CHAPTER 2

Functional Characteristics

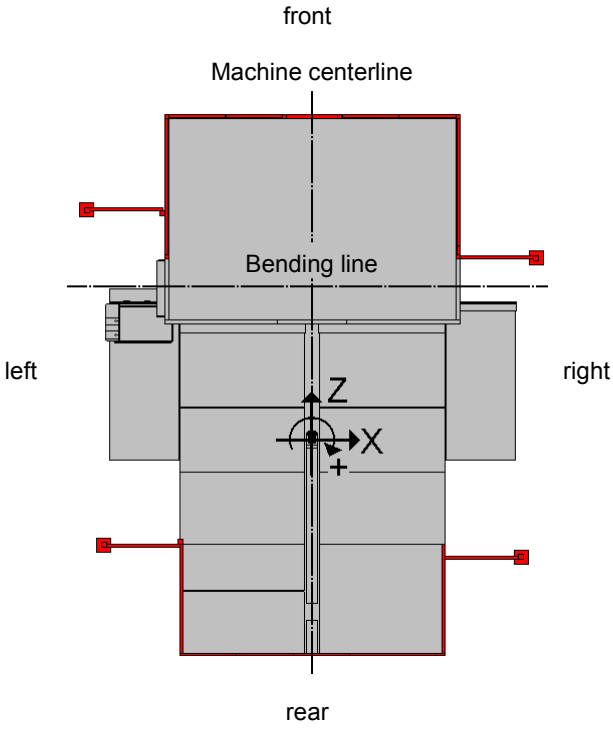
2.1 General Information

The panel bender is a numerical controlled automatic system for bending cold rolled sheets made out of non carbon, unalloyed or austenitic steel. Optionally, aluminium or brass sheets can also be processed. Please see *Technical Data* on page 2-51.

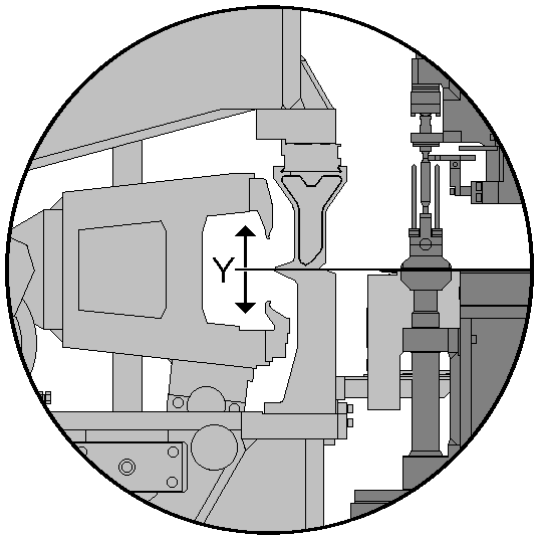
To boost the efficiency of the panel bender, the machine mode can be adapted to the respective production scenarios. Operators can select a *High Speed Mode*, a *Standard Mode,* or an *Economy Mode*. For more information, see *Productivity* on page 2-54.

2.2 Definition of the mobile axes and directions

Top view of the basic machine

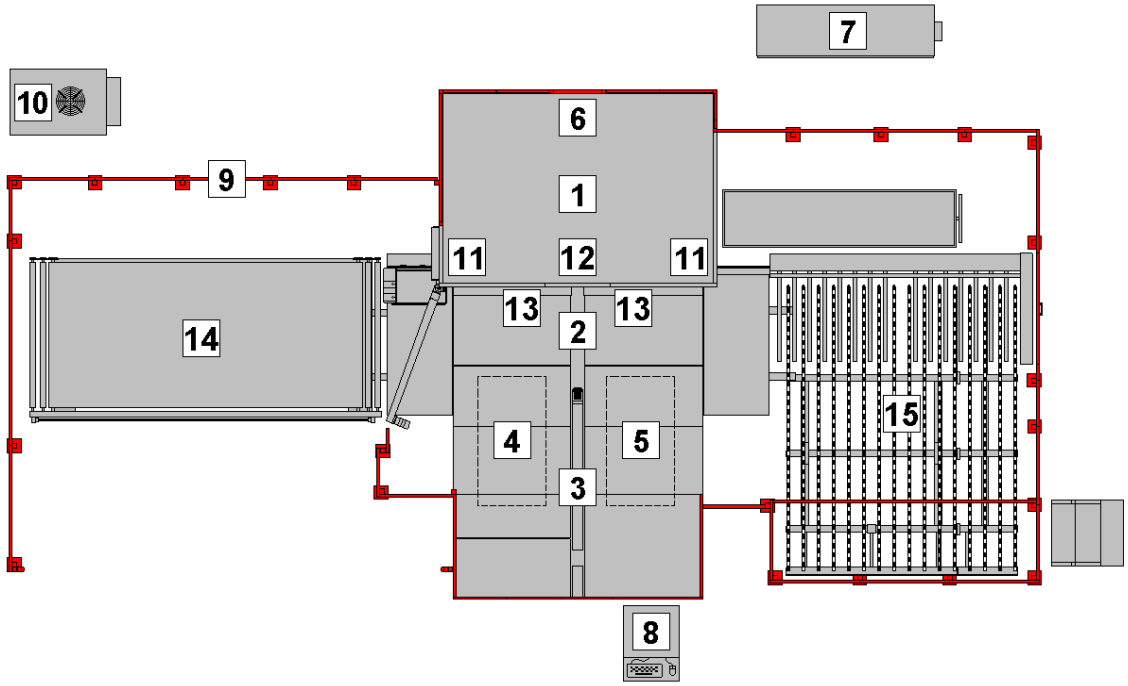


Detailed view of the bending tools



The picture above shows the referencing and the aligning system of the machine. Herewith, the direction of movement and orientation of sheets and machine parts can be clearly defined.

2.3 Main components of the machine



Basic machine

1 Bending machine
2 Centering table
3 Manipulator

Hydraulics

4 Oil container
5 Main pump aggregate

Pneumatics

6 Maintenance unit

Electricity

7 Switch cabinet
8 Control desk

Additional facilities

9 Safety fence and protective coverings
10 Chille

Options

11 CLA tooling
12 CUT Option
13 P Option

Feeding- and unloading units

14 Feeding unit
15 Unloading unit

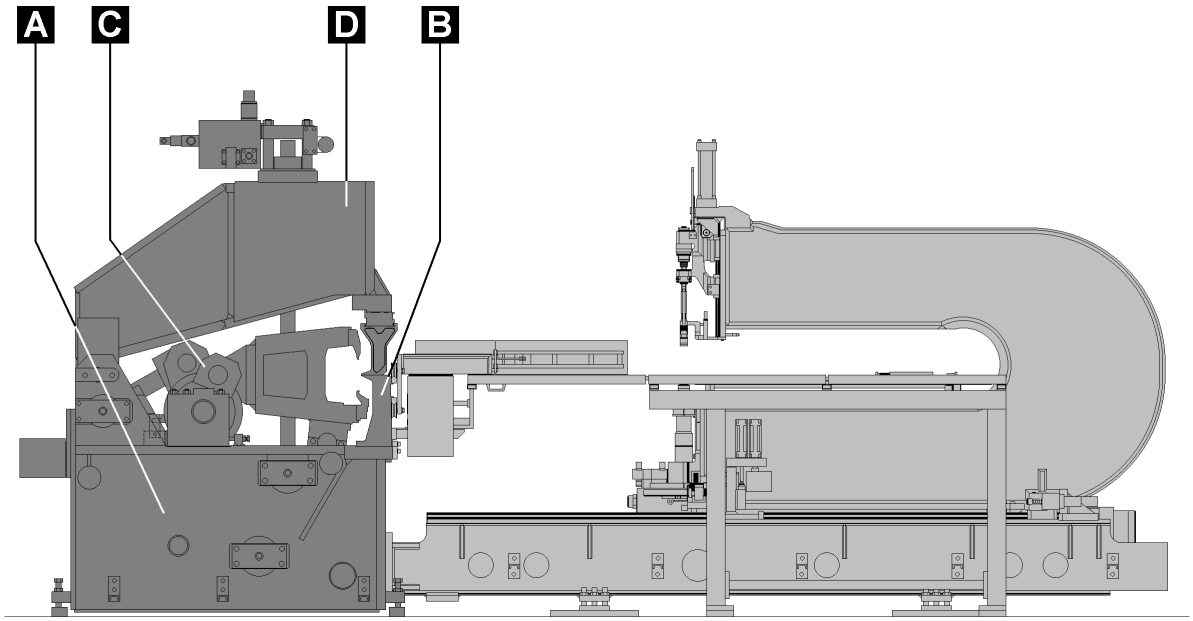
2.3.1 Basic Machine

The basic machine receives the sheet (blank) from the feeding unit, bends it and passes the finished processed panel onto the unloader/accumulator unit. The basic machine consists of the **bending machine**, the **centering table** as well as the **manipulator**.

Bending machine

The manipulator positions the sheet (blank) in place and this is bent by the bending machine according to the job given in the bending program.

Components of the bending machine:



A Frame **B** Counterblade **C** Bending unit **D** Blankholder

A Frame

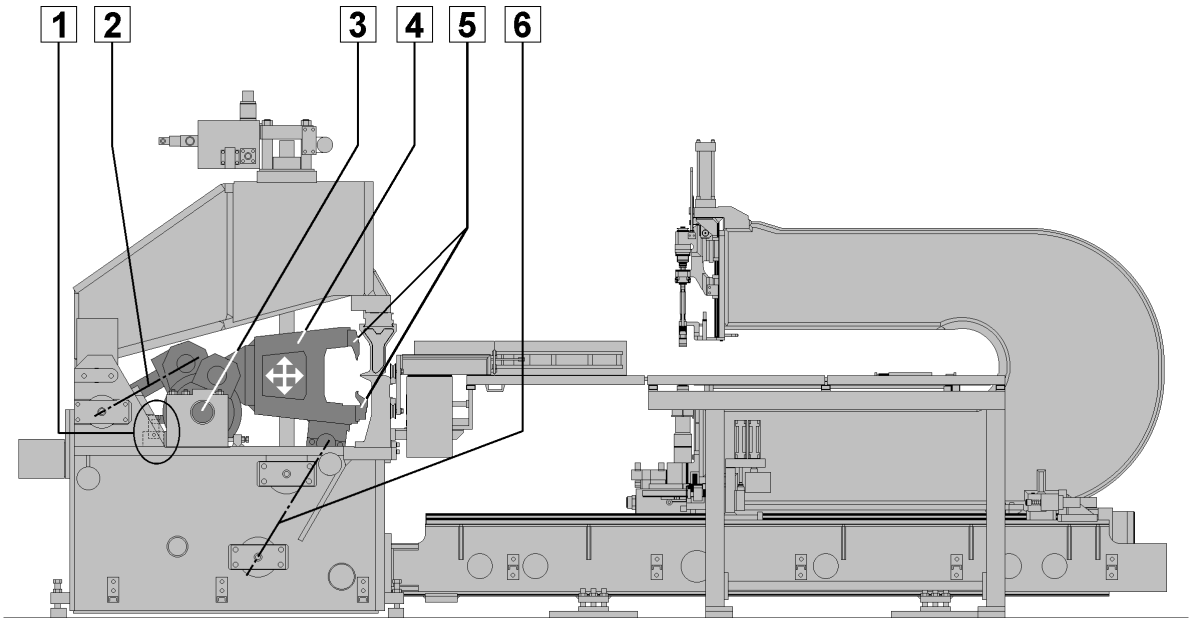
The counterblade, bending unit and blankholder are mounted on the frame.

B Counterblade

This is mounted on the front part of the frame. During the bending process, the blankholder presses the blank against the counterblade. The blank is clamped and herewith secured from slipping out of place.

C Bending unit

This executes the bending of the blank. The bending unit consists of the safety lowering device of the bladeholder 1, the bladeholder 4, the upper and lower bending tool 5, the torque rod 3, the horizontal bending unit 2 as well as the vertical bending unit 6.



The lowering safety device of the bladeholder prevents the bladeholder from dropping onto the counterblade or blankholder tooling when the hydraulics are switched off. A bracket mounted rotatably on the frame is activated by a pneumatic cylinder which hooks into one of the cogs on the torque rod.

The bladeholder is the carrier for the bending tools. It is flexibly mounted on the torque rod. Sheet metal is bent by moving the bladeholder in the horizontal or the vertical direction over the horizontal or the vertical bending unit.

Upper and lower bending tools are mounted on the two ends of the C-formed bending blade. There are bending tools with different geometrical features. Smaller bending spaces require a finer pair of bending tools, the processing of thicker blanks requires stronger bending tools. The bending tools remain on the machine until they need replacing due to wear. They are not changed for a production change-over.

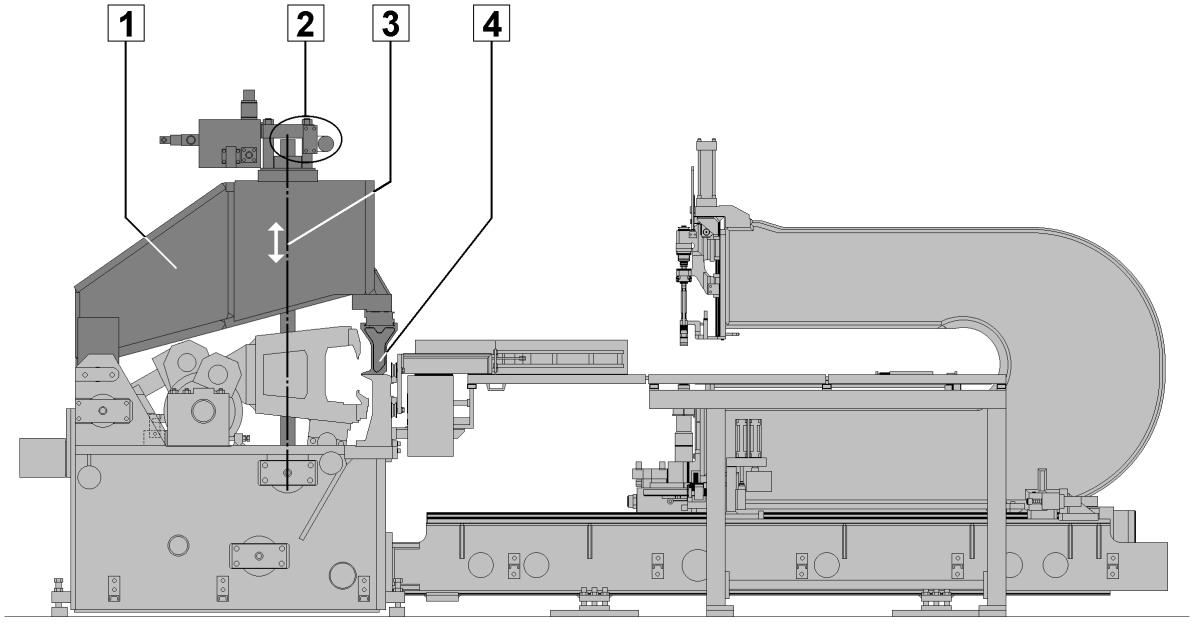
The torque rod holds the bladeholder with its bending tools parallel to the counterblade. Its two ends are fixed directly to the frame. Its axis runs parallel to the bending line. The torque rod is flexibly connected via brackets to the bladeholder and horizontal bending unit.

The horizontal bending unit moves the bladeholder via the torque rod in horizontal direction. It consists of two hydraulic cylinders with appropriate measuring system and servo valve. Each cylinder is fixed by two bolts flexibly on the frame. Control is via 4-way directional control servo valves and linear measuring system. The piston rods are connected rotatably with the respective brackets of the torque rod.

The vertical bending unit moves the bladeholder in vertical direction. It consists of two hydraulic cylinders with appropriate measuring system and servo valve. Each cylinder is fixed by two bolts flexibly on the frame. Control is via 4-way directional control servo valves and linear measuring system. The piston rods are connected rotatably with the respective brackets to the bladeholder.

D Blankholder

During the bending process, the blankholder presses the blank against the counterblade. The blank is clamped and herewith secured from slipping out of place. It consists of the blankholder lowering safety device 2 , the blankholder frame 1 , the blankholder cylinders 3 and the blankholder tooling 4 .

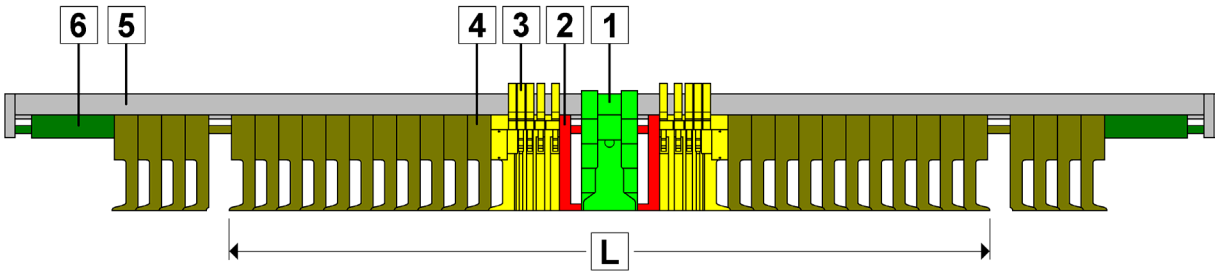


The lowering safety device of the blankholder prevents the blankholder from falling onto the counterblade when the blankholder is raised and the hydraulics are switched off (tool changing position). Via a rail, a pneumatic cylinder turns a stop block on all blankholder cylinders between the upper end of the piston rod and the support block.

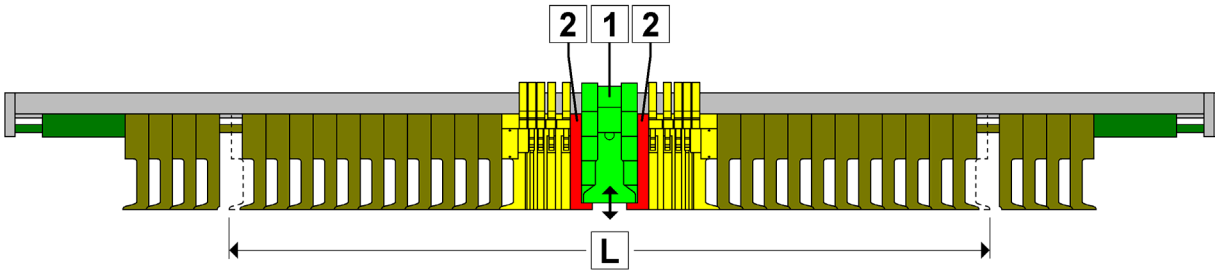
The blankholder frame serves as a carrier for the blankholder tooling. It is mounted rotatably to the frame of the machine and is moved up and down hydraulically by the blankholder cylinders.

The four blankholder cylinders press the blankholder frame with the blankholder tooling against the counterblade during the bending process so that the sheet in between is clamped and herewith secured in place. The two outer cylinders have stroke and clamp functions, the two inner ones only have clamping functions. Each cylinder is connected rotatably to the blankholder frame. The piston rods project through recesses on the bladeholder and their ends are fixed flexibly to the frame of the machine. An electrically triggered 4-way directional servo control valve regulates the positioning. Controlling is effected via a linear measuring system. A proportional pressure reducing valve alters the clamping force of the blankholder cylinder proportional to the bending length.

The blankholder tooling is composed of a central segment **1** and of two tool sets, one each disposed symmetrically on the central segment's left and right, each set consisting of a contraction segment **2** , five composition segments **3** , and the outer segments **4** . The tool clamping fixture **6** forms the termination on both sides. This tool clamping fixture is a hydraulic cylinder urging the various segments against the central segment while the bending cycle is in progress. All segments as well as the tool clamping fixture are supported on the tooling guide (dovetail guide) **5** mounted on the bottom of the retaining jaw (blankholder plate).
The blankholder tooling length **L** can be changed in steps of 5 mm. Such changes are carried out automatically by the machine control system (bending program). It is not necessary to exchange or manually move individual segments.
For length adjustment, the composition segments of each tool set are combined by swinging them inward or outward, as required, and a spacing (gap) between two outer segments is created in the required position. This gap is created by extending hydraulic pistons provided in each of the outer segments.
The time required for the readjustment of the individual segments (readjustment of blankholder tooling length) is about 4 to 5 seconds. This procedure takes place while the metal sheets are unloaded from and fed to the machine. As a consequence, tool adjustment times (setting-up times) will not cause any process delays.



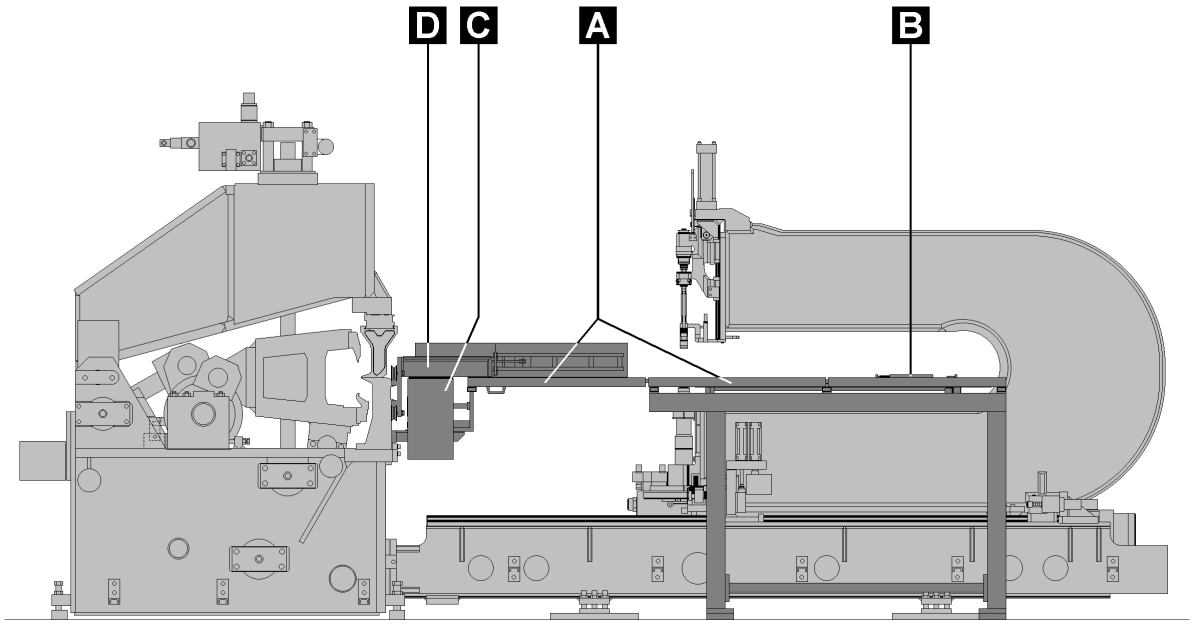
In the case of panels that are bent inward on all sides, it will be necessary to disengage the blankholder once the bending process has been completed. With the help of two contraction segments **2** in combination with central segment **1** that can be lifted and lowered, you can shorten the blankholder length **L** to such a point where it will be possible to move the blankholder out of (disengage it from) the panel. This process is carried out automatically by the machine control system.



Centering table

The centering table is a rectangular working surface which has several functions integrated into it. The table has the task of receiving the sheet (blank) from the feeding unit, centering it so that an exact clamping by the manipulator is possible and to pass the finished sheet (panel) on to the unloading unit.

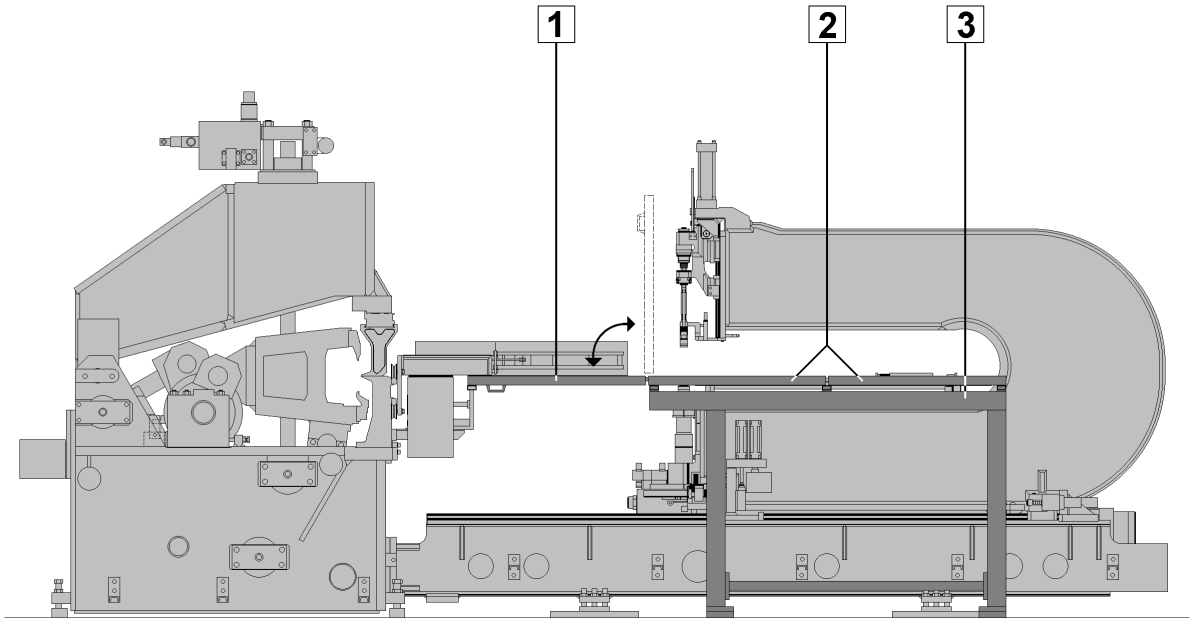
Sections of the centering table:



A Fixed table
B Z-Pusher
C XZ-reference tables
D Sheet transport

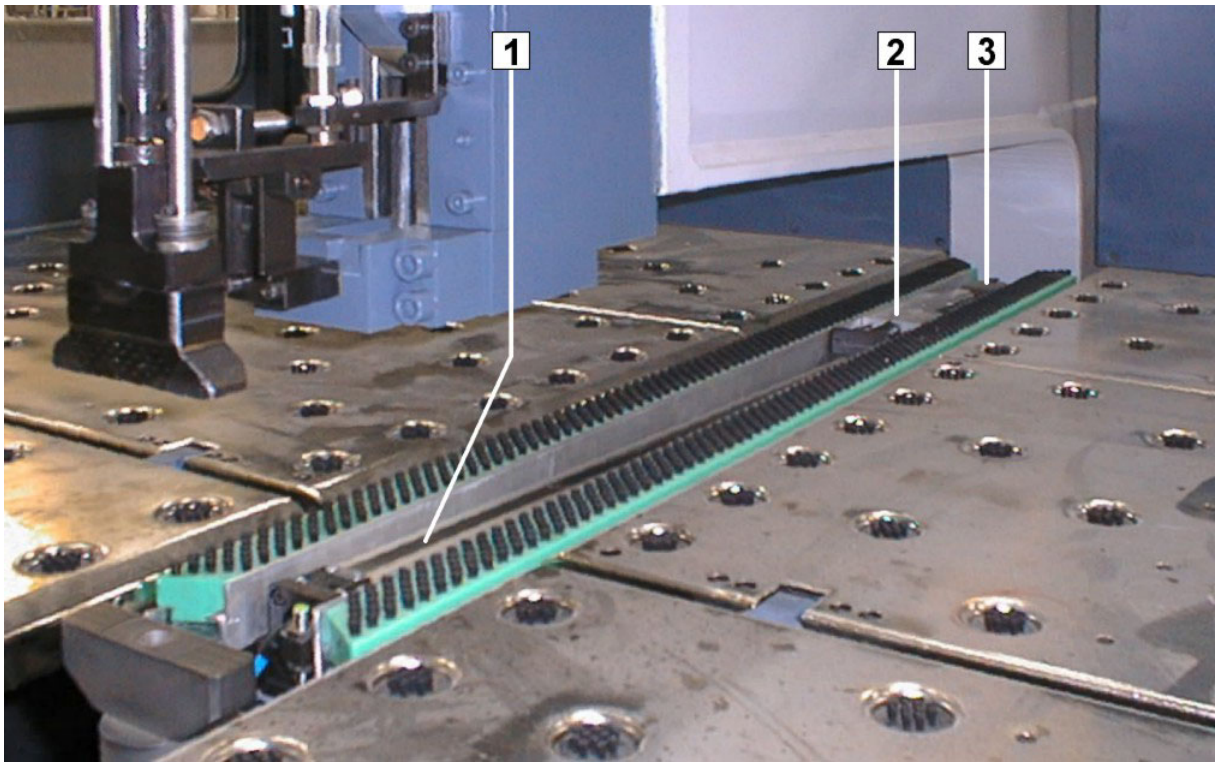
A Fixed table

This is a rectangular brush table in several parts which represents the working surface for the sheet manipulation. It is situated in front of the bending machine connected with the XZ-reference table left and the XZ-reference table right. To make access to the reference tables and bending machine easier, the front parts of the table 1 have been designed to fold up. The rear table parts 2 are mounted on the left and right of the manipulator each on a frame 3.



B Z-Pusher

These push the sheet for the centring procedure against the left and right XZ-reference. The Z-pusher is in the middle of the working surface on the C-frame of the manipulator.
The Z-pusher consists of a Z-pusher carriage 1 , a Z-pusher carriage raiser 3 and a Z-pusher head 2 .



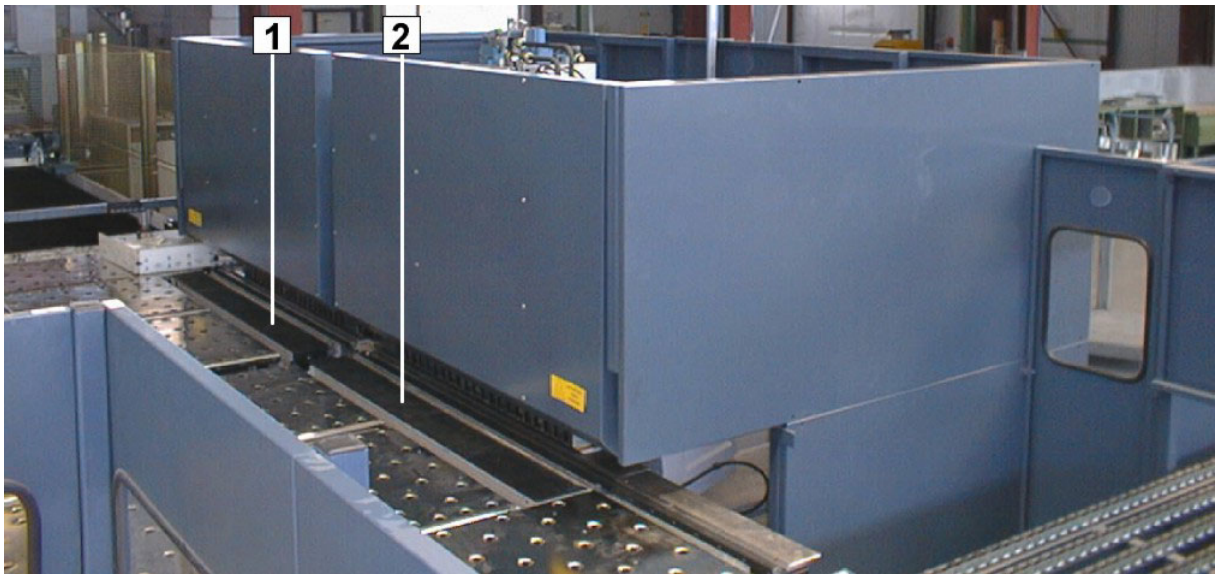
The Z-pusher carriage is a pneumatic cylinder without a piston rod. It is sunk slightly tilted in the working surface. The front part is mounted flexibly onto the frame of the manipulator. The rear part is connected to the piston rod of the Z-pusher carriage raiser.

The Z-pusher carriage raiser lifts the rear part of the Z-pusher carriage for the centering procedure of the sheet and with this brings it to a horizontal position. The Z-pusher head moves forwards and presses the sheet against the XZ-references.

The Z-pusher head has a cushioned ejector plate guided by two rods. Damping happens when the sheet hits the ejector plate it is pressed against the spring power backwards onto a hydraulic damper which is situated between the rod guidances.

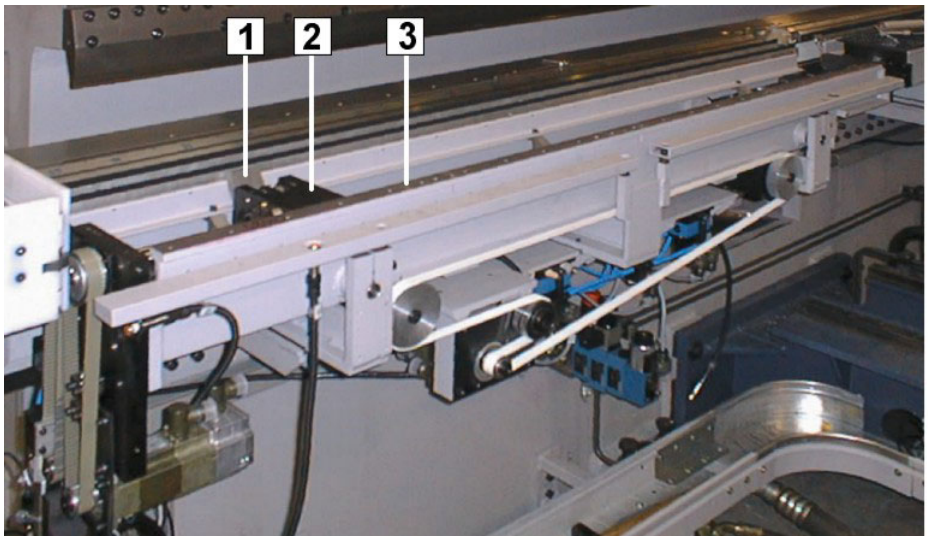
C XZ-reference tables

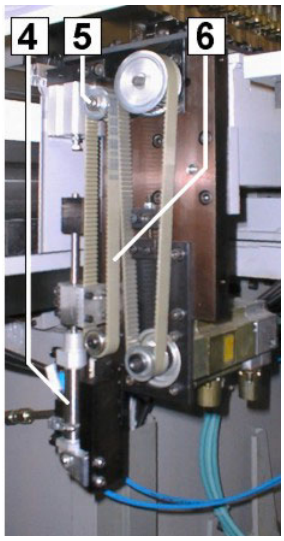
Together with the Z-pusher, the left XZ-reference table 1 and the right XZ-reference table 2 center the sheet (blank), which has been placed onto the working surface by the sheet transport system, such that exact clamping by the manipulator is possible. They are fixed at the front of the bending machine and at the same time form the support for the folding tables of the fixed table.



Structure and function of left XZ-reference table:

The essential parts of the reference table are the left XZ-reference 1 , the swiveling mechanism, the X-positioning-carriage for the left XZ-reference 2 as well as the Z-positioning-carriage for the left XZ-reference 3 .





The left XZ-reference is located in the working surface, sunk into the Z-positioning carriage of the left XZ-reference. To center the sheet (blank), the swiveling mechanism lifts the left XZ-reference out of the work surface.

The swiveling mechanism consists of the swiveling shaft **5** supported in the Z-positioning carriage for the left XZ-reference, and of the pneumatic cylinder **4** which, via the toothed belt **6** , turns the swiveling shaft. The left XZ-reference is disposed on the swiveling shaft. It is connected to the swiveling shaft through a feather key and can be moved by sliding it along the shaft axis.

By turning the swiveling shaft, the left XZ-reference can be moved to the following positions:

1. Sunk into the work surface:
   Pneumatic cylinder **4** in retracted end position.
2. Centering position:
   Pneumatic cylinder **4** in position abutting the fixed reference.

The X-positioning carriage for the right XZ-reference is disposed in the Z-adjuster of the right XZ-reference. It moves the left XZ-reference, which is supported on the swiveling shaft, in the X-direction along the shaft axis. The X-positioning carriage for the right XZ-reference is guided along a dovetail guide. Its positioning results from a ball spindle which drives a three-phase motor with encoder via a toothed belt.

The Z-positioning carriage for the left XZ-reference enables the movement of the XZ-reference in Z-direction. It is guided on round guides. Its positioning results from two trapezoid thread spindles which drive a three-phase motor with encoder via a toothed belt.

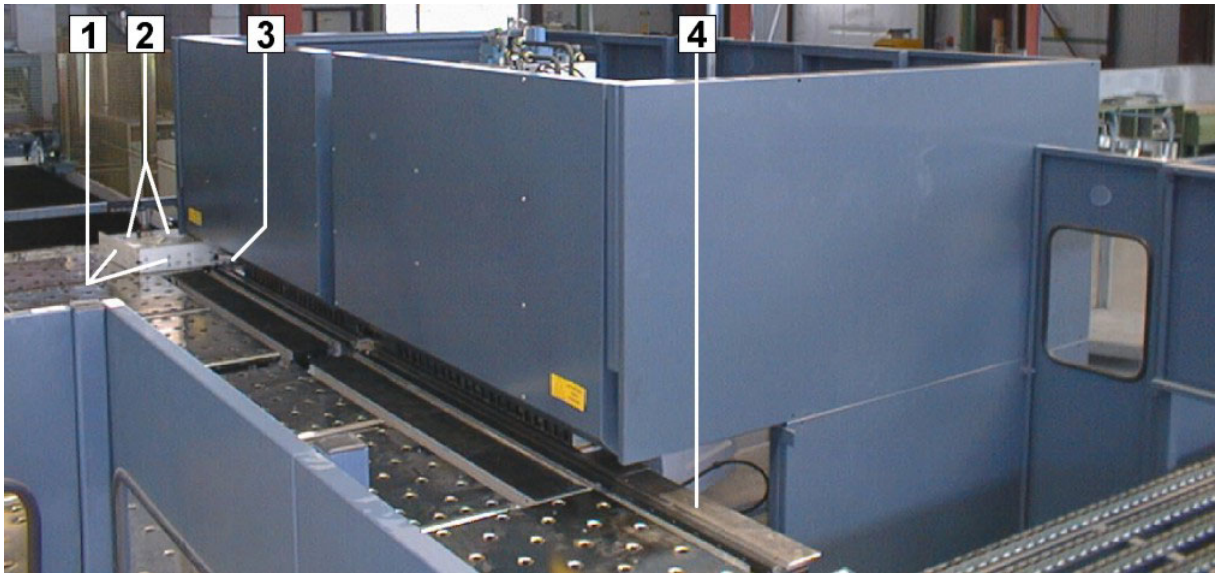
Structure and function of right XZ-reference table:

Same as for left XZ-reference table. However, in this case, the Z-adjuster for the right XZ-reference is used for positioning.

Unlike the Z-positioning carriage for the left XZ reference, ***the Z-adjuster for the right XZ-reference*** is actuated by a pneumatic cylinder. A pneumatic cylinder pushes it to the front or rear end position, as the case may be.

D Sheet transport

Receives the sheet (blank) for bending from the feeding unit, pulls it onto the working surface, places it near the references and at the same time pushes the finished bent panel onto the unloading unit. The sheet transport consists of a transport sledge, a drive unit and a tensioning cylinder.



The transport sledge moves between the feeding and unloading unit along the line of bending (in X-direction) on a roller guide attached to the counterblade **4** . On the transport sledge, there are two pincers **2** and an unloading arm **1** . The transport sledge grips the sheet (blank) for bending, pulls it from the feeding unit onto the working surface, places it near the references and at the same time pushes the finished bent sheet (panel) with the unloading arm off the working surface onto the unloading unit. To stop the transport sledge from colliding with sheets which have already been placed on the working surface, the rear part of the unloading arm has been fitted with a swivel-mechanism. For maintenance work or transport purposes, this can also be swivelled in. In order to unload parts which have a last bend downwards from the machine, the unloading arm has a projection **3** on its front part which encompasses the counterblade. If the panel does not cover the entire width of the pincer, then aided by a shut-off valve this pincer is disconnected to avoid marking the panel.

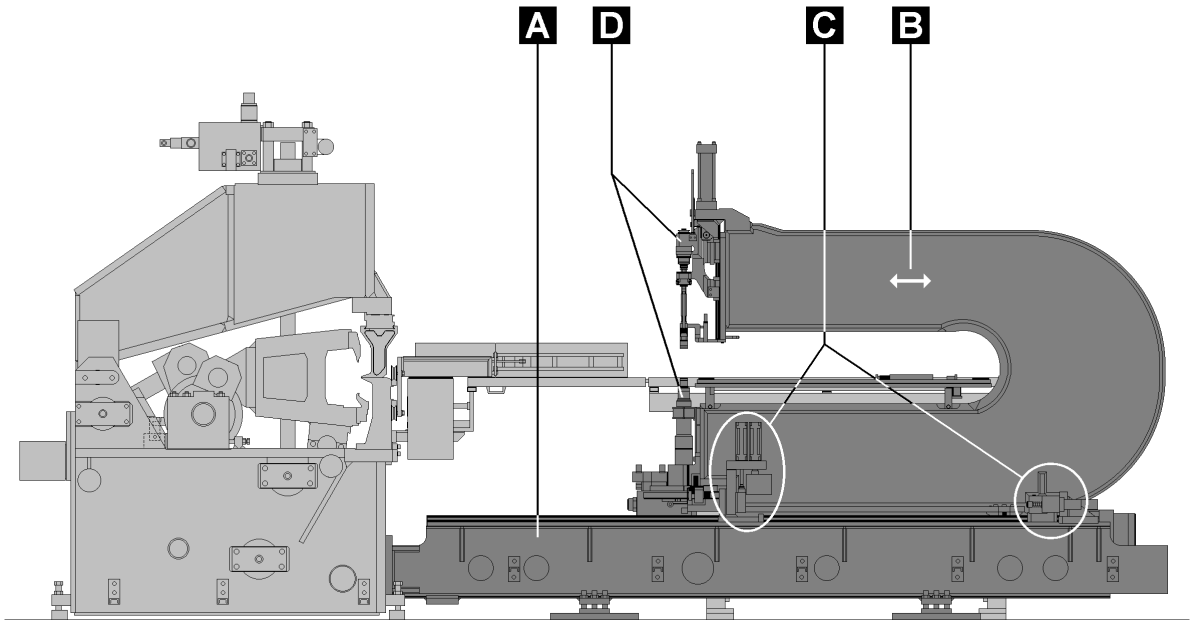
The drive unit is disposed on the left side of the bending machine at the Counterblade. It consists of an AC servo motor with encoder which via a gear, a spindle and a toothed gear drives a toothed belt which is positioned horizontal to the line of bending. The transport sledge is clamped by a bracket with cogs to the joint of the toothed belt.

The tensioning cylinder is disposed on the right side of the bending machine at the Counterblade. It is used to tension the toothed belt while the transport sledge is in motion in order to ensure an exact positioning of the transport sledge and prevent a possible skipping of teeth. In addition, the tensioning unit allows the toothed belt to yield when the manipulator travels into the counterblade.

Manipulator

The manipulator clamps the already centered blank which has been placed on the centering table, turns it and manipulates it into the various bending positions and pushes it into the bending machine.

Components of the Manipulator:



A Base frame
B C-frame
C Stroke regulator
D Clamp/turning device

A Base frame

This is under the centering table. Its front end is fixed to the bending machine. The C-frame is guided on the base frame.

B C-frame

Glides on two guides which are mounted at the top of the base frame. Its position control is by means of a ball spindle which drives a three-phase current servo motor with encoder.

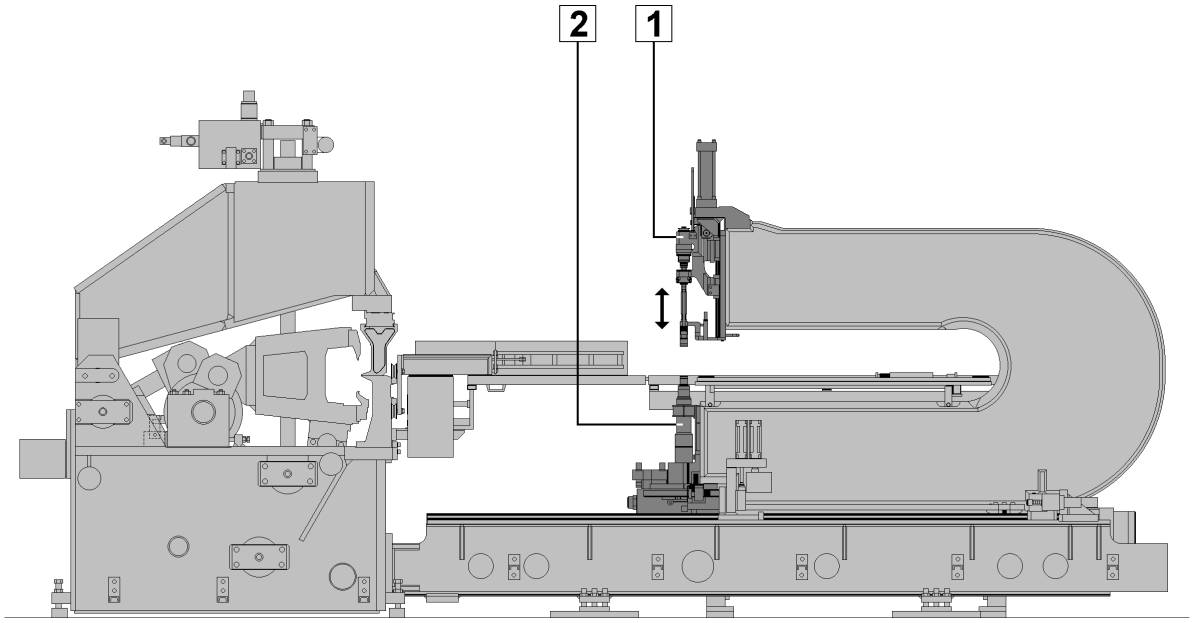
C Stroke regulator

A mechanical protection against collisions of the clamp/turning device with the bending machine. Normally, the limit damper mounted on the C-frame moves against the fixed reference mounted on the base frame and on doing so, fixes the front end of travel position of the manipulator. Depending upon the position of the clamp/turning device it could be

necessary to limit the stroke. For this purpose, a pneumatic cylinder pushes a spacer piece (stroke regulator) in front of the fixed reference. This is done automatically and supervised by the controls via a limit switch.

D Clamp/turning device

Clamps the sheet and rotates it into the different bending positions. The clamp/turning device is mounted on the front of the C-frame and consists of the upper clamping rod **1** as well as the rotator **2** with rotator locking.



The clamping rod is the upper part of the clamp/turning device. The sheet is held in place by a rectangular shaped clamping jaw which is pushed down by a double-acting hydraulic cylinder, pressing the sheet against the clamping jaw of the rotator. Consequently, the sheet in the middle is clamped.

The rotator is the lower part of the clamp/turning device and turns the clamped sheet to the required bending position. Alternately in clockwise or anti-clockwise direction. It consists of a rotary spindle run on bearings in the C-frame with a clamping jaw and index disk as well as a toothed disk. The rotary spindle is driven by a three-phase servo motor via a planetary gear, pinion and toothed disk.

The rotator locking fixes the rotator in its specific positions. At the same time a hydraulic cylinder pushes against the side of the index disk which is rigidly connected to the rotary spindle.

2.3.2 Hydraulics

The essential parts of the hydraulic unit are the oil tank, the filter/cooling station, the main pump aggregate, the hydraulic cylinders as well as the hydraulic control blocks.

Oil tank and filter/cooling station

The oil tank and filter/cooling station are disposed on the left next to the manipulator under the fixed table. The filling volume of the oil tank **1** is 600 dm³. To filter and cool the hydraulic oil it is permanently circulated via the mobile filter **3** (absolute filtration 3 micron) and the water/oil heat exchanger **4** through the circulation pump **5** (vane pump). A 2/2 way directional control valve **2** controls the feeding of the cooling water to the water/oil heat exchanger. The operating pressure of the circulation pump is shown on screen. The mobile filter is equipped with an electric dirt detector. The level indicator also has electric monitoring by a fluid level control, and the maximum oil temperature (60°C) has electric monitoring as well by a thermostat **7**. The hydraulic system is shut down automatically if the oil level is too low and/or the oil temperature too high. In addition, the oil tank is equipped with a standstill heating. When the oil temperature is too low, i.e. at night, a thermostat switches on the immersion heater **8** as well as the circulation pump. The

circulation pump establishes ideal distribution of the temperature in the oil tank. The standstill heating is turned off by the main switch.

ATTENTION: The EMERGENCY-OFF switches do not effect the standstill heating! Therefore, in an emergency situation the main switch must be turned off.

Main pump aggregate

The main pump unit is arranged adjacent to the manipulator under the fixed table. It made up mainly by the electric motor **9**, the pump carrier **10**, the readjustable axial piston pump (main pump) **11** with electrohydraulic pressure and pivoting-angle control as well as integrated electronics, the readjustable axial piston pump (pressure maintaining pump) **14** with hydraulic pressure controller, the pump monitoring and fuse block **12** for the main pump as well as the pressure measuring transducer for the pressure maintaining pump.
The two axial piston pumps draw in the hydraulic oil via a suction hose, a compensator, and a suction pipe **13** and pump it to the machine's control blocks. To keep the power loss to a minimum, when one, or several actuators at the same time, are moved, the machine control system prompts a remote adjustment of the main pump to the operating pressure and output regulator settings required for the respective operating mode (*High Speed Mode*, *Standard Mode,* or *Economy Mode*).
For maintenance work, the suction line can be shut off using a shut-off valve **6** with limit-switch control. The operating pressures of main and pressure maintaining pumps are shown in an on-screen display.

2.3.3 Pneumatics

The pneumatic unit consists of a maintenance unit as well as various valves and cylinders. At the feed-in point, there must be a pressure of 6 to 12 bar. The operating pressure within the Salvagnini system is 6 bar and is monitored by a pressure transducer. The operating pressure is shown in an on-screen display.

In connection with the generation of compressed air, dust, steam, gas, oil, etc. are sucked into the compressor, together with air from the surrounding environment. To ensure the proper functioning of all pneumatic components, the compressed air must be filtered before being fed to the Salvagnini system.

Cleanness class as per PNEUROP 6611/1984 Recommendation:

Contaminant	Class	Max. Particle Content	Comment
Dust	3	5 mg/m³	Mass of particles is below 5µg.
Oil	5	25 mg/m³	
Water	3	5,57 g/m³	If the work environment is air-conditioned and the minimum temperature is greater than 12°C. (corresponds to a dew point of +2°C)
	2	0,88 g/m³	If the work environment is not air-conditioned and the minimum temperature is greater than -10°C. (corresponds to a dew point of -20°C)

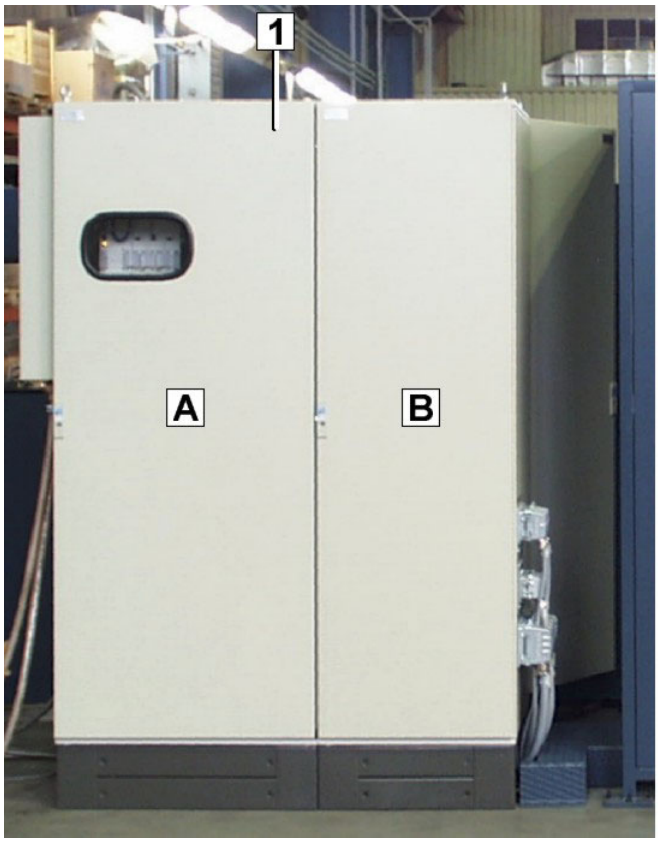
The following table lists the maximum air consumption $\mathbf{Q_{max}}$ for every single system component, the average air consumption with a cycle time of 30 seconds $\mathbf{Q_{30\ SEC}}$ as well as the average air consumption with a cycle time of 60 seconds $\mathbf{Q_{60\ SEC}}$. The consumption is specified in standard liters per minute [Nl/min]. A standard liter per minute corresponds to the quantity of air flowing in standard conditions (1 bar and 20°C) through the last section of the pneumatic system within one minute.

Air consumption:

Consuming point		Q_{max}	$Q_{30\ SEC}$	$Q_{60\ SEC}$
Basic machine	P4-2512	300 Nl/min	40 Nl/min	20 Nl/min
Unloading unit	SAP 2715	75 Nl/min	22 Nl/min	11 Nl/min

2.3.4 Electrics

The electrics consists of the switch cabinet **1** , the control desk **2** as well as various drive and control components like limit switches, proximity switches, manometric switches, solenoid valves. They are collected together in groups and wired on intermediate terminal boxes. The incremental transmitter, resolver, servo valves and motors are directly connected with the switch cabinet.
The construction of the electric equipment is according to EN 60204 (IEC 204-1).



Switch cabinet

The switch cabinet **1** is accessible both from the front and from the rear.
Section **A** contains the power circuitry. This is where the main switch, motor circuits, transistorized pulse-controlled converters for servomotors, power supply, switching gear for safety circuits and various control relays as redundant equipment for machine protection are accommodated. Section **B** contains the voltage supplies, the Micromach control system with double-Euroformat boards as well as all required multiway plug-in connectors for sensors, actuators, and encoders. The power cables are connected through terminals. Multiway connectors supply the control signals up to the input and output boards.
Heat is dissipated with the help of an air/water heat exchanger.

Control desk

The control desk **2** contains a workstation which consists of a computer with data modem, network card, screen, keyboard and mouse (see *Workstation* on page 2-32) as well as all the command and message devices for general operating functions (please see chapter *Operation*).
The bending programs for controlling the machine are created by the operator at the control desk using the Salvagnini-programming language. Additionally, various help programs can be called-up for error diagnosis, display of machine parameters etc. (please see chapter *Instructions for using the control devices*).
Heat is dissipated with the help of an air/water heat exchanger.

2.3.5 Additional devices

Safety guards and protective coverings

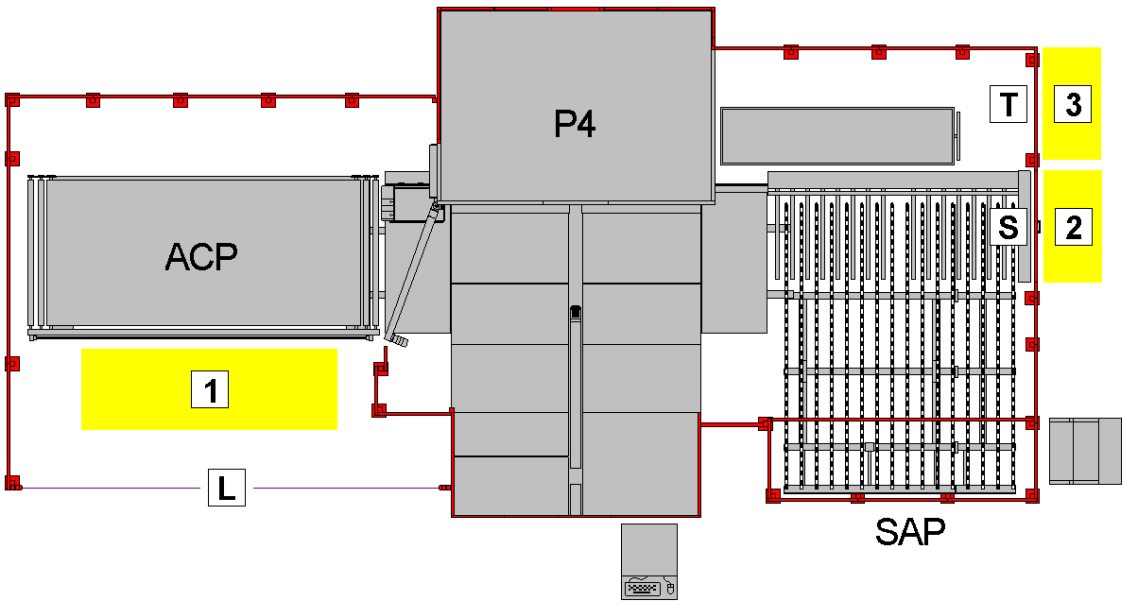
For the protection of the machine operator, the danger areas of the panel bender have been protected with safety fencing and protective coverings. All the doors of the safety devices are controlled by safety switches. To enter the danger area, i.e. for the purpose of maintenance work or to change tooling, the machine has to be in a defined position (tool changing position or turn-off position). Only then can the appropriate safety key be removed from the control desk and the corresponding door be opened. Please see *Personal safety through defined position of the machine* in chapter *Safety regulations*.

The danger area of the machine is safeguarded by a safety fence. Listed below are areas of access:

1 **Sheet loading area:**
Protection is given here by a light barrier **L** . On entering this area no more machine movement is possible. The sheet transport as well as the feeding unit **ACP** and the off-loading unit **SAP** are turned off, but not the basic machine **P4**. A continuation of the machine cycle results only after the danger area has been exited and by effecting a quit on the control desk.

2 **Removal area for DL-bent sheets (last bend downwards):**
Here, a manually operated safety flap **S** serves as protection.

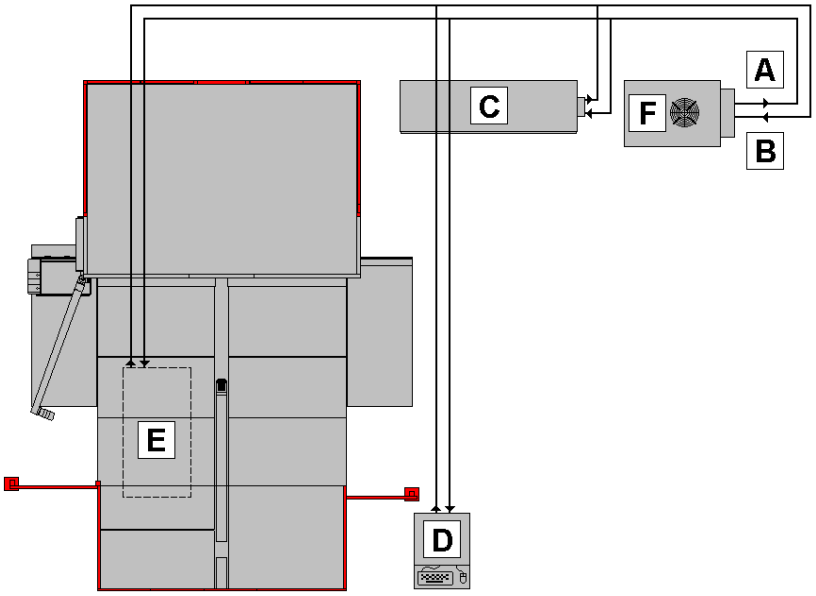
3 **Removal area for CUT-Profiles:**
Here, a manually operated door **T** serves as protection.



Cooling system

The cooling of the switch cabinet and the control desk is effected by water through an air/water heat exchanger and the hydraulic unit cooling functions via an oil/water heat exchanger either in an open cycle with water consumption or in a closed cycle via a chiller (optional). We recommend the installation of a closed cycle cooling system even though the prime costs are higher.
In both cases, in order to avoid corrosion of metal parts and calciferous deposits, it is necessary that the water being used has been treated accordingly.

Schematic view of the cooling system:



- **A** Cool water flow
- **B** Cool water runback
- **C** Switch cabinet
- **D** Control desk
- **E** Hydraulic unit
- **F** Cooling system (option; inapplicable for the open cycle cooling system)

Connection/technical data for the cooling system:

Cooling water	Switch cabinet	Control desk	Hydraulic unit
max. feed temperature	20°C	20°C	20°C
max. pressure	4 bar	4 bar	2 - 4 bar
rate of flow	3 l/min	3 l/min	22,5 l/min
dimension feed	DN 19	DN 19	G 1/2
dimension runback	DN 19	DN 19	G 1/2

The total rate of flow as well as the line length of the main pipe lines of the cooling water flow and runback must be adequately dimensioned.
The positions of the cooling circuit connections are shown on the foundation plan (see *Annex* in chapter *Storage, Assembly and Transport*). Fit the pipe lines after the installation of the whole machine unit.

Required cool water quality:

	open cycle	closed cycle
water hardness	not more than 20 mg Ca per litre H_2O	not more than 80 mg Ca per litre H_2O
filtering	at least 150 µm	at least 150 µm
PH-value	neutral or slightly alkaline	neutral or slightly alkaline

Conversion table for the different degrees of water hardness:

	°fH	°eH	°dH	mg Ca/l	mmol Ca/l
French Grade °fH	1	0,7	0,56	4,008	0,1
English Grade °eH	1,43	1	0,8	5,73	0,143
German Grade °dH	1,79	1,25	1	7,17	0,179
mg Ca/l	0,25	0,175	0,14	1	0,025
mmol Ca/l	10	-	5,6	40,08	1

A) <u>System with open cooling circuit</u>

The cooling system with the open circuit requires an automatic doser so that chemical substances can continuously be added for water treatment. The substances permitted for water treatment are subject to the national laws prevailing in the respective country. Please inform yourself at your local water authority.
When selecting the automatic doser unit please make sure that it is in accordance with valid national standards and also that the treated water corresponds with the required qualities (please see the table above).
In order to avoid the chemical substances from being discharged into the environment, it is important that the sewage water is purified. Pay attention to the countries relevant statutory specifications with regards to endangerment to groundwater!
The cooling water demand is approx. 2,0 m^3/h. The inlet temperature must not exceed 20°C.

B) System with closed cooling circuit

Cooling systems with closed circuits require one water treatment only. For this purpose, please use the liquid TERM 501 from the company DEPUREX 88. The water treatment is effected by dissolving the liquid in the cooling water. In doing so, pay attention to the dosage specifications!

Cooling liquid TERM501

ATTENTION: TERM501 is alkaline, but not caustic. Wear protective gloves and glasses when handling this liquid. Should splashes get onto skin or in eyes, rinse immediately under running water or with diluted boric acid. Do not swallow, not even in a diluted state. Water which has been treated with TERM501 is no longer drinkable.

Characteristics

Anticorrosion:
Stimulates the development of a protective layer on the surface of the metal, eliminates gases found in the water and keeps the pH-value of the water alkaline.

Antiscaling:
Deters the development of calciferous deposits.

Dispersal:
Slowly reduces scale in the old units.

Physical properties

It is a watery solution of organic low molecular weight dispersion.

State:..... liquid
Colour: ..... brown-yellow
Odour: ..... slightly ammoniacal
pH-value:..... 10,5
Specific gravity at 20°C:..... 1,05-1,1 g/ml
Flammability: ..... non-flammable
Storage time: ..... unlimited

Dosage

First filling or refilling of the unit:..... 12,5 g/l Wasser
Topping up: ..... 100 g/m^3 Wasser

Approx. 2 kg is sufficient for the water treatment of the unit.

Testing

DEPUREX88 produces a colour test case (kit) which measures if there are calciferous deposits in the existing concentration of liquid in the cooling water circuit. The colour test case controls the state of the system and restores the optimum concentration against calciferous deposits.

Code Numbers for ordering at Salvagnini

Package of 1,5 kg .....Code 3953010002
Package of 30 kg .....Code 3953010001
Colour test case (kit) for TERM501 .....Code 3953100001

Chiller (Optional)

During installation, ensure that the chiller is positioned at least 1,5 m away from the hall walls and the top of the chiller is 6 m clear of the hall ceiling.

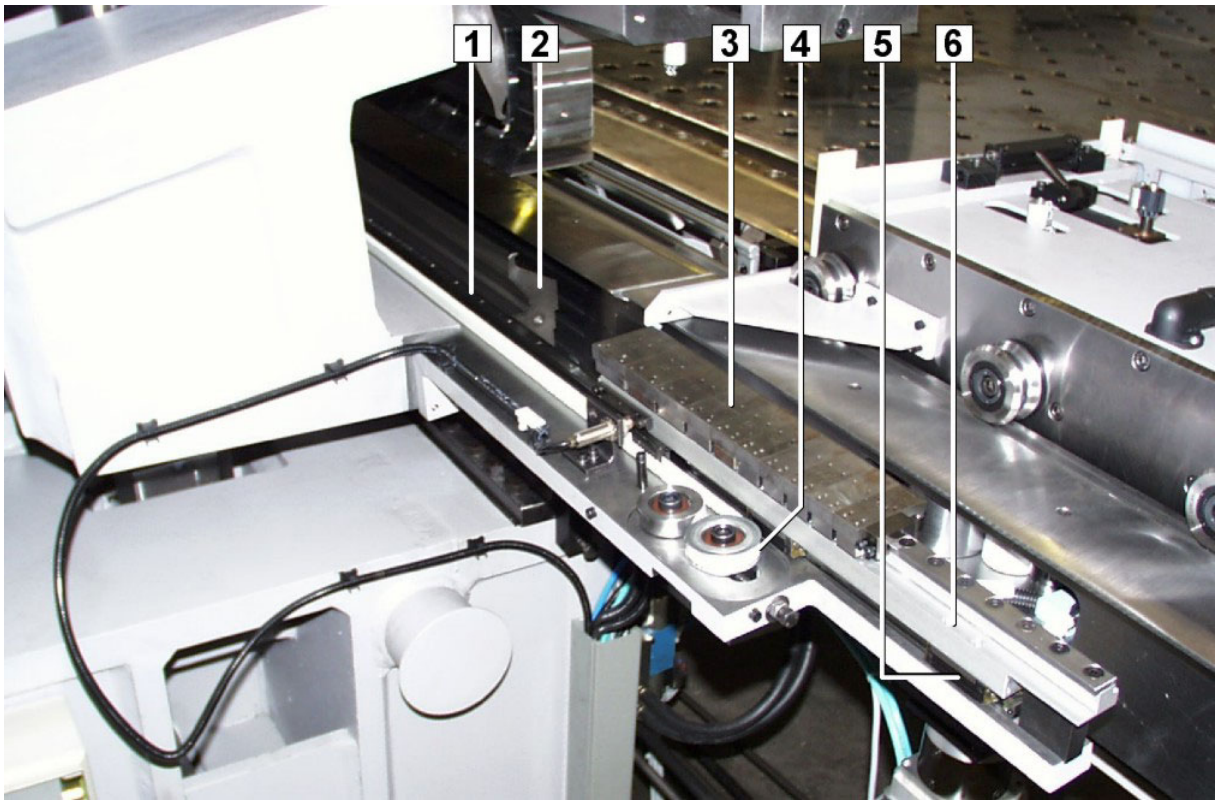
Provide for sufficient air supply. The ambient air have to be clean and must not include flammable gases or solvent vapours. Warm air which is emitted from the fans of the chiller or other systems must not be sucked in again for cooling.

Further information concerning installation, connection, filling up and initial operation of the chiller see *Water Chiller - Maintenance and operating manual*.

2.3.6 Options

CLA tooling

CLA tooling is needed to make bends having an interrupted line of bending, i.e., when on a sheet's side only certain sections are to be bent as is the case with welding tabs.
CLA tooling consists of bending tools disposed to the left and right of the bladeholder, respectively, and forming an elongation of the lower bending tool. The standard length of each tool is from 25 mm (minimum) to 500 mm (maximum). The length is either specified or results from combining single segments. By means of a standardized tool holding fixture, the bending tools **3** are mounted on tool holders **6** which glide on carriages **5** supported in a linear guide **1** . The guide runs behind the lower bending tool **2** along the entire length of the bladeholder. The carriages are moved symmetrically to the machine center via a toothed belt **4** onto which they are fixed with a clasp. The movement is effected by a three-phase current servomotor with encoder.
For the bending process the bending tools slide onto the lower bending tool. When the bladeholder is raised, then only that part of the sheet is bent which is in contact with the bending tools. When the bending tools are not needed they are placed in a waiting position on the outside ends of the lower bending blade.



CUT Option

The CUT option allows you to produce a number of separate profiles from a piece of sheet metal (blank). Once the bending process has been completed, the most recently produced profile is severed from the blank and transported into a parts container. The CUT option consists of the blankholder knife, the bladeholder knife as well as the swing-in mechanism for the bladeholder knife and is fitted in combination with the P option (see Page 2-28).

The blankholder knife **1** is disposed on the P option (at the blankholder). For the cutting process, it is pivoted under the blankholder tooling. Then, the blankholder is lowered toward the counterblade and clamps the metal sheet located therebetween.

The bladeholder knife **2** is disposed on the bladeholder. For the cutting process, it is pivoted downward hydraulically by the swing-in mechanism for the bladeholder knife until it abuts the lower bending tool. The bladeholder is position horizontally in a way that the cutting gap determined by the software will be established between the blankholder knife and the bladeholder knife. Then, upward movement of the bladeholder causes the metal sheet to be cut. Horizontal forces are transferred onto the bladeholder via the support of the swing-in mechanism.

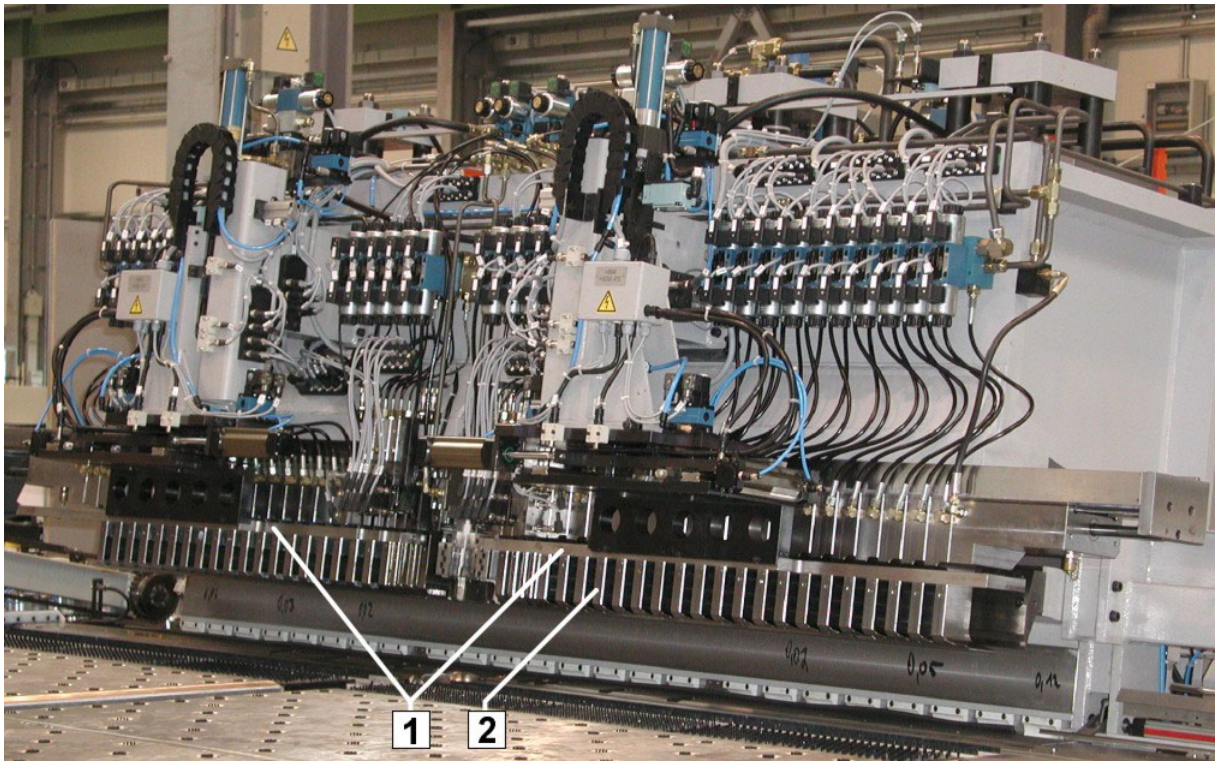
The swing-in mechanism for the bladeholder knife is also located on the bladeholder. It consists of the swing arm support, the swing arm drive, the unloading tray **3** , and the unloading tray drive. The unloading tray is mounted on a linear guide and moved by a pneumatic cylinder without piston rod **4** . For the cutting process, the swing arm drive hydraulically pivots the bladeholder knife downward, together with the unloading tray. Then, the unloading tray is moved behind the bladeholder knife into the left end position. Once the

cutting process has been carried out, the cut off sheet-metal piece drops into the unloading tray. Now, the tray leaves the machine and moves into its right end position where it is subsequently tilted upward by the swing arm drive. During this process, the sheet-metal piece drops into the pieces container **5** located underneath.

ATTENTION: On machines with CLA tools, all bending tools and clamping pieces must be removed from the CLA tool holders before the CUT option can be used.

P Option

The P option allows you to pivot various supplementary tools **1** under the blankholder tooling **2**, e.g., radius tools, or, in combination with the CUT option, also cutting blades. The P option consists of two parts mounted at the front of the blankholder, directly above the blankholder tooling.

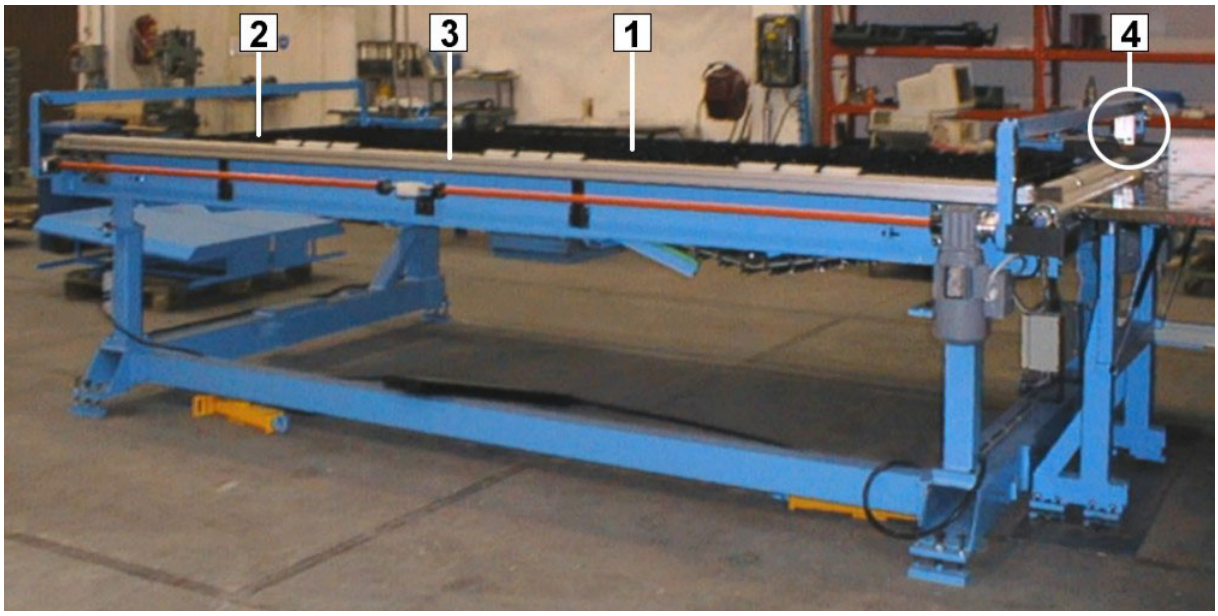


2.3.7 Feeding and unloading units

Sheets are fed and removed from the basic machine via feeding and unloading units.

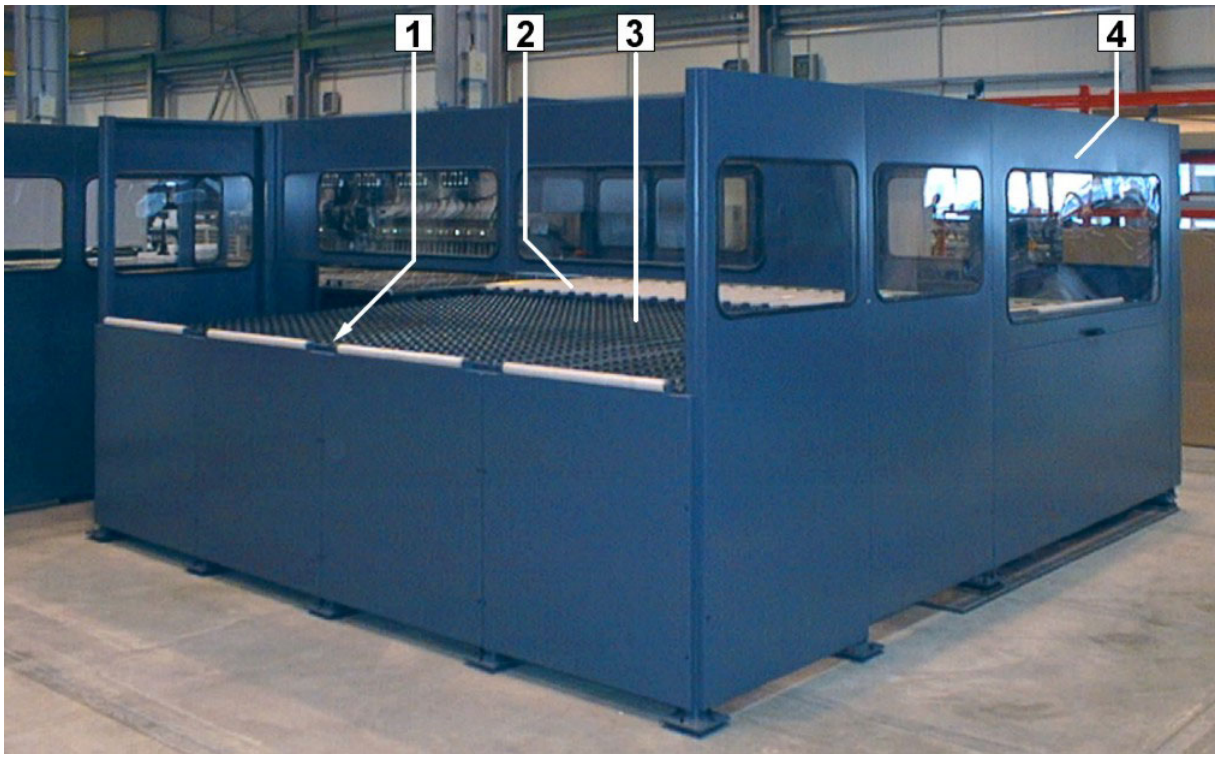
Automatic loading table without destacking (ACP)

The loading table serves as a feeding unit for the basic machine. Sheets (blanks) are placed onto the brush table **1** either manually by the operator or during line operation by transporting these via rotary brushes **2** from a unit placed infront of this table. After the sheet has been placed onto the brush table, a centering unit **3** automatically centers it. Until removed by the sheet transport of the basic machine, light or thin sheets (blanks) are jammed additionally by a clamp unit **4**.



Unloading unit (SAP)

The unloading unit is a fully automatic discharge unit for the finished bent sheets (panels). It consists of the unloader (SPR) **2** and the accumulator (AIP) **3** .



The unloader is connected to the basic machine. It is a table whose surface consists of rollers. The rollers are driven via a flat belt by a geared motor.

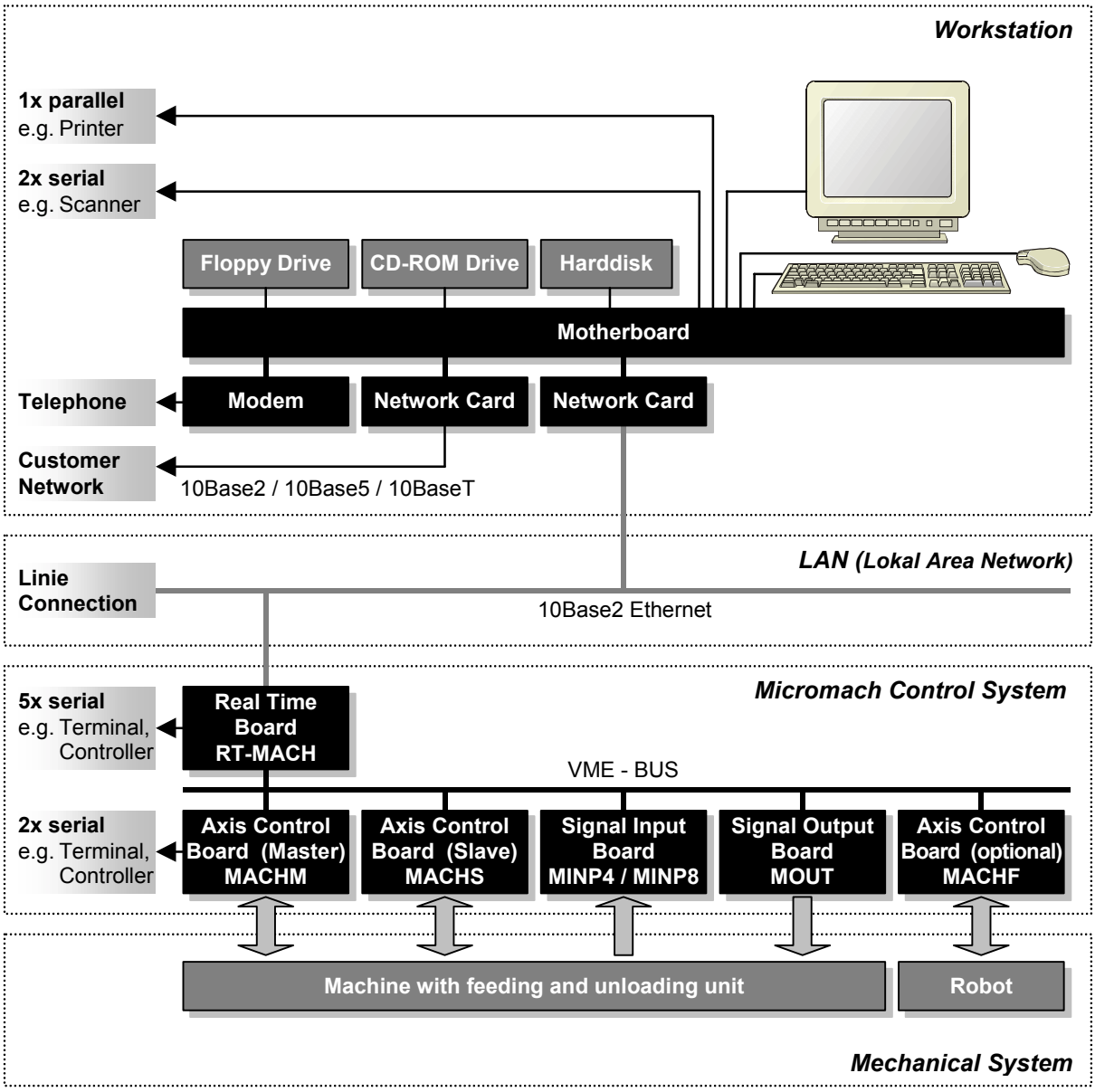
The accumulator is installed and connected to the unloading unit. It has an inclining roller table surface operated by a pneumatic cylinder, which is partly developed as a rake. These rakes are engaged between the rollers of the unloading unit.
When the sheet transport system of the basic machine pushes a sheet (panel) off the centering table, the unloading unit receives it and lays it down. Following this, the panel accumulator lifts the deposited sheet (blank) off the unloading unit by slightly tilting its roller table surface and allows the sheet (blank) to slide forward against a damped reference **1** . There it can be removed safely by the operator.
DL-bent sheets (last bend in a downward direction) constitute an exception. These sheets are transported by the unloading unit all the way up to the protective flap **4**. The protective flap must be opened manually by the machine operator in order to remove the metal sheet.

2.4 Data Processing

The monitoring and control unit for the mechanical system is made up of a workstation based on Windows NT ® and the Salvagnini software package as well as the Micromach control system consisting of a real-time board that administrates the input, output, and axis boards. A local network handles the data exchange between the workstation and the Micromach control system.

The machine together with its loading and unloading units (loading table, unloading table, robot) is referred to as the mechanical system. Monitoring and control is handled by electric, hydraulic, and pneumatic equipment such as relays, valves, and the like.

Overview of the Salvagnini-control-system:



2.4.1 Control desk

It is a computer with data modem, network board, screen, keyboard, and mouse. The workstation is used to monitor the machine. It is disposed in the control desk (see page 2-20) and coupled via the LAN (Local Area Network) to the Micromach control system where a signal processor board manages the input, output, and axis boards for the mechanical system. See *Micromach Control System* on Pages 2-33 et seq.

Windows NT ® and the Salvagnini software package are installed on the workstation. This is where the bending programs for the production are created, stored, and executed. See Chapter *Instructions for using the control devices*.

The Windows NT ® operating system is supplied on a CD-ROM and together with a software license, a user's guide, and an emergency recovery disk (ERD). The information on the emergency recovery disk is needed to restore the system files, the system configuration, and the start environment variables in the event of a fatal error (damaged files). We recommend that you update the emergency recovery disk after every change of your hardware or software configuration. To do so, follow the procedure described in the Windows NT ® user's guide or the on-screen instructions of the Windows Help.

2.4.2 LAN (Lokal Area Network)

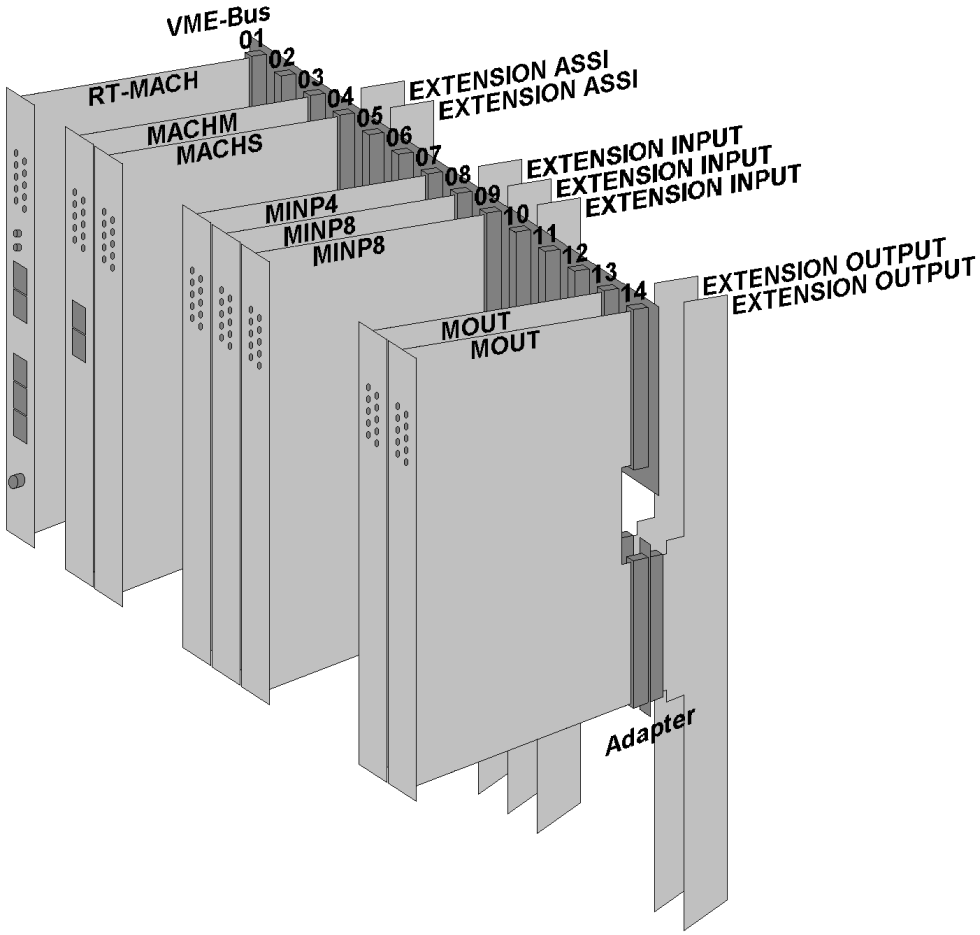
The local network is used for data transfer between the workstation and the Micromach control system. The type of cabling used is 10Base2, the software protocol used is TCP/IP. 10Base2 or Thinwire-Ethernet (sometimes also referred to as "Cheapernet") is the 802.3 standard of the Institute of Electrical and Electronics Engineers (IEEE) for Ethernet signal transmission via thin coaxial cables at a data transmission rate of 10 Mbits/s. Base stands for baseband, a technology used for the transfer of signals in the form of direct current pulses, unlike transfer on separate carrier frequencies.
A cabling topology consistent with the 10Base2 standard consists of type RG58 thin coaxial cables arranged in a bus configuration and having an impedance of 50 ohms. In view of attenuation (loss in signal intensity), the total length of the cable in the bus configuration must be not be greater than 185 m. The number of stations directly connected via T-pieces to the cable is limited to 30. To connect them, BNC plug-in connectors are used.

NOTE: Connection of Salvagnini system to customer network
To avoid malfunctions in the Salvagnini system, a second network board for connection to the customer network was provided in the workstation. This board permits the connection to Ethernet cabling topologies to the 10Base2, 10Base5 or 10BaseT standards.

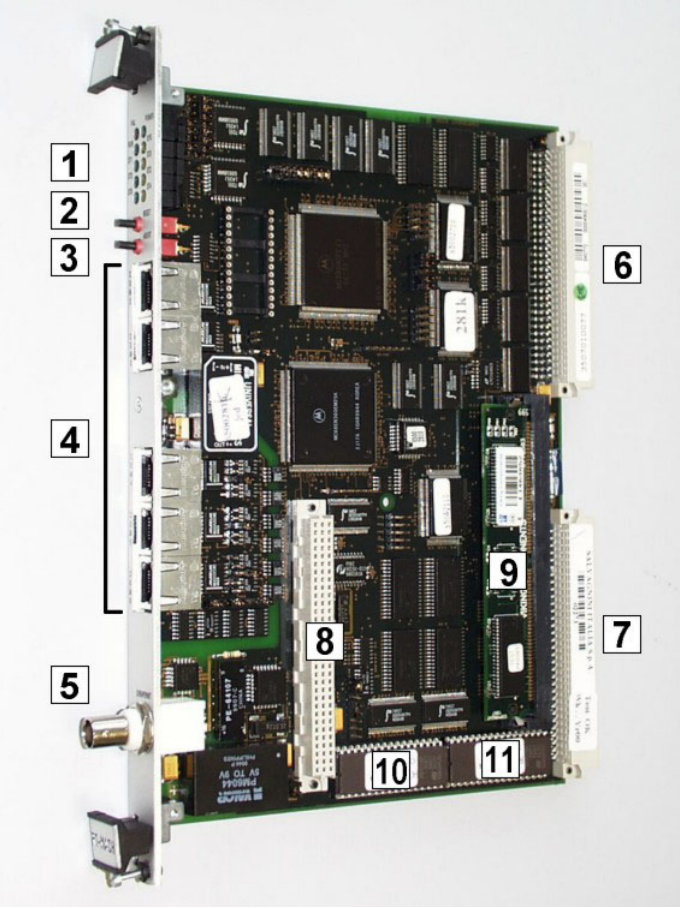
2.4.3 Micromach Control System

All data transfer processes from the workstation to the machine and vice versa run via the Micromach control system. It consists of different electronic boards accommodated in a rack in the switch cabinet.

Arrangement of the electronic boards:

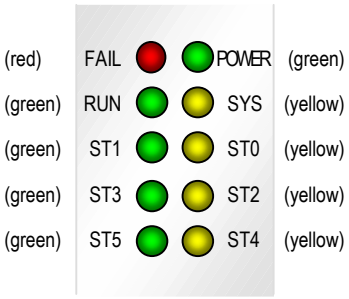


RT-MACH - Real Time Board

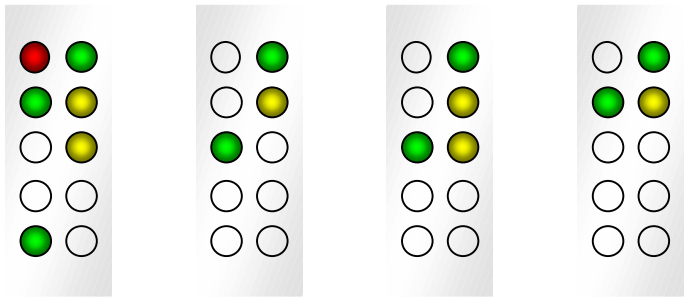


Also referred to as "Real Time CPU“, as on it the processes are executed in the real-time mode. It is the main control board and serves as communications unit between the workstation and the input, output, and axis boards for the mechanical system (machine). The exchange of data between the electronic boards takes place via the VME bus.

1 LED indicators:



indicator status depends on operating mode:



autotest (ST5 flashes)

sending application software (ST1 flashes)

system configuration

normal operation (RUN flashes)

2 RESET pushbutton

Pushing this pushbutton causes all active control processes to be deleted, a reset of all electronic boards to be executed, all data transfer processes to be closed, and the bootstrap phase to be started. During the bootstrap process, the RT-MACH board will first perform an autotest to check its functions (takes about 5 seconds). Then, the network connection, which permits data transfer to and from the workstation, will be set up.

3 ABORT pushbutton

This pushbutton is needed only during the software development phase in order to manually interrupt program execution.
Any process abortion or restart of the system may be carried out only via the workstation software (SysConShell).

4 RJ 45 plug-in connectors

Five serial RS232C outputs. This is where supplementary equipment such as video display terminals, controllers, torque limiters, and the like can be hooked up. These outputs can also be designed to RS232/422/485.

5 BNC network connection

6 Plug-in connector for the VME bus

7 VSB plug-in connector (VME-Subsystem-Bus)

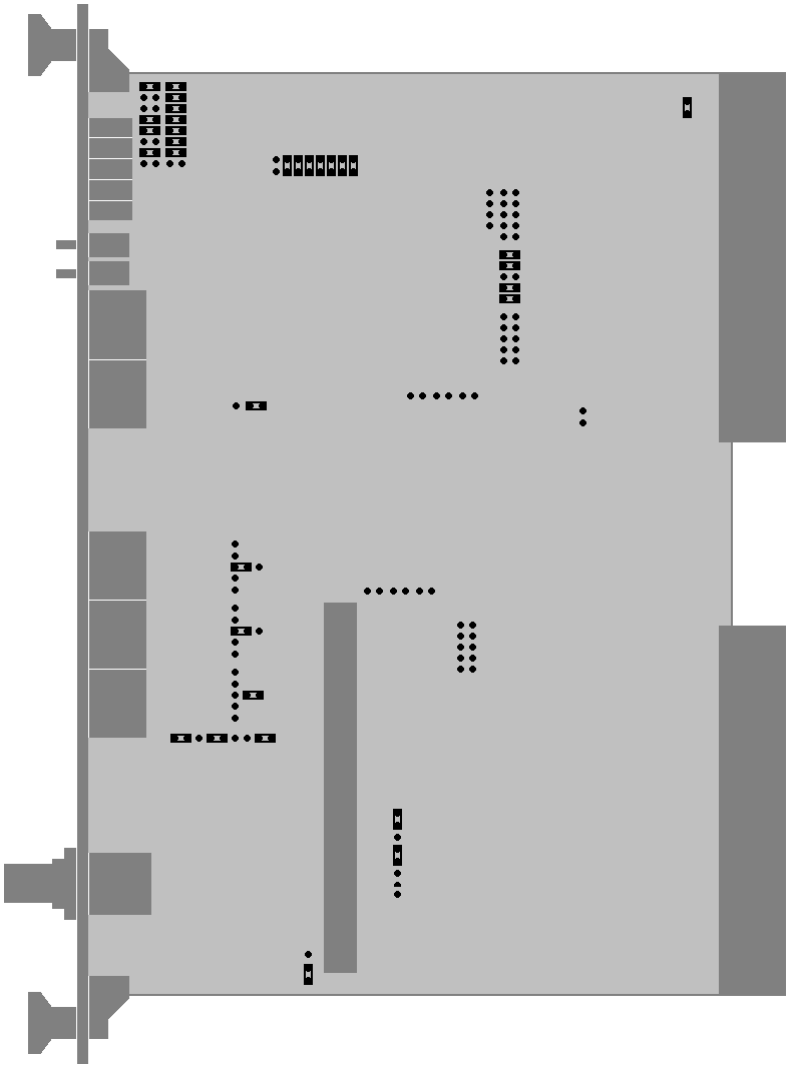
8 Plug-in connector

9 Memory module

10 EPROM RTCPU 1.1 (O AAAA)

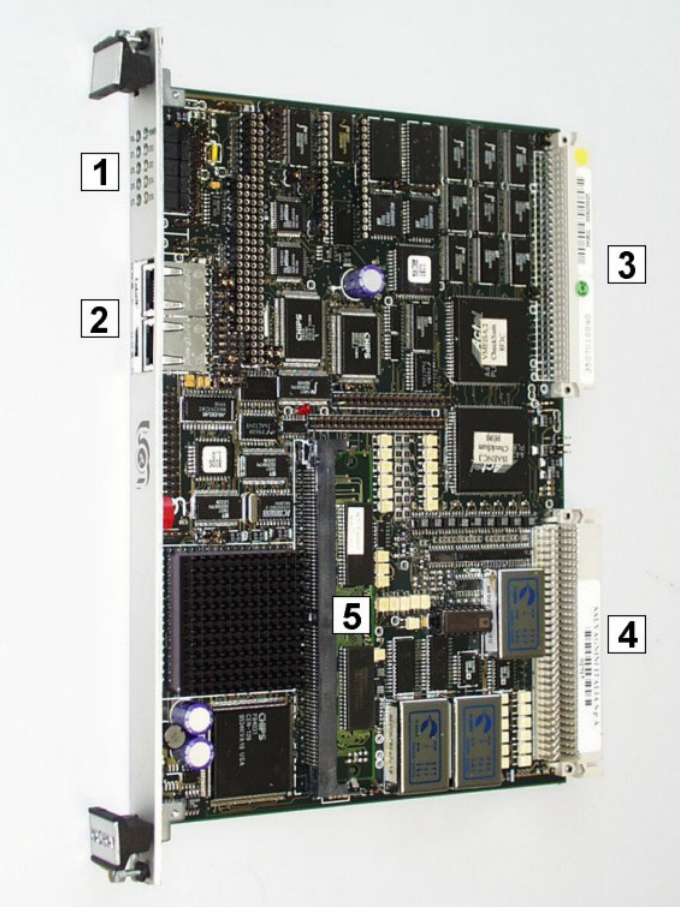
11 EPROM RTCPU 1.1 (E CA56)

Jumper assignment on RT-MACH



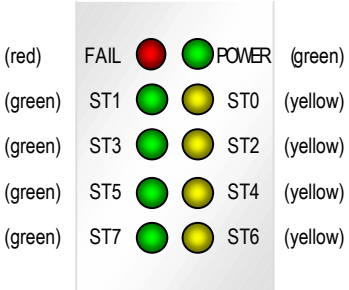
Addressing of the board and specifying the available components on the board is done by using jumpers. These jumpers are preconfigured by Salvagnini. Therefore, the customer does not need to do any jumper configuring himself.

MACHM - Axis Control Board (Master)

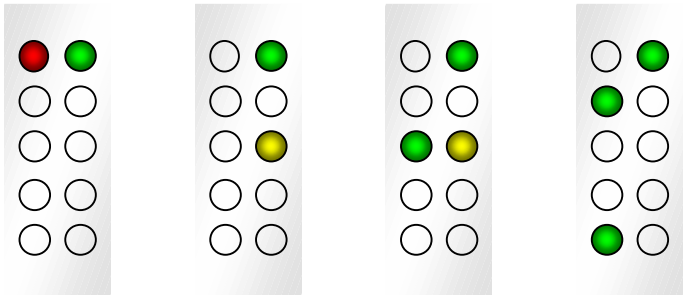


The MACHM board communicates with the control units as well as the position encoders for the axes and thus transmits commands from the electronic system to the various machine axes. Control units are e.g. servo-valves (for hydraulic drives) or frequency converters (for asynchronous motors). Position encoders are used to determine the current axis position and to detect the rotational speed and direction of drive motors.

1 LED indicators:



indicator status depends on operating mode:



autotest

sending application software

system configuration

normal operation (ST1 flashes)

2 RJ 45 plug-in connectors

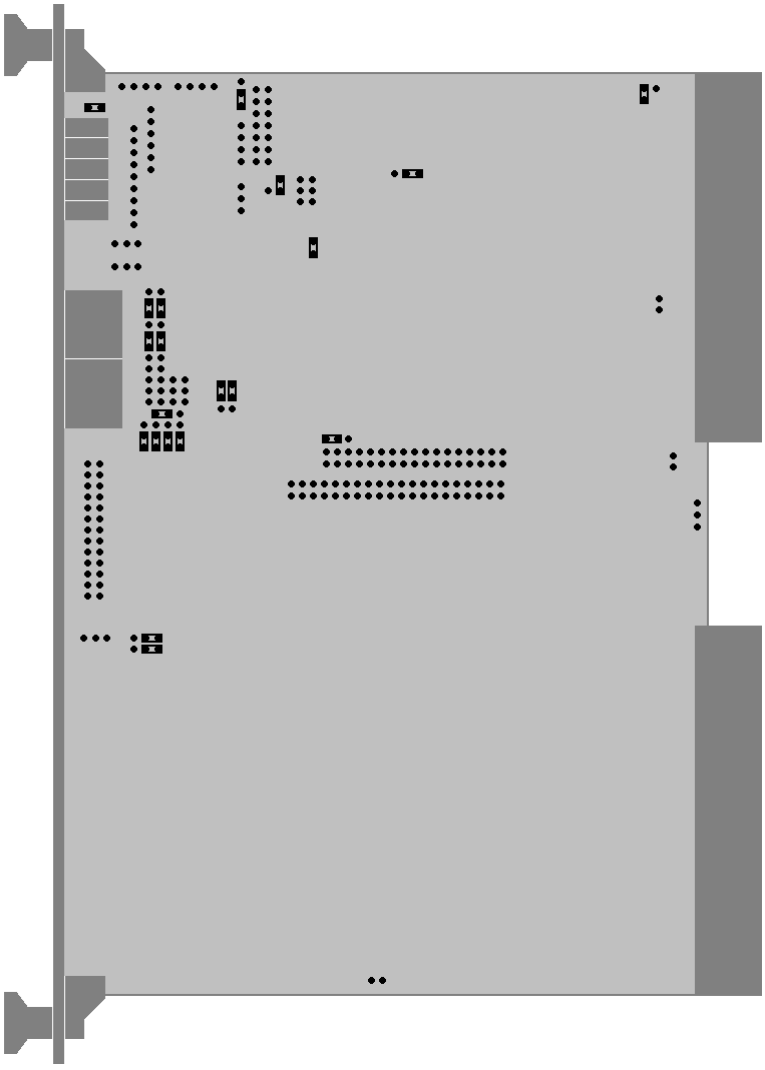
Two serial RS232C outputs. This is where supplementary equipment such as video display terminals, controllers, torque limiters, and the like can be hooked up. These outputs can also be designed to RS232/422/485.

3 Plug-in connector for the VME bus

4 Plug-in connector for the adapter to the EXTENSION ASSI extension board

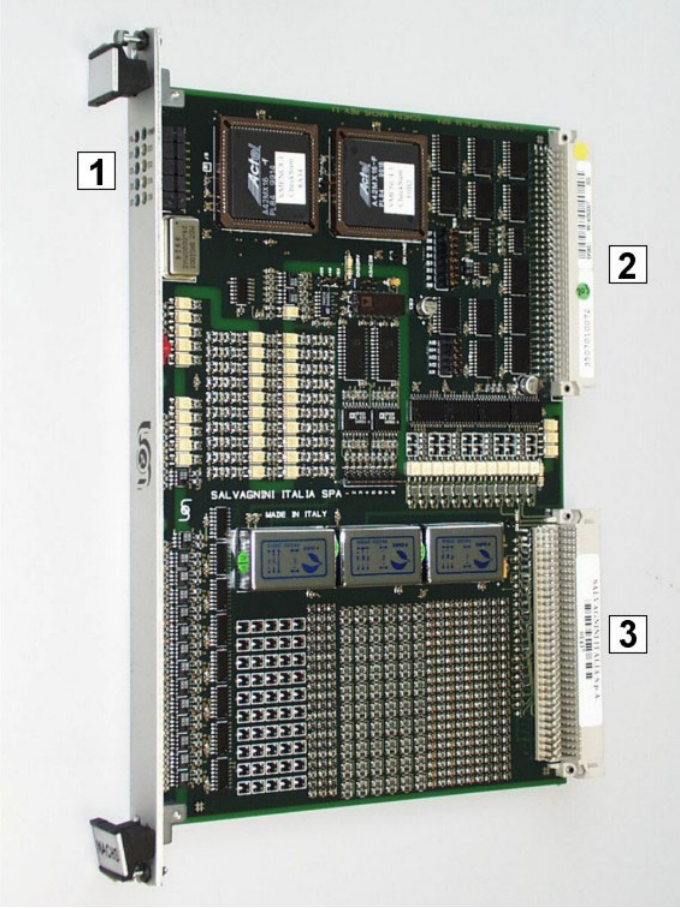
5 Memory module

Jumper assignment on MACHM



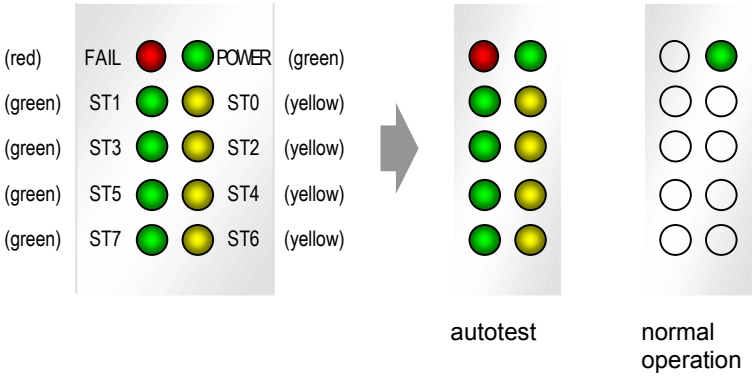
Addressing of the board and specifying the available components on the board is done by using jumpers. These jumpers are preconfigured by Salvagnini. Therefore, the customer does not need to do any jumper configuring himself.

MACHS - Axis Control Board (Slave)



The MACHS board is used to support the MACHM board. It communicates with the control units as well as the position encoders for the axes and thus transmits commands from the electronic system to the various machine axes. Control units are e.g. servo-valves (for hydraulic drives) or frequency converters (for asynchronous motors). Position encoders are used to determine the current axis position and to detect the rotational speed and direction of drive motors.

1 LED indicators:

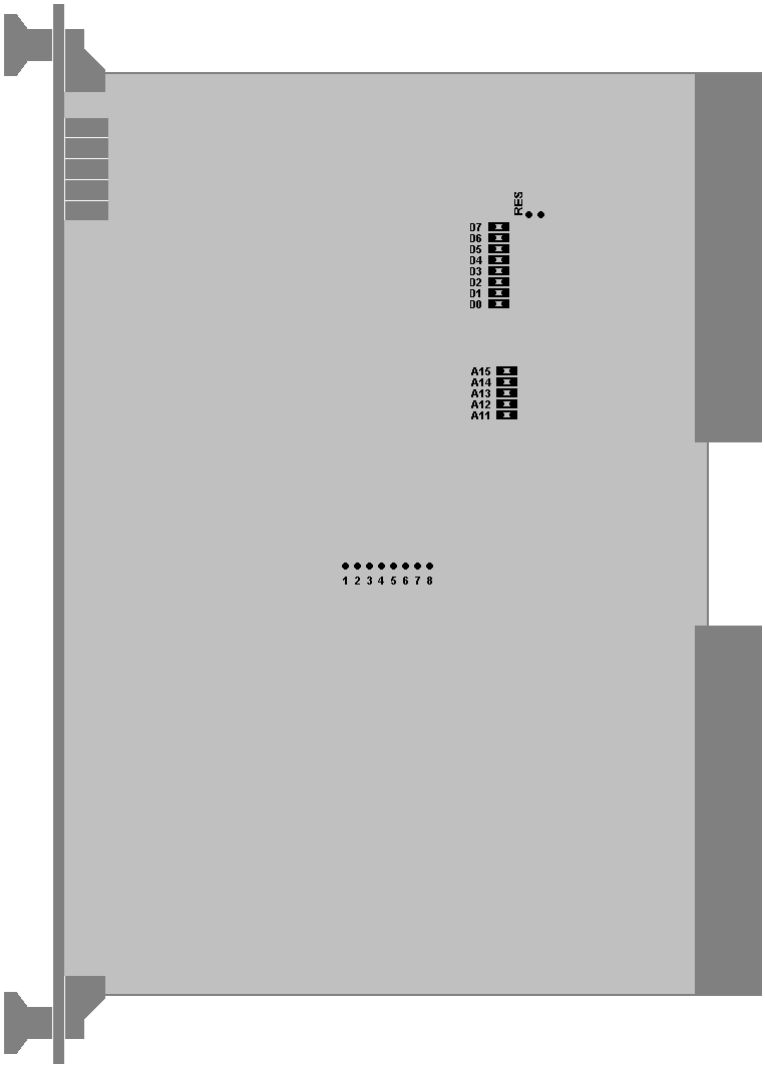


indicator status depends on operating mode:

2 Plug-in connector for the VME bus

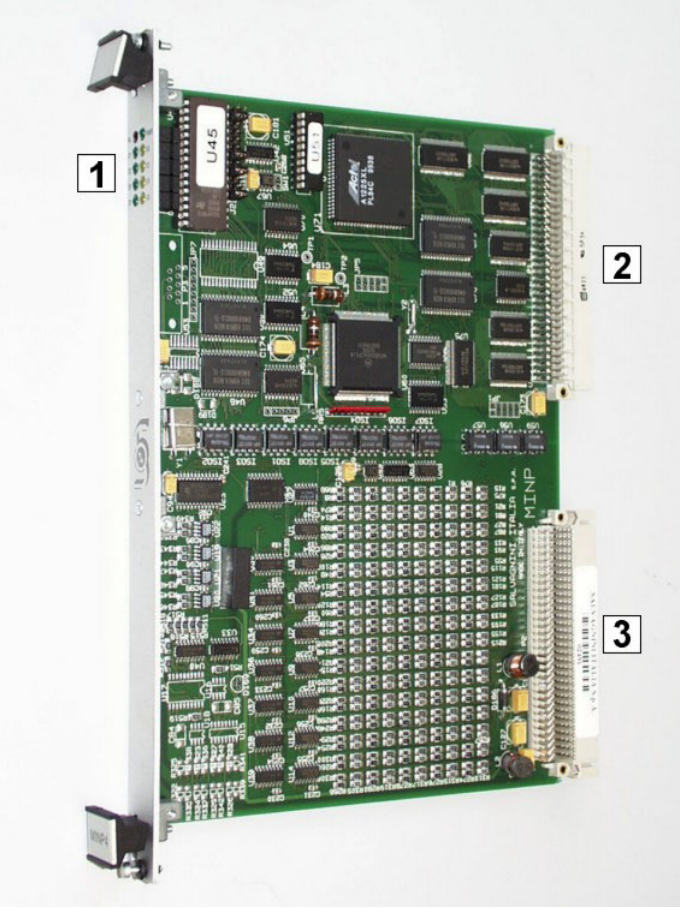
3 Plug-in connector for the adapter to the EXTENSION ASSI extension board

Jumper assignment on MACHS



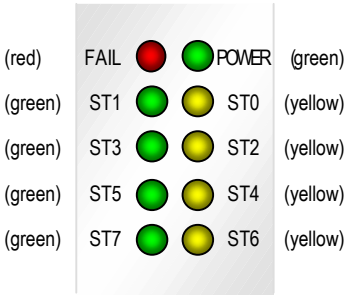
Addressing of the board and specifying the available components on the board is done by using jumpers. These jumpers are preconfigured by Salvagnini. Therefore, the customer does not need to do any jumper configuring himself.

MINP4 - Signal Input Board

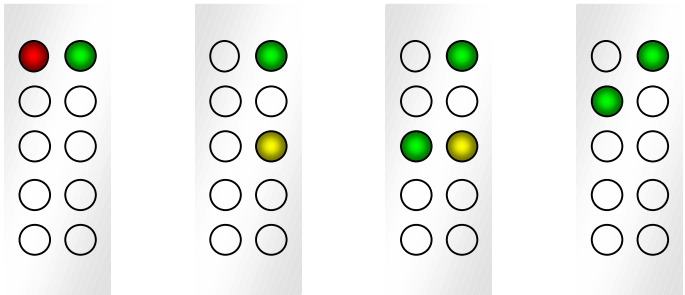


The MINP4 board administrates analog and digital inputs.
It receives its signals from proximity switches, microswitches, limit switches, etc. and converts them into commands understood by the electronic system.

1 LED indicators:



indicator status depends on operating mode:



activating

sending application software

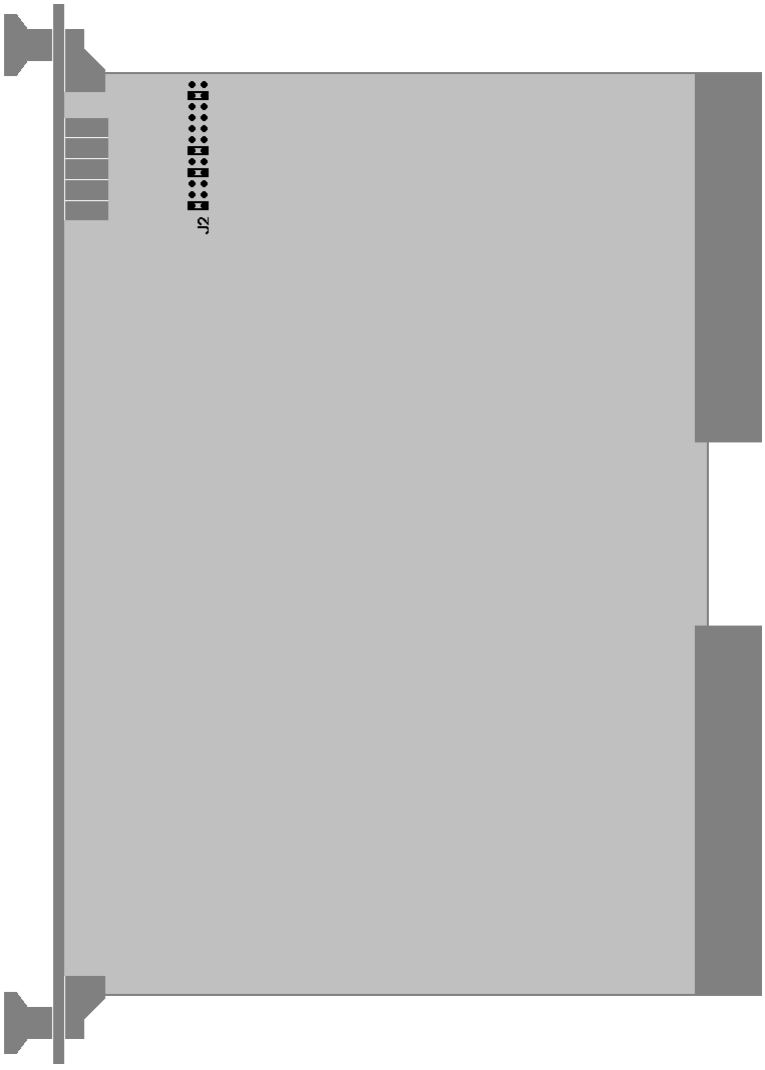
system configuration

normal operation (ST1 flashes)

2 Plug-in connector for the VME bus

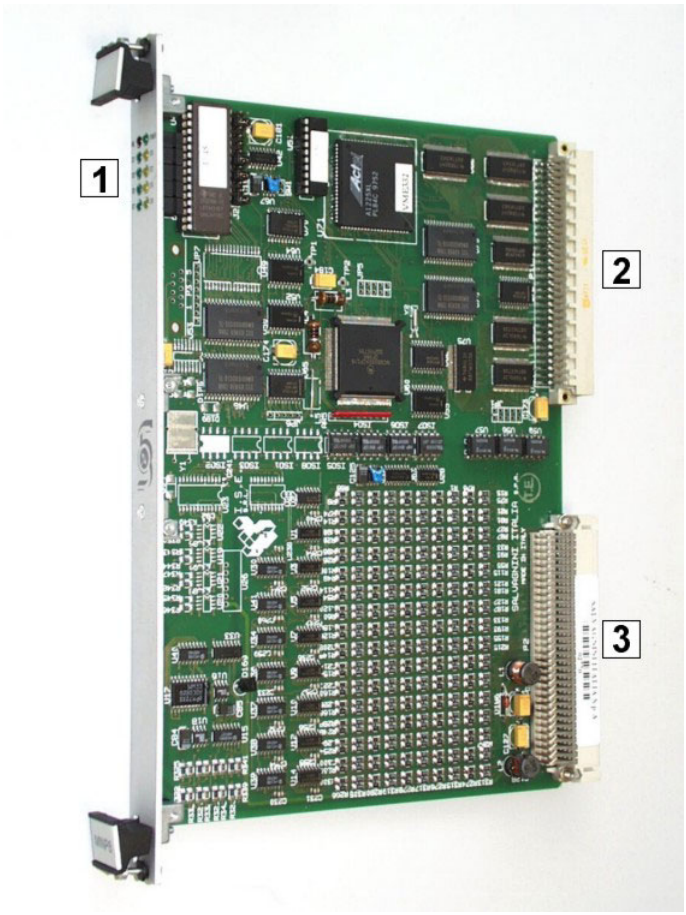
3 Plug-in connector for the adapter to the EXTENSION INPUT extension board

Jumper assignment on MINP4



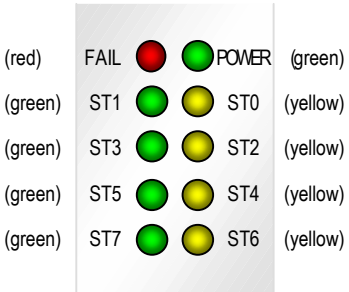
Addressing of the board and specifying the available components on the board is done by using jumpers. These jumpers are preconfigured by Salvagnini. Therefore, the customer does not need to do any jumper configuring himself.

MINP8 - Signal Input Board

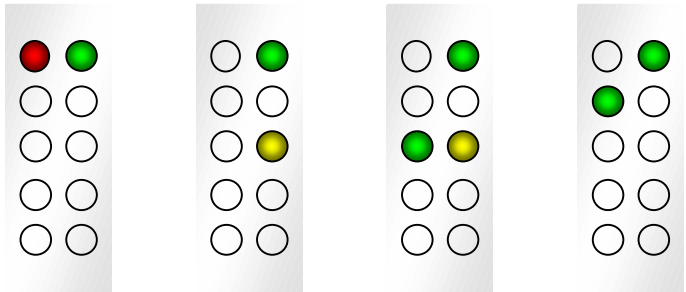


The MINP8 board administrates analog and digital inputs.
It receives its signals from proximity switches, microswitches, limit switches, etc. and converts them into commands understood by the electronic system.

1 LED indicators:



indicator status depends on operating mode:



activating

sending application software

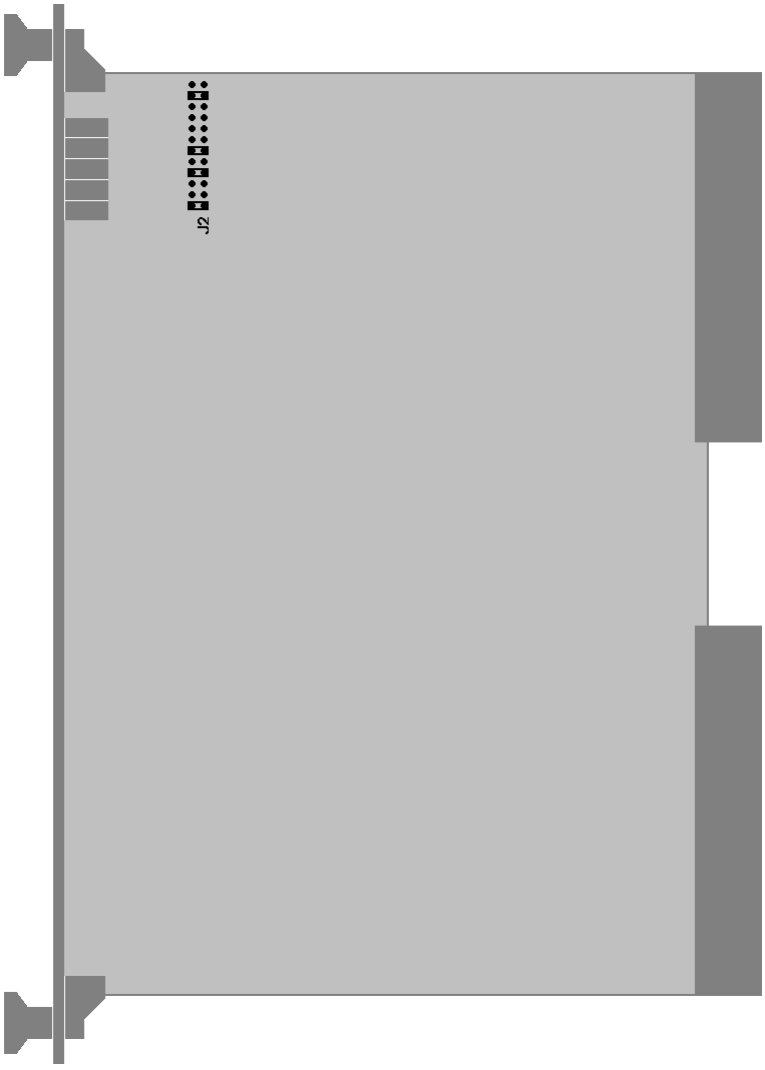
system configuration

normal operation (ST1 flashes)

2 Plug-in connector for the VME bus

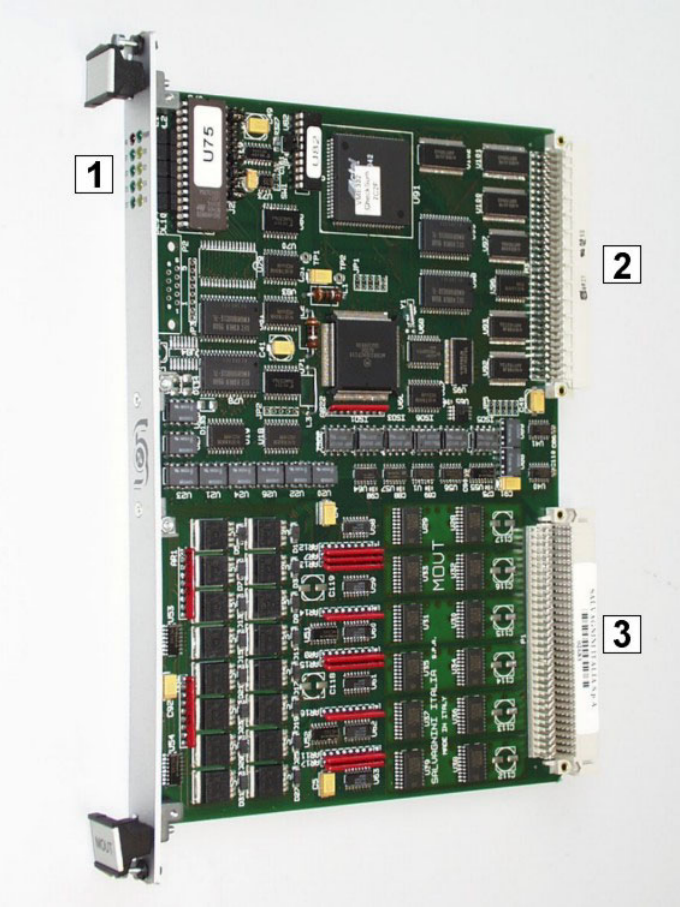
3 Plug-in connector for the adapter to the EXTENSION INPUT extension board

Jumper assignment on MINP8



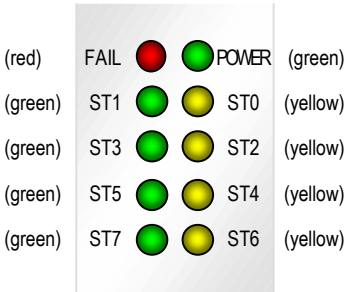
Addressing of the board and specifying the available components on the board is done by using jumpers. These jumpers are preconfigured by Salvagnini. Therefore, the customer does not need to do any jumper configuring himself.

MOUT - Signal Output Board

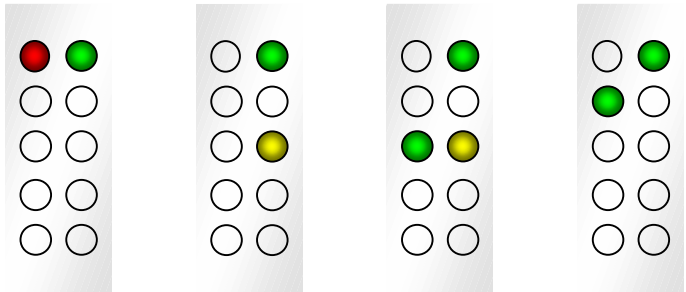


The MOUT board administrates digital as well as PWM (pulse-width modulation) outputs.
It receives its commands from the electronic system and converts them into a format suited to control electric, hydraulic, and pneumatic equipment such as relays, electric valves, lamps, acoustic or optic warning signals.

1 LED indicators:



indicator status depends on operating mode:



activating

sending application software

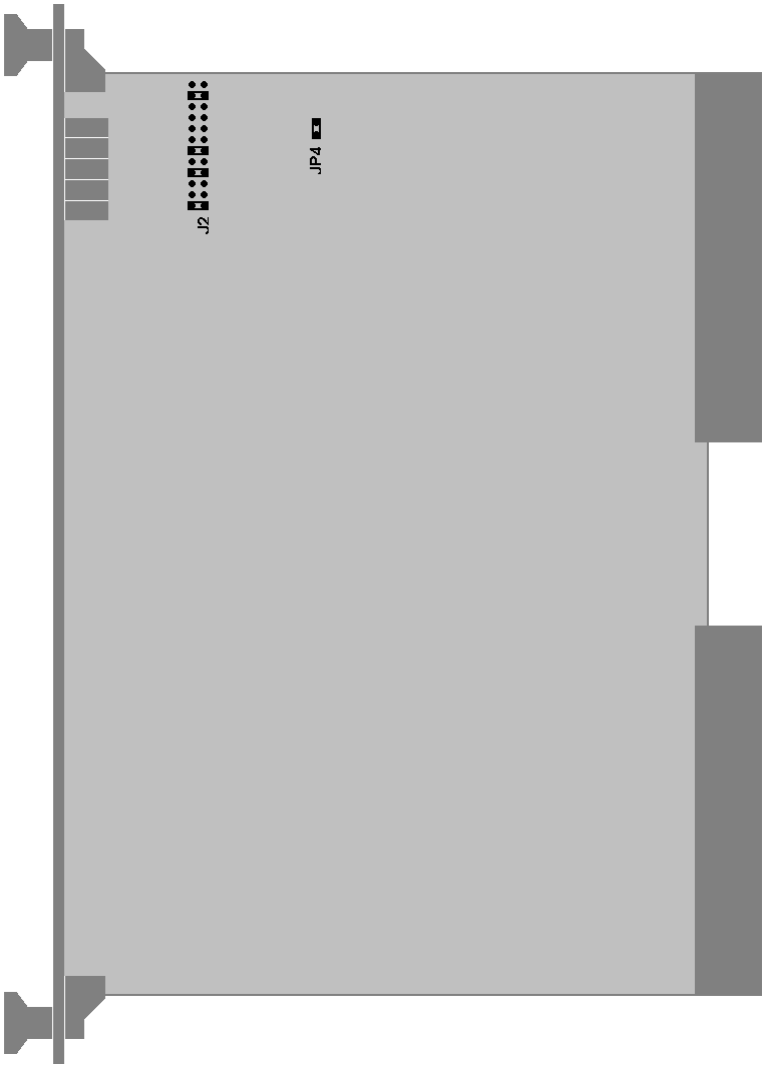
system configuration

normal operation (ST1 flashes)

2 Plug-in connector for the VME bus

3 Plug-in connector for the adapter to the EXTENSION OUTPUT extension board

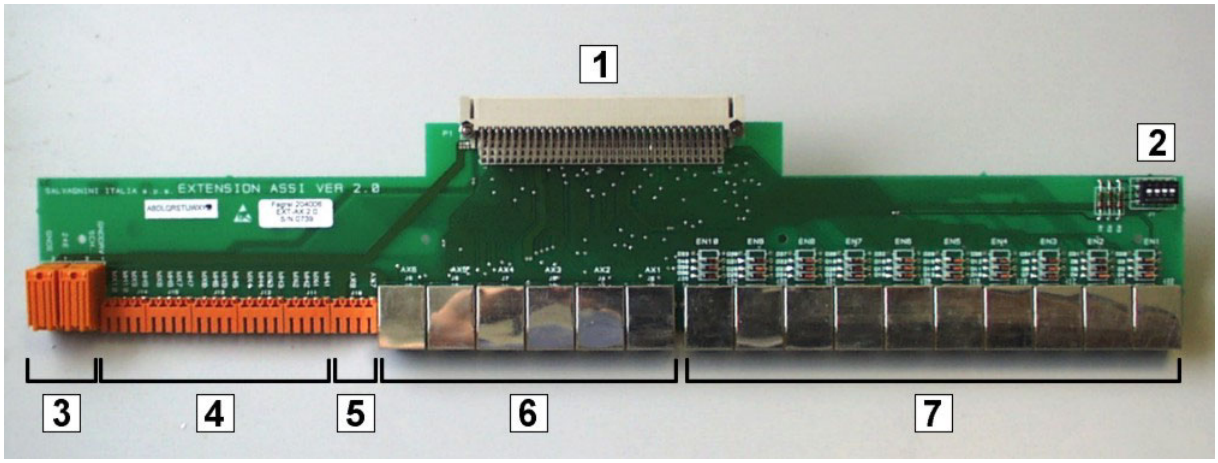
Jumper assignment on MOUT



Addressing of the board and specifying the available components on the board is done by using jumpers. These jumpers are preconfigured by Salvagnini. Therefore, the customer does not need to do any jumper configuring himself.

EXTENSION ASSI - Extension board

Connects the axis boards (MACHM, MACHS, MACHF) with the control units and with the position encoders of the machine axes.
Control units are for example servo-valves (in hydraulic drives) or frequency converters (in asynchronous motors). Position encoders are optical and magnetic linear or rotational encoders. They are used to determine the current axis position and to detect the rotational speed and direction of drive motors.



1 Plug-in connector for the adapter to the axis board (MACHM, MACHS, MACHF)

2 DIP switches for board addressing.
For setting, see *Appendix 1* in Chapter *Electrical System*.

3 Screwed connectors for the supply of the board (5VE / 24E / shielding / GNDE)

4 Plug-in connectors for digital inputs (MH1 / MX1 through MH10 / MX10)

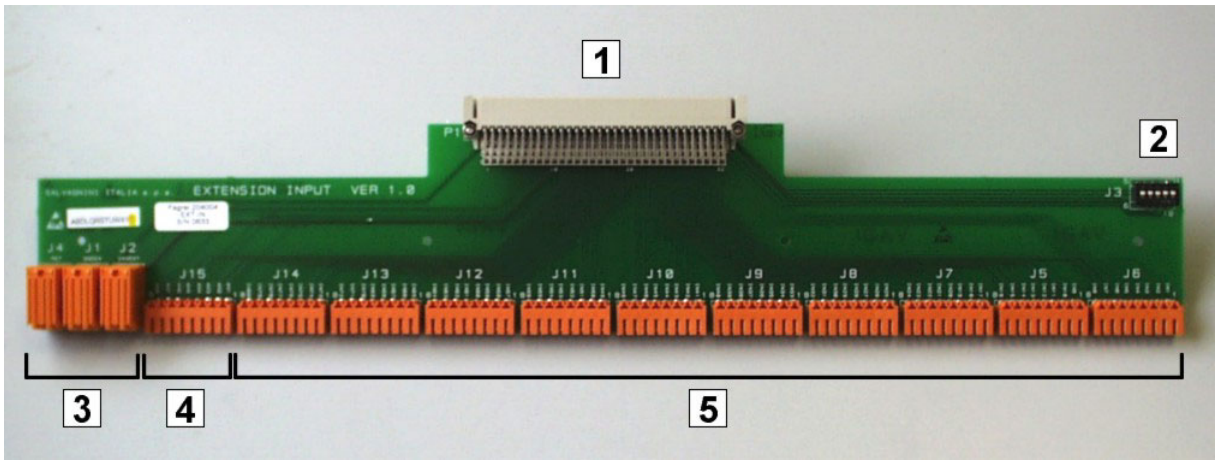
5 Plug-in connectors for analog outputs (AX7 / AX8)

6 RJ 45 plug-in connectors for DAC outputs (AX1 through AX6)

7 RJ 45 plug-in connectors for encoder signal inputs (EN1 through EN10)

EXTENSION INPUT - Extension board

Connects the signal input board (MINP) with the proximity switches, microswitches, limit switches, etc. on the machine.



1 Plug-in connector for the adapter to the signal input board (MINP)

2 DIP switches for board addressing.
For setting, see *Appendix 1* in Chapter *Electrical System*.

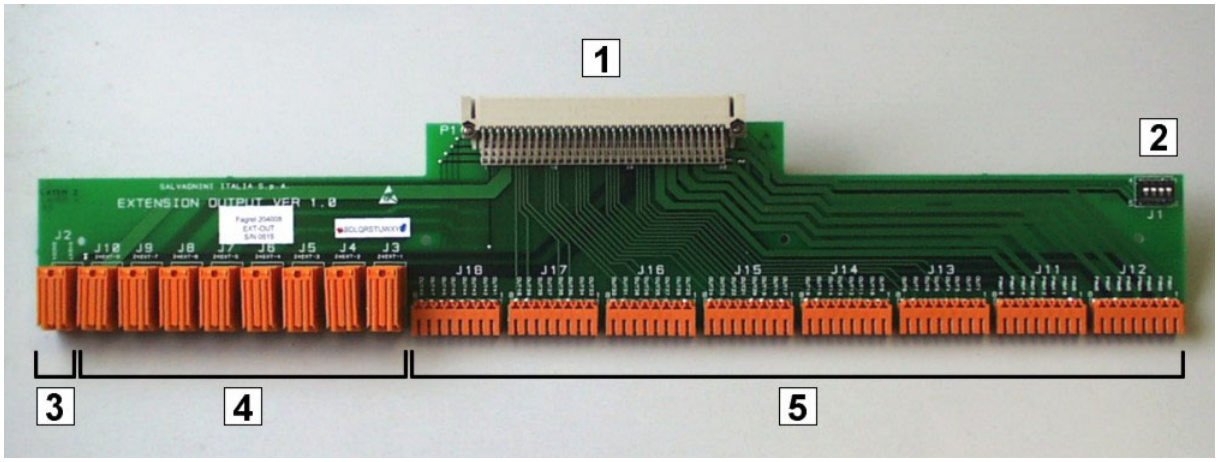
3 Screwed connectors for supply of the board (24VEXT / GNDE / RET)

4 Plug-in connectors for analog input signals (AN1 through AN8)

5 Plug-in connectors for digital input signals (IN1 through IN80)

EXTENSION OUTPUT - Extension board

Connects the signal output board (MOUT) with the electrical, hydraulic, and pneumatic installations of the machine, such as relays, electric valves, lamps, acoustic or also optical warning signals.



1 Connector for the adapter to the signal output board (MOUT)

2 DIP switches for the board's addressing.
For setting, see *Appendix 1* in Chapter *Electrical System*.

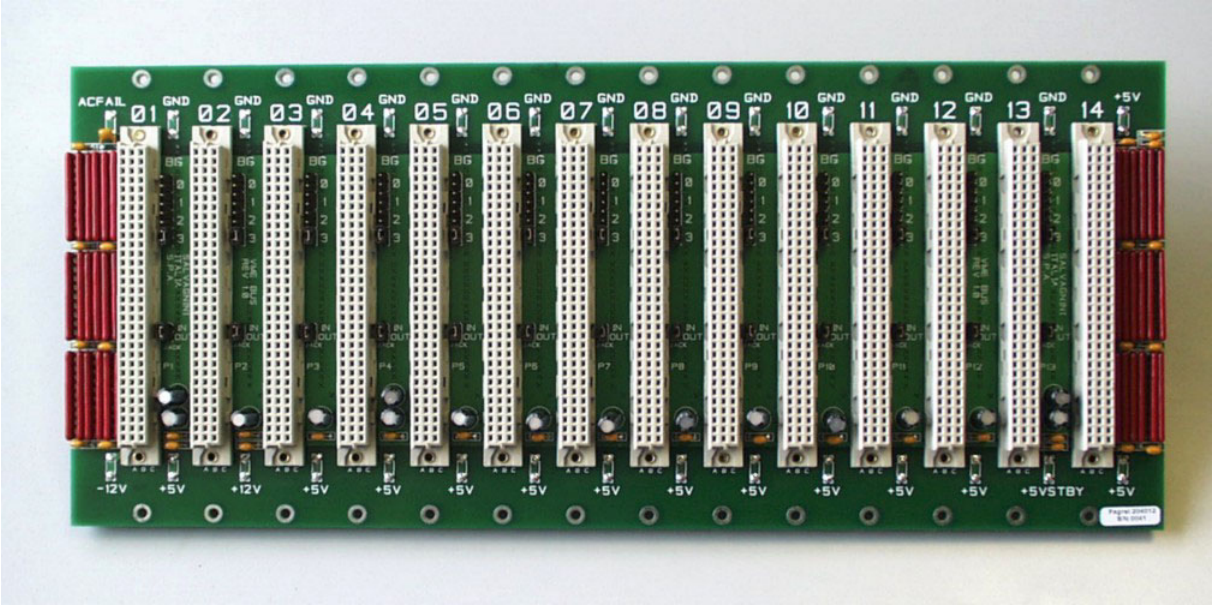
3 Screwed connectors for supply of the board (5VEXT / GND24)

4 Screwed connectors for 24V supply (24VEXT-1 through 24VEXT-8)

5 Plug-in connectors for output signals (OUT1 through OUT64)

VME - Bus

The VME bus (Versa-Module-Europe) connects the various electronic boards with one another. In addition, this standard industrial bus allows you to connect other commercially available hardware products to the Salvagnini system.



Jumper assignment at slots 01 through 14:

If a slot remains vacant, then jumper no. 3 must be set at this slot.
In this connection, see *Appendix 1* in the Chapter *Electrical System*.

2.5 Technical data

NOTE: Specifications in the *Technical Data* are valid for the standard panel bender. For differences to the standard specifications see your acknowledgement of order.

2.5.1 General Specifications

Ambience conditions:
Temperature ..... +10 to +40 °C
Humidity ..... 0 to 90 %

Sound level:
By the operators position on main terminal ..... 72 dB (A)

Dimensions:
Space requirement (L x W x H) ..... approx. 12,8 x 7,7 x 2,5 m
Working height ..... 1,09 m

Total weight:
Without oil filling ..... approx. 25410 kg
Heaviest part is the bending machine ..... approx. 16880 kg

Filling quantity of hydraulic unit:
Basic machine ..... approx. 600 dm³ (Litres)
(Hydraulic oils: Please see *Changing the hydraulic oil* in chapter *Maintenance*)

Cooling water filling quantity (System with closed cooling circuit):
Filling quantity of chiller R 81 (optional) ..... approx. 175 dm³ (Litres)
Filling quantity of chiller R 101 (optional) ..... approx. 260 dm³ (Litres)
(Cooling liquid: Please see *Required cool water quality* on page 2-23)

2.5.2 Supplies

Electric supply of panel bender:

Supply voltage (3~ + PE)	200 V ± 5%	220 V ± 10%	400 V ± 10%	460 V ± 5%	575 V ± 5%
Frequency	50/60 Hz ± 1%	50/60 Hz ± 1%	50/60 Hz ± 1%	60 Hz ± 1%	60 Hz ± 1%
Cross section for connection (Cu / IEC204-1-15C)	4x 70 mm^2	4x 70 mm^2	4x 25 mm^2	4x 16 mm^2	4x 16 mm^2
Supply circuit fuses (gl/gll - IEC)	160 A	160 A	80 A	63 A	63 A
Average current	84 A	76 A	42 A	37 A	29 A
Nominal power	24 kW	24 kW	24 kW	24 kW	24 kW
Control voltage				24 V AC and DC	
Voltage for Industrial-PC, monitor and power supply				220 V AC	

ATTENTION: If a residual current operated device is used in the mains supply, then it must be d.c.-sensitive.

Electric supply of chiller R 81 (optional):

Supply voltage (3~ + PE)	200 V	220 V	400 V	480 V	575 V
Frequency	50/60 Hz	50/60 Hz	50/60 Hz	60 Hz	60 Hz
Cross section for connection (Cu / IEC204-1-15C)	4x 10 mm^2	4x 10 mm^2	4x 6 mm^2	4x 4 mm^2	4x 4 mm^2
Supply circuit fuses (gl/gll - IEC)	40 A	40 A	25 A	20 A	20 A
Nominal power	11,75 kW	11,75 kW	11,75 kW	11,75 kW	11,75 kW

Electric supply of chiller R 101 (optional):

Supply voltage (3~ + PE)	200 V	220 V	400 V	480 V	575 V
Frequency	50/60 Hz	50/60 Hz	50/60 Hz	60 Hz	60 Hz
Cross section for connection (Cu / IEC204-1-15C)	4x 12 mm^2	4x 12 mm^2	4x 8 mm^2	4x 6 mm^2	4x 6 mm^2
Supply circuit fuses (gl/gll - IEC)	50 A	50 A	35 A	30 A	30 A
Nominal power	14,9 kW	14,9 kW	14,9 kW	14,9 kW	14,9 kW

Interconnection with other DP (data processing) devices:

Network supply:	10Base2 according to IEEE 802.3 standard (or thinwire-ethernet), signal transmission over thin-coaxial-cable (RG58 type, impedance of 50 Ohm), BNC-connector, 10Mbit/s data transfer rate, TCP/IP software protocol
	10Base5 according to IEEE 802.3 standard (or thickwire-ethernet), signal transmission over thick-coaxial-cable, AUI-connector, 10Mbit/s data transfer rate, TCP/IP software protocol
	10BaseT according to IEEE 802.3 standard, signal transmission over unshielded-twisted-pair-cable, RJ45-connector, 10Mbit/s data transfer rate, TCP/IP software protocol
Serial supply:	point to point connection, standard RS232, synchronous/asynchronous, asynchronous default

Cooling water supply (System with open cooling circuit):

Consumption..... approx. 2,0 m^3/h
Inlet temperature.....max. 20 °C
(Cooling liquid: Please see *Required cool water quality* on page 2-23)

Compressed-air supply:

Requisite pressure at feeding point.....6 to 12 bar
Compressed air consumption at 6 bar .....approx. 375 Nl/min

2.5.3 Productivity

Machine tolerance:

Angular accuracy	± 1°
Dimensional tolerance of bent pieces	± 0,2 mm
Repeat accuracy	± 0,1 mm
Positioning accuracy in centering	± 0,1 mm
Straightness of bent pieces	± 0,1 mm/m

Optimizing productivity by changing the machine's operating mode:
To boost the efficiency of the panel bender, the machine's operating mode can be adapted to the respective production scenarios. Operators can select a *Standard Mode,* a *High Speed Mode* (for shorter cycle times), or an *Economy Mode* (for reducing power consumption). The operating mode can be changed by selecting a related statement in the bending program. See the *MCM-command* in the chapter *Programming Guide*. If no specific statement is entered in the bending program, the machine will operate in the *High Speed Mode*.

Changing the blankholder tooling length:

Tooling readjustment time:	Tooling length is readjusted automatically while new sheets are fed and already machined sheets are unloaded, respectively. As a consequence, tooling readjustment times (setting-up times) will not cause any process delays.
Length adjustment:	Is carried out by means of the bending program (software) and possible in steps of 5 mm

2.5.4 Characteristics of the sheets for processing

ATTENTION: Please keep the following information in mind. The processing of other materials, blanks having larger dimensions or other kinds of surfaces (i.e. harder or rusty blanks) can accelerate wear of the tooling, or cause breakage of the tooling or other damage to the panel bender. Apart from this, the blanks must be free of shavings and punched out pieces. Otherwise, you might risk damaging the blankholder. Salvagnini will not be liable for any damage arising from the above mentioned scenarios. The user alone shall bear the risk for any such decisions. In case of doubt, please consult with a Salvagnini technician.

Surface quality:
The sheet surface can be non-oiled, uncoated, metallically coated, or inorganically coated (e.g. zinc). Painted or coated metal sheets should only be machined when provided with a protective foil. The surface must not be rough (r) to DIN 1623 Part 1.

Type of surface	Surface structure
usual cold-rolled surface (O3)	smooth (g)
best surface (O5)	smooth (g) or matt (m)

Evenness:
The sheets must be even to the extent that when the sheet is layed on either side on a flat surface, the space between the surface and the sheet does not exceed a maximum of 5 times the sheet thickness, however the maximum edge wavyness must not be more than ± 5 mm.

Material properties:
Cold-rolled metal sheets, magnetic and non-magnetic sheets out of soft, plain steel or austenitic steel. Optionally, stainless steel sheets, aluminium or brass sheets can also be processed. The values in parentheses in the following table apply only if CLA tools are used.

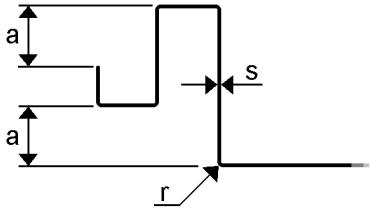
Material	max. tensile strength	min. sheet thickness	max. sheet thickness
stainless steel	600 N/mm²	0,50 mm	1,25 (1,00) mm
steel	410 N/mm²	0,50 mm	2,00 (1,50) mm
aluminium	265 N/mm²	0,50 mm	3,00 (1,50) mm

Minimum and maximum dimensions of the sheets (punched blanks):

Dimension [mm]	ALA 25/450/200	ALA 25/540/130	ALA 30/510/200	ALA 30/600/130
Length min./max.	455 / 2695	545 / 2695	515 / 2695	605 / 2695
Width min./max.	190 / 1500	190 / 1500	190 / 1500	190 / 1500
max. diagonal	2700	2700	2700	2700
max. centering dim.	2500	2500	2500	2500

2.5.5 Details for producing profiles and panels

Bending characteristic:

	Standard	Reduced	Reduced
upper bending tools:	 LS	 LSA	 LSS
lower bending tools:	LI 	LIA 	LIS 
	$a_{min.} = 10 + 2s$	$a_{min.} = 8,5 + 2s$	$a_{min.} = 6 + 2s$
max. sheet thickness s with bending angle:	2,0 mm at ±135°	2,0 mm at ±90°	1,0 mm at ±90°
max. angle with sheet thickness s:	±135° at 2,0 mm	±125° at 1,2 mm	±90° at 1,0 mm
max. sheet thickness s for safety flap:	2,0 mm	2,0 mm	1,0 mm
min. bending height:		5s	
outside bending radius r with sheet thickness s and bending angle of 90° (Standard / Maximum / Minimum):	1,25 mm / 1,75 mm / 1,00 mm at s = 0,5 mm 2,25 mm / 2,75 mm / 1,75 mm at s = 1,0 mm 4,00 mm / 4,75 mm / 3,50 mm at s = 2,0 mm		

Notes:
The maximum bending angles can be bent during a single bending action. An additional bend is needed for larger angles.
The maximum bending angle with CLA-tools is + 90°. With the LIS-bending-tool the option CLA cannot be used.

Minimum and maximum dimensions of the finished profiles and panels:

Dimension [mm]	ALA 25/450/200	ALA 25/540/130	ALA 30/510/200	ALA 30/600/130
for panel fig. 1				
Width: Y_{min} / Y_{max}	200 + k / 1500	124 + k / 1500	200 + k / 1500	124 + k / 1500
Length: X_{min} / X_{max}	446 + 4s / 2500	536 + 4s / 2500	506 + 4s / 2500	596 + 4s / 2500
Height: H_{max}	127	127	127	127
for panel fig. 2				
Width: Y_{min} / Y_{max}	A_{min}+ a + b / 1500	A_{min}+ a + b / 1500	A_{min}+ a + b / 1500	A_{min}+ a + b / 1500
Length: X_{min} / X_{max}	446 + 4s / 2500	536 + 4s / 2500	506 + 4s / 2500	596 + 4s / 2500
Height: H_{max}	127	127	127	127
Inner width: A_{min}	200 + k	124 + k	200 + k	124 + k
Inward bending:				
a_{max} = b_{max}	45	45	45	45
c_{max} = d_{max}	25	25	30	30

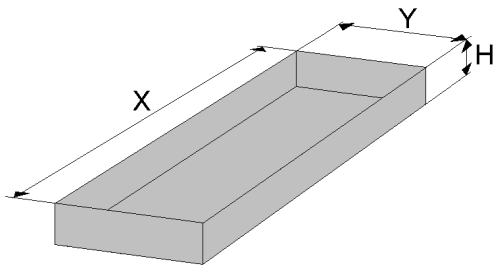


Fig. 1

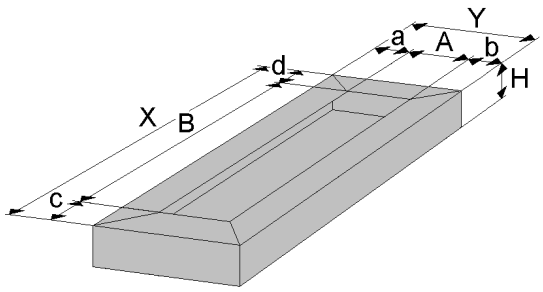


Fig. 2

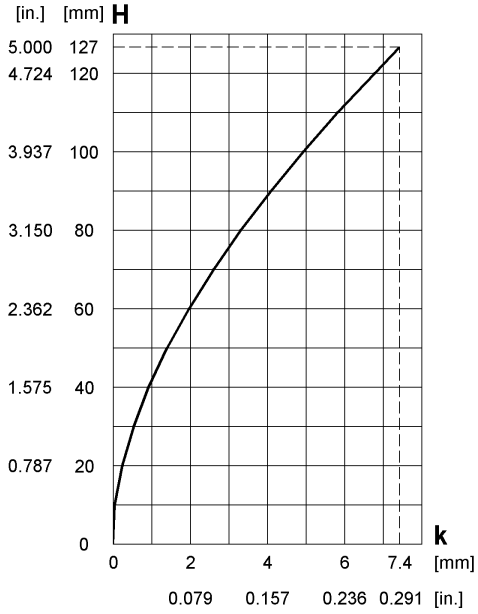


Fig.3 Correction value k

Notes:

The production of smallest possible panels depends on:

- Loading possibility (min. length, min. width)
- Bending height: The minimum width of the panel becomes greater with increasing bending height. The reason for this is due to the arc-shaped movement effected by the blankholder.
- Centering possibility (size, corner notching)
- If the manipulator can transfer. For example, a panel with a minimum width and a short positive bend on each side, cannot be bent.

The production of largest possible panels depends on:

- Loading possibility (max. length, max. width)
- Maximum possible diagonal