The capacitve nozzle came into contact with excessively long material during the machining process.

– Tactile: the sensor ring is loose

– Crossjet: the Crossjet is not firmly installed in its housing

Discharge air filter not working

– a <Stop Work> is generated automatically

<Stop durch Gasjet Errror>

– Difference in pressure in the process channel used at a given time between the primary and secondary gas pressures of <1bar

Laser error

– Cumulative error message on the laser control (MCS) to the CNC

Other error messages or spontaneous stop causes: see the "System Messages « section.

2. Programmed stop

Stop to check the cutting quality and optimize the process by means of:

– <STOP WORK>

– <STOP PART>

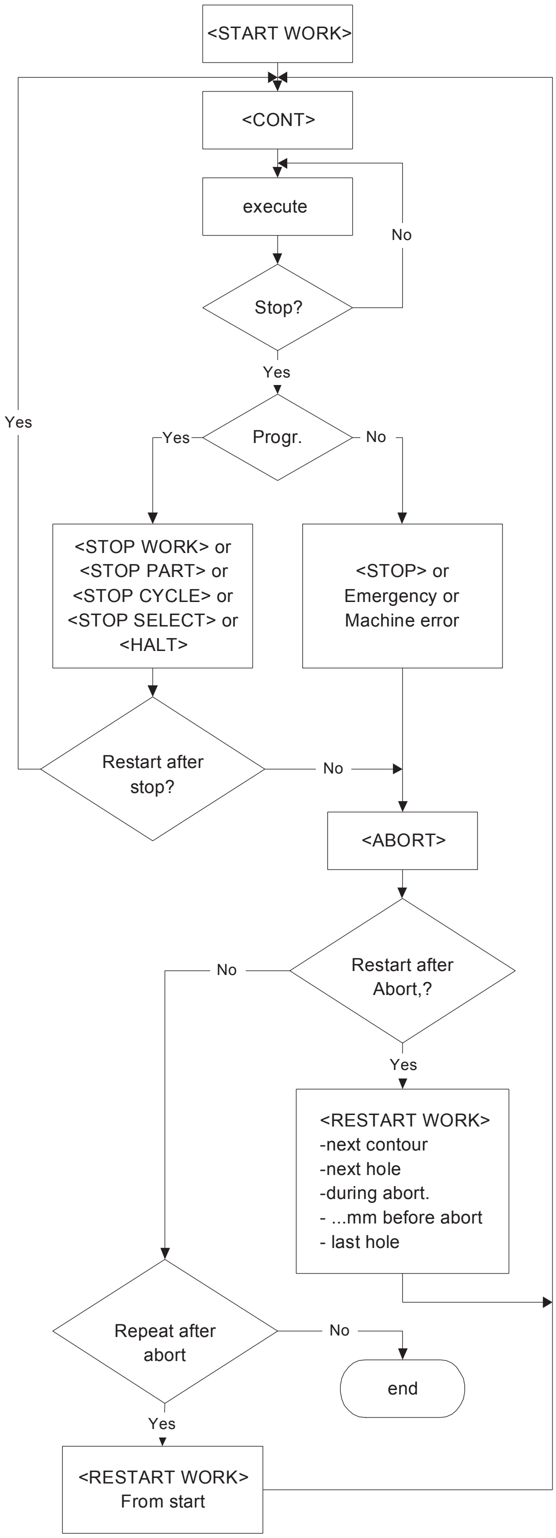
– <STOP SELECT>

– <SINGLE STEP>

– <HALT>

– <SERVICE>

Machining with stops



2.12 Programmed Stop in Machining

2.12.1 STOP WORK

Stop before the machine command M4 or after M5. The program section between two machine commands may contain a sequence of geometrical elements (e.g. the external contour) or a positioning path.

– If you select <STOP WORK> before "machining on"(M4), the system stops machining before the head is lowered.

– If you press <STOP WORK> before "machining off" (M5), the system stops machining after the head is raised.

2.12.2 STOP PART

Stop at 0 point of the next contour.

Use:

– <STOP PART> while the first contour is being machined: check whether the selected parameters, with the current machine adjustments, the quality of the material inserted and the outline to be obtained provide the required machining quality (machining is stopped after the first contour. Pick up the part and assess the machining quality. If you want to change the parameters, select the <PARAM> menu.

– Check whether the cut part is slanting and remove the part, if necessary.

– Reposition the starting point of the entire machining plan using <HAND>. This applies, for example, when the cutting plan must refer to a sheet from which parts have already been cut on other occasions.

⚠ CAUTION

When the starting point is moved, there is a risk of collision

– Never correct in the - direction (Minus)!

– Check that the size of the plan is feasible for the size of the machine

2.12.3 STOP CYCLE

Stop at the reference point before the next execution of the machining plan.

Use:

To change the process parameters, focal length, nozzle distance or the focus position if:

- the characteristics of the material to be machined change
- the thickness of the part changes when passing from one plan to another.

2.12.4 STOP SELECT

Stops at a predefined point, before lowering. When a plan is created or edited, a programmed stop must be assigned (M01).

Use:

- When the operator has to carry out manipulations during the machining process.

2.12.5 HALT

The machining process can be brought to a halt at any time (even within a geometrical element) by pressing <HALT>.

The feed rate, after <HALT> has been pressed, is gradually reduced to zero, the laser beam is deactivated and the tool is raised.

If the sequence of programs reaches a detachment or pause during the deceleration time, these commands are still executed.

If <Halt> is pressed during a piercing process, the stop is executed after the piercing operation has been completed!

Use:

- visible reduction in the machining quality following a change in the nozzle distance or the presence of slag.
- gas alarm while a long geometrical element is being cut on a thick plate, so there would be insufficient gas for a programmed stop activated by pressing <STOP WORK>.

2.13 Spontaneous Stop in Machining

STOP

When the red <Stop> key on the CNC manual control is pressed, the machining plan will be stopped immediately. The drives are immediately blocked via software.

Use:

– Sheet edge detection must be stopped immediately to avoid the risk of collision

– The head is about to move onto an already cut surface of the part

– The head is about to go over the edges of the part

– The machining quality is so bad that the head could get damaged

Unlike activation of the emergency stop button, when <STOP> is pressed, the axis power supply and the resonator remain on. The machining process can be continued more quickly using <Restart> than after an emergency stop.

In dubious situations, execute an emergency stop as this is the only way of shutting off the power supply to the drives and the resonator!

	CAUTION
	The <STOP> activated via software is not an emergency stop!

2.14 Restarting After a Stop

Restarting the machining process directly by pressing <CONT>

The machining process can only be directly restarted after a programmed stop. Select <CONT> to restart the machining process.

2.15 Aborting After a Stop

2.15.1 Aborting the machining process by pressing <ABORT>.

The machining process can be aborted using <ABORT> after programmed and spontaneous stops.

After a spontaneous stop, the abort function is the only way of proceeding. The control system only accepts the <ABORT> function: to eliminate the cause of the stop, the axes have been moved manually after turning the equipment off. Subsequently, the control system requires a defined position of the axes. This is done by moving the axes to the reference point.

The machining process is aborted, indicating the number of records. The interrupted record or the last record processed is displayed. If the plan comprises subprograms, the number of the subprogram record, e.g.. "N4" is also indicated.

The prompt: "move to reference point - wait <CONT> <ABORT> appears in the system message area.

If you select <CONT>, the axes move to the reference position. Now choose one of "restart", "repeat" and "new machining cycle" (see following sections).

2.15.2 Maintaining the current position of the axes with <ABORT> after the abort

After the first <ABORT> command, which aborted the process, with a programmed stop the current axis position can be maintained by pressing <ABORT> a second time (instead of moving them to the reference point by pressing <CONT>).

2.16 Restart after the abort

2.16.1 <RESTART WORK> after the abort

<RESTART WORK> enables you to continue processing a stopped plan at any point.

This even applies when the machine has been turned off, e.g. overnight. The next day, machining of the started plan can be resumed by pressing <RESTART WORK>.

2.16.2 Restart after stop outside a contour

Stop after a detachment (M5) and before completion of the next piercing operation (M4). Restart from last detachment. Any interrupted positioning will be repeated.

Only the following restart functions are available:

- From the front
- Next figure
- Next piercing
- During abortion
- HP-record/UP-record
- n Incisions back
- Profile lock-on

2.16.3 Restart after stop inside the contour

Stop after the piercing operation (M4) and before the detachment (M5). Select the restart:

- Next figure
- Next piercing
- During abortion
- mm before abortion
- At last piercing
- from the front
- HP-record/UP-record
- n Incisions back
- Profile lock-on

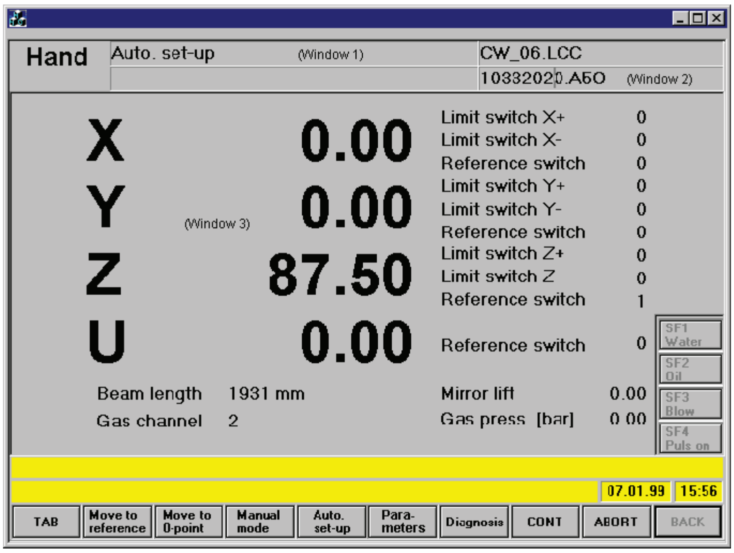
2.16.4 Restart with tracer point

With the parameters "calibration 1", "calibration 3" and "Restart inside the contour", the calibration is not made until the next piercing operation, as calibration in a position that has already been cut is not allowed. The started cut is completed with the nozzle distance calibrated before the abort operation. With "calibration 2", an immediate calibration to the reference position is obtained.

2.16.5 Repeating after an abort

If you want to repeat a stopped cutting plan on a new part from the start, select the RESTART "from start" function

3. HAND Menu



If you press <HAND>, the manual mode menu will appear on the display. The <Hand> menu includes the <Manual operation> function.

Manual operation is necessary in order to:

– Search for the focus position after changing a lens
– center the nozzle
– check the nozzle distance
– set up the machine mirror
– Some straight test cuts can be made in CW or pulse mode
– Reposition if the part to be machined is located in a particular position (only possible if <Stop Part> is active on the <Work> menu)
– In the case of particular machining head settings (also possible on the <Work> menu providing the <Service> function is enabled.

Window 1 Window 1 shows the current NC operating mode (manual mode, moving to reference point, moving to 0 point, automatic mode, set up).

Window 2 The parameter file currently used by the CNC system is indicated in window 2.

Window 3 Window 3 shows the actual values of the axes on the left and the current values of the limiting switches (travel ends) and as a reference for the axes. Below these is information about the current gas channel and the gas pressure present.

On machines with the (optional) flying optics system, the current length of the beam and the travel of the mirror are also indicated.

– The "beam length" value depends on the type of machine and the current position of the axes.

– The "mirror travel" value depends on the selections made in the <SETUP>, flying optics system setup values" and, if operating mode 2 has been chosen, depends also on the focus position resulting from the "characteristic data of cutting head" parameters.

The SF1-SF3 keys (Water, Oil, Blow) are used for preselecting the Crossjet functions, which may be activated in manual mode and during automatic setup using the <CROSSJET> key on the manual control. By pressing one of the function keys, you can set up the corresponding Crossjet nozzle.

In manual mode, SF4 (Pulse ON), is used for switching between CW operating mode and pulse mode. In this mode, the pulse parameters can be detected.

3.1 Moving to the Reference Point

The reference point is used by the control system as a point in which the axes have a defined position. The position of the reference point is determined by the switches present on the machine.

Select "moving to the reference point":

– before activating the "table change" (if the axes are not yet in the reference position)

– before moving to the 0 point

– vor dem Handschneiden

Once "moving to the reference point" has been selected, there are two available options:

– move to the reference point by pressing <CONT>

– return to the manual menu by pressing <ABORT>

This function is disabled during the cutting process and is not highlighted (light colour).

3.2 Moving to the 0 point

This function is only activated and highlighted when the machine is at the reference point.

The 0 point is the 0 point of the machine's coordinate system and is defined by a distance of movement with respect to the reference point.

This value is defined when the machine is put into operation in the <Config. Hardware>, <XYU-axis configuration>, <X/Y reference coordinate> and should not be modified subsequently.

Once "moving to the 0 point" has been selected, there are two available options:

– move to the 0 point by pressing <CONT> (positioning feed),e.g. to check whether the movement values of the setup values or from the cutting plan correspond to the actual position of the part.

– return to the manual menu by pressing <ABORT>

The starting point of the machine can be moved in <Setup>, <Set-up Machine>, <X/Y-axis: start coordinate>.

Application:

– when working with travel ends or alignment systems etc.

– moving the starting point of the sheet edge detection measuring system.

The starting point of the machining plan may be moved to the starting point of the machine by means of the command (G51), through sheet edge detection or the manual key.

– if sheet edge detection is enabled, (G51) will be ignored.

– If (G51) is enabled, the starting coordinates are ignored.

The (G51) command is programmed in the Din-Editor (Data) editor or in the Bysoft.

3.2.1 Move to zero reference point using STOP CYCLE and HALT key

Press the STOP CYCLE key then the HALT key on the machine keyboard to move to the zero reference point first (even after prior edge detection).

Application:

For cutting plans containing a rotation code and whose zero reference point is unknown.

3.3 Manual Control

At this point, the axes can only be moved using the manual control (For a description of the manual control system, see the CNC manual mode section). This function is disabled and is not highlighted during the cutting process, except in the case of a <STOP PART> or <STOP SERVICE> command.

Reference point for the actual values shown on the display:

– after starting the system or the Reset CNC command, it corresponds to the current position.

– after moving the reference point, it corresponds to the starting point of the machine

– after moving to the starting point, it corresponds to the starting coordinates

– after starting a machining plan, the starting point of the plan is defined by means of the starting coordinates, (G51) , or through sheet edge detection

3.3.1 General Positioning with Keys

The axes continue to move until the keys are released.

3.3.2 Precision positioning using the knob

The <MANUAL ADJUST> key is not self-retaining. Using one hand to hold down the key, use the other to press the key corresponding to the desired axis, to determine the direction of movement. Using the handwheel, move to the selected axis without releasing the key.

3.3.3 Feed

Three different feed rates are available:

– Fast general positioning, with the tool raised (<Setup>, machine setup values, manual control feed with head raised) The Z axis must correspond to the reference point.

– Slow precision positioning, with the tool lowered (<Setup>, machine setup values, manual control feed with head lowered)

– Cutting speed determined by the parameters activated, by pressing <BURN> and the corresponding direction key

The feed rate of the rotary axis refers to the angular velocity. The perimetral velocity varies according to the radius of the part being machined. This is read from the last plan loaded or the plan active at that particular moment. If it is not an «approximate» program, it will take its value from the <Setup> menu, <Set-up values>, <Tube radius>.

NOTE

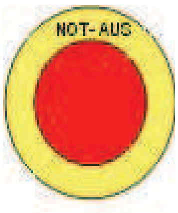
In manual mode, feeds are only considered in steps of 133. This means that the minimum feed is 133 mm/min, then 266 mm/min, etc. In automatic mode, the feed set is correctly executed. Therefore, with the same setting, there are differences in "cutting feed". These differences must be borne in mind during the detection of parameters in manual mode.

3.3.4 Master Mode

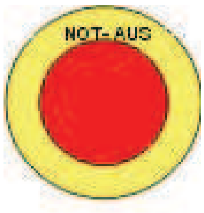
May only be used by trained service technicians!

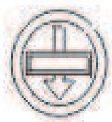
Folding door
(Bysprint)

Gate
(Bystar, Bylas)

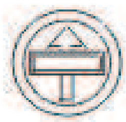


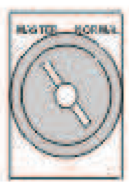
Emergency



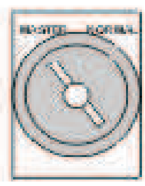


Safety door unlocking switch





Master switch



⚠ WARNING

Wear protective glasses. Laser class 4!

Bystronic

With the safety door open, all the axis drives present a reduced torque. In addition, the shutter is closed and the operator locks it so that it cannot be opened. The words <Shutter locked> appear on the MCS laser control of the gas distribution box. To work under these conditions with the manual control, the key-operated switch must be turned to the left position. Only one function can be activated a time. On the manual control, the OK key must be pressed halfway down (together with the emergency stop), activating the desired function key at the same time. In this status, the drive activated at that particular moment is set to a torque of 100%. When the Ok key or the function key is released, the drives resume reduced operation

⚠CAUTION

if the OK key is pressed all the way down, an emergency stop will result).

3.3.5 Manual Calibration

This function is used for setting the capacitive adjustment of the nozzle distance in manual mode. To this aim, deactivate and reactivate the <TOOL> key on the manual control and then press <Z+> (calibration is always started from the reference point of the Z axis). The calibration will be carried out the next time the cutting head is lowered with <Z->. Keep the <TOOL> key pressed until calibration is completed with the reduction of the <Cutting> distance.

After a stop with <STOP SERVICE>, movement is possible using the manual control. After the nozzle has been replaced or cleaned, the manual control permits calibration at any point of the plate or calibration plate. When the stop service is confirmed by pressing <CONT>, the tool returns automatically to the stop position (the starting point is not moved by the machining plan).

3.3.6 Limiting the movement of the axes

The movement of the axes is limited in three phases:

1. Limiting switches:

If the axes go beyond the limit switch. the CNC stops the drives (it is possible to move away from this position in manual mode).

2. Travel end:

When the axes go beyond a travel end switch, the CNC system cuts off the power to the drives (turn the machine off, move to the correct position and restart the machine).

3. Mechanical blocks.

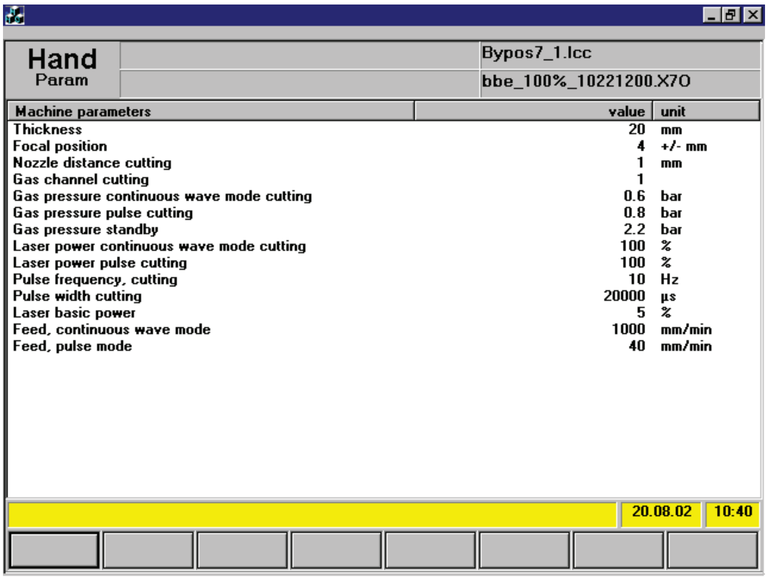
The deceleration travel between the travel end and the mechanical block is designed exclusively for deceleration from the movement speed. If the axes are moved at positioning speed beyond the travel end switches, the guides could be damaged on impact with the block!

3.4 Automatic Setup

Using the <automatic setup> function, the axes may be moved to four preset positions. This option enables the axes to be moved during the laser beam setup. After selecting <automatic setup> and confirming by pressing <CONT>, the machine moves to the 0 point. Subsequently, the operator may move to the preset position by pressing the X+, X-, Y+, Y- and <CONT> keys in the desired direction.

The control system detects the distance moved from the definitions given in the <Setup>, <Setup machine>, <X/Y-axis: service point>. This function is only activated and highlighted when the axes are at the reference point or at the 0 point.

3.5 Active Parameters



This function is only activated and highlighted in <Manual control> and during <Automatic setup>. The active parameters are are always those processed most recently on the <Work> menu.

The function is used for changing single parameters currently used by the CNC and relevant for manual mode. The single parameters are selected using the arrow keys and the value is changed using the number keys. The plausibility of the values entered is checked and then they are sent directly to the CNC system. <BACK> is used for exiting from the menu and returning to the previous function. The parameters that are changed in this way are only active in manual mode and, when you exit from the <Hand> menu, are restored to their original status.

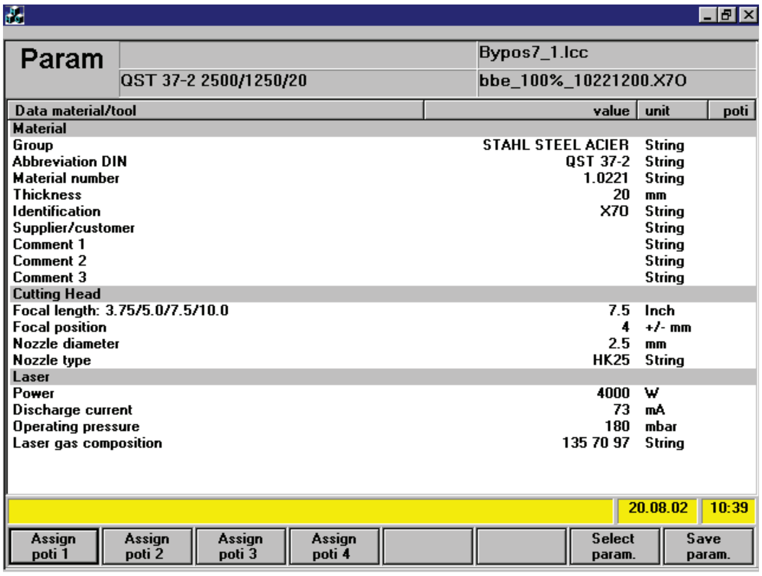
3.6 Diagnosis

This function is used for analysing the control system of the plant and diagnosing errors.

<BACK> is used for returning to the previous menu.

System-Stati	not implemented.
CNC History	The latest actions and reactions of the plant are indicated, namely: – Functions selected by the operator in abbreviated form. – All the wait states with a mnemonic abbreviation – All system stops and errors
Cut-Buffer	Representation of the current contents of the main memory of the CNC.
INK-Buffer	Representation of the current contents of the incremental buffer of the CNC.
POS-Buffer	Representation of the current contents of the positioning buffer of the CNC.
Prom-Check	Indication of the check digit on segments of code in the form of text files for checking the condition of the Prom.
R-Dump store	This function is used for the instantaneous acquisition of a plant status (error). The necessary files are saved to a diskette in drive A.
R-Dump load	This function is used for reconstructing a plant status (error). The necessary files are loaded from a floppy disk in drive A. This function is only accessible to operators who have a password.

4. PARAM Menu



This menu is displayed when the <Param> key is pressed . The menu is only active while the cutting plan is being machined (after pressing the <Start Work> key on the <Work> menu). All the process parameters available are stored in the "Param« directory on the hard disk of the PPC as default parameters.

Before starting each machining process, the CNC reads a machining plan and a process parameter file. From the <Param> menu access can be gained only to the process parameters that are present at this point in the CNC.

The following functions are available on the <Param> menu:

– Change single parameters (even during the machining process). The parameters are adopted at the next possible logical opportunity

– Load a new parameter file in the CNC. The drive and directory of the start file may be selected freely.

– Save parameter files present in the CNC as files in a memory area that may be selected freely

– 4 Soft-Potis are available. They may be linked to four parameters that may be selected freely

Bystronic

In PARAM, the following menu pages are available:

DATA MATERIAL/TOOL

PARAMETERS CONTINOUS MODE

SPECIAL PARAMETERS

PARAMETERS PULSE MODE

PARAMETERS ENGRAVING

CW - MACRO PARAMETERS 1/2

PARAMETERS CUT CONTROL

ADDITION INFORMATION

The Page Up/Page Dn keys are used to choose the desired page. The parameters appear on a list together with the relative units and values. A third column indicates the association of a parameter with one of four potentiometers.

The cursor keys are used to select individual parameters, and the relative values are entered using the number keys. Each parameter, which must fall within an established range, is checked for plausibility when entered. The entry of values outside this range generates the message: <Enter a value between the established minimum and maximum limits>. A new entry can then be made only after the error message is confirmed with <OK>.

4.1 Characteristic Data of Material / Tool

The characteristic data of the material / tool includes the adjustment values and characteristic parameters of the material, the Laser and the cutting head (see the "Laser" and "beam guide" sections). The characteristic data is stored and loaded together with other parameters.

Material

Groupe

(e.g. group of materials to the DIN standard)

Abbreviation DIN

(e.g. material code in to DIN standard)

Material number

(e.g. category code to DIN standard)

Thickness

(mm)

thickness of material

Identification

(e.g. company code)

Supplier/customer

(e.g. material supplier)

Comment 1

Comment 2

Comment 3

Cutting head

Focal length: 3.75/5.0/7.5/10.0

(Inch)

Focus distance of the focusing lens

Focal position

(mm)

Focus position in the material

Nozzle diameter

(mm)

Nozzle specification (e.g. 1.0)

Nozzle type

Nozzle type (e.g. HK 10)

Laser

Power

(Watt)

Laser power

Discharg current

(mA)

Discharge current of Laser at a certain power

Operating pressure

(mbar)

Working pressure of Laser

Laser gas composition

Composition of gas mixture for the Laser
(He, C02, N2).

4.2 Parameters Continuous Mode

NOTE

The parameter Laser basic power is not applicable to the LSC/Lascon3 controller type

Feed continuous wave mode

(mm/min)

Rated feed in continuous mode (active between M4 and M5 functions). When the plan is acquired from the MMC by the CNC, the value of the "F" address is copied in this parameter (if present this value must be present in the G29 block, otherwise it is not active).

Piercing time, continuous wave mode

(s)

Piercing time in continuous mode. When the plan is acquired from the data input memory by the main memory, the value of the "Q" address is copied to this parameter (if present, this value must be present in the G29 block, otherwise it is not active).

CW piercing

1 = Tactile

This type of piercing is used mainly for thin sheets (Steel/Stainless steel).

– **Advantages:** protects nozzles and lenses and has reduced piercing times

– **Disadvantages:** The piercing holes are a bit bigger than those produced starting from the <Nozzle distance piercing> function.

The laser power is increased by the 0% power to <Laser power piercing>, as soon as the <Z- dimension, sensor on sheet> signal is generated (15mm above the surface of the sheet). At the same time, the <Piercing speed> (5000mm/min) becomes active.During <piercing-tactile>, with highly reflecting materials, reflections that may destroy the flying optics system (optional) may be produced.

2 = Z-dimension

This type of piercing is used mainly for thin sheets (steel > 6mm).

– **Advantages:** protects nozzles and lenses, produces flat piercing craters and has reduced piercing times. By effect of the laser beam that is not 100% focused, the surface heats considerably. Consequently, the absorption of laser radiation increases. The <Lifting height, nozzle> nozzle should be lifted by at least 40 mm .

Special application: Piercing sheet coated with film. In this way, during piercing, the film is melted or removed at the piercing point and consequently cannot swell. The <Lifting height, nozzle> nozzle should be lifted by at least 40 mm.

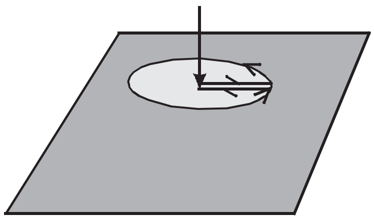
The laser power is increased as soon as the head starts to move down from the Z height. If the actual position does not coincide with the Z height, the Z axis moves to this height (set the Z height in the <special parameters>, < Lifting height, nozzle>).

When the <Piercing from Z height> function is used, while machining highly reflective material, reflections that could damage the optical components may occur.

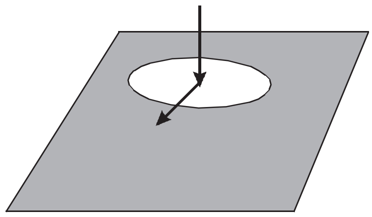
3 = Nozzle

The laser power is only increased when the <Nozzle distance piercing> piercing distance has been reached.

4 = Circle



After piercing, at half the <cutting feed rate>, a 2 mm circle is cut around the piercing point, and the tool returns to the centre. The hole created in this way facilitates the initial cut. Circular piercing can only be activated in continuous mode. The piercing time may have to be reset.



The 2 mm circle and the next initial cut are however cut with the preset operating mode. It is not advisable to readjust the nozzle distance when the tool is positioned on the cut hole. Readjustment can be avoided by selecting the same nozzle distance in the piercing and cutting parameters. If different operating modes are selected for circular piercing and contour cutting, make sure that the same nozzle distance is entered in both sets of parameters.

Nozzle distance piercing

(mm)

Distance between the nozzle and the part during piercing.

Nozzle distance cutting

(mm)

Distance between the nozzle and the part during machining.

Laser power piercing

(%)

Laser power active during the piercing time (expressed as a percentage of the rated power of the laser).

Laser power cutting

(%)

Laser power (as a percentage of the rated laser power) while cutting in normal mode with rated feed.

Modulation:

(%)

Adaptation of laser power with reduced feed (acceleration, deceleration and reduction of speed for curves, corners and initial cuts). The percentage value defines the speed (as a percentage of the rated feed) at which the power (linear) must be reduced.

Laser basic power

(%)

The basic power is the minimum value to which the power may drop by effect of modulation. The percentage value refers to the rated laser power. <Laser power> is only activated when modulation is activated.

Text gas typ

Comment line: This line can be used, for example, for recording the association between the type of gas and its number (If, for example, oxygen is connected to <Gas channel 1> and nitrogen to <Gas channel 2>, the comment lines could be expressed as follows: 1 = O2, 2 = N2).

Gas channel piercing:

Select the type of gas for the <piercing> process.

Gas channel cutting:

Select the type of gas for the <cutting> process.

Gas pressure CW- piercing:

(bar)

Gas pressure for the <piercing> process. A piercing pressure of over 10 bars for low pressure gas channel 1 causes the <incorrect parameter> warning message to be displayed.

Gas pressure CW- cutting:

(bar)

Gas pressure for the <cutting> process. If cutting gas pressures of over 10 bars are used for channel 1, the <incorrect parameter> message will appear in that these high pressures are not allowed.

Gas ramp CW piercing / cutting:

(s)

Gas pressure ramp from piercing pressure to cutting pressure in the start-up phase. This parameter is used for cutting without oxide. The correct pressure depends on the shape of the cut. The gas pressure is increased in a linear fashion within a given period of time after circular piercing or normal piercing. The gas ramp is only carried out, if:

– the piercing time value is > 0

– both piercing and cutting are carried out in CW mode

– the same gas was selected for piercing and cutting

– piercing pressure is lower than cutting pressure

Gas pressure standby

(bar)

Gas pressure for the <Standby> function: the <Standby> function is active during positioning before a machining process and between two machining processes. In this way, the purity of the process gas and the cleanliness of the lens are ensured. At the same time, in piercing without a time, the necessary pressure is already present in the head (and the lens is protected). The type of gas active must however be compatible with the gas to be used for the next machining process, otherwise a washing process will be triggered automatically (<Set-up values purge gas> on the <Setup> menu).

Y-Feed, move to corner:

(mm/min)

Speed during the machining of corners of tubes and sections using the rotating axis.

Tool radius:

(mm)

The radius of the tool corresponds to half the width of the kerf. Set the width of the kerf on by carrying out cutting tests. As the lateral surfaces of the kerf in a vertical direction are not perfectly parallel, if the plate is thick, the measuring depth must be defined. The value may be entered with two decimal places. This parameter is activated, if the plan contains the G41 / G42 functions (left/ right tool radius compensation).

	CAUTION
	The minimum gas pressure, which must always be maintained, must be at least 1.5 - 2 bars (to protect the lens). An excessively high gas pressure leads to an unnecessary waste of gas on the positioning paths.

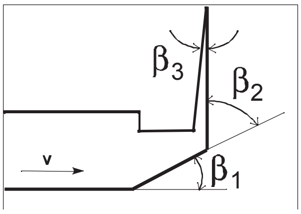
4.3 Special Parameters

These parameters are for optimizing the machining quality when the part has an unusual shape (small radii, corners, very small parts, passages, complex geometrical shapes etc.).

Critical angle, dwell time:

(Degree)

It is only active if the "Dwell" function is activated.



– **v:** Machining direction

– **β:** This angle defines the change in direction between straight lines in the geometry of the part.

If the current angle of the change in direction β1 or β2 is greater than the <Critical angle, dwell time> angle, machining will slow down at that angle to a feed of 0 mm/min by means of the <Brake factor> parameter. The <dwell time> parameter produces a delay. Once the delay time has passed, the feed rate may be restored to the value set using the <Acceleration factor> parameter. This system is used mainly with thick steel sheets (> 6 mm).

If the current angle of the change in direction is less than the <Critical angle, dwell time> angle, this means that the parameter is not active on this angle (with thin sheets of < 6mm, for example, a value of over 175° is provided).

With a contour having an acute angle (β3) of less than 15°, a radius for the tip of the contour is automatically defined. The <Critical angle, dwell time> parameter is no longer applied. The <Tool radius> parameter automatically determines the radius by taking it from the active parameters. The feed rate in the radius depends on the <Dynamic factor> parameter.

Dwell time:

(ms)

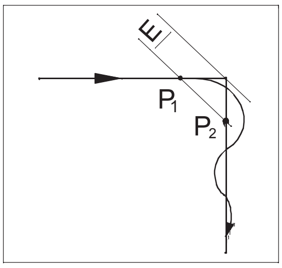
It is only active if the "Dwell" function is activated.

Time of rate 0 in the corners.

Enables the molten material to be eliminated, by blowing it away so that the gas beam is not deviated by the molten material, but can flow vertically through the kerf. It is used for thick plates. Optimize the dwell time on the basis of machining tests. Select a short dwell time if possible, so as to avoid increasing unnecessarily the accumulation of heat in the corner.

Angle tolerance:

(mm)



It is used mainly with thin sheets (< 6mm). The angular allowance <Angle tolerance> is active at all angles in which the <Critical angle, dwell time> parameter is not active and the tip of the contour is not less than 15°.

The moment of inertia of the mass of the axes, in changes in direction, causes the cutting line to deviate from the one set geometrically.

The control system takes the oscillation of the axes into account, controlling the drives - in corners- along one phase (in the sketch, between P1 and P2). The smaller the deviation admitted from the geometrical shape, the slower the speed at which the corner is cut will be. The user must optimize the "angular tolerance" value on the basis of the machining tests. Do not select values below the one necessary to obtain the required precision.

Dynamic factor:

The maximum speed within radius is calculated by the control system on the basis of the radius of the contour and the chord deviation according to the following formula. This value is compared with the rated feed. The smaller of the two values is adopted as the actual speed.

– **v** = $900 \times \mathrm{Df} \times \sqrt{\mathrm{R} \times \Delta\mathrm{S}}$

– **v** : maximum dynamic feed [mm]

– **Df** :Dynamic factor [-]

– **R** :Radius [mm]

– **ΔS** :Chord deviation [mm]/1000

Optimize the dynamic factor on the basis of the machining tests, when small radii are to be machined.

The table below indicates the radius at which work can be continued maintaining the feed rate set in the presence of a constant chord deviation of 10µm. If smaller radii are machined, the feed rate will be reduced accordingly.

Radius Table

Feed rate	Dynamic Factor										
[mm/min]	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**1.1**	**1.2**	**1.3**
1000	1.37	0.77	0.49	0.34	0.25	0.19	0.15	0.12	0.10	0.09	0.07
2000	5.49	3.09	1.98	1.37	1.01	0.77	0.61	0.49	0.41	0.34	0.29
3000	12.35	6.94	4.44	3.09	2.27	1.74	1.37	1.11	0.92	0.77	0.66
4000	21.95	12.35	7.90	5.49	4.03	3.09	2.44	1.98	1.63	1.37	1.17
5000	34.29	19.29	12.35	8.57	6.30	4.82	3.81	3.09	2.55	2.14	1.83
6000	49.38	27.78	17.78	12.35	9.07	6.94	5.49	4.44	3.67	3.09	2.63
7000	67.22	37.81	24.20	16.80	12.35	9.45	7.47	6.05	5.00	4.20	3.58
8000	87.79	49.38	31.60	21.95	16.12	12.35	9.75	7.90	6.53	5.49	4.68
9000	111.11	62.50	40.00	27.78	20.41	15.63	12.35	10.00	8.26	6.94	5.92
10000	137.17	77.16	49.38	34.29	25.20	19.29	15.24	12.35	10.20	8.57	7.31
11000	165.98	93.36	59.75	41.50	30.49	23.34	18.44	14.94	12.35	10.37	8.84
12000	197.53	111.11	71.11	49.38	36.28	27.78	21.95	17.78	14.69	12.35	10.52

Acceleeration factor, lead-in:

(m/s^2)

If there are difficult starting conditions after piercing, this parameter enables a safer process to be obtained. If the acceleration of the initial cut is less than 0.1 and less than the <contour acceleration factor>, the initial cut is made without modulation.

– Activated for standard piercing.

– Not activated for engraving, welding, burnoff, CommonCut (M18) and if the "piercing time" is set to 0.

Acceleration factor:

(m/s^2)

The acceleration factor influences the precision of the contours after a change in direction. This value may influence the characteristics of the cut in this zone, in that the process gas pressure is not proportional to the feed rate. A higher factor entails a shorter acceleration path while a lower factor means a longer path.

Brake factor:

(m/s²)

The deceleration factor influences the precision of the contours before a change in direction. This factor may influence the characteristics of the cut in this zone.

Delay time before processing:

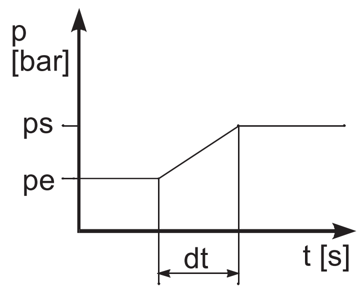
(s)

Dwell time between piercing and machining to

– increase the process gas pressure

– Cooling of the piercing point in very thick sheets before the initial cut

– If the <Cross blowing after piercing> function is active, the <Delay time before processing> parameter determines the blowing time.



pe: piercing pressure

ps: machining pressure

dt: dwell time

Lifting height, nozzle:

(mm)

Distance between the tip of the nozzle and the part during positioning (the "nozzle lifting height" is also indicated, in abbreviated form, as "Z height").

Use:

it is used to prevent collisions with slanting parts during positioning.

Lifting height before tube turning:

(mm)

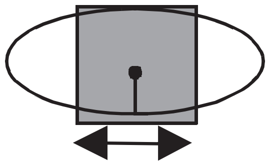
Distance between the tip of the nozzle and the part during movements of the rotating axis.

Use:

During the machining of corner tubes and profiles, the head must be lifted before the tube is rotated so that the part does not collide with the head during rotation.

Sensor off field size:

(mm)



With <SENSOR OFF> activated, the contour is cut within a square around the piercing point, the sides of which have a length equal to "Size of field for Sensor-OFF", without capacitive or tactile sensing. In flying piercing, the Sensor-OFF function is not considered.

Sensor off piercing: 0=off, 1=on:

The piercing process may be selected with the cutting parameter <Sensor-Off piercing: 0=off, 1=on>. This type of piercing may also be used for circular or rectangular section tubes. During the piercing process, the height of the sheet is measured by the cutting head before all piercing operations. At this point, the next piercing process is carried out with the height adjustment disabled, up to the height measured. In this way, there is no piercing spray and the Z axis carries out a precise piercing operation. By default, this parameter is disabled.

⚠ CAUTION

When lowering with the height adjustment disabled, the Z axis cannot identify the sheet and is thus positioned "blindly" at the previously detected height!

Floating cut start and end: 0=off, 1=on

With normal piercing, positioning takes place on two axes and piercing with one axis. With the <Floating cut start and end: 0=off, 1=on> function, the end of cut is performed very quickly. After the end of the cut, positioning is performed on the next contour and on three axes. If the piercing time parameter is also set to zero, on-the-fly piercing can be peformed as well. Consequently, the <Piercing time> and <Delay time before processing> delay times are not taken into consideration.

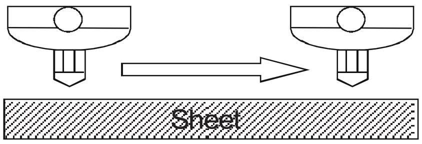
During the piercing and end of cut phases, a distinction must be made between the following two cases:

– Positioning on three axes (positioning and piercing take place at the same time)

– Positioning on two axes with the cutting head down

Describtion for positioning

1. Flying piercing in and cut out (two-axis with lowered cutting head)

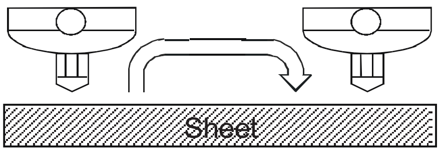


If the <lowered positioning> parameter has been inserted in the cutting program using the BYSOFT software or the (M06=in & M07=off) parameter in the DinEditor, positioning between two contours will take place on two axes and with the <Nozzle distance cut-ting>. At the same time, the <Delay time before lowered positioning> parameter is activated on the <Setup> menu. This machining option is called "two-axis positioning".

NOTE

When using the option "oil mist", the two-axis positioning will not be exe-cuted. The piercing mode determines the method of piercing-in.

2. Flying piercing in and cut out with tactile piercing mode (three-axis)



This positioning option is called "three-axis positioning". In three-axis positioning all three axes are moved simultaneously.

The cutting head is withdrawn and raised normally, however, without three-axis movement under the fol-lowing conditions:

– At the end of a figure

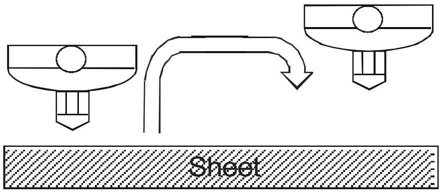
– After exceeding the parameter max. positioning distance for small lift-off height

– After changing the Pulsed piercing mode (M14/15)

NOTE

The Nozzle distance piercing parameter is not taken into account.

3. Flying piercing in and cut out with nozzle distance (three-axis)

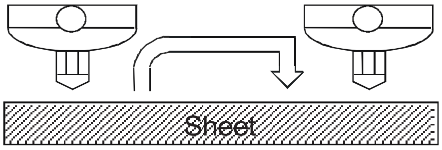


These functions are performed for the Z-dimension, Nozzle and Circle piercing modes. The parameters Lifting height, nozzle and Nozzle distance piercing affect the mode and height of piercing. If Crossjet, Circle or Pulsed piercing are enabled then the head stops at the piercing point, and the pierced hole is made.

NOTE

The Nozzle distance piercing parameter is taken into account

4. flying end of cut (three axes)



By entering a piercing time all piercing modes assume their normal function.

Settings and use of flying piercing in and cut out

Descripion	Adjustments	Application
1. Flying piercing in and cut out (two-axis with lowered cutting head)	Piercing time = 0 sec. Floating cut start and end = on M6/M7 in program	Steel up to a thickness of 1.5mm Alu / Inox up to a thickness of 1mm
2. Flying piercing in and cut out with tactile piercing mode (three-axis)	Piercing time = 0 sec. Lifting height, nozzle = max. 12mm Piercing type = 1 Tactil Floating cut start and end = on	Steel thickness 2-3mm Alu / Inox thickness 1.5-3mm
3. Flying piercing in and cut out with nozzle distance (three-axis)	Piercing time = 0 sec. Lifting height, nozzle = max. 12mm Piercing type = Nozzle/Z-dimension/Circle Floating cut start and end = on	Steel thickness 2-3mm Alu / Inox thickness 1.5-3mm
4. Flying end of cut (three axes)	Piercing time > 0 sec. Lifting height, nozzle = to max. value Piercing type = all Nozzle distance piercing = to max. value Floating cut start and end = on	Possible in all thicknesses for reducing nonproductive times and optimizing piercing holes in various thicknesses and materials.

Flying pierce and end of cut guidelines

To execute flying pierce and end of cut correctly, some conditions must be borne in mind. The table below may be used as a guideline for optimizing the programs:

Material and thickness of sheet	Minimum length of initial cut	Flying pierce and end of cut	Nozzle height (mm)
Steel, up to 1.5mm	3mm	Two axes	-
Steel, up to 2-3mm	5mm or 1.5 - 2 x sheet thickness	Three axes	3-10mm
Stainless steel/Allum/ other, up to 1mm	3mm	Two axes	-
Stainless steel/Allum/ other, up to 1.1-3mm	5mm or 1.5 - 2 x sheet thickness	Three axes	3-6mm

With flying pierce and end of cut, the single contours are recalculated transforming them into a single contour. This means that any changes in the parameters (for example, feed rate, insertion of microwebs, type of piercing etc.) are received with a delay (with some exceptions). With piercing and end of cut and the <Clean after x pierces: 0=off, >0=on> parameter, the number x cannot be changed dynamically. The value valid at the start of the flying contours is maintained through to the end of the cycle.

The cutting speed should not be higher than 6m/min with flying piercing and end of cut otherwise the Z axis would not have sufficient time to move down, if it is increased, the length of the initial cut will also be increased.

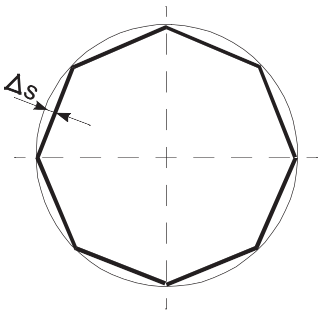
Care must also be taken not to go beyond the maximum positioning path. This path is set to a maximum of 100mm with the head down and a maximum of 200 mm with positioning on three axes.

Using mobile piercing and end of cut, the nozzle gets dirty very easily. We therefore recommend you activate the nozzle cleaning function. The lens is not likely to get dirty more easily.

If the conditions indicated in the table above cannot be maintained, flying piercing and end of cut must not be used. It is however possible to use flying piercing and end of cut partially within a part using a process macro.

Chordal deviation:

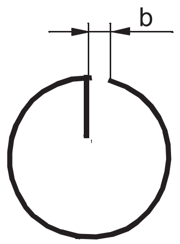
(µm)



All the curved elements of the contour are converted by the control system into straight segments. The chord deviation (Δs) is a measurement of the precision with which these straight segments approximate to the arc. The smaller the chord deviation, the closer the approximation will be, but also the slower the speed at which the calculation will be made by the control system. Therefore, do not choose a smaller chord deviation than necessary to obtain the required tolerances.

Width of microbars:

(mm)



If the width (b) of the microbars is correct, the contours can be detached from the plate manually with a slight pressure. Set the optimum length by machining tests. It depends on the type of material and the thickness of the part.

Piercing type, microbar:

1 = CW

2 = pulse

3 = no time

Type of piercing after the microbar. With M80 before M5, no further piercing is performed after the microbar.

Oil-mist time before piercing:

(s)

Before each piercing operation, starting from the <Lifting height, nozzle> (Z height), the piercing position is sprayed with oil mist for the preset time. Oil mist is used to prevent slag sticking to the plate while thick plates are being pierced.

The value 0 corresponds to the special case "working without oil mist".

Cross blowing after piercing:

0 = off

Without cross blowing

1 = on

Cross blowing after piercing, during the "delay time before machining". During piercing, the molten material is forced by the process gas from the cavity of the hole upwards. The thicker the material, the more the splashing and, consequently, the greater the risk that they reach the nozzle still in a liquid state, solidifying on it. Use cross blowing to remove the liquefied material.

4.4 Parameters Pulse Mode

The pulse modes are described in the "Laser" section; a summary and available options are provided in the "machining" section. The parameters may be divided into pulse parameters for cutting and pulse parameters for piercing.

NOTE

For the MCS/SSI controller type the following parameters do not apply to piercing and cutting operation:

– Pulse switch: 1 = normal pulse (NP), 2 = Superpulse (SP), 3 = Megapulse (MP)

– Pulse width, super pulse

The parameter Pulse width, normal pulse has been renamed as the parameters Pulse width, piercing and Pulse width, cutting.

NOTE

For the LCS/LASCON3 controller type the following parameters do not apply to piercing and cutting operation:

– Pulse switch: 1 = normal pulse (NP), 2 = Superpulse (SP), 3 = Megapulse (MP)

– Pulse width, super pulse

– Laser basic power Pulse

The parameter Pulse width, normal pulse has been renamed as the parameters Pulse width, piercing and Pulse width, cutting.

PIERCING MOD:

Piercing time, pulse mode:

(s)

Piercing time for laser pulse mode piercing (activated between M14 and M15).

Nozzle distance, piercing:

(mm)

Distance between the nozzle and the part during piercing.

Gas pressure, pulse piercing:

(bar)

Gas pressure for piercing, according to the type of gas in the channel - for piercing in continuous mode.

Pulse switch:

1 = normal pulse (NP)

2 = Superpulse (SP)

3 = Megapulse (MP)

Laser power piercing:

(%)

Laser power during piercing in Normal pulse or Superpulse mode. The percentage value refers to the maximum laser power.

Initial pulse frequency, piercing:

(Hz)

The number of pulses per second with selected Laser power, to be activated at the start of the piercing operation.

End pulse frequency, piercing:

(Hz)

During the piercing time, the pulse frequency is increased gradually from the initial frequency to the final frequency.

Pulse width, normal pulse:

(µs)

Amplitude of normal pulse in microseconds.

Pulse width, super pulse:

(µs)

Amplitude of "superpulse" in microseconds.

CUTTING MOD:

Feed, pulse mode:

(mm/min)

Rated feed in pulse mode (activated between the machine functions M12 and M13)

Nozzle distance, cutting:

(mm)

Distance between the nozzle and the part during machining.

Gas pressure, pulse cutting:

(bar)

Cutting gas pressure, according to the type of gas present in the cutting gas channel in continuous mode.

Pulse switch:

1 = Normal pulse (NP)

2 = Superpulse (SP)

3 = Megapulse (MP)

Pulse frequency, cutting:

(Hz)

Number of pulses per second with selected laser power for pulse operation.

Pulse width, normal pulse:

(µs)

Amplitude of normal pulse in microseconds. Select a smaller pulse amplitude (in seconds) than the result obtained dividing 1 by the "cutting pulse frequency" (if a higher value is set, the machine will work in continuous mode).

Pulse width, super pulse:

(µs)

Amplitude of "Superpulse" in microseconds.

Laser power, cutting:

(%)

Laser power during pulse operation, expressed as a percentage on the power rating of the same Laser.

Laser basic power pulse

(%)

The basic power is the minimum value to which the laser power may be reduced during the pulse pause. The percentage value refers to the rated laser power. During normal pulse operation, in the pauses between pulses, the Laser power is lowered to its minimum.

Tool radius puls mode

(mm)

The radius of the tool corresponds to half the width of the kerf. Measure this width on the basis of test cuts. The value may be set with 2 decimal places. This parameter is active, if the plan comprises the G41 / G42 functions (left / right tool compensation).

4.5 Parameters Engraving

Meaning of the single engraving and burnoff parameters (REPEAT function)

Feed engraving:

(mm/min)

Rated feed activated for engraving between the machine functions M16 (obligatorily with M4) and M5. Use while engraving or burning off painted plates (activated in the <REPEAT> function).

Nozzle distance, engraving:

(mm)

Distance between the nozzle and the part during engraving or burnoff

Gas channel, engraving:

Select the type of gas for <engraving>

Gas pressure, engraving:

(bar)

Cutting gas pressure, according to the type of gas present in the engraving gas channel.

Laser power, engraving:

(%)

Laser power reduced while engraving or burning off plates (activated in the <REPEAT> function)

Typ of engraving:

1 = CW

Preset and constant CW Laser power while engraving

2 = Modulation

Engraving with modulated Laser power according to the feed

4.6 Macroparameters CW 1/2

Application macro programming

Single shapes (circles, rectangles), contours (angles, radii) and elements (partial radii) may become process macros. In order to use process macros, the commands G10 - S1 or S2 (process macro 1 / 2) must be inserted in the BYSOFT program or in the Din- Editor. The G10 block is inserted with the M04 command. The process macro is disabled by G10 - S0. In processing a cutting parameter, the data is identical to the CW data. The parameters apply starting from the corresponding position. The changes in speed (Deceleration/acceleration) are executed in the present or subsequent blocks of the process macro. The process macro may be changed dynamically during the cutting process.

The following applications may be executed using process macros.

– fast cutting, but with a lower cutting quality due to the quality of the corners.

– machining complex contours, difficult changes in direction, etc.

– single holes that present excessively short initial flags

– for smaller holes 0.5 -2 x material thickness, a reduction of 10 - 30% in the feed rate and gas pressure is sufficient

For the macros, use may be made of the following parameters:

Macro desigination:

Description of macro

Feedrate:

(mm/min)

The parameters are described under the item <Parameters for continuous operation>.

Nozzle distance:

(mm)

The parameters are described under the item <Parameters for continuous operation>.

Focal position:

(+/- mm)

The parameters are described under the item <Parameters for continuous operation>.

Laser power:

(Watt)

The parameters are described under the item <Parameters for continuous operation>.

Modulation:

(%)

The parameters are described under the item <Parameters for continuous operation>.

Gas pressure:

(bar)

The parameters are described under the item <Parameters for continuous operation>.

Gas channel:

The parameters are described under the item <Parameters for continuous operation>.

Piercing time:

(s)

The parameters are described under the item <Parameters for continuous operation>.

Tool radius:

(mm)

The parameters are described under the item <Parameters for continuous operation>.

4.7 Parameter CutControl

Calibration threshold gaschannel 1/2

(mm)

The base signal as determined from <Calibration threshold gaschannel 1/2> parameter is entered here in <Setup> menu.

4.8 Supplementary Information

Supplementary information that does not have affect the machining process.

Commentary line:	comment line
Rom / Ram-version:	e.g. P6111
Date of parameter creation:	e.g. 21.11.2000

4.9 Assigning Potentiometers 1, 2, 3 and 4

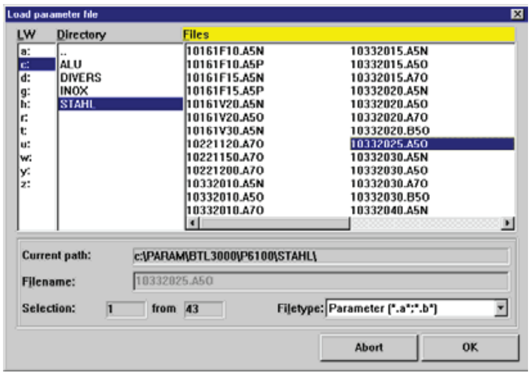
A parameter selected using the cursor is assigned the corresponding software potentiometer, providing that it is significant for the parameter selected. You can freely assign four parameters to one of the four potentiometers. At this point, the parameter may be changed during the cutting process by means of the potentiometer.

4.10 Selecting Parameters

To enable the parameter file to be selected, a window appears providing access to all drives and all directories. The "default" extension of all the files is *.* . Other extensions are however available and can be selected freely.

.a / *.b* / *.c* / *.d* / *.s* / *.*

In the "file type" window, this default setting can be changed.

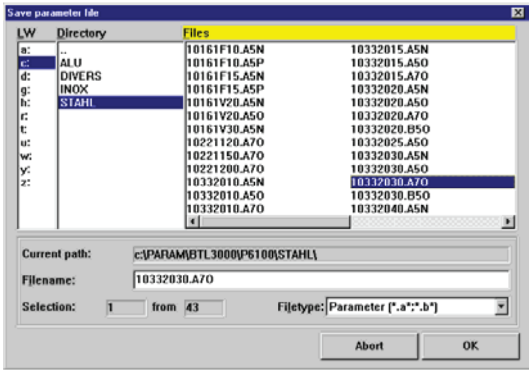


4.11 Saving Parameters

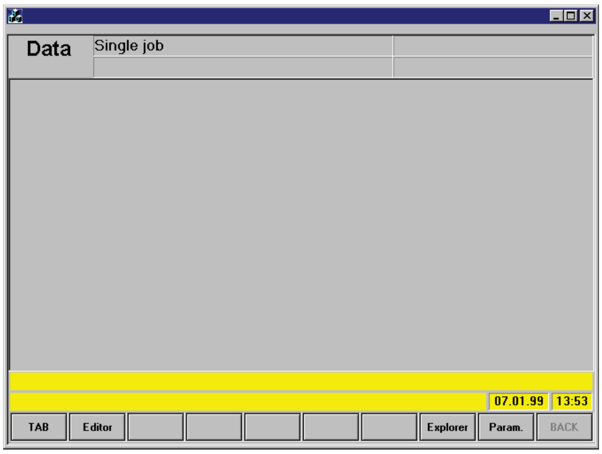
Any modified and adapted parameters can be overwritten with the same file name or be saved under any other name in the directory of your choice. For this purpose, a window appears providing access to all drives, directories and files which are presented for selection by their extension type.

Parameter:

.a / *.b* / *.c* / *.d* / *.s* / *.*



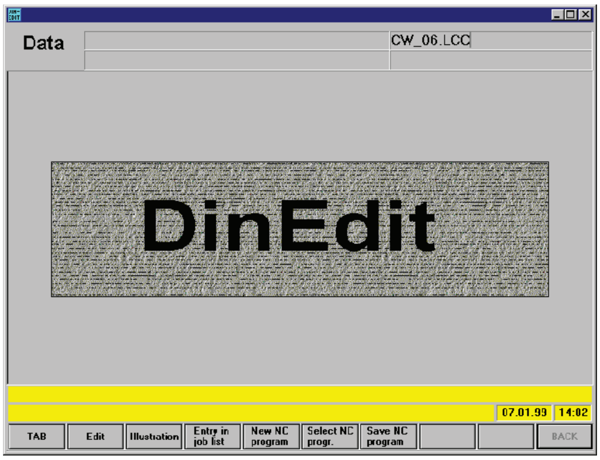
5. DATA Menu



This menu is displayed when the <Data> key is pressed. On the <Data> menu, the operator may use or change an existing process parameter or generate another by selecting <Param.>.

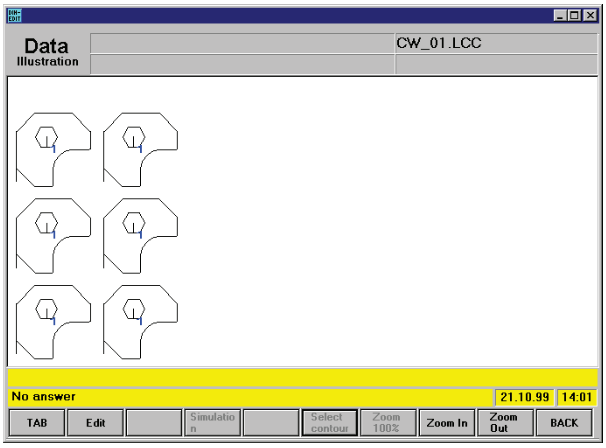
When the <Explorer> key is pressed, Windows Explorer is started. In addition, the DinEdit program may be started from this menu.

5.1 DinEdit



The <S1> key may be used to start the <DinEdit> editor, an independent editing program. To distinguish it clearly from the MMC, a graphic with the word <DinEdit> appears on the initial screen of the program. A machining plan may be represented graphically or in NC codes.

5.1.1 Graphic



The machining plan selected at a given moment or the plan edited is represented graphically. The <Graphik> application shows the machining plan in its full size.

Simulation

(not yet available)

Selection of contour

(not yet available)

Zoom Function

The zoom function can be seen on the list of symbols, when the DinEdit program is started. The list of symbols includes <Zoom in>, <Zoom out> and <Zoom 100%>. The size of the graphical representation can be changed using the <+>/<-> keys on the PC or machine keyboard.

Zoom in

The current contents of the screen are enlarged.

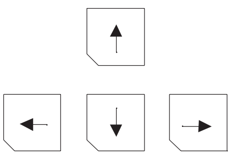
Zoom out

The current contents of the screen are reduced in size.

Zoom to 100%

The contents of the screen are reset to standard dimensions.

Movement



The arrow keys on the machine or PC keyboard are used for moving the graphic displayed horizontally and vertically.

Storing in the joblist

A machining plan that has been modified must also be saved. Once it has been saved, the <Storing in the joblist> field is activated on the symbol list. By pressing on this field, the machining plan is automatically placed on the job list.

New numeric control program

This function opens an empty input box that may be used to create a new machining plan.

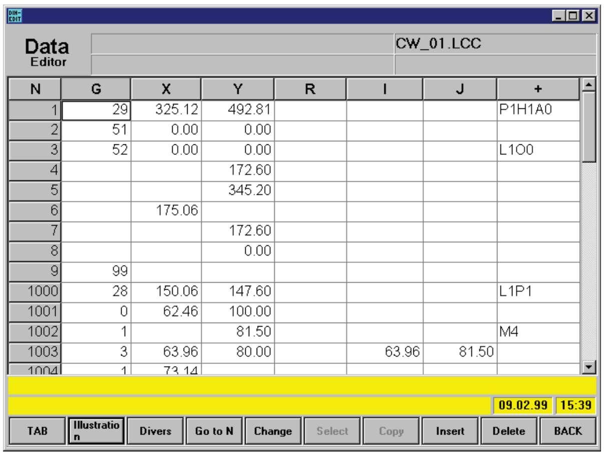
Selection of numeric control program

To select an NC program to be machined, a dialog box is displayed, providing access to all drives, directories and files selected with available extensions.

Storage of numeric control programs

Modified numeric control programs can be stored under the same name or under any new name

5.1.2 DATA Editor



This Editor is used for editing and creating values, comments and any NC program parameters required, using the CNC or PC keyboard. This Editor constitutes an independent program and may only be started when the MMC is already running. It is divided into six columns of addresses.

Addresses

The Editor operates by referring to data records.

The G functions represent path conditions.

Columns X and Y contain coordinates. Column R contains radii, only.

When the user quits the editor, a plausibility check is automatically performed. However, the user must make sure that the data being entered can be processed in a way that makes sense. Be especially careful to avoid:

– Making typing errors when entering numbers for functions M and G

– Entering modified movements that can cause the axes to hit the limit switches.

Check the plan by using the <GRAPHIC> function to identify errors (in typing), which can be seen on the graph.

N Address

Consecutive numbering of the lines. When a new line is inserted, the others are renumbered.

G address

The admissible numbers and their respective meanings are shown in the table on page 5-54. The numbers can be overwritten and cancelled. If an address has no number, it will not be assigned a number and will continue to have no number.

X and Y addresses

Coordinates or dimensions. The values can be overwritten, cancelled or maintained.

R address

Radius of circle, corner or tube. The values can be overwritten, cancelled or maintained.

I and J addresses

The centre of the arcs on the circles. The values can be overwritten, cancelled or maintained. These columns are selected only when no radius or arc has been defined for the circles.

+ address

Optional functions. Various optional functions are available, depending on the G functions. Optional functions are found (in the order in which they were entered) on a line and are listed in the same column. The functions are accompanied by letters and number values which can be overwritten, cancelled or maintained.

Go to N

This function enables the user to jump to a specified N address.

Modify

The data in the currently selected field can be modified using this function.

Marking

(not yet available)

Copying

(not yet available)

Insert a new data record

This editing function is used to insert a new data record.

It moves an empty data record to the desired position.

Deletion

This editing function is used to delete data records.

Data records from number Nxxx to number Nzzz are deleted.

Divers

Contains the zoom functions and a function that updates the line numbers.

Zoom to 100%

The contents of the screen are reset to standard dimensions.

Zoom in

The current contents of the screen are enlarged.

Zoom out

The current contents of the screen are reduced in size.

Updating of the N code

The line numbers in a modified numeric control program are listed in ascending order.

5.1.3 Defined Address List

Code	Meaning	Format	Unit
A	Ordner number	05	
C	Rotating corner of the template in degrees	+0320	(Degrees)
F	Feeding speed with interpolation	05	(mm/min)
G	Path condition (G address or G function)	02	
H	Number of executions of the program	05	
I	X co-ordinate of centre of circle	+ 0520	(mm)
J	Y co-ordinate of centre of circle	+ 0520	(mm)

Code	Meaning	Format	Unit
L	Subprogram number	03	
M	Supplementary function	02	
N	Record numbers	06	
O	Rotating code (0=0°, 1=90°, 2=180°, 3=270°; only after G52)	03	
P	Program number (main..) / Template number (subprogram..)	05	
Q	Piercing time different from the parameter	0210	(s)
R	Radius	0520	(mm)
U	Rotating co-ordinate	+ 0320	(Degrees)
X	X co-ordinate (main.) /X value (subprogram)	+ 0520	(mm)
Y	Y co-ordinate (main.) /Y the value (subprogram)	+ 0520	(mm)
Z	Z lifting height different from the parameter	0520	(mm)

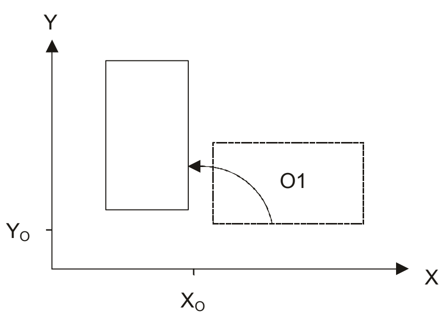
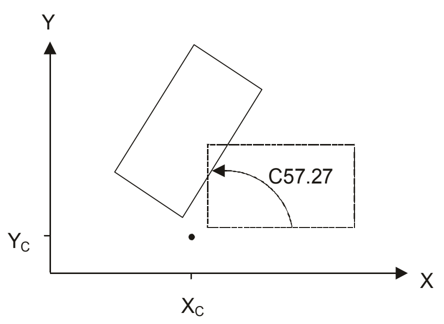
NOTE

If the "inches" unit of measurement has been selected in the <Machine set-up values> in the <SETUP> , the format of addresses I, J, R and X, Y, Z will be: (+) 0430 Inch.

The addresses not present in the table are not defined and are ignored by the control system. If typing errors are made, unexpected results may be obtained.

For the Q address no reasonable applications for Bystronic machines are currently known.

The Bytube software module in Bysoft calculates the Z height for a greater lifting height for tube rotation. The calculated Z height depends on the size of the tube being machined.

O address with rotation code	**C address with indication of degrees**
	

5.1.4 G-Functions

– For the addresses in brackets, the control system acquires the preset value, providing that no new values are entered on the keyboard.

– For all the addresses assigned, entry of numeric values on the keyboard is obligatory. Otherwise machining may be stopped (" memory error" message).

– Entry of M address is optional.

Indications about the single functions

At the G0 address, the control system detects the speed rate from the <positioning speed> parameter.

At addresses G1 to G3, the control system detects the speed rate according to the type of machining process (G10 - G12) from the Cutting, Engraving or Welding parameters.

Bearing in mind this rated value, the system calculates the speed on the basis of the following factors:

– <acceleration factor>

– <dynamic factor> and <angular tolerance>, providing that these parameters are activated

At addresses G11 (engraving) and M16 (reduced power) the control system uses fixed values for the following special parameters, irrespective of the preset values:

Critical angle dwell time	**175**
Angular tolerance	**0.08**
Acceleration factor	**1**
Acceleration factor, initial cut	**1**

Summary of the G functions

The next page shows a list of the G functions.

5.1.5 List of G Functions

Code	Allocated. address	Description
0	XY	Positioning
1	XYM	Straight-line
2	XYRM	Clockwise circular arch (start, end and radius)
3	XYRM	Counter clockwise circular arch (start, end and radius)
2	XYIJM	Clockwise circular arch (start, end and centre)
3	XYIJM	Counter clockwise circular arch (start, end and centre)
4	M	Machine control without movement of the axis (z.B. G0 X50 Y100
(10)		Cutting (Default value, to be programmed only in the re-changeover from the engraving or the welding). With the G10 function together with S1 or S2, a process macro is activated.
11		Engraving
12		Welding
(17)		Machining of the workpieces in the XY plan (input values to be programmed only for the re-changeover of the rotation axis)
20		Machining of round tubes with the rotating axis
23		Machining of tubes with rectangular section with the rotating axis
28	XYL(P)	Start of the subprogram for the single template
29	XY(P)H(A)(F)(Q)	Start of the main program
40		Delete tool radius compensation
41		Left-hand tool radius compensation
42		Right-hand tool radius compensation
51	(XY(R)(U)(Z)	Main program origin co-ordinate
52	XY(R)(Z)LO(T)C	Coordinates of the 0-point of the subprogram (which refer to the 0-point of the main program) O and C are mutually exclusive
85	XYRU	U axis, corners, no X movement or proportional movement (R is a rounded calculated radius, U is a plan of destination)

Code	Allocated. address	Description
86	XYRU	U axis, corners, cross input and linear output (R is a rounded calculated radius, U is a destination plan)
87	XYRU	U axis, corners, linear input and cross output (R is a rounded calculated radius, U is a destination plan)
98		End of the subprogram
99		End of the main program

5.1.6 M Functions

Code	Meaning	Validity	Active before or after the G function
1	Programmed interruption with <STOP SELECT>active	single record	after
4	Machining on	all	before
5	Machining off	all	after
6	Lowered positioning on	all	before
7	Lowered positioning off	all	after
8	Cooling water on	all volatile	before
9	Cooling water off	all volatile	after
10	Sensing OFF	all	before
11	Sensing ON	all	after
12	Pulse mode cutting on	all	before
13	Pulse mode cutting off	all	after
14	Pulse piercing on	all	before
15	Pulse piercing off	all	after
16	Reduced power	M4 a M5	before
17	Dwell	single record	before
18	Piercing without piercing time by taking in to account the parameters <Gas ramp, CW piercing / cutting> and <Acceleration factor, lead-in>	single record	before

Code	Meaning	Validity	Active before or after the G function
19	Interruption on auxiliary message	single record	before
20	Interruption off auxiliary message f	single record	after
21 - 28	Storage location Bysmart		
30, 32	Free functions, changeover	record/volatile	before
31, 33	Free functions, changeover	record/volatile	after
40, 42	Free functions, confirmed	single record	before
41, 43	Free functions confirmed	single record	after
50, 52	Free functions, confirm / <CONT>	single record	before
51, 53	Free functions, confirm / <CONT>	single record	after
80	Microbar		after

Validity of the M Functions

Record

The function is active for the record that contains it.

Global

The function is active starting from the record that contains the "On" command, until the record that contains the "Off" command.

Dynamic

The function is associated with an external signal, which may arrive even while a G address is being processed (see the example in the following "free functions" section).

Free Functions

The free functions are used for coordinating the specific customer processes and tools with machining on a laser beam machine.

A large number of applications may be imagined. Some examples are provided below to explain the functions.

Switching

These functions have a similar effect to the "Cooling water On/Off" functions (M8 and M9)

– In combination with records G1 to G3, these M functions have a dynamic effect. Even M numbers are activated before the record, while odd M numbers are activated after the record.

– Before M4, after M5 and in combination with G4, these commands have a static effect.

Example of how a dynamic M function is used: a clamping chuck for a welding is equipped with proximity sensors to prevent collisions with the machining head. When the head moves close, the chuck opens and when the head moves away, the spindle locks.

Confirming

These functions have a similar effect to a "supplementary signal interruption".

They always cause an interruption in the machining sequence. The latter is resumed when the confirmation signal is given. If necessary, the cutting operation is interrupted and the cut ends. M42/43 lift the tool to the maximum Z height.

Example of how to use an M function with confirmation: external drill. At the end of a drilling operation, the drill emits the confirmation signal.

Confirming or <CONT>

These functions have a similar effect to an "optional stop", but are independent of <STOP SELECT>.

They always cause an interruption in the machining sequence. The latter is resumed when the confirmation signal is given. If necessary, the cutting operation is interrupted and the cut ends. M52/53 cause the tool to be lifted to the maximum Z height.

Example of how an M function is used with confirmation or <CONT>: external quality control in unattended machining, by measuring the temperature. If the maximum allowed temperature is exceeded, machining is interrupted until the confirmation signal is given.

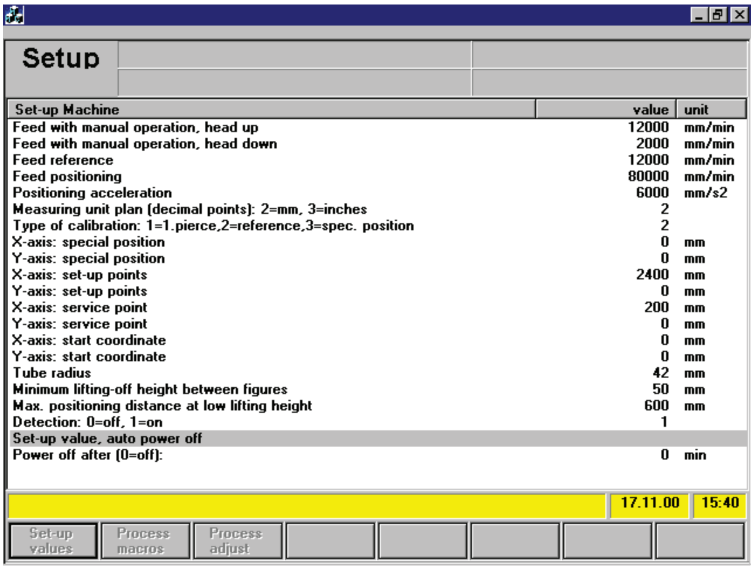
5.2 Explorer

This function comprises all the functions of Windows 95 Explorer and is used, in particular, for copying, moving, renaming, searching for and deleting data. In order to use it, familiarity with Windows 95 is required.

5.3 Param

Enables the user to create, modify and store parameters that have no influence on the cutting process in progress. This data is not transferred to the computer numeric control system.

6. SETUP



This menu is displayed when the <Setup> key is pressed. The Set-up menu contains the set-up parameters for the machine, laser, edge detection system and microjoints, as well as the set-up parameters for any machines with optional equipment (for example, it contains characteristic curves if the machine is equipped with flying optics). The menu is composed of a number of pages which can be scrolled backwards and forwards using the Page Up and Page Dn keys.

6.1 Set-Up Machine

Feed with manual operation, head up:

(mm/min)

Feed for rough positioning in manual mode, head in reference position.

Feed with manual operation, head down:

(mm/min)

Speed for fine positioning and for machining in manual mode with the head lowered. Activated, as long as <Z-> is actuated. If <BURN> is actuated supplementary, change automatically to value „Feed continuous operation“ of processing parameters.

Feed reference:

(mm/min)

Speed during movement to reference. This type of feed is limited to 30 m/min with a view to limiting the stress on the guides during the stopping phase.

Feed positioning:

(mm/min)

Speed during positioning, automatic set-up and movement to the 0 point. This feed is limited by the control system to 130 m/min. This type of feed is not active in manual mode.

Positioning acceleration:

(mm/s^2)

This value is valid for the x and y axes within the indicated range.

Measuring unit plan:

2 = MM

Unit of measurement in mm

3 = INCHES

Unit of measurement in inches. A plan with the "inches" unit of measurement is converted for machining into the "mm" unit of measurement (the measurements are displayed, however, in inches). In extreme cases, this conversion may cause errors due to rounding.

Type of calibration:

1 = 1.pierce

Calibration to point for first piercing operation specified in the plan

2 = reference

Calibration to reference point

3 = spec.position

Calibration to preset position

X-axis: special position:

(mm)

X value for presetting the special calibration position

Y-axis: special position:

(mm)

Y value for presetting the special calibration position

X-axis: set-up points:

(mm)

Distance of set-up positions in the X direction. This value is necessary to set up the laser beam (automatic set-up).

Y- axis: set-up points:

(mm)

Distance of set-up positions in the Y direction. This value is necessary to set up the laser beam (automatic set-up).

X- axis: service point:

(mm)

Distance between the service point and the machine's starting point.

Y- axis: service point:

(mm)

Distance between the service point and the machine's starting point.

X- axis: start coordinate:

(mm)

Distance between the starting point of the plan and the starting point of the machine. If the plan contains a G51 address, the <X axis, initial coordinate> function is ignored.

Y- axis: start coordinate:

(mm)

Distance between the starting point of the plan and the starting point of the machine. If the plan contains a G51 address, the <Y axis, initial coordinate> function is ignored.

Tube radius:

(mm)

Preset value for the radius of the tube during machining with a rotating axis. The control system reads the actual radius of the tube for conversion of the Y coordinates into rotary movements by the cutting plan.

Min. lifting-off height between figures:

(mm)

This set-up value defines the lift-off height when positioning between two figures. This improves process reliability.

max. positioning with reduced height:

(mm)

This value delimits the positioning path with a reduced height or no height distance. If the parameter value <max. positioning with reduced height> is overrun, so the end cut will be made with parameter hight <min. lifting-off height between figures>. This limitation only applies to flat cutting and not to tube cutting. Downward positioning does not apply to this path. With a flying end of cut, the height will be the distance between the shapes during positioning. This also applies to the flying start of cut and, in this case, the initial cut is sufficient to move downwards. The parameter is only static and is only read when the NC program is started. Changing it during the cutting process has no effect.

Detection:

0 = off

Cut without height detection. The tool is positioned in absolute mode at the desired height. This height is calculated on the basis of the current parameters: absolute height = thickness of material + nozzle distance.

1 = on

Cutting with capacitive height sensing.

6.2 Set-up value, auto power off

Power off after:

0 = off

Automatic power off takes effect as soon as this parameter is set to any value greater than zero

Condition

– all cutting plans executed

– Cutting head in reference position

(for further details, see Machining area of the Operator's Manual.)

NOTE

Before starting up the machine, the parameter must be reset to zero.

Stacking:

0 = off

1 = on

Only active if a loading/unloading unit is present.

6.3 Set-Up Laser

For a description of the terminology used, see the "Laser" section. Meaning of the single set-up values:

Laser: 0=off, 1=Standby, 2=on, 3=automatic:

0 = off

Switches the laser off and remembers the previous switch setting (1-3)

1 = Standby

Follow cutting plan but without laser, e.g. for test purposes

2 = on

Switches on laser manually

3 = automatic

With this setting the laser is powered up automatically after switching on the main switch on the machine.

Pulse width, single pulse:

(ms)

Duration of a single pulse. This value is necessary to determine the focus position and to center the nozzle.

Laser power, single pulse:

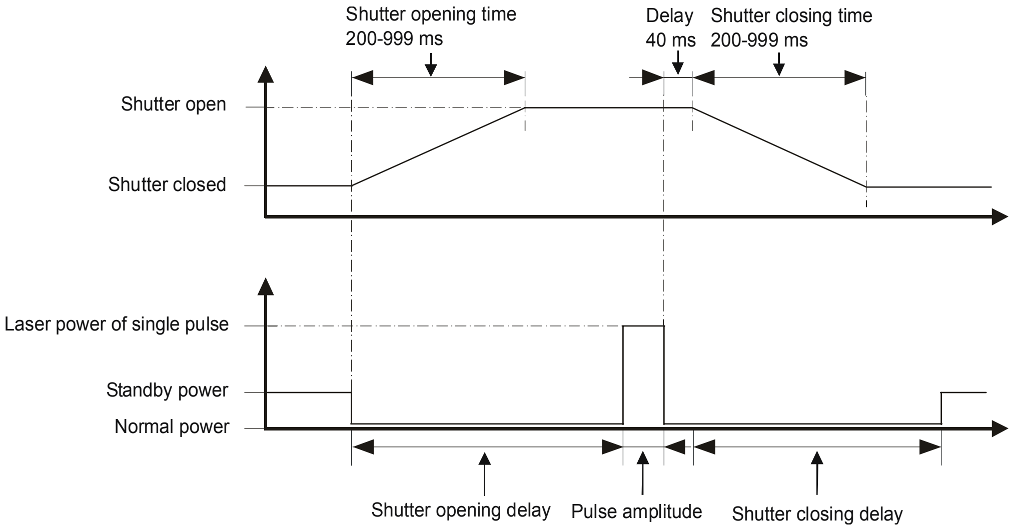
(%)

Laser power of a single pulse. This value is necessary to determine the focus position and to center the nozzle.

Delay time, shutter open/closed:

(ms)

Delay time between the opening of the shutter and the increase in laser power from normal power to the preset value (piercing, cutting, pulse). This delay time is necessary to open and close the shutter and depends on the air pressure present. Check the minimum value of this parameter for your machine, increasing it gradually with a lower pulse power and comparing it with the burnoff mark. The maximum burnoff indicates that the shutter is completely open (see nozzle centering).



Delay time before lowered positioning:

(ms)

Delay time between end of cut and the positioning process. This time is necessary during positioning without lifting the head. During this time, the laser power is reduced to a value to avoid cutting tracks during positioning.

6.4 Set-up values purge gas

Min. purging pressure after change of gas type:

(bar)

If the gas channel is changed in any phase of the process, here the washing gas pressure can be adjusted. A wash cycle is also performed after a change in the cutting gas activated by a process macro.

Min. purging time after change of gas type:

(s)

If the gas channel is changed in any phase of the process, here the washing time can be adjusted. A wash cycle is also performed after a change in the cutting gas activated by a process macro.

Waiting for flushingpressure beeing reduced to initial pressure*factor

Check the pressure value set and wait until the pressure drops to the desired value. The delay is up to 3 seconds. The maximum value is equal to the initial cutting pressure multiplied by a factor of 1.2 - 99. The factor 99 does not produce a delay time.

The gas used is always the one used for the last cut or manual mode. During the cut, the stand-by gas channel is automatically determined with piercing from the next activity. Positioning takes place when the gas is changed to the new gas. Providing that the minimum washing time is not (0), the wash starts with <Min. purging pressure after change of gas type> during positioning. The washing time after the next pierce is thus reduced, providing that another gas change is not made after piercing.

Pre-purging time after interruption

(ms)

To protect the lens, a preflush operation can be performed after each stop in the cutting process. The pressure and type of gas used depend on the subsequent piercing procedure.

6.5 Set-Up Values Edge Detection

To identify the position of the part in flat machining by sensing the edge of the part:

– The plate does not have to be oriented using the positioning marks

– Less stress on the supporting grid with heavy plates

– No scratches are made on the part

One condition is that the dimensions of the plate correspond at least to the dimensions specified in the plan (G29).

The edge detection path starts at a length set in the "detection increase" parameter (see figure). The control system calculates the starting point of the plate, according to the edges sensed, and, depending on the value of the "detection" parameter, also the angle a of the part with respect to the axes. The system positions the corner point of the machining plan (G51) at the calculated starting point of the part and rotates the machining plan, if the angle a has also been calculated.

The "X and Y axes, initial coordinates" parameters between the "machine set-up values", and any distance of the starting point with the G51 address in the machining plan are ignored.

Execution of detection

1. movement to the reference point

2. calibration of sensing device

3. edge sensing

4. movement to starting point of the plan.

As far as the quality of the plate is concerned, make sure that the plate has clear-cut and, if possible, vertical edges, if a high sensing precision is required. If <INHIBIT> has been activated, the starting point is determined on the first plate only. The angle a and movement to the starting point remain unchanged.

If your system is equipped with positioning arms, block the positioning function (see the "machining area" section).

Detection:

0 =off

No edge detection

1 = X

Left edge detection only in X direction. It is the fastest type of detection. Use when loading from the plate-holding table, if the plates are pushed on the table to the marks.

2 = X/Y

Detection of starting point in X and Y directions. Detection with two sensing paths. Use with loading systems in which the rotation of the plate with respect to the machine axis is negligible.

3 = X/Y/angle

Detection of starting point in the X and Y directions and calculation of the angle of rotation a. Use with manual loading or by means of the lifting unit, or when a high degree of precision is required in the parallelism between the cut and the edge of the part. One point of the position of the edge is sensed at the center of the shortest edge, together with two points on the longest edge of the part.

Sheet loading:

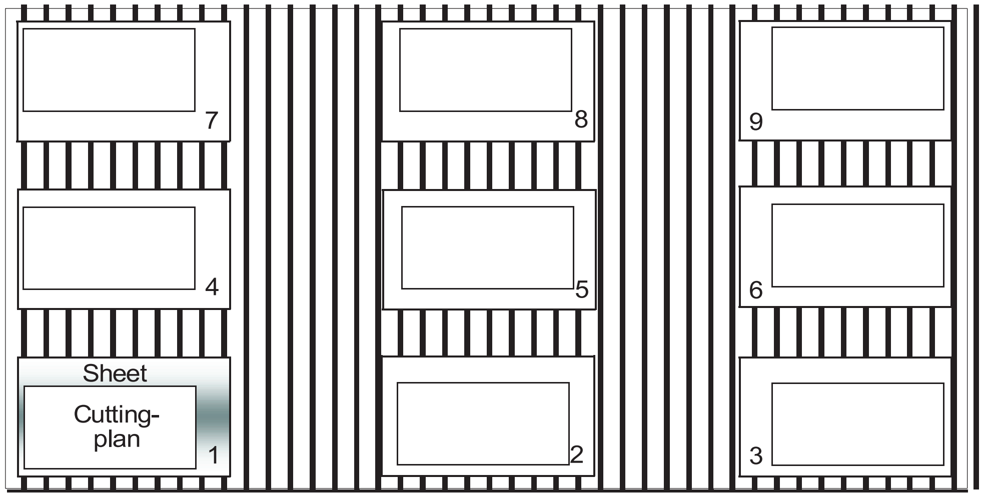
A configuration value for material requests to the transport system (PLC) causes the material data for loading a new sheet to be transmitted from the MMC via the CNC, as happens for operation with the sheet storage system, but independently of it

If a request for material to the transport system (PLC) is active, an extension of an initial X- and Y- coordinate must be executed as block G51. If sheet edge detection is active, the coordinates are calculated, according to the type of table loading, by the set-up and configuration (PLC). The sheet storage system and PLC material request configurations may only be selected if the CNC is equipped with the 2, DIOCOM.

Table loading with sheet edge detection may be performed from any angle or even at the centre of the cutting table. Detection is however always carried out at the bottom left-hand corner of the table.

number	**loading**	**number**	**loading**
1	front left	**6**	middle right
2	front middle	**7**	back left
3	front right	**8**	back middle
4	middle left	**9**	back right
5	middle middle		

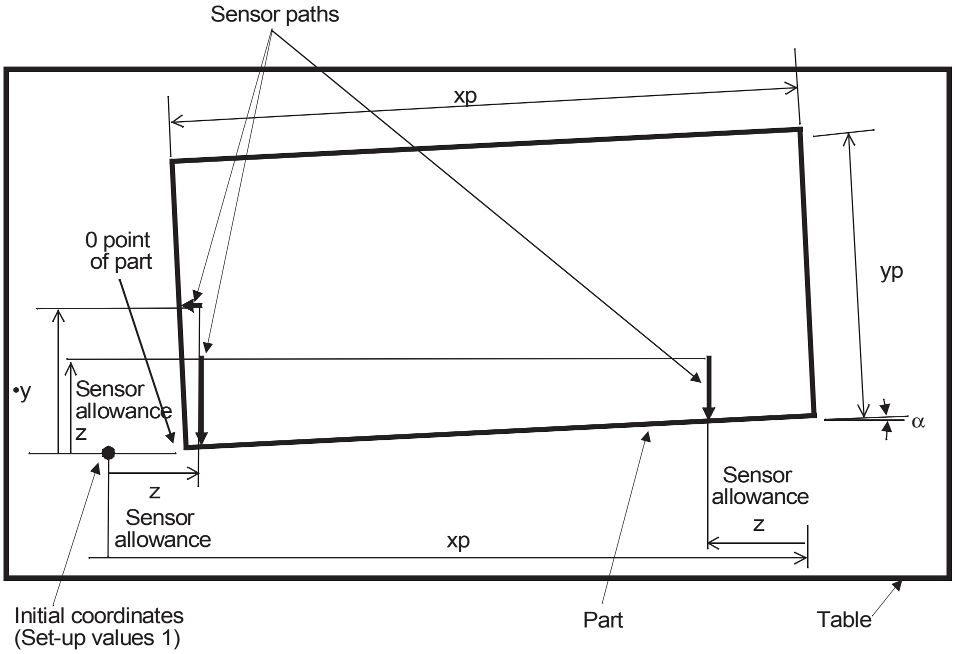
Cutting table



Sensor allowance:

(mm)

Detection starts on the part to be machined and moves towards its edge (detection path). The increase z comprises the position tolerance of the plates on the stack and the loading tolerance. The value must be less than the G29 measurement of the plan.



X-distance, scanning device:

(mm)

As, on the edge of the part, only half the nozzle is positioned on metal material, the capacity changes with respect to detection on a continuous surface. The parameter comprises this offset caused by edge sensing (standard value, see test protocol). This parameter enables a machining distance from the edge to be created, if the cutting plan does not specify this distance (in the G52 address).

Y- distance, scanning device:

(mm)

Similar to the X distance.

Scanning feed:

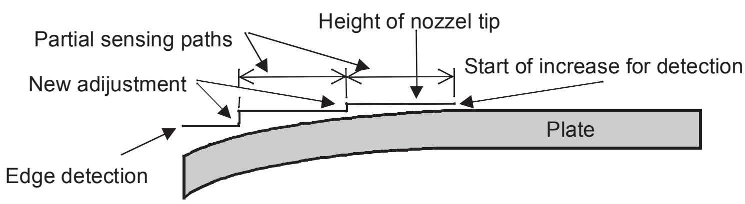
(mm/min)

Maximum speed allowed during detection. The lower the speed the more precise detection will be.

Scanning line section:

(mm)

Length of partial paths after which capacitive sensing readjusts the nozzle distance again. This readjustment enables plates that are not flat to be sensed. The special case "no adjustment" corresponds to the value 0.



To rationalize production, the increase for sensing should as small as possible, the detection feed as high as possible and the partial paths long, if possible. The optimum values must be determined by measurement.

Sampling tolerance:

(mm)

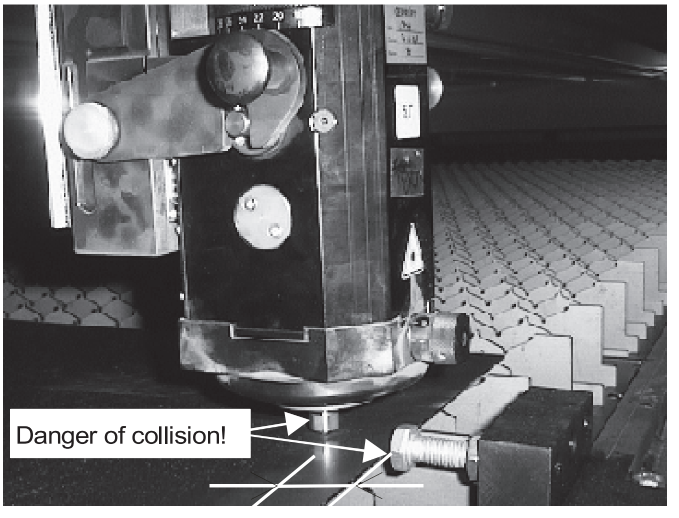
Edge detection with check-points is activated through <Sampling tolerance (0= no check points)> setup value.

In both X and Y directions an additional point is detected and compared to the edges as detected taking into account their position. Should one of the check-points deviate more than sensing allowance, detection is repeated on slightly displaced detection locations.

After three unsuccessful detection attempts, detection is stopped and the warning message <Warning: inaccurate sampling> is displayed. After 5-second warning, the cutting plan is run with the most accurate value of the 3 values as previously detected.

This process is applicable to zero-point sensing, as well as template sensing

	CAUTION
	Danger during edge detection with thin sheet!



Sheet distance (20 mm. Min.)

When the edge detection takes place near a metal sheet travel end there is danger of collision between the cutting head and the travel end.

Make sure that the metal sheet is at least 20 mm far from the travel end. In that way a collision between the cutting head and the travel end is avoided during edge detection.

6.6 Set-Up Values Microjoints

Microjoints prevent:

– the dropping or tilting of contours during automatic plate unloading

– the tilting of contours during positioning with the head lowered

– burning during end of cut while cutting stainless steel

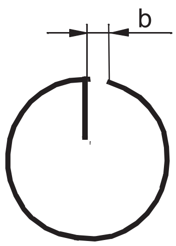
Function:

0 = off

Microjoints are not executed. Any microjoints programmed in the machining plan are ignored.

1 = on

Microjoint only as a supplementary function in the machining plan: M80 before M5 in any position between two geometrical elements. In this way, more than one microjoint is possible per contour. The geometrical element before M80 is shortened by the width b of the microjoint (see figure).



2= automatic

In contours with dimensions between the <minimum X dimension> and the <maximum X dimension> the control system automatically positions exactly one microjoint per cut. Before each detachment, the control system creates a microjoint, anticipating the end of the cut.

3 = weld bridge

A weld bridge is set instead of a microjoint. This parameter must be enabled before starting on the cutting plan. The <weld bridge> function is primariliy designed for thick sheet steel, where the thickness means that these parts cannot be removed, or only with difficulty, if microjoints are used.

Critical parts: X-dimension max.:

(mm)

Activated only with "2 = Automatic". If the microjoints are only used for preventing tilting, the webs are useless for X dimensions of more than twice the distance between the rack supports of the grid.

Critical parts: X-dimension min.:

(mm)

Activated only with "2 = Automatic". Parts smaller than the "minimum X dimension are considered "cutouts" that will not be subjected to further machining and will thus be eliminated by the small part conveyor.

If you want to stop these small parts from tilting or remaining on the table, the value must be less than the distance between the rack supports of the grid.

Critical parts: Y-dimension max.:

(mm)

Only active with "2 = Automatic". If the value is equal to 0, the direction is not taken into consideration.

Critical parts: Y-dimension min.:

(mm)

Only active with "2 = Automatic". Parts smaller than the "Min. Y measurement" are considered small parts (cut outs) which will not be processed further and will therefore have to be removed by the conveyor.

The parameters of the microjoints function that depend on the material (<microjoints width>, <type of piercing after microjoints>) are described in the <special parameters> Nozzel cleaning set-up values.

6.7 Set-up values for weld bridge

Microjoint welding complements microjoint cutting. Mixed mode use of microjoint cutting and welding is not possible. Microjoint welding can be performed with a laser power of 2.4 kW upwards, using either oxygen or nitrogen.

Welding with oxygen. (Structural steel)

The surface of the material is heated up and melts in the cutting gap. A weld point is formed of approximate size 6-8mm. Material thicknesses between 4 and 12mm are practical.

Welding with nitrogen: (Inox and structural steel with N_2)

The surface of the material is heated up and melts in the cutting gap. A weld point is formed of approximate size 2-3mm. Material thicknesses between 4 and 8mm are practical.

The same gas type should be used for welding as for cutting, otherwise the long purge times will reduce the advantages of welding.

You can define the parameters for microjoint welding using the set-up values. Microjoint welding is enabled under Setup, Microjoint set-up values, function: 3= weld bridge. Weld points are programmed using (M80/M81 microjoint).

Nozzle distance:

(mm)

Nozzle distance at the weld position

Default values: (in mm)

O_2: 50

N_2: 8

Offset from cutting gap into unwanted part:

(mm)

The weld point can be shifted from the center of the cutting gap into the waste piece by entering a displacement value. This minimises damage to the cut part caused by the weld point on the surface of the part.

Default values: (in mm)

O_2: 0.8

N_2: 0

Gas channel:

Weld gas type. Welding can be performed with oxygen or nitrogen.

Gas pressure:

(bar)

Gas pressure during welding

Default values: (in bar)

O_2: 0.2

N_2: 0.1

Laser power:

(%)

Laser power during welding

Default values: (in %)

BTL:	**2.4**	**3.0**	**4.0**
O_2:	100	85	60
N_2:	45	35	25

Welding time:

(s)

Time spent by the laser beam making the weld point on the material

Default values: (in s)

BTL:	**2.4**	**3.0**	**4.0**
O_2:	0.5	0.4	0.4
N_2:	1	1	1

Overcut:

(mm)

The overcut is the cutting distance travelled beyond the programmed weld bridge before the laser makes the weld bridge.

Default values: (in mm)

O_2: 25

N_2: 6

Retraction path before interrupt:

(mm)

Restart point before welding interrupt

Default values: (in mm)

O_2: 0

N_2: 0

Acceleration factor:

(m/s²)

Acceleration factor when approaching in cutting gap

Default values: (in m/s^2)

O_2: 3

N_2: 3

Gas ramp CW:

(s)

CW gas ramp when approaching in cutting gap

Default values: (in s)

O_2: 0

N_2: 0

6.8 Set-Up Values Nozzle cleaning

Manual activation of nozzle cleaning

For manual activation, select <Service> and, if necessary, <Stop>. Once the maintenance position has been reached, the cleaning process can be started by repeating the <Service> function.

Number of cleaning passes:

The nozzle is cleaned by passing x times on the brass brush. During the cleaning process, the cutting gas is activated. Once cleaning has been completed, reset the calibrating plate.

Clean at end of cutting plan:

0=off

At the end of the cutting plan, the nozzle is not cleaned.

1=on

The nozzle is cleaned before moving to the reference point, at the end of the cutting plan.

Clean after x pierces:

0=off

During execution of a cutting plan, the nozzle is not cleaned.

>0=on

The nozzle is cleaned after the number of piercing operations specified in the parameter.

Distance Z-reference -cleaning height:

(mm)

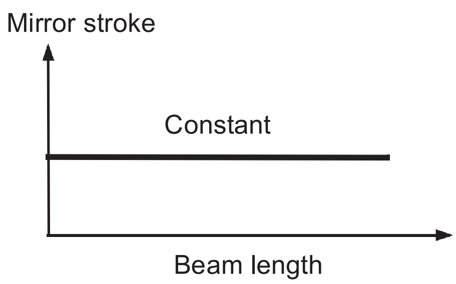
This value defines how far the cutting head is to be lowered with respect to the reference position, to clean the nozzle.

6.9 Set-Up Values Adaptive Optics 1

Operating mode:

0 = Fix

The mirror lift specified by the parameter Fixed mirror lift for operating mode= 0 is adopted

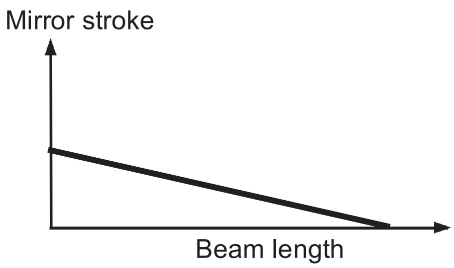


NOTE

No characteristic curve is followed.

1 = focus correction

In operating mode 1, mirror lift correction is used to compensate for the variation in focal point position as a function of beam length within the cutting range. These mirror lifts are saved in the five characterisitc curve points. See "Characteristic curve" in the Setup menu



NOTE

Compensation follows the characteristic curve

2 = focus correction + focus position

In operating mode 2, one only needs to manually add the Focal position, cutting head parameter (dependent on cutting head (focal length)) given in the Set-up values, adaptive optics (Setup) to the focal point reference position (focal point at nozzle tip). All necessary settings and corrections are then performed by the CNC.

The CNC takes into account the following values:

– Focal length from the cutting head characteristic data (Param menu)

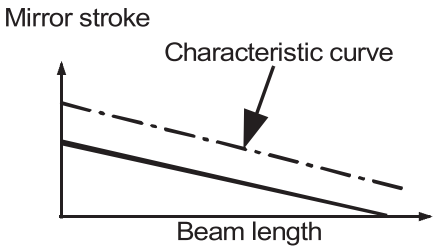
– Focal position from the cutting head characteristic data (Param menu)

– Nozzle distance from the currently enabled parameters (Param menu)

– Lift/focus change for optical system (Setup menu)

– Focal position, cutting head of optical system (Setup menu)

– Instantaneous mirror lift to be generated from characteristic curve (setup menu)



NOTE

Compensation follows the characteristic curve plus focal point correction

Fixed mirror lift for operating mode = 0:

This value is used to define the fixed mirror lift for operating mode 0, whch is used for sevicing purposes. A negative lift (<0mm) produces a concave mirror, a mirror lift of 0mm generates a flat mirror and a positive lift (>0mm) creates a convex mirror.

Characteristic curve:

The characteristic curve is used to compensate for variations in the position of the focal point (dependent on the beam property) over the whole cutting range. The Maintenance folder contains more precise details on how to adjust this compensation curve. The beam length begins 400mm outside the effective cutting range. Five points on the characteristic curve are taken at regular intervals along the whole beam path. Points 2, 3, 4 and 5 are adjusted using mirror lift correction to give the focal point position of point 1.

Lift/focus change:

(µm/mm)

This parameter is defined by the type of adaptive mirror used and by the focal length chosen. It is used by the CNC in operating mode 2 to convert all values dependent on the focal point position (in mm) into a lift in mm.

Focal position, cutting head:

(mm)

In order to be able to generate the whole range of focal point positions (dependent on the focal length) using the mirror lift, the negative mirror lift range must also be taken into account. This is achieved by adding this value to the cutting head reference position, and then the CNC compensating by taking off the lift value.

6.10 Set-Up values CutControl

CutControl / Process control

CutControl monitors the cutting process in the CW normal operating mode. Piercing, pulsing, engraving, pre-burning and macros are not monitored. Process control begins, depending on the initial cut and/or operation start, after an <HALT> and stops after before the end of cutting. It does not affect any process characteristics, such as modulation, angular feed rate, etc. Any changes in CutControl values can be activated only after the next control cycle, as they may be forced through <HALT> or a calibration operation.

Process control runs based on the light emitted by any work-piece. The light emitted by the work-piece is sensed on a mirror through three Si-detectors. The mirror and detectors are mounted in the sliding element of the cutting head. The cutting heads are provided with suitable adhesive labels.

CutControl applications

CutControl is suitably used for materials of thickness as follows:

- 1-12mm thick stainless steel
- 1-6mm thick steel

Determining calibration threshold:

The calibration process is started during a proper cutting in either cutting or manual mode by setting <Calibration during cut> parameter in <Setup> menu to 1. When performing calibration, a signal is captured every 20 ms and added to calculate the mean value. After a short time (about 2s) the determined value is recorded by the control system on the right-hand side of the same line. This is the calibration threshold for the material in question. This value can be also repeatedly determined, for checking purposes. Then this value shall be manually entered in <Calibration threshold gaschannel 2> parameter in the <Param> menu. As a rule, the determined value does no more significantly change and therefore shall be repeatedly verified for checking purposes only.

A new calibration value is to be determined whenever any another material grade or type of surface are to be cut.

When calibration is completed or after early interruption of cutting, the setup value will be automatically reset (= 0).

Set-up values for calibration thresholds

Material thickness [mm]	Stainless steel	Structural steel
1	300	300
2	300	300
3	300	300
4	300	350
5	300	400
6	350	450
8	450	-
10	480	-
12	550	-

CutControl: 0=off,1=on:

Cutting without/with process monitoring

Calibration during cut: 0=off, 1=trigger:

Base signal determination in case of proper cutting in either cutting or manual mode.

Calibration threshold gaschannel 1 (Display):

Determined basic signal of proper cutting with gas channel 1(O2).The calibration threshold values cannot be exceeded; they are used to display the values as determined through calibration. These values must be manually transferred to the parameters and the parameters must be stored.

Calibration threshold gaschannel 2 (Display):

Determined basic signal of proper cutting with gas channel 2 (N2).The calibration threshold values cannot be exceeded; they are used to display the values as determined through calibration. These values must be manually transferred to the parameters and the parameters must be stored.

6.11 Set-up values for edge detection with CutControl

More accurate edge detection is achieved by using Cut Control. When Cut Control is employed, the following steps are performed in addition to capacitive edge detetion:

– After capacitive edge detection the machine moves approximately 5 mm beyond the edge of the sheet.

– The laser is switched on with Detection laser power and Detection gas pressure enabled

– The laser is moved backwards until the laser beam touches the sheet edge

– The machine stops in this position and saves the detected reading found using Cut Control

– The machine travels to the next edge detection location

Detection with CutControl:

(0=off, 1=on)

Edge detection with Cut Control on/off

Detection feed:

(mm/min)

Feed rate during detection

Detection nozzle distance:

(mm)

Optimum nozzle distance for an accurate signal

Detection gas channel:

Gas type for detection

Detection gas pressure:

(bar)

Gas pressure during detection

Detection laser power:

(%)

Percentage laser power during detection

Detection level:

Minimum signal level for sheet detection. An error can arise if the detection point lies on a support grid.

7. Comments on NC Programs and System Messages

7.1 Comments on NC Programs

Comments on NC programs are used to provide information and extend system data detection (BDE).

The comments are based on a record (G function). They may be added after the record, on the same line or on the next line. They may even be inserted in the record, between the words, but not within words. A word inside the record is intended to mean a character followed by a number, e.g. G1, X15, M4 .

The use of comments is subject to the following limitations:

– Comments inserted before the first record are not used.

If the record contains more than one comment, only the last one is used.

– Due to the attribution of comments, cutting plans containing comments on the activation of subprograms (G52) cannot be processed in inverse mode (incorrect placement of comments)

7.1.1 Valid comments

– N1002G1Y15M4 (piercing 1)

– N1005G2X10.5Y0 (arc of circle)

– N1100(hole 3)G3X10R30M4(complete)M5

7.1.2 Invalid comments

– N1120G3X(X value)10.3Y15R2(radius)00M4

7.1.3 Validity of comments displayed

Generally, comments are activated in static and flying mode after the corresponding record, but before any M functions, except for G52 records, subprogram calls, G98 and G99 records, end of subprogram and main program, which are activated before the corresponding record.

The comments remain unchanged until:

– Entry of a new comment, even a blank string ()

– End of main program or subprogram.

– Confirmation of a selected stop (M1), an interruption (M19/20), an additional signal (M40-53).

7.2 System Messages

A list of laser control system messages is provided in the "Laser" section.

WARNING

All work on electrical systems shall be restricted to qualified electricians observing applicable regulations and codes of practice.

7.2.1 System Error Status

The system error status indicates system faults or errors. The system will not work.

System Messages	Cause	Remedy
Controller not ready	Intermediate circuit voltage cannot be switched on now	Check fuse switch F2 Reset CPU
Drives not ready	Servosystem fault.	Press the CPU e Servo reset key in the CNC control cabinet
Emergency off external	One of the "EMERGENCY STOP" buttons has been pressed The machine's safety chain has been activated	Release the pushbutton by rotating it, switch off the resonator control system using the key-operated switch and press the <RESET> key on the control cabinet of the SPS.
Drives locked	Safety door open Key-operated switch in left position	Close safety door Turn the key-operated switch to the right position

7.2.2 System Warning

The system warning indicate system faults or errors. The system will not work to its full potential.

System Messages	Cause	Remedy
Warning: Bypos error	Adaptive optics faults in operating mode 0=fix generate only this error message: they do not generate any emergency stop.	Emergency mode operation. After correction of a Bypos-fault, enter operating mode 1 or 2.
Warning: inaccurate sampling	Required accuracy was not attained in edge detection with check-points. In subsequent machining the values with the smallest deviation are used.	Machining is automatically resumed after a 5 second pause. The process can be terminated during this interval if the required tolerance is not achieved.
Gas warning	Difference between current and necessary gas pressure less than 1 bar	Check the gas supply and replace the cylinder identified
W-axis warning:frequency outside tolerance	The free oscillation frequency of the capacitive device for adjusting the W axis before calibration does not lie in the allowed frequency range.	Call Bystronic Customer Services
Warning: park crossjet	The Crossjet is in the working position but is not being used at the moment.	Park the Crossjet.
CutControl: plasma formation	The CutControl has detected plasma	Adapt the parameter (not compulsory)
CutControl: cutting problems	The CutControl has detected some cutting problem. (Plasma)	Adapt parameter, clean the cutting head (not compulsory)
PLC transport fault	Operation with sheet storage system: the transport system driven by the PLC signals a fault at the input or output.	Eliminate the fault in the transport system.

7.2.3 Wait State

The wait state refers to situations that terminate on their own or are terminated by means of a signal from the PLC or when the <CONT> key is pressed.

System Messages	Cause	Remedy
Waiting for stops	The mechanical travel ends (if present) are made to withdraw.	
Waiting for material	Machining process continuing without automatic exchange of shuttle table	Continue machining by pressing <CONT> Abort machining by pressing <ABORT> Press <Mat Pos> on the console
Waiting for stacking	Operation with Bysort. The unloading plan is sent.	If transmission errors occur repeatedly, the function may be aborted by pressing the <ABORT> key
Waiting for cutting data	The control is waiting for the NC program	
Move to reference	The system moves to the reference point This message appears as a warning before movement to the reference point in manual mode.	Start the movement by pressing <CONT> Abort the procedure by pressing <ABORT>
Move to zero point	The system moves to the starting point This message appears as a warning before movement to the zero point in manual mode.	Start the movement by pressing <CONT> Abort the procedure by pressing <ABORT>
Optional stop M01	The system has stopped at a stop programmed by M1, if the <STOP SELECT> function is enabled. Confirmation given via the PLC or manually.	Continue machining by pressing <CONT> Abort machining by pressing <ABORT>
Waiting for additional signal M19/ M20	The system is at a programmed stopping position (M19/20,M40 - M53) Confirmation given via the PLC or manually.	Continue machining by pressing <CONT> Abort machining by pressing <ABORT>

System Messages	Cause	Remedy
Restart seam detection	The tube handler is trying to detect the weld bead	only if optional tube handlers are available
Wait for upper seam detector	Weld bead detector raised	only if optional tube handlers are available
Wait for end of laser manual operation	The laser is still in manual mode at Start Work, or when enabling CNC manual operation	Switch laser to CNC operation via laser controller.
Wait for laser to be ready	The laser is still powering up at Start Work, or when enabling CNC manual operation	Wait or terminate Start Work with ABORT. Manual operation is not possible without laser functions

7.2.4 Stops

Stops are requested from the machine keyboard and must always be confirmed by pressing <CONT>, external <CONT> or <ABORT>.

System Messages	Cause	Remedy
Stop service	This message only appears when the axes are in their service position.	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.
Interruption stop	This message appears when the axes have stopped following a <HALT> command	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.
Stop cycle	This message appears when the axes are in their reference position	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.
Stop part	This message appears when the axes are situated at the 0 point of the next part	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.
Stop work	This message appears when the axes are at a halt before or after the following machining step.	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.
Stop at origin	This message appears if <HALT> was initiated during <Stop Cycle> The axes stop at the zero reference point of the cutting plan.	The zero reference point can be offset in manual operation. <CONT> to continue or <ABORT> to terminate

System Messages	Cause	Remedy
Stop for contour capture	This message appears after a restart with contour lock-on, as a prompt to move to the restart point manually.	After selecting the restart point: <CONT> to continue or <ABORT> to terminate
Single step	This message appears when the program is processed in single steps (line by line)	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.

7.2.5 Confirmations

Confirmations have the purpose of ensuring the safety of the operator and the machine and are given by pressing <CONT>, external <CONT> or <ABORT>.

System Messages	Cause	Remedy
Forced continue	Confirmation, using <CONT>, of: Wait for material Stop when requested using M01 Wait for M19/M20 supplementary signal	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.
Inverse work not possible	If the entire plan consists of a single contour, the INVERS key cannot be used	Program single sections of the contour in the form of subprograms
Axis movement OK?	Confirmation of movement in manual operating mode: Travel to reference point Travel to starting point Movement of axes during automatic set-up	Confirm the message by pressing <CONT> to continue or <ABORT> to abort.

7.2.6 Emergency Stop

An emergency stop aborts the cutting process and manual operating mode. Confirmation must be given by pressing the <ABORT> key. In some cases, a Restart may be executed.

System Messages	Cause	Remedy
Emergency off internal	The <STOP> key has been pressed The machine's safety chain has been activated	Press <ABORT> on the MMC
Emergency off external	One of the "EMERGENCY STOP" buttons has been pressed The machine's safety chain has been activated	Release the pushbutton by rotating it, switch off the resonator control system using the key-operated switch and press the <RESET> key on the control cabinet of the SPS
Stop by laser	Laser not ready The pressure switch of the resonator has been activated Insufficient chilling water flow rate	Wait for "Laser Ready" on display of the Laser control or switch off the Laser with the key, if it is not to be used. Check compressed air supply Check chilling
Stop by crash	During cutting, the nozzle has touched the sheet or the nozzle is dirty Tactil ringsensor broken off	Check the nozzle distance, clean the nozzle Replace ring
Stop by limit switch X+	The X+ travel end has been exceeded and machining has been aborted (e.g. due to coordinates situated outside the work area)	Confirm using <ABORT>. A Restart cannot be executed. Return from travel end in manual mode.
Stop by limit switch X-	The X- travel end has been exceeded and machining has been aborted (e.g. due to coordinates situated outside the work area)	Confirm using <ABORT>. A Restart cannot be executed. Return from travel end in manual mode.
Stop by limit switch Y+	The Y+ travel end has been exceeded and machining has been aborted (e.g. due to coordinates situated outside the work area)	Confirm using <ABORT>. A Restart cannot be executed. Return from travel end in manual mode.

System Messages	Cause	Remedy
Stop by limit switch Y-	The Y- travel end has been exceeded and machining has been aborted (e.g. due to coordinates situated outside the work area)	Confirm using <ABORT>. A Restart cannot be executed. Return from travel end in manual mode.
Stop by limit switch Z+	The Z+ travel end has been exceeded and machining has been aborted (e.g. due to positions outside the movement path)	Confirm using <ABORT>. A Restart cannot be executed. Return from travel end in manual mode.
Stop by limit switch Z-	The Z- travel end has been exceeded and machining has been aborted (e.g. due to positions outside the movement path)	Confirm using <ABORT>. A Restart cannot be executed. Return from travel end in manual mode.
Stop by axis limitation, bridge	The crossbar has had a collision and broken the safety chain.	Move the bridge by hand out of the limit position (mechanical knob-operated switch) Then reset the CPU and bridge servo.
Stop by axis limitation, carriage	The carriage has had a collision and broken the safety chain.	Move the carriage by hand out of the limit position (mechanical knob-operated switch) Then reset the CPU and carriage servo.
Stop by gas jet error	The gas pressure is below the required level.	Confirm by pressing <ABORT> and replace the corresponding gas cylinder.
Stop since crossjet not in position	The Crossjet has been torn	Confirm by pressing <ABORT> and replace the Crossjet.
Stop due to W-axis frequency error	The frequency of the capacitive device for adjusting the W axis is too low. The lowering process has been stopped.	Confirm by pressing <ABORT> Check the cutting head in particular for any moisture present.
Stop because controller not ready	PLC not ready for operation (CNC)	Confirm by pressing <ABORT> and inform the Bystronic customer engineering service.

System Messages	Cause	Remedy
Stop because drives not ready	Servo device faulty.	Press the reset key in the CNC control box, on the CPU and on the Servo device
Stop by safety cir-quit failure	Safety door open Key-operated switch set in left position	Confirm by pressing <ABORT> and check the safety door and the key-operated switch
Stop by Watchdog, stop - fail	One of the axes is moving or was moved with the safety device open.	Press the reset key in the CNC control box, on the CPU and on the Servo device
Stop by Watchdog, CNC - fail	A Software error has caused the CNC system to crash	Press the CPU reset button in the CNC cabinet.
NC-Stop: error at switching over to virtuel machine 01 - 03:	Switching over to another virtual machine is allowed only when positioned on the reference point and outside cutting or manual operating mode.	Quit with <ABORT> and move the system to the reference point.
01 = CNC at cutting		
02 = CNC in manual mode		
03 = CNC not in reference pos.		
Stop by plausibility test...	When machining, before each movement, actual value and pre-set value are compared to axis position. Should actual position deviate from plane co-ordinates by more than 5 mm, machining stops. The cause may be a defective encoder, card or software. The axis (axes) that caused the problem and the location are shown as well.	Check the cutting plan. Contact Bystronic after-sale service. Re-start is only possible under some limited circumstances.
in X at approaching reference		
in Y at approaching reference		
in X/Y at approaching reference		
in X at zero point		
in Y at zero point		
in X/Y at zero point		

System Messages	Cause	Remedy
in X at piercing in		
in Y at piercing in		
in X/Y at piercing in		
in X at piercing out		
in Y at piercing out		
X/Y at piercing out		
Stop by plausibility test in Z, sensor off inadequate	An attempt was made to cut rectangular cross-section tubes with <Sensor off>	Re-start the operation from the beginning with activated sensor (Setup).
Stop by plausibility test in Z, not calibrated	Lowering without preliminary calibration. System error!	Recalibrate Call Bystronic Customer Services
Stop by plausibility test in Z, stopping distance too little	The deceleration path as calculated is longer than actual raising height. Possible causes: Axis wrongly configured Sensing frequency fault	Contact Bystronic after-sale service for configuration check-up. As a rule, operation is on longer possible.
Stop by plausibility test in Z, material detected at reference	Sensing frequency fault. Possible causes: mechanical failure of the cutting head wrong assembly moisture in plug-in connections	Check for cutting head proper operating state. Call Bystronic Customer Services
Stop from CutControl: no sheet edge detected	When using Cut Control for accurate edge detection, no edge could be detected in the area of previous capacitive detection.	Check Cut Control head and detection setup, and repeat procedure.

7.2.7 Abort a Cutting Process

Stops in the cutting process must be confirmed by pressing the <ABORT> key. The restart cannot be executed in any case.

System Messages	Cause	Remedy
No beginning of cutting plan	Incorrect plan	Correct the cutting plan in Bysoft or in the data editor Reload the plan
No end of cutting plan	Incorrect plan	Correct the cutting plan in Bysoft or in the data editor Reload the plan
Invalid subprogram number	Incorrect plan	Correct the cutting plan in Bysoft or in the data editor Reload the plan
Cutting plan dimensions too large	Incorrect plan	Correct the cutting plan in Bysoft or in the data editor Reload the plan
Converted cutting plan too large	LCC file too large	Split the plan into two parts Reload the plan
Faulty cutting plan structure	Machining sequence calculation error due to read error or data errors in plan	Correct the cutting plan in Bysoft or in the data editor Reload the plan
Incremental buffer overflow	Software error	Inform the Bystronic customer engineering service.
Flat cut: chuck in working position	A flat cutting plan has been started with the clamping chuck still in position. The procedure is aborted.	Abort the start procedure using <ABORT>
Tube cut: chuck swivelled away	A tube cutting plan with the rotating axis has been started, despite the fact that the chuck is not in position. The procedure is aborted.	Abort the start procedure by pressing <CONT> or <ABORT>
Sheet count = 0	The value of the letter H in the plan is 0 Machining is aborted	Modify the number of runs in Job Detail under Job List and send the program to the CNC again (modification also possible using the "H" code under DATA or BYSOFT).

System Messages	Cause	Remedy
Shuttle table active	During the machining process, the <Waiting for material> position has been skipped intentionally by pressing <CONT> or due to a missing signal. The enabling test has detected that the <Shuttle table activated> signal is still present.	Stop machining by pressing <CONT> or <ABORT> and start it from the beginning again. A Restart cannot be executed.

7.2.8 Error Adaptive Optics

Error in the adaptive optics entail abort the cutting process and manual operating mode. You must confirm by pressing the <ABORT> key. In some cases, a restart may be executed.

System Messages	Cause	Remedy
Bypos: Timeout during transmission	The Diehl device is not switched on The serial connection has been interrupted SERCOM not suited to the flying optics	Switch on the flying optics Check the serial connection Call the Bystronic customer service
Bypos: UART parity error Bypos: UART Overrun Error Bypos: UART Framing Error	Faults in the serial connection	Check the serial connection Call the Bystronic customer engineering service
Bypos: Protocol error	Faulty serial connection (a message has been sent incorrectly three times) CNC and flying optics have lost the report frequency	Check the serial connection Operating error, repeat the procedure from the start
Error of the Bypos control	Internal error of adaptive optics. Transmission or status errors of flying optics cause an emergency stop	Confirm the message using <ABORT>. A detailed error message will appear thus enabling the exact cause to be identified. Call the Bystronic customer engineering service

System Messages	Cause	Remedy
Bypos voltage 1/2 not ready	The Bystronic Bypos device is not ready or is faulty	Call the Bystronic customer engineering service

7.2.9 Transport System Faults

Faults may arise in the transport system during operation with a sheet storage system connected. If faults arise the cutting process must be aborted. In general, you must confirm by pressing the <ABORT> key. In no case may a restart be execute

System Messages	Cause	Remedy
PLC transport fault, serial number	The transport system signals a general fault.	Check the transport system
PLC transport sequence error, serial number	The transport system confirms a load with an incorrect sequential number.	Unload the shuttle tables and restart the cutting process.

7.2.10 MMC DNC Error Messages

The DNC messages are configured partially in a modular way. The warning line may contain two blocks of text one after the other. Any supplementary text available is indicated first and the DNC error message always follows.

System Messages	Cause
Time-Out	During communication, the time limit for receiving a character was reached.
EOT	During communication, the EOT command signal was received unexpectedly.
File error	The MMC cannot create, read or write the temporary file that the MMC requires to save the data temporarily.
Unknown DNC-Error	During communication, an unknown error occurred.
DNC interface in use	The COM-Port requested is already being used for DNC communication.
PGM aborted	Data transmission / Upload was interrupted by the MMC using the EOT signal.
No answer	The receiver (e.g. CNC) is not answering calls using ENQ.
Wrong answer received	The receiver (e.g. CNC) did not respect the answer format of the first six characters.

System Messages	Cause
Wrong character received	An illegal character was received in DNC protocol (e.g. incorrect command signal during protocol)
Wrong Block Check number	The Block Check number calculated does not correspond to the number received.
Wrong block assign	Incorrect attribution of block size, block number and initial block during program downloading operation. The starting point of the file is greater than the file itself.
DNC connection retention. --> <CTRL+F9> to continue	The MMC has not been able to establish a connection with the CNC at start-up and is now working in OFFLINE mode. Data cannot be exchanged with the CNC. If the CNC is reactivated, communication may be resumed with the CNC by means of the key combination <CTRL+F9>. The MMC should then be restarted.

7.2.11 MMC Supplementary Texts for DNC Error Messages

These supplementary texts are optional and provide information about the activity during which the fault occurred. These additions are created and handled by the MMC.

System Messages	Cause
Delete NC-Programm	Error in the NC program deletion instruction.
Material Request to PLC	Error in the transmission of a request for material to the sheet storage system (PLC)
Material Request to CNC	Error in the transmission of a request for material to the CNC
Error when sending NC program	Error in the transmission of an NC program to the CNC system
Parameterfile	Error in the transmission of the parameter file to the CNC
Store	If the Laser machine has a sheet storage system: error in reading the status of the sheet storage system (PLC).

7.2.12 Laser status

Actual laser status during laser power up, operation and flooding

LCS/LASCON3 status	MCS/SSI status	Cause
Laser status: Reset ok Laser status: apply vacuum Laser status: fill with gas Laser status: start turbine Laser status: switch on energizing	Laser status: LASER OFF Laser status: RUNNING VACUUM Laser status: RUNNING GAS Laser status: RUNNING BLOWER	Status information when powering up the laser (progress display
Laser status: hand mode	Laser status: LOCAL	Laser being controlled manually
Laser status: flood	Laser status: RUNNING FLOOD	Additional information during switch-off

7.2.13 Laser error

The status conditions below only lead to an emergency stop during cutting and if there is a collective error

LCS/LASCON3 status	MCS/SSI status	Cause
Laser error: compressed air, water Laser error: vacuum punp Laser error: inverter, turbine Laser error: energizing Laser error: gas warning Laser error: gas error Laser error: service error	Laser error: WATER/AIR ERROR Laser error: OVER CURRENT Laser error: TUBE OUT Laser error: GASWARNING Laser error: GAS MIX ERROR Laser error: ERROR HV DESK	The error is acknowledged on the laser controller concerned. Refer to the laser controller specification for error details

Operator's Manual

BYSTAR

Beam Path

Issue 07.2000

Table of contents

6 Beam Path

From the outlet orifice of the resonator, the laser beam is routed via polarizing mirrors, deflecting mirrors and focusing lens to the workpiece.

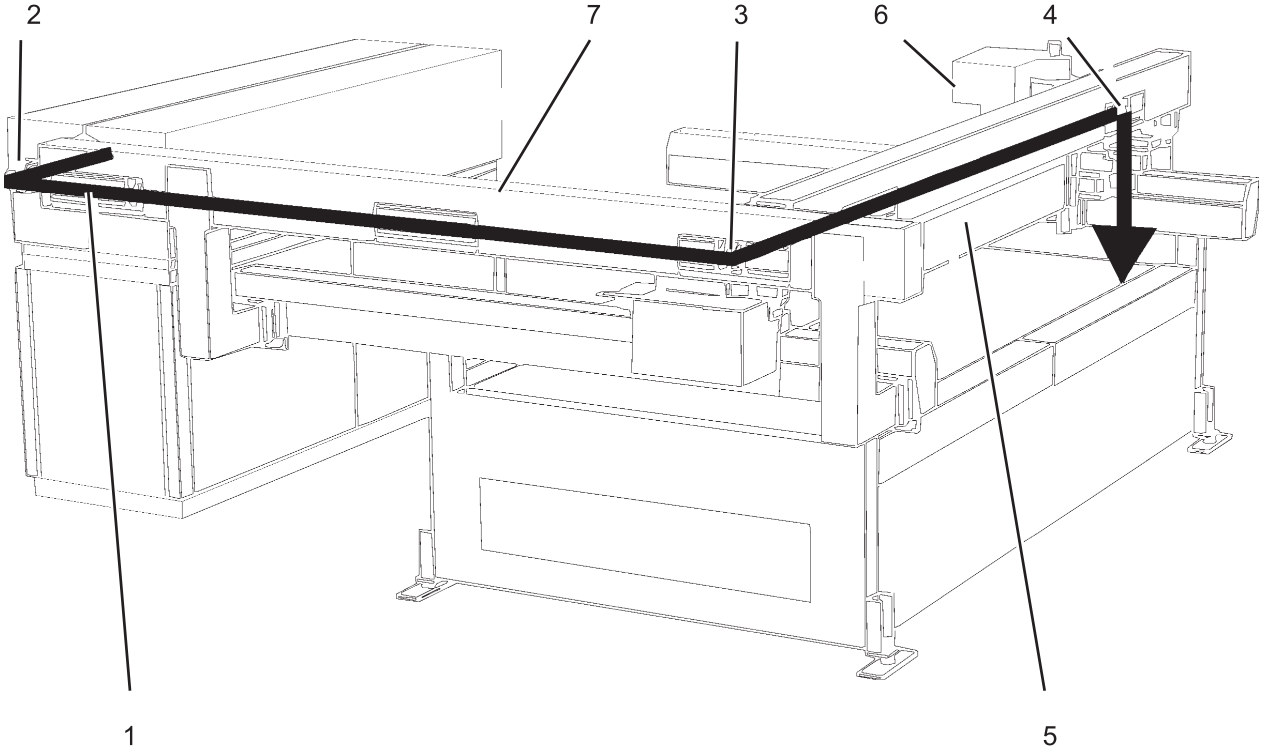
The path between the laser beam outlet and the the cutting head inlet on the Z axis is called the laser beam path.

The beam path is completely enclosed by parts of the machine, dust bellows and protection enclosures. The dust bellows and the protection enclosures protect persons in the machine area from stray radiation and from contact with the laser beam.

Contemporarily they protect the optical system from environment. During machining, the crossbar, the carriage and the deflecting mirrors fitted on it are in motion. Hence, the optical length of the laser beam varies. This routing system of the laser beam is called “Floating Optical System”.

Danger:

Danger of fire and explosion. The laser beam can cause fire to liquid, inflammable vapours and explosives.
Foreign bodies, liquids and gas may downgrade the beam quality. Keep cleaning agents, solvents as well as their vapours away from the beam path!



1 laser beam
2 resonator deflecting mirror
3 crossbar deflecting mirror
4 carriage deflecting mirror (Z-axis)
5 crossbar
6 carriage
7 laser beam enclosure

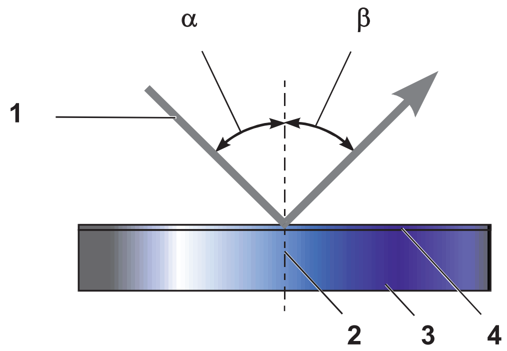
6.1 Beam deflection

6.1.1 Deflecting mirrors

The deflecting mirrors are used for the deflection of the laser beam along the axis of the machine.

The mirrors used are plain. This feature helps preserving the characteristics of the beam (parallelism for example).

The angle of incidence and angle of folding are referenced to the incidence axis. The angle of incidence equals the angle of folding. If the deflecting mirror is rotated by a certain angle, the direction of the reflected beam varies by twice the value of this angle .

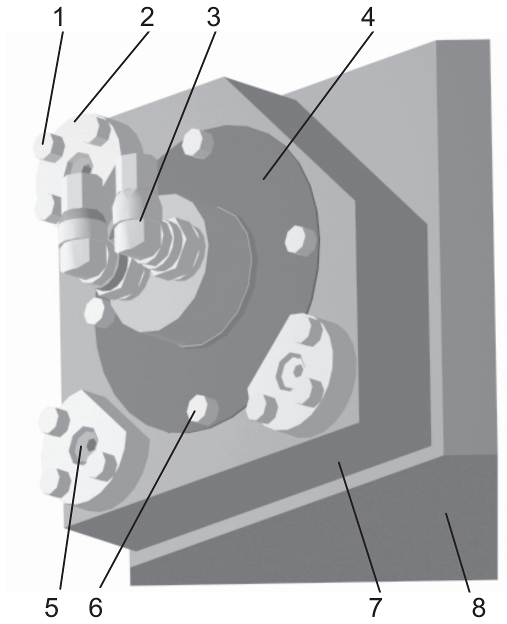


1 laser beam
2 incidence axis
3 support material
4 coating
α angle of incidence
β angle of reflection

☞ **Notice:**

When replacing the deflecting mirrors note the exact denomination of the mirrors. Pay particular attention to the difference between folding, deflecting, telescope and polarizing mirrors! (See maintenance manual and the spare parts catalogue)

The folding mirrors are held in their holders by a locking ring. By means of adjusting screws, the mirror holder may be rotated horizontally and vertically. The screws for adjusting the beam path are regulated during setup, so the operator is not required to make any further regulation.

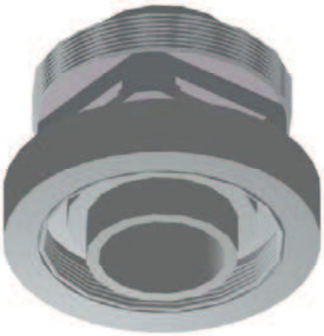


1 Cover securing screws
2 Rough adjustment cover
3 Cooling water connection
4 Mirror holder
5 Fine adjustment screw
6 Mirror securing screw
7 Mirror supporting plate
8 Folding prism

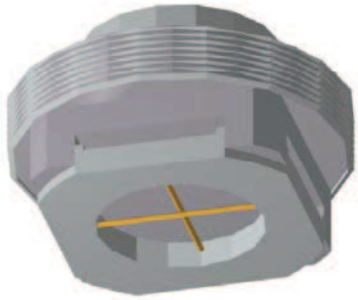
Components of the machine's set of accessories

The set of accessories includes the following beam aligning tools. These tools are to be used exclusively by trained staff. Keep the tools always at the disposal of the Bystronic assembly technician.

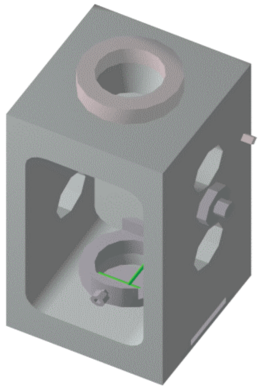
Shooting device for adjusting the first two mirrors of the beam expansion system.



For adjusting the mirror of the axis of the crossbar (1st folding mirror).



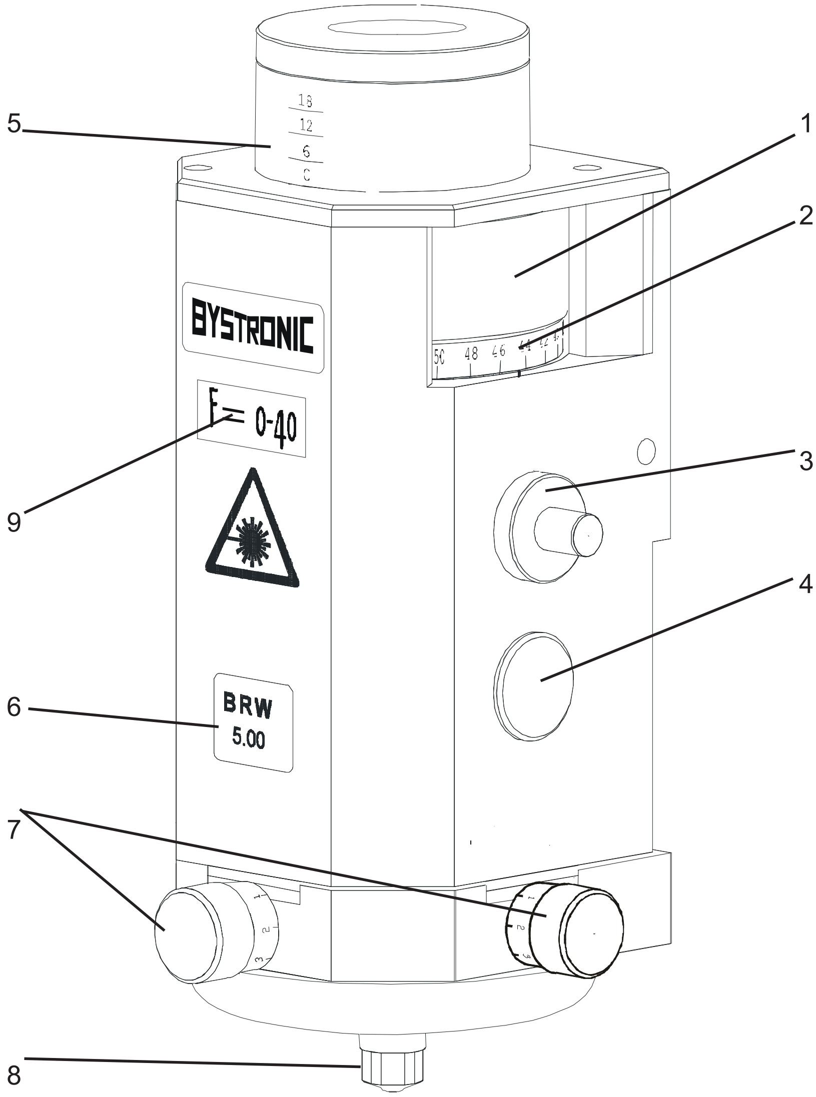
Shooting device for adjusting the mirror of the carriage axis. (2nd deflecting mirror).



Shooting device for adjusting the mirror of the Z axis.

6.2 Cutting head

6.2.1 Structure



1 **Adjusting ring** for adjusting the focal position

2 **Centesimal scale** on the adjusting ring

3 Pin for the machinig head supporting structure on the Z axis

4 Anti-twist protection

5 **Millimetric scale** for reading the focal position at several positions on the adjusting ring

6 Indication of the **focal distance** of the focusing lens

7 **Centering screws** for moving the nozzle horizontally during the centering phase

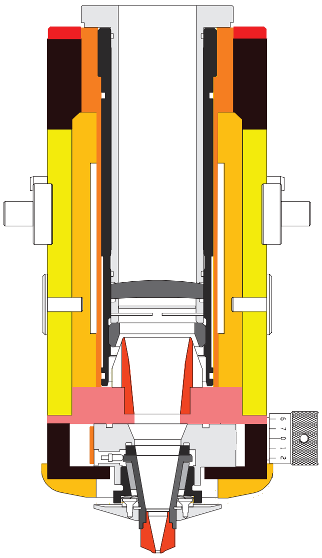
8 **Nozzle** modulates the flow of process gas at the laser beam output

9 **Focus position** actually determined

6.2.2 Functions

The lens integrated in the cutting head focuses the laser beam. The process gas supplied through the cutting head is conveyed through the nozzle on the workpiece.

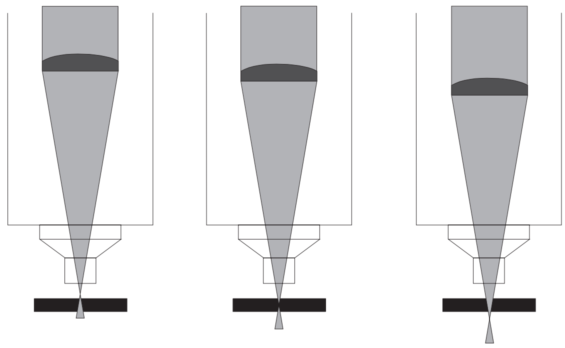
Cross section cutting head



The single cutting heads can be classified by the different focus distance of their lens (3.75", 5", 7.5" etc.).

The focal distance affects the usability of the cutting head. For information concerning this operation, see the following pages. All lens diameters are the same, 1.5" = 38 mm.

In the cutting process, the focus point can be, depending on the material, above, on, in or beneath the workpiece.



The material molten during cutting by the laser beam is blown away from the workpiece through the process gas, creating a kerf. For a more detailed description of process gas see the "Gas Control" chapter.

Ranges of use of the cutting heads

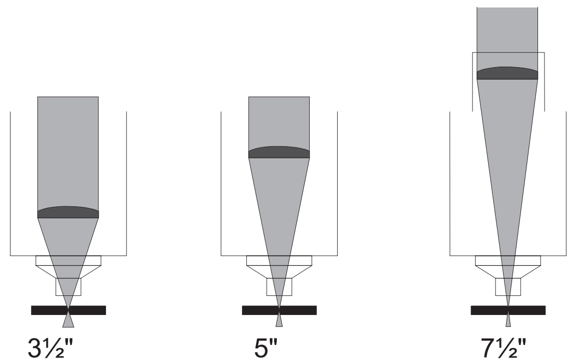
To maximize the results of the cutting with various materials different cutting heads with different focus distances are available. The table below gives the various ranges of use.

Focus distance of the lens [Inch]	Focus diameter [µm]	Focus length [mm]	Application range			
			Type of material	Gauge [mm]	Type of gas	Pressure [bar]
3.75	100	0.4	Construction Steel (St 37) Galv.constr.steel Copper	≤ 4 ≤ 3 ≤ 3	O_2 O_2 O_2	≤ 4 ≤ 3 ≤ 12
5.00	130	0.6	Construction Steel (St 37) Galv.constr.steel Inox (1.4301) Alloy	≤ 6 ≤ 4 ≤ 6 ≤ 4	O_2 N_2 N_2 N_2	≤ 5 ≤ 12 8-16 8-16
7.50	190	1.4	Construction Steel (St 37) Inox (1.4301) Alloy	≤ 20 ≤ 15 ≤ 8	O_2 N_2 N_2	≤ 5 8-20 8-20

Influence of focus distance on machining

Reduced focus distance

- reduced focus diameter
- higher intensity in the focus point
- higher cutting speed with thin metal plate
- unsuitable to cut thick metal plate
- less suitable for deep cutting
- critical focus position
- narrow cutting kerf
- lens close to the workpiece (it can get soiled)



High focus distance

- higher focus diameter
- lower intensity in the focus point
- higher cutting speed with thin metal plate
- high cutting performance with thick metal plate
- high performance in deep cutting
- focus position not particularly sensitive
- larger cutting kerf
- lens far away from the workpiece

6.2.3 Removal and assembly of the cutting head

Removing the head

The head shall have to be removed:

– when shifting from welding to cutting and vice versa
– when changing material or material gauge, that will require a different focus distance
– when the cutting quality is poor, it is necessary to check the nozzle and the lens

1. Move the axes until the head is easily accessible
2. Open the safety door.
3. Support the head with one hand and unscrew with the other hand the two locking levers.
4. Tip over the head to avoid dust particles falling onto the lens. Close the opening with its protective cover (if the opening is not closed, dirt particles could deposit on the lens causing damage, when the head will be re-assembled and the laser beam warms up these particles). Place the head with the nozzle facing downwards or in a horizontal position.

Assembling the head

Remove the protective cover from the head and fit it with one hand in the ring nut support. Press it evenly against the ring nut until all locking levers are completely screwed in.

6.2.4 Sensor

A sensor is intended to mean a measuring tool that regulates the distance between the workpiece and the nozzle. The nozzle distance is regulated according to the cutting parameters.

Unlike the tactile sensor, the capacitive sensor is integrated in the cutting head. The tactile sensor must be mounted specially on the outer side of the cutting head. It is an optional Bystronic device and may be ordered separately.

Application

Capacitive sensing enables the nozzle distance to be adjusted for all the parts and sheets that conduct electricity. For all other parts, the nozzle distance may be adjusted by tactile sensing.

Notice:

The two types of sensing cannot be used at the same time. The tactile sensor must be removed after use or the cutting head must be changed.

Capacitive sensor

Operation

The nozzle and the workpiece constitute the two plates of a variable capacitor. This capacitor is connected to the regulator by a special cable. The regulator compares the capacitive load with the rated value corresponding to the selected nozzle distance. The nozzle distance may be set to the selected value by moving the Z axis.

Assembly

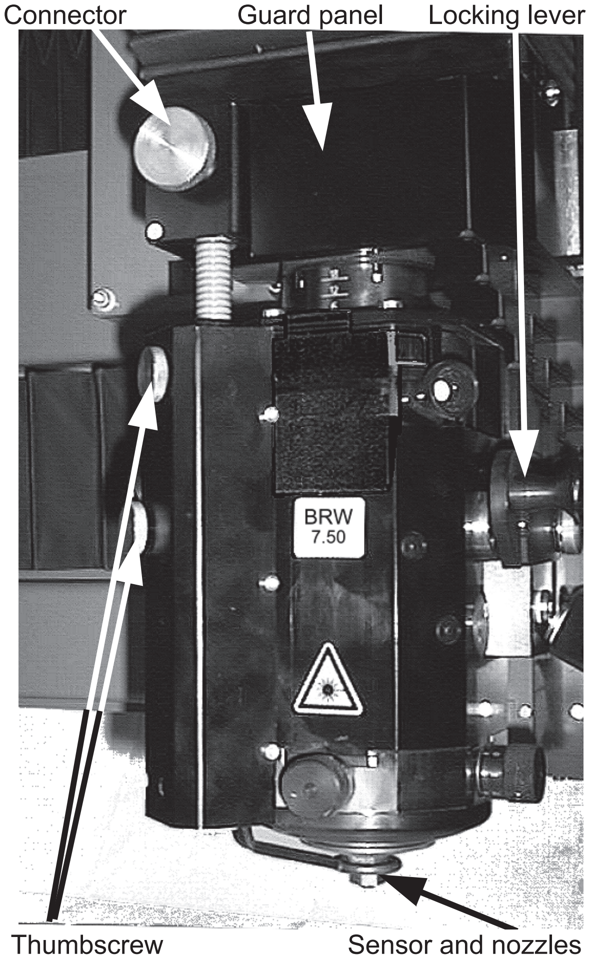
The capacitive sensor is assembled in a fixed position inside the rear of the cutting head. It must not be tampered with in any way.

Determining the reference point

When a cutting process is started, the distance is adjusted automatically at the reference point. To determine the reference point, see the MMC section of the operator's manual of the laser machine.

Tactile sensor (optional)

The tactile sensor is not installed on all laser machines.



Operation

The sensor creates contact with the surface of the workpiece. In this way, an electric circuit is closed. The nozzle distance is then adjusted in relation to the sensor. The reference point is determined in the same way in the reference position.

Assembly

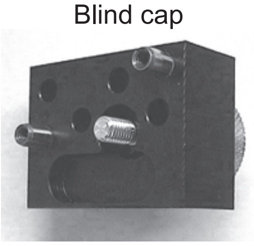
The sensor is assembled on the side of the cutting head. Insert the cutting head and fix it to the Z axis using the locking lever. Insert the connector in the socket on the carriage. The sensor may be removed simply by loosening the two thumbscrews.

Notice:

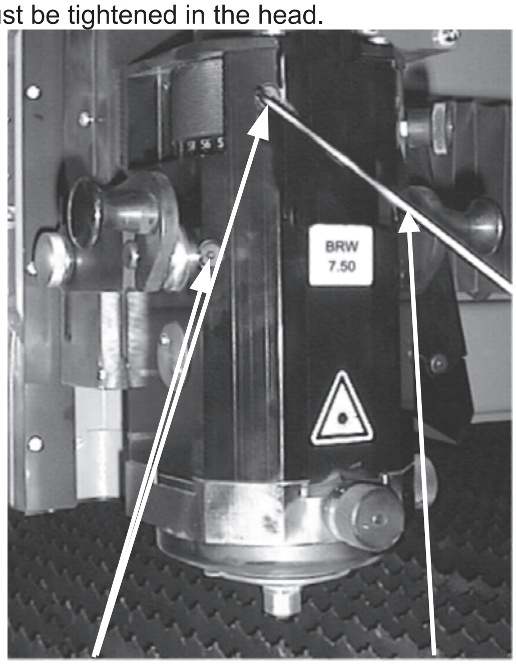
If the tactile sensor is not assembled, simply apply a blind cap (see figure below). No dirt must get into the structure. The two guard panels must always be assembled.

Keep the cap with the accessories of the laser machine.

Blind cap

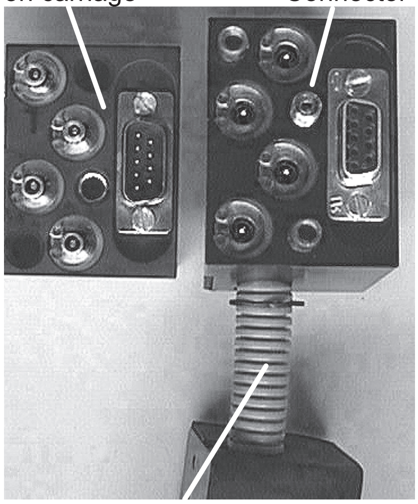


Having removed the tactile sensor, the screws must be tightened in the head.



Socket head screws | Allen key

Socket on carriage | Connector



Connection to sensor

Setting the reference point

After assembly, the distance between the sensor and the tip of the nozzle must be adjusted. This is done by carrying out the following procedure:

1. Move to the reference position.
2. Load a job or press <Restart>.
3. Click on the <Service> key on the keyboard.
4. Press <Cont>.
5. At this point, the reference setting process is executed automatically. The nozzle moves down to the reference plate creating a contact. The sensor follows the movement and also moves down to the base plate. The nozzle then returns to the distance set in the parameter and saves this position.

Generally speaking, the reference point only has to be set once. If required, however, the process described above may be repeated.

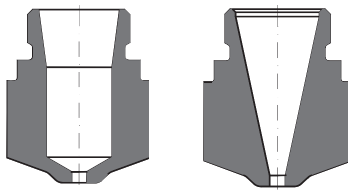
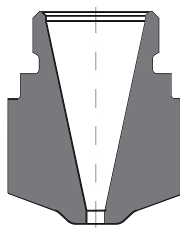
6.3 Nozzles

The form and the diameter of the nozzle depend on the following:

- focus distance
- focus position
- gas pressure
- low rate
- shape of the gas jet
- type of sensor
- range of use

The available range of Bystronic nozzles is the result of a thorough analysis aimed at optimizing all these factors. The following table gives a list of the nozzles available.

Shape of nozzle and range of use

Mode	Material gauge [mm]		Geometry of nozzles
Low pressure (0-8 bar)	**Steel**	**HK or K**	
	1	**K10**	
	2	**K10**	
	3	**K10**	
	4	**K10**	
	5	**K10**	
	6	**K12**	
	8	**K12**	
	10	**K12**	
	12	**K12**	
	15	**K15**	
	20	**K20**	
High pressure (8-20 bar)	**Inox N_2** [1)]		
	1	**HK15**	
	2	**HK15**	
	3	**HK17**	
	4	**HK17**	
	5	**HK17**	
	6	**HK20**	
	8	**HK25**	
	10	**HK25**	
	12-15	**HK30**	
	Inox O_2 [2)]		
	1	**HK10**	
	2	**HK10**	
	3	**HK10**	
	4	**HK10**	
	5	**HK10**	
	Alu		
	1	**HK15**	
	2	**HK15**	
	3	**HK17**	
	4	**HK17**	
	5	**HK17**	
	6	**HK20**	
	8	**HK25**	

[1)] Stainless steel Inox N_2 means cut with nitrogen

[2)] Stainless steel Inox O_2 means cut with oxygen

Identification of the nozzles

No letter	= normal pressure	(0-8 bar)
H	= High pressure	(8-20 bar)
K	= Capacitive scanning	
08	= Nozzle diameter	0.8 mm
10	= Nozzle diameter	1 mm
12	= Nozzle diameter	1.25 mm
15	= Nozzle diameter	1.5 mm
17	= Nozzle diameter	1.75 mm
20	= Nozzle diameter	2 mm
25	= Nozzle diameter	2.5 mm
30	= Nozzle diameter	3 mm

Example: H K 17

H = High pressure
K = Capacitive scanning
17 = Nozzle diameter 1.75 mm

01 = progressive no. 01-99

6.3.1 Replacing the nozzle

The nozzle shall have to be replaced:

– When the machine has to be set-up for another workpiece which requires a different nozzle according to the parameter record.

– When the machining quality gets poorer and also when the nozzle is damaged.

1. Clean externally the nozzle and the body of the nozzle.
2. Unscrew the nozzle manually counter-clockwise; if the nozzle is jammed, unscrew it with a wrench.
3. Holding the new nozzle tighten it only manually and not with the ring wrench!
4. Every time a nozzle is replaced, a precision centering should be carried out.

6.3.2 Fine centering

Fine centering should be carried out after:

– coarse centering

– replacing the nozzle

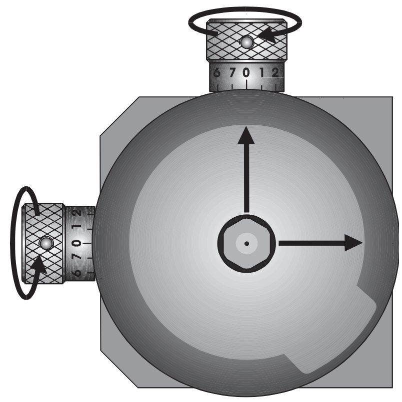
Shift the focus position before the fine centering if this is required by the material in question.

1. Apply a strip of transparent adhesive tape to the nozzle on the cutting head.
2. Select "Setup" and then “Laser setup values“ on the MMC.
3. Set the “Laser single pulse power” with value 1%.
4. Set the pulse time to approx. 20-100 ms.
5. Enter a “Shutter open/close delay time” of 400 ms.
6. Switch to <Hand> “Manual mode“.

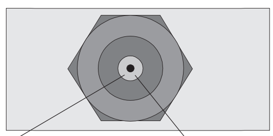
Danger:

Laser Class 4! Invisible laser radiation. Avoid direct or indirect exposure of eyes and skin. Wear eye protection glasses.

7. Close the safety door.
8. Select the <PLUS> key on the remote.
9. With the aid of a mirror held under the nozzle, check whether the hole burnt by the laser beam in the strip of adhesive tape is perfectly in line with the hole in the nozzle.
10. If necessary, center the nozzle using the relevant screws.
11. Repeat steps 1-8 until the laser beam is directed perfectly through the nozzle.

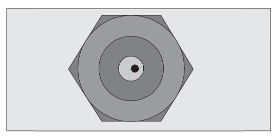


centered



Nozzle orifice
Laser burnt-in mark

Needs centering



Correction: move the cutting nozzle to the right.

Notice:

Adjusting the centering screw will cause a shifting of the nozzle not of the burnt-in hole. The thread of the screws is clockwise: that means that a clockwise turn will get the nozzle close to the screw, while a counter-clockwise turn will get the screw further away from the nozzle.

Notice:

A good machining quality depends on the good centering of the nozzle. If the nozzle is not well centered, the laser beam will touch the nozzle and cause deformation of the beam itself. Pay maximum care to the centering of the nozzle.

12. Exit from manual mode and close the safety door.

6.3.3 Nozzle cooling

While machining reflecting materials, aluminium and stainless steel, the nozzle accumulates heat as a result of the reflections. The same applies to steel starting from a thickness of 6 mm. This may have a detrimental effect on capacitive sensing (the nozzle distance changes).

The nozzle can be air-cooled. The adjusting knob is used for setting the pressure.

The blue adjusting knob is situated on the front right-hand side of the carriage

The nozzle cooling also prevents the tarnishing (dirt build up) on the cutting head due to smoke gases which are produced when cutting steel.

6.3.4 Adjusting the nozzle distance and the focal position

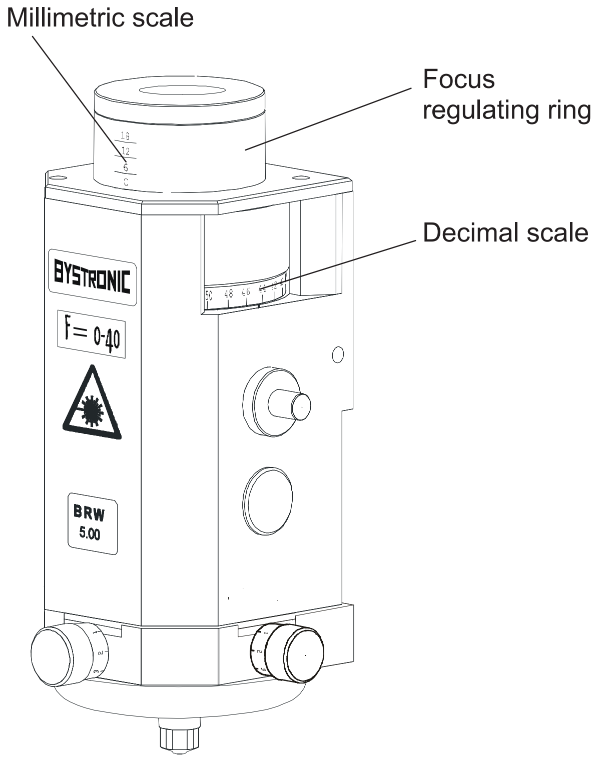
Determining the parameters

For the various materials and thicknesses used, different nozzle distances and focal positions are required. There is a set of parameters for the materials used most frequently on the machine. (A printed copy of these lists of parameters is given in the "Machine Journal“). Determine the nozzle distance and focal position for other materials starting from the set of parameters of the most similar material.

If the lens has been replaced, make a setting as described in the "Maintenance" section before adjusting the nozzle distance and focal position.

In focus position 0, the focus is situated on the surface of the sheet. Focus positions above the surface of the sheet are marked with a mathematical minus sign and the positions below the surface of the sheet (inside or below the sheet) with a plus sign.

Follow the same procedure as for setting the focus position



One turn on the decimal scale corresponds to a variation in height of 6 mm, i.e. 1 unit corresponds to 2/10 mm.

1. Turn the focus regulating ring until the sliding element is in its uppermost position. The zero notch will become visible on the millimetric scale and the adjusting ring, and this corresponds to the maximum top focus position.
2. Turn the focus adjusting ring in the «plus» direction until the zero notch reappears. This corresponds to position 0 on the adjusting ring, that is, 6 on the millimetric scale. Another complete turn of the focus regulating ring produces a movement of 6 mm, and therefore a total of 12 mm, which may be read on the millimetric scale. Another turn produces a movement of 18 mm.
3. Read the intermediate values on the decimal scale. For example, the number 0-40 means that when a rotation is performed downwards from position 0, the number 40 must appear on the decimal scale.
4. Find out the necessary nozzle lifting height from the <Work> menu, «Info« (for example, nozzle lifting height, 0.7 mm). Start from the focus position, marked on the head label (for example, 0-40). Add the necessary nozzle lifting height to the value on the label (for example, 40 + 7 = 47) and apply this value to the adjusting ring.
5. Find out the necessary focus position for the part from the "Work" menu, »Info« (for example, focus position 5 mm, that is, 5 mm in the material).
6. Add this value to the one on the adjusting ring (for example, 47 + 50 = 97). The value 97 is located in the 2nd sector, that is, between 6 and 12 mm. Turn the adjusting ring 3.7 mm beyond the 2nd zero notch (6 mm), and thus to notch 37.

6.3.5 Nozzle cleaning device (optional)

The nozzle cleaning device consists of a brush assembled on the basic frame. It represents an important tool for ensuring a perfect cut especially in fully automatic operation together with BYTRANS.

Field of use:

During operation, the nozzle head is dirtied by splashes of material. By wiping it with the brush, these residues of material may be removed. The cleaning device is suitable for the following materials:

- structural steel (all thicknesses)
- stainless steel (all thicknesses)
- aluminium up to a thickness of 3 mm

When aluminium sheets with a greater thickness are cut, the drops stick too tightly to the nozzle and therefore wiping with a brush or your hand (in gloves) is not enough to remove them.

Use:

The nozzle may be cleaned automatically at the end of a machining cycle or via the manual menu. For further details, see the "Adjustment values of nozzle cleaning device“ section of the MMC chapter.

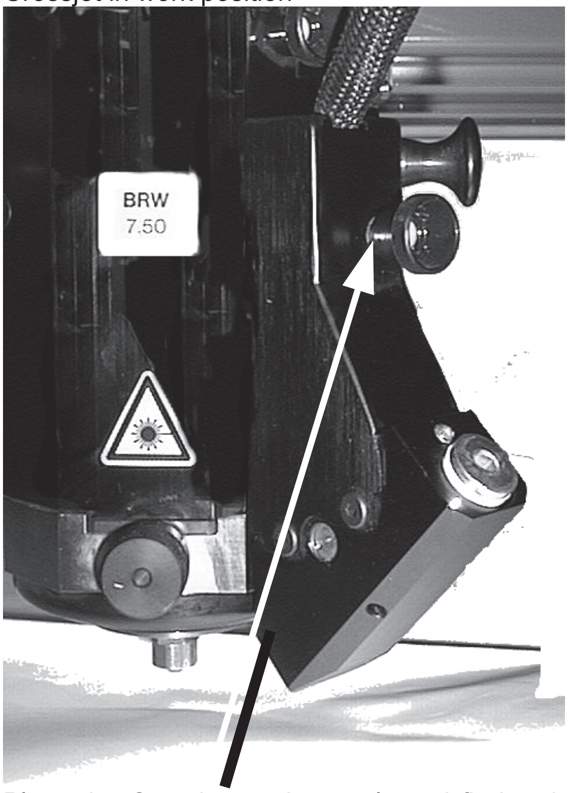
Replacement:

When the brush is saturated with splashed metal material it will no longer work. Contact the Bystronic spare parts service to order a new brush. The new brush may be assembled in place of the old one.

6.4 Crossjet (Option)

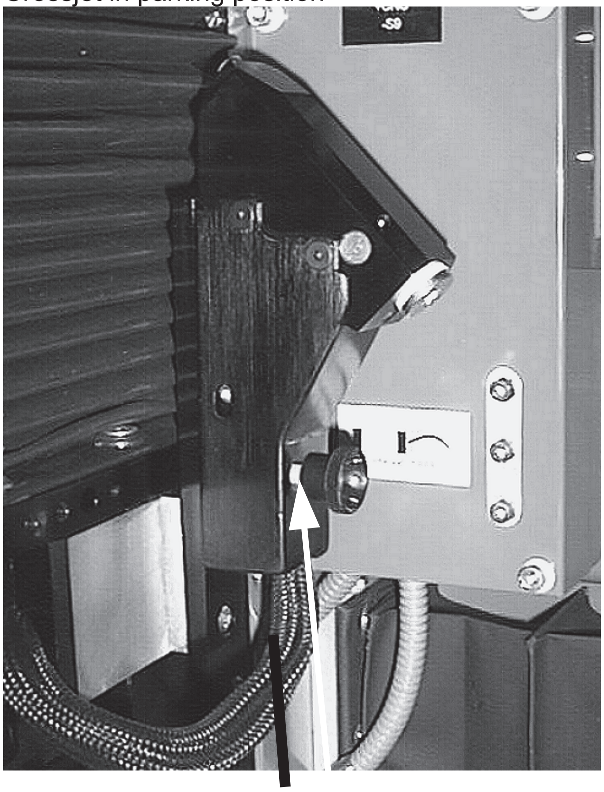
6.4.1 Operation and use

Crossjet in work position



Place the Crossjet on the pawls and fix it using the assembly screws

Crossjet in parking position



Place the Crossjet on the pawls and fix it using the assembly screws.

The Crossjet prevents excessive development of heat during the piercing phase.

The Crossjet comprises two openings. The oil flows through the head nozzle. Air passes through the opening below the nozzle.

The Crossjet is to be used for steel and aluminium starting from a thickness of 6 mm. With this and greater thicknesses, it effectively prevents molten material from sticking during the piercing process.

The rest position of the Crossjet is always the parking position. Only assemble the Crossjet in the work position when it is actually necessary. In this way, you will avoid dirtying the Crossjet unnecessarily.

6.4.2 Manual control

Move the Crossjet from the parking position to the work position.

Move the machine to the reference point. From the "Manual“ menu select "automatic adjustment“. The machines now moves to the starting point.

Switch on the manual control keyboard and press <Z-> to move the head down.

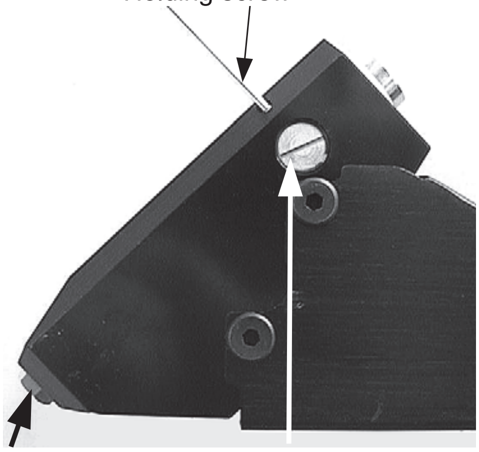
Pressing SF2 or SF3 (Oil, Blow) selects the functions of the Crossjet which, during manual operation, are activated during automatic adjustment using the <CROSSJET> key on the manual control.

6.4.3 Adjustments and operating modes

Oil mist

Oil mist consists of oil and air. Oil mist is sprayed onto the sheet being machined before piercing. The film of oil prevents flash from sticking to the sheet during piercing by forcing it upwards.

The thickness of the oil film depends on the flow rate, the diameter of the nozzle and the spraying time.



The adjusting screw is used for changing the flow rate. To do this, loosen the holding screw first. At the factory, the flow rate is set to the maximum opening.

To adjust the spraying time, on the PC panel of the MMC select "Param“ "Oil mist time before piercing“ or in "Work“ "active parameters“, "special parameters“.

The oil mist is not activated before piercing in pulse mode and or before piercing after "positioning with head down“.

Notice:

When the <SF2 Crossjet> key is pressed, the machine switches automatically to piercing mode no. 2 "piercing with Z value“. This happens even if another piercing mode has been selected in the parameters.

Adjustments and modes of operation

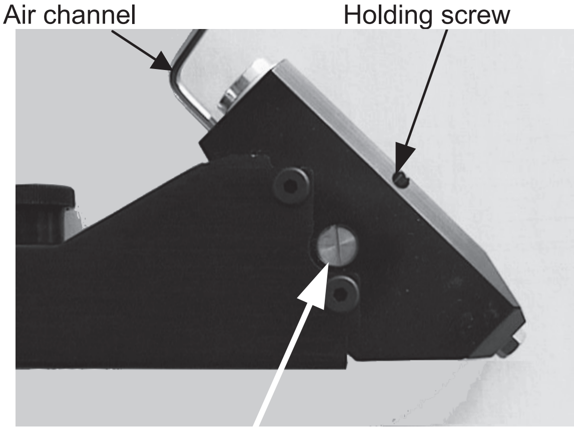
Warning:

Fire risk! The oil vapours may spontaneously catch fire in contact with the beam or the hot surface of the sheet being machined. Insert the oil required only in the amount specified according to the function. For further details, see the suppliers documentation chapter of the maintenance manual.

Crossblowing

A compressed air jet blows sideways the flash expelled upwards during piercing, thus reducing further its adhesion to the part being machined and the nozzle.

The air jet may be regulated using the adjusting screw. To do this, loosen the holding screw first. When the air channel screw is loosened, the channel may be checked and any dirt removed.

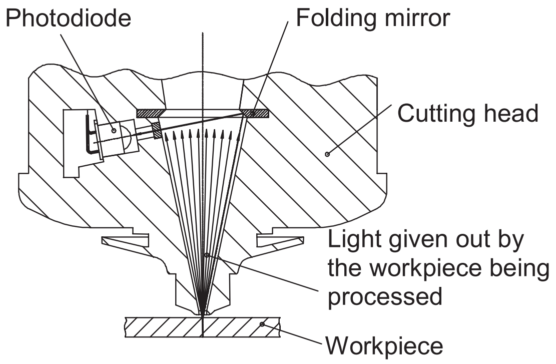


Cross blowing is turned on and off using the "Cross blowing after piercing“ parameter on the "Work" menu, "active parameters“, "special parameters“. The blowing time is determined by the "delay time before machining“ parameter on the "Work“ menu, "active parameters“, "Laser parameters for continuous operation“.

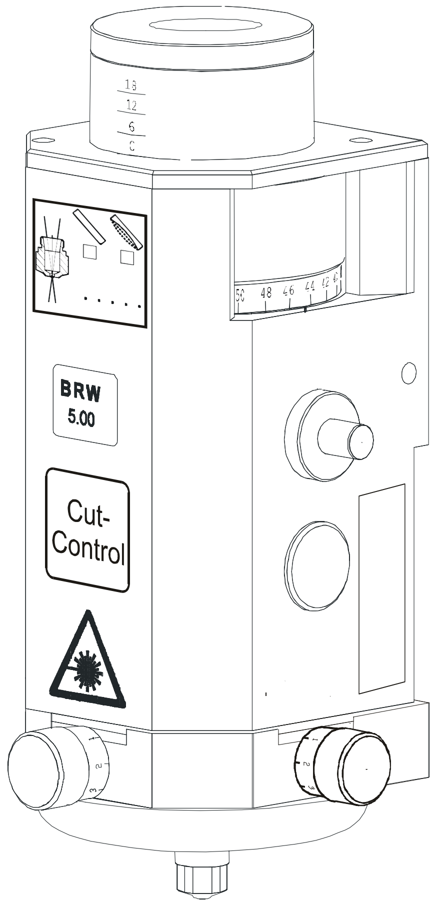
6.5 Cut Control (Option)

6.5.1 Structure and operation

Cut Control checks the cutting process by using stainless steel fusion. The process control is based on the light given out by the piece being processed and regulates the feed or stops the cutting process.



The cutting head with the optional Cut Control can only be distinguished externally from the normal cutting head by the adhesive label. The Cut Control cutting head (5 and 7,5) can be assembled and used in place of the normal cutting head. Handling and setting up operations (eg. changing nozzles, centring, focal position, etc.) remain unchanged. The Cut Control function can only be activated on machines equipped with the correct hardware and software. The CNC software version should be P6110 or higher. Earlier machine models can be equipped with the Cut Control later on. Please contact Bystronic's customer service for information concerning this option.



The light emitted during the CW cut of the steel is diverted using a toric mirror and measured by three silicon photodiodes. Mirror and photodiodes are incorporated in the sliding element of the cutting head (see drawing). The photodiode measuring signals are transformed on the SENSOS-Print (incorporated in the cutting head) and transmitted to the PROMON card in the CNC rack. The CNC control processes the signal and monitors the cutting process. Perforation, pulse emissions and engraving are not checked. The Cut Control is only activated after cut acceleration. If a cutting process is carried out during a stage where the cut is deteriorating, the signal changes and is corrected by using the two adjustment functions.

Forward travel reduction function:

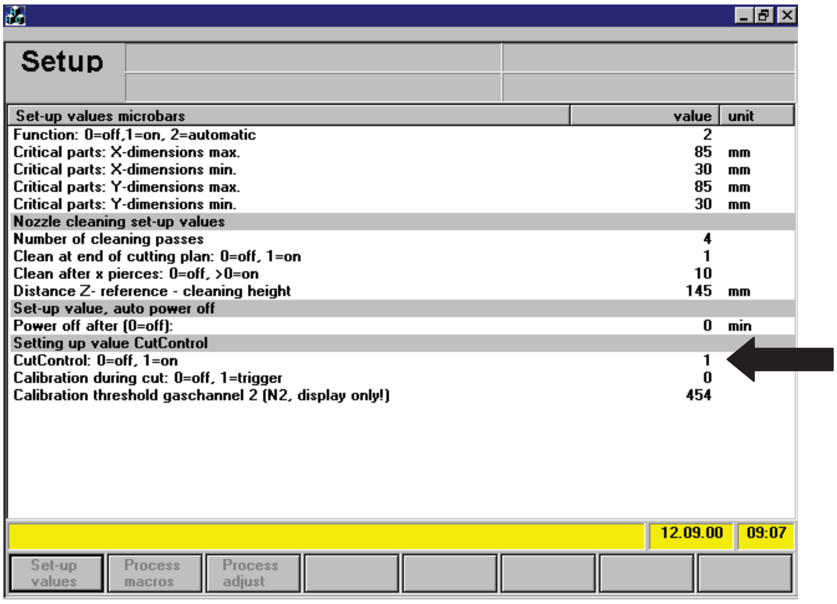
If the signal reaches the threshold alarm or plasma, the forward travel will be gradually reduced according to a preset percentage. The reduction continues until the value is below the alarm threshold or plasma or until maximum reduction is reached. Forward travel reduction is then kept constant during the “Reduced forward travel time period." If the alarm stops or the plasma runs out, the forward travel will begin to accelerate until it reaches the original nominal value (value in the cutting parameter).

Stop forward travel function:

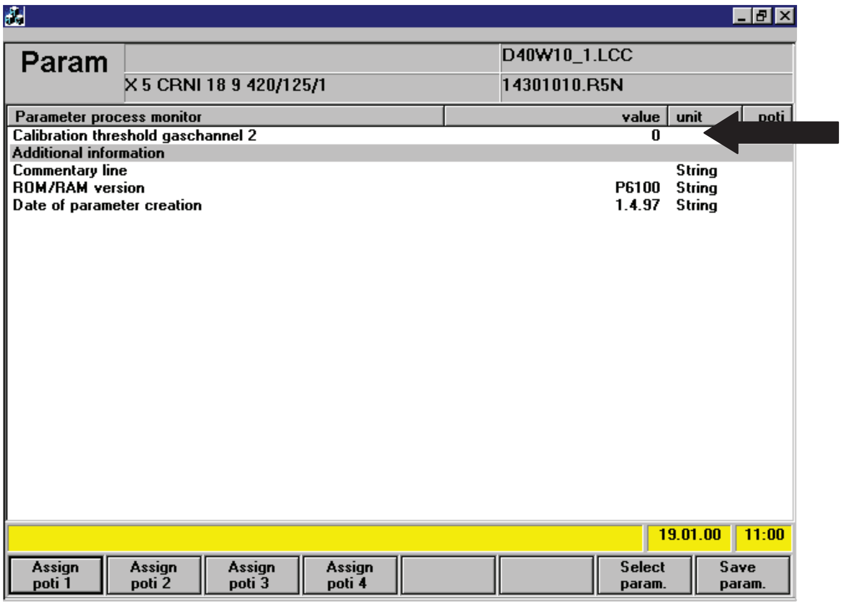
If the value of the signal does not go down below the alarm threshold or plasma or the stopping threshold is exceeded, it will be stopped and detached. When this happens, it is reset to a predefined quantity (at the most, up to the last perforation) and the cut is then repeated. Resetting is limited to a maximum number for edge cutting; after that number, it activates a normal STOP function, preventing an uncontrolled endless repetition in the case of irregular cutting conditions.

6.5.2 Settings

If the machine is equipped with the optional Cut Control, the relating parameters can be found in the "Setup" and "Cutting parameters" menu. The function can be activated or disactivated in the "Setup" menu. To perform this operation, set the "Cut Control" parameter to 1=on.



At the time the equipment is delivered, the basic values for the calibration threshold relating to different thicknesses are pre-programmed into the memory. This value is displayed in the parameter "Gas channel 2 calibration threshold" in the "Setup" menu. As a rule, the customer does not need to calibrate it. The parameter " Calibration during the cut" must therefore be left at zero. If, when observing the cutting process, it is noted that the reaction thresholds are much too high or low, it is possible to change them without performing a new calibration. For this purpose, go to the " Parameters " menu and change the value for "Gas channel 2 calibration threshold". Only make small adjustments, then observe the cutting process.

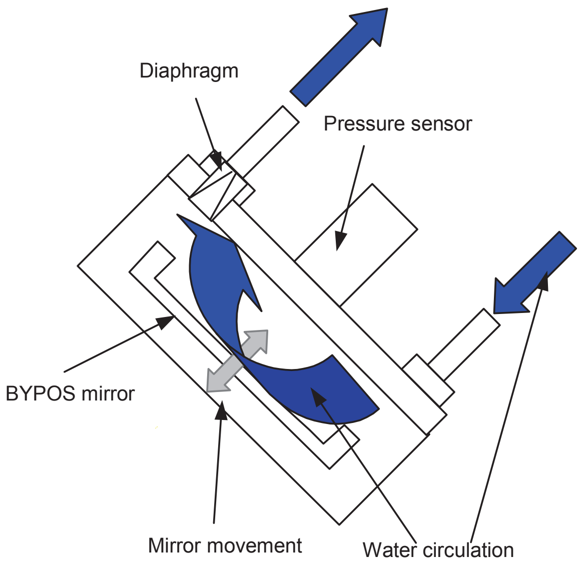


6.6 BYPOS-W

6.6.1 Product Description

For machines with flying optics, the focus point changes over the working range of the plant. The greater the distance between the exit window and the lens, the deeper the focus point lies. The reason for this is a natural divergence of the laser beam. Due to this, different qualities of cutting arise for large working ranges.

With the use of adaptive optics (BYPOS), the focus parameters, independent of environmental influences such as the variable distance of the focussing optic, can be held constant by the laser in plants with "flying" optics, or even controlled to suit the process and workpiece.

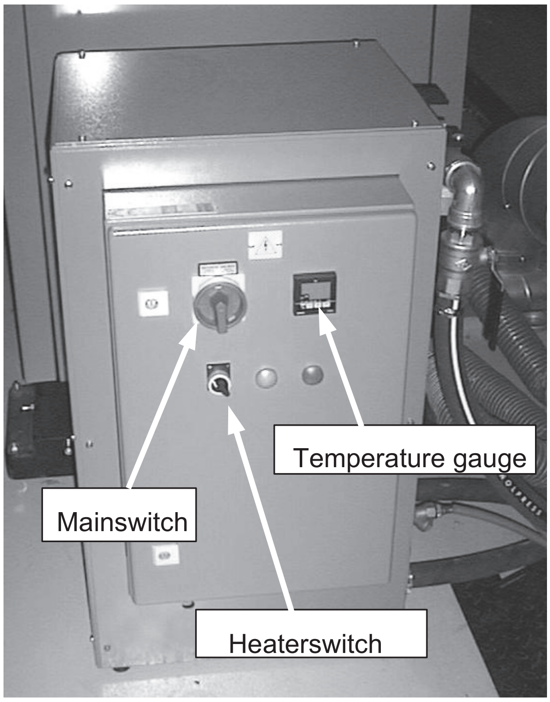


BYPOS mirror with holder

6.6.2 Principle of Operation

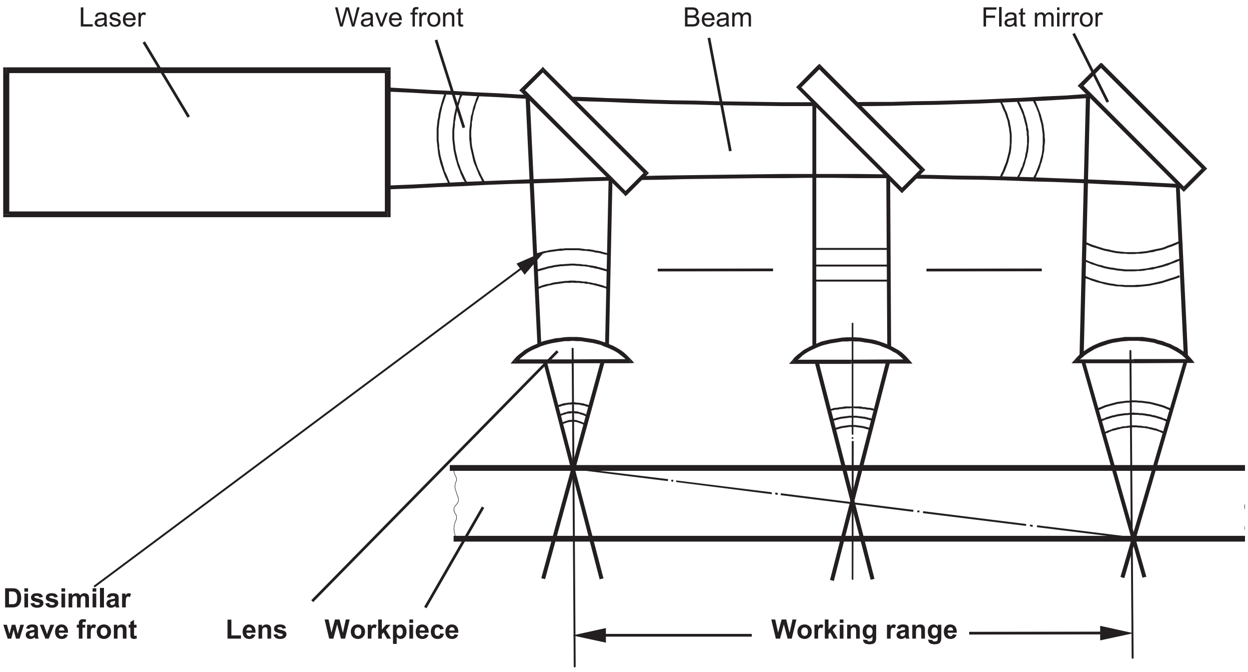
As the adaptive optic, Bystronic uses a deformable mirror which is designed so that, in continuous operation, the mirror surface guarantees reproducible optical characteristics. The deformable mirror replaces the normal 90° deviation mirror on the Z axis. The mirror surface is deformed by means of cooling water pressure. A pressure boost station interposed in the cooling circuit increases the water pressure to 14 bars. The control electronics control and monitor the pressure of the cold water flowing in the mirror via a proportional solenoid control valve and a pressure sensor on the mirror.

The pressure boost station is equipped with a heater which, for laser cutting tools with two cooling circulations, can preset the temperature of the BYPOS circulation. For tools with only one circulation, the heater is to be switched off.



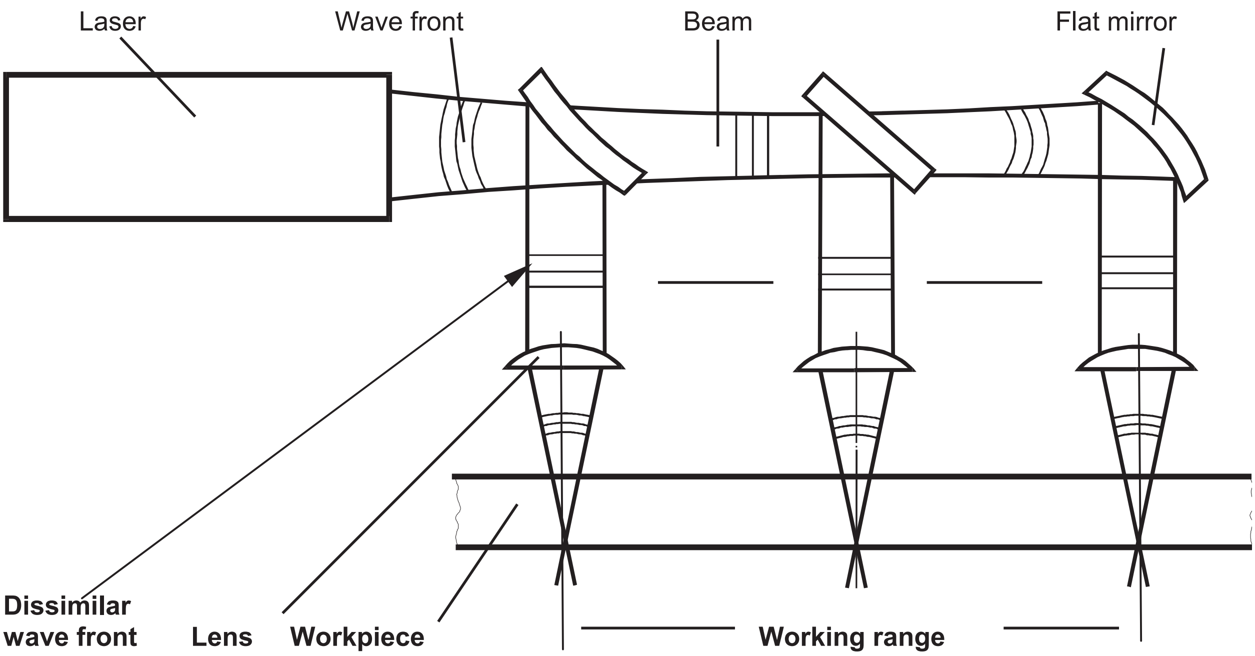
Cutting behaviour without BYPOS

The focus point shifts downwards in the cutting area depending on the length of the beam between laser and lens.



Cutting behaviour with BYPOS

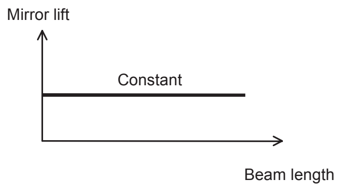
The focus point remains constant across the entire cutting area.



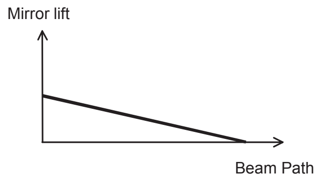
6.6.3 Operating Modes with BYPOS

With BYPOS you can work in various operating modes:

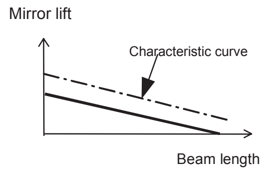
Operating mode 0
(Fixed)



Operating mode 1
(Focus correction)



Operating mode 2
(Focus correction + focus point)



The choice of operating mode is made in the "Set-up" menu under "Setup values adaptive optic 1".

6.6.4 Operating Mode 0

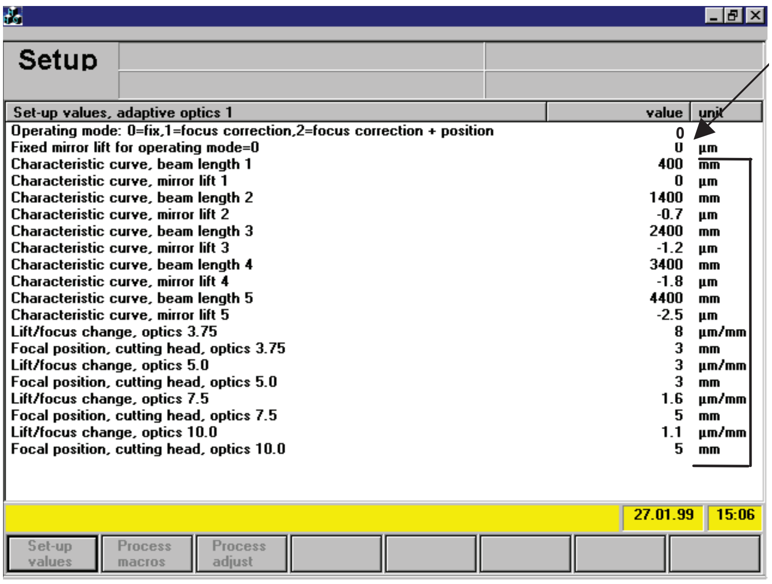
In the whole cutting area, the predefined mirror lift remains constant – regardless of the beam length. With this mode of operation the focus point is **not** automatically readjusted. This must be done manually on the cutting head. The set-up value of the focus point can be found in the relevant cutting parameters.

With a mirror lift of 0µm the adaptive mirror corresponds to a flat mirror. The adjustment range which is technically possible with values between -40µm to +40µm, shifts the focus point by about 20mm.

If the mode is tested by shooting into a plexiglass cube, the mirror lift must be set – without fail – to 0µm.

Parameter of Operating mode 0

In the "Setup" "Setup values adaptive optic 1" menu, the following parameters have to be set:



Operating mode (fixed) = 0
Fixed mirror lift = Xµm

The fixed mirror lift is normally set to 0

In this mode of operation, the other values have no effect!

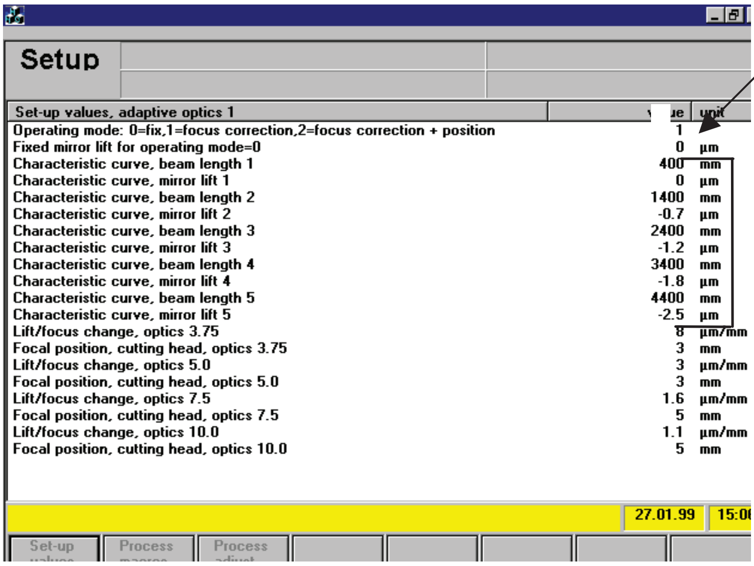
6.6.5 Operating Mode 1

The mirror lift is changed depending on the beam length. This dependency (mirror lift to beam length) is recorded in the characteristic curve. The characteristic curve is defined by 5 mirror lifts at 5 different points along the beam path length. These mirror lifts are determined by cutting trials at the corresponding beam path lengths and stored in "Setup" as parameters. For these cutting trials, the 7.5" cutting head and 8mm Inox plate are to be used.

In operating mode 1, the focus point is **not** automatically readjusted for different types and thicknesses of plate. This is only possible in operating mode 2.

Operating mode 1 parameters

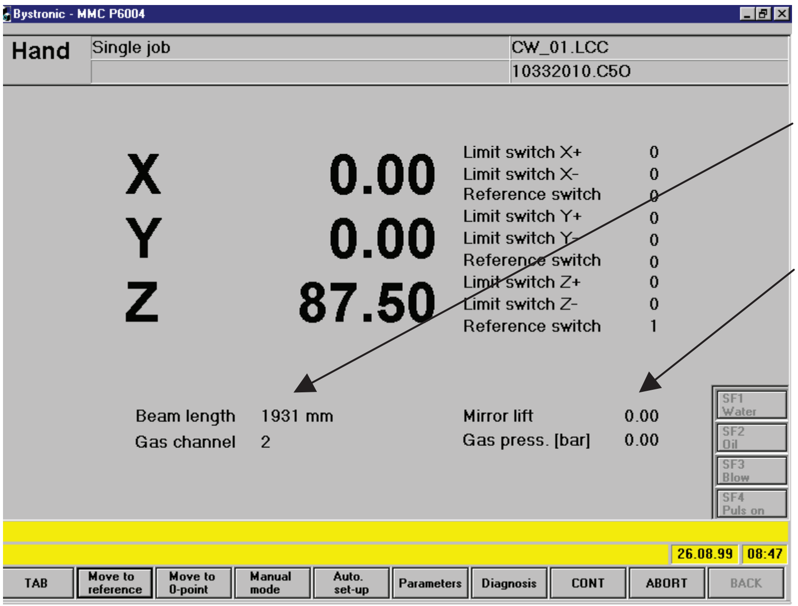
For operating mode 1 the following parameters are relevant:



Operating mode = 1

(The value 'Fixed mirror lift' is of no significance in this operating mode)

The inputs for definition of the characteristic curve (5 pairs of co-ordinates: beam length/mirror lift) are set in the factory. After a change of optic or Bypos mirror it may be necessary to re-determine the values with cutting tests in accordance with the following procedure.



In the <Hand> menu, the current beam length and the mirror lift calculated from this (setpoint value) can be followed during the procedure.

For correct calculation of the beam length, the reference point must be moved to beforehand. (At the reference point the beam length is 200mm)

6.6.6 Determining the characteristic curve

PREREQUISITES

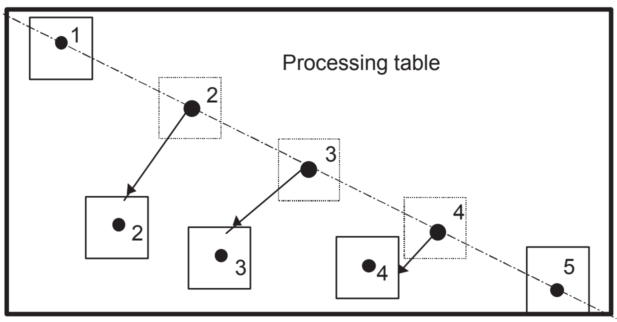
- Optics and beam guide must be in perfect condition
- Material : Inox 8mm (preferred : 1.4301)
- Cutting head 7.5"
- Testpart bypos_t.lcc (is saved in C:\setup\BTL...) If this file does not exist, it has to be created on the site according to attached bypos_t.lcc drawing.

PROCEDURE

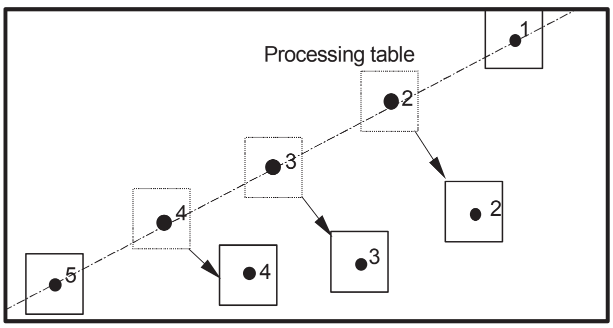
1. Choose operating mode 0 and Lift 0 (flat mirror)
2. Move to reference
3. Move to characteristic curve point 1 (minimum beam length – see following table)
4. Cut test piece and correct focus point on the cutting head until an optimal cut is achieved. You should try to find the **deepest possible focus point** at which still no hard burr arises.
5. Move to characteristic curve point 5 (maximum beam length).
6. Cut the same test piece without altering the focus point on the cutting head while doing so. The correction of the focus point is to be done by changing the "Fixed mirror lift to operating mode=0" parameter. A greater lift produces a deeper focus point and vice versa. Adjust the parameter until an optimum cut occurs.
7. The connection between the two limit points determines a straight line as the characteristic curve. The lift values for the intermediate points are calculated by interpolation and stored. (Menu "Setup" characteristic curve: Beam length / mirror lift 1-5)
8. Select operating mode 1. (Instead of the fixed mirror lift, the CNC now takes the calculated lift value from the characteristic curve, and this can be checked in the "Hand" menu for mirror lift).
9. By means of test cuts at the intermediate points, the characteristic curve is checked in operating mode 1 and corrected if necessary. (Correction of the lift value of the corresponding point for adapting the focus point).

The beam length determines the place at which the test cut must be made. The position on the processing table is not yet given by the beam length alone. The plate for the test cut does not have to lie exactly on the diagonal of the table. The test cuts can be made on the bench diagonal or by moving the plate to another position – as shown in the following diagrams. The current beam path length can be read out in the "Hand" menu.

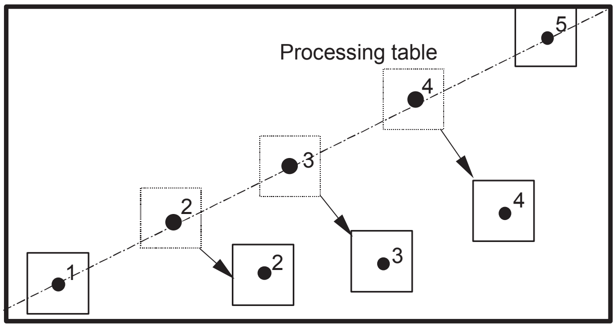
Beam entry - left



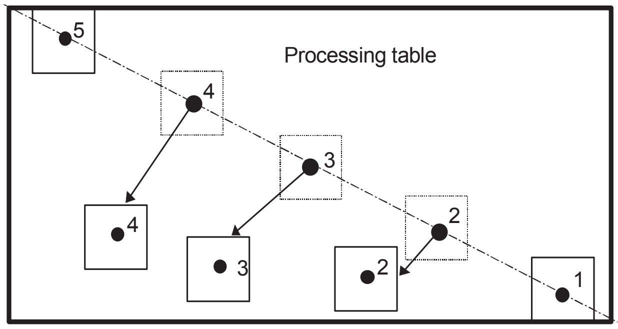
Beam entry - right



Beam entry – bottom left



Beam entry – bottom right



Averaging the characteristic curve

In very rare cases, it is necessary to average the characteristic curve. This is to be done if the mirror lift in Point 5 makes up more than ¼ of the total mirror lift.

By altering the lift value of each characteristic curve point by the same value, the whole characteristic curve can be moved parallel. In this way, for large lift differences, the characteristic curve is averaged around the zero value. However, this correction must be compensated for on the cutting head. The conversion factors necessary for this can be found in the "Setup" "Setup values – Adaptive optic 1" menu.

The characteristic curve was determined for a cutting head. For another cutting head (e.g. 5"), or after a change of lens, only the focus-zero-point and the focus point for the appropriate plate thickness have to be re-determined.

The determined characteristic curve applies to all focal lengths!

On the following table you see the beam lengths for the characteristic curve points at which the mirror strokes need to be determined.

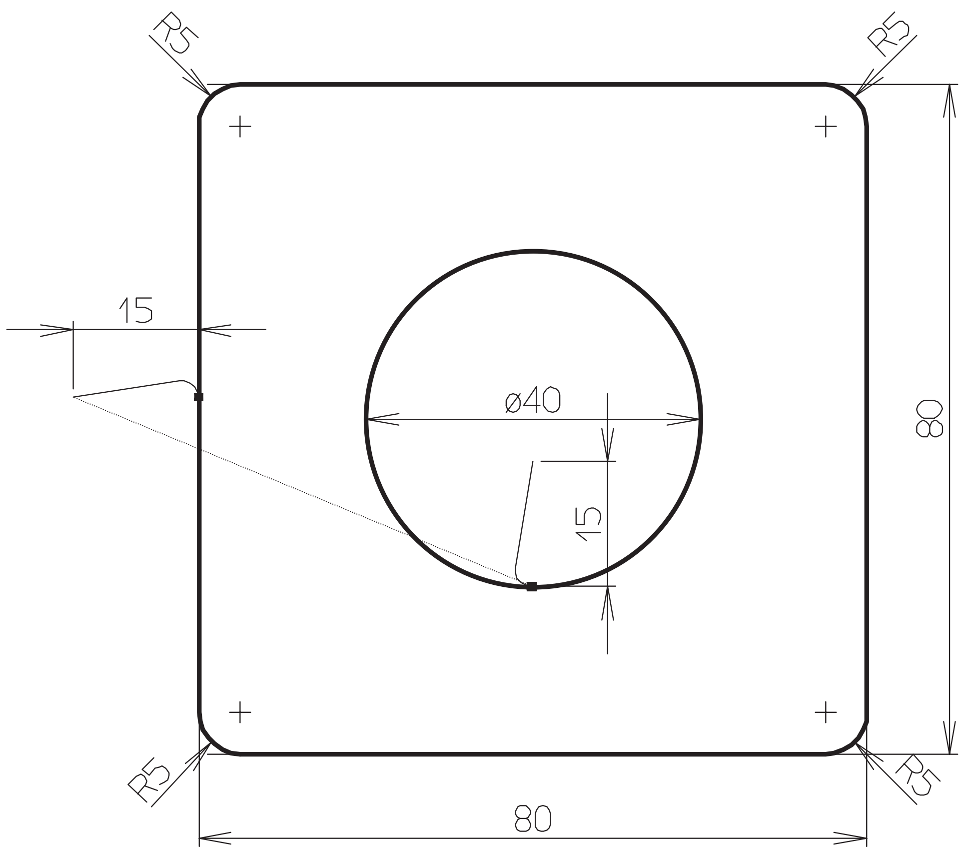
These experimental characteristic curves can deviate from machine to machine because of different optical path aeration.

Likewise, a readjustment of the characteristic curve can be necessary after a lens change in the resonator (especially in the output window).

Distribution of the beam length points

Machine size	**Characteristic curve points**					
	Char. curve point	1	2	3	4	5
2512	Beam length (mm)	600	1200	2000	2800	3600
3015	Beam length (mm)	600	1400	2400	3400	4400
4015	Beam length (mm)	600	1700	3000	4300	5600
4020	Beam length (mm)	600	1800	3200	4600	6000
4025	Beam length (mm)	600	2300	3800	5200	6800
6520	Beam length (mm)	600	2600	4600	6600	8600
6525	Beam length (mm)	600	2700	4800	6900	9000
6530	Beam length (mm)	600	2800	5000	7200	9400

Test part bypos_t.lcc



Kunde : Bystronic Laser AG	Technologie : Laserschneiden			Dicke : 8.00	Masseinheit : mm
Material : Nichtrost. Stahl X5CrNi18 9	Material Code: 1.4301			Zeichnungs Nr. bypos_t	
		Datum	Name		
Common Cut : Nein	Gezeichnet	25.05.99	bbe	Bezeichnung bypos_t	
Füllteil : Nein	Geändert	25.05.99	bbe		
Drehwinkel : 0	Dimension X : 95.00				
Dateiname : 00000154.BPD	Dimension Y : 80.00			BYSTRONIC	bysoft The CAM-Software
Bearbeitungsfolge ok : Ja	Fläche effektiv : 5121.90				
Anz. bearb. Konturen : 2	Fläche Rechteck : 7600.00				

6.6.7 Operating mode 2

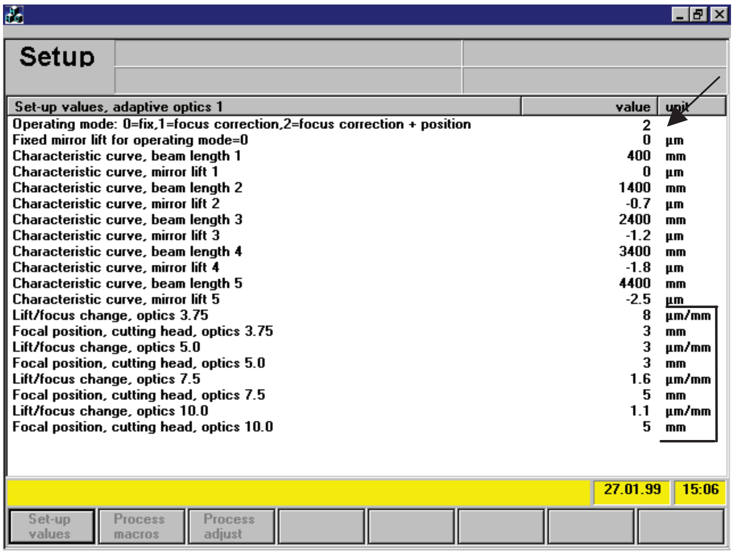
Prerequisite for operating mode 2 is the existence of a valid characteristic curve for operating mode 1. In operating mode 2 the focus point, which otherwise in the cutting parameters is only there for information, is taken as a parameter. In this operating mode, on a change of material, the cutting head need no longer be set manually. It is set automatically by the adaptive optic. The total lift is calculated from the position-dependent characteristic curve value (characteristic curve from Operating mode 1) plus OFFSET which is dependent on the characteristic data (function of focal length, focus point and nozzle distance – these values are taken from the relevant cutting parameters). The calculation is done in accordance with:

OFFSET = [Lift/focus change] · (Focus point + Nozzle distance – [Cutting head focus point])

The two machine parameters which are dependent on the focal length:

– Lift/focus change
– Cutting head focus point

are input at the factory and are stored in the "Setup" menu. These values will be in the "Config HW" as these values must not be altered by mistake.



Operating mode = 2

Do not alter these values!

Working with operating mode 2

To work with operating mode 2, proceed as follows:

– It is assumed that the cutting head's focus zero point is known. If not then it is to be determined.
– Select operating mode 2 (as described above).
– Set or check "Cutting head Optic 7.5” / 5” focus point " (from Set-up) on the cutting head. Once the cutting heads are correctly set, no alterations have to be made later.
– Read-in the cutting plan and the cutting parameter. For this it is essential that the focal length in the cutting parameter agrees with that of the cutting head. If not, the focus point will be wrongly calculated.
– Check or replace the cutting nozzle. If several jobs are automatically processed one after the other, the largest of the required nozzles must be used. Additional parameter alterations may be necessary. This is necessary if, in automatic operation, very different plate thicknesses are cut.
– Centralise the cutting nozzle and then start the cutting process.

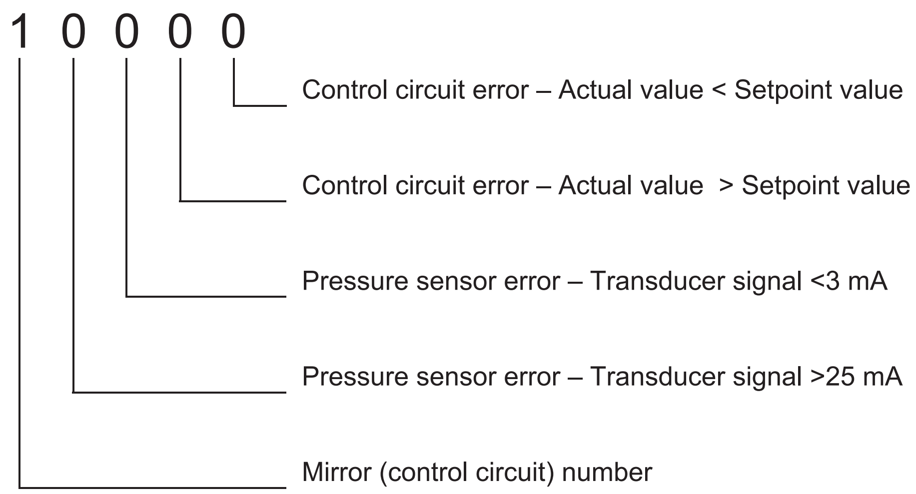
6.6.8 Error Messages BYPOS

When ready for operations, various causes of errors can be inferred from the 4 error bits of the transducer monitoring and the control monitoring.

MMC Error Messages

Error no.	*Description*	*Cause*
11	Control circuit error: Actual value < Setpoint value	• Current controller or end stage defective • Proportional valve not activated • Advance value of the controlled magnitude too small for the set setpoint value • Transducer is defective or not connected • Can occur together with Error 13
12	Control circuit error: Actual value > Setpoint value	• Current controller or end stage defective • The proportional valve is fully activated • Transducer defective • Can occur together with Error 14
13	Pressure sensor error: transducer signal <3 mA	• Transducer defective • Wiring to the transducer broken
14	Pressure sensor error: transducer signal >25 mA	• Transducer defective • Signal and power lines from the transducer are shorted • Transducer is overloaded by the controlled magnitude

As from CNC P6104, the representation of the Bypos error messages is coded in accordance with the following scheme:



Errors are shown by a 1 in the relevant position. (An error code of 10000 indicates normal operation, i.e. no errors). With this coding, several errors can be shown simultaneously.

Operator's Manual

Handling

Machining area

Version and document identification

Chapter 7

Document identification: LMBBE_05_V01_EN.fm

Please always quote the above product identification and version number when reordering this manual.

Please notify us of any errors or any suggestions for changes, at:

Bystronic Laser AG

Technische Dokumentation

Industriestrasse 21

CH-3362 Niederönz

Tel.+4162-956 33 33
Fax.+4162-956 33 80

Trademarks:

Table of contens

CHAPTER 7

Machining area

Table of contens

7. Machining area

7.1 General

Operation is implemented using the RS View program and is displayed on a PC. The operator interface is configured so that the operation can be carried out using either the mouse or the keyboard.

Fig. 7.1 -1

7.1.1 Starting the software

The software is started as follows:

1. Turn on PPC main switch

2. Windows NT is started

3. RS-View with Project Handling (analogous to the MMC) is automatically started and appears in the foreground

4. Wait for data exchange between the PLC and PPC

5. The root menu "Main" appears on the screen

6. By pressing the **[**Alt**]** and **[**Tab**]** keys, one can switch back and forth between the RS-View and MMC programs.

7.1.2 Operator interface

In order to be able to clearly state the text, the images in the modules are always shown in the documentation with the **active** and **inactive** display. In order to keep the same display, however, the operator must select the needed display using the right mouse button or the **[**Page Up**]** / **[**Page Down**]** button.

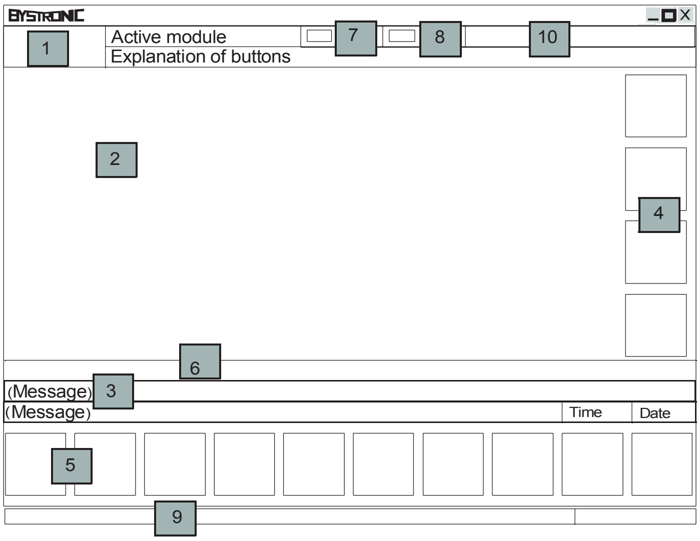
Switching between the main field (**2**) and the menu field (**5**) is possible by using the **[**PageUp**]** (main field) / **[**PageDown**]** (menu field) buttons or the right mouse button.

NOTE

All F-functions in the main field (**2**) are only valid for the corresponding active module and must not be mixed up with the F functions of the keyboard, which relate to the active menu field (**5**).

The operator interface has the following basic layout:

Fig. 7.1 -2



Operator interface overview:

Tab. 7.1-1

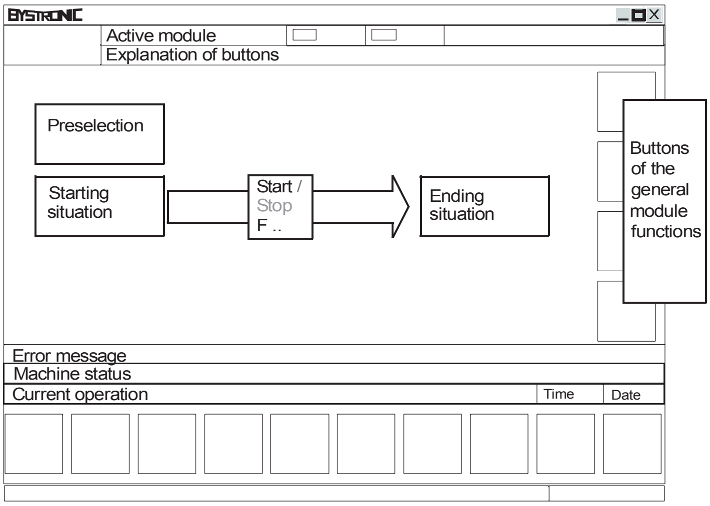
1	Title field:	This field shows the current menu
2	Main field:	The processes or functions of the modules are displayed in this field.
3	Message field:	These fields show the pending messages.
4	Function fields:	These fields are reserved for the general functions.
5	Menu fields:	These fields are used for menu navigation (module selection)
6	Alarm message:	Only evident if a message is pending.
7	Alarm field:	This field flashes red if an alarm message is pending.
8	Communication field:	This field appears green if the communication-to-programmable-controller connection is in working order. If connection is lost, the field appears red and an alarm message is pending.
9	System field RS_View	This field is created by RS-View.

NOTE

If the mouse cursor is located in the system field RSView (**9**), one can no longer switch from the main field to the menu field.

The various processes depending on the machine configuration are displayed in the main window.

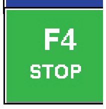
Fig. 7.1 -3



Buttons of the main field

An illustrated process is started using the Start button and afterwards can be stopped using the same button. If the Start button is reselected, the process is continued. The buttons change according to the status of the screen being displayed.

Start button blue = a process can be started.



Stop button green = a process can be stopped.

The buttons of the general module functions activate / deactivate a process that acts on the entire module. Included in this are the approaching of the park position or the activation / deactivation of Automatic mode.

Buttons of the function fields

These buttons can **only** be activated using the mouse.

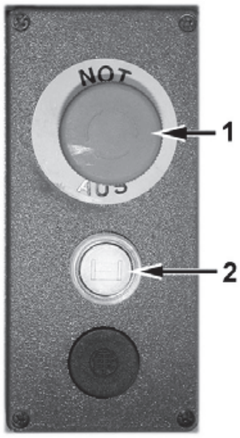
Gray button = process inactive

Blue button = process active

7.2 Operator console handling

7.2.1 Operating elements relevant to personal safety

Fig. 7.2 -1



Button **[**NOT-AUS**]** (**1**)

By activating the **[**Emergency off**]** button (Not-Aus), all electrical consumers are disconnected from supply. This does not apply for the controller, the suction (filter) and the vacuum pump of the loading system, if present.

The "Emergency shutoff" alarm message appears on the screen.

In order to bring the system back into a defined status after an emergency shutoff, proceed as follows.

1. Fix the problem

2. Reset Emergency Shutoff button (Not-Aus)

3. Shut off laser controller (MCS)

4. Press the reset button on the STL control cabinet (button must light up).

5. Shut off laser controller (MCS) ("see Laser Operating Instructions")

6. Start up laser and start machining process

Enable light barrier button (**2**)

The light barrier protects you from access to the danger zone where there are movements of the shuttle table and a loading/unloading system. As soon as the light beam is interrupted, the drives of the transport systems in question are powered off. The programmable controller stores the last program step.

The following states are visible via illumination of the lamp:

Lamp flashing:

The light barrier circuit is interrupted. Prompt by controller to press the enable button.

Lamp lit:

The light barrier circuit is in working order and active.

7.2.2 Status fields

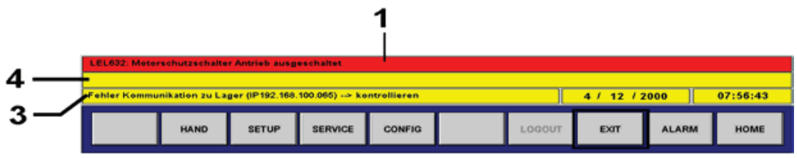
We differentiate between alarm and machine messages:

Machine message

In lines (**3**) and (**4**) messages concerning the machine status are displayed. The messages give information about the momentary status of the machining process. Information concerning the commands that follow immediately thereafter are displayed for further processing. In field (**3**) the current machine status is visible and in field (**4**) the current machining process is repeated.

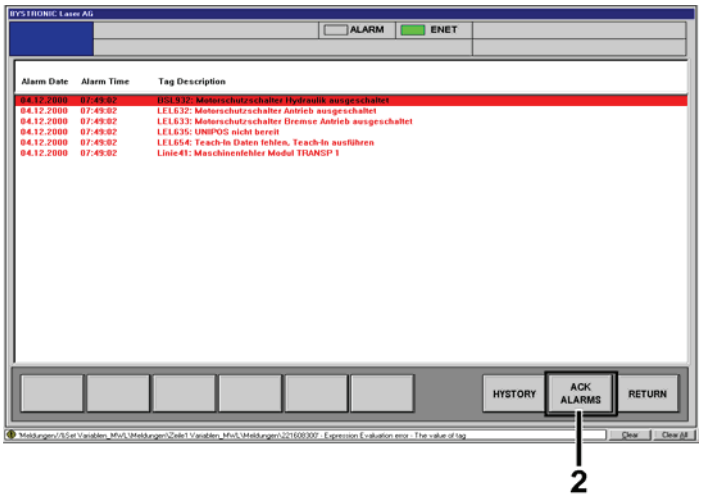
Alarm messages:

Fig. 7.2 -2



Any errors are shown on the display as clear text (**1**). By pressing the **[**ALARM**]** button the list where all errors are indicated is displayed.

Fig. 7.2 -3



If there are several errors, they can be shown in a list and be deleted using the button **[**ACK ALARMS**]** (**2**).

Alarm messages (**1**) are triggered by an erroneous controller state.

Various severe causes are shown using different colors for the error messaging.

Tab. 7.2-1

Alarm message color	**Meaning**
red	Current, pending alarm message which shuts down the system.
violet	Confirmed alarm message which remains in the list over a certain period of time.
blue	Unconfirmed alarm message, which does not cause an immediate shutdown of the system.

If a fault occurs, this triggers an alarm message and all automatic sequences and the manual mode in the corresponding module are stopped. After the problem is fixed and the alarm is acknowledged, operation can be continued.

7.3 HAND menu

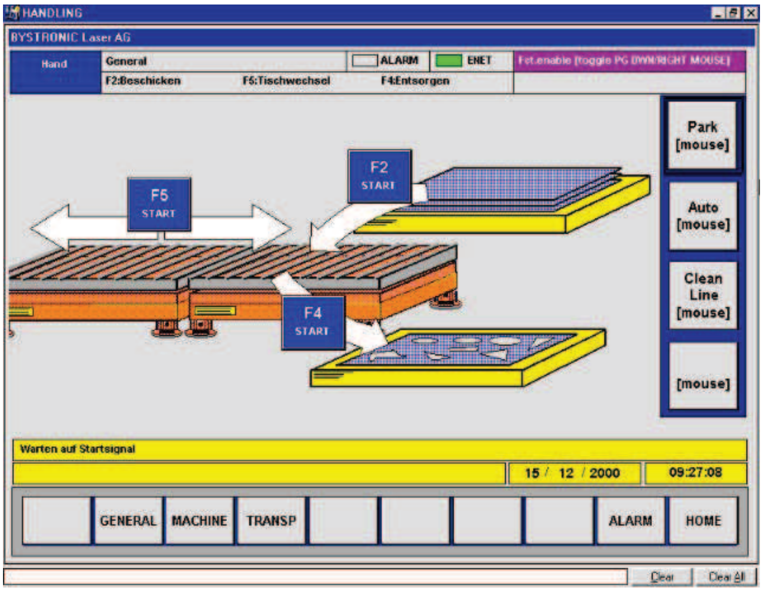
The Hand menu is used for starting semi-automatic and fully automatic processes.

HAND

By pressing the button **[**Hand**]** the following screen view is displayed.
In the Hand menu you can switch back and forth between the configured menus.
See example below, (Fig. 7.3-1 [GENERAL], [MACHINE] [TRANSP]).

7.3.1 GENERAL

Fig. 7.3 -1



On the one hand, the most important manual functions of the configured menus are displayed on this screen, and on the other hand this screen can be used to trigger processes that belong to several modules. The buttons **[**F2**]** and **[**F4**]** are optional and only active if a transport system is present: Likewise, using the buttons **[**Gen-eral**]**, **[**Machine**]**, **[**Transp**]**, **[**Alarm**]** and **[**Home**]** one can switch back and forth between the menus. (Transp = Transport menu)

Button description of the GENERAL menu

Tab. 7.3-1

Process description:	**Park**
Process description:	All configured Handling modules move into the park positions (base position).
Starting the process:	Press the **[**Park**]** button: If the process is active, the button changes color from gray to blue. If the process cannot be started, a corresponding message appears in the menu in which the start condition is missing.
Stopping the process:	Press the **[**Park**]** button: The entire handling stops and the button changes colors from blue to gray.
Process description:	**Auto**
Process description	All configured Handling modules move into the park positions. Afterwards, automatic mode is started.
Starting the process:	Press the **[**Auto**]** button: If the process is active, the button changes color from gray to blue. If the process cannot be started, a corresponding message appears in the module in which the start condition is missing.
Stopping the process:	Press the **[**Auto**]** button: All handling modules stop, and the button changes colors from blue to gray. Afterwards, this process can be restarted; and the process is continued. The process can be reset using **[**Park**]**; the Handling modules move back into the park positions.
Process description:	**Clean Line**
Process description:	The handling area is cleared. Material on the system is automatically unloaded or disposed of.
Starting the process:	Press the **[**Clean Line**]** button: If the process is active, the button changes color from gray to blue. If the process cannot be started, a corresponding message appears in the module in which the start condition is missing.
Stopping the process:	Press the **[**Clean Line**]** button: All handling modules stop, and the button changes colors from blue to gray. Afterwards, this process can be restarted; and the process is continued. The process can be reset using **[**Park**]**; the Handling modules move back into the park positions.
Process description:	**F2** (optional = transport system available)
Process description:	Material is loaded from the material position set in the "TRANSP" setup module onto the shuttle table. (For a more detailed description of the process see "TRANSP" module)

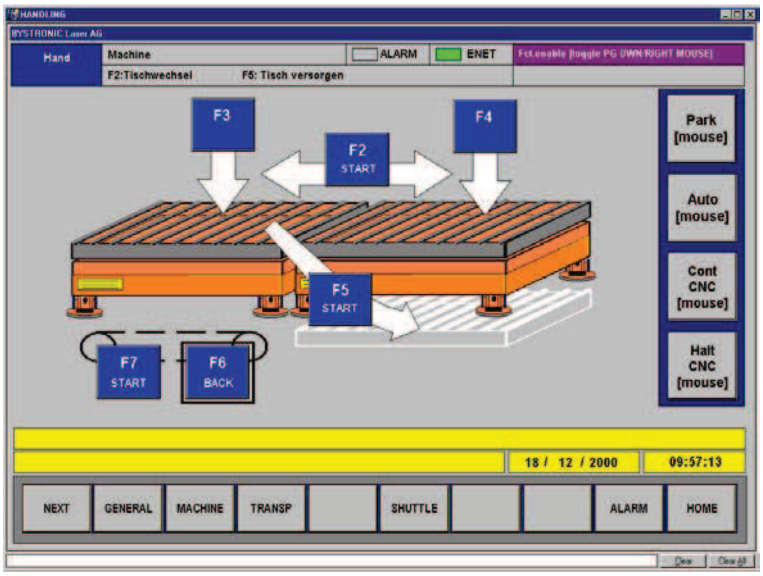
Starting the process:	Press the [F2 Start] button: If the process is active, the button changes color from blue to green. If the process cannot be started, the corresponding message appears that the start condition is missing in the TRANSP module (continue in the module).
Stopping the process:	Press the [F2 Stop] button: The handling stops and the button changes colors from green to blue. Afterwards, this process can be restarted; and the process is continued. The process can be reset using [Park]; the transport system moves back into the waiting position.
Process description:	**F4** (optional = transport system available)
Process description:	Material is removed from the shuttle table to the material position set in the "TRANSP" setup module. (A more detailed description of the process follows in the "TRANSP" module)
Starting the process:	Press the [F4 Start] button: If the process is active, the button changes color from blue to green. If the process cannot be started, the corresponding message appears that the start condition is missing in the TRANSP module (continue in the module).
Stopping the process:	Press the [F4 Stop] button: The transport system stops, and the button changes colors from green to blue. Afterwards, this process can be restarted; and the process is continued. The process can be reset using [Park]; the transport system moves back into the waiting position.
Process description:	**F5**
Process description:	A table exchange process is triggered.
Starting the process:	Press the [F5] Start button: If the process is active, the button changes color from blue to green. If the process cannot be started, the corresponding message that the start condition is missing in the TRANSP module appears.
Stopping the process:	Press the [F5] Stop button: The transport system stops, and the button changes colors from green to blue. Afterwards, this process can be restarted; and the process is continued. The process can be reset using [Park]; the transport system moves back into the waiting position.

NOTE

The described processes, depend on configuration and setup!

7.3.2 Overview in the MACHINE module

Fig. 7.3 -2



Main field

Tab. 7.3-1

F2	Table exchange button
F3	Modify material state cutting position
F4	Modify material state loading area
F5	Provide shuttle table
F6	Small parts conveyor backwards
F7	Small parts conveyor forward

Function fields

Tab. 7.3-2

Park	In this module, the shuttle table goes into its park position
Auto	When the button is pressed, the table exchange process is triggered by the CNC.
Cont CNC	Continuation of the machining sequence after **[**START**]**, **[**STOP**]** or after a request for confirmation. The function corresponds to that of the **[**CONT**]** key on the PC-panel machine keyboard. For additional information see MMC chapter.

Halt CNC	**[**HALT CNC**]** may be used to interrupt the machining process at any time (even within a geometric element). After pressing **[**HALT CNC**]**, the feed rate is gradually reduced to zero, the laser beam is deactivated and the tool lifted. If a cutout function or a pause in the program is reached during the braking phase, these commands are still executed. **Application examples:** – If a collision with the cutting head is predicted. – If there is a visible reduction in machining quality due to a change in the nozzle distance or the presence of slag. For additional information see MMC chapter.

7.3.3 Menu fields in the MACHINE menu

7.3.3.1 Table exchange process

Exchanging the table can be performed with the **[**F2**]** button in the "Hand / Machine" module. The button indicates whether the table exchange process is active.

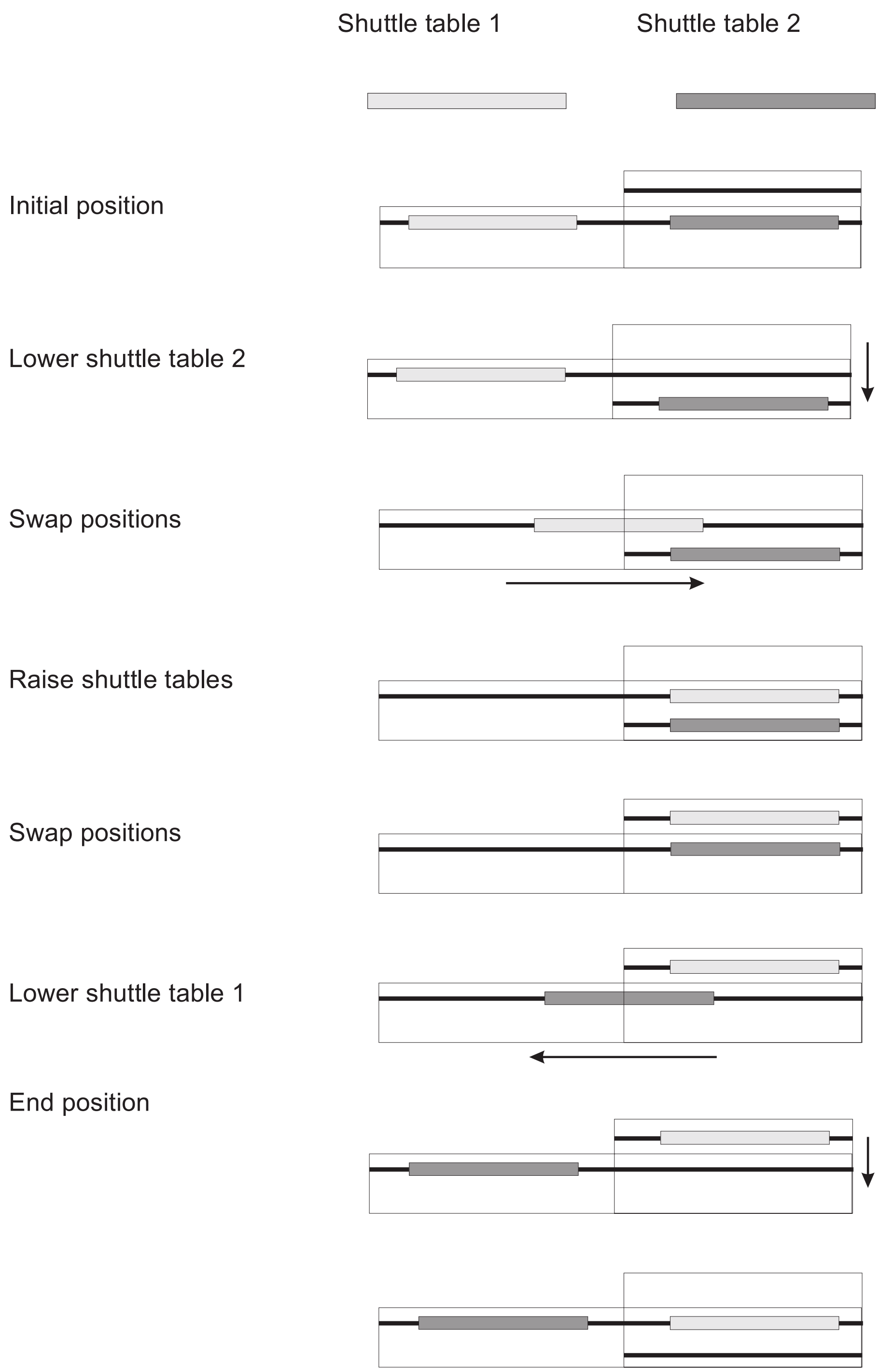
[F2**]** button blue:

The system is ready to execute a table exchange process.

[F2**]** button green:

A table exchange process is being executed.

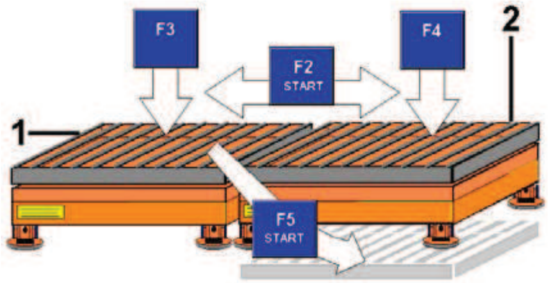
The following graphic shows a typical sequence of a table exchange process:



7.3.3.2 Modify material positions

You can enter the material positions using the buttons **[**F3**]**, **[**F4**]**. A raw sheet is set either on the loading position (**1**) or in the cutting position (**2**). The colored sheet displays the position of the raw sheet on the table.

Fig. 7.3 -3



1: Cutting position

2: Loading position

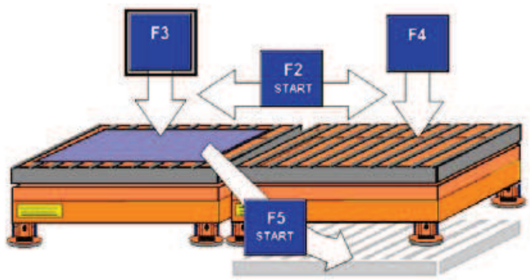
[F2**]**: Table exchange button

[F3**]** and **[**F4**]**: Modify material state button

[F5**]**: Provide table button

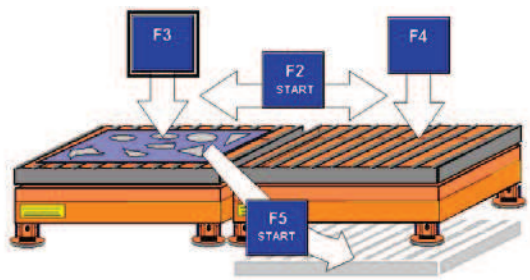
There is no material on the shuttle table in the cutting position (**1**) and loading position (**2**). If there is a difference between the target state and actual state, press the buttons **[**F3**]** or **[**F4**]** until the current actual status is reached.

Fig. 7.3 -4

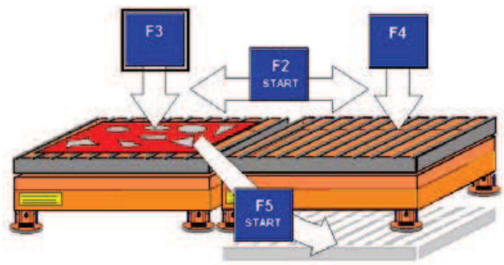


A raw material sheet is located on the cutting table (sheet marked with blue coloring).

Fig. 7.3 -5



Cut material is located on the cutting table (machined sheet with cut-out parts is marked with blue coloring).



Cut material is located on the cutting table (machined sheet with cut-out parts is marked with blue coloring).

7.3.3.3 Provide table

By pressing the button **[**F5**]** both tables are moved into the area of the loading position.

This function is needed for machining tubes (activation of U-axis) or for cleaning the cutting area.

In order to move the table back into the cutting position, the button **[**F2**]** must be used to activate a table exchange process.

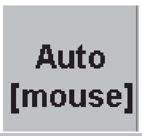
7.3.3.4 Small parts conveyor

While the **[**F6**]** button is depressed, the small parts conveyor runs backwards.

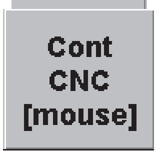
Pressing the **[**F7**]** button once makes the small parts conveyor run forward for **three** minutes.

7.3.4 Function fields in the MACHINE module

By pressing the **[**Park**]** button both tables are moved into the defined park position (reference position). If the shuttle tables are already in the reference position, they remain there.



If the function button **[**Auto**]** is active (blue), the table exchange process (function **[**F2**]**) is automatically started by the CNC after the cutting process is complete.



Button **[**CONT CNC**]**. The function **[**CONT CNC**]** corresponds to the **[**S7**] key** in the "Work" menu and in the "Hand" menu of the MMC (for additional information see also the MMC manual).

Button **[**HALT CNC**].** The function **[**HALT CNC**]** corresponds to the **[**HALT**]** key on Panel PC keyboard (for additional information, see also the MMC manual).

7.4 Setup menu

Login

The menus "SETUP", "SERVICE" and "CONFIG" are password protected. The "CONFIG" module can only be modified by Bystronic service technicians.

In order to make modifications in the "SETUP" menu, a login must first be executed.

Fig. 7.4 -1

By pressing the [SETUP], [SERVICE] or [CONFIG] buttons, the login window appears in the Main menu with the keyed characters blocked out.

After pressing the [LOGIN] button, a dialog box appears in which a password is entered and must be confirmed by pressing [Enter].

Fig. 7.4 -2

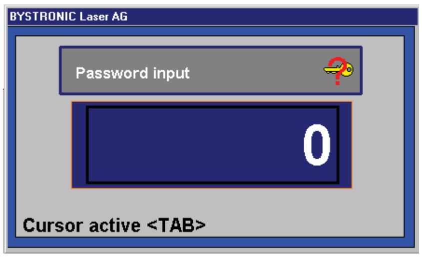


Fig. 7.4 -3

When the correct password is entered, the view of the login window (key enable) changes.

Now the values of the submenu can be modified.

7.4.1 Setup General

Different settings can be modified in connection with handling in the "Setup / General" menu.

NEXT

Flip to the next page by pressing the **[Next]** button.

NOTE

- Loading 01 = Loading of a material position **on the cutting table.**
- Loading 02 = Loading of a material position **on a different position** (can be used to load, e.g. distance material).

Tab. 7.4-1

Menu item	Description
Menu: "Setup / General" screen 1/3	
TAB Loading from material position 1 ☑	Load raw material from material position 01 onto the cutting table (with suction cup).
F1 Removal to material position 1 ☑	Unload raw material from the cutting table to material position 01 (with suction cup).
F2 Disposal onto material position 1 ☐	Dispose machined material from the cutting table to material position 01 (only with the double rake system)
F3 Disposal waste to material position 1 ☐	Dispose machined material from the cutting table to material position 01 (only with the double rake system)
F5 Loading from material position 2 ☐	Load raw material from material position 02 onto the cutting table (with suction cup).
F6 Removal to material position 2 ☐	Unload raw material from the cutting table to material position 02 (with suction cup).
F7 Disposal onto material position 2 ☑	Dispose machined material from the cutting table to material position 02 (only with the double rake system)
F8 Disposal waste to material position 2 ☑	Dispose machined material from the cutting table to material position 02 (only with the double rake system)
Menu: "Setup / General" screen 2/3	
TAB Loading 2 from material position 1 ☐	Load raw material from material position 01.

Menu item	Description
F1 Loading 2 onto material position 1	Load raw material onto material position 01.
F4 Automatic mode including storage unit	Automatic operation of laser machine and storage system possible.
F5 Loading 2 from material position 2	Load raw material from material position 02.
F6 Loading 2 onto material position 2	Load raw material to material position 02.
Menu: "Setup / General" screen 3/3	
TAB Dispose remaining material without BYSORT	Even though the Bysort system is available, the remaining material is disposed of without this system.
F1 Serial number check	Activate serial number monitoring (if it is deactivated, a zero is transferred).
F2 Full automatic line w/o loading	Fully automatic operation is activated without loading (material must be manually placed).
F3 Panelsprache [DE] F4 Panelsprache [EN]	F8 Panelsprache [FR] F9 Panelsprache [IT]
Selected active language is marked in green. When a language change is made, it is implemented only after the software is restarted.	
F5 In case of failure, dispose BYSORT with LEL	The transport system disposes of the remaining grid and the cut parts.
F6 Job data management	Job data management (cutting plans to be implemented) is activated.
F7 Full automatic line w/o disposal	Fully automatic operation is activated without disposal (material must be manually disposed).

7.4.2 Setup Machine

Blocking the shuttle table exchange process

In the "Setup / Machine" menu, you can block the shuttle table exchange process **[**F5**]**.

Fig. 7.4 -4

The shuttle table exchange is enabled.

Fig. 7.4 -5

The shuttle table exchange is blocked. No activation possible using the operating software.

Small parts conveyor

Fig. 7.4 -6

Automatic operation of the small parts conveyor:

Only if the menu entry is activated, does the small parts conveyor run in cutting mode. Otherwise the small parts conveyor must be activated using jog mode. (see page 1.3.3.4)

NOTE

It is recommended that the small parts conveyor always be operated in automatic mode. Only if the remaining parts are regularly removed into the catch tank is a trouble-free operation of the machine possible.

7.5 Service menu

The "SERVICE" menu is password protected and is used for step-by-step operation of the system. This menu must only be utilized by Bystronic service technicians.

7.6 Config menu

The "CONFIG" menu is password protected and is used for hardware configuration of the system. This menu must only be modified by Bystronic service technicians.

7.7 Rotary axis (Option)

The rotary axis is a supplementary device that is suitable for machining tubes and profiles. The rotary axis consists of a clamping spindle (four jaws), tail stock and two pedal units.

7.7.1 Clamping spindle

You can operate the clamping spindle using the foot pedals or the "Service / General" menu on the panel PC.

Clamping and release of a workpiece.

1. Open the safety door.

2. Using the pressure regulating valve and a test part, adjust the locking pressure of the pneumatic screwdriver.

3. Clamp/release workpiece and close safety door.

4. Implement cutting plan.

NOTE

The optimum locking pressure depends on the size and weight of the workpiece. Choose the lowest possible locking pressure. In general, a pressure of about 2 bars is sufficient. Move the pneumatic cylinder to about 1 cm from its maximum travel.

⚠WARNING

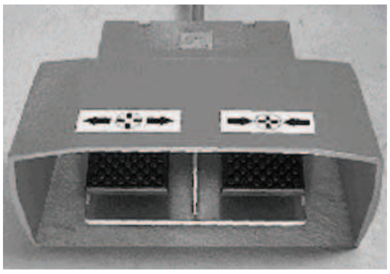
When the safety door is open, the pneumatic clamping spindle can be moved.

Risk of crushing between the pneumatic screwdriver and the locking spindle. Do not place your hands between the screwdriver and the clamping spindle.

Risk of crushing between the jaws of the spindle and between the jaws and the workpiece. Do not hold the workpiece from the front. During setup, do not lean against the jaws of the spindle.

Pedal unit: Spindle locking device

Fig. 7.7 -1



Open spindle ¦ Close spindle

Close spindle

Moving the jaws towards the center.

– With parts to be gripped from the inside, this movement releases them.
– With parts to be gripped from the outside, this movement fixes them

Open spindle

Moving the jaws outwards:

– With parts to be gripped from the inside, this movement fixes them.
– With parts to be gripped from the outside, this movement releases them.

7.7.2 Tailstock

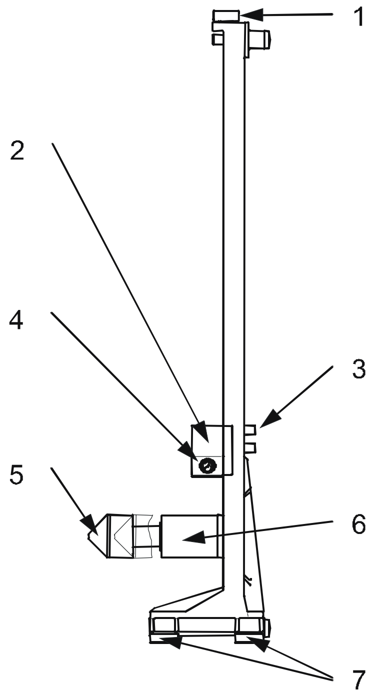
The tailstock is used for centering the workpieces to be locked in the rotary spindle. Two different steel tailstocks are provided. They differ in the diameter of their opening at the tip. One version has a diameter of 8 mm. The other has a diameter of 30 mm. Always use the tailstock with the largest possible diameter. This opening is used for suction. The tailstock can be moved along the two profile guides. To machine the workpiece, fix it using the two clamping screws and release it when it has to be moved.

1. Move the tailstock into the desired position and then tighten the screws on the locking jaws.

2. Make the electrical and pneumatic connections.

3. Regulate the locking pressure by means of the pressure regulating valve.

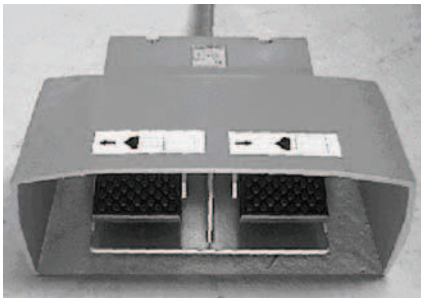
Fig. 7.7 -2



1	Glide roller
2	Pressure regulation valve
3	Pneumatic connection
4	Manometer
5	Tailstock
6	Pneumatic cylinder
7	Locking jaw screws (2 pieces)

Pedal unit: Tailstock

Fig. 7.7 -3



Position tailstock ¦ Release tailstock

WARNING

When the safety door is open, the pneumatic clamping spindle can be moved.

Risk of crushing during the positioning operation!

Risk of crushing from accidental positioning or releasing of the tailstock!

7.7.3 Machining with rotary axis

Switching from flat machining to machining round profiles:

1. Run with the shuttle tables at starting position or end position (see page [1.3.3.3])

2. Press the position tail stock pedal once only for a short time.

3. Remove the protective cover of the rotary axis / tailstock.

4. Connect the compressed air tubes to the tailstock.

5. Press the "release tailstock" pedal

6. Move the tailstock into the desired position.

7. Close the safety door. Move to the reference position. Check to see whether the spindle turns to the reference position.

8. Open the safety door. Press the Lock spindle pedal. Now the spindle drive scroll rotates in the clockwise direction. Release the pedal, as soon as the start of the scroll passes the opening of jaw no. 4

9. Insert jaw no. 1 in slot no. 1.

10. Activate "lock spindle" again as soon as jaw no. 1 is inserted in the guide.

11. Repeat this procedure to insert jaws 2-4.

12. Press the "lock spindle" pedal until the ends of the jaws no longer protrude from the spindle.

13. At this point, you can start to machine tubes. Always lock the tube first and then apply pressure to the tube using the tail stock.

14. During the machining process, make sure to maintain a minimum distance of 100 mm between the tailstock and the cutting head. Otherwise, there is a risk of the tailstock colliding with the cutting head centering screw. If in doubt, execute a test cycle first in "test" mode.

NOTE

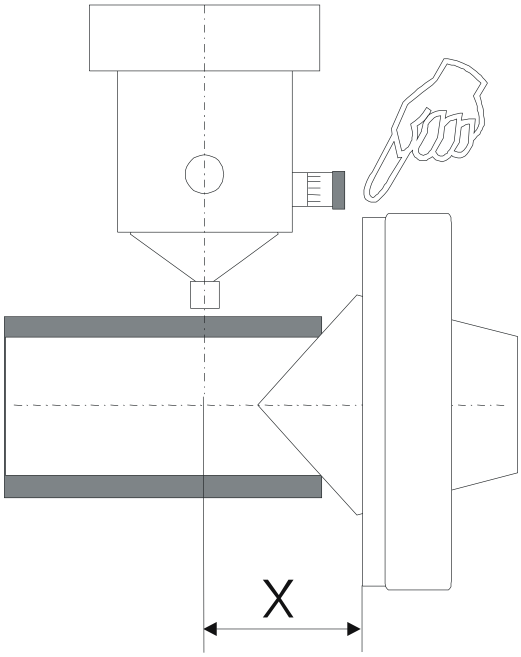
The dust produced during the machining process is also deposited inside the spindle, increasing friction and wear considerably. Therefore, avoid increasing the locking pressure when adhesion is reduced (through-slip during rotary movement), but instead clean the spindle, if necessary, following the maintenance instructions given by the manufacturer.

Use suitable load lifting devices, if you have to machine heavy parts. Choose the lowest possible locking pressure.

Set up and adjust the cutting head before positioning or after releasing the workpiece.

Cutting head

Fig. 7.7 -4



The distance x must be at least 100 mm

Now mount the suction tube. Regulate the shutter so as to obtain maximum suction power, without any whistling. Make sure that the suction tube does not collide with the small parts conveyor.

Switching from tube machining to flat machining:

1. Remove the jaws of the clamping spindle. You can release them using the spindle pedal. Hold the jaws before they fall out.

2. Position the tailstock using the pedals

3. Detach the air tubes.

4. Push the tailstock all the way into the spindle (parking position)

5. Mount the cover plate.

6. Execute a shuttle table once.

Operator's Manual

Laser Machine

Transport and Installation

Issue 02.98

Contents

9 Transport and Installation

Setting up the machine includes removing it from the packaging, installing and assembling it, setting it up for the first time and testing it. This procedure is carried out by Bystronic with the customer's cooperation. It is put into operation following instructions given in another manual.

9.1 Disassembling the machine for transport

The indications that follow also apply to the disassembly of material prepared for transport when repairs and revisions are to be carried out.

General Information

- We recommend that the only disassembly operations you perform are those described in the maintenance manual. Other disassembly operations must only be performed by persons who have had further maintenance training.
- Power off the machine and unplug it from the electrical, gas and compressed air supplies.
- Detach all connections such as cables, hydraulic and pneumatic circuits, pipes and mechanical connections. detach the connections, if possible, at one end only.
- Grease and oil all the uncovered parts of the machine.

Detach all the connections with the water meter and remove all water from the cooling circuit.

Head

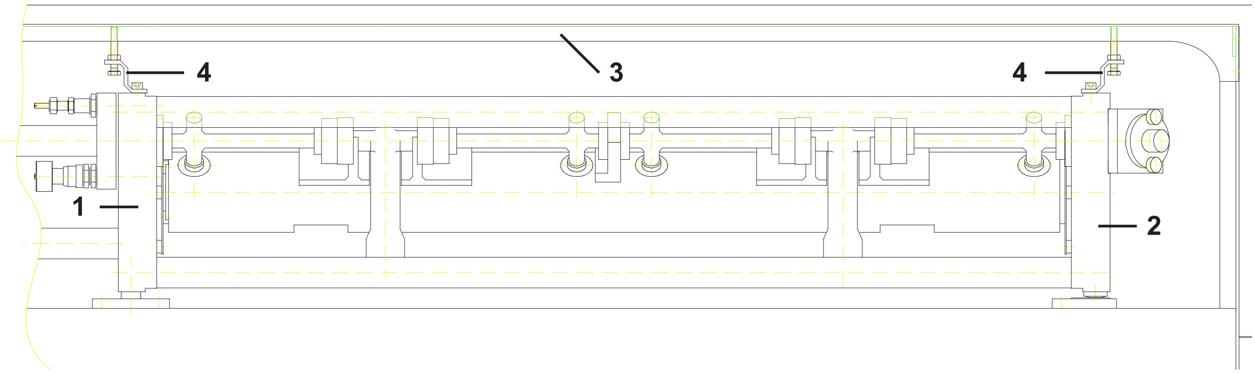
apply the protective cover to the entrance. If this opening is not covered, damp may penetrate inside to the lens and damage it. Remove any remaining cooling water if there is a risk of it freezing during transport or storage.

9.2 Preparing for transport

- Cover all the openings on the beam path so that they are all airtight.
- Lock all moving parts.
- For transport, use crates of a size that is suited to the size and weight of the components and that thus enable their contents to be firmly held in position.
- Indicate the contents of the containers by marking them on the top. With components that contain optical components or glass parts, indicate exactly what they contain also on the package.
- The components of the system must be prepared for transport so that they can be lifted with a crane or lift truck.
- Organize the loading, transporting and unloading phases: accompany the goods with a clearly defined installation plan, so that, during the unloading phase, the crates can be arranged, as far as possible, in the order in which they will be required during assembly.

9.2.1 Resonator

Schematic representation of the top part of the resonator



1 mirror front plate
2 mirror end plate
3 frame, top part of resonator
4 safety device for transport 2-04307

Assemble the safety devices on the top part of the resonator both for the actual transport phase and for subsequent maneuvers on the installation site.

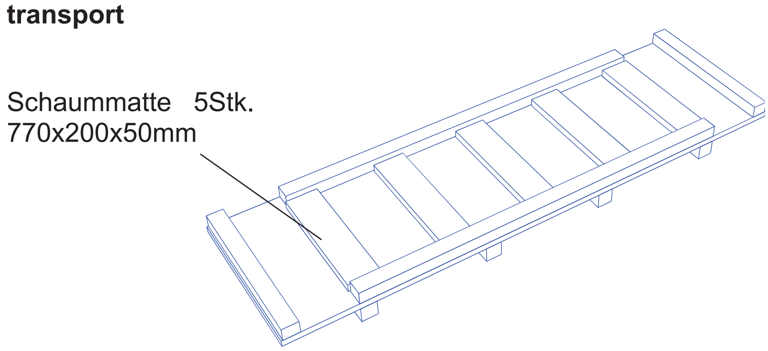
1. Screw the transport safety devices (4) to both sides of the mirror plate (1 and 2) .
2. Fix both safety devices (4) with the frame to the top part of the resonator (3) using the screws.

Other operations involved in preparing the resonator for transport

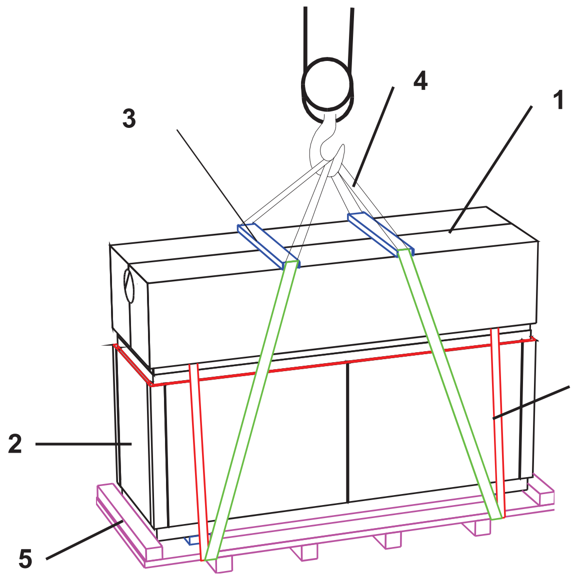
1. Prepare the floor on which it is to be transported by covering it with 5 foam rubber mats to absorb shocks.
2. Lift the resonator with a crane, lifting belts and arms. The arms protect the resonator while lifting it with the crane.
3. Loosen the feet to adjust the height so that the resonator is positioned well on the mats.
4. Pack the height adjusting feet in the bottom part of the resonator.
5. Fix the resonator to the floor using the fixing belts.

If there is a risk of freezing during transport or the resonator is to be stored for a long period of time, the entire cooling circuit of the resonator must be removed. This circuit consists of the cooling device, the radiator of the high-voltage power supply cabinet and the radiator in the laser.

Floor for transport

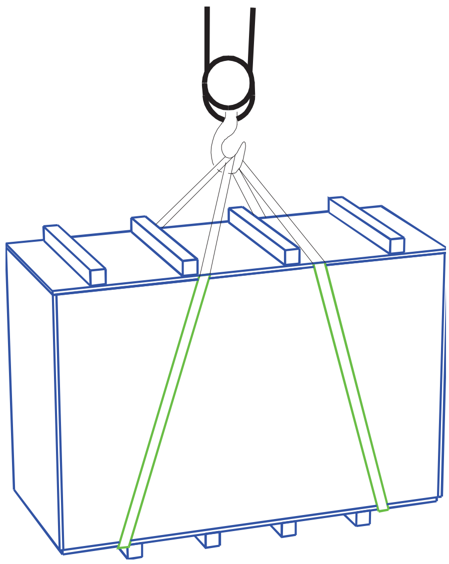


Transport on lorries



1 Top part of Laser
2 Bottom part of Laser
3 Arms
4 Suspension belts
5 Support skids
6 Fixing belts

Transport in containers



When transported in a container, the resonator must be packed in a wooden crate.
The high-pressure pump and the resonator can be hoisted using suspension belts.

Important information about the resonator package

– If it is to be transported overseas (in containers), the resonator is packed in Cortec_VCI 126 (green) film, before being placed in the cage. To provide protection against corrosion, Cortec VCI-137 foam is distributed in the bottom part and top part of the resonator.
– If it is to be transported by lorry, the resonator is completely wrapped in blister packing.

Cage measurements

	Internal measurements (cm)	External measurements (cm)
BTL 1800	265 x 101 x 175	272 x 108 x 190
BTL 3000/3500	335 x 101 x 175	342 x 108 x 190

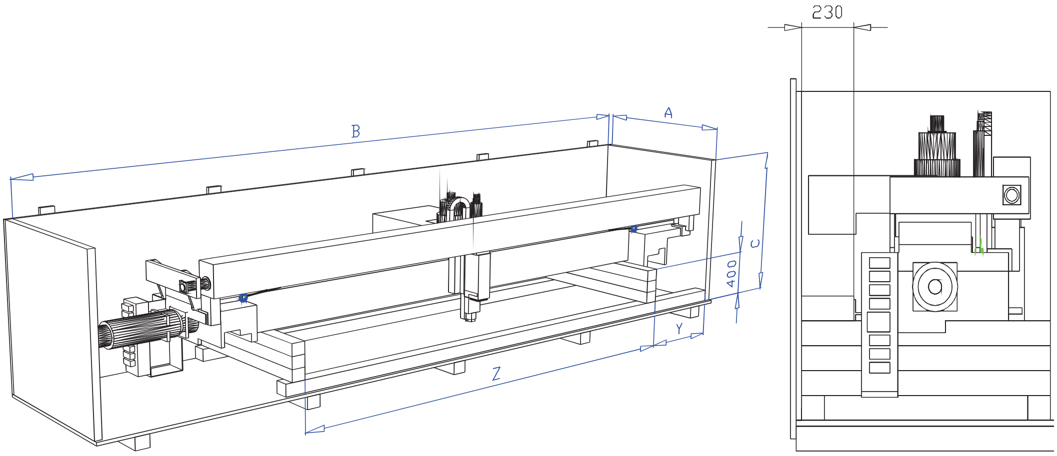
Laser

Caution:

The resonator contains glass parts! Always use the support skids to move the resonator to the final installation site! If the system has already been used before transport, follow also the instructions given in the “Disassembly” section.

9.2.2 Cutting bar with small material

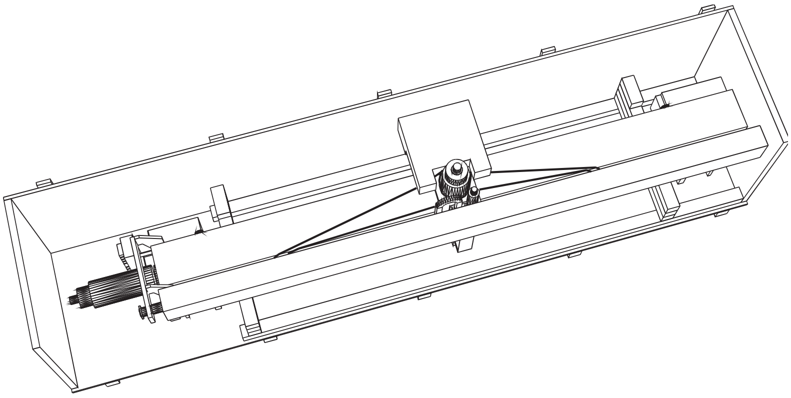
Cutting bar complete with power cables and cutting carriage, Z axis.



Cage Measurements

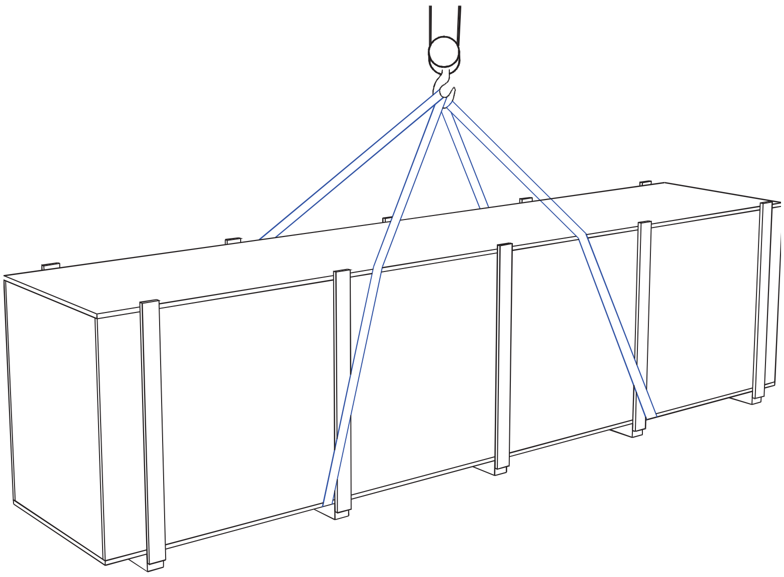
	A mm	B mm	C mm	Y mm	Z mm
Bystar 2512	1100	4900	1300	600	2900
Bystar 3015	1100	5400	1300	600	3350
Bystar 4020	1100	6600	1300	700	4300
Bysprint 2512	1100	3000	1300	500	1380
Bysprint 3015	1100	3000	1300	500	1380

Fixing the cutting carriage



The cutting head is held from the side by a retaining belt which is tightened around the motor and the two front eyebolts. This mechanism stops the cutting head from moving during transport.

Cage ready for transport



Weight of the cage ready for transport including the small material with the following weight.

– Bystar	2512	1850 Kg
– Bystar	3015	2000 Kg
– Bystar	4020	2000 Kg
– Bysprint	2512	550 Kg
– Bysprint	3015	600 Kg

Small Material

Small material is put in the cutting bar cage. This material consists of:

- Spare part set for the BTL 1800 / 3000 / 3500 resonator
- Sealing ring set (Byjet)
- Wear part set
- Console for CPM

Important information for the packaging of the cutting bar and small material

– If it is to be transported by lorry, the cutting bar with its parts is completely wrapped in blister packing.

Warning:
A further cage is required for the Bystar 4020. The main frame of the Bystar 4020 is removed for transport, the conveyor belt must therefore be packed in a separate crate.

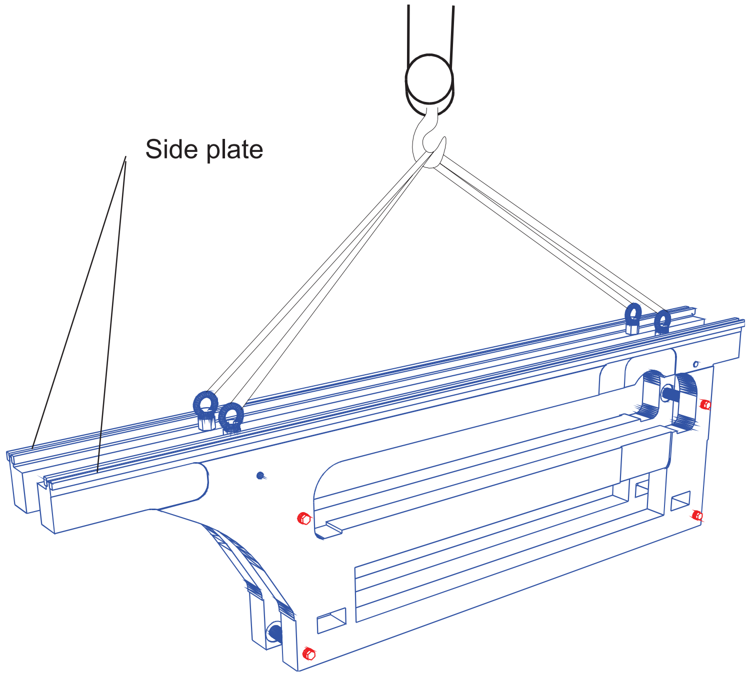
This crate, which measures 850x600x800mm, contains:

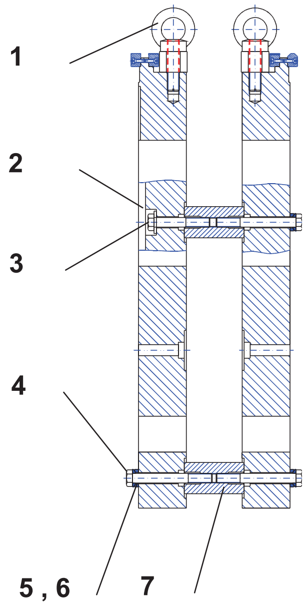
– Scraper drive
– Parts for scraper
– Consumable parts

Weight: ca. 150 Kg .

9.2.3 Side plates of the main frame of the Bystar 4020 and Bylas

The main frame of the Bystar, Bylas is disassembled for transport. The side plates are prepared for transport as shown in the drawings listed below:





1	Eye bolt M30	Sec.Bystronic Dr.. n°.: 3-06183	4 parts.
2	Lock washer 25/56x6	DIN 6796	2 parts.
3	Hexagonal head screws with M24x140 shank	DIN 931	2 parts.
4	Hexagonal head screws with M24x200 shank	DIN 931	6 parts.
5	Spherical washers No.05.24500.340	DIN 6319C	6 parts.
6	Seat of ball and socket joint No.05.24600.340	DIN 6319D	6 parts.
7	Transport tube	Sec. Bystronic Dis.. n°.: 3-06031	4 parts.

9.2.4 Machine frame

The basic frame of the Bystar 3015 / 2512 and Bysprint models are fitted with four eyebolts, where the belts for hoisting are attached. Transport the basic frame using a suitable lift truck. (Also valid for Byjet 3015).

9.2.5 Electrical control boxes

These are also fitted with eyebolts for transport using belts.

9.2.6 Fitted lifting units

As far as the 2512 and 3015 Laser systems are concerned, the lifting units are transported as a single part. As with the frame, they can be hoisted by means of the four hoisting points. The lifting units of the 4020 and Bylas systems are screwed onto the side panels in a similar way, with four eyebolts.

9.3 Transport

For transport use is made of 2 tractor trucks or 2 40’ containers (overseas).

Use a crane or lift truck for unloading, internal transport and installation.

For the measurements and weights of the main components, see the table below:

Measurements and weights

	L x B x H [m]	Mass [kg]
Main frame incl. 2 tables		
Bystar 2512	4 x 1.95 x 1.1	4’200
Bystar 3015	4.6 x 2.2 x 1.1	4’800
Bysprint 2512	4 x 1.95 x 1.1	4’200
Bysprint 3015	4x6x2.2 x 1.1	4’800
2 Side plates for Bystar 4020		2x1900
2 Frames for Bystar 4020		2x 700
2 Tables for Bystar 4020		2x 275
2 Joint for main frame 4020		2 x 175
Scraper base for Bystar 4020		1000
2 guides forscraper base 4020		2 x 125
Conveyor for Bystar 4020		580
Carriages and crossbars		
Bystar 2512	4.6 x0.8 x 1.3	800
Bystar 3015	5.1 x0.8 x 1.3	800
Bystar 4020	6.1 x0.8 x 1.3	900
Bysprint 2512	2.5 x0.8 x 1.3	400
Bysprint 3015	2.8 x0.8 x 1.3	450
Protective door		
Bystar 2512	3.5 x 2.0 x 0.3	220
Bystar 3015	4.0 x 2.0 x 0.3	280
Bystar 4020	5.0 x 2.0 x 0.3	310
Hydraulic unit		150
Laser BTL 1800	2.5 x 0.95 x 1.8	1700
BTL3000/3500	3.5 x 0.95 x 1.8	1800
Cooling device. WKL 180	1.35 x 0.9 x 1.4	450
PEDIA HT 30	1.3 x 0.9 x 2.0	450
CPM, LAS- and CNCcabinet	2.0 x 1.2 x 2.0	1’150
Gas cabinet single	0.95 x 0.91.9	270
double	1.9 x 0.9 x 1.9	540
Modular design:		
Interchange table		
Intermediate frame drive		160
2 lifting units		2 x 300
Guides 2 parts		2 x 75
2 tables each		400
Power supply		
Bysprint / Bystar 2512	3.7 x 1.95 x 1.1	1’100
Bysprint / Bystar 3015	4.3 x 2.2 x 1.1	1’200
Bysprint / Bystar 4020	5.5 x 2.7 x 1.1	1’200
Plate-holding table 2 parts		
Bysprint / Bystar 2512	3.6 x 1.4 x2.5	500
Bysprint / Bystar 3015	4.0 x 1.6 x2.5	690
Bysprint / Bystar 4020	4.8 x 2.0 x2.5	690
Rotating axis (incl tailstock)	0.8 x 0.5 x 0.5	170
Herding filter Bystar 2512		950
Herding filter Bystar 3015		1’090
Herding filter Bystar 4020		1'090
Supplementary equipment:		
Exhaust air filter		1200

9.4 Unloading

Follow also the instructions given in the "Loading" section.

Warning:

When positioning the single components, avoid knocking and denting them. Damage to the machine parts may reduce machining precision and the life of the machine.

Temporary storage

Store in dry places only, with temperatures in the range +10°- +35° C.

9.5 Removing the packaging

Check the goods sent immediately after its arrival to check that there is nothing missing and no damage was caused during transport!
Should any damage be found, draw up a report in the presence of the person responsible for transport and inform Bysronic immediately, indicating the damage found!

9.6 Assembly

– Before starting assembly, make arrangements with Bystronic and the person responsible for assembly at the customer's site, so that all parties are informed of any recent changes made.
– Include the training phase that follows assembly in the start of production time plan.
– Place wells and channels on the floor; these must be accessible and positioned outside the space occupied by the machine. The floor slab on which the machine rests must not be cracked or feature expansion joints.
– Clearly mark the outline and the position of the machine frame and resonator and the outline of the control cabinets on the floor. If you have a water level, determine the differences in level between the feet (flatness of floor).
– Clear the asse,bly site of sand.

The following connections must be made available by the user

– electrical and pneumatic connection for about the 3rd day of assembly.
– connection to the gas line on about the 5th day of assembly.

Operator’s Manual

Laser Machine

Cutting technology

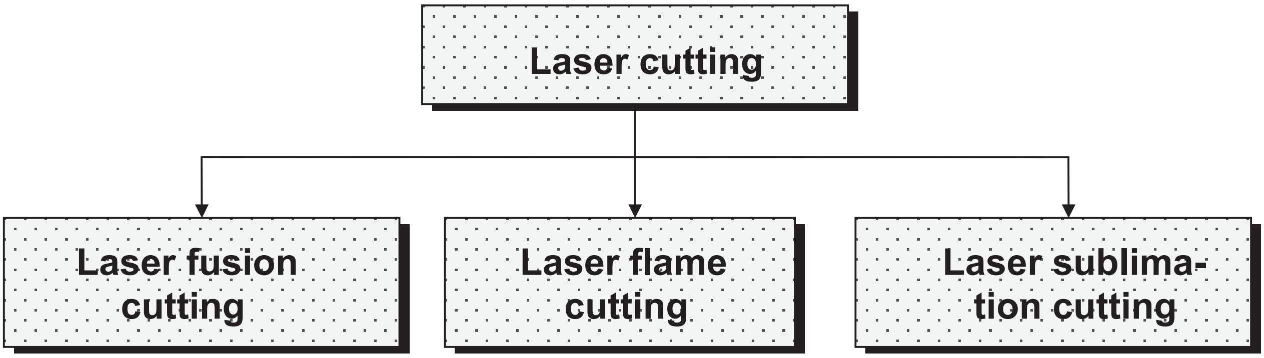
Issue 07.2000

Table of contents

10 Cutting technology

10.1 Laser cutting methods

The term cutting technology has been selected as a generic term used to describe the processing of raw materials with a laser cutting machine. The engraving can be considered as a type of cutting process. In the engraving, energy acts on the material for a short period of time, so that only the surface is processed.



10.1.1 Laser fusion cutting

In the laser fusion cutting the workpiece is locally melted and the molten material is ejected with the help of a flow of gas (Nitrogen N_2). As the transport of material takes place in the liquid phase only, this process is referred to as laser fusion cutting.

The laser beam is supplied with a inert cutting gas of great purity which forces the molten material out of the kerf but is not involved in the cutting process itself.

– Laser fusion cutting allows a higher cutting speed than that of laser flame cutting and laser sublimation cutting. The energy evaporation necessary is generally higher than the energy necessary required to melt the material. The laser beam is absorbed only in part in the laser fusion cutting.

– The maximum cutting speed increases with the laser power and decreases in an almost inverse proportion to the thickness of the panel and the temperature of the material fusion. The limit factors, once the laser power is preset are the gas pressure in the kerf and the heat conduction.

– The laser fusion cutting can produce oxide free cuts in iron material and on titanium.

– The density field of the power flow that generates the fusion, but yet does not generate evaporation, ranges for steel between 10^4 W/cm^2 e 10^5 W/cm^2.

10.1.2 Laser flame cutting

Laser flame cutting differs from fusion cutting in the use of oxygen as a process gas. Thanks to the interaction between the oxygen and the heated metal, a reaction which results in further heating of the material is triggered. Due to this effect, the cutting rates achievable with this method in structural steel, of the speed that, according to thickness of the panel and power of the laser are greater than those obtain with fusion cutting.

On the other hand this procedure may produce cuts of lower quality in comparison to those produced with fusion cutting. In fact they can create larger kerf, noticeable roughness, increased heat affected zones, lesser quality of the edges.

- Flame cutting may be critical in the machining of precision templates and acute geometrical angles (danger of eliminating the angle by burning it). The contribution of heat can be limited by using the pulse mode.
- The laser power used determines the cutting speed. The limit factors, once the laser power is set, are the availability of oxygen and the heat conduction.

10.1.3 Laser sublimation cutting

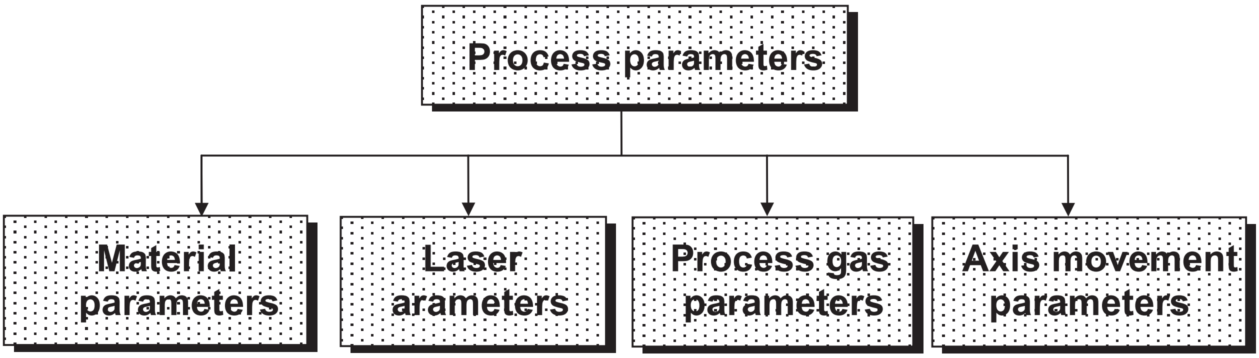
In the process of laser sublimation cutting the material is evaporated in the kerf very high laser intensities are required in this case.

In order to prevent a condensation of material vapour on the kerf walls, the thickness of the material must not greatly exceed the laser beam diameter. This machining is therefore only suited for application in which expulsion of molten material must be avoided by all means. It is actually noted a limited usage fields for iron based alloys.

This machining process cannot be carried out on materials such as wood or special ceramic which do not present a melting phase and are therefore unlikely to allow the material vapours to recondense. In addition, these materials normally enable much thicker cuts to be made.

- In laser sublimation cutting, the optimum beam focusing depends on the material thickness and the beam quality.
- The laser power and heat of evaporation have only a modest influence on the optimum focus position.
- The maximum cutting speed, once the thickness of the panel is specified, is inversely proportional to the temperature of evaporation of the materials.
- The necessary power density must be greater than 10^8 Watt/cm^2 (in the Bystronic laser and equal to a maximum of 1.5^x10^7 Watt/cm^2) and depends on the material, the cutting depth, and the beam focus position.
- The maximum cutting speed and the given thickness of the panel, assuming a sufficient laser power, the maximum cutting speed is limited by the speed of the gas jet.

10.2 Machining process



The term “machining process” refers to the interaction between the laser beam, process gas and the workpiece.

10.2.1 Cutting process

The area in which this process occurs is the cutting front. The laser power acting on this cutting front must heat the workpiece to the temperature required to change the material phase into molten material and vapour.

The cutting front is made up of an almost vertical surface which is heated and melted by the absorbed laser radiation.

– In the laser flame cutting, this fusion zone is furtherly heated by the oxygen flow entering the kerf and reaches a temperature near the boiling point. The resulting high evaporation causes a removal of material. At the same time, thanks to the process gas, the liquid material is expelled from the lower side of the workpiece.

– In laser fusion cutting, the liquid material is expelled by this gas, which also protects the kerf against oxidation. The continuous fusion zone is progressively shifted following the direction of the cut. Therefore creating a continuos kerf.

Many important operations of laser cutting process take place in this zone. The analysis of these operations can provide important information on laser cutting. This way, it is possible to calculate the cutting speed and explain the formation of the drag line characteristics.

10.2.2 Material properties

The result of the cutting operation carried out on the workpiece can be a clean cut or on the contrary present a cut edge ragged or with burns.

The most important factors that influence the cutting quality are:

- the alloy composition
- material microstructure
- the quality of the surface
- the roughness of the surface
- the treatment of the surface
- the reflection of the beam
- the thermal conductivity
- the point of fusion
- the heat fusion
- the temperature of evaporation

Alloy components

The alloy composition influences in a determined way the robustness, the specific weight, the weldability, the resistance to oxides, and acid materials. Some important elements forming the alloys of ferrous materials are: carbon, chrome, nickel, magnesium and zinc.

The higher the carbon content, the more difficult it is to cut the material (the critical limit is found with 0,8% of carbon). The following carbon steels can be well cut with the laser:

St 37-2, StW 22, DIN 1.203.

Fundamental microstructure of the material

The finer the grain that makes the microstructure of the material to be cut, the better the quality of the edges would be in general.

Quality and roughness of the surfaces

If the surface presents rusty areas or an oxidized layer, the contours of the cut will prove irregular and present many breakage points.

If corrugated sheets are to be cut, choose the cutting parameters for the maximum thickness. The undulation must always be towards the bottom (reflection).

Treatment of the surface

The most frequent treatment of the surfaces are galvanizing, focus galvanizing, enamelling, anodizing or recovering with a laminated plastic film.

- The panels treated with zinc tend to form drops on the edge lesser that the cut, depending on the thickness of the lamination
- The quality of the cutting depends on the composition of the components of the painted products with enamelled panels.

How to proceed in the machining of enamelled panels:

- Activate <REPEAT> on the CNC control
- Select for the first pass (G11) a set of parameters with reduced power (engraving) for a pre-burnt-in mark of the treated surfaces.
- Select for the second pass (G10) the set of parameters that corresponds to the material to be cut.

The panels with a coating of laminated material are very suitable for the laser cut. In order for the capacitive scanning to work without any problems, and for the laminated coating to obtain optimum adhering, (avoiding forming blisters), the laminated side must always be on the upper part of the cut piece.

Beam reflection

How the beam is reflected by the surfaces of the workpiece depends on the basic material, the roughness and treatment of the surfaces. Some aluminium alloys (e.g. Anticorodal), copper, brass and stainless steel sheets are characterized by high reflectivity.

While cutting these materials, pay particular attention to the fine adjustment of the focus position.

Thermal conductivity

Material with a low thermal conductivity needs, for melting, less power, compared to materials with a higher thermal conductivity.

For example in steel, and chrome-nickel, the required power is less than the typical values of structural steel, also with a lesser absorption of the heat resulting from the process.

On the other hand materials such as copper, aluminium an brass dissipate a large portion of the heat generated by the absorption of the laser beam. As the heat is conducted away from the beam target point, the material in the heat affected area is more difficult to melt.

Heat-affected zone

Laser cutting and laser fusion cutting may result in the modification of materials in the edge zones of the cut materials.

The following table contains indicative values regarding the extension of the thermal affected area in function of the metal base and the thickness of the material.

Material thickness [mm]	**Thermal affected zone [mm]**		
	St 37	Steel	Aluminium
1	0.05	0.05	0.10
2	0.10	0.10	0.20
3	0.15	0.15	0.30
4	0.20	0.35	0.40
5	0.25	0.34	0.50
6	0.30	0.55	0.60
8	0.40	0.75	0.70
10	0.50	0.85	------
12	0.60	------	------

- When machining low carbon steels or oxide-free steels, the hardening in the heat affected zone is reduced.
- In high-carbon steels (example Ck60) a hardness increase in the area of the edges will occur.
- In hard-rolled aluminium alloys, the heat-affected zone will even be slightly softer than the remaining material.

10.2.3 Machinability of the different materials

Structural steel

Good results are obtained when this material is cut with oxygen. The Laser is used in CW mode. If the control system modifies the feed rate while machining contours with very tight bends, it adapts the laser power to the axis feed rate through modulation.

When working, for example, with oxygen as the process gas, the cutting edge will prove slightly oxidized. For sheets with a thickness of up to 4 mm use can be made of high-pressure cutting with nitrogen as the process gas. In this case, the cutting edges will not be oxidized.

Complicated contours and holes (∅ less than the thickness of the material) should be cut in pulse mode. In this way, the cutting of sharp corners and thin joints will be avoided.

– The higher the carbon content of the steel, the more the hardening of the cutting edges and the risk of burnt-off mark of the live angles will exist.
– Panels with a higher alloy percentage are more difficult to cut compared to those with a lower percentage.
– An oxidated or sandblasted surface will allow for a lower cutting quality.
– Heat residues on the panel surface have a negative effect on the cutting results.
– Starting from a thickness of 12 mm, good results are obtained using special plates for Lasers (e.g. Raex) and oiling the surface of the part during machining.The oil film reduces the adhesion of the slags to the surface and considerably helps the cutting. The oil film does not influence the results of the cutting operation.
– Cut only steel treated twice to eliminate tension. The impure contents in fused steel in effervescent conditions have in fact a great influence on the cutting results. Also the roller calender and internal stress will affect the cutting behaviour.
– For templates of small dimensions and panel thickness of 15 to 20 mm, steel with fine grain is recommended.
  (For example: „Raex-250-Laser“ of the steelworks Rautaruukki Raahe. This steel is obtained from a particular fusion with a maximum silicon content of 0,03% and a maximum carbon content of 0,012%.
  The traction resistance is equal to 360-440 N/mm^2.
  The limited yield ReH is equal to at least 250 N/mm^2.
  This steel has the following peculiar properties:
– no slag formation during the laser cutting
– no scrap of the cut pieces
– optimum folding
– reduced spring-back
– good welding suitability
– This steel is available in thickness up to 30 mm
– Inferior cutting results are obtained using St 52-3, as this steel tends to cause material runouts and burr caused by the viscous slags.
– To cut structural steel with a clean surface, the directions given below must be followed:

≤ Si 0.04 %:	to be preferred; excellent for laser machining
< Si 0.25 %:	slightly inferior cuts may be obtained in some cases
> Si 0.25 %:	quality of steel less suited to laser cutting and worse or inconsistent results are likely to be obtained.

Notice:

The tolerance in accordance with the DIN standard for steel up to St 52 is Si ≤ 0.55 %. This indication is too imprecise for machining with the laser beam.

Stainless steel

Cut this material

– with oxygen, if the oxidation of the edges is not considered important.

- with nitrogen to obtain oxide-free and burr edges that may then be cut without further treatments.
- using high laser power it is possible to obtain, with at high pressure cutting with nitrogen, and with equal thickness, a comparable or even higher speed than that possible with oxygen cutting.
- to cut stainless steel with nitrogen, starting from 5 mm on all table surfaces, without burr, an adjusting of the focal position is necessary. Re-entering the focal position and reducing the speed, makes it possible to carry out clean cuts even though small burr will be unavoidable. With the option „BYPOS“ the manual regulation of the focal position is not necessary.
- spreading an oil film on the plate surface will allow for better piercing results, without reducing the quality of the machining.

For stainless steel choose

- cutting with oxygen: pulse mode with a reduced feeding for sheet thickness from 5 mm.
- a distance of the nozzles that is substantially greater for the perforation compared to the cut. A greater nozzle distance helps to prevent splatter on the lens.

Aluminium

Aluminium and its alloys should preferably be cut in continuous mode. Despite their high reflectivity and capacity to conduct heat, aluminium sheets with a thickness of up to 8 mm can be cut, according to the type of alloy and the Laser power.

In the high pressure cutting procedure, the aluminium must be cut with Nitrogen:

- When oxygen is used as the process gas, the cutting surface becomes rough and hard. Only a little flash is produced but it is difficult to eliminate.
- with nitrogen, the cutting surface becomes smooth. When machining panels up to 4 mm. of thickness, it is possible to obtain, with optimal regulation, a cut practically without burr. With panels of higher thickness a burr difficult to remove will build up.
- Pure aluminium is more difficult to cut due to its alloys.
- The higher the alloy percentages and the hardness are, the easier the cutting of the material.
- Metal sheeting up to 3mm thick can be cut with oxygen.

Notice:

It is recommended to cut aluminium only when the machine is installed with the option “Reflection absorption”. Otherwise the reflections can damage the optical group.

Titanium

The sheets of titanium are cut using argon and nitrogen as process gas. The cutting parameters are stored in the PC panel.

When cutting with nitrogen yellowish cutting surfaces develop, and easily white ones when cutting with argon.

Copper and brass

- Both these materials feature a high reflection level and a very good thermal conductivity.
- Brass, with thickness up to 3mm, can be cut with nitrogen.

– Copper, with thickness up to of 3 mm, can be cut and oxygen must be used as process gas.

Notice:

It is recommended to cut copper only when the machine is installed with the option “Reflection absorption”. The reflections can damage the optical group.

Synthetic materials

Warning:

Keep in mind, in the cutting of synthetic materials, the focus hazards and the possible emission of dangerous substances. A list of these emissions is available in the chapter "Appendix".

Machinable synthetic materials: thermoplastics, thermosetting materials and elastomers. The machining of PVC or polyethylene is not possible with the Bystronic laser machine due to the fact that the released vapours cannot be adequately evacuated. For these two materials, it is better to use waterjet machining.

Acrylic glass can be cut with the laser. Nitrogen is used as process gas at a pressure that must be lower than 0,5 bar. This way a glossy cutting surface is created.

Organic substances

Danger:

A fire hazard exists in all organic substances cutting (use nitrogen as a process gas).

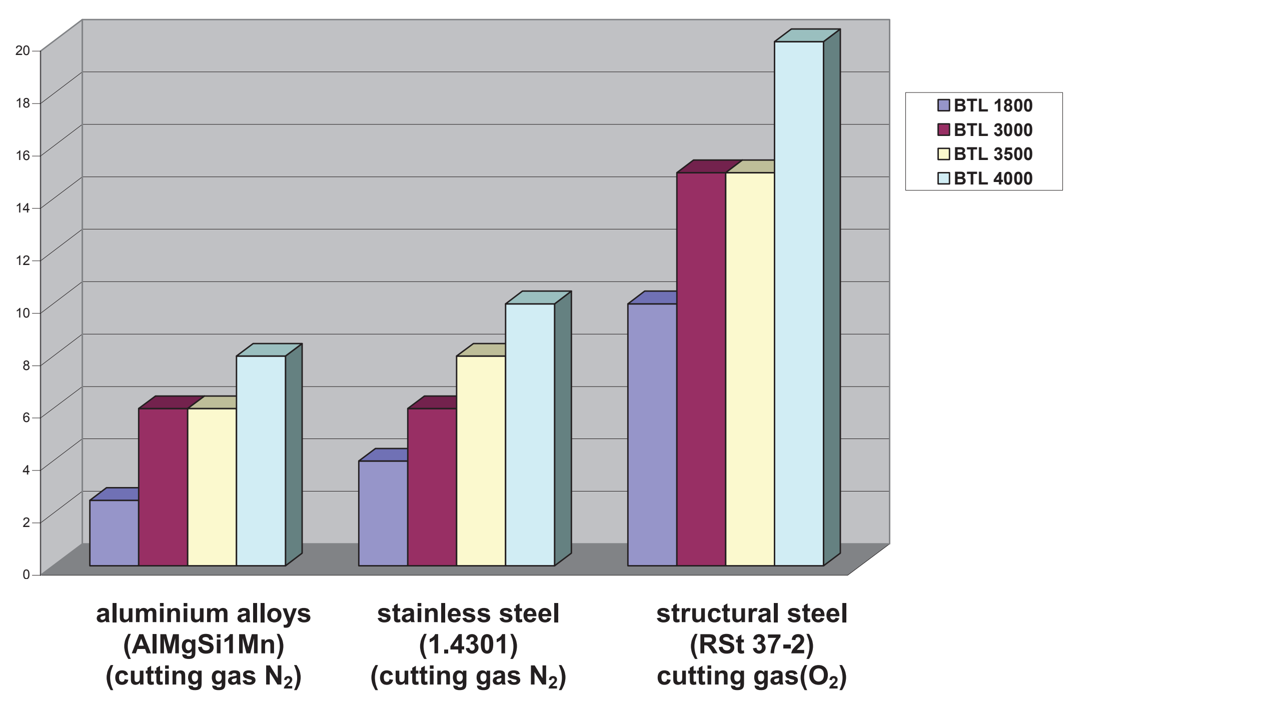
Wood, leather, cardboard and paper can be cut with the laser. The edge of the cut will be charred (brown colouring). The higher the feeding, the lesser the carbonization. When machining glued wood it is impossible to guarantee a clean cut, as each glue decomposes differently, depending on its type and kind.

Other Materials

Information about other materials of interest to you can be obtained from the Bystronic customer engineering service.

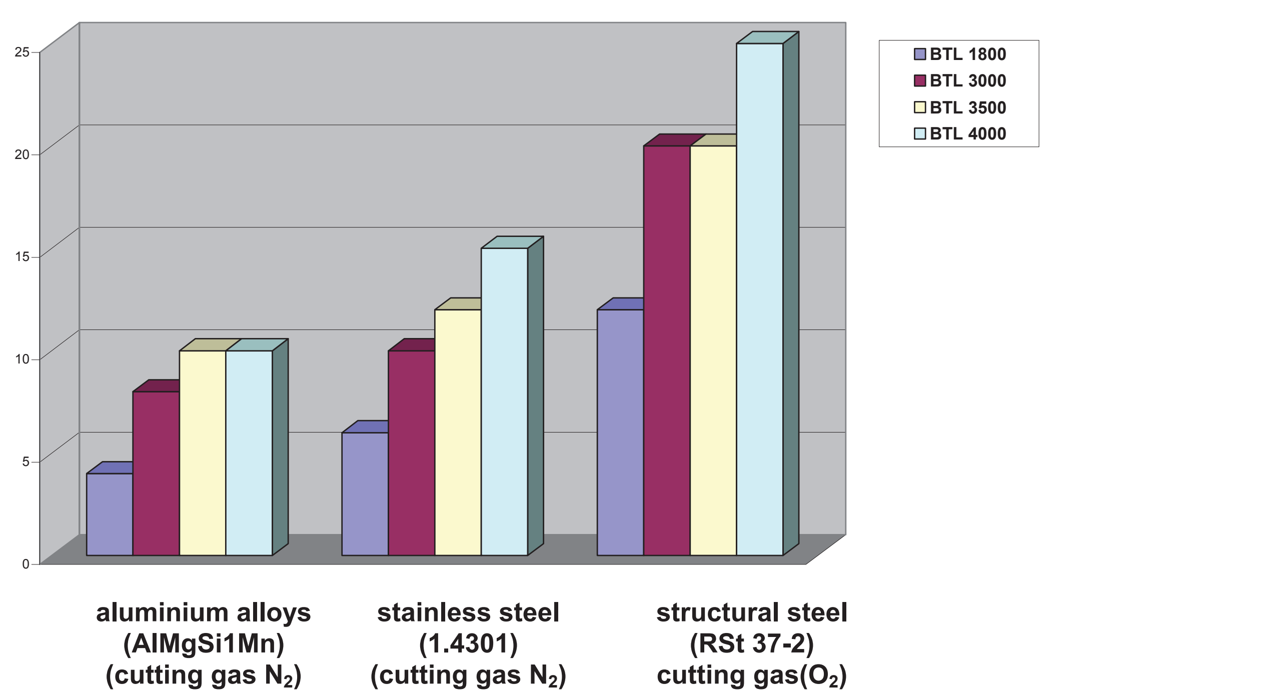
10.2.4 Cuttable thickness according to the materials

(production values mm)



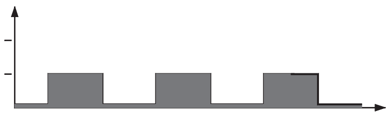
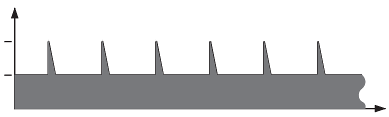
Max. possible thickness of the cutting material only possible with optimum machine and parameter adjustment.

(maximum values)



10.2.5 Laser operating options

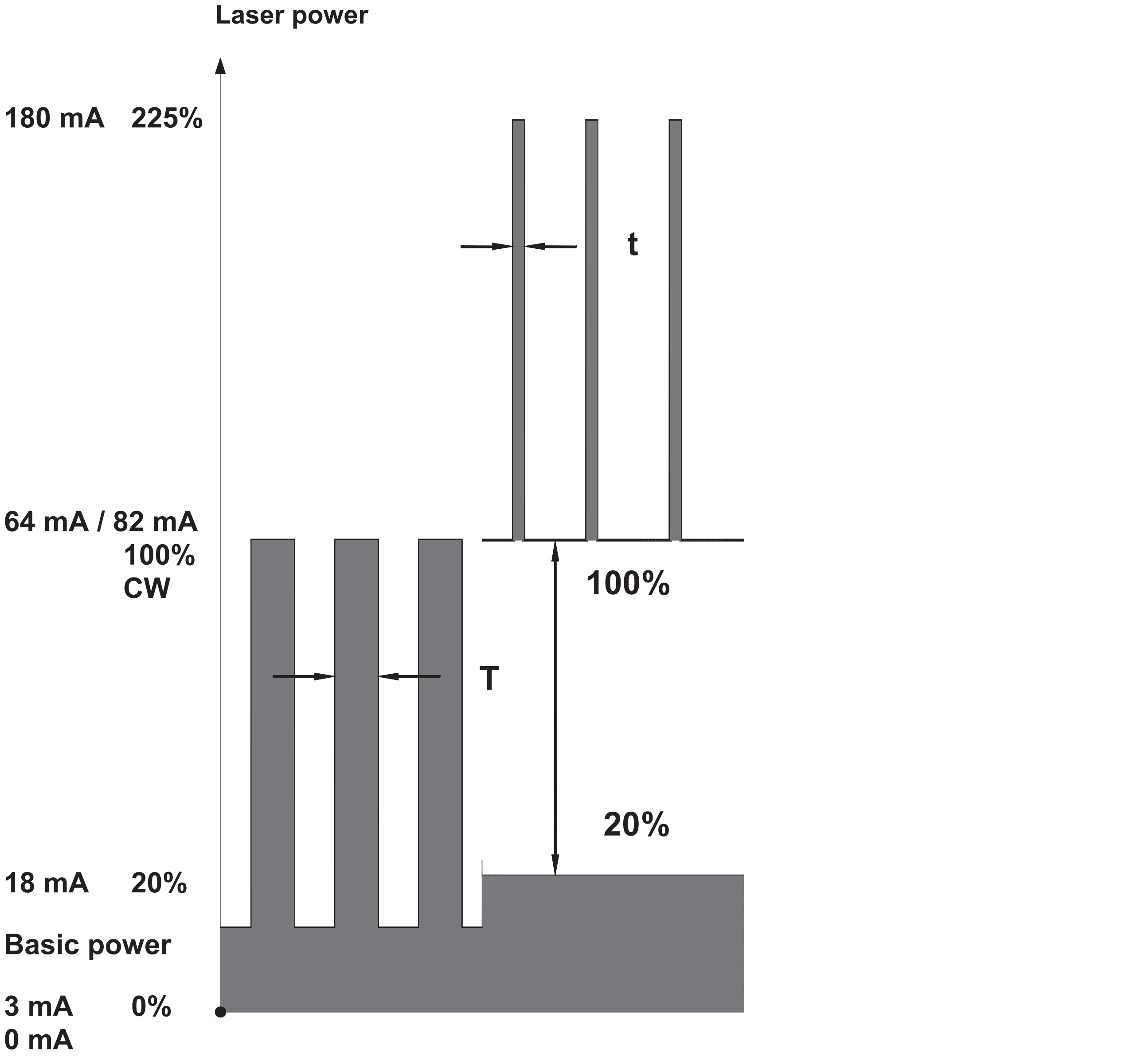
Composition of the various types of machining and their types of application.

Mode	Symbolic representation	Application	Example
Continuous mode CW		- low pressure cutting - normal cutting - high pressure cutting	→ structural steel with O_2 → aluminium with N_2 → stainless steel with N_2 A constant power obtains a relatively precise cut
Modulation MOD		- cutting angles - acceleration and braking	In active modulation the laser power is adapted to the axis speed. That way the burnt-off mark of the angles are avoided (so called „cold angles“).
Normal pulse NP		- piercing - fine contours	→ Example structural steel: - small holes on the contour after the micro joint - small holes up to a minimum of ½ the material thickness - thin contours
Superpulse SP		- piercing - materials with high reflection level	→ stainless steel with 0_2 → steel resistant to heat with 0_2 Increase in laser power for resonators up to 3000W. Laser power = 100% CW + superpulses. Recommended for stainless steel and aluminium with nitrogen).

Notice:

The Super pulse operating mode must not be used for the BTL resonator 4000. If this operating mode is used, it can cause the resonator to overload.

Overview of pulse mode



	NP	SP
Type of pulse	Normal pulse	Super pulse
Pulse switches	1	2
Frequency	1-2500 Hz	1-2500 Hz
Pulse duration. NP (T)	100-25500 µs	——
Pulse duration. SP (t)	——	10-200 µs
Laser power CW	2-100 %	20-100 %
Base power GW	2-100 %	——
Performance	Basic power min. 2%	CW min. 20%

10.2.6 Gas parameters

The gas parameters include:

– type of gas
– gas pressure
– nozzle diameter
– nozzle geometry

The gas pressure and the geometry of the nozzle determine the roughness of the edges and the burr formations.

the process gas consumption depends on the nozzle diameter and the gas pressure.

More information on process gas is contained in the chapter „Gas regulation” whereas information’s regarding the nozzles and their distance are found in the chapter „Beam path“.

– The gas pressure for cutting application reaches 5 bar for low pressure and 20 bar for high pressure.
– The conventional cutting nozzle presents a circular opening with cone-tapering.
– It is necessary to maintain reduced distance as much as possible between the nozzle and the workpiece surface. The lesser the distance, the higher the quantity of gas that will effectively strike the kerf. Distances between 0.5 and 1.5 are often used.

10.3 General indications for machining

For each indication the user can find approximate values for the parameters in the paragraph "indications for single materials“ as from page 10-19 on.

10.3.1 Piercing

The parameters value for the piercing are different from Piercing those for the cutting.

Continuous mode piercing

Advantage: Fast piercing.
Disadvantage: A piercing crater is created.

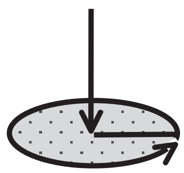
Pulse mode piercing

Advantage: Small piercing hole.
Disadvantage: Time consuming piercing procedure.

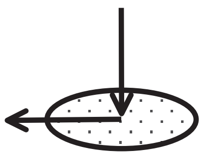
Flying piercing with head down positioning

Use the cutting parameter for “Start flying cut“(eg. 10332r10.L50). Using this parameter ensures that the lens is protected from splatter.

Circular piercing in stainless steel and aluminium



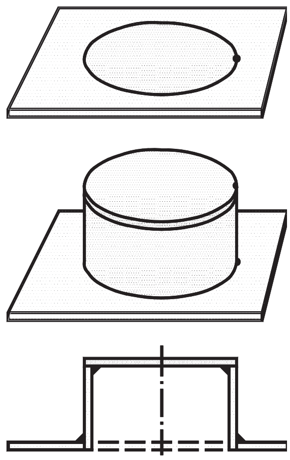
1. After piercing, a circle with a diameter of 2 mm is cut with cutting Laser power.



2. The position is lowered and the template is moved closer through the initial hole made.

The hole is necessary in order to expel molten material formed during the acceleration phase and to start the cutting process.

Pulse mode piercing on the contour



Pulse piercing is used when holes have to be cut on the contour.

Notice:

The thickness of the sheet in mm corresponds approximately to the piercing time in seconds

If both the cut part and the remaining part of the sheet are required, use the "pulse piercing (M14/15)“ function directly on the contour.

Delay time before piercing in Continuous mode

Program a value for the parameter “Delay time before machining”, if the piercing is to be done in continuous mode. During this time the heat around the piercing hole decreases by a few degrees, making it possible to obtain a good cutting quality when starting the machining. In the parameters tables, in the section “indications depending on the material” chose the highest value for “Delay time before machining” when the diameter of the piercing hole is lower than the panel thickness.

10.3.2 Initial and final cut on steel

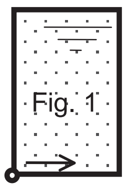
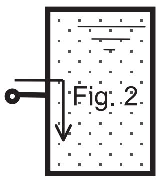
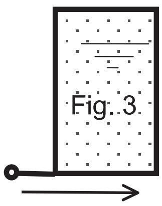
The setting up of the initial cut is simplified considerably when **Bysoft 6.2** is used. Length of cut and geometry are set automatically.

External contour

The piercing is normally done in CW mode. This type of piercing is faster, but it produces a hole that is bigger than that obtained when using the pulse mode. For this reason, the location of the start-cut piercing is usually chosen outside of the contour (fig. 2-3). The length of cut between the piercing and the actual contour is called section of initial cut or cut-end.

A possible change of focus of the laser beam between the end of the section of initial cut and the contour is recognizable by the uneven edge of the cut on the workpiece (fig. 2). The user will have to try as much as possible to program the section of the initial cut on an ideal line extending from one side of the geometrical element (fig. 3)

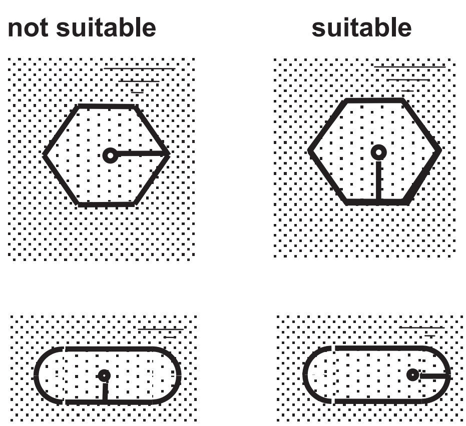
If you later want to select the rounding automatic function or program a small inner contour for plates with a thickness higher than 10 mm (the heat of the inital cut at the end of the cut has not been dissipated yet) you must program the initial cut vertically on a geometrical element.

Workpieces with additional machining suitable	Small internal templates with high gauge plates, corners with radius	Low gauge plate, corners without radius
 Fig. 1	 Fig. 2	 Fig. 3
CW piercing hole on the contour: inferior angle	External CW piercing hole of the contour. Input visible on the contour, inferior	CW piercing hole outside the contour. Entry on contour along a line. No marks on workpiece.

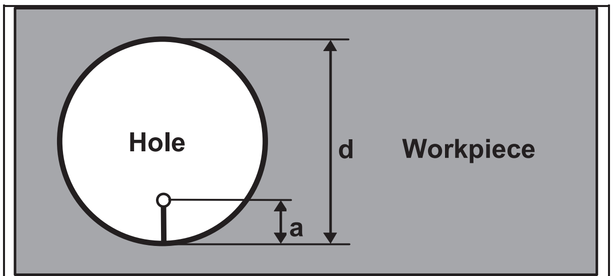
– Program the section of initial cut as an independent geometrical element.

Inner contour (crop-end)

In case of **inner contour with small surface,** it is very important that the heat generated during piercing can dissipate before starting the cut. It is necessary to avoid programming the piercing in narrow sections and to program the piercing at an ample angle degree in respect to the contour. This will facilitate the heat dissipation.



The length of the initial cut depends on the thickness of the sheet and the diameter of the hole

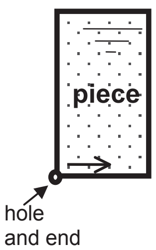
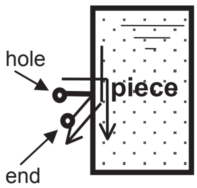
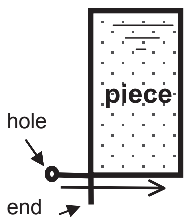


Sheet thick-ness [mm]	Hole diameter d [mm]	Initial cut length a [mm]
1-6	d < 10	From centre of hole (d/2)
	d < 10	From centre of hole 5
8 -12	d < 20	From centre of hole (d/2)
	d < 20	10
15 -25	d < 30	From centre of hole (d/2)
	d < 30	15

10.3.3 Initial and final cut on stainless steel and aluminium

The cutting without oxidation is normally done in CW mode. The spaces of acceleration and deceleration must be in this case outside of the templates, so that no burr can form on the template.

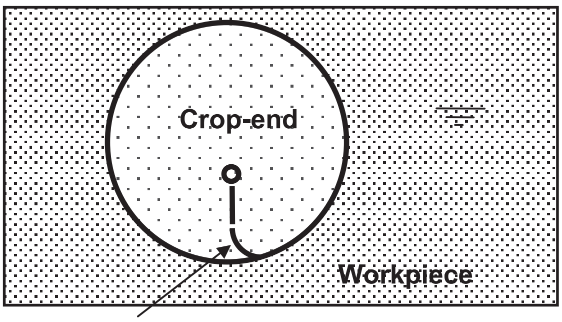
External contour

mediocre	acceptable	good
		
CW piercing hole on contour: mediocre angle	CW piercing hole outside the outline: Visible entry point on contour: mediocre	CW piercing hole out of contour. Entry point on contour along a line. No sign on workpiece.

Internal contour (crop-ends)

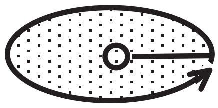
Notice:

In case of piercing or other crop ends, it is best to program a connection section between the section of initial cut and the contour.

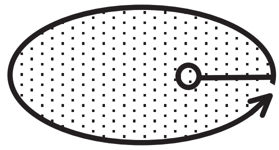


Beam

Length of the initial cut section in case of crop-ends



Piercing in the centre of the hole up to 30mm in diameter



Length of initial cut depending on the thickness of the panel beyond 30mm in diameter

10.3.4 Machining of holes

Build up of burr in the holes

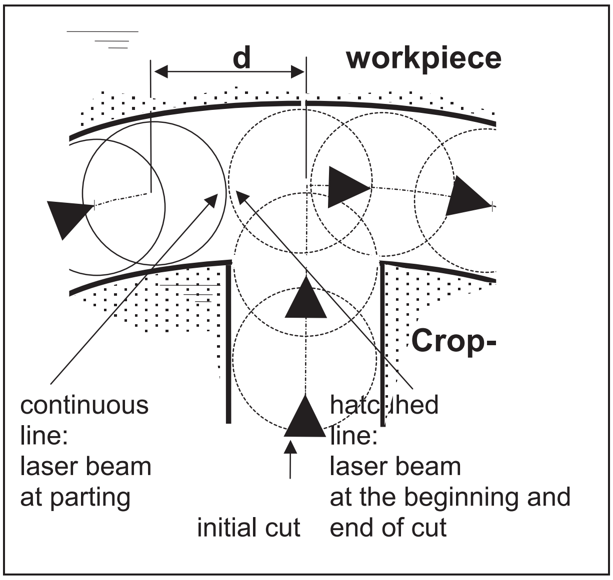
The build up of burr means that the cutting rate of the hole is too high. Correction: chose a smaller value for the dynamic factor.

If the dynamic factor is reduced excessively, burrs form on the template. To correct: Make the cut in pulse mode.

The speed at which holes are cut can be varied further, according to the feed, by means of the dynamic factor. If the dynamic factor is too high for thin sheets, the holes will not be perfectly circular. If the factor is too low, the contours of the holes will be burnt. If the dynamic factor is too high with thick sheets, flash will form or the material will not be pierced. If the factor is too small, the cut made may close as a result of melting, causing flash to form. Reason: the material overheats and there is greater absorption.

10.3.5 Micro joint

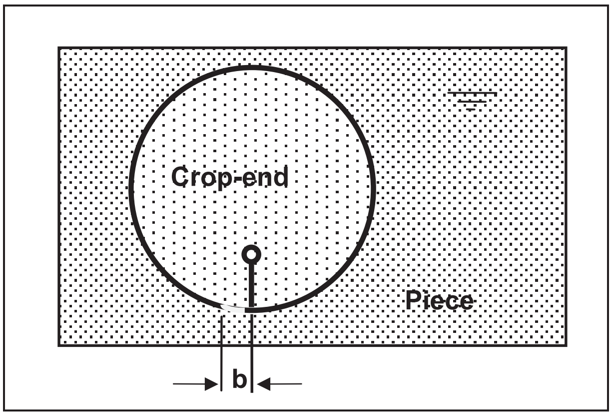
The insertion of a micro joint causes the Laser to be deactivated at the distance "b“ before the geometrical end of the cut out. Consequently, the cut out remains connected to the part and does not tilt. In this case, once the cutting plan has been completed, detach the cut out manually or pick it up with a bar magnet, having opened the safety door. The width b of the web must be at least the same as the width d of the kerf.



The cut piece bends already, and the laser beam hits it sideways, creating a burnt-in mark on its surface. The molten material of this burnt-in mark reflects again the laser beam provoking itself another burnt-in mark on the crop-end.

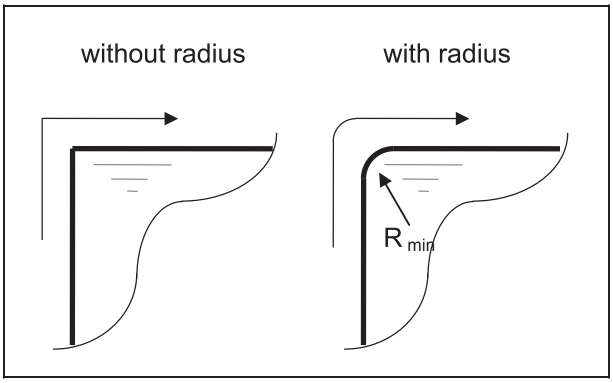
It is necessary to create some bonding, in order to avoid these burnt-in marks. The SPM control has an automatic function for bonding.

The insertion of a micro joint causes the Laser to be deactivated at the distance "b“ before the geometrical end of the cut out. Consequently, the cut out remains connected to the part and does not tilt. In this case, once the cutting plan has been completed, detach the cut out manually or pick it up with a bar magnet, having opened the safety door. The width b of the web must be at least the same as the width d of the kerf.



10.3.6 Machining of angles

Machining of obtuse angles with radius



Where possible, avoid angels with no radius. The advantages of angles with radius compared with those with no radius are:

- the axis are shifted more dynamically
- heat-affected zone reduced
- less build up of burr
- time saving
- reduced risk of injury

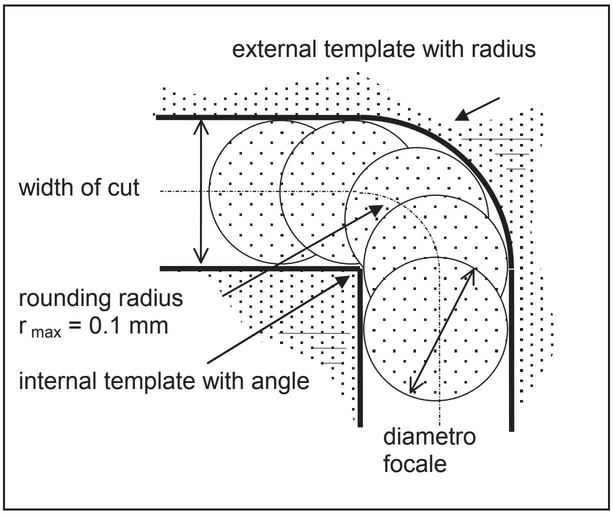
Optimum rounding radius:

$R_{optimum}$ = panel thickness in mm divided by 10, but not less than 1 mm

Maximum radius, when on the internal template is required on angle with no radius:

R_{edge} = half cut width

With this type of beam an angle with no radius is still generated, but the axis now shifts dynamically:

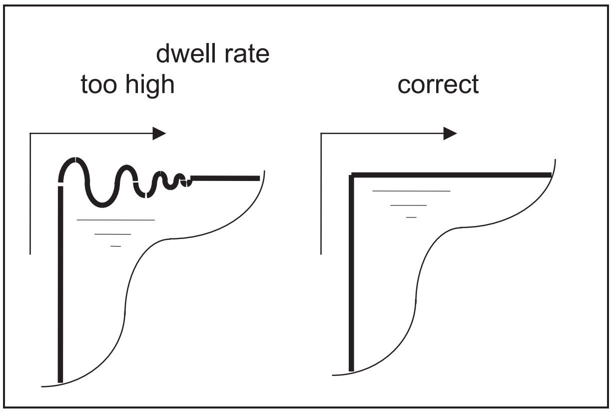


Machining of obtuse angles with “Dwell Rate”

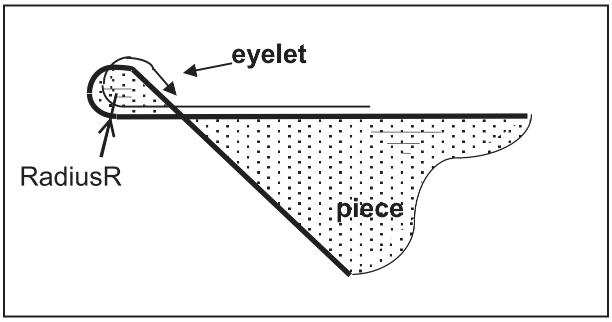
If an angle with no radius is required also on the external template, in a subsequent machining, it is necessary to program the angle without the rounding radius. Instead program the parameter “Dwell rate”.

Notice:

If the dwell rate is set too high, corrugations will appear on the workpiece



Acute angles with eyelets on thin panels



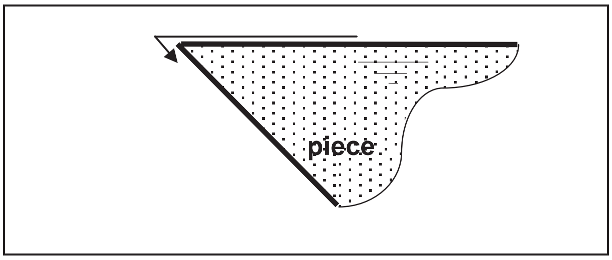
When cutting at high speed on thin panels, it is recommended to use the technique of the eyelets This type of solution presents the following advantages:

– The axis run an acute angle on constant directional variation.
– The workpiece itself is cut at a constant speed.
– An overoscillation of the axis is avoided, preventing any build up of burr.
– The heat affection on the angle is reduced.

Acute angles on thick panels with "Dwell rate"

When machining very thick panels, using the "eyelet machining", the workpiece must bear too much heat. In case of this type of machining on thick panels, set the "dwell time" parameter for machining acute angles.

The machine moves to the angle and dwells for the preset time before resuming motion exiting the angle.



If a value is programmed for the "dwell time", the control ignores the inputted value for the parameter "idle time rate".

10.4 Tips for certain materials

10.4.1 Cutting of structural steel

Perforation values and times for guidance only:

See the charts concerned in the appendix of chapter MMC in the user manual.

Starting after piercing in continuous mode

The table below contains the general values for the delay time before the start of the machining process and for the acceleration factor at startup in continuous mode. During the delay time set prior to machining, the heat accumulated during piercing may spread along the workpiece. In this way, the formation of major breakages at start-up may be avoided.

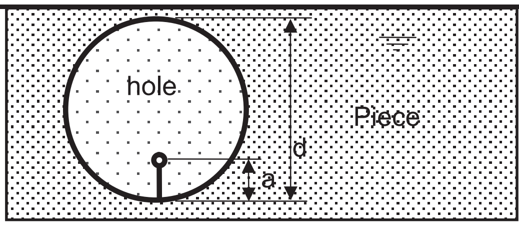
Notice:

With holes having a diameter of less than the thickness of the sheet, increase the delay time before machining with respect to the general values indicated below or perform the piercing operation in pulse mode

Laser BTL series				
Panel-thick-ness	Focal dist.	delay time before machining		accelera-tion factor
		Figure> panel thickness	Figure< panel thickness	approach
[mm]	[mm]	[s]	[s]	[-]
1	5	0.1	0.1	1
2	5	0.2	0.2	1
3	5	0.2	0.2	1
4	5	0.3	0.3	1
5	7.5	0.3	0.3	1
6	7.5	0.4	0.8	1
8	7.5	0.5	1.2	1
10	7.5	0.8	1.5	1
12	7.5	0.8	2	1
*15	7.5	0.8	2.5	1
*20	7.5	1	3	1

* These thicknesses cannot be cut with the BTL 1800.

Initial cuts of the holes



Panel thickness [mm]	Diameter of the hole d [mm]	Length of initial cut a [mm]
1-6	d < 10	hole from the centre
	d > 10	5
8-12	d < 20	hole from the centre
	d > 20	10
15-25	d < 30	hole from the centre
	d > 30	15

See also **Bysoft** technical assistant

Roundness of the holes

The roundness of the holes can be modified with the dynamic factor. If the holes are not cut in a circular shape, select the smaller value as the dynamic factor.

The dynamic factor depends on the type of machine, feed during cutting and type of laser.

Dynamics factor values for guidance only:

Panel thickness [mm]	Bysprint	Bystar 3015	Bystar 4020/25
1-3	1	0.8	0.5
4-20	0.8	0.8	0.8

General indications for the programming of the initial cuts are contained in pages 10-14 recommendations regarding the machining of holes are contained in pages 10-17.

Machining of obtuse angles with the parameter „dwell rate“ (quality of cuts)

The following charts contains indicative values for the parameter "dwell rate" express in the function of the laser machine center. For indications of the general type of machining of angles on thin panels see pages 10-17.

Angular tolerance values used for guidance only [mm]:

Panel thickness [mm]	Bysprint	Bystar 3015	Bystar 4020/25
1-2	0.15	0.10	0.05
3-4	0.10	0.10	0.07
5-10	0.10	0.10	0.10

Machining with eyelets of acute angles on thin panels

Panel thickness [mm]	Radius of the eyelet [mm/min]
1-5	3
6-10	4
12-20	5

Machining of acute angles with the parameter „dwell time“ on very thick workpieces

The following table contains indicative values of the parameters “dwell time“ express in function of the thickness of the panel. For indications on general type of machining of angles on thick panels see page 10-17.

Panel thickness [mm]	Dwell time [ms]
1-12	100
13-15	200
16-20	500

Machining of thick panels

General indications

– Use the pointed grid, in case of critical workpieces, lift the panel, laying it on the support grid.

– Distance of each piece in the cutting program: a = double thickness of the panel.

– The general values for the initial cut length and the "dwell time“ parameter are indicated on page 10-20.

Piercing

– Oil the panel. The oil film prevents adhesion of the sprays caused by the piercing on the surfaces of the panel and does not have a negative influence on the cutting procedure.

– The crossjet sprays an oil mist, consisting of a mixture of air and oil. The oil mist cools the perforation point. Using the “traverse blowing” function, it is possible to get the perforation spray further away. This avoids the perforation spray sticking to the sheetmetal.

For the perforation of thick sheets with a lot of perforations (pre-perforated), the software modules “Bysoft 5.3 ByADD” or “**Bysoft 6.x bywork**” are available.

– All piercing operations are performed before the contours are cut. The amount of heat to which the workpiece being machined is subjected is thus reduced considerably and distributed more evenly.

– It is also possible to use cutting head with older lenses for preliminary piercing. However, for the cutting of the templates, is best to mount a cutting head with a new lens!

– Once the preliminary piercing program is terminated, clean the sprays, oil the panel and continue the machining.

Cutting

Pay attention that the temperature of the plate does not exceed 40°, otherwise „material runouts“ will form along the cutting edges.

– In the cutting of small holes, do not start until the piercing hole has cooled down (parameter „delay time before machining“) or use the piercing program for panel thickness of 15-20 mm.

– To stabilize the cutting sequence, pay attention to the geometrical reports: cutting of small holes and the complicated templates.

– During the first pass only cut one piece every two, then cut the others during the second pass.

– Stop machining until the plate has cooled to less than 40°, should its temperature rise to this level despite the precautions taken.

Example with complicated templates on thick panel. Good cutting quality obtained, with a sequence of cutting sub-divided at various stages in order to optimize the distribution of heat and the cooling down time:

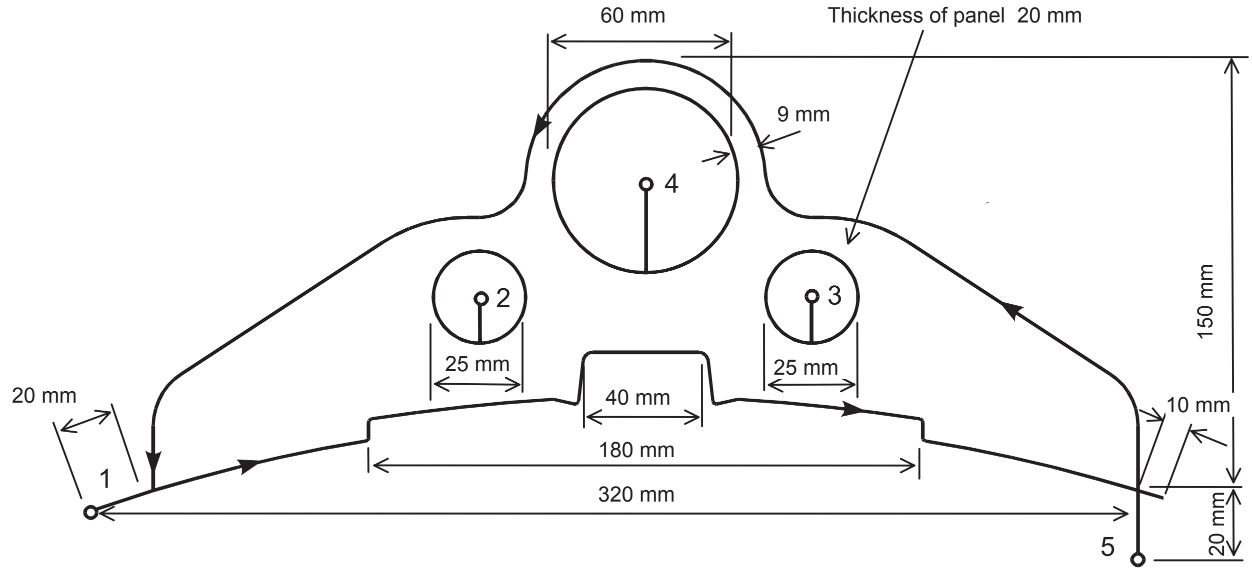


Fig.1: Geometry of the machine components. The numbers indicate the sequence of piercing

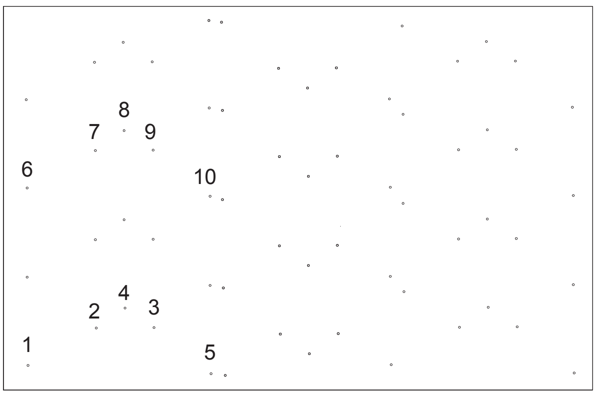
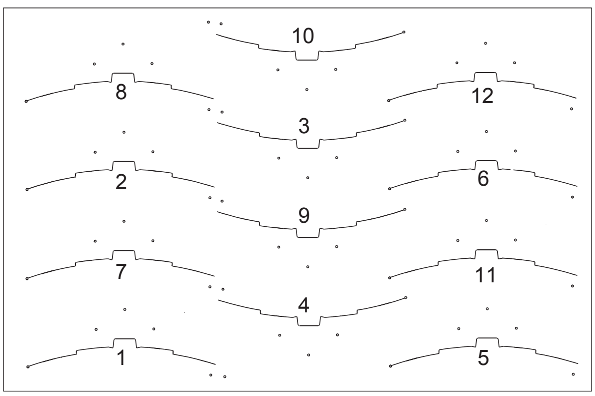


Fig. 2: Cut plate with the preliminary piercing program (piercing time 2,5 seconds per hole)



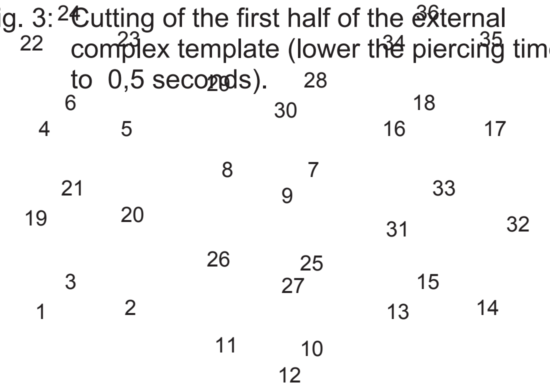


Fig. 3: Cutting of the first half of the external complex template (lower the piercing time to 0,5 seconds).

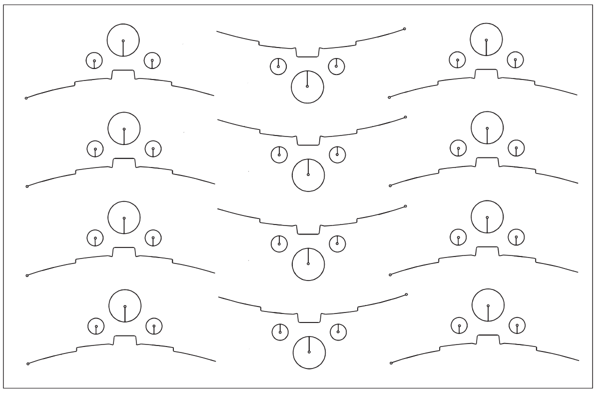


Fig. 4: cutting of the holes

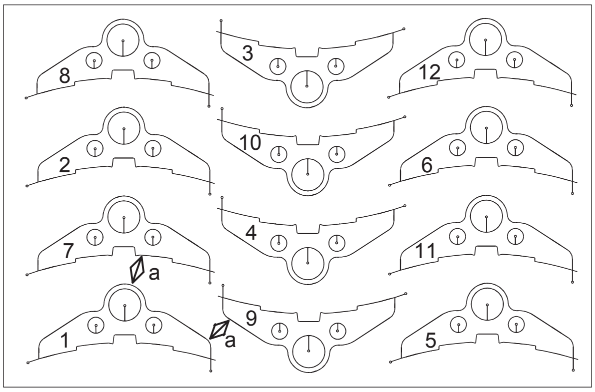


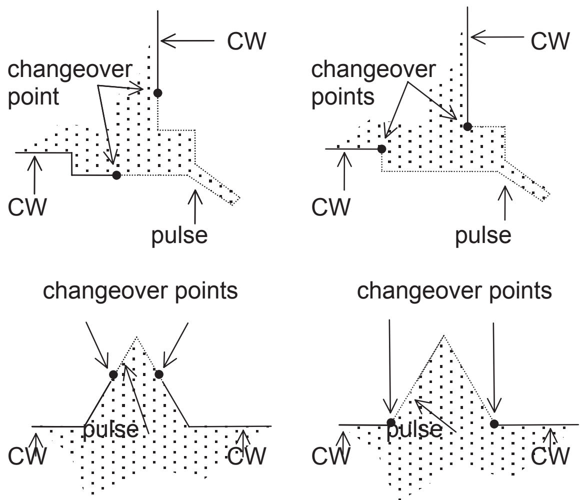
Fig. 5: Conclusion of the machining (distance of the template a = double thickness of the panel)

Pulse mode cutting

Activate the laser cutting on pulse mode in case of critical templates.

– Panels from 1 to 15 mm
– Cutting rate around 5 to 10 times inferior to the CW laser cutting.
– Panels from 1 to 6 mm are more suitable to pulse machining.
– On the other hand panels from 8 to 15 mm are more difficult to machine in pulse mode.
– Do not cut internal pieces in pulse mode.
– Preset the changeover points of cutting to CW pulse cutting, so that the passage corresponds to an angle.
– Do not changeover on straight-line or curvilinear sections with wide radius, as the switch from one mode to the other will cause a small material runout:

not suitable! **suitable!**



10.4.2 Cutting stainless steel without oxidation

The gas used for the process is nitrogen.

Indicative values and piercing times

See the chart in the appendix of the chapter for the MMC in the user manual.

Starting after piercing

Once the preset piercing time has elapsed, the machine starts the preset acceleration factor. For the thickness of panels for which in the following column of the “Initial hole” there is a “Yes”, it will be necessary to have an initial hole (Circular pierce) (See page 10-15)

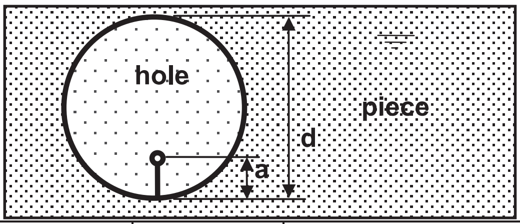
Laser BTL 1800		
Thick-ness [mm]	**Acceleration factors in approach [-]**	**Circular pierce required**
1-1.5	1	no
2-2.5	0.7	no
3	0.3	no
4	0.05	no
5	0.02	no

Laser BTL 3000/3500/4000		
Thick-ness [mm]	**Acceleration factors in approach [-]**	**Circular pierce required**
1	1	no
2	0.8	no
3	0.5	no
4	0.4	no
5	0.1	no
6	0.02	no
8-12	0.001	yes
**15	0.001	yes

** Only with BTL 4000

Initial cutting of the holes

The length of the initial holes depends on the thickness of the panel and the diameter of the hole.



Thickness of panel [mm]	Diameter of the hole [mm]	Length of the initial hole [mm]
1-6	d < 20 d > 20	hole from the centre (d/2) 10
8-12	d < 30 d > 30	hole from the centre (d/2) 15

Roundness of the holes

For the roundness of the holes and the dynamics factor, the same values of the steel used for construction apply. See page 10-19.

Delay rate (quality of cuts)

For delay rate, the same values of the steel used for construction apply. See page 10-19.

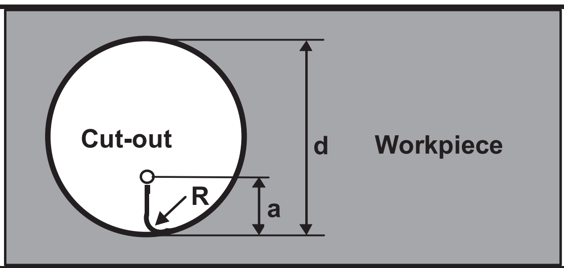
Machining with eyelets

Indicative values of the dimensions of the eyelet’s

Thickness [mm]	Radius eyelet [mm/min]
1-4	4
5	5
6	6
8	8
10	10
12	12

Internal contours (initial cuts)

With holes or other cut-outs, we recommend you program the passage from the attachment of the initial cut to the contour to be machined with a suitable arc.



Thick-ness [mm]	Hole diameter [mm]	Length of initial cut a [mm]	Arc R [mm]
1-6	d < 20	From centre of hole (d/2)	1
	d > 20	10	1
8-12	d < 30	From centre of hole (d/2)	1
	d > 30	15	1

For further information about angular tolerance and loops, see the MMC chapter “special parameters“.

10.4.3 Cutting of aluminium without formation of oxide

The gas used for the process is nitrogen.

Indicative values and piercing times

See the chart in the appendix of the chapter for the MMC in the user manual.

Starting after piercing

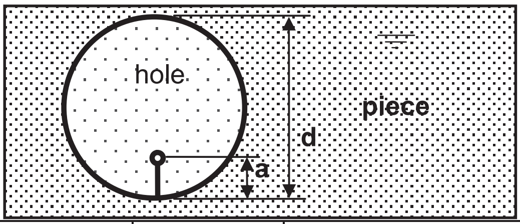
Once the preset piercing time has elapsed, the machine starts the preset acceleration factor. For the panel thickness for which in the column “necessary initial hole” (Circular pierce) there is a “Yes”, it will be necessary to have an initial hole. (See pages 10-13)

Laser BTL 1800		
Thickness of the panel [mm]	**Acceleration factor in approach [-]**	**Circular pierce required**
1	1	no
2-3	0.3	no
4	0.03	yes

Laser BTL 3000/3500/4000		
Thickness of the panel [mm]	**Acceleration factor in approach [-]**	**Circular pierce required**
1	1	no
2	0.8	no
3	0.5	no
4	0.1	no
5	0.01	no
6-8	0.001	yes

Initial cutting of the holes

The length of the initial cuts depends on the thickness of the panel and the diameter of the hole.



Thickness of the panel [mm]	Diameter of the hole [mm]	Length of the initial cutting to [mm]
1-6	d < 20 d > 20	hole from the centre (d/2) 10
8-12	d < 30 d > 30	hole from the centre (d/2) 15

Roundness of the holes

For the roundness of the holes and the dynamics factor, the same values of the steel used for construction apply. See page 10-19.

Delay rate (quality of cuts)

For delay rate, the same values of the steel used for construction apply. See page 10-19.

Delay rate (quality of cuts)

Orientative values for the delay rate

Thickness [mm]	Delay rate [mm/min]
1-5	0.1
6	0.08
8	0.06
10	0.04

Machining with eyelets

Orientative values for eyelet radii

Thickness of the panel [mm]	Eyelet radius [mm/min]
1-4	2
5-6	3
8-10	4

For further information about angular tolerance and loops, see the MMC chapter “special parameters“.

10.4.4 Grates

The bars may be made of different metals. Copper bars have the longest life as they are the most resistant to heat stress. Slag can be removed easily. The high reflectivity of copper may have a negative effect when working with thin sheets and small holes (the holes become imprecise), or cuts without oxides (formation of plasma, interruption of the beam). Steel and V_2A are the materials that interfere the least with the cutting process.

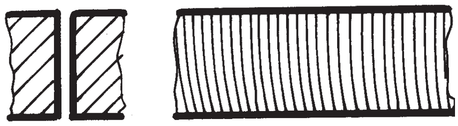
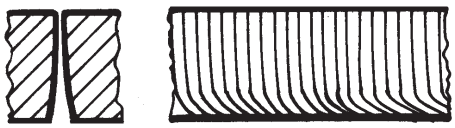
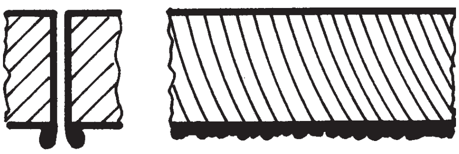
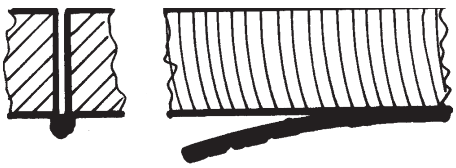
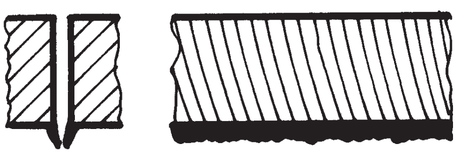
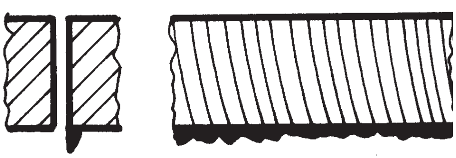
Steel and V_2A bars can be cut by the customer himself. The cutting plans are available on the hard disk of the PC. The life of these bars depends on the Laser power used for cutting.

Advantage of steel: it is economical

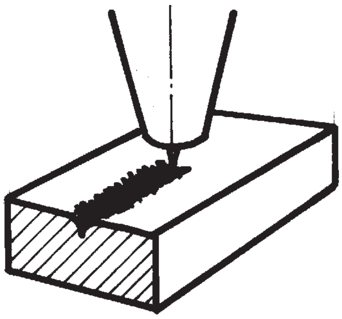
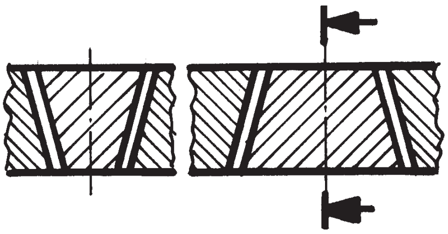
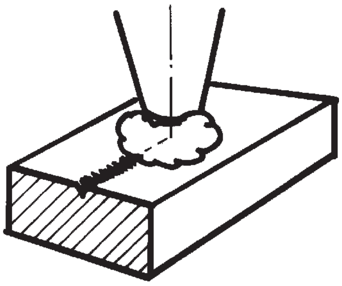
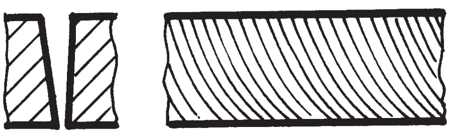
Advantage of V_2A: Due to the type of material, sprayed material cannot oxidize on this grate.

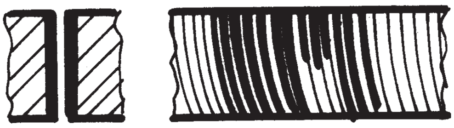
Advice: Cut the bars with O_2: this cuts costs.

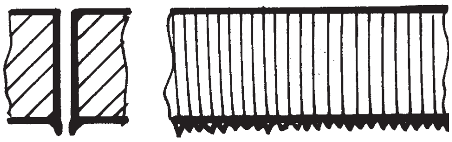
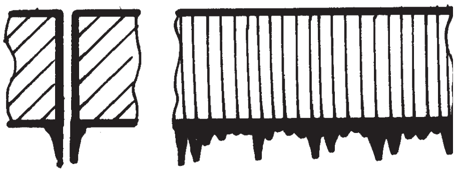
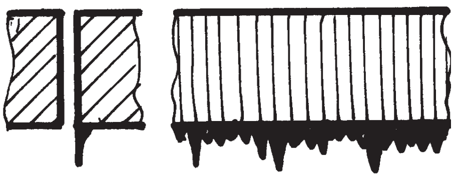
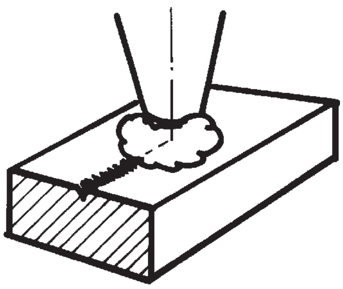
10.5 Assessing the Cuts

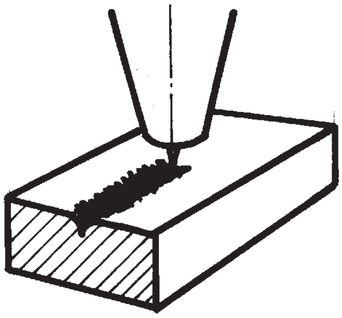
Structural steel: cutting with O_2		
Error	**Possible causes**	**Solutions**
No burr, uniform drag lines 	right power right feed rate	
Considerable deviation of drag lines on bottom part, cutting hole wider at the bottom 	feed rate too high laser power too low gas pressure too low focal position too high	reduce feed rate increase laser power increase gas pressure lower focus
Burrs on bottom surfaces similar to slag, even drop shaped and easy to remove 	feed rate too high gas pressure too low focal position too high	reduce feed rate increase gas pressure lower focus
Metal burrs joined together can be removed as a single piece 	focal position too high	lower focus
Metal burrs on bottom surfaces, difficult to remove 	feed rate too high gas pressure too low impurities in gas focal position too high	reduce feed rate increase gas pressure use purer gas lower focus
Burrs on one side only 	nozzle incorrectly centered nozzle orifice defective	center nozzle replace nozzle

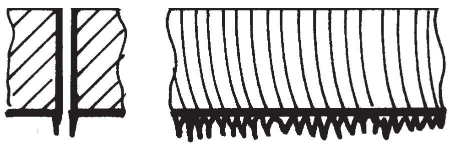
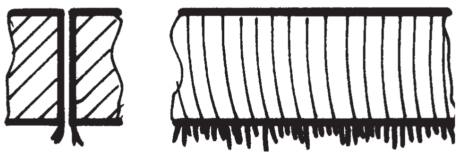
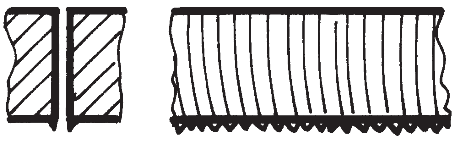
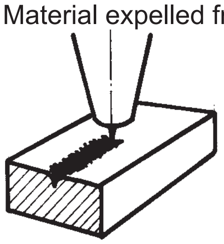
Structural steel: cutting with O_2

Errors	Possible causes	Elimination
Material expelled from top side 	power too low feed rate too high	increase power reduce feed rate
Slanting cuts 2 good sides, 2 bad sides 	polarizing mirror not suitable, mounted not correctly or defective polarizing mirror mounted in the place of the deflection mirror	check the polarizing mirror check the deflection mirror
Blue plasma, workpiece not cut off during machining 	wrong gas (N_2) feed rate too high power too low	use oxygen as process gas reduce feed rate increase power
Inaccurate cutting surfaces 	gas pressure too high damaged nozzle nozzle diameter too big poor material	lower the gas pressure replace the nozzle install the right nozzle material with smooth and even surface
No burrs, drag lines slanting a long way back cut narrower at the bottom 	feed rate too high	reduce feed rate

Structural steel: cutting with O_2		
Errors	**Possible causes**	**Elimination**
Formation of craters 	gas pressure too high feed rate too low focus too high rust on surface of plate workpiece under machining has overheated impurities in material	reduce gas pressure increase feed rate lower focus use better qualitymaterial
Extremely rough cutting surface 	focal position too high gas pressure too high feed rate too low material too hot	lower focus reduce gas pressure increase feed rate cool material

Stainless steel: high-pressure cutting with N_2		
Error	**Possible causes**	**Solutions**
Formation of fine, regular burrs in the form of drops 	focus too low feed rate too high	raise focus reduce feed rate
Formation of long irregular burrs on both sides in the form of filaments, with tarnishing on large templates 	feed rate too low focal position too high gas pressure too low material too hot	increase feed rate lower focus increase gas pressure cool material
Formation of long irregular burrs on just one side of the cutting edge 	nozzle not centered focal position too high gas pressure too low speed too low	center nozzle lower focus increase gas pressure increase speed
Cutting edge yellowish	nitrogen containing oxygen impurities	use a higher quality of nitrogen
Formation of plasma on straight sections 	feed rate too high power too low focus too low	reduce feed rate increasepower raise focus
The beam breaks	feed rate too high power too low focus too low	reduce feed rate increase power raise focus
Formation of plasma at corners	angular tolerance too high modulation to high acceleration to high	reduce angular tolerance reduce modulation or acceleration

Stainless steel: high-pressure cutting with N_2		
The beam breaks at the beginning	acceleration too high focus too low The molten material cannot be expelled	reduce acceleration raise focus use circular piercing Use gas ramp
Rough cut	nozzle damaged lens dirty	change nozzle clean lens, replace if necessary
Material expelled from the top 	power too low excessive feed gas pressure too high	increase power reduce feed reduce gas pressure

Aluminum alloys: high-pressure cutting with N_2		
Error	**Possible causes**	**Solutions**
Formation of long, irregular burrs on both sides in the form of filaments, difficult to remove 	focal position too high gas pressure too low feed rate too low	lower focus increase gas pressure increase feed rate
Formation of long, irregular burrs on both sides, removable by hand 	feed rate too low	increase feed rate
Rough cut	nozzle diameter too large nozzle damaged gas pressure too high	assemble right nozzle replace nozzle reduce gas pressure
Formation of fine, regular burrs, difficult to remove 	focus too low feed rate too high	raise focus reduce feed rate feed rate
Formation of plasma on straight sections	feed rate too high focus to low	reduce feed rate raise focal point
Beam breaks	feed rate too high	reduce feed rate
Formation of plasma on corners	angular tolerance too high modulation to high acceleration to high	reduce angular tolerance reduce modulation or acceleration
The beam breaks at the beginning	approach speed too high focus too low	reduce approach speed raise focus
Rough cut	nozzle damaged	replace nozzle
Material expelled from top 	power too low excessive feed	increase power reduce feed

10.6 Trouble-shooting

To maximize machining quality observe the following directions:

- precise regulation of the machine
- maintenance according to the maintenance plan
- process material conforming to the above requirements
- surface of the workpiece without rust or oxide (pickled, smooth)
- parameters suited to the material and the plate gauge in question
- preset interconnected parameters

Check the following points whenever you notice a downgrading of the machining quality:

1. parameters
2. machining head
3. beam path
4. resonator

Parameters

Never overwrite the standard parameters set on the machine when it was supplied.

Create a new directory for your optimized parameters.

If there is a deterioration in the machining quality, check if the standard parameters stored on the machine have undergone substantial changes with respect to your optimized parameters.

Machining head

- distance between the nozzles according to the parameters
- nozzle shape according to the parameters
- focus length according to the parameters
- sensor free of slags
- focus poit
- nozzle fine-centered
- clean lens
- lens system fitted and correctly fixed licked in place
- check the water cooling system of the cutting head

Beam path

- deviation mirror (cleaning, housing, cooling)
- laser type on strap
- solvent in the air
- four beam inlet points on the cutting table
- vertical incidence of the laser beam on the lens
- overpressure in the beam channel and the dust bellow
- sufficient air quality for the beam channel

Resonator

- optical mark of the gas discharge
- overpressure on the output window
- laser sealing
- deflection mirror
- polarizing mirror
- final mirror
- expansion lens system
- output window
- electrodes lay-out

10.7 Steel cutting instructions

When cutting steel, the cut plates reach extremely high temperatures.

This is due to:

– Laser beam
– Presence of carbon (C) in the steel, which favors the melting process.
– Presence of process gas (O_2) which favors the melting process.
– Presence of other components in the alloy.

The generation and development of heat are physical processes and have nothing to do with the quality of the laser cutting system.

The heat generated may become so high as to affect the quality of the cut preventing the elimination of the molten material. The cut workpieces may no longer be used.

These problems arise with various material thicknesses, workpiece sizes, hole shapes and types of laser.

The aim of the present cutting instructions is therefore to help solve steel cutting problems, enable work to be continued and warn the user when it may not be possible to do so.

The following definitions are required in order to do this.

10.7.1 Definition of maximum thickness / normal thickness

Maximum thickness means the thickness of materials that can be cut using the full cutting power of the laser.

Table: Maximum thickness for BTL series

Type of Laser	STW 22 or STW 37-2	RAEX 250	ST 52	RAEX 420	Special steel with a high C or Si content*
BTL 1800	10 - 12 mm	12 - 15 mm	8 - 12 mm	10 - 15 mm	Ask for details in each particular case
BTL 3000/3500/4000	15 - 20 mm	16 - 20 mm	12 - 20 mm	15 - 20 mm	Ask for details in each particular case

All thicknesses of materials below the maximum limit are considered normal thicknesses.

* Steel coated with paint, protective coatings, film, galvanizing, etc.

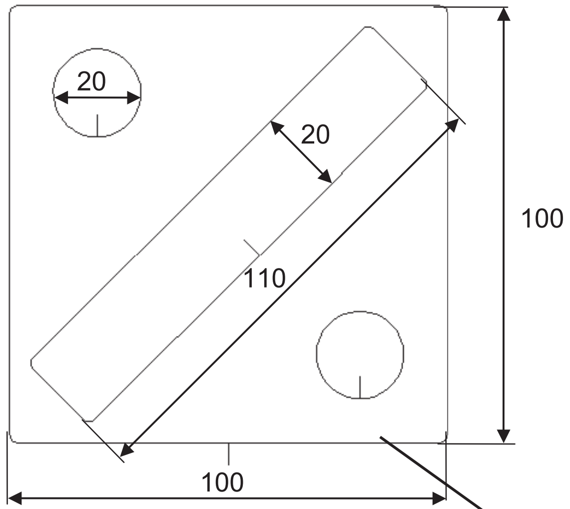
Bearing in mind the present instructions, Bystronic laser cutting systems are capable of cutting maximum thicknesses (e.g. RAEX 250, thickness 20 mm).

10.7.2 Defining surface A

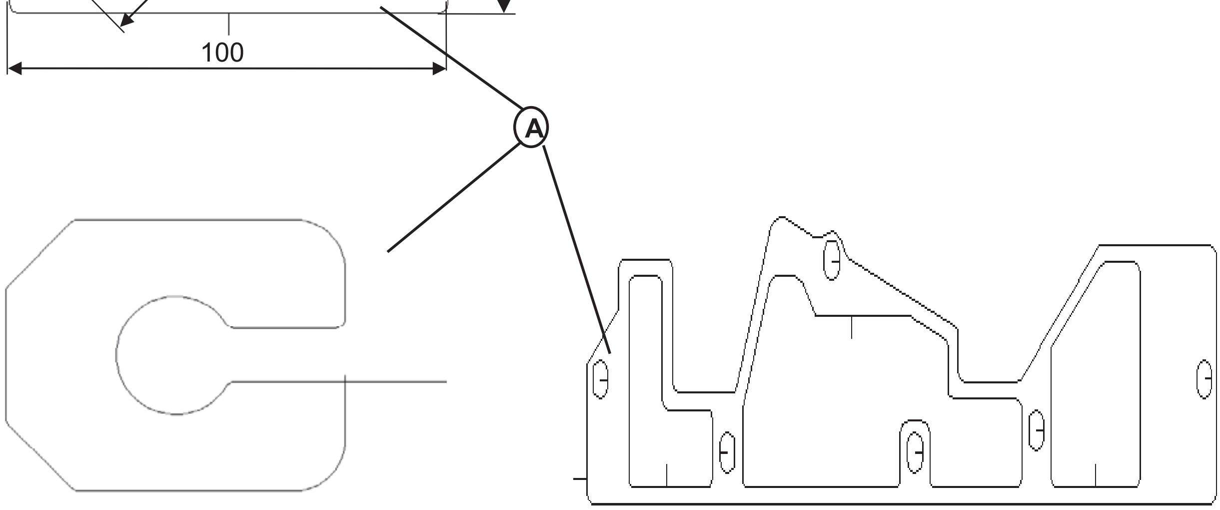
Bystronic defines the geometrical surface of a workpiece (DIN or KMT file) according to the criteria listed below.

Surface of workpiece A = surface inside a delimited external template. Holes, slots and passages are subtracted.

Example:



Square	=	100 cm^2
2 holes	=	- 6.3 cm^2
1 slot	=	- 22 cm^2
Surface of workpiece	=	71.7 cm^2
		========



10.7.3 Defining the size

A large amount of heat accumulates mainly with maximum thicknesses and small workpieces. The size classification depends on the thickness of the plate.

Table: Defining the size in relation to the thickness of the plate

Thickness in mm	Small size (cm^2)	Average size (cm^2)	Large size (cm^2)
15 - 20	$A \leq 150$	$150 \leq A \leq 1350$	$1350 \leq A$
12 - 14.9	$A \leq 100$	$100 \leq A \leq 900$	$900 \leq A$
8 - 11.9	$A \leq 75$	$75 \leq A \leq 675$	$675 \leq A$
4 - 7.9	$A \leq 40$	$40 \leq A \leq 360$	$360 \leq A$
2 - 3.9	$A \leq 20$	$20 \leq A \leq 180$	$180 \leq A$
0.5 - 1.9	$A \leq 10$	$10 \leq A \leq 90$	$90 \leq A$

Table valid for BTL series

If heating problems arise on small workpieces with plate thicknesses of up to 4 mm, they can be cut with nitrogen (N_2) instead of oxygen (O_2).

Advantages:

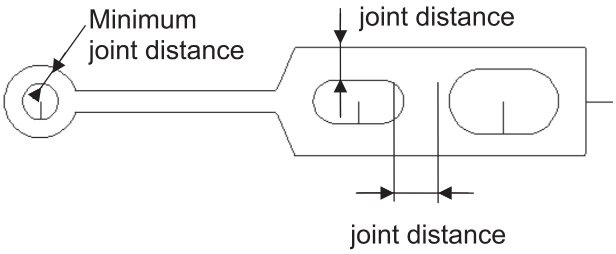
- Nitrogen cools the cutting edge and the workpiece considerably.
- Clean metal surface.
- Extremely limited area affected by the heat.

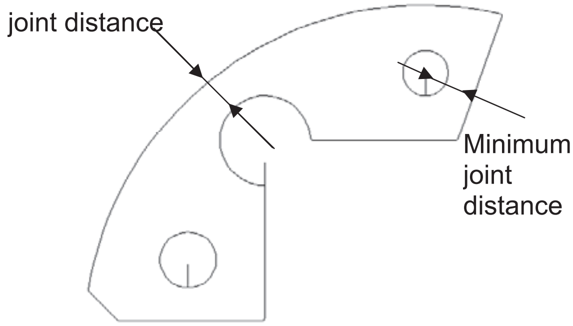
The cutting parameters are the same for stainless steel plates with the same thickness. Only feed must be reduced by 10-20 %.

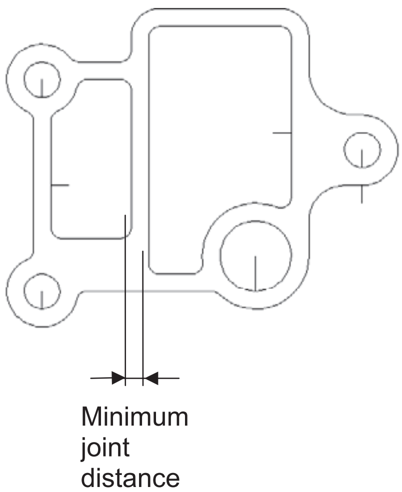
10.7.4 Defining the joint width and minimum joint width

The distances between the holes, distances of the external template of the cut workpiece and the distances between templates are generally defined as the joint width. The shortest distance within a workpiece is defined the minimum joint width.

Example:



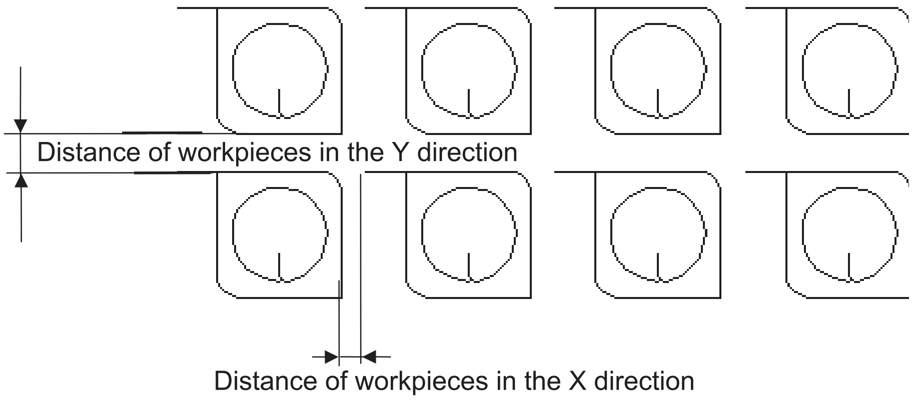




10.7.5 Distance of workpieces

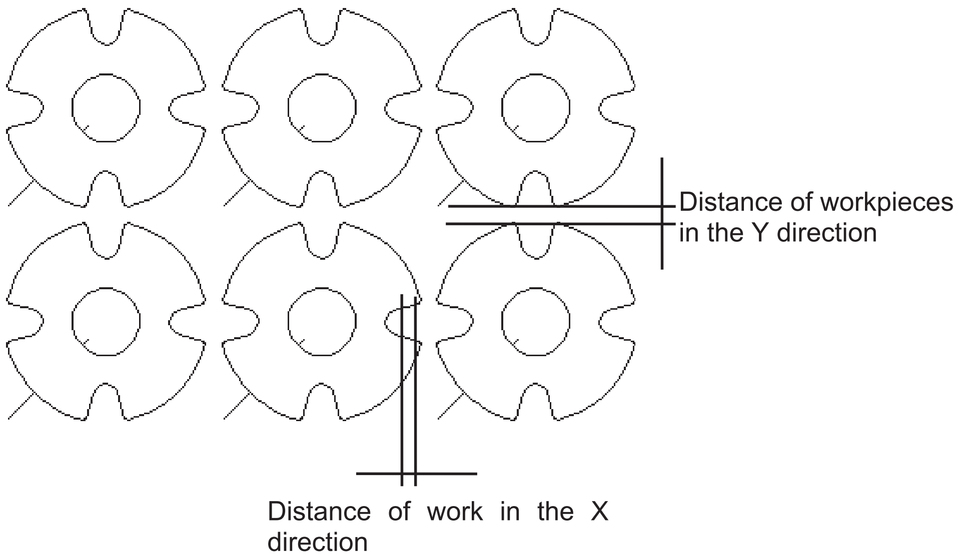
The distance is defined as the minimum distance between two workpieces. Initial cuts outside the template are considered as forming a part of the workpiece.

Example



Some material may be saved if the initial cut is set suitably

Example:

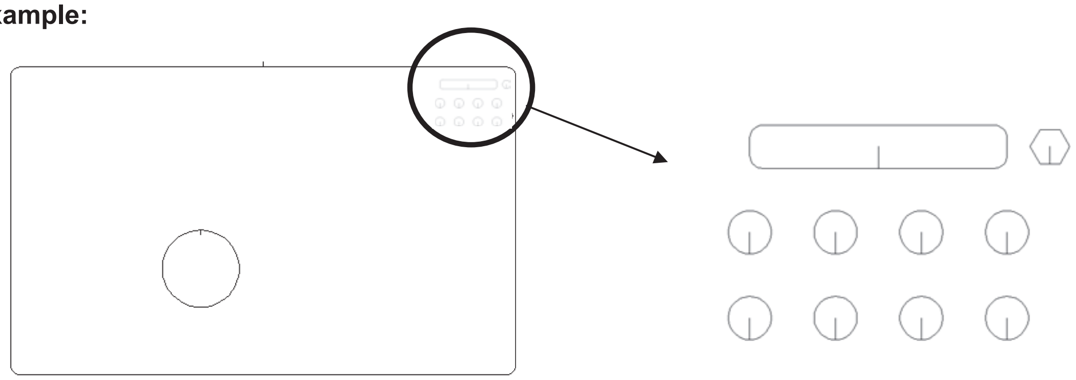


10.7.6 Conformation of holes

Even large workpieces may overheat to a certain degree, when holes are cut close to one another. The conformation of holes is subject to the same rules and definitions as single workpieces.

The same definitions and rules as for a similar single workpiece apply to this sector.

Example:

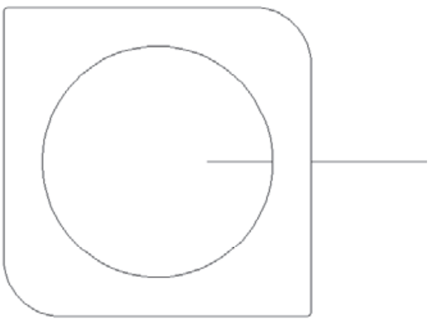


The same definitions and rules as for a similar single workpiece apply to this sector.

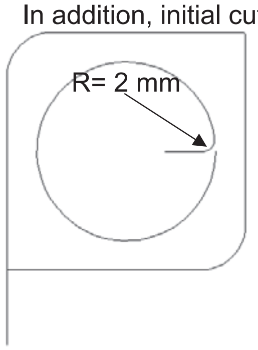
10.8 Piercing and initial cuts

- During piercing, a large amount of heat is generated on the plate. Suitable positioning of piercing and initial cutting lengths may prevent overheating.
- With maximum thicknesses, an initial cut with a radius is required to make sure that the cutting process is as uniform as possible.

Incorrectly set initial cut



Correctly set initial cut
In addition, initial cut with radius



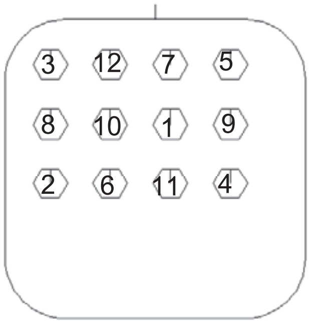
10.9 Cutting small parts

10.9.1 of normal thickness

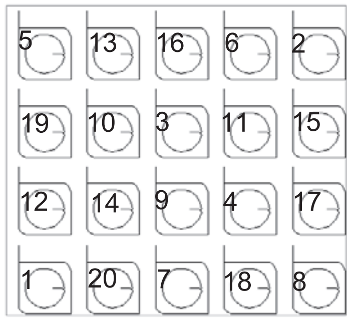
In order to cut workpieces of this type with the necessary process safety, the guidelines given below must be respected.

- Fit all the pointed templates with a radius (R). R= $^{1}/_{10}$ x thickness, minimum 1 mm.
- Minimum passage (holes, slots) 1.2 - 1.5 x plate thickness.
- Minimum joint thickness 1.2 - 1.5 x plate thickness.
- Minimum distance of workpieces 1 - 1.5 x plate thickness, minimum 10 mm, to ensure safe capacitive sensing.
- While cutting with the sensor ring, the step distance must be at least equal to ½ the diameter of the sensor
- Initial cutting length 1 x plate thickness, minimum 10 mm
- Suitable programming (cutting sequence in the DIN part) to obtain optimum distribution of heat in a workpiece.
- Suitable nesting (cutting sequence of single workpiece in cutting plan). In this way, the heat is well distributed in the cutting plan.

Single workpiece



Cutting plan



The numeric values illustrate the cutting sequence.

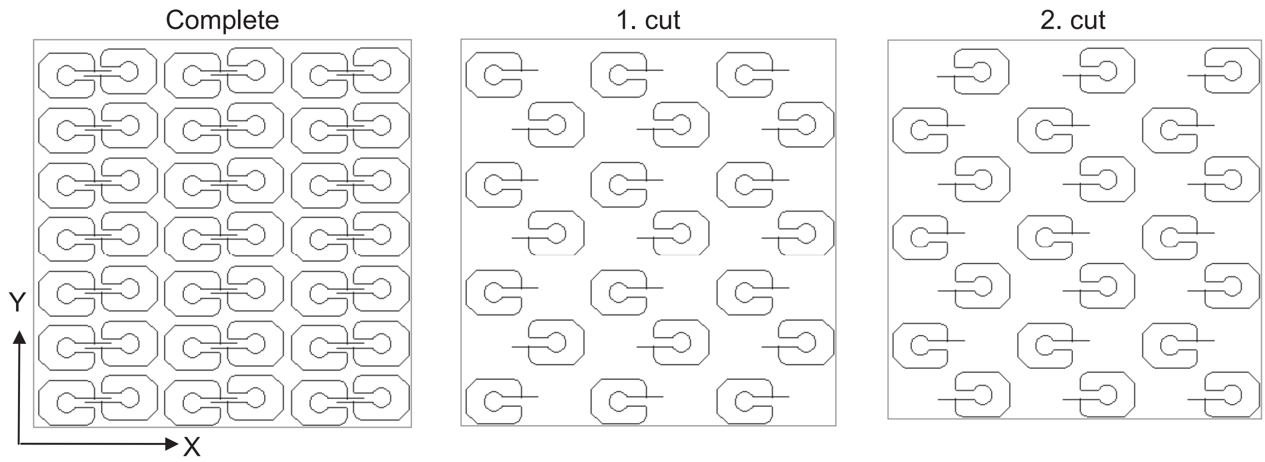
If the guidelines are not respected, the plate may overheat. The first signs of overheating are rough cutting surfaces, burned template cuts and non-extinguished molten material.

Example 1: 2-Phase Cut

Raex 250, thickness 15 mm

Plate size	x= 675 mm
	y= 689 mm
Workpiece size	x= 100 mm
	y= 80 mm
Template distance	x= -18 mm
	y= 17 mm

The complete cutting plan is divided into two new cutting plans. In the first plan, only every other workpiece is cut (1 cut). At this point, the cut must be interrupted until the temperature of the plate drops below 40 ° C. The remaining workpieces may be cut subsequently (2 cut).

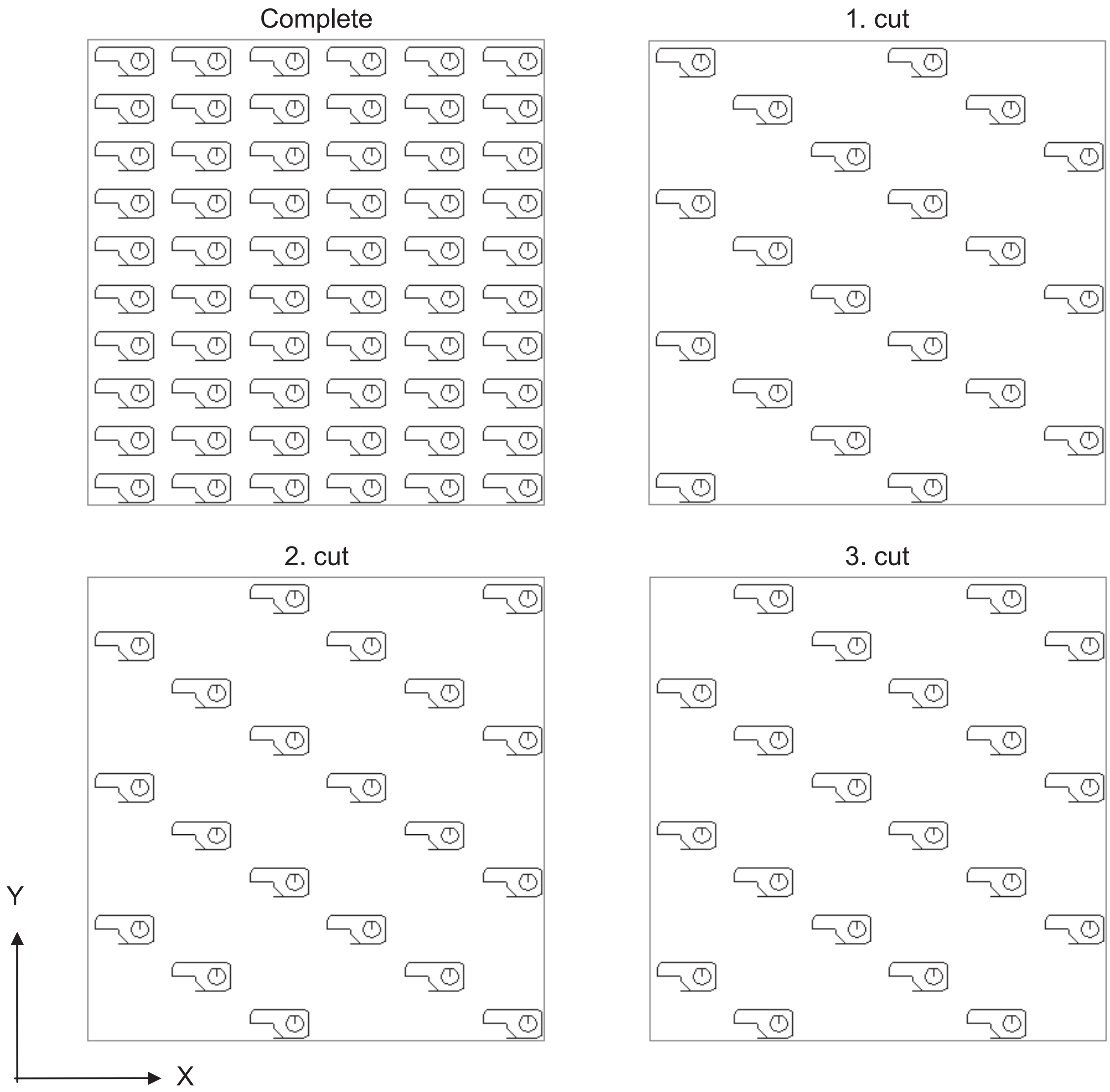


Example 2: 3-Phase Cut

Raex 250, thickness 12 mm

Plate size	x= 477 mm
	y= 485 mm
Workpiece size	x= 62 mm
	y= 30 mm
Template distance	x= 20 mm
	y= 20 mm

Procedure similar to the two-phase cut, but during the first phase, one every three workpieces is cut (1. cut). The cut must interrupted until the temperature of the plate drops below 40 °C. The second group of workpieces is cut subsequently (2. Cut). The third cut follows the same procedure as the second cut.



10.9.2 with maximum thickness

The following guidelines must be respected.

- Fit all pointed templates with a radius (R). R min = 1 mm
- Initial cut of radius, R min = 1 - 3 mm
- Minimum passage (holes, slots)1.5 - 2.5 x plate thickness
- Minimum joint width 1.5 - 2.5 x plate thickness
- Minimum distance of workpieces 1.5 - 2 x plate thickness, minimum 15 mm
- Length of initial cut 1 x plate thickness, minimum 15 mm
- Suitable programming (Cutting sequence in DIN part) to obtain optimum distribution of heat in a workpiece.
- Suitable nesting (Cutting sequence of single workpiece in cutting plan). In this way, heat is well distributed in the cutting plan.
- Prepierce, if necessary

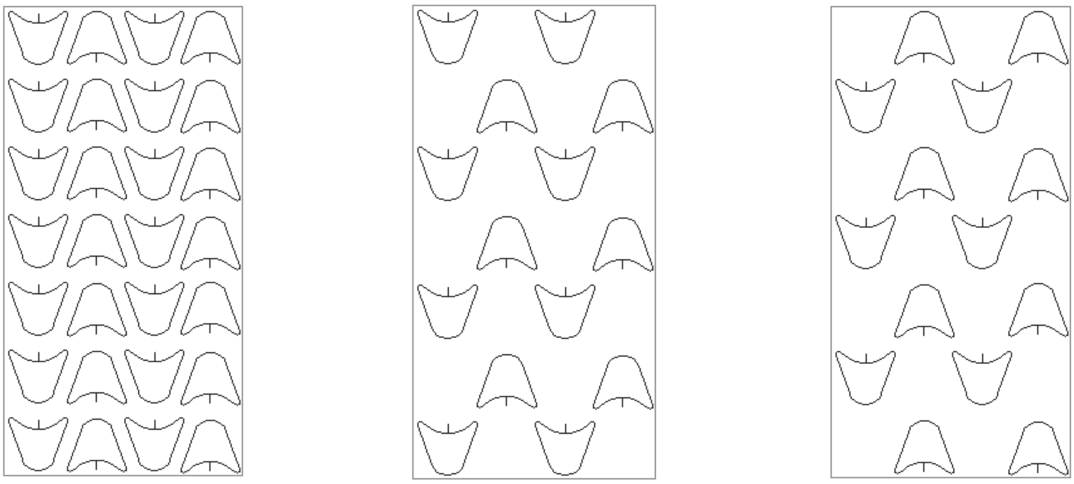
Example 3: 2-Phase Cut

Raex 250, thickness 18 mm

Plate size	x= 485 mm
	y= 960 mm
Workpiece size,	x= 122 mm
	y= 110 mm
Template distance	x= -1 mm
	y= 30 mm

Make cuts 1 and 2 when the temperature of the plate is less than 40 °C.

Complete 1.cut 2. cut



Despite the measures proposed, it may happen, during production, that the necessary process safety is not ensured when cutting small workpieces of maximum width. Workpieces may be cut, but only as single workpieces, not as part of a nested cutting plan. The user must use his own experience in order to decide on this limit.

10.10 Surface of materials

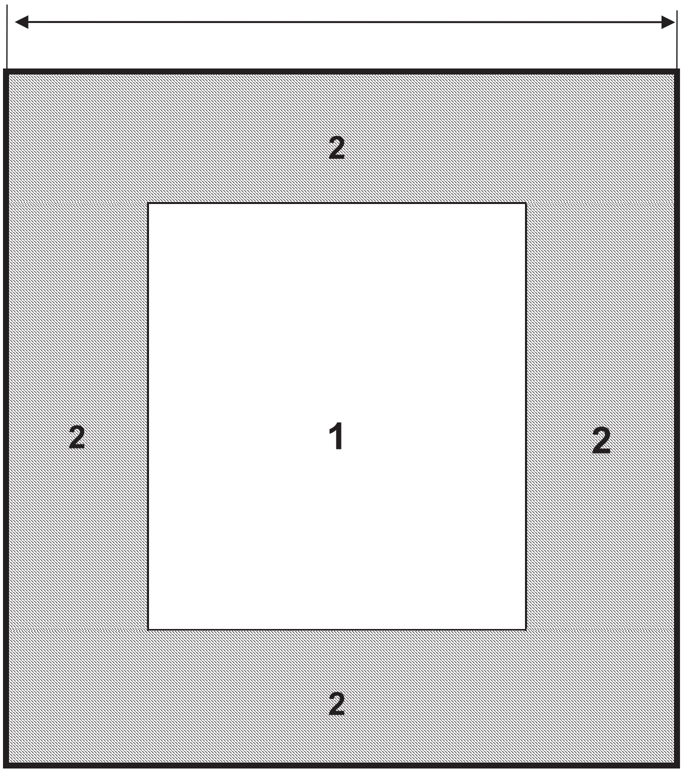
The surface of the materials has an important effect on the results and quality of the cut.

Negative effects	Positive effects
– Calamine – Rust – Slag – Uneven surface with cracks and bumps – Dirt in general – Steel stamping, marks caused by rollers – Color markings **Example:** cheap ST52 plate that has been exposed to the elements.	– Fine, flat surfaces with microslag – Slightly oiled plate – Pickled plate – Clean and greased plate – Sanded or peened surfaces are suitable with reservation but preferable compared to rusty surfaces **Example:** RAEX plate recommended by Bystronic.

10.11 Stress

Less valuable plates present substantially more residual stress and react poorly to laser cutting. The stress forms during manufacture of the plate.

Higher quality plates present less stress. Varying stress is often observed within a plate. The highest stress levels are observed in marginal areas due to the fact that they cool more quickly. By suitable nesting, a higher level of manufacturing safety may be achieved.



Area 1: Less stress on the plate. Workpieces subject to marked deformation must be nested in this area (e.g. long thin strips)

Area 2: More stress on the plate. Simple workpieces not subject to deformation must be placed in this area.

10.12 Primers, paints, protective coatings, zinc-plating

All these and similar surface treatments have a negative influence on the cutting quality. Oxygen and, for example, paints react during the cutting process in the kerf. This causes rather a rough and fringed cut. Another problem is the difference in thickness of the various layers on the same plate. Protective coatings of a different thickness have a negative effect on capacitive sensing.

Solutions:

Thickness up to 4 mm: Nitrogen machining
Thickness > 4 mm: Remove protection cover by engraving in first working process

Notice:

Galvanized sheets are not suitable for pre-engraving!

10.13 Alloy constituents

The quality and power of the cut depend on the alloy constituents. In steel, a high Si content determines a rough cutting edge and causes an increase in the formation of slag and flash.

Amounts of carbon > 0.16% may give poor results with sharp corners and small holes.

Bystronic recommends the use of controlled alloy composition laser plates for maximum thicknesses.

	C content %	Si content%
RAEX 250	0.12	0.01
RAEX 420	0.13	0.01

10.14 Greasing

Piercing injectors stick less strongly to oily surfaces and consequently, the negative effect on capacitive sensing is reduced. Greasing may be done in one of several different ways.

- Crossjet machining
- Purchase of greased plates
- Manual greasing of dry plates

Caution:

Under no circumstances may use be made of inflammable oils. Use exclusively **Protective welding oil.**

10.15 Radius

During laser machining, pointed templates must substantially be avoided. It is much easier for the machine, for all changes in direction, to cut with a radius, for example, of 1-2 mm.

This gives the following advantages.

- No burning of corners.
- Time saving due to a continuous process.
- Clean laser cut.
- The risk of damaging the workpiece is reduced.

10.16 Pre-Piercing

If the workpieces are cut with many holes or shears or small workpieces are nested together tightly, Bystronic recommends prepiercing.

Operating procedure:

- Insert the pre-piercing functions in the LCC plan using the **Bysoft** 5,3 ByADD or **Bysoft 6.0 bywork** software program
- Prepierce the entire plate.
- Clear the plate of any spray created by piercing.
- Leave the plate to cool if necessary
- Cut

Tip:

For prepiercing, activate a smaller nozzle than the one used for cutting. (E.g. K12 instead of K17). The piercing pressure must be double to avoid spraying the lenses. Prepiercing gives a reduction of the heat generated in the plate and the prepiercing hole becomes smaller.

Once all the holes have been precut, the machine moves automatically to the 0-point. In this position, the nozzles can be replaced easily.

The "Piercing" gas pressure may subsequently be restored to its initial value and the piercing time and oxygen are reduced.

By following these procedures, you can cut holes and passages 0.8-1 time the thickness of a plate of normal thickness without pulses.

Notice:

If the sheet is heated strongly during the cut, it expands and so the prepierced holes may move this way, the precut holes may move.

Solution:

Reduce the surfaces to be machined, by dividing a large cutting plan (e.g. 1x2 m) into two small ones (e.g. 1x1 m).

The single workpieces must be cut in several phases due to the thermal expansion, exclusively for workpieces without any tolerance.

10.17 Workpieces not suitable for production

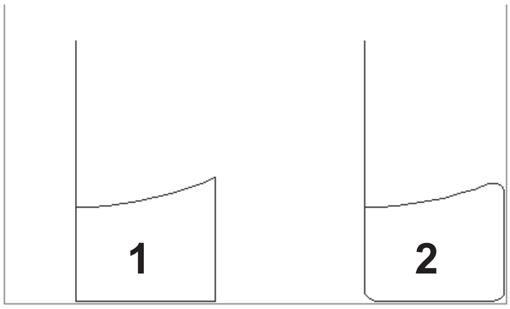
These are above all small workpieces of maximum thickness. In reality, unusual shapes of normal thickness may also present cutting problems.

Example 4

Raex 250, thickness 20 mm

Plate dimensions	x= 88 mm
	y= 83 mm
Workpiece dimensions	x= 25 mm
	y= 17 mm

- Template 1 cannot be cut in this way without radii.
- Template 2 with R= 2 mm can be cut, with reservation, as a single workpiece.
- Workpieces of maximum thickness with these dimensions are not suitable for production.



Operator's Manual

Laser Machine

Appendix

Issue 07.2000

Index

11 Appendix

11.1 Emissions during metals machining

Harmful substances emitted during thermal machining process

TLV: Threshold limit value for concentration in the work environment. The maximum average allowed concentration of machining material in the air, present in the form of gas, vapour or dust, based on actual knowledge does not present any danger to the health to the large majority of people present in the work environment, considering the average exposure during the work period of 8 hours a week even for prolonged periods (Definition according to SUVA, "Threshold limit value for reasons of public health in the workplace").

TIC: Technical indicative concentration. In case the actual knowledge to determine the TLV value is not sufficient, the mainly used TIC will be substituted.

Metal	**Symbol**	**TLV/TIC Value [mg/m^3]**	**Vapour and dust effect**
Aluminium	Al	6	Inert, irritation of the respiratory tract
Beryllium	Be	TIC 0.005	Cancerogenic, very toxic
Lead	Pb	0.1	Toxic, nervous system and blood poisoning
Cadmium	Cd	-	Toxic, suspected to be Cancerogenic, lesion of respiratory organs, kidneys and stomach
Chromium	Cr	TIC 0.1	Cancerogenic, toxic
Cobalt	Co	-	Cancerogenic, lesion of respiratory organs
Iron	Fe	6	Inert, possibly impairment of pulmonary function
Copper	Cu	0.1	Toxic, metal fever
Magnesium	Mg	6	Inert, possibly impairment of pulmonary function
Manganese	Mn	5	Toxic, irritation of the respiratory tract, possibly lesion of the nervous system
Molybdenum	Mo	5	Toxic, lesion of respiratory organs
Nickel	Ni	TIC 0.5	Cancerogenic, toxic
Vanadium	Va	0.1	Toxic, irritation of eyes and of the respiratory tract, possibly impairment of the lungs
Zinc	Zn	5	Toxic, metal fever
Tin	Sn	2	Toxic, metal fever

11.2 Emissions during synthetic material machining

Main components of volatile synthetic material decomposition products. Judgement of endangering

Synthetic material	**Symbol**	**Volatile substances**	**TLV Value [ppm]**	**Vapour and dust effect**
Polyoxymethylene	POM	Formaldehyde	0.5	Sensitizer
Epoxy resins on bisphenol base	A	Phenol	5	Intoxication by skin absorption
Chloroprene-caoutchouc	CR	Chloroprene (2-Chloro-1, 3-Butadiene) Hydrogen chloride	10 5	Intoxication by skin absorption
Polystyrene	PS	Styrene	50	
Acrylonitrile-butadiene-styrene-copolymer	ABS	Styrene 1,3 Butadiene Acrylonitrile	50 5 2	 Cancerogenic effect Cancerogenic effect
Styrene-acrylonitrile-copolymer	SAN	Acrylontrile styrene	2 50	Cancerogenic effect
Polycarbonate	PC	Phenol	5	Intoxication by skin absorption
Polyvinyl chloride	PVC	Hydrogene chloride Dioctylphthalate Dibutylphthalate Benzene	5 5 5 16	 Cancerogenic effect
Polyamide 6	PA 6	E-Caprolactam	4	
Polyamide 66	PA 66	Cyclopentanone Hexamethylene diamine		
Polyethylene	HDPE LDPE	Al. hydrocarbons Al. aldehydes	 0.5	
Polytetrafluor ethylene	PTFE	Tetrafluoretene Hexafluorpropene Octafluorbutene		
Polymethyl-methacrylate	PMMA	Methylmethacrylate	50	

Synthetic materials	Symbol	Volatile substances	TLV Value [ppm]	Effect
Polyurethane	PUR	Ether Glyc. Ether diisocyanate Cyanehydrogen Aromatic amines cl. Phosphoric acid ester 1,2-dichloroethane 2-Chloroethanol	 0.005 10 2 10 1	 Sensibilizers Intoxication by skin absorption
Polypropylene	PP	Aliphatic hydrocarbons	50	
Polybutylene-terephtalate (Polyester)	PBTB	1,3-Butadiene benzene	5 16	Cancerogenic effect
Polyacrylonitrile	PAN	Acrylonitrile Cyanehydrogen	2 10	Cancerogenic effect Intoxication by skin absorption
Cellulose acetate	CA	Ethanoic acide	10	
Polyphenylene-terephthalamide (Kevlar)	PPD-T	Benzene Styrene Phenylisocyanates Naphthalene Biphenyl Benzo(a)pyrenes	16 50 0.005 10 0.2	Cancerogenic effect Sensibilizers Cancerogenic effect
Majority of synthetic materials		Respirable super-fine dust	6	Cancerogenic effect Sensibilizers Intoxication by skin absorption

11.3 Description of abbreviations used

The abbreviations defined by Bystronic are explained in the description. The list of the abbreviations that follows is by no means complete.

Abbre viation	Wording	Description
AC	(ALTERNING CURRENT)	Alternating current
BSL	(BESCHICKUNG LASERMASCHINE)	Bystronic's name for the laser cutting machine's SPS software
CAN	(CONTROLLER AREA NETWORK)	Line system for data transmission
CNC	(COMPUTER NUMERIC CONTROL)	The process data is translated into machine code and is transmitted using this computer system
CPU	(CENTRAL PROCESSING UNIT)	Component of the computer that processes the code
CW mode	(CONTINUOUS WAVE MODE)	Operating mode of the laser (continuous mode)
DC	(DIRECT CURRENT)	Direct current
EMC	(ELECTRONIC MAGNETIC COMPATIBILITY)	German: EMV; what effect do electromagnetic waves have on different bodies?
HF	(HIGH FREQUENCY)	High frequency
HW	(HARDWARE)	Calculator components
LASER	(LIGHT AMPLIFICATION BY STIMULATED EMISSION OF RADIATION)	Light amplification by stimulated emission of radiation
LEL	(LADE ENTLADESYSTEM LASER)	Bystronic abbreviation for the loading / unloading unit
LCD	(LIQUID CRYSTAL DISPLAY)	Screen on the PC Panel
LED	(LIGHT EMITTING DIODE)	Light-emitting diode
MAK	(MAXIMAL ARBEITSPLATZKONZENTRATION)	Maximum concentration of emissions on the work area
MCS	(MICRO CONTROLLER SYSTEM)	Controller for the Bystronic laser
MMC	(MAN MACHINE COMMUNICATION)	Checks the Bystronic machine (CNC and PC)
MMI	(MAN MACHINE INTERFACE)	Bystronic input module for the SPS control
PLC	(PROGRAMMABLE LASER CONTROL)	German SPS
PPC	(PANEL PC)	Bystronic Personal Computer used for entering the process parameters and controlling the machine

SPS	(SPEICHER PROGRAMMIERBARE STEUERUNG)	Control unit with input module that progressively carries out the programs
STL	(SCHNEID TISCH LASER)	Bystronic control system for laser cutting machines with shuttle table, CNC and small parts conveyor
SW	(SOFTWARE)	Programs
TVL	(THRESHOLD VALUE LIMIT)	German MAK

Operator's Manual

Laser Machine

Glossary

Issue 11.96

12 Glossary

Axial flow laser	Type of laser in which the flow of the active means runs along the optical axis of the resonator and therefore parallel to the laser beam itself. (DIN 32511).
CO_2 laser	Gas laser, of which the active means is composed by a mixture of nitrogen, carbon dioxide and helium. The switch to laser takes place in molecule of CO_2, and in this transformation a radiation averaging 10.6 µm is liberated (DIN 32511).
Divergence	Opening angle of the laser beam, tht is produced in the far field (Fraunhofer area) by the widening of the beam section in the direction of the propagation (DIN 32511).
.	
Far field	Radiation field of a laser at the Z distance from the beam waist, where the distance results relevant in respect to the to the length of Rayleigh Zr (DIN 32511).
Laser device encapsulated	The laser version assigned, because of its costructive charateristics limitating the accessible radiation, to a lower class than that corresponding to the effective values of the built-in laser (IEC 825 / EN 60825)
Excitation of the direct current field	Excitation through direct current.
Cinematic resonator suspension	The resonator is fixedly supported in one point only, the other supports permit the movements suitable to compensate the variation of the length caused by the oscillation of the temperature.
Laser	All equipment fit to generate or amplify an electromagnetic radiation at wavelengths intervals from 180 nm to 1 mm, mainly through stimulated or controlled emissions (IEC 825).
Laser active means	Gas, solids, fluids, in which the laser radiation is generated (DIN 32511).
Class of the laser	Laser radiation lower than the limit values of the laser radiation available for the required wavelengths and emissions duration, according to the legislations IEC 825 / EN 60825
Max. concentration. In the working environment	(TLV value) The maximum average admissible concentration of a process substance, present in the form of gas, vapour or dust, which to the best of current knowledge does not damage the health of greater majority of healthy persons present in the work environment, Keeping in mind the exposure regulations during a work period of 8 hours a day and 42 hours per week even for extended periods.

Mode	Longitudinal or transversal vibrations in the laser resonator, which are automatically created during the passage of the resonator (DIN 32511).
Mode characteristics	The three-dimensional characteristic of the mode (distribution of the power over the section of the laser beam) determines the suitability of the laser for the different types of machining (cutting, welding, tempering), the characteristics in the time of the mode influence the homogeneousness of the machining with the laser.
Nausea	Sickness, stimulation to vomiting
Length of Rayleigh	Distance of the waist beam, in correspondence to that of the surface of the section of the beams that doubles (DIN 32511).
Directional stability	Three-dimensional stability in the direction of the laser beam or a laser plant for a defined period of time, referred to the mechanical axis of the optical system (DIN 32511).
Base value of the tension	Minimum path tension still able to maintain active the loading, the corresponding lasr power is called the base power. According to the type of transmission of the output window, the laser power results de-torqued or shortly before de-torquing, the laser works close to its threshold value.
Waist beam	local minimum diameter of the laser with flat wave front (DIN 32511)
Tactile	Concerning the meaning of the sensor= with contact of the workpiece
TEM	Abbreviation for transversal excitation vibrations.Describes the distribution of energy along the section fo the beam (DIN 32511).

Operator's Manual

BYSTAR

Alphabetical Index

Issue 01.2001

Alphabetical Index

-F-

-G-

-H-

-I-

-K-

-L-

-M-

-T-

-U-

-V-

-W-

-Z-