

AKUSENSE

PHOTOVOLTAIC INDUSTRY

SENSOR APPLICATION
SOLUTIONS



VISION OF AKUSENSE

TO SUPPORT
CUSTOMERS TO BE INDUSTRY LEADERS



COMPANY OVERVIEW

AKUSENSE GROUP is an innovation company specializing in industrial photoelectric sensors and deep learning technology, majorly focusing on manufacturing high precision positioning, deep learning, precision measurement, and obstacle avoidance sensors and providing related solutions. We provide precision intelligence and AI sensing technology for such industries as 3C electronics, new energy, semiconductor manufacturing process, medical electronics and service robotics. There are two brands serving the market, AKUSENSE and MEIJIDENKI.

Our Production and Research Team accounts for more than 30% of the total. The core team established by a group of senior scientists and engineers who have been engaged in industrial sensors over 20 years. We have our own labs for precision optics and AI vision. As more than 10% of our annual revenue invested in research and development each year, our new products launched very fast from time to time. We are an intelligent sensor company with more than 120 core patents as well as many international certificates such as ISO 9001, ISO 14000, CE, UL, TUV and ROHS. Meanwhile, OEM and ODM services are available. With over 6,000,000 sensors being exported to more than 70 countries and regions throughout the world per year, Akusense is helping our customers to become the industry leaders from Smart Industry and IOT Field in the era of Industry 4.0.

18000⁺
Users

260⁺
Agent Cities

240⁺
Distributors

6million⁺
Production Capacity

120⁺
Core Patents

70⁺
Countries & Regions

* Above statistics are as of October 2023

ADVANTAGE

Leading in independent technology and algorithms more than 20 years experience in the R&D team of industrial sensor experts.
Rich and mature product line and system, achieving precision+intelligence+quality+innovation.
Rich experience in application scenarios, 3C Industry+New Energy industry+Robot and AGV industry.
Support solution customization, technology training, sample trial, industry excellent experience.

INDUSTRIAL CUSTOMIZATION EXPERT

Industrial sensors design

(Position detection, measurement, safety identification and diagnosis)



UL/CSA/CE standard requirements design



Adaptive displacement sensor design



High-precision analog sensors design



Product development process management and manufacturability design



QUALITY CONCEPT

DO IT RIGHT
AT THE FIRST TIME



SPECIALISING IN INTELLIGENT SENSING SOLUTIONS FOR LITHIUM-ION EQUIPMENT



Customised to your needs

Pre-engineered solutions are individually tailored to the specific application of your equipment, saving time and costs and guaranteeing optimum performance.



Complete service system

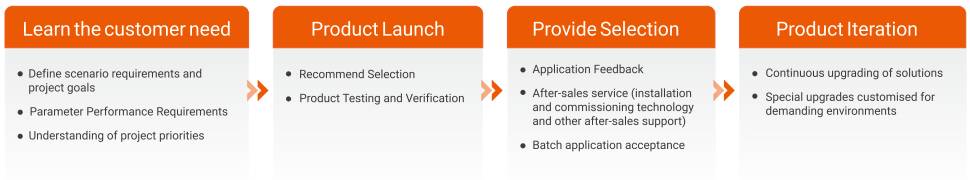
Our project team will co-operate with you from the collection of requirements to testing and validation, as well as after-sales service. The office network of 10+ cities (constantly expanding) ensures that we can respond quickly to the needs of users.



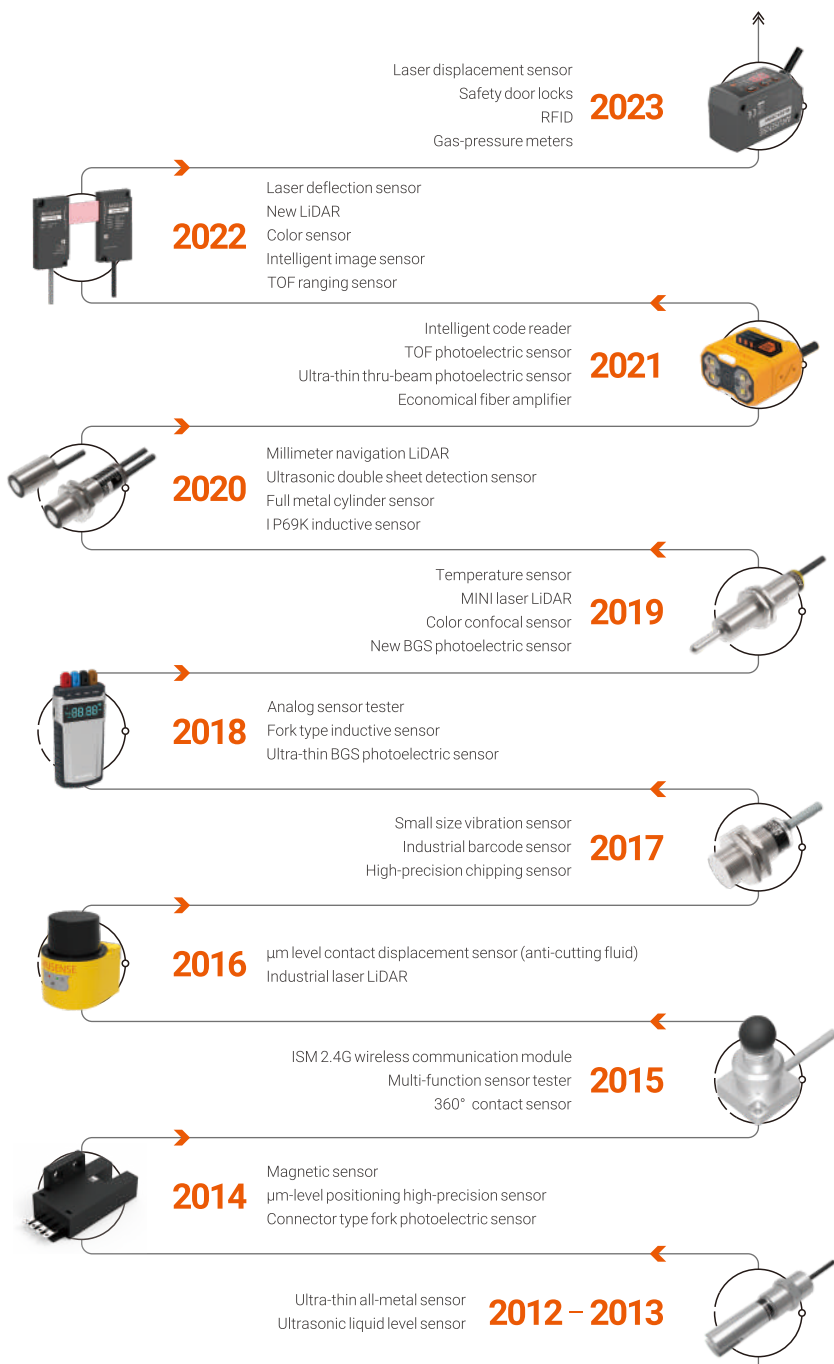
Rich industry experience

Rich product lines and project experience, as well as the hardcore R&D team of senior engineers at home and abroad, support the engineers to customise high-quality and efficient solutions for you, so that your equipment is more competitive in the market.

Your solution path



DEVELOPMENT HISTORY



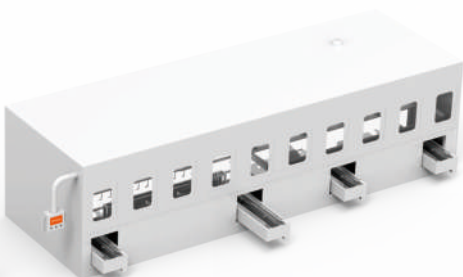
Sensor Solutions for Photovoltaic Industry



Conveyor



Wafer Sorting Equipment



Single Polycrystalline Flock Making And Cleaning



Photovoltaic Oxidation Equipment



Fresnel System

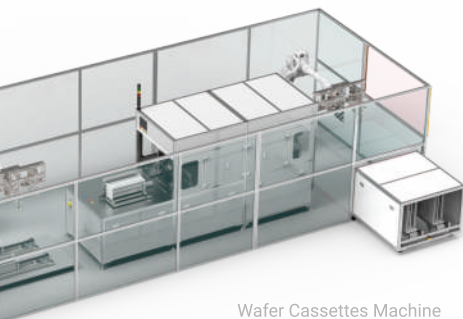


PV Module EL Appearance Inspection Equipment

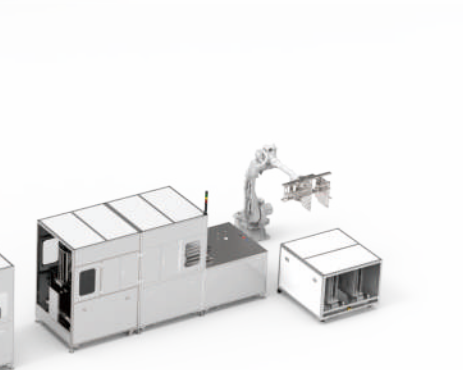


PV String Welder

Cell Sorting System



Wafer Cassettes Machine



Photovoltaic Panel Layout Machine

1 Wafer Production And Processing

Conveyor

- Wafer presence recognition P11
- Edge detection P11

Wafer Sorting Equipment

- Wafer single and double sheet inspection P12

Single Polycrystalline Flock Making And Cleaning

- Integrated machine wafer in place inspection P12
- Wafer cassettes positioning / forward and reverse detection P13
- Protective door close or not P14

Photovoltaic Oxidation Equipment

- Wafer stack height control P17
- Area security P17

Wafer Cassettes Machine

- Wafer cassettes rotation 90° positive and negative positioning detection P18
- Wafer cassettes column positioning detection P18
- Robotic wafer cassettes gripping and positioning P19
- AGV vehicle obstacle avoidance P20

2 Photovoltaic Cell Production

Cell Sorting System

- Cell positioning detection P23

PV String Welder

- Material detection in grid line P23
- Detection string welder EL detection P24
- Wafer cassettes presence detection P24

Photovoltaic Panel Layout Machine

- Module movement limit detection P25
- Cell real-time positioning P25
- Safety Protection P26

3 Photovoltaic Module Production

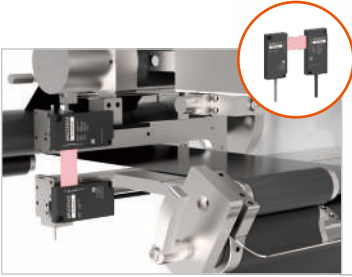
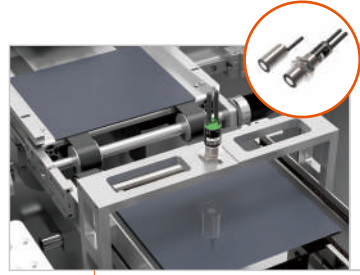
PV Module EL Appearance Inspection Equipment

- Junction box cover OK/NG P29
- Weld scar condition detection of busbar solder joints P29
- Solar panel appearance defect inspection P30

Fresnel System

- Heliostat horizontal orientation detection P30

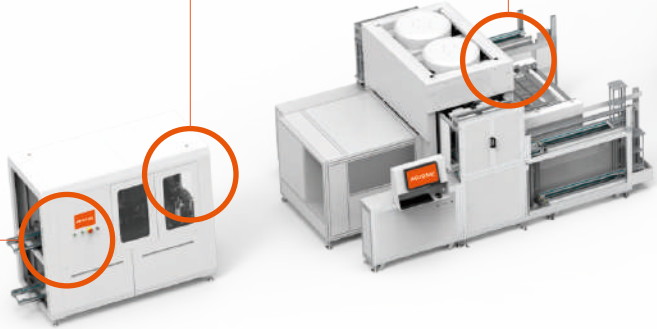
Wafer Production And Processing (1)



Edge detection

Thru beam edge sensor with high precision
ETD-0612

- Suitable for multi-scene edge control/positioning/measurement
- Using laser alignment measurement principle, Repeatability $\pm 1\mu\text{m}$



Wafer presence recognition

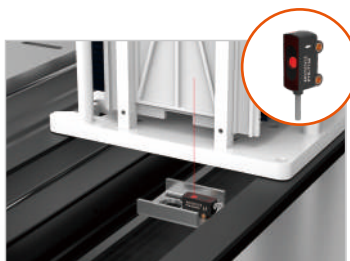
BGS photo sensor
ESB-BS30 Series

- Small spot, with obvious advantages for accurate positioning of small objects and thin films
- Excellent background suppression, stable detection of objects of various colours

Wafer single and double sheet inspection

Ultrasonic sensor MUD Series

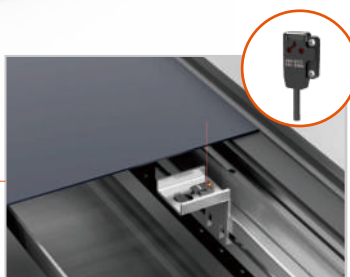
- Three inspection modes (single sheet, double sheet, empty material) adjustable with learning and teaching function, can be quickly adapted to the scene debugging
- Multi-specification material detection



Wafer cassettes positioning / forward and reverse detection

Small square photoelectric sensor PTN Series

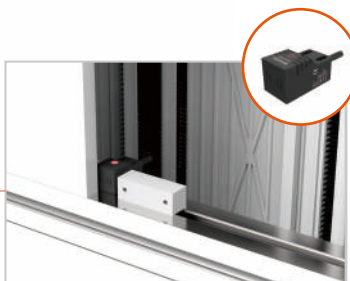
- Compact housing, as big as a tall finger, high mounting flexibility
- IP67, can be applied in harsh conditions



Integrated machine wafer in place inspection

Ultra-thin photo sensor ESL Series

- The product is only 3.5mm thick, which is ideal for installation in spaceconstrained scenarios.
- Fast response time to match the equipment for rapid operation



Protective door close or not

Square Proximity Sensor TQN18 Series

- Repeatability <math>< 1.0\% (SI)</math>, switching frequency 1KHz
- IP67, effective and robust product performance

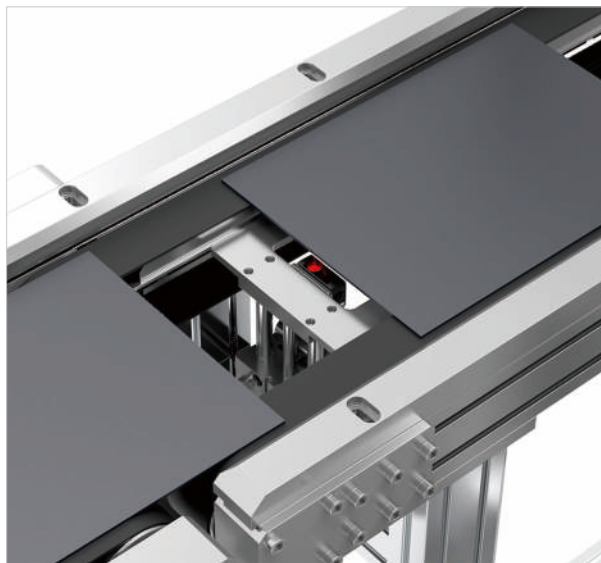
Wafer presence recognition Edge detection

Wafer presence recognition

Recommendation:
BGS photoelectric sensor
ESB-BS30 Series

Silicon wafers in the fully automated track, the need for sensors to identify the normal passage of silicon wafers through the track, and at the same time to send signals to the mechanism for the next step in the processing of silicon wafers, due to the diversity of silicon wafers and the degree of reflectivity to the sensor to detect the trouble;

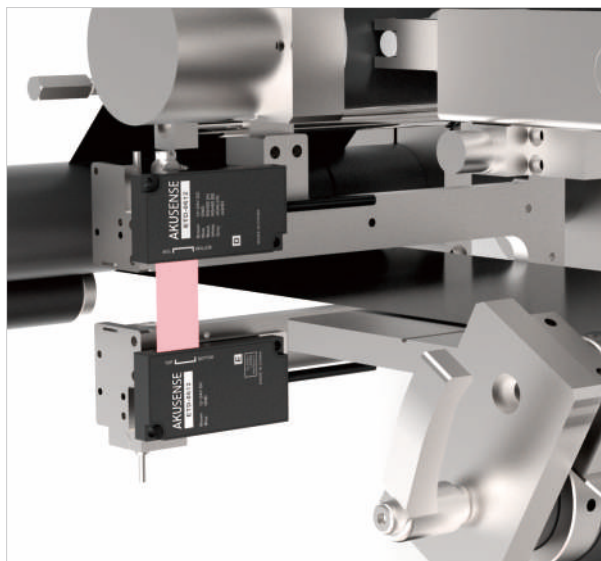
Choose the background suppression type small spot photoelectric ESB-BS series, the light energy will be further focused, can avoid the light scattering to the measured object around the false action, but also improve the detection accuracy, for the accurate positioning of small objects, thin film, there are obvious advantages.



Edge detection

Recommendation:
Precision Laser thru-beam Sensor
ETD-0612 Series

Silicon wafers in the track conveying line sometimes occur positional shift, can not reach the designated position, here need to choose the guiding sensor to detect the positional shift, to ensure that the position of silicon wafers positioning accuracy; Precision laser deflection sensor ETD-0612 series can reach micron level accuracy.



Wafer single and double sheet inspection Integrated machine wafer in place inspection

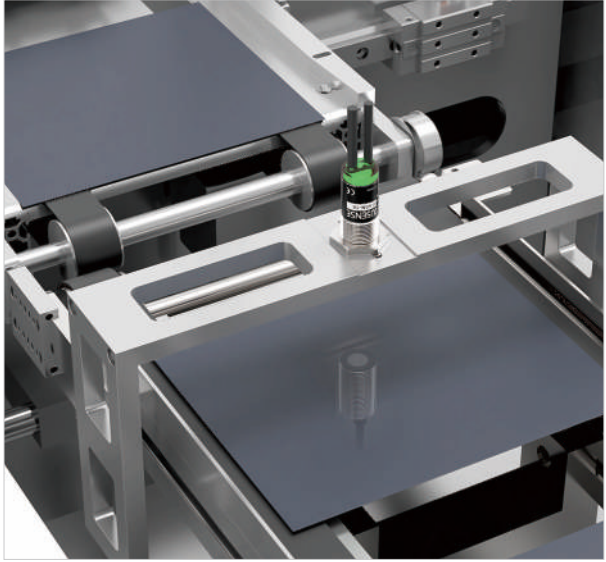
Wafer single and double sheet inspection

Recommendation:

Ultrasonic sensors MUD series

PV wafer transfer process requires the use of sensors fixed. Detecting multiple sheets of material in the wafer transport process without the influence of wafer colour or glossy surface, bonding in the wafer. The sensors can be used to detect multiple sheets of material in the wafer transport process without being affected by wafer colour or glossy surfaces, wafers bonded with water in the wafers, or wafers with different thicknesses are tightly bonded. In this case, a corresponding signal should be given and the machine should reject or empty the stacked material and stop the next step. Stop the next step.

The MUD series with the ultrasonic detection principle is used for detecting empty material and single and double sheets, three detection modes. Adjustable, with learning and teaching function, can be quickly adjusted to adapt to the site of a variety of specification material detection, test to adapt to the site of a variety of specifications of material detection.

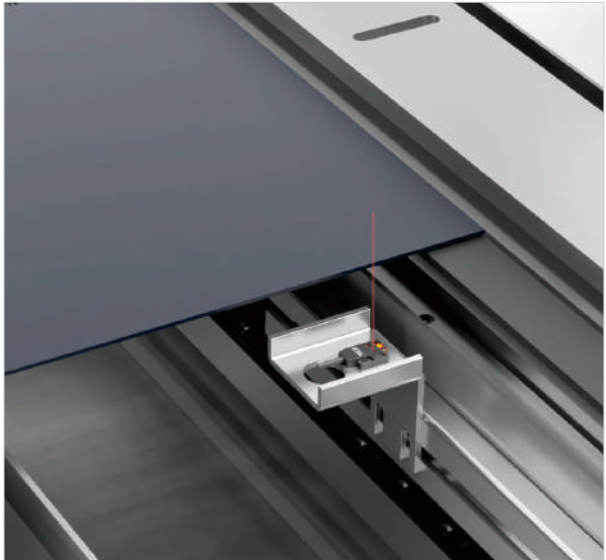


Integrated machine wafer in place inspection

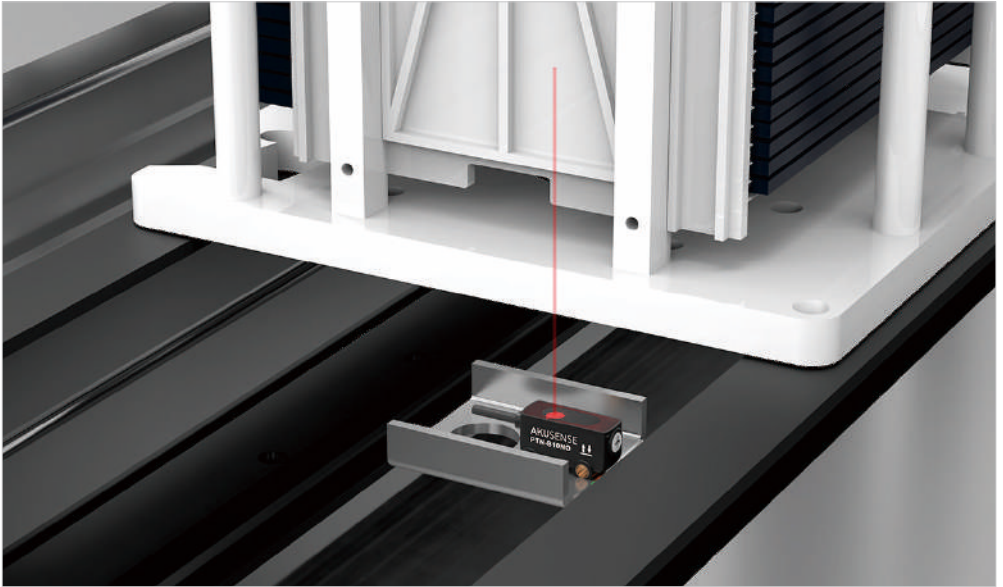
Recommendation:

Ultra-thin photoelectric ESL series

Installation of sensors in equipment with tight mounting space. Detects wafers in place; For larger detection distances, the Ultra Slim Series can be used. The Ultra Slim series of photoelectric sensors is only 3.5mm thick and offers excellent performance and stability. Only 3.5mm thick, these sensors offer excellent performance and stable detection of wafers in place, making them ideal for installation in tight spaces. The product is only 3.5mm thick and has excellent performance in detecting the wafer in place stably, making it ideal for installation in space-constrained. The ESL series is only 3.5mm thick and has excellent performance.



Wafer cassettes positioning / forward and reverse detection



Wafer cassettes positioning / forward and reverse detection

Recommendation:
Mini square photoelectric
PTN sensors

Solution:

In the texturing and cleaning equipment, sensors are used to locate and distinguish the front and back of the cassettes.

Due to the limitation of the installation space, small size sensor is required;

PTN series sensors are only little finger sized, they support side-by-side/face to face installations. They also possess with excellent anti-light interference performance and background suppression function, making stable detection possible.

Protective door close or not



Protective door close or not

Recommendation:
TQN18 inductive proximity
sensors

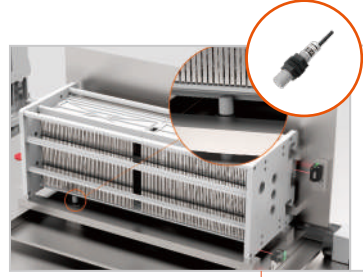
Solution:

A sensor needs to be installed on the protective door to detect whether the door is closed.

The detection distance is required to be 7.5mm, and the repeatability is within 0.1mm;

Akusense's square inductive proximity is selected, the detection distance is 8mm, and the waist-shaped mounting hole is simple to install, and can reliably monitor the status of protective gate.

Wafer Production And Processing (2)

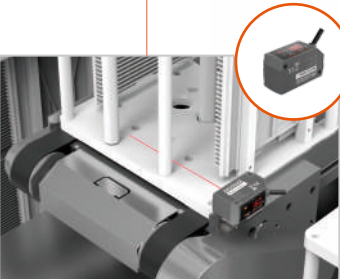
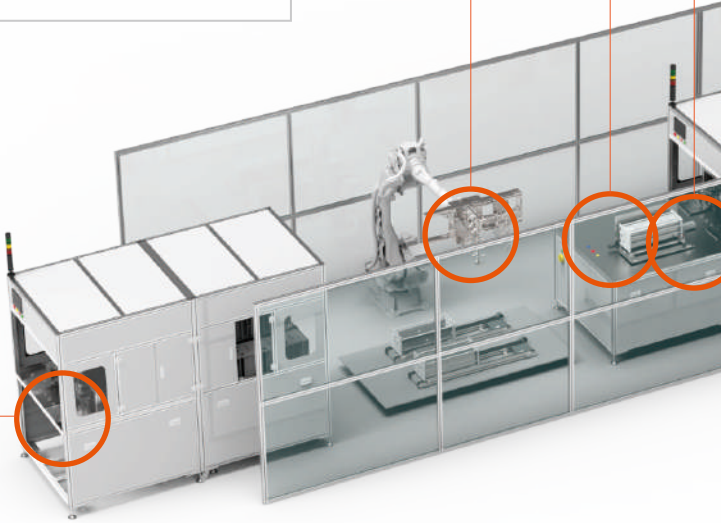


Robotic wafer cassettes gripping and positioning

BGS photoelectric sensor

ESB Series

- Unaffected by background, can stably detect materials of any color
- Dynamic filtering algorithm can achieve optimal detection results in various environments



Wafer stack height control

Laser displacement sensor

MLD25 Series

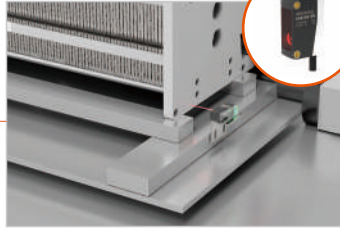
- Micron-level repeatability, 485 communication, real-time and efficient feedback of data values
- Widely used in length/distance/surface roughness measurement in industry and scientific research fields

Wafer cassettes column positioning detection

Capacitive proximity sensor

CKF12 Series

- Using capacitance detection principle, high repeatability
- Standard M12 mounting thread, easy to use

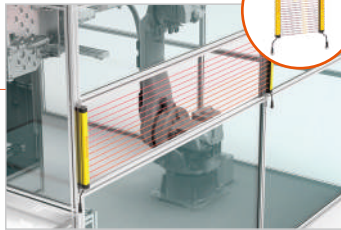


Wafer cassettes rotation 90° positive and negative positioning detection

BGS photoelectric

ESB-BS15N

- Excellent background suppression performance, unaffected by the color and material of various silicon wafers
- Strong anti-light interference ability, no fear of other light interference in the production line

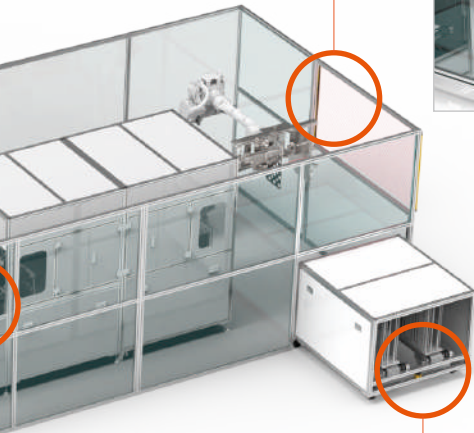


Area security

light curtain

BSL Series

- A variety of optical axis spacing (10/20/40mm) and number of optical axes are available
- AS-33C lidar TDF detection principle, with the mainstream performance of single-line lidar dynamic filtering algorithm, can achieve optimal detection results in various environments using line synchronization technology to effectively avoid light source signal interference



AGV vehicle obstacle avoidance

LIDAR

AS-33C

- TDF detection principle, with top class single-line performance lidar
- Serial port (Type-C interface) communication, online output measurement data (including distance and light intensity data in all directions)

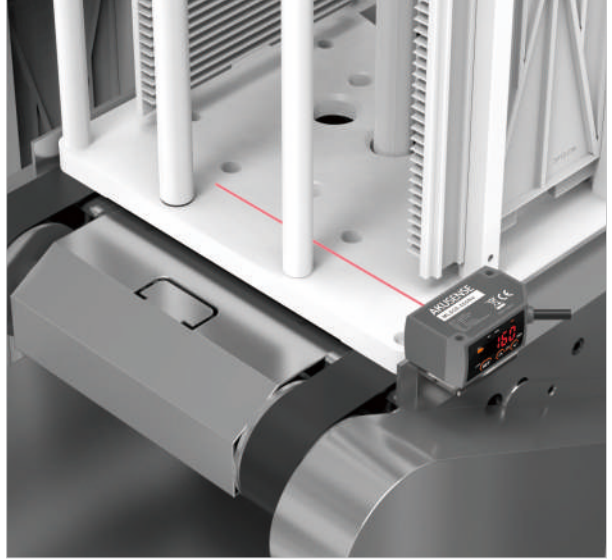
Wafer stack height control Area security

Wafer stack height control

Recommendation:
**MLD25 series laser displacement
Sensor**

The wafer will be placed and stacked here after oxidation, the stacking needs to stop after the materials reach to the specified height;

MLD25 laser displacement sensor is used to control the stacking height. The accuracy can reach micron level, and even the gap of a silicon wafer can be detected; 485 communication provides real-time and efficient feedback of data values.

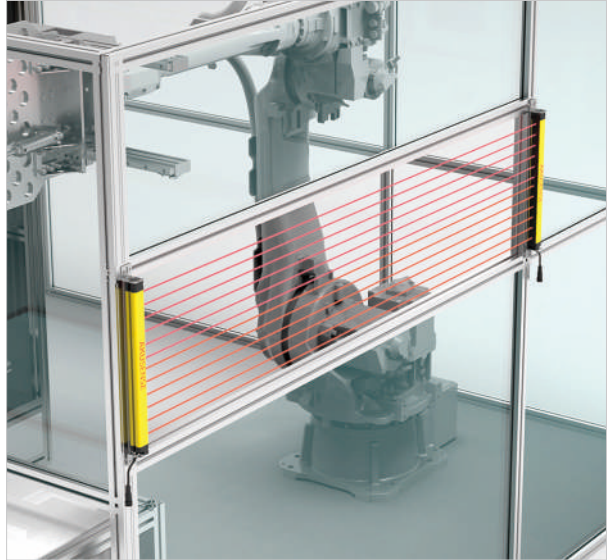


Area security

Recommendation:
BSL series light curtain

On single and polycrystalline texturing machines, area safety sensors need to be used to monitor the motion of personnel to avoid injuries;

AKUSENSE's BSL series light curtains provide a variety of optical axis spacing and optical axis numbers for option, 10mm, 20mm, 40mm axis spacing for different applications, BSL sensor can also be quickly customized according to equipment size requirements.



Wafer cassettes rotation 90° positive and negative positioning detection

Wafer cassettes column positioning detection

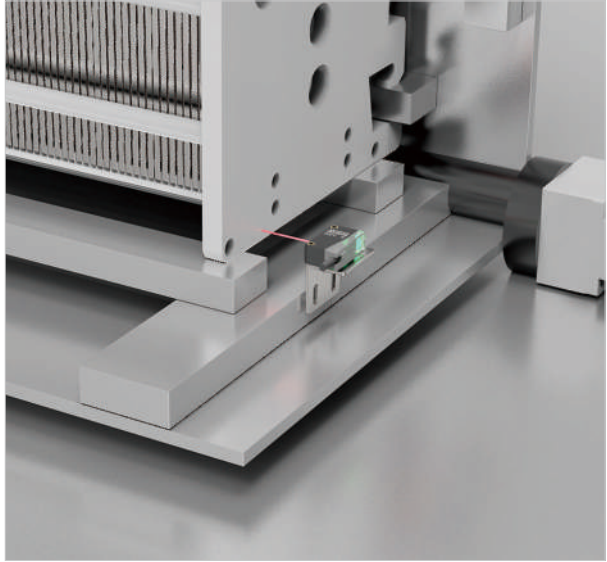
Wafer cassettes rotation 90° positive and negative positioning detection

Recommendation:
Small spot BGS ESB-BS15N photoelectric sensor

It is necessary to detect and confirm whether the cassettes has completed its 90° rotation; the detection needs to be conducted via a 20mm hole, so light spot needs to be small and the sensor is able to filter out interference.

BGS ESB-BS15 is able to filter out those interferences caused by the color of various silicon wafers and the background, and the spot is only 2mm at 150mm; it's able to sense small difference in level, and only recognizes cassette's positioning hole at 30mm.

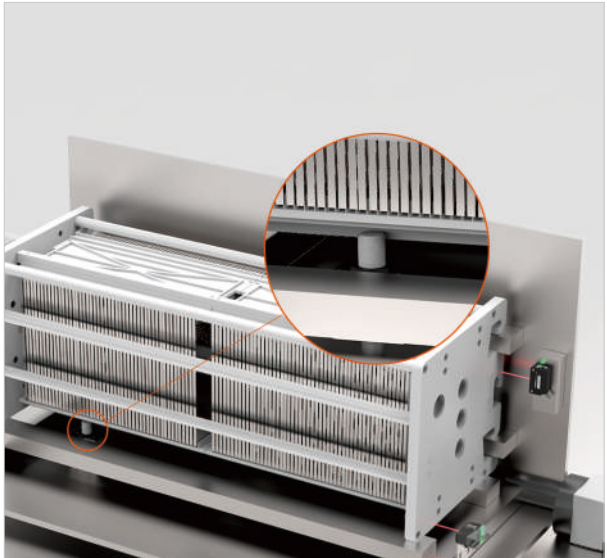
ESB-BS15 provides strong red light anti-interference ability, even if it is illuminated by the red light sensor at the opposite way, the stability of the detection will not be affected at all.



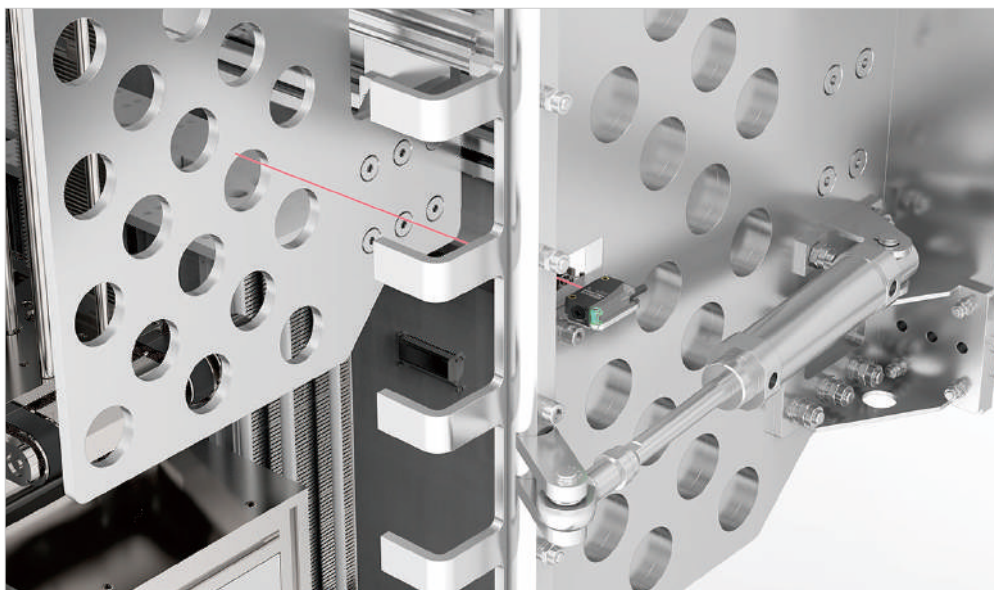
Wafer cassettes column positioning detection

Recommendation:
CKF12 series capacitive proximity sensor

This process is to locate the handle of cassettes during transmission, the detection distance is 2mm, and the repeatability needs to be less than 0.1mm. The cassettes is non-metallic, so capacitive proximity sensor is preferred. CKF12-03 series sensors offer high repeatability and detection distance is 1 to 3mm.



Robotic wafer cassettes gripping and positioning



Robotic wafer cassettes gripping and positioning

Recommendation:
BGS photoelectric
ESB Series

Solution:

At this station, sensors are needed to position the wafer cassette carrier, driving the manipulator to grab the carrier. Carriers come in various colors and materials, including black, milky white, light brown, dark blue, etc... Therefore, it is necessary to select a sensor that is not affected by color. The ambient light in this workstation is strong, so anti-interference performance is essential.

The ESB-BS15N is selected with excellent background suppression performance. It is not affected by color and has strong anti-light interference ability. It is almost not affected by reflection interference from the floor surface under the robot, the metal surface of the equipment as well as the glass surface. It has strong capabilities to resist LED light interference. Even if the LED light is installed above the equipment, the ESB-BS15N sensor will not be affected at all and can very well complete the task of grabbing and positioning materials by the manipulator.

AGV vehicle obstacle avoidance



AGV vehicle obstacle avoidance

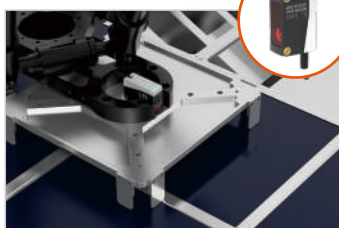
Recommendation:
LiDAR AS-33C

Solution:

After the AGV receives the transportation task, it calculates through the internal program to find the mobile shelf to accept the goods, and transports the mobile shelf filled with wafer cassette carriers to the next process for loading. During this process, the AGV car is required to automatically avoid obstacles during the transportation of goods, to avoid breaking the silicon wafers at the same time.

The AS-33C series laser obstacle avoidance LiDAR installed in the AGV car performs a wide range of 270° area detection at a distance of 10m around it. 3 obstacle avoidance areas are set to meet the three states of vehicle running, deceleration and stop. The detection accuracy is $\pm 2\text{cm}$.

Photovoltaic Cell Production

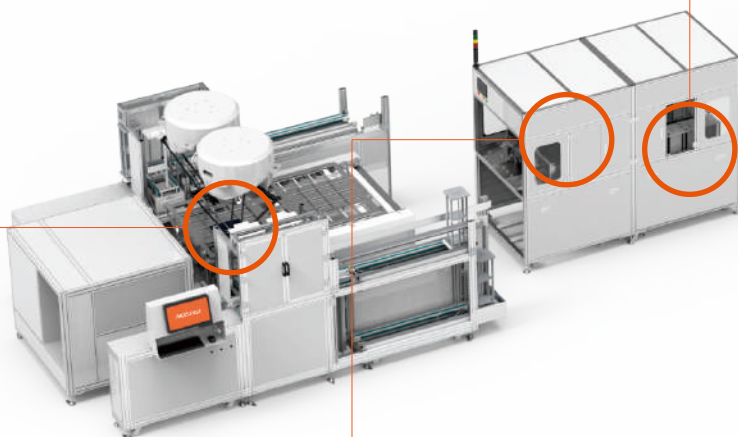


Cell positioning detection

BGS photoelectric sensor

ESB-BS30 Series

- Small light spot, having advantages for precise positioning of small objects and thin slices.
- Excellent background suppression function. Various color objects can be stably detected



Material detection in grid line

Proximity sensor

TMF series

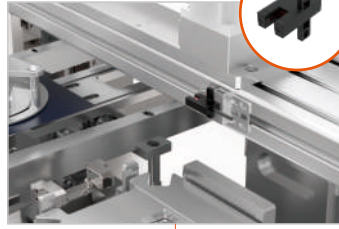
- Hard-core stainless steel housing and sensing surface material, sturdy and durable
- M8 standard thread, compact size, easy to use



Detection string welder EL detection

AKUSENSE IVS vision system +IVS vision sensor

- High matching: systematic machine vision hardware matching
- Strong interaction: Integration of deep learning and traditional algorithms

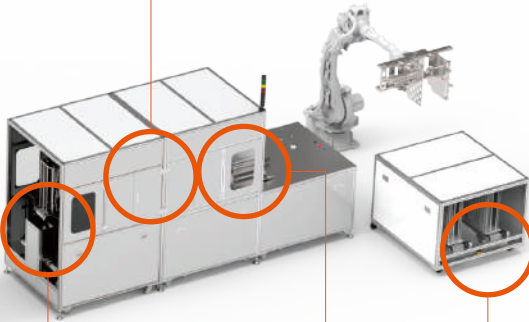


Module movement limit detection

Fork sensor

ST-303 Series

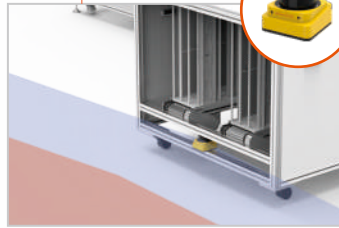
- All-in-one design for chip, repeat accuracy is up to 0.01mm
- 12 shapes for option like F/T/R/L/K/T, etc.



Wafer cassettes presence detection

Photoelectric sensor PTE-TM10 series

- Through-beam detection principle, with max. 10m sensing distance
- Standard 25.4mm mounting hole pitch, L on and D on switchable



Safety Protection

LIDAR AS-100C

- Integrated SLAM natural navigation function and safety protection function
- Provide high-quality measurement data output and signal strength



Cell real-time positioning

Laser sensor

ELE-B35 Series

- The detection is not affected by the color of the detected object
- Strong ability to resist light interference and can operate stably in reflective environments

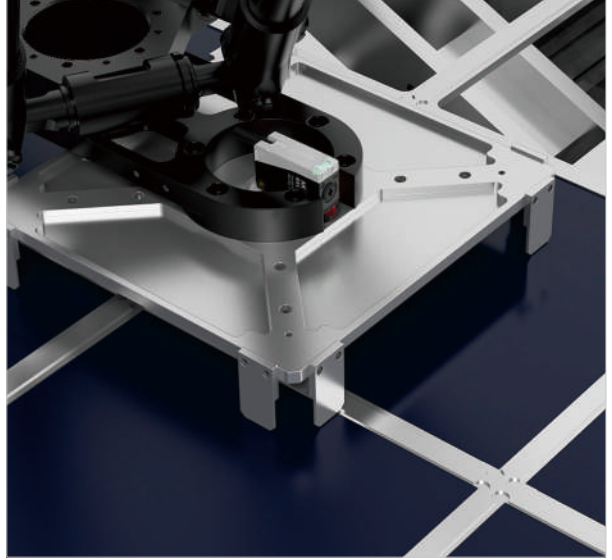
Cell positioning detection Material detection in grid line

Cell positioning detection

Recommendation:
BGS photo sensor
ESB-BS30 series

It is necessary to detect and confirm whether the wafer cassette carrier has completed rotating 90°, the sensor needs to pass through a 20mm hole for detection, and the light spot is required to be small and to be able to shield items outside the detection target distance.

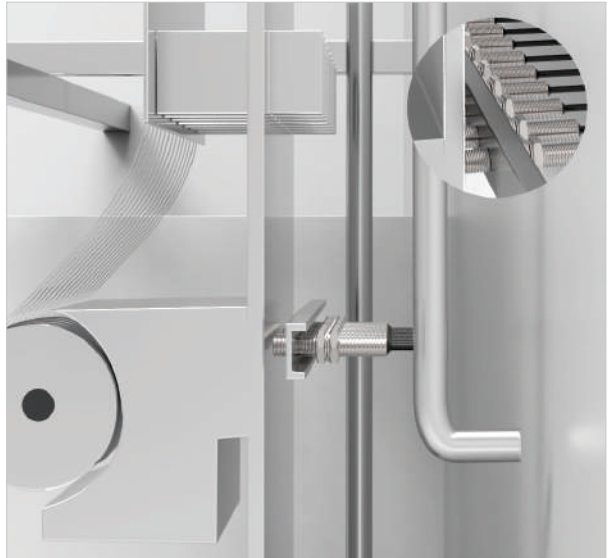
The photo sensor ESB-BS30N with small light spot and background suppression function is not affected by the color and material of various silicon wafers, and the spot is only 2mm at 150mm. It has the ability to identify step differences, and can shield the silicon wafer at 50mm, and only recognizes the carriers hole at 30mm. It has strong red light antiinterference ability. Even if it is illuminated by the red-light sensor at the opposite station, the stability of the detection will not be affected at all.



Material detection in grid line

Recommendation:
Proximity sensor with stainless steel sensing surface-TMF series

On the photovoltaic string welding machine, when the grid wire is being fed, a sensor needs to be used to monitor the status of the grid wire in real time. If the grid wire is broken or there is an abnormal state of material shortage, the sensor will send out a signal to drive the equipment and machine to stop working, prompting workers to check for abnormal equipment operation; The proximity sensor TMF stainless steel series is selected. The hard-core stainless steel housing and sensing surface material are not easily damaged even if there is a collision, friction with the workpiece, or collision. It is stronger and more durable than ordinary proximity sensors.



Detection string welder EL detection Wafer cassettes presence detection

Detection string welder EL detection

The core component of photovoltaic solar energy is the photovoltaic cell module. In addition to the defects of the battery material itself, the multiple processing of the cells during production may also cause defects in the cells. In addition, mechanical damage during installation and use will affect the service life of components. Therefore, visual inspection is required for detecting defects such as cracks, black spots, short circuits, bright spots, broken grid, weak welding, over-soldering, etc.

Solution:

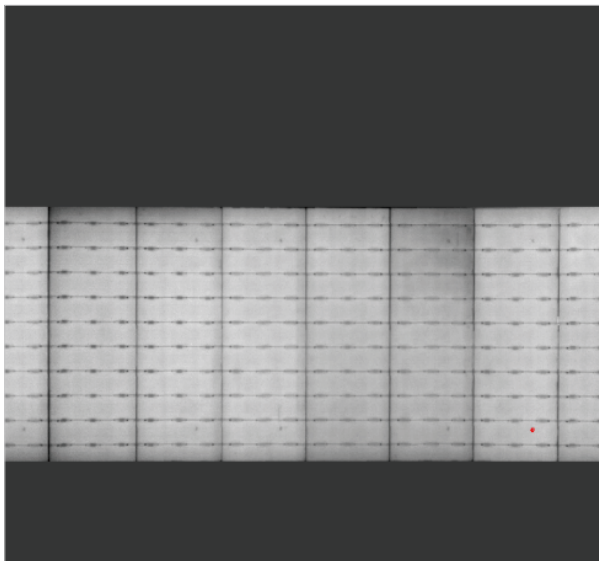
AKUSENSE IVS vision system+IVS vision sensor

High matching: Based on traditional algorithms + AI, EL images are classified through deep learning algorithms

Strong interaction: achieving efficient identification and precise positioning

Project results:

1. Missed detection rate: 0
2. False detection rate≤0.1%
3. Detection speed ≥7200PCS/h



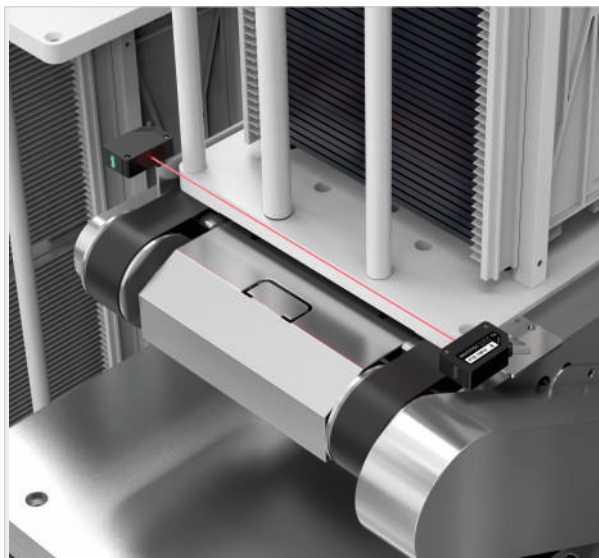
Wafer cassettes presence detection

Recommendation:

Photo sensor PTE-TM10 Series

A sensor needs to be installed on the wafer cassette carrier transmission line to detect whether the carrier is present, and the sensor detection distance is required to be up to 10m;

The photo sensor PTE-TM10 series is selected. It adopts the throughbeam detection principle and has stable detection effect, which can meet the needs of medium and long-distance applications on site. It has a standard 25.4mm mounting hole, L on and D on can be switched, and debugging is simple and convenient.

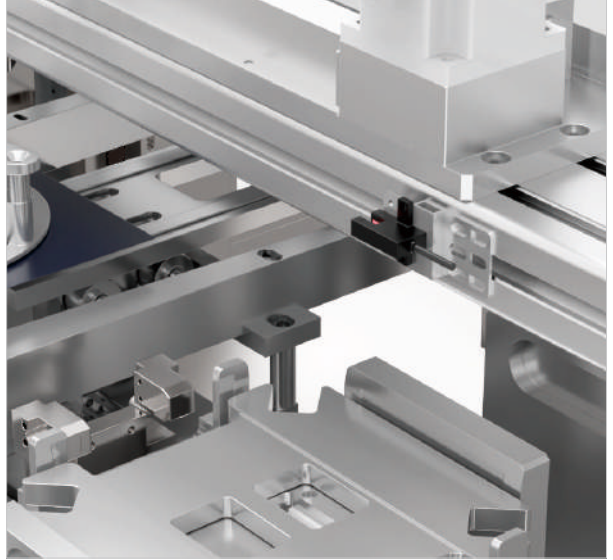


Module movement limit detection Cell real-time positioning

Module movement limit detection

Recommendation:
ST-303 Series of Fork Sensor

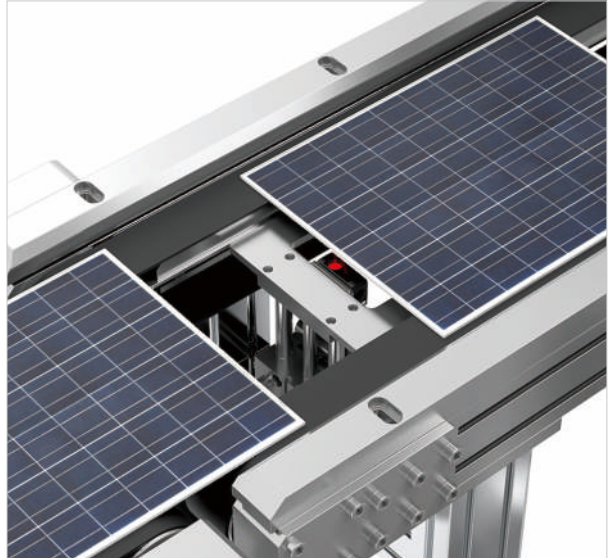
Sensors are used to detect the extreme position of module movement for cells, which requires high repeatability; ST-303, one of the Fork sensors with an accuracy of up to 0.01mm is selected to precisely sense the position of the module; with 0.3ms response time, it guards the equipment operates flexibly.



Cell real-time positioning

Recommendation:
ELE-B35 Series, Laser Sensor

Docking with the string welding machine, after the battery cells are welded in series, a robot or module will place the battery strings on the glass with EVA film laid according to the requirements, and a sensor is needed to automatically locate the glass transmission; the ELE-B35, the laser sensor is selected, which is not affected by the color of the object being tested and has strong anti-interference ability to stray light.

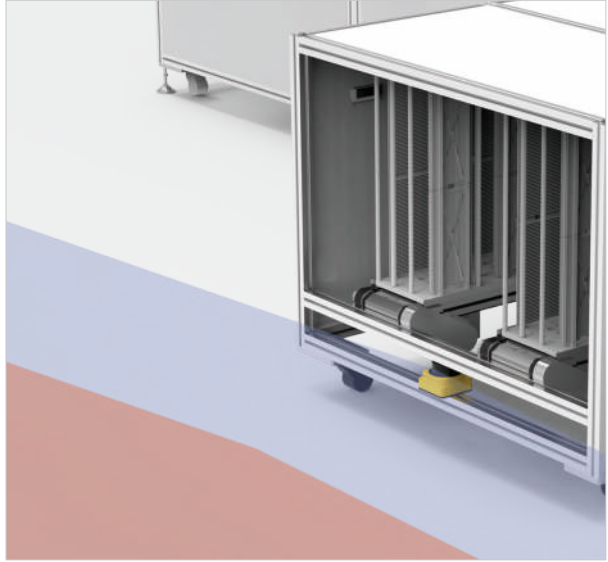


Safety Protection

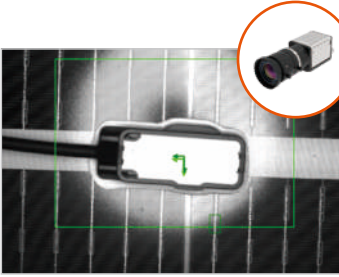
Recommendation:
AS-100C, LiDAR Scanner

AGVs need to be fitted with LiDAR Scanner to navigate and reach accurate positioning of the loading position. The safety guarding of AGVs can be switched between guarding zones according to speed and direction;

AS-100C integrates SLAM natural navigation with safety protection, providing high-quality measurement data output and signal strength values, enabling 10 safety zones to be switched with autonomous navigation.



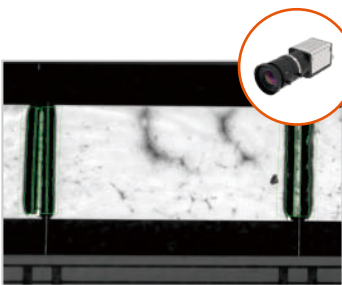
Photovoltaic Module Production



Junction box cover OK/NG

AKUSENSE IVS Vision System +IVS Visual Sensor

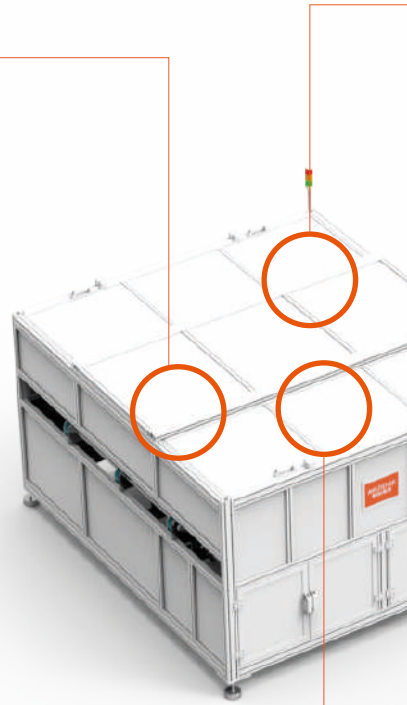
- High matching: with Systematic Machine Vision Hardware
- Strong interaction: Integration of deep learning and traditional algorithms

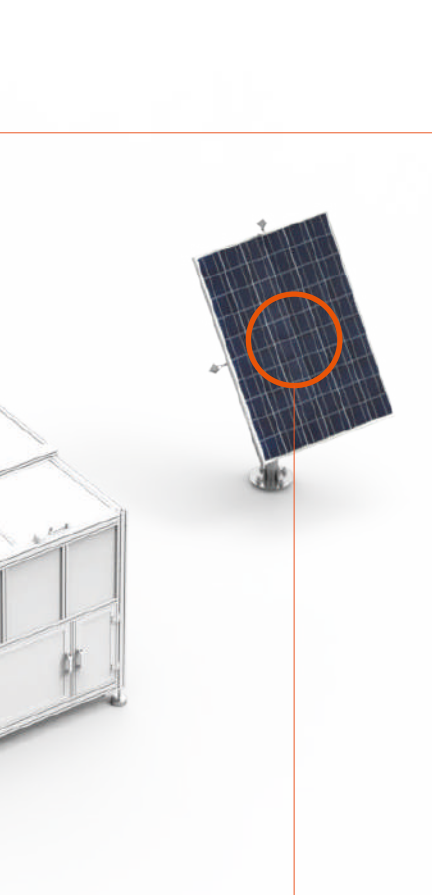


Weld scar condition detection of busbar solder joints

AKUSENSE IVS Vision System+ IVS Vision Sensor + AI Platform

- High matching: with Systematic Machine Vision Hardware
- Strong interaction: deep learning and traditional algorithms are fused together

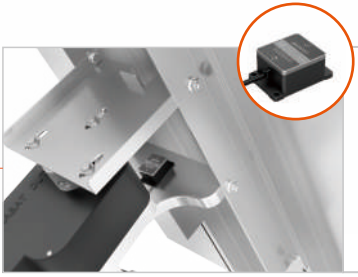




Solar panel appearance defect inspection

AI Image Recognition
**Industry camera + telecentric lens
+ customized light source
+ AKUSENSE AIV Platform**

- 4-pixel ultra-fine recognition
- Detection and edge recognition of the object with pixel-level precision



Heliostat horizontal orientation detection

Dual-axis measurement series
Inclination sensor

- Wide voltage input
- Dual-axis inclination measurement

Junction box cover OK/NG

Weld scar condition detection of busbar solder joints

Junction box cover OK/NG

Project requirements:

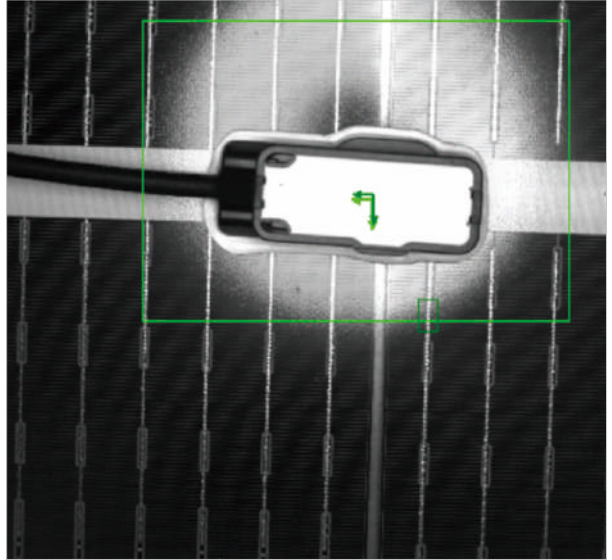
The junction box is a connector between the solar cell array and the solar charging control device. The final sealing of the welded junction box is an indispensable process in the production and processing of the junction box. The existing sealing machine presses the head down as a whole, so that the upper cover of the junction box is sealed and adhered to the lower cover. It is necessary to detect the positioning of the cover grabbing, the positioning of the front box body before sealing, and whether the cover is sealed after sealing.

Solutions:

AKUSENSE IVS vision system + IVS vision sensor
Pat Find4 positioning, based on pyramid acceleration profile feature matching technology
Signal control solution: Industry-specific measuring module for gripping and box positioning on snap-on lidding machines

Project result:

1. Leakage rate: 0 .
- 2.Repeat positioning accuracy $\pm 0.01\text{mm}$.



Weld scar condition detection of busbar solder joints

Project requirements:

The dynamic detection of Welding Points and Welding Scars is difficult after the collector belt is welded, while the small and numerous weld joints make it difficult to deploy the vision system.

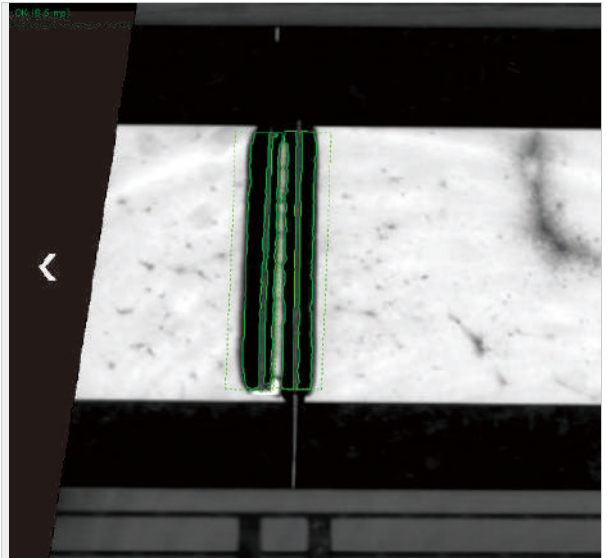
Solutions:

AKUSENSE IVS Vision System + IVS Vision Sensor + AI platform

Adopt "traditional algorithm + deep learning + deep learning" to solve the problem of dynamic detection with high accuracy.

Project result:

1. leakage detection rate: 0
2. False detection rate < 0.01
3. Positioning accuracy rate of 99.99%
4. detection speed $\geq 2\text{s}$ / board



Solar panel appearance defect inspection Heliostat horizontal orientation detection



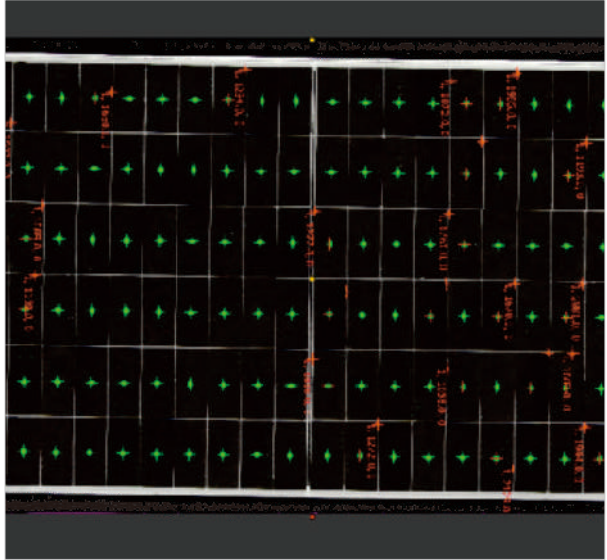
Solar panel appearance defect inspection

Recommendation:

Industry Camera + Telecentric Lens + Customised Light Source + AKU AIV Platform

Solar panel appearance inspection involves dozens of defects such as chipped edges, missing corners, surface back stains, etc. There are many inspection needs, and at the same time, when using vision inspection, because of the positional requirements of the starting weld joints, the requirements for the detection of the positioning accuracy are also very high; the traditional manual inspection methods are inefficient, with a high error rate, and high product loss. Therefore, the customer needs a more comprehensive and efficient vision department to complete the efficiency leap in the production of solar panels, it is an important component of photovoltaic.

Using the Aku AIV learning platform's unique defect detection function, combined with industrial cameras, telecentric lenses and customised light sources, defects with a wide range of different characteristics can be efficiently identified and accurately located, so that the features being detected can be ideally visualised and clear images can be quickly generated.



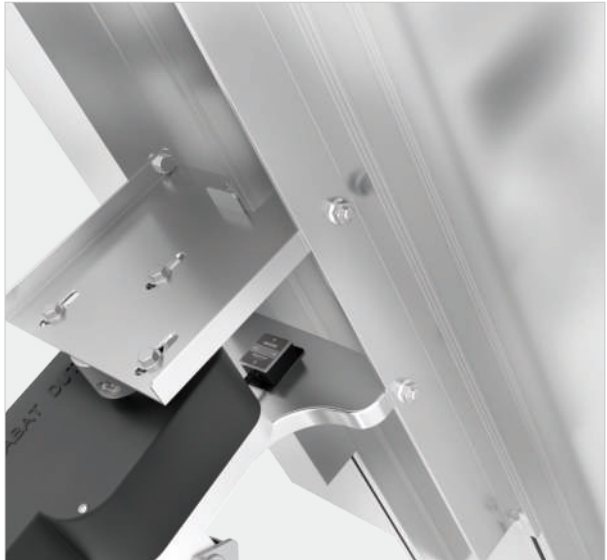
Heliostat horizontal orientation detection

Recommendation:

Biaxial Measuring Inclinometer

In Fresnel power systems, to avoid spurious losses caused by inaccurate alignment of the heliostat, an inclination sensor is required to detect the horizontal orientation of the heliostat.

This series can withstand high ambient temperatures and accurately measure the angle of inclination to ensure that the heliostat is aligned with direct sunlight, thus converting as much solar radiation as possible into electrical energy.





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