AZIMUTH

Presses & Automation – Since 1975

Instruction Manual
AZ-PB

Table of Contents

1.Word of Caution

- This machine is rated for 480V/60Hz and 600V/60Hz in star configuration. Make sure to properly connect the machine
- Before using the machine, make sure the shut height is properly adjusted to your tooling
- Before using the machine with material, make sure to perform a visual inspection and try to cycle it 5 times to verify that nothing has been damaged during transport (guarding system, etc.)
- Never operate this machine until you've read & understood that this machine is dangerous. Placing your hands or any part of your body in this machine could lead to serious injuries or death. Warnings are posted around the machine for this purpose.
- Never operate this machine without training
- Never operate this machine without the use of a guard or safety device that will always protect you from injuries.
- Never perform maintenance operations on this machine unless the power is turned off and locked.
- Never operate the equipment in teams of two or more
- Never leave the workspace during the equipment operation
- Follow the lockout procedures when leaving or servicing the equipment

*** Never put your hands in the machine unless the power is turned off and locked out **

The following general conditions must be followed.

- Check the machine and make sure that here is no damage when taking delivery of your machine. Please ask your dealer for replacement of shipping damage within 7 days starting the date of purchase, replacement requests are invalid after 7 days.
- Please check whether the accessories are missing while delivery of your machine. If there are any missing parts, please ask your dealer for the provision of the parts in question within 7 days from the date of purchase. Request you make after 7 days will not be considered.
- Failures caused by use of improper power connections are not covered by warranty of your machine. Make sure to verify phases before startup. Repair of such failures will bring you financial burden.
- Make sure your machine is grounded and there are no voltage fluctuations on power supply.
- Do not try to attach external parts to each other's slots or their own slot the wrong way. Do all connections while the machine is off, do not try to attach or detach any parts while the machine is running.
- Do not interfere with software on the machine. Any modification to the software can be done only if Azimuth approves the request. Otherwise, it will cause your machine to be out of warranty.
- Make sure all connections to the machine are correctly made.
- Machine work surface must be flat, non-slip and solid.
- If our machine works with another machine than Azimuth ones, the manufacturer is not liable for any damage or work loss due to shock, moving around or vibrations in the event of overload of the other machine.
- Loading capacity of the machine must not be exceeded. Work overload will damage the machine and all components rotating (follow approval drawings and quote dimension specifications).
- Make sure the machine is working as shown by the technical service during installation.
- Do not modify the equipment at will. Azimuth is not responsible for damage or accident caused by unauthorized components or modifications.

Safety information

Introduction

This manual serves as purpose of safety and operation for the operator. The operation shall abide by safety rules stipulated by the user's factory.
Before machine start, inspection and maintenance, the operator shall read, understand and observe this manual.
Before starting the machine, check whether or not the handle, button and safety protection device are in proper position. Be sure persons around are at safe place.
Maintain a complete and effective safety protection device. Repair or replace failed parts in time. Neglecting safety rules and improper operation may lead heavy loss of life and property.
This manual is supposed to put near the machine for the operator to read and review it .

Safety rules

Operators must always wear proper work clothing and know how to stop the press before starting it.

The press must never be used beyond its rated capacity, and tooling must not be touched while the machine is running. Cleaning with compressed air is prohibited, and the work area must be kept free from dirt, oil, obstacles, and slippery conditions.

Any oil leaks should be dealt with immediately to prevent accidents. Lubrication or maintenance may only be performed when the press is stopped and locked out, with clear warning signs in place to prevent accidental startup. Power isolation during maintenance must be ensured by locking the switch, removing fuses, placing warning tags, or assigning a safety guard.

Tooling adjustments must never be made while the press is in motion, and no part of the machine should ever be stopped by hand or with foreign objects. Only the correct punches, dies, and tools may be used, and all guards and safety devices must be in place and functional at all times.

The operator must always supervise the press during operation and should never touch the electrical controls with wet hands.

Fuses must only be replaced with ones of the correct rating, and only qualified electrical engineers may perform electrical troubleshooting.

At no time should an operator place hands or any part of the body between the punch and die, even during adjustments or inspection. Modifications to the machine are not allowed.

If the press has been stored for a long period, it must be thoroughly checked and given a trial run before returning to service.

Inspections and maintenance must only be carried out by trained and experienced personnel, and work may only begin after confirming with a multimeter that no residual voltage remains at least ten minutes after power has been cut.

Machine specifications

Descriptions		Unit	PB0615
Nominal force		kN	630
Bending length		mm	1500
Distance between columns		mm	1100
Throat depth		mm	410
Stroke		mm	215
Worktable height		mm	755
Worktable width		mm	50
Max. open height		mm	520
Approach speed		mm/s	160
Working speed		mm/s	1
Return speed		mm/s	140
Motor power		kW	5.5
CNC system		Delem DA53T control system from Holland for Y1、Y2、X and flexibility compensation	
Oil tank capacity		L	175
Back gauge	**Stroke**	mm	X
			600
	Accuracy	mm	±0.10
	Speed	mm/s	400
	Power	kW	1
Machine weight		kg	5000

Installation and transport

There are 2 hooks on each side of the machine. As the machine has a high center of gravity, the front side is heavier than the back side. Be cautious about balance of the machine, so it will not fall over when you are transporting it with the steel pipe. Lifting fork of the forklift must be in the direction front of the machine. Machine lifting refers to figure 1.

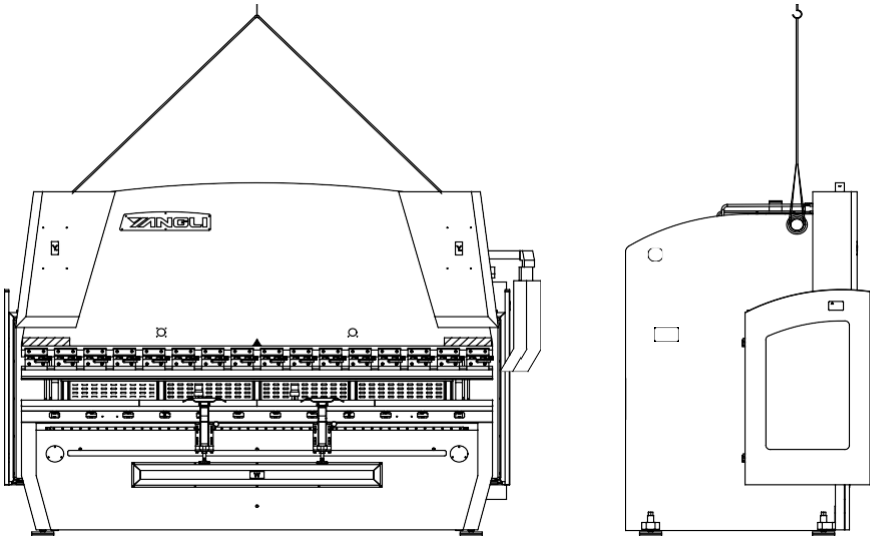


Figure 1 Machine Lifting

Foundation preparation

The cement foundation of the machine must be prepared 10 days before the machine installation. Foundation dimension refers to figure 2. For more details, refer to foundation drawing.

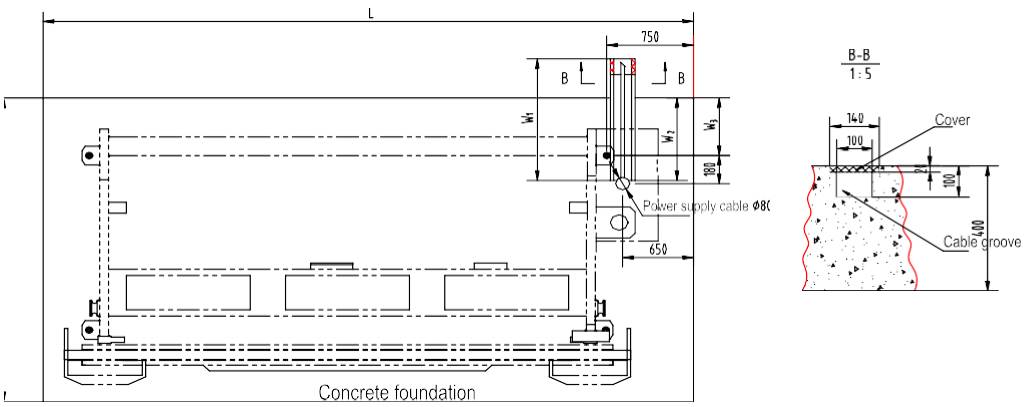


Figure 2 Foundation

1.1 Cleaning

Clean the rust-preventive grease on following parts before starting the machine:

a) Piston rod

b) Encoder guide

c) Backgauge guide ways, ballscrews and beam surface.

d) Ram guide

e) Worktable, die holders and dies.

Notes: alcohol and kerosene oil are allowed for cleaning except for scouring agent with dissolving power.

1.2 Leveling

Place the machine on the foundation plate. Distance between machine base and floor is 5mm. Level the machine with jack bolts.

Putting the machine in a horizontal position in the front-rear direction, adjust the jack bolts to measure the gradient of the table with the spirit level (of accuracy ±0.05mm/m) at both ends of the table. Put the machine in a vertical position in the left-right direction with the spirit level (of accuracy ±0.05mm/m)at the table center.

Repeat the above steps after the electrical connection work. Tighten the nut of the jack bolts and the nut of the anchor bolts respectively.

Check and adjust the gradient of the machine again after 30-50 hours operation for the soil quality and bearing capacity.

1.3 Electrical wiring

After the main switch is connected (phase conductors L1, L2, L3,PE), starting the oil pump motor only for 2-3 seconds, and check if rotation of the oil pump motor is in the direction of the indicated arrow. Exchange the two-phase conductors if not.

Cable inlet is at the bottom of the electrical cabinet.

Note:

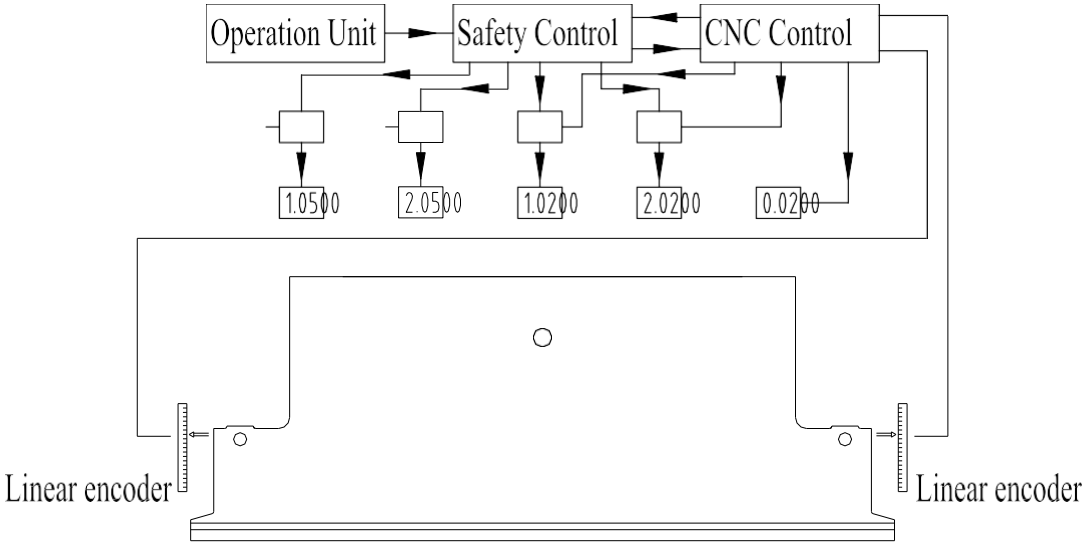
a) Make power supply meets power requirement of machine.

b) Only the trained and authorized personnel can carry out electrical

Working Principles

The machine is a combination of CNC, servo and hydraulic technology. Control valves control the ram movement, and the encoders on both sides of the machine control the moving distance. CNC system offers operator-machine dialogue and processing simulation.

Delem system controls opening of the servo proportional valves of two oil cylinders. Oil flow in the cylinders is distributed again by the servo proportional valves to cause linear movement of the ram. Moving distance is set by CNC system and determined by pulse number. (figure 3)



Signals from CNC controller transfer into hydraulic signals through the servo valve. Each oil cylinder has separate circuit controlled by the servo proportional valve, reverse valve and fill valve.

CNC-Controlled Axes

The following axes are controlled by CNC

Y1- Ram left cylinder
Y2- Ram right cylinder
W- Lower beam crowning compensation cylinder (i.e. flexibility compensation system)
X, X1, X2- Backgauge movement front-back

R,R1,R2- Backgauge movement upper-down

Z,Z1,Z2- Backgauge movement left-right

Note

Ram position can be programmed in absolute equation or angle size.

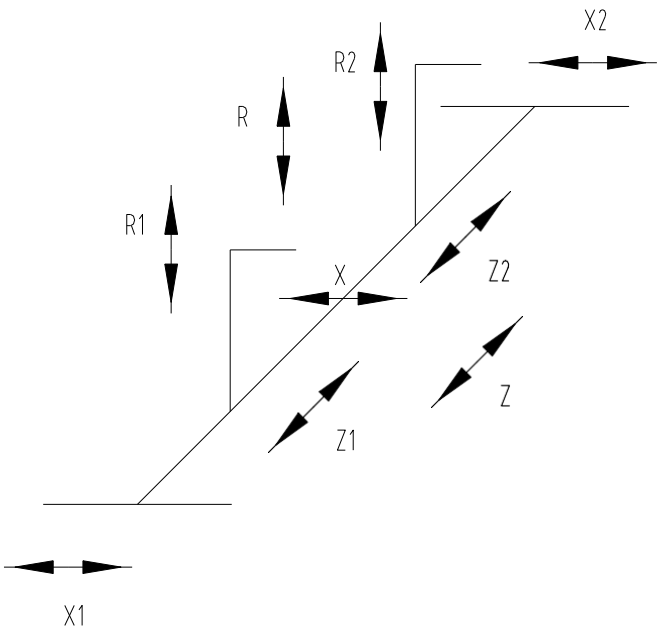


Figure 4 Control Axes of Backgauge

Positions and features of axes

Position of control axes are shown in the following table

Axes	Reference Point Position	Actual Value
Y1 ram L (upper or down)	Worktable surface	Distance between punch and worktable surface
Y2 ram R (upper or down)	Worktable surface	Distance between punch and worktable surface
X,X1,X2 backgauge (front back)	Die center	Distance between die center and backgauge
R,R1,R2 backgauge (upper or down)	Die surface	Distance between highest point and lowest point of backgauge
Z1 left backgauge (left to right)	Left side of the machine	Distance from left backgauge finger center
Z2 right backgauge (right to left)	Right side of the machine	Distance from right backgauge finger center

Notes

1. CNC programming is for all axes.
2. L and R is accordance of front of the machine as a reference.

Standard configuration of backgauge

CNC system

Servo motor drive X-axis to move front-back; Z-axis and R-axis are adjusted manually.

Backgauge adopts imported linear guide and ball screw with transmission accuracy ±0.01mm, positioning accuracy ±0.02mm.

Backgauge can also be controlled separately for large quantity of workpiece processing with high accuracy requirement.

Cautions

1. It will damage the machine and die when backgauge is out of die safe area.
2. Adjust Z- axis manually only from the rear of the machine.
3. Be cautious of moving backgauge, avoiding collision with the die.

Backgauge, consisting of a ram across machine bed and two stop fingers, is supported by linear guide ways and ball screws, which are driven by the servo motor.

Hydraulics

PB-63T,100T,160T,250T and up press brakes are equipped with hydraulic system, which comprises of the following modules

Synchronous control module, fill valve, power module (integrated with high-pressure internal gear pump) or pump control block, flexibility compensation assembly of hydraulic proportional control.
Combination of hydraulic system, CNC system and feedback measurement system ensures accurate positioning and good synchronization.

Oil tank

Hydraulic oil tank, which is welded on inside of mainframe, is equipped with oil filter, motor, oil pump, high pressure valve and pressure control valve. There is a cock at bottom of the oil tank.

Motor

Motor, 3-phase, class 4.

Oil pump

Oil pump, high-pressure internal gear pump and main motor are connected with elastic coupling. (Coupling is not needed if power module is used.)

High pressure filter

High pressure filter is of filtering class 10um, max pressure 400bar. Filter shall be replaced when it is blocked or oil changes.

Synchronous servo valve

CNC system and servo amplifier control flow of synchronous servo valve on top of oil cylinder so as to control movement speed of slide in such way as quick travel, bending speed, BDC (bottom dead center), return and TDC (top dead center).

Fill valve

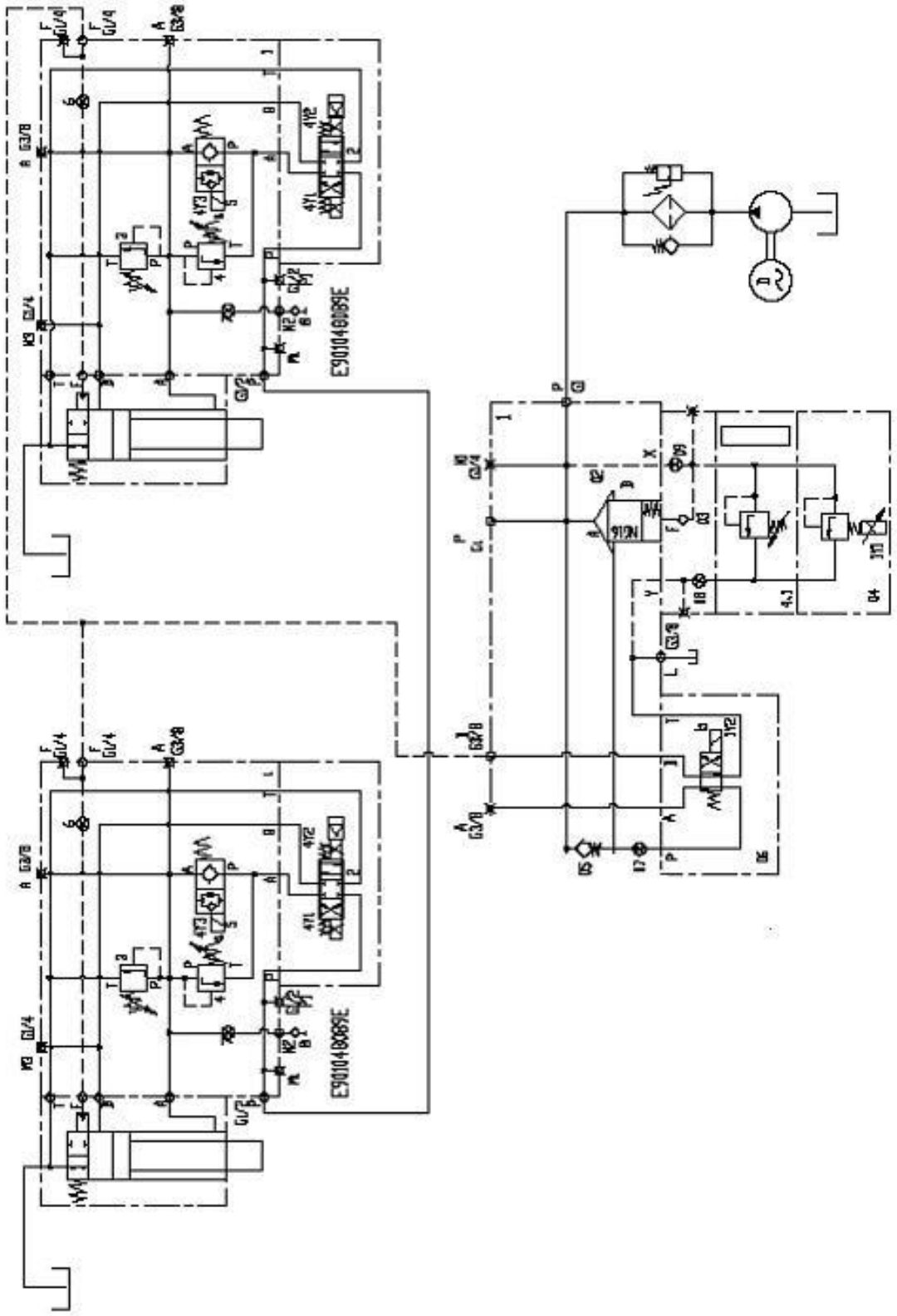
Fill valve, located on top of oil cylinder, is often open. It supplies or collects oil to or from hydraulic oil cylinder. Fill valve closes when the press brake is bending sheet metal. Its close and open action is controlled by a four-position two-way reversal valve integrated on control module.

Pressure control valve

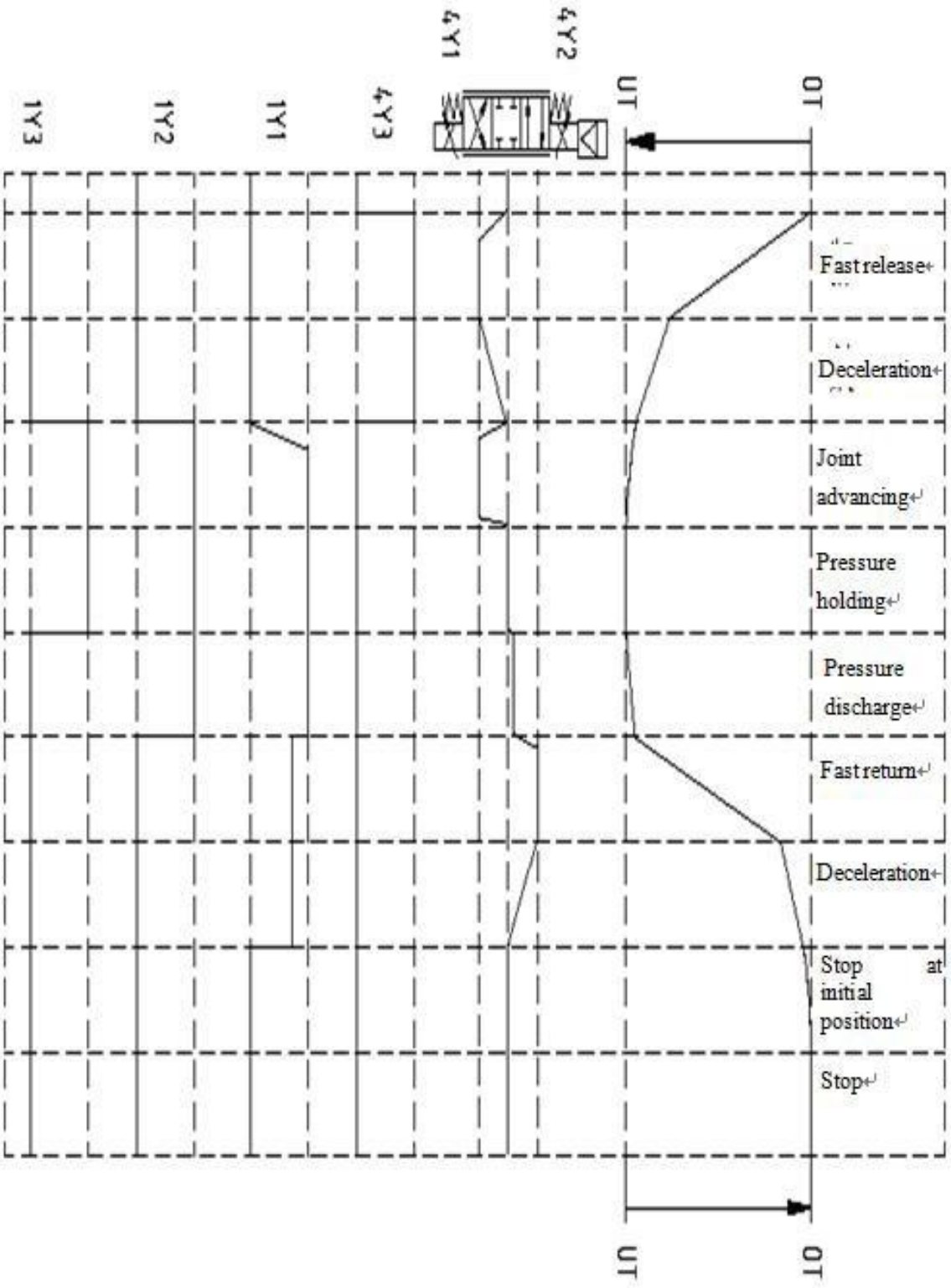
Pressure control valve on the servo valve can adjust back pressure of return.

Hydraulic circuit

Hydraulic circuit of hydraulic control system and option (attached
drawing 1) Parts list of hydraulic control system and option (drawing 1)
Operational procedure of hydraulic control system(drawing 2)



drawing 1


4Y1
4Y2
1Y3
1Y2
1Y1
4Y3
UT
OT
Fast release
Deceleration
Joint advancing
Pressure holding
Pressure discharge
Fast return
Deceleration
Stop at initial position
Stop
UT
OT

drawing 2

Hydraulic feature

Max. working pressure (system pressure) 30MPa
Hydraulic media is mineral oil selected in accordance with DIN51524. Please consult for other hydraulic oil.
Temperature range of hydraulic oil: min. -10℃, max. +70℃
Viscosity range of hydraulic oil: min. 10mm^2/s, max. 600mm^2/s. Suggested viscosity for continuous work is between 20mm^2/s and 100mm^2/s.
Pollution class of hydraulic oil: max. class 8 in accordance with NAS1638. Filter: filtration ratio $\beta_{10} > 75$.

Installation and operation of hydraulic system

Read and observe the following rules before installation, adjustment and maintenance of hydraulic system.
Only trained or authorized personnel are permitted to carry out installation, adjustment and maintenance of hydraulic system.

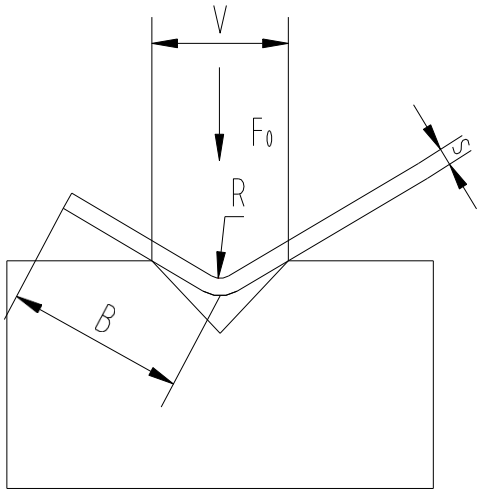
1. Principally, for maintenance of the machine, slide shall be at BDC (or chocked with wooden block), Make sure main power switch is shut off and will not be activated.
2. Empty pressure oil in energy accumulator before maintaining hydraulic system.
3. Keep system clean during installation, repair and maintenance in case any dirt in system leads system or machine failure.
4. Only mentioned parts can be used on the machine.

It is not allowed to adjust screws with red or yellow waxed-seal.

Ensure the system meets the following requirement before installing hydraulic system:
Slide speed downward shall not be more than 5mm/s when opening connector M2 for measuring pressure, or magnetic ball valve (1.0500/2.0500)is powered off. Slide speed downward shall not be more than 1mm/s when proportional reversing valve is powered off. Slide speed downward shall not be more than 10mm/s when special safety protection measure is not available for the machine with only manual feed.
Residual wave of electrical signal shall be prevented for hydraulic system. (Residual may delay closing time of magnetic valve.)

Dies selection

Figure 7-1 Die



Where:
F_0: Bending force each meter for the sheet metal of tensile strength 450N/mm^2 （kN/m）
S: Sheet metal thickness （mm）
B: Min. bending width （mm）
V: Width of the lower die open （
mm） R: Bending radius （mm）
Width V of V-groove die is in accordance with the sheet thickness S. The relation formula is as follows:
S＜3mm V=(6 ~ 8) × S

S＞3mm V=(8 ~ 12) × S
Change of width V of die is followed by change of min. bending width B and bending radius R.

(1) Bending force
In cycle mode of the press brake, input control unit with bending angle, bending condition. Required bending force can be calculated automatically by control unit. You can also calculate required bending force in accordance with table of bending force.
Where:
Tensile strength of sheet metal 45kg/mm^2
(450N/mm^2) Certain width V of die and sheet metal
thickness Required bending force each meter （
T/m）

Calculation formula for required bending force each meter :

F1 = $F_0 \cdot \sigma/450$ （T/m）

Where:

Tensile strength of sheet metal: σkg/mm^2

Required bending force each meter （T/m）

(2) Air bending force calculation formula:

F = F_0·σ/450·L

F_0：value (T/m)in table of bending force

σ：Tensile strength of sheet metal to be bent（kg/mm^2） L：

Length of sheet metal to be bent (m)

Bending angles may vary if bending force provided by the machine is less than required level.

(3) Pressure F for coining

F = （3~5）·F_0·σ/450·L

F_0：value (T/m)in table of bending force

σ：Tensile strength of sheet metal to be bent（kg/mm^2） L：

Length of sheet metal to be bent (m)

The pressure set by the CNC unit shall not be lower than the allowable pressure for dies.

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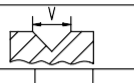
Table of

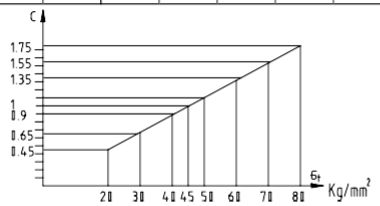
bending force unit

Table of Bending Force



42 - 48 Kg/mm²

V	R	B	0.5	0.8	1	1.2	1.5	1.8	2	2.5	3	4	5	6	8	10	12	15	20
4	0.7	2.6	4	10.5															
8	1.5	5.2	2	5.5	8	11.5	18												
10	1.7	6.5		4.1	6.5	9.5	14.5	21	26										
12	2	7.8			5.5	8	12	17.5	21.5	33.5									
16	2.7	10.4				6	9	13	16	25	36								
20	3.4	13					7.5	10.5	13	20	29	52							
25	4.2	16						8.5	10.5	16	23	41	64						
30	5	20								14	19	34	54	77					
35	6	23									17	30	46	66					
40	7	26									15	26	40	58	103				
45	7.5	29										23	36	52	91				
50	8.5	32										21	32	46	82	128			
55	9	36											30	42	75	117			
60	10	39											27	39	69	107			
65	10.8	42											25	36	63	99	142		
70	11.7	45												33	59	92	132		
75	12.5	49												31	55	86	123		
80	13.5	52												29	52	80	116	180	
85	14	55													49	76	109	170	
90	15	58													46	71	103	160	
100	17	65													41	64	93	144	256



Punch selection

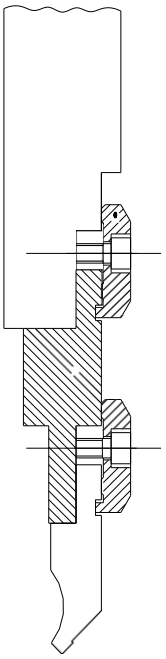


Figure 5 Punch

Section of punch (upper die) depends on required bending force. Punch has max pressure limit. Be cautious of the special dies, which have different load.

Dies mounting

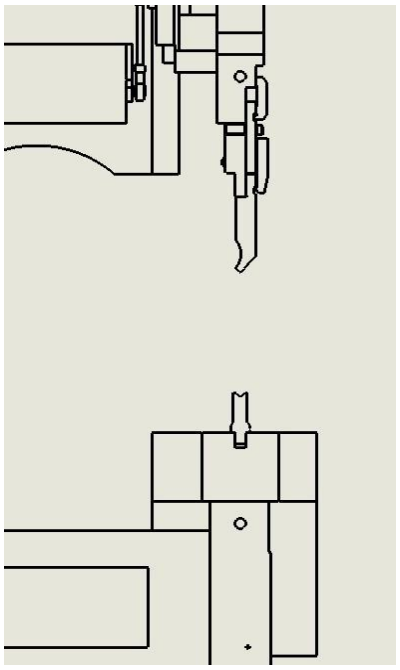


Figure 6 Dies mounting

a. Set MANUAL control and AXES STOP for CNC system before dies mounting in case any risk occurs.

(1) Mount die holders.

(2) Place dies on die holders, set the die clamp bolts.

(3) Move slide slowly until clearance between slide and die equals to height of workpiece approximately.

(4) Fix the punch and die, and place them on slide. Tighten slightly clamp bolts or close the clamp.

Thin sheet metal

The table is of tensile strength of thin sheet metal for reference. Table

Description	Tensile Strength kg/mm^2	Remarks
Aluminum	10.5	Soft hardness
	13.3	Middle
	19.6	High
Brass	32.9	Soft
Copper	25.9	Rolled
Nickel-copper	42	Middle
	59.5	High
Chrome-plated aluminum	24.5	Soft
Fe	35	Wrought iron
Steel	46.9	0.25%C
	66.5	0.5%C
	80.5	0.75%C
	91	1.0%C
	105	1.2%C
1# roll steel	52.5	
Stainless steel 18-8	66.5	

Cautions about Double-hemming Tooling:

When you use double-hemming tooling, dimensions, impedance strength and bottoming height of punch and die must be input into the tooling list of the machine.
Impedance strength of punch: C≤ 0.1 T/mm; Impedance strength of die: C≤ 0.07 T/mm.
Never input the value which is higher than maximum into the machine, in case causing any tooling damage.
After making a correct tooling setting, start trial bending with a=90 °(not start with a=30 °to avoid any tooling damage.
Doubling-hemming tooling usage scope:
Cold rolled sheet: tensile strengthσb ≈ 400, sheet thickness ≤

2mm Stainless steel: tensile strengthσb ≈ 700, sheet thickness ≤

1mm

When using double-hemming tooling, you must change code of punch and die in the program to avoid tooling damage.

CNC system parameters

1.4 Parameters

1. All parameters have been set before the machine is delivered, which will guarantee operation safety.
2. Modification of the machine parameters must be informed and confirmed by the manufacturer.
3. The customer shall take responsibility of accidents if they change the parameters without abiding by Item 2.

1.5 Machine control

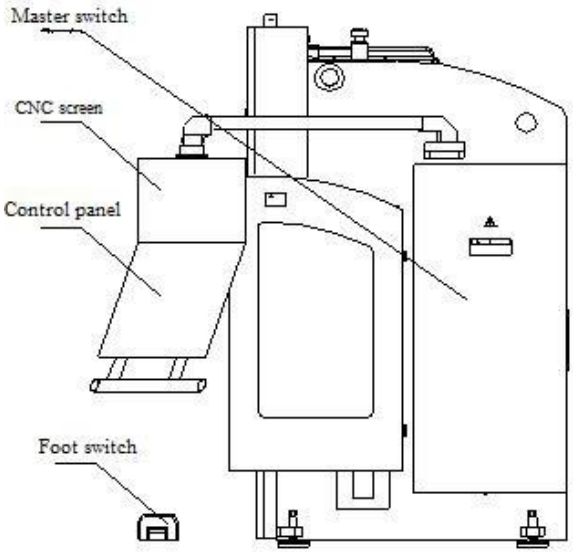


Figure 7 Delem DA53T system

Machine start and stop

Cautions before start

1. Be sure no any accident and damage will happen before starting the machine.
2. Safe and proper conditions shall be provided for the machine operation. All safety and protection facilities shall be available.
3. Avoid any improper operation that may cause risk.
4. Stop the machine immediately and remove the fault quickly.
5. Troubleshooting must be done under guidance and supervision of the technician or personnel who is well familiarized with the machine.
6. Fault checking is carried out from outside of the machine. If necessary, must stop the machine for checking.
7. Only trained personnel are qualified to operate the machine.

Starting the machine

1. Release the EMERGENCY STOP lock and lock on control panel.
2. Turn the main power switch to “1” (ON) and key switch to “1” (ON), the green indicator light is on.
3. Turn operation mode switch to “1” (FOOT).
4. Start the oil pump and main motor. The green indicator light is on.
5. Select required bending sequence.
6. Select AUTOMATIC mode on CNC system with indicator on.
7. Pressing foot petal, slide moves downward to bend sheet metal. Slide returns after remaining pressure for some time, release the foot pedal.

Troubleshooting (table 9-1)

Table

Faults	Causes	Remedies
Machine can't start	EMERGENCY STOP button is pressed	Reset EMERGENCY STOP button
	Safety cover of the machine is open	Close safety cover of the machine
	CNC alarm or servo alarm	Check alarm message and solve the trouble
	Error message on CNC display。（Initiating Windows does not end）	Check CNC unit
	Machine is not ready by control circuit	Check control circuit
Slide does not move when pressing foot pedal	Damaged contact of foot pedal or damaged cable	Chang foot pedal
	Unfinished return of reference point	Return reference point
	BDC is not set	Set BDC
	Slide is not at TDC	Move slide to TDC
	Motor does not run	Check electrical system
	Control circuit fails or is damaged	Check circuit and wiring
Unsteady movement of slide	Improperly set parameter	Check and confirm properly set parameter
	Loose bolts connecting slide	Check connection section and tighten bolts
	Failed control device	Check control device
Abnormal noise	Improper tension of timing belt	Adjust tension of timing belt

from backgauge for running machine	Lack of lubrication grease on guide ways and ball screws	Lubricate parts
Different bending angle in the middle from at both ends	Improper setting of worktable compensation device	Reset compensation value
Different bending angle at both ends	Pressure too low	Increase pressure
	Parallelism of slide vertically out of tolerance	Check initial value of Y-axis Adjust slide parallelism
	Parallelism of dies out of tolerance	Adjust or change dies. Reset worktable compensation.
	Inconsistent workpiece (different thickness, etc.)	Use consistent workpiece
Different bending angle from set angle	Pressure too low	Increase pressure.
	Dwell time too low	Prolong dwell time
	Bending speed too slow	Increase bending speed
	Poor workpiece quality (inconsistent thickness and tensile strength, etc.)	Use consistent workpiece
	Small width of V-groove of die	Use big width of V-groove of die

Stopping the machine

Following ways are for stopping machine.

1. Stop at BDC (bottom dead center)

--The ram moves to BDC (bottom dead center)

--Stop the main motor.

--Turn off the power.

2. Chock the ram with two pieces of wood with same height. (for maintenance)

--Place two pieces of wood with same height on the worktable.

--Turn OPERATION MODE switch to “0” (MANUAL).

--Operate handwheel on CNC panel.

After the ram stops, move the ram downward by handwheel until it slightly contacts the wood.

--Turn off the power (“0”).

3. Emergency Stopping

Pressing EMERGENCY STOP button, the pump stops and all axes movement stops. But CNC is still powered.

Steps of restarting the machine is as follows after emergency stop:

--Clockwise turn the EMERGENCY STOP button. (Releasing the lock of EMERGENCY STOP)

--Press the PUMP START button.

a) It is important to match installed dies on the machine with ones in CNC system program before the machine begins to work.

b) Programmed value of X-axis shall not less than min. bending distance b (refer to bending parameters table)

Maintenance

General requirements of maintenance

--Experienced maintenance and test personnel must carefully read this Manual.
--It is proposed to let the manufacturer to check the machine one time.
--The operators or person in charge of the machine shall carry out daily check on potential leakage parts or flexible connection section.
--If abnormal situation of the machine occurs, stop the machine immediately and remove the fault in time. Just inform the manufacturer once you cannot cope with it.
Responsible personnel: operators or persons in charge.

Weekly maintenance

Guide ways: Lubrication. Replenish guide ways with lubrication grease after every 100Km travel. Replenish single slide with 7cm^3 grease.
Ball screws: Lubrication. Replenish lubrication grease every 3 months, fill grease on steel ball and its groove through the lubrication hole.
--Back gauge: Clean, lubrication.
Check tension of timing
belt. Check parallelism.
Check transmit parts.
Check zero position of all axes weekly, make a compensation on CNC. Details refer to attached lubrication drawing 3.
--Die: Clean and check wear and damage
situation. Responsible personnel: operators or
persons in charge.

Maintenance of Hydraulic System
Hydraulic oil filling:
When the ram is at TDC (top dead center), just see the oil level mark to check oil level daily. If necessary, refill oil into the oil tank.
It is necessary for hydraulic oil to circulate in same direction if filled oil overpasses capacity of oil tank by 10%. The circulation time can be calculated by oil tank capacity and circular frequency of hydraulic pump.
$T = 5 \cdot V / Q$
T – Circular time (min)
V – Oil tank capacity Q –Circular frequency of the oil pump (l / min)
When the ram is at TDC (top dead center), refill oil into the oil tank until oil reaches the middle of the oil mark. (See from the rear of the oil tank.)
High power filter:
It is necessary to clean the filter core after 200 hours of running, then check and clean it every six months, or 1000 hours of running, or when the yellow indicator is on. Requirement of filtration net is 10μm. Oil shall circulate over 1 hour after filter core is changed.

Filter core shall be changed within 8 hours after the indicator is on.

Responsible personnel: operators or persons in charge.

1.6 Function test

Linear guide ways and ball screws test
Sensors signal test
Fixture of ram test Backgauge
transmission test Fastness of
backgauge test Adjustability of
dies test Connection of all bolts
test
Bending test of workpiece with various thickness

1.7 Oil Change

Hydraulic oil shall change every 1 years or 2000 hours of running. The change way is as follows:
--The ram moves to TDC (top dead center), and is chocked with two pieces of wood with same height.
--Open the cut-off valve at bottom of the oil tank, and discharge the hydraulic oil.
--Refill the hydraulic oil to the middle of oil mark. The ram (slide block) stops at TDC (top dead center).
--Hydraulic oil shall circulate for about 1 hour before restarting the machine.
--Replact a filter core of 10um after hydraulic oil circulation.
Recommended lubrication grease:
Mobil H46 hydraulic oil; Shell S2-M46 hydraulic oil; Total ZS46 hydraulic oil.

Responsible personnel: operators or persons in charge.