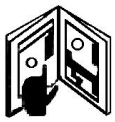
E-Bend Master

Operation Manual of Bend Workstation Control System

V1.00

	• Before using this product, please read this document carefully and follow all safety instructions and main text. • The installation, operation, and maintenance of this product and other equipment shall be performed by personnel authorized by our company through corresponding training.
	• Make sure to deliver this operation manual to the personnel performing the actual operation.
	• For any questions about this document or after-sales support for this product, please contact us using the information on the back cover. We are committed to serving you.

Revision History

order number	edition	date	explain
1	V1.00	2025-9-29	new document

catalogue

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P r e f a c e

Summary

This manual is designed to guide users on how to utilize this product in conjunction with and control the bending workstation for production.

This manual covers the installation, configuration, and usage of this product.

Reader target

This document is primarily intended for the following individuals:

- ESTUN Technical Service Engineer
- debugging engineer of machine tool manufacturer

Brief Introduction of the content

This document consists of five chapters and an appendix, with the following summaries of each chapter.

chapters and sections	content
Chapter 1 About E-Bend Master	The functions and usage of E-Bend Master are introduced.
Chapter 2 Production Operation	Guide users on how to use the production operation interface for production.
Chapter 3 Production Statistics	Guide users on how to use the production statistics feature to view production reports.
Chapter 4 Status Monitoring	Guide users to use the status monitoring feature to check the robot's IO status in real time.
Chapter 5 System Settings	Guide users on configuring system parameters.

Agree on

symbolic convention

The following safety signs may appear in this article, and their meanings are as follows.

symbol	explain
	danger sign 。 Failure to comply with the safety instructions associated with this mark may endanger personal life and health.
	warning signs 。 Failure to comply with the safety instructions associated with this mark may significantly endanger the environment and the safety of the device.
	have got to do 。 Users must follow the instructions related to this logo.
	Do not do. Users must follow the instructions related to this logo.
	Description or hint. This mark indicates that the information helps users understand the main text more easily or emphasizes and supplements it.

Chapter 1 About E-Bend Master

1.1 Product presentation

The E-Bend Master is an integrated master control system specifically designed for industrial robot bending workstations. Addressing industry pain points such as isolated robot-bending machine interactions and frequent manual interventions, this system achieves unified monitoring, adjustment, and management, serving as the workstation's "digital brain".

Core advantages and features

- Digital Twin and Real-Time Monitoring: Leveraging digital twin technology, the system accurately replicates the on-site layout at a 1:1 scale, enabling real-time synchronization of robot movement paths with equipment status. This allows users to conduct visual inspections without entering the equipment enclosure.
- Remote teaching-free interaction: Operators can bypass physical teaching devices and CNC panels, performing remote spot operations, step switching, and real-time adjustments to angles and X-axis compensation values directly from the main control terminal, significantly improving debugging efficiency and operational safety.
- Flexible production management: Supports one-click offline programming data distribution, with features including workpiece file management, loading/unloading diagram archiving, and automated mold allocation. For multi-variety and small-batch production, enables quick line switching via QR code scanning.
- Production transparency and data traceability: The system automatically tracks core KPIs including processing cycles, yield rates, and equipment utilization rates, delivering multi-dimensional production statistics and detailed historical alarm records to support production optimization decisions.

E-Bend Master adheres to the design principle of 'simplicity and practicality,' featuring an intuitive human-machine interface that lowers the barrier to automated operations, helping enterprises achieve intelligent, efficient, and transparent bending production.



图 1-1 product appearance

1.2 Function Introduction

The E-Bend Master inherits ESTUN's classic operation philosophy, enabling effortless control of robotic bending workstations through its intuitive interface. Featuring a user-friendly design, intuitive operation, and precise functionality, it offers the following control capabilities:

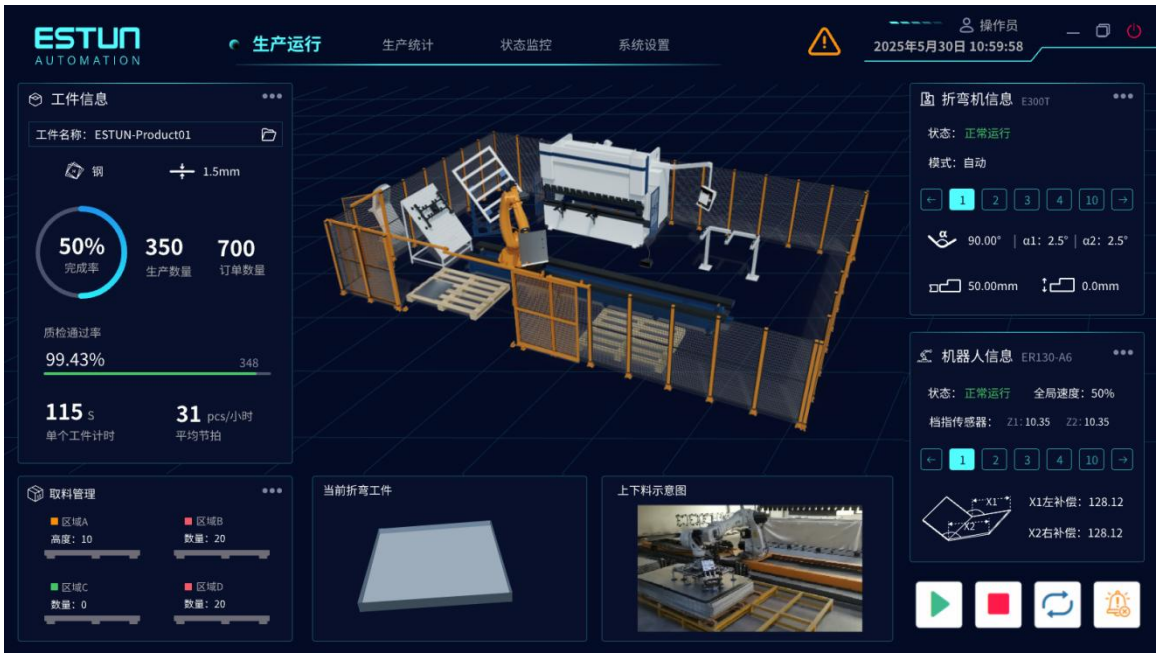
- ❑ Online monitoring: 1:1 recreation of workstation scenarios with real-time robot status tracking.
- ❑ Motion trajectory: Synchronize the robot's motion trajectory in real time.
- ❑ Instant Positioning: Real-time location visualization with instant movement, effectively reducing safety risks.
- ❑ Intelligent palletizing: dynamically manages pallet data to enhance production efficiency.
- ❑ Dynamic Information Management: Intelligent management of order information to optimize sheet metal utilization.
- ❑ Processing rhythm: Ensure accurate processing rhythm and arrange production orders rationally.
- ❑ Flexible bending: External interruptions are prohibited during the bending process.
- ❑ Online adjustment of bending size: parametric online adjustment of bending size of sheet metal
- ❑ Supports remote spot control, bend point adjustment, and teaching.
- ❑ Support one-click restore to original;
- ❑ Support one-click robot status switching
- ❑ real-time monitoring of the robot and the bending machine status;
- ❑ It has automatic alarm and one-key reset mechanism;

- ❑ Exceptional rapid response and positioning to ensure stable production line operation.
- ❑ Visual display of physical and virtual IO signal partitioning;
- ❑ Supports queries by year, month, week, day, or custom time range, and by production order number.
- ❑ It provides users with decision support for production optimization by calculating total number of statistics, single piece time, average production beat, good rate, etc.

Chapter 2 Production Run

The production operation interface serves as the core control center of this system, primarily designed for field operators and process engineers. It enables centralized monitoring of the bending machine, robots, and material status, supporting the initiation, monitoring, and fine-tuning of production processes without operating the teaching display.

2.1 Main interface



Layout Guide

The interface is divided into five main functional areas, enabling synchronized display of data and visual status.

- ❑ Workpiece information (top left): Displays basic information of the current machining task (model, material, plate thickness) and production statistics (progress, cycle time, pass rate).
- ❑ Digital twin monitoring (center): 1:13D scene reconstruction of workstation layout, displaying real-time motion trajectories of robots and bending machines.
- ❑ Material retrieval management (lower left): Monitor the height and quantity of materials in zones A, B, C, and D to ensure consistent retrieval.
- ❑ The device interaction area (right side) provides real-time monitoring for modifying bending machine step parameters and tracking the robot's operational status, including speed, sensor readings, and coordinate compensation.

- Auxiliary and Control (Bottom): Includes 3D previews of the current workpiece, real-time loading/unloading photos, and global operation buttons (Start, Stop, Loop Reset, Alarm Clear).

Core Functional Features

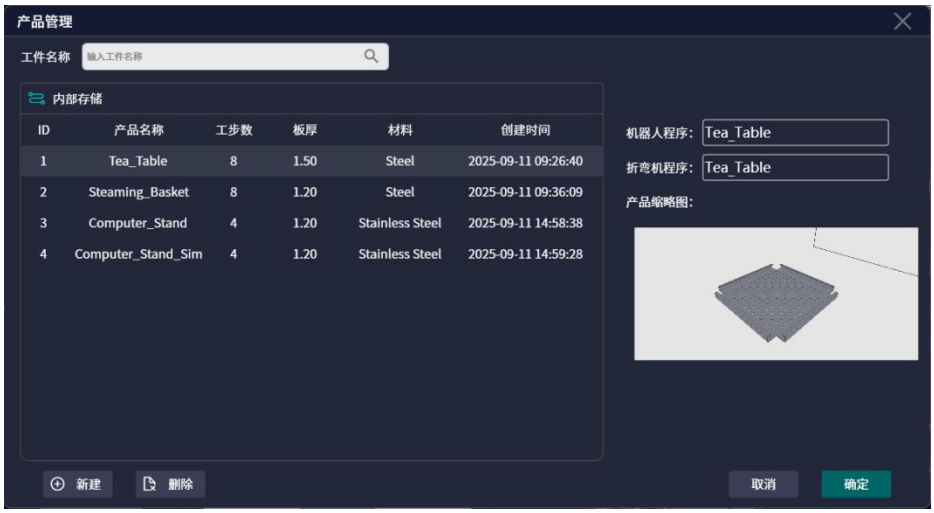
- Production status transparency: The system automatically calculates the timing and average cycle time of individual workpieces, and updates the order completion percentage in real time, enabling operators to monitor production progress.
- Visualized inspection: With digital twin technology, operators can monitor the bending process in 360° within the system, enabling real-time status verification without physical access to the facility.
- Online parameter fine-tuning: Users can directly adjust the bending compensation angles (α1, α2) and X-axis position on the right side of the interface, with updated parameters being instantly transmitted to the controller.
- Alarm and Reset: When any device malfunctions, the alarm status in the upper-right corner of the system will change. Operators can clear resolved alarms with a single click using the reset button in the lower-right corner.

2.2 Product Management

This module is primarily used to manage the workpiece models, associated programs, and order processing parameters stored in the system. Users can utilize this feature to quickly switch between different products and view process parameters.

2.2.1 Workpiece Management

Click the folder icon in the "Workpiece Information" area of the Production and Operation interface to access the "Product Management" interface.



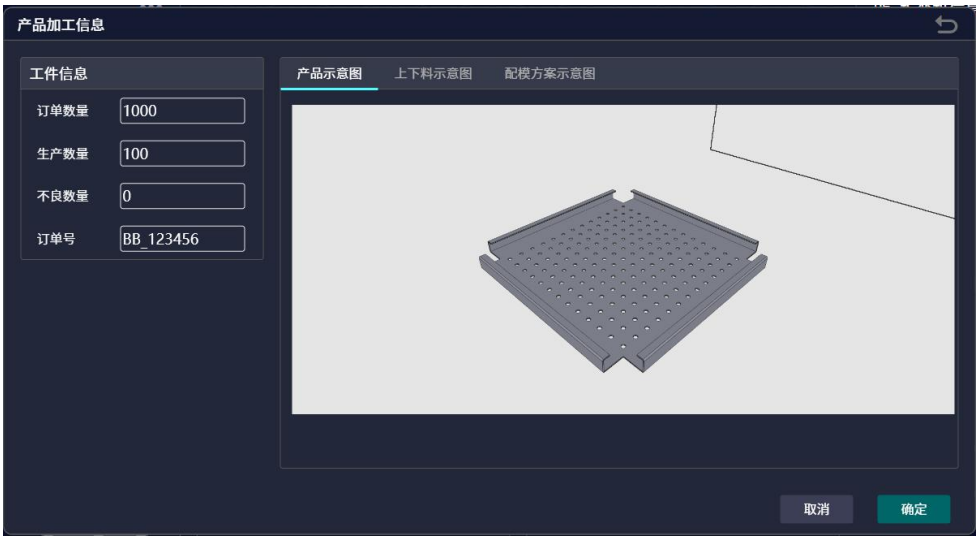
- ❑ Product list query: The left side of the interface displays all internal storage workpiece information, including ID, product name, total steps, plate thickness, material, and creation time. Users can quickly filter by workpiece name using the search box at the top.
- ❑ Program Association Management: Select any product in the list, and the program name of the robot and the bending machine associated with it will automatically appear on the right, along with a 3D thumbnail for verification.
- ❑ Product switch and new creation:
  - ➢ Process switching: Select the target row and click 'OK' to load all process data of the product to the main interface.
  - ➢ Create or delete: Create new workpiece files manually or delete expired process records.

2.2.2 Product Processing Information

Double-click the selected row in the product management list to open the "Product Processing Information" details page. The left side displays real-time core order statistics (order quantity, produced quantity, defective quantity, and order number).

Product diagram

Display the 3D model of the current workpiece after forming to help the operator visually confirm the finished product style and avoid confusion with similar workpieces.



Loading and unloading diagram

The interface realizes the wireless interconnection between the mobile terminal and the central control system through the QR code.

- ❑ Procedure: Connect your phone to a designated WiFi (e.g., Estun-BendingCell). After scanning the QR code, you can directly upload photos of the on-site palletizing, palletizing plans, or

specific material handling requirements to the system, enabling quick archiving of process data and on-site verification.



Schematic diagram of configuration scheme

This module provides intuitive graphical tools for managing and configuring bending machine die installation schemes. Through this interface, operators can ensure

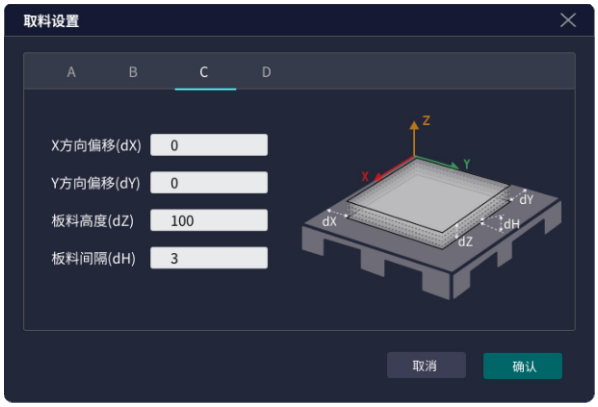


that the die layout in the software matches the actual arrangement on the physical machine tool.

- Graphical layout: The top ruler visually displays the mold's installation position and span on the bending machine (e.g., positional offset of a 1000mm-length mold).
  - Position preview: The installation span and relative position of the upper mold (green block) and lower mold (blue block) are clearly displayed on the scale.
  - Interactive drag-and-drop: Users can directly select the mold block on the ruler with the mouse and quickly adjust the physical installation position of the mold on the machine tool by dragging left and right. After adjustment, the "Position" value in the parameter table below will update synchronously.

- Detailed Parameter Table: This table provides a comprehensive record of key parameters including mold type (upper/mold bottom), mold name, installation coordinates, height, angle, radius, and V-groove.
  - Add: Click the "Add" button on the right to select and add new upper or lower die segments from the die library.
  - Delete: Select a mold record in the list and click the ** "Delete" ** button to remove it from the current mold configuration.
- Program synchronization: Supports updating or downloading programs for robots and bending machines to ensure consistency between offline-generated programs and on-site running programs.

2.3 Material Management



The material handling module configures the physical parameters for robotic workpiece retrieval from the pallet. By precisely setting the offset and stacking parameters for each material zone, the system automatically generates accurate robotic grasping trajectories, ensuring that suction cups or grippers maintain correct grasping depth even in multi-layer palletizing scenarios.

Go to material setting

In the "Material Retrieval Management" area at the lower left of the production interface, click the "More" button at the upper right to open the "Material Retrieval Settings" dialog box.

Material Taking Parameters

The material retrieval interface features four tabs (A, B, C, D) above, each corresponding to a distinct retrieval zone on the workstation. Users must configure independent parameters for each zone based on its actual placement.

Parameter name	function declaration	Set suggestions
X-axis offset (dX)	Set the fine-tuning amount of the center point of the material center along the X-axis of the coordinate system.	If the robot's gripper deviates from the workpiece center, this value can be used for positive or negative correction.
Y-axis offset (dY)	Set the fine-tuning amount of the center point of the material center along the Y-axis of the coordinate system.	When used with dX, ensure the suction cup precisely covers the workpiece's optimal stress-bearing area.
Sheet height (dZ)	Set the total height of workpieces stacked on the current pallet (unit: mm).	Measure the total distance from the worktable surface to the top sheet metal. This value determines the starting height for the robot to begin searching for the workpiece.
Sheet spacing (dH)	Set the thickness of a single sheet or the spacing between adjacent sheets (unit: mm).	This parameter is critical. The system automatically reduces the grab height based on the dH value after each product grab to ensure the accuracy of the next grab.



- Regional independence: Parameters in regions A, B, C, and D do not interfere with each other. Before switching production modes (e.g., switching from region A to region C), verify that the parameters in the corresponding tabs are correct.
- Dynamic linkage: The sheet metal height and spacing specified in the 'Material Retrieval Settings' will directly affect the percentage progress and thermal map display in the main interface's' Material Retrieval Management'.
- Coordinate calibration: It is recommended to perform a low-speed trial run during initial setup or when switching to new workpiece specifications, to verify if the dX and dY offsets meet the required gripping parameters.
- Save to take effect: After completing the parameter settings, click the "Confirm" button in the lower right corner to send the settings to the controller and make them effective.

2.4 Bending machine information

The bending machine information module is located in the upper right corner of the production interface. It primarily monitors the machine's real-time operational status while enabling remote step switching and fine-tuning of process parameters, allowing remote control even when the operator is not physically present.



Status Monitoring and Quick Access

- Real-time status display: Clearly shows the current operating status of the bending machine (e.g., normal operation, stopped, alarm) and processing mode (e.g., automatic, manual, single-step).
- Quick access: Click the More button (...) in the upper-right corner of the area to instantly open the Product Processing Information window for your current workpiece (see Section 2.2.2), allowing you to quickly verify the mold design or schematic.

Workstation Management and Switching

The total number of steps and the number of steps being processed are displayed synchronously.

- Step switching: When the equipment is idle, users can directly click the step number buttons (e.g., 01,02,03...) on the interface to switch between steps.
- Real-time feedback: After switching the process step, the bending angle icon and value at the bottom of the interface will update to the preset angle for that step.

Angle compensation and remote distribution

To address machining precision deviations, the system features angle compensation functionality, eliminating the need for operators to enter the workstation enclosure for manual adjustments.

- Compensation parameter adjustment: When the system is offline, users can directly click the input fields to modify the values of α1 (left angle compensation) and α2 (right angle compensation).
- One-click transmission: Enter the target compensation value and press Enter to instantly transmit the parameters to the CNC system of the bending machine via the communication protocol.

For production safety, the work step switching and compensation modification functions are only active when the bending machine is in the 'stopped' state.

2.5 Robot Information

The robot information module is located in the lower right corner of the main interface, providing real-time monitoring of the robot's operational status, sensor feedback, and adjustment of core process parameters.



Real-time monitoring parameters

- Status display: Shows the robot's real-time status (e.g., running, stopped, paused) and current enabled state.
- Global speed: Shows the robot's current speed percentage.
- Finger-stop sensor values: Real-time display of feedback values for the rear finger-stop Z1 and Z2.

Work step and compensation adjustment

- Step monitoring: Displays the current bending step number (e.g., 01,02...) being performed by the robot.
- X1/X2 compensation modification:
  - When the system is offline, users can directly click the 'X1 Left Compensation' or 'X2 Right Compensation' input fields to adjust the values.
  - Press Enter after modification to send the compensation value directly to the robot controller.

- Dynamic speed adjustment: Global speed can be modified in real time during operation. Press Enter to apply the new value.

2.5.1 Robot operation

Click the More button in the upper right corner of the robot information area to open the Robot Operation pop-up window. This window allows you to switch the robot's working mode and manually adjust the gripper position with precision.



Pattern enabling control

Switch the robot's control logic state quickly with the top icon:

- Mode selection: Switch between manual and automatic mode.
- Mode: Switch between single-step and continuous operation.
- Enable switch: controls the robot motor's enable or disable state.

Tool Center/Grip Adjustment

The interface center provides graphical arrow keys for manually controlling the displacement of the robot tool center point (TCP).

- Adjust mode:
  - Tap: Hold the arrow keys to move continuously.
  - Move: Click to move the set distance or angle.
- Parameter settings: Users can customize the stroke distance (mm), angle (°), and point speed (%) below.

2.5.2 Demonstrator operation

Click the ** "Teaching Device" icon** in the "Robot Operation" pop-up window to enter the virtual teaching device interface. This module provides full support for manual robot operation without a physical teaching device.



Coordinate System and Point Motion Control

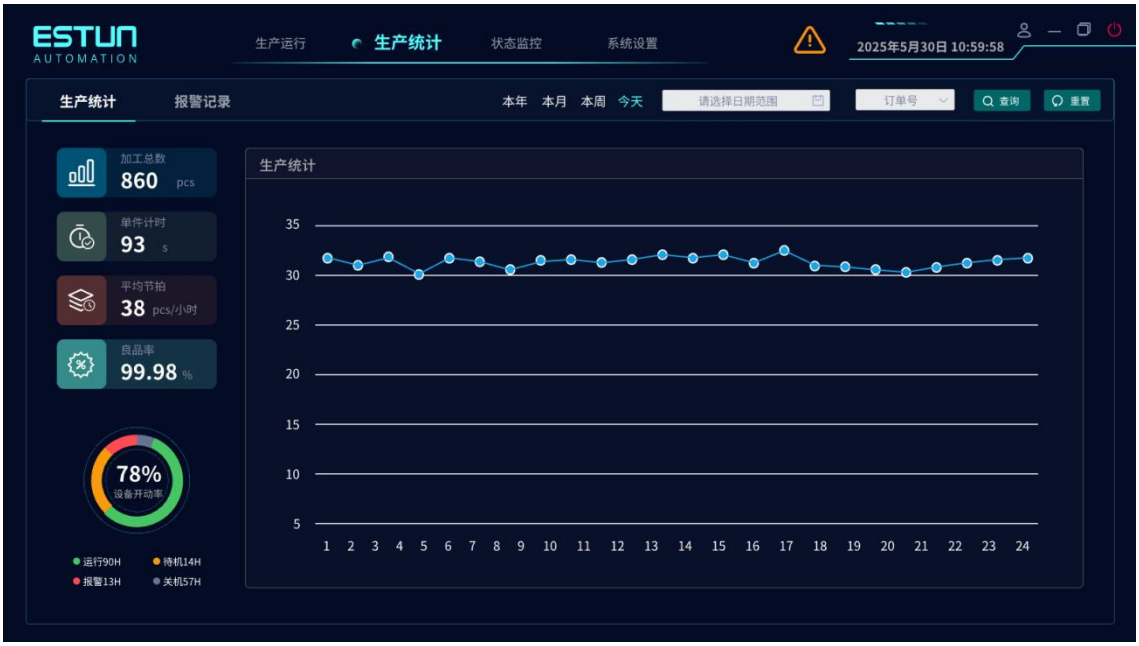
Users can switch between different coordinate systems based on their operational habits for point movement.

- ❑ World coordinate system: controls linear displacement of the X, Y, and Z axes and the A, B, and C attitude angles.
- ❑ Tool coordinate system: Moves based on the current tool tip direction.
- ❑ Joint axis operation: Independently control the rotation of six joint axes (A1 to A6) in the robot.

Chapter 3 Manufacturing Statistics

3.1 Manufacturing statistics

The production statistics interface is primarily used for multidimensional analysis of historical production data from workstations. Managers can use this interface to evaluate production efficiency, monitor product quality, and analyze equipment utilization rates, providing data support for optimizing production plans.



Data Query and Filter

The top of the interface provides flexible filtering tools to quickly locate specific production data:

- Filter by time dimension:
  - Shortcut key: Switch between viewing data for this year, this month, this week, or today with one click.
  - Custom time range: Use the date range selector to specify the start and end dates of the query.
- Filter by order number: Select specific order numbers from the drop-down menu to track processing details for a specific batch of products.
- Operation buttons: After setting the filter conditions, click "Query" to update the data, or click "Reset" to restore the default state.

Core Performance Indicators (KPIs)

The left side of the interface displays four core metrics in real time as cards within the current filter range:

- Total processed: The cumulative number of workpieces completed during the statistical period (e.g., 860 pcs).
- Single-piece timing: the actual processing time of the most recent workpiece (e.g., 93 s).
- Average beat: The system calculates the average production rate (e.g., 38 pcs/hour) to evaluate production line throughput.
- Quality rate: Displays the percentage of qualified products (e.g., 99.98%), providing an intuitive reflection of production quality.

Device utilization analysis

The pie chart in the lower left corner displays the equipment's operational rate and time distribution of various states, helping identify production bottlenecks.

- Run: The actual time the device is bent.
- Standby: The time the device is powered on but not running a program.
- Alarm: Duration of equipment downtime due to abnormal failure.
- Power off: the time the device is not powered on.
- Data reference: The center of the ring displays the total operational percentage (e.g., 78%), with the specific hours for each status listed below.

Production Trend Chart

The large-scale line chart at the interface center dynamically displays fluctuations in production output.

- X-axis: represents time (e.g., 24-hour period or sequential dates).
- Y-axis: represents the output value.
- Function: Users can visually monitor production stability across different periods by observing the fluctuations of the line. If output drops significantly during a period, the "Alarm Record" can be used to check for frequent failures.

3.2 Alarm record



Alert Query and Filter

Users can quickly filter alarm data using the filter tool at the top of the interface based on their troubleshooting needs:

- ❑ Time dimension: Supports filtering by "This Year", "This Month", "This Week", "Today", or "Custom Date Range".
- ❑ Action: After setting the conditions, click ** "Query" to update the list; click "Reset" to clear the current filter and restore the default display.

List information description

The alarm list provides a detailed record of key parameters for each abnormal event:

- ❑ Level: Visualizes severity through icons. Red indicates critical failures or downtime, yellow indicates general warnings, and blue/green indicates status notifications or operation records.
- ❑ ID: The unique code (e.g., A.902, A.853) assigned to the alarm in the system, enabling quick reference to the equipment's technical manual for troubleshooting.
- ❑ Device type: Identifies the alarm source, such as "robot" or "bending machine".
- ❑ Alarm event: Briefly describe the fault (e.g., "2D vision photo command failed to trigger!" or "PLC: Low Air Pressure").
- ❑ Alarm time: Accurately records the exact date and time when the alarm occurred.

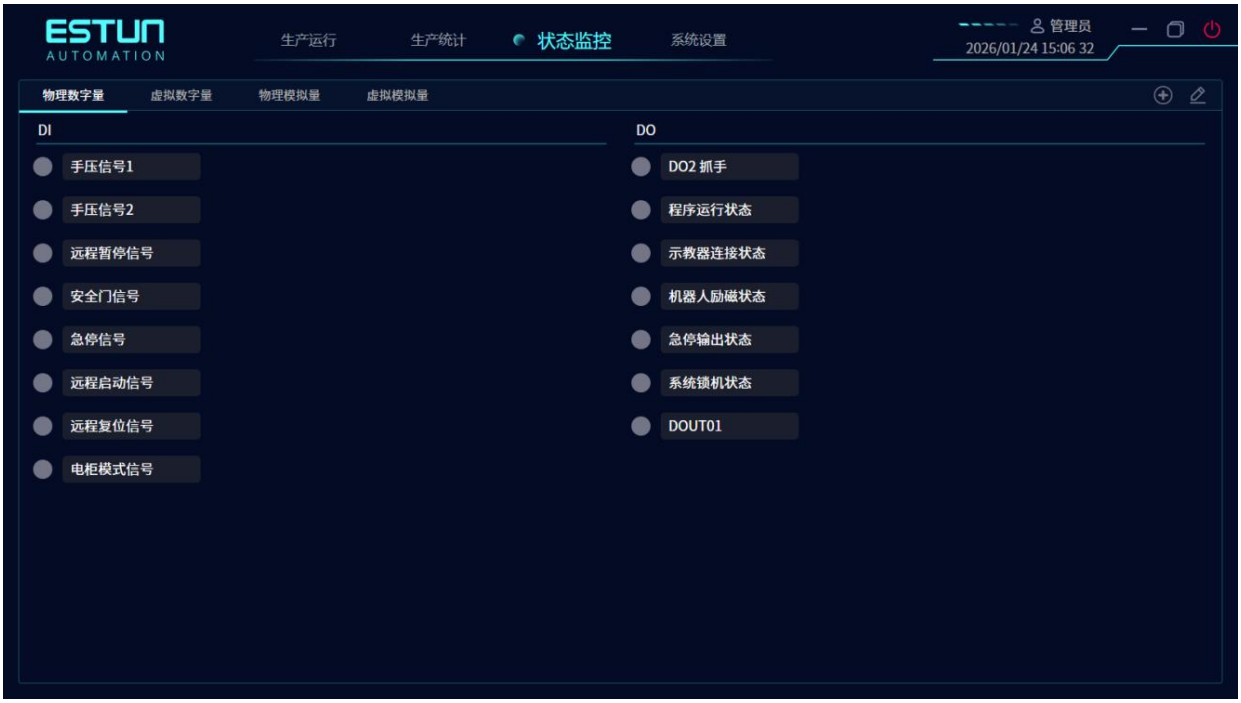
Chapter 4 Condition Monitoring

The status monitoring interface serves as the system's "neural hub" feedback zone, primarily used for real-time monitoring of robot signal states. Through this interface, users can customize monitoring variables and perform forced interactions on output signals, enabling remote troubleshooting and functional verification.

4.1 Interface Layout and Categories

Tap "Status Monitor" in the bottom navigation bar to enter this interface. The system categorizes monitoring data into four types, which can be switched via the top tab:

- ❑ Physical digital quantity: corresponds to the actual switch signal (DI/DO) at the terminal block of the robot control cabinet.
- ❑ Virtual digital quantity: A Boolean signal internally defined in the robot program logic.
- ❑ Physical analog signals: such as pressure sensors, voltage, etc.
- ❑ Virtual analog quantity: A floating-point or integer variable calculated internally by the robot program.



4.2 Monitoring Variable Management

Users can flexibly configure signal points to display on the interface according to actual process requirements.

Add monitoring points

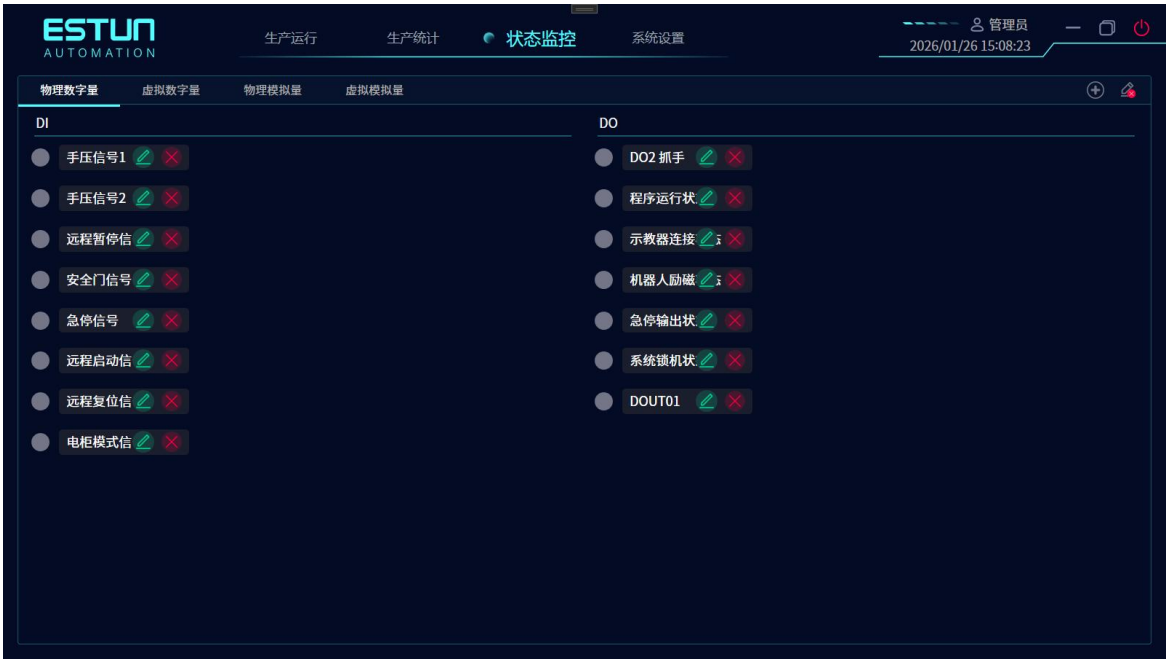
1. Go to the corresponding monitoring category interface (e.g., physical digital quantity).
2. Click the "+" button in the upper right corner to open the Add Variable dialog.
3. Configure the following parameters in the pop-up:
   - Data point description: A custom display name (e.g., Remote Start Signal).
   - Data point index: the address index in the hardware or logic (e.g., 1).
   - Data point type: Select whether the signal is input or output.
4. Click Add to complete the configuration.



Edit and delete points

To modify existing variables, enter Edit Mode:

1. Click the Edit (Pencil icon) next to the plus sign in the top-right corner. All variable cards will display green edit icons and red delete icons.
2. Edit: Click the green icon to open the edit pop-up and reset the point name and index.
3. Delete: Click the red icon to remove the variable directly from the current monitoring list.
4. Exit: Click the Edit icon in the upper right corner again to exit edit mode and save changes.



Signal Monitoring and Remote Operation

The system visually indicates the signal's real-time on/off status through color:

- ❑ Gray: indicates a signal of 0 (off/reset state).
- ❑ Green: indicates a signal of 1 (closed/set).

Digital Output (DO) Forced Operation

In non-edit mode, the operator can remotely control the output type of digital quantities (ensure security permissions are met):

1. Directly click the target digital variable card (e.g., DO2 gripper).
2. In the "Digital Output Operation" window:
3. Click "Set": Forces the signal output to 1.
4. Click Reset: Forces the signal to reset to 0.
5. After completing the operation, click the X in the upper right corner to close the pop-up.





Safety note: Before performing the "set" operation, ensure the workstation is unoccupied and that the operation will not cause the product to fall or collide with other equipment.

Chapter 5 System Settings

The system settings interface serves as the core configuration hub for E-Bend Master. This chapter focuses on configuring communication protocols and operational benchmarks between workstation hardware terminals (robots, bending machines) and the offline bending software (E-Bend Studio), ensuring closed-loop logic and stable communication across the entire station.



5.1 Robot Parameter Settings

This module establishes the physical connection between the main control system and the robot control cabinet, with a predefined safe operating range.

communication junction

- ❑ IP address: Enter the static IP address of the robot control cabinet (e.g., 192.168.60.68).
- ❑ Ping test: Click this button after entering the address to automatically check network connectivity.

sensor reference value

Initial Reference Point for Calibrating Finger Sensor of Robot

- ❑ Sensor reference value 1/2: Set the reference offset for the Z_1 and Z_2 axes (e.g., 6).

communication junction

Users can customize the logical axis and movement direction for the up, down, left, and right arrow keys in the interface:

- Point movement coordinates/direction: Specify the corresponding X, Y axes and positive/negative directions.
- Demonstration speed range: Set the speed limit in manual mode (e.g., 1~10%).

safe starting position

- Return-to-zero safety position: Sets the X, Y, and Z coordinates for the robot during the return-to-zero operation.
- The three-axis allowable range (minimum and maximum values) prevents collisions during zeroing.
- Home Position: The preset initial standby posture of the robot, recording the specific angle values of each joint from A1 to A7.

5.2 OPUCA Set Up

This module is responsible for high-frequency data exchange with the bending machine's CNC system and the mold library.

- Server URL: Enter the OPCUA server access path for the bending machine (e.g., opc.tcp://192.168.60.88:4840/).
- Machine tool die area parameters:
  - Tooling area width: Sets the total effective width for installing tooling on the machine tool.
  - Machine tool die area spacing: Set the physical interval between die installation positions.

5.3 E-Bend Studio Communication Settings

This module facilitates data exchange between the master control system and the offline programming simulation software E-Bend Studio, supporting remote program push and download for offline operations.

- Local IP: Display and configure the IP address of the industrial PC running this master control software (e.g., 192.168.56.1).
- Socket port: Specifies a dedicated communication port for data reception (e.g., 39151).

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