ASRS²
Automated Storage and Retrieval System


Overview

The ASRS² is an automatic storage and retrieval system for use in CIM cell, similar in design to most industrial automatic storage and retrieval systems. The ASRS² has 72 cells arranged in two parallel storage racks.

A dedicated Cartesian robot tends the two storage racks and transfers parts between storage cells and conveyor pallets stopped at the ASRS station. The robot is controlled by ACL Controller-B, a real-time, multi-tasking controller.

Mechanical Unit – Cartesian Robot

Number of axes	4 plus gripper
Construction	Robot: 3-axis Cartesian cantilever closed structure plus rotational (axis) movement of end effector.
	Storage unit: 72 cells in 2 arrays of 6x6

Axis Movement	Axis Range	Maximum Speed
Axis 1: horizontal translation (longitudinal)	1240 mm	50 m/min
Axis 2: vertical translation	950 mm	40 m/min
Axis 3: horizontal translation (lateral)	150 mm	
Axis 4: horizontal rotation	180°	

Load capacity	5 kg (11 lb)
Repeatabiliy	± 0.2 mm (0.008")
Actuators: Axes 1,2,3,4	DC servo motors
Transmission	
Axes 1,2,3	High precision ball screws
Axis 4	Harmonic drive
Feedback: Axes 1,2,3,4	Optical encoders
Grippers	Pneumatic, independently controlled
Weight (including racks and robot)	350 kg (770 lb)
Safety features	2 emergency switches on ASRS² unit. System can be connected to safety mats, lights, screens, etc. Emergency and servo power switches on controller front panel. Current limit and short circuit protection on all axes. Software protection: impact, thermic, limit.

Controller
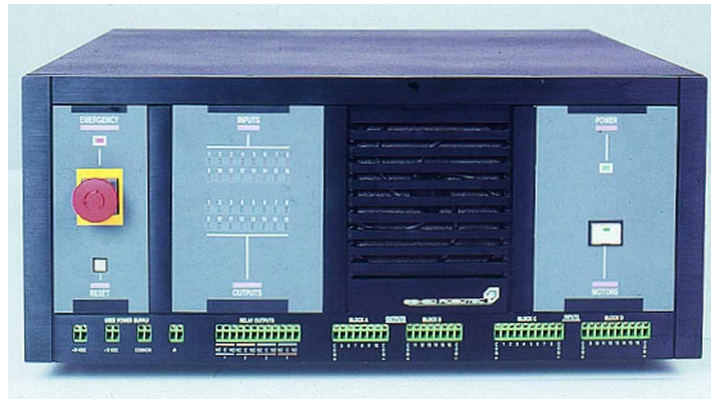
Type of Control	Stand-alone, real-time multitasking, PID, PWM
Number of axes	4 servo (expandable to 12 servo)
Path control	Point to point, continuous path
Inputs/Outputs	16 inputs (TTL, 12 V or 24 V, in two floating block), 16 outputs (4 relay, 12 open collector)
CPU	Motorola 68020, Motorola FPU – MC68881
Communication	2 RS232 channels (expandable to 10), Bi-directional parallel port (for printer or fast communication)
Dimensions	L=479 mm W=490 mm H=206 mm L=17" W=19.3" H=8.11"
Weight	36 kg (79 lb)

Front Panel
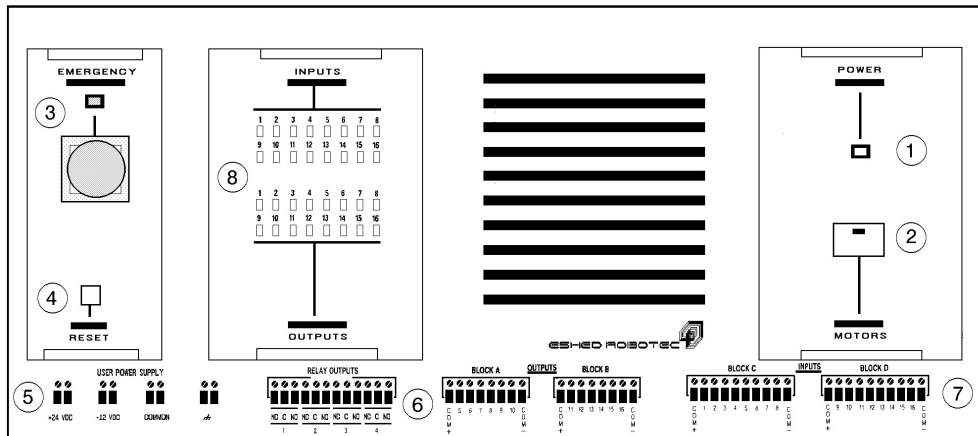
The front panel of the controller contains switches, LEDs and connection terminals for operator use.

POWER Switch

This switch is located at the back of the controller.

The POWER switch connects and disconnects 100/110/220/240VAC power to the controller. When the switch is turned on, the system is activated.

1 - POWER LED

This yellow LED lights up when the POWER switch is on. It indicates that power is being supplied to the controller.

2 - MOTORS Switch

This switch connects and disconnects DC voltage to all the connected motors. A green LED is embedded in the switch, and lights up when the switch is on. The controller's CPU keeps track of the switch's on/off status, and causes the message, motor power switch is off, to appear when the switch is not depressed.

3 - EMERGENCY Button and LED

When the EMERGENCY button is pressed, the following occurs:

- Motor power is disconnected; all motor movement stops the green MOTORS LED shuts off.

- The COFF (control off) state is activated. The red emergency LED lights up. An emergency message appears on monitor. All running programs (including BACKG) are aborted. The inputs and outputs are frozen in their current state. The user power supply remains in normal operation. HOME and CON cannot be activated. If it exists, the user program, EMERG, will be executed. Release the EMERGENCY button by turning it clockwise, as indicated by the arrows on the button. When the EMERGENCY button is released, the following occurs: An

exit emergency message appears on the monitor. The red emergency LED shuts off. The green MOTORS LED turns on. If it exists, the user program BACKG will start running.

To resume normal operation, do the following:

- Activate CON.

- Reactivate user programs. (All positions, including home, remain in memory.)

4 - RESET Switch

Like the RESET button on a PC computer, pressing this switch restarts the controller, as if it were being turned on.

5 - USER POWER SUPPLY Terminals

The USER POWER SUPPLY allows external devices in the user's applications to receive power from the controller. The controller's USER POWER SUPPLY has four terminals: +24VDC 2A regulated floating power supply. +12VDC 2A regulated floating power supply. Floating Common. Safety Ground.

6 - OUTPUT Terminals

The 16 outputs allow the robotic system to transmit signals to external devices in the robot's environment. The Controller-B has two types of outputs: 4relay outputs and 12 open collector outputs. Outputs may also be connected by means of the two Centronics 36pin connector (I/O BLOCK) at the rear of the controller.

7 - INPUT Terminals

The 16 inputs allow the robotic system to receive signals from external devices in the robot's environment. Inputs may also be connected by means of the two Centronics 36pin connector (I/OBLOCK) at the rear of the controller.

9 - INPUT and OUTPUT LEDs

16 green LEDs, corresponding to outputs 116, light up when the outputs are on.

16 yellow LEDs, corresponding to inputs 116, light up when the inputs are on.

Back Panel
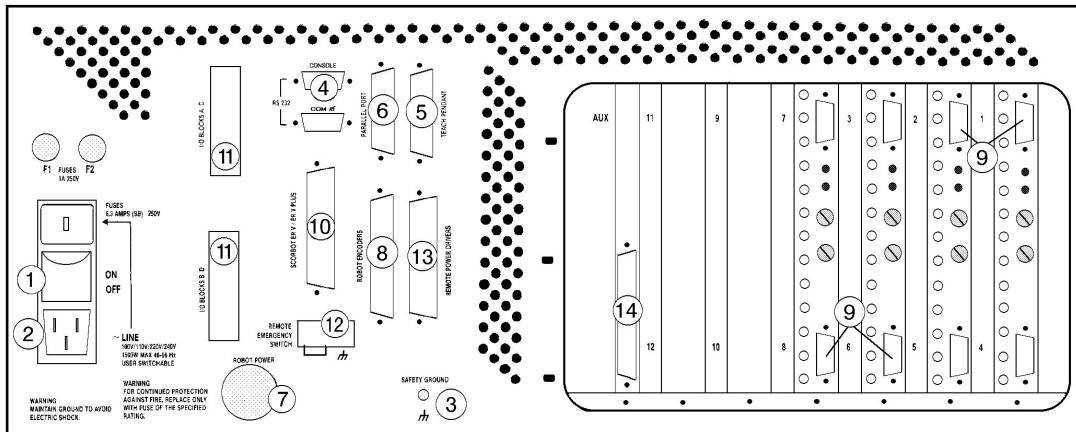
1. Power On/Off Switch,

2. Power Line socket 100/110/220/240VAC,

3. Safety Ground terminal,

4. RS232 channels: Console and COM 0, D9 male

5. Teach Pendant connector, D25 male

6. Parallel Port connector, D25 female

7. Robot Power connector, 19-pin round female

8. Robot Encoders connector, D37 male

9. Axis Driver connectors, D9 female

10. SCORBOT-ER Vplus connector; RESERVED, D50 male; DO NOT USE

11. I/O Block connectors, 36-pin Centronics female

12. Remote Emergency Switch terminal,

13. Remote Servo Driver Command Output connector, D50 male,

14. Auxiliary RS232 multiport (optional)

Cartesian (XYZ) Coordinates
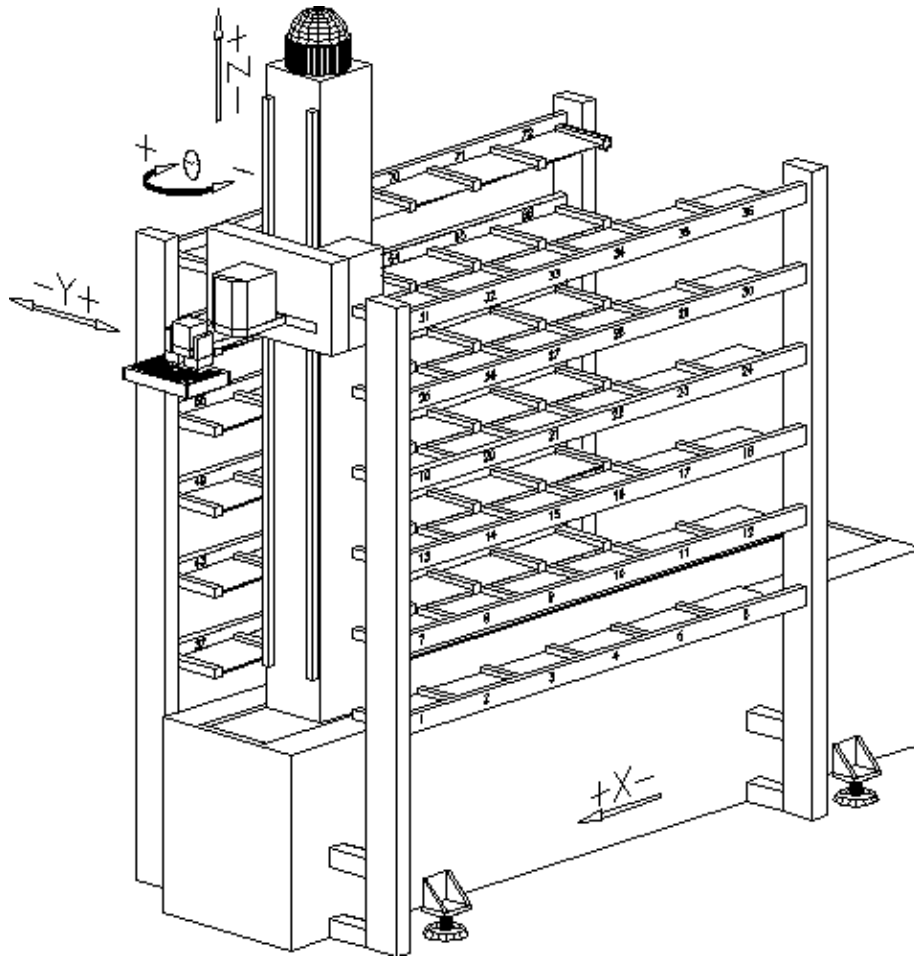
Working with ASRS²

The gripper is located at the top rear end of the of the ASRS².

Before moving the ASRS², check the air supply for appropriate functioning of the gripper.

Before homing the ASRS² be sure there is no template in the gripper and that the Y and θ axes are in center position.
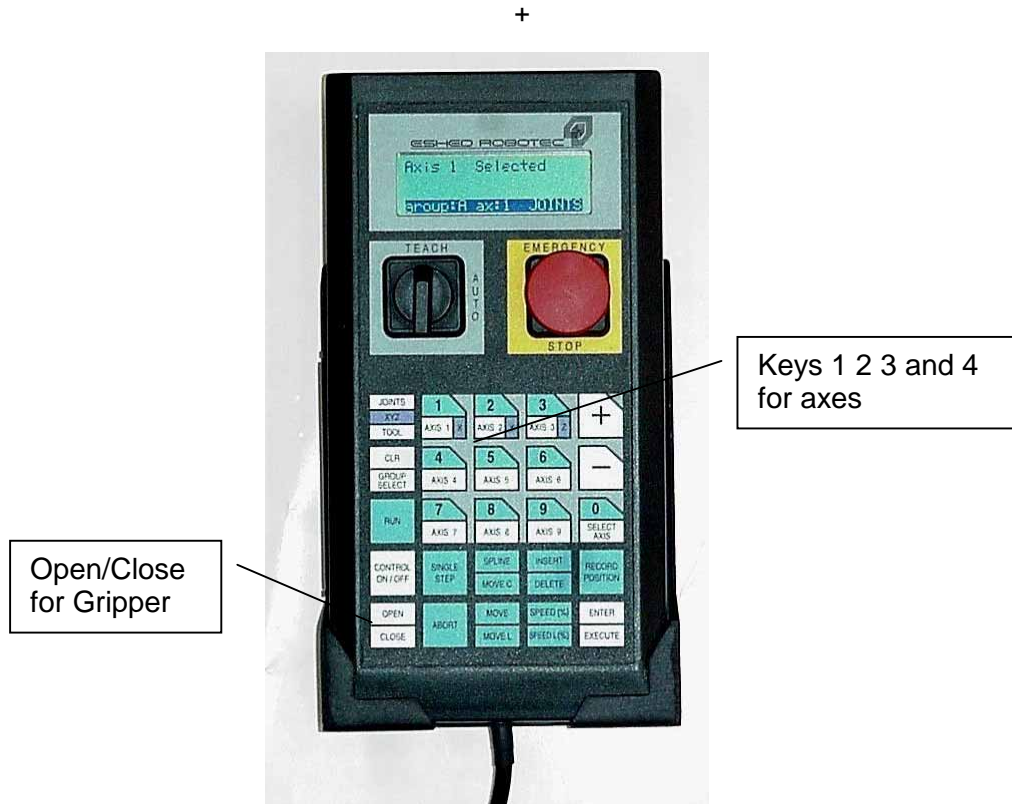
Homing Sequence

To home the ASRS, do either of the following:

- From the TP, run Program **1**, or

- Using ATS at the Station 1 PC, run the program **HOMES**.

At the end of the homing procedure the message HOMING COMPLETE should appear on the TP display and on the ATS screen.

Teach Pendant Operation

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Keys 1 2 3 and 4 for axes

Open/Close for Gripper

Using ATS at the Station 1 PC, enter the command **ATTACH CIM.**

Use care when controlling the ASRS² from the TP.

To control the ASRS² system from the TP, the TP must be opperating in JOINT mode (not XYZ).

The following keys are used to control the ASRS². (see diagram above).

ASRS² Axis	Use TP Key
X axis	Axis 1
Y axis	Axis 3
Z axis	Axis 2
θ axis	Axis 4
Gripper	Open/Close
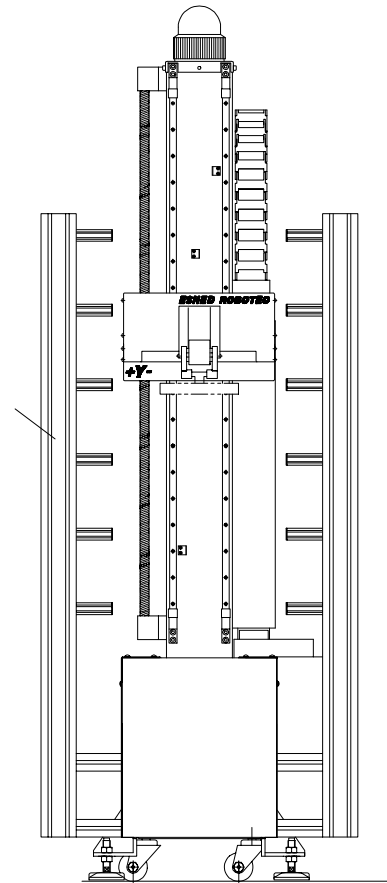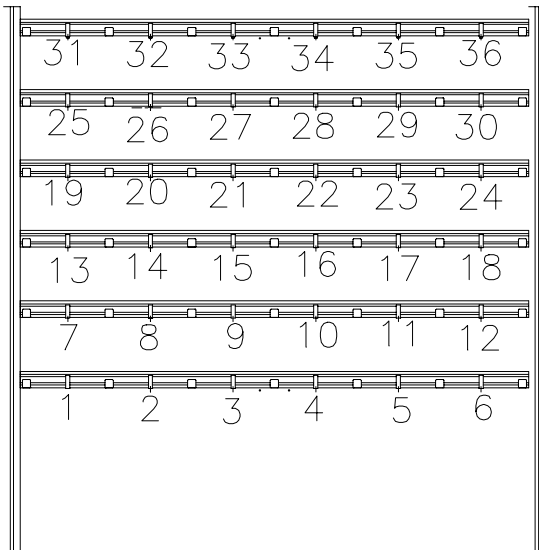
Right storage rack of ASRS²

The left storage rack is identical to the right one, the storage racks are numbered from 37 – 72.

In order to place the gripper at the pick / place location you have to know the index of the cell that you want to pick the template from. You also have to know the index of the place you want to place the template.

Robot Positions

There is a safety position CIM [499] where the gripper is placed in a front middle position.

For every pick/place position there are 3 additional positions that must be used to ensure successful manipulation.

CIM [400] + index.   Gripper above and beside the cell, facing front of ASRS.

CIM [300] + index.   Gripper above and beside the cell, facing the cell..

CIM [200] + index.   Gripper above the pick/place position, inside cell.

CIM [100] + index.   Gripper at the pick/place position.

Before manipulating the robot make sure that:

- There is air pressure in order to open / close the gripper.

- There is a template in the index that you want to take from.

- The place that you want to put the template is free.

The correct way to pick up a template is:

>   MOVE CIM [499]   (Safety position)
>   (Make sure the gripper is open.)
>   MOVE CIM [400] + index.
>   MOVE CIM [300] + index.
>   MOVE CIM [200] + index.
>   MOVE CIM [100] + index.
>   CLOSE the gripper.
>   MOVE CIM [200] + index
>   MOVE CIM [300] + index
>   MOVE CIM [400] + index
>   MOVE CIM [499]   (Safety position)

Programming Tasks

ATS

Activate ATS (command line options).

Screen overview (command screen, backup screen, etc.)

ACL Programming using ATS

DEFP, DIMP	Define positions in ACL
HERE	Teach absolute positions in ACL
TEACHR	Teach relative positions in ACL
LISTP	List defined positions
LISTPV	List position vector
DELP	Delete positions
MOVE, MOVED	Move to positions in Joint mode
MOVEL, MOVELD	Move to positions in Linear mode

Editing a Program using ATS

EDIT   Enable Edit mode

EXIT   Quit Edit mode

Exercise

Write a small program that will move the $ASRS^2$ between two points, changing the speeds and motion type during the program.

Exercise

Write a small program that will pick a template from one location and place it on a different location, changing the speeds and motion type during the program.

ACL Programming using ACLoff-line

Activate ACLoff-line (command line options).

Screen overview (download screen, edit screen, ATS screen)

Editing a Program using ACL-Offline

EDITOR   Enable Edit mode

DOWNLOAD   Download program to the controller

Exercise

Write a small program that will move the $ASRS^2$ between two points, changing the speeds and motion type during the program. Download and execute the program.

Exercise

Write a small program that will pick a template from one location and place it on a different location, changing the speeds and motion type during the program. Download and execute the program.