

Electronic Component Pick-and-Place Machine

Description

An ultra-high-speed surface mount technology (SMT) machine that places electronic components on PCBs. Uses computer vision for precision placement and operates at speeds up to 50,000 components per hour.

Tags

Create tags for the following parameters. Choose a fitting name and hierarchical structure for the tags.

- Machine Name: The name of the machine - "ChipPlace Lightning #4"
- Machine Serial Number: A unique identifier of the production machine - "CPL4000-2023-004"
- Plant: The plant where the machine is located - "Dresden Electronics Manufacturing"
- Production Segment: The production segment where the machine is located - "Automotive Electronics"
- Production Line: The production line where the machine is located - "SMT Assembly Line 5"
- Production Order: The name / number of the current production order. Is empty if there is no active order - "PO-2024-ECU-9981"
- Article: The name / number of the article that is being produced. Is empty if there is no active order - "ART-ECU-V2-MAIN"
- Quantity: The # of PCBs that need to be produced to fulfill the order - "8,000 PCBs"
- Target Placement Speed: The target placement speed based on the current article - "42,000 CPH"
- Actual Placement Speed: The actual placement speed (components per hour) - "41,847 CPH"
- Target Placement Accuracy X: The target placement accuracy in X direction - " $\pm 15 \mu\text{m}$ "
- Actual Placement Accuracy X: The actual placement accuracy in X direction for the last component - " $\pm 12.3 \mu\text{m}$ "
- Target Placement Accuracy Y: The target placement accuracy in Y direction - " $\pm 15 \mu\text{m}$ "
- Actual Placement Accuracy Y: The actual placement accuracy in Y direction for the last component - " $\pm 13.7 \mu\text{m}$ "
- Vision Processing Time: The time required for component recognition and alignment - "28.5 ms"
- Head Position X: The current X position of the placement head - "147.823 mm"
- Head Position Y: The current Y position of the placement head - "89.456 mm"
- Target Head Acceleration: The target acceleration for head movement optimization - "2.8 G"
- Actual Head Acceleration: The actual measured head acceleration - "2.75 G"
- Vacuum Pressure: The vacuum pressure for component pickup - "-78.5 kPa"
- Target Cycle Time: The target cycle time per component placement - "0.72 seconds"
- Actual Cycle Time: The actual cycle time of the last component placement - "0.73 seconds"
- Current Nozzle Type: The currently active nozzle type - "Nozzle Type 4" (Type 1-8)
- Vision System Pass Rate: The percentage of components passing vision inspection - "99.7%"
- Feeder 01 Component Count: The remaining components in feeder position 01 - "4,847 pcs"
- Feeder 02 Component Count: The remaining components in feeder position 02 - "12,456 pcs"
- Feeder 03 Component Count: The remaining components in feeder position 03 - "8,923 pcs"
- Feeder 04 Component Count: The remaining components in feeder position 04 - "156 pcs"
- PCB Index Current: The index number of the current PCB being processed - "PCB #2,847"
- Machine Status: The current operational status of the machine. The options are: (Stopped/Starting/Running/Stopping/Error/Maintenance/Setup) - "Running"

- Current Operation: The current placement operation phase - "Placing" (Loading PCB/Placing/Vision Check/Unloading PCB/Nozzle Change)
- Components Placed Good: The total number of components successfully placed since startup - "12,847,569 components"
- Components Failed Pickup: The number of components that failed pickup since startup - "2,847 components"
- Components Failed Vision: The number of components that failed vision inspection since startup - "1,923 components"
- Components Failed Placement: The number of components that failed placement accuracy since startup - "1,156 components"
- Total Components Failed: The total number of failed component placements since startup - "5,926 components"
- Total Components: The total number of component placement attempts since startup - "12,853,495 components"
- PCBs Completed Good: The number of PCBs completed successfully for the current order - "2,845 PCBs"
- PCBs Completed Bad: The number of PCBs with placement errors for the current order - "12 PCBs"
- Total PCBs Order: The total number of PCBs processed for the current order - "2,857 PCBs"
- Production Order Progress: The completion percentage of the current production order - "35.7%"
- Nozzle Change Count: The number of automatic nozzle changes performed - "847 changes"
- Component Traceability Lot: The lot number of components currently being placed - "COMP-LOT-2024-R456"
- SPC Placement Offset Trend: The statistical trend of placement accuracy deviation - "+2.3 μm drift"

Alarms

If any single parameter deviates by more than 2% from the target value for 3 cycles in a row, an alarm should be triggered that contains (i) the parameter in question (ii) the values of the last three cycles that were out of order. The machine status is also changed to "Error".

If any single parameter deviates by more than 10% from the target value for a single cycle, an alarm should be triggered that contains (i) the parameter in question (ii) the values of the last three cycles that were out of order. The machine status is also changed to "Error".

Special electronics manufacturing alarms:

- Placement accuracy alarm: If placement accuracy exceeds $\pm 25\mu\text{m}$ in any direction
- Vision system alarm: If vision pass rate drops below 99%
- Vacuum pressure alarm: If vacuum pressure is insufficient for reliable pickup
- Feeder empty alarm: If any active feeder component count drops to zero
- Nozzle contamination alarm: If pickup success rate drops below 98%
- Component recognition alarm: If unknown components are detected

Methods

Implement methods for the following features:

- Start the machine: Machine state changes from stopped to starting. Once the machine is done starting up, the status changes to running
- Stop the machine: Machine state changes from running, error or maintenance to stopping. Once the machine is done stopping, the status changes to stopped
- Load production order: Allows to enter all the required information for a production order. That includes the order number, the article, the target quantity as well as all the target values. This method also resets the counters for good / bad / total PCBs for the order
- Enter maintenance mode: Machine status changes from its current state to Maintenance
- Enter setup mode: Machine status changes to Setup for program loading and feeder configuration
- Reset counters: Allows to reset the counters for total components placed, total failed components and total PCBs
- Load SMT program: Loads component placement program with coordinates and component data
- Calibrate vision system: Initiates automatic vision system calibration sequence
- Change nozzle: Manually initiates nozzle change to specified nozzle type
- Refill feeder: Updates component count after feeder refill operation
- Start placement accuracy check: Initiates precision measurement cycle for placement verification
- Emergency stop: Immediate halt of all movement for safety (head position preserved)