



XR Series X-Ray User Manual



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Welcome

Thank you for your purchase of the XR Series X-ray contaminant detection system. This manual provides a detailed description of the functions, operation, software, and troubleshooting methods for this system. Before placing the equipment into operation, please carefully read this manual to ensure proper and safe operation.

TDI Packsys guarantees that the hardware and accessories provided at the time of purchase are free of any defects in materials or workmanship in accordance with the warranty stipulated in your purchase agreement.

We reserve the right to modify the contents or replace this manual without prior notice. As improved capabilities and features are introduced, the manual will be updated accordingly. If there is a minor discrepancy between the description in this manual and the actual system, please refer to the actual system.

If there is any operation, feature or component that is not described in the manual, please consult with your TDI Packsys sales or service team. When operating, maintaining, and inspecting this product, pay special attention to the relevant items in this manual and the precautions marked on the unit to ensure all adequate safety measures are followed.

It is strictly forbidden for users to make any modifications to the system without prior permission from TDI Packsys. Doing so will immediately void all warranties and render the system non-compliant and ineligible for certification for safety and performance.

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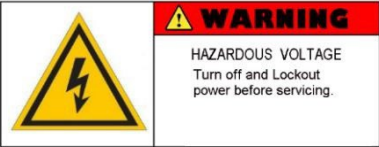
Chapter 1: Overview

This manual is suitable for XR Series X-ray inspection system. This chapter introduces the equipment installation and maintenance precautions as well as the appearance of the equipment. Please adhere to the safety precautions described in this chapter and perform all operations safely in accordance with this manual.

1-1 Safety Signs

Safety labels are divided into four types: prohibitive labels, warning labels, instruction labels and prompt labels. The different labels can be distinguished by their color. Different labels are used in different parts of the standard X-ray inspection equipment according to the situation. Operation and maintenance personnel must observe the labels to ensure safe operation.

- Red icons are usually circular and used to indicate prohibited operations.
- Yellow icons are usually triangular and used to indicate danger.

Serial Number	Label	Location	Content
1		Power connection line located on the side of the system.	Warning The equipment is connected to single-phase AC220V voltage. Please pay attention to the high voltage hazard when connecting to the power supply
2		Above the conveyor belt on both sides of the equipment	Danger Do not touch the conveyor belt while the equipment is running.
3		The grounding screw on the lower left of the device	Caution Please pay attention to the equipment grounding when using
4		At the pull ring of the front baffle of the equipment	Warning It is forbidden to open the machine during active operation
5		Middle of the front cover of the system	Warning Do not open the door without authorization, beware of X-ray radiation leakage

1-1-1 Safety Precautions

The safety precautions described in this manual provide the user with proper safety guidance when using this equipment in a production setting. To ensure the safety of the operator, as well as the normal operation of the equipment, please comply with all marked safety precautions.

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1-1-1-1 X-Ray Radiation

This equipment contains an X-ray light source. If X-ray energy is not properly contained, it creates a hazardous condition. The machine is equipped with two protective measures: a fully shielded protection cabinet and protective curtains. When the equipment is used normally, the radiation emissions are less than 1uSv/h (well below the FDA standard of 5uSv/h). It is strictly forbidden for the user to disassemble the device without authorization or open the device cabinet or open/cut/modify the protective curtains.

1-1-1-2 High Voltage

This equipment contains high-voltage components. The X-Ray tube voltage is generally 60KV or above. To prevent high-voltage electric shock hazards, users must avoid direct contact with the internal components of the chassis during use.

1-1-1-3 Vibration and Tipping

This equipment is a precision machine, and the mechanical components and internal structure may be damaged due to vibration or tipping, which can cause the detection performance to decline or fail. During transportation, installation, and use, be sure to avoid any impact or vibration from external forces.

1-1-1-4 Power Requirements

This equipment is powered by a single-phase AC220V power supply. Please make sure the housing of the system is grounded. To prevent the generation of static electricity and avoid interference from external electromagnetic waves, the system's grounding terminal must be separate and properly grounded. All machine parts must be connected to the rack or grounded separately. Grounding resistance should be less than 0.1Ω. Other supporting equipment or any other conductors near the system should also be grounded. It is prohibited to use any live conductor (e.g., a grounded neutral wire) as a ground connection wire.

This equipment has a grounding screw and label at the bottom of a support foot. The system must be grounded before use. If you are not sure whether the power supply line is grounded, please set up a separate grounding line and install a grounding stake near the equipment.

1-1-1-5 Working Environment Requirement

Temperature: 32-104°F; Humidity: 30-85% (no dew). Do not use in close proximity to a location that emits flammable or corrosive gases or solutions.

1-1-1-6 Cooling

The system is water cooled by an enclosed heat exchanger. Water must be kept at or below 80°F.

1-1-1-7 Emergency Stop

For emergencies or machine failures, immediately press the emergency stop switch. This will immediately stop the conveyor belt and turn off the X-ray source. After the fault is eliminated, start the device according to the standard safety steps. If the fault cannot be eliminated, please contact our service department for maintenance support. Additionally, the equipment should comply with the following electrical safety measures: distribution boxes, switchboards, knife switches, sockets, plugs and wires related to the equipment power connection must be kept in good condition and must not be damaged; equipment maintenance should be carried out by TDI service personnel or professional electricians designated by our company; if you find damaged wires or switches, please contact an electrician and do not operate until the issue has been resolved.



Only qualified, trained, and licensed electrical personnel should perform electrical maintenance work on the machine. Any repair or maintenance technician must read this manual in detail and understand all contents including safety signage.

1-1-2 Equipment Grounding and Equipotential Bonding

Product grounding, either earth or chassis ground, has two purposes: 1) The safety of the equipment due to any voltage fluctuations or discharges during operation, which can damage electrical components or harm anyone who contacts the machine. 2) The operational reliability of the equipment. The inside of the X-ray system is a complex system composed of a variety of electrical components. Reliable grounding can channel redundant interference signals to the ground, ensuring normal operation of the equipment.

The function of an equipotential connection is to make the potential in the protection range the same as the machine potential, avoiding accidents due to potential difference. To ensure the safe operation of all production equipment and operator personal safety, please ensure equipotential connections and reliable grounding of the related electrical equipment are in place before and after the equipment power supplies to prevent safety problems caused by any potential differences between the equipment.

This system requires AC220V $\pm 10\%$ as the standard configuration. The working frequency is 60 ± 3 Hz. If there is a high or low power supply voltage, or voltage fluctuations, please use a regulated power supply or UPS. Before the equipment is powered on, the equipment power supply grounding and chassis grounding must be complete.

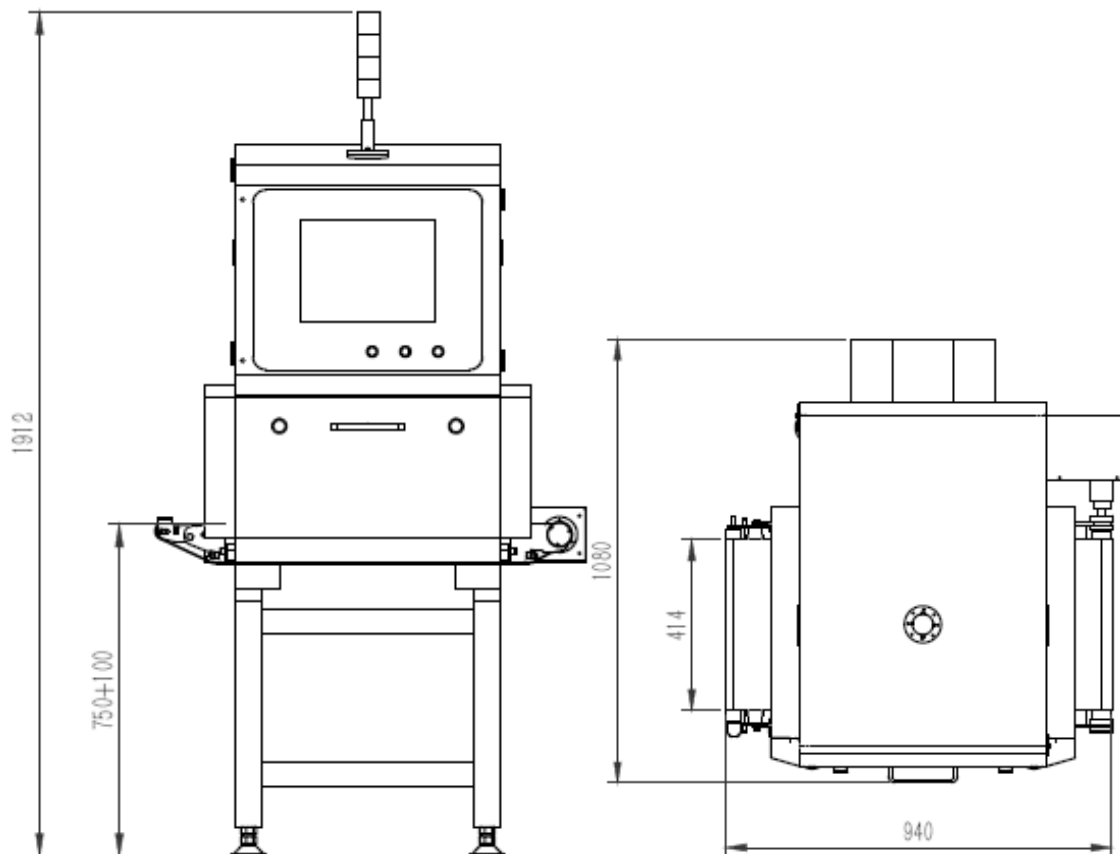
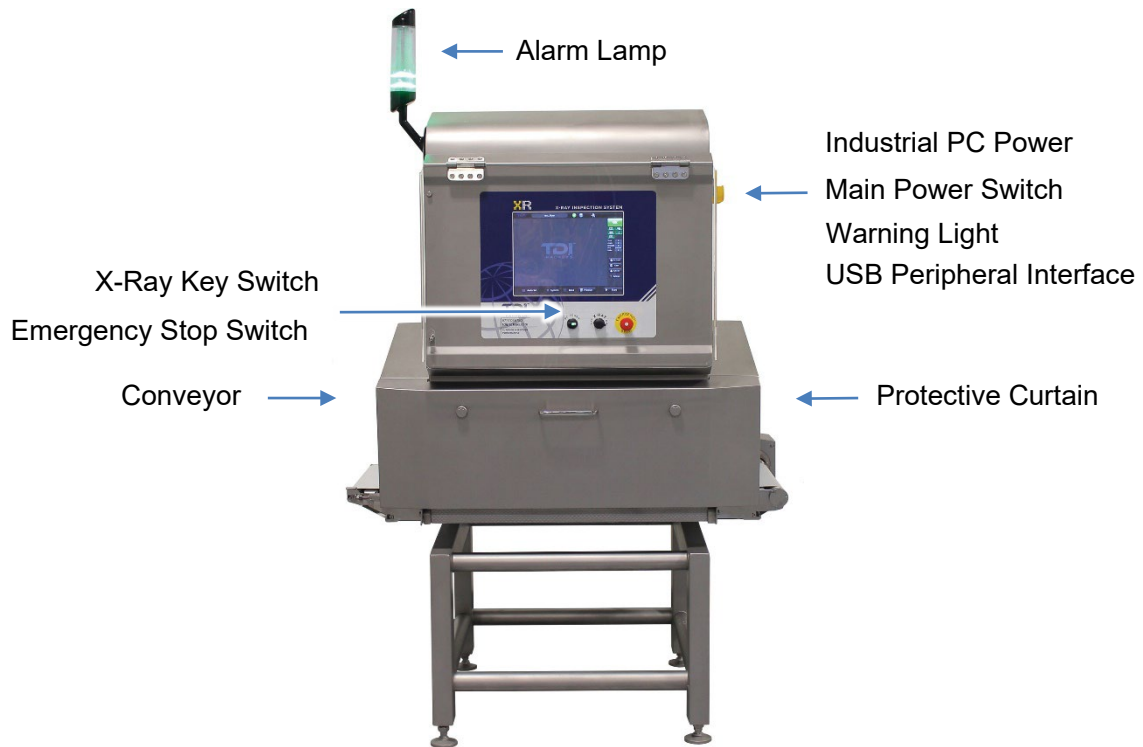
This equipment has a grounding screw and a grounding point label at the bottom of a foot. The equipment must be grounded before use. If you are not sure whether the power supply line is grounded, you must configure a grounding line or install a grounding point near the equipment.

Connect the lead wire to the terminal through the interface screw to complete the ground connection of the power supply line. The specifications of the grounding lead generally use 2.5mm² pure copper wire with an insulating sheath



1-1-3 XR Series

XR-G3-4080 The standard model drawing and size drawing are shown below:



Chapter 2: Device Startup and Shutdown

This chapter covers the startup and shutdown operations of the equipment. Throughout this chapter, users can quickly understand the operational flow of the X-ray contaminant detection system program.

2-1 Device Boot

To use the X-ray equipment, first connect the power supply of the machine and turn on the main power switch. Turn on the power of the industrial computer using the PC Power button and the X-ray contaminant detection system program software will start automatically after the operating system has loaded. The specific operation steps are as follows.

2-1-1 Peripheral Switches

Connect the external power plug to the power supply, press the red Emergency Stop Switch and ensure that the X-Ray key switch is in the 'Off' position.



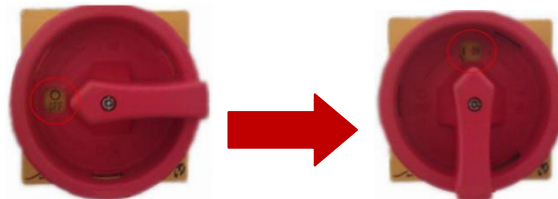
Emergency Stop



X-Ray Switch

2-1-2 Main Power

Turn the main power switch on the upper right side of the device to the right to turn it **【ON】**, as shown in the figure below:



After the main power supply is turned on, the main power supply can be turned off only after the industrial PC has been properly shut down. During the normal operation of the system, do not directly turn off the main power supply, otherwise system data may become lost or corrupted.

2-1-3 Industrial PC Power Supply

Press the green industrial computer switch or toggle switch on the front of the device and wait for the industrial PC to startup and load the operating system.

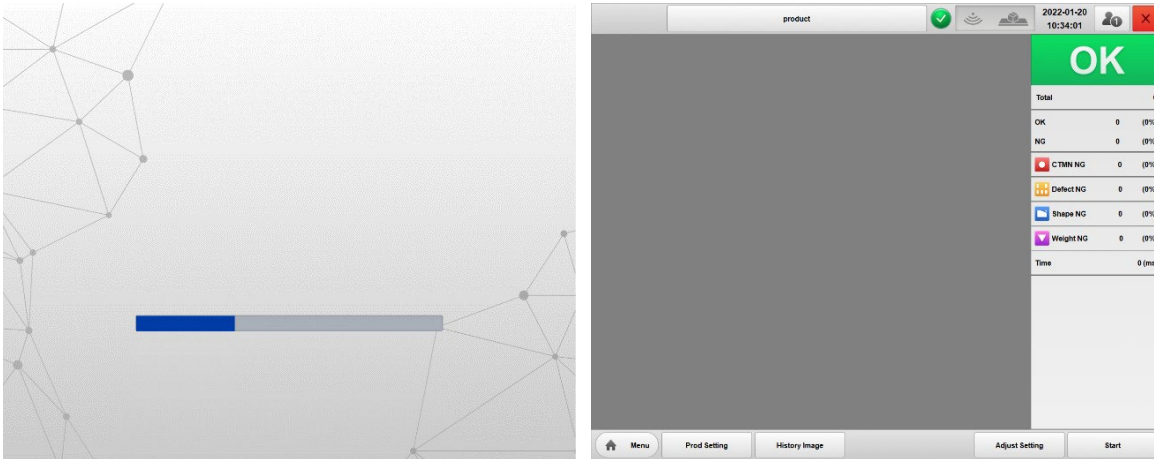


2-1-4 Perform X-Ray Inspection Program

After the industrial PC is started, the software program will automatically load.

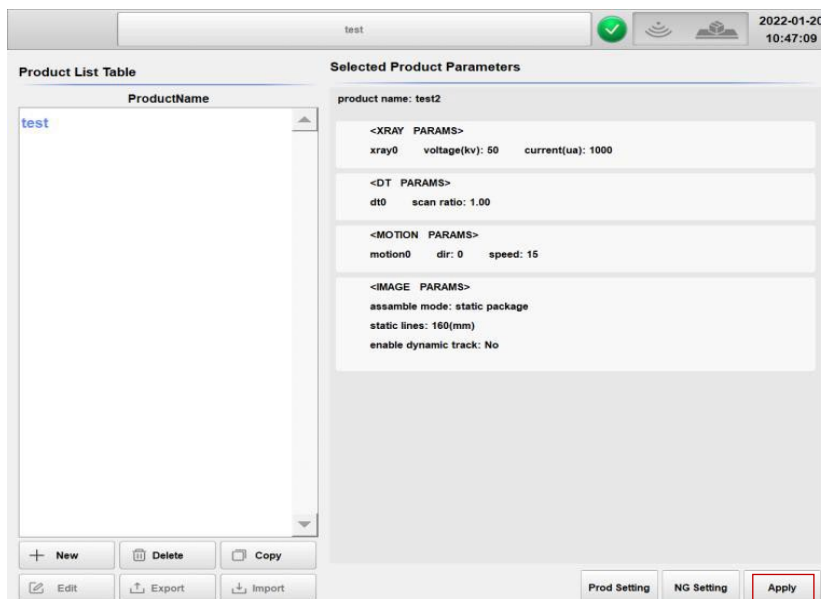
2-1-5 Program Start Interface

Once the detection program has started, an initialization is performed, and the initialization progress can be seen from the progress bar shown on the screen (below left). This process can take up to a minute. The initialization includes loading configuration files, monitoring the connection and running status of various external devices, loading system parameters, and self-checking. After the initialization is completed, the software will enter the main interface of the program, as shown in the figure (below right):



2-1-6 Product Select

Before starting the product test, select the product by clicking [Menu], [Product Management] in the main interface. The software enters the product operation interface where you can select the product to be tested. Click the [Apply] icon in the lower right corner to confirm your selection.



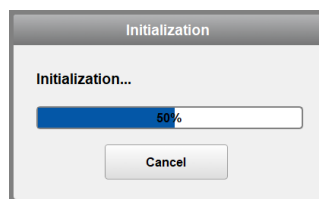
For detailed steps of adding products, please refer to Chapter 4 [Products] .

2-1-7 X-Ray Generator Warm-Up

After the program initialization is completed, enter the main interface of the system. If the device has not been used for an extended period, when you click the **【Start】** button in the lower right corner of the main interface the system will automatically start the X-ray warm-up procedure. The progress bar will give an approximate time frame for the warm-up to complete. The longer the device has not been in use, the longer the warm-up time needed to ensure safe operation.

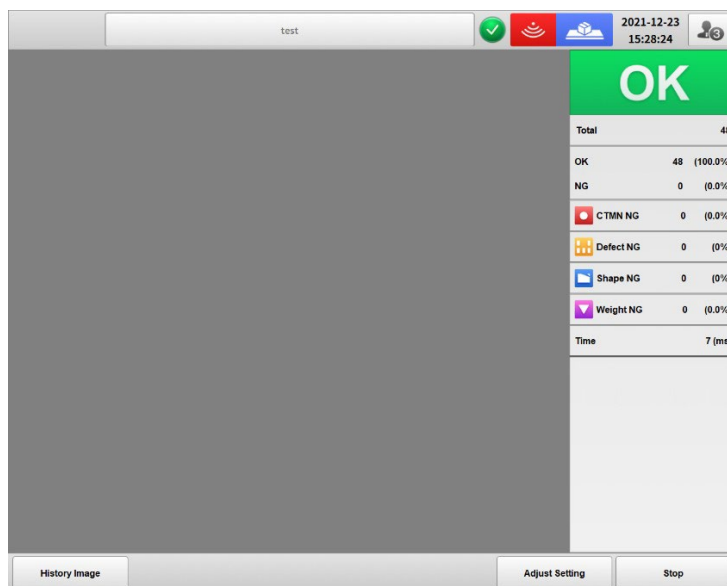
2-1-8 Detector Initialization

After the system is warmed up, click the **【Start】** button and the system will proceed to the detector initialization process. During the initialization process, the conveyor belt may run but it must be empty/free of any product, or this will affect the detector calibration and cause dark or incorrect images. Once initialization is complete, the software will enter into the inspection interface.



2-1-9 Automatic Inspection

After the initialization process is complete, the X-ray machine enters the automatic product inspection state, and the conveyor belt starts. The red X-ray indicator lamp will illuminate indicating that X-rays are being produced and the user can begin passing product.



When the system runs the contaminant detection program, it is necessary to ensure that the PC is not running other programs simultaneously. If other working software is operating at the same time, the efficiency of the detection program will be reduced, and the image processing speed could be affected.

2-2 Equipment Shut-Off

It is important to properly shut down the software and PC before turning off the main power to the system. First, stop the software inspection program then shut down Windows using the Start menu and choose the Shut Down option. Once Windows shuts down and the HMI screen goes black, the main power switch can be turned off. Detailed instructions are as follows.

2-2-1 Exit Automatic Inspection

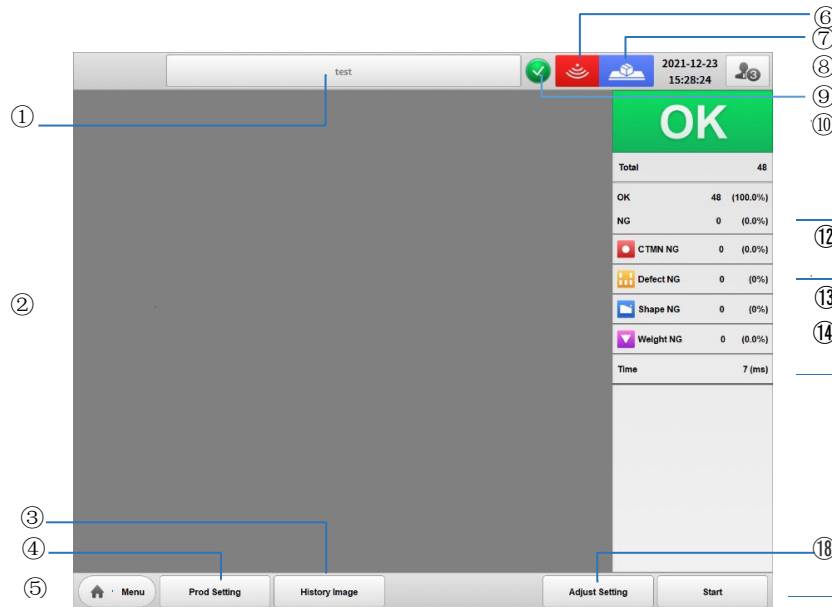
Click the **【Stop】** button at the bottom right of the automatic inspection interface. This will stop the detection and turn off the X-ray source as well as the conveyor belt before returning to the main interface of the program. From here, you can close the software using the “X” button in the upper right corner. The machine will prompt for confirmation to close the software. Choose ‘Yes’ to return to Windows. Click the ‘Start’ button in the lower left corner and choose ‘Shut Down’ to shutdown Windows.

2-2-2 Exit System

Once Windows has shut down, release the green power button of the industrial PC or turn the toggle switch off. Turn the main power switch to the OFF position, and then turn off the X-Ray key switch. It is recommended that the key be removed at this time and stored in a safe place. If the device will not be used for an extended period of time, the power cord should be unplugged and properly stored.

Chapter 3: Overview of the Main Interface

This chapter introduces the main interface of the X-ray contaminant detection system in detail as shown in the figure below. Through this chapter, the user can understand the functions and operation of each part of the program interface. Detailed functions of each component are introduced as follows:



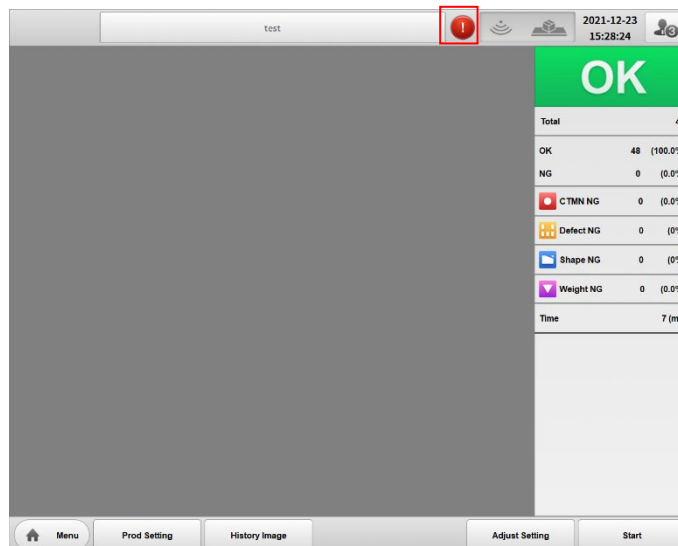
①	Product name	Displays the name of the product being inspected
②	Image display area	Displays the X-ray image of the product
③	Historical images	Displays images of inspected NG products
④	Product settings	Create, delete, copy and other product operations
⑤	Main Menu	Includes Product Management, System Settings, System Function settings, and other functions
⑥	Peripheral Indicators	Displays the status of external devices. This displays red in an abnormal/fault condition
⑦	Conveyor belt indicator	Grey – Conveyor off. Blue – Conveyor on.
⑧	Permission settings	Used to switch User Levels/User permissions
⑨	Xray generator indicator light	Green means the Xray generator is off, Yellow means ready to open, red means generator is creating X-rays
⑩	Inspection results	During automatic inspection, if there is no foreign object, this will display OK, and if there is a foreign object, it will display NG
⑪	Total	Total number of products tested
⑫	Product Statistics	NG and OK product quantity and percentage statistics
⑬	Foreign body/CTMN NG	Product quantity and percentage statistics of foreign matter NG
⑭	Defect NG	Product quantity and percentage statistics of defective NG
⑮	Shape NG	Product quantity and percentage statistics for shape NG
⑯	Weight NG	Product quantity and percentage statistics by weight NG
⑰	Time	The image processing time of detection operation (in ms)
⑱	Debug settings	Includes detection parameter setting and NG setting
⑲	Start	Used for X-ray warm-up, initialization, automatic inspection operations

3-1 Peripheral Indicators

 The peripheral indicator is used to verify the operating status of all external devices. When all external devices are normal, a green icon will be displayed. If there is an abnormality or fault, a red warning icon will be displayed adjacent to the external device in question. A description of the fault will be shown in the box below the device status, as shown below:



According to the example screen shown above, #8. Door_Back is in a fault condition. The abnormal situation is that the back door is open to indicate for the user to confirm the back door is fully closed. If you click the [close] button in the lower right corner, the user can return to the main interface and the alarm will stop, but the warning icon is still red because the fault was not cleared. If the fault is cleared, the alarm screen will automatically exit and the warning icon changes to green. 

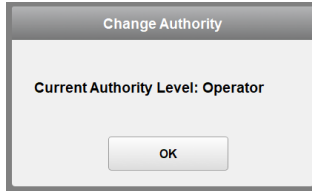


Monitoring of external equipment is conducted to prevent X-ray radiation leakage caused by human error. The X-Rays can only be generated when all fault conditions are cleared

3-2 Switching Users/Permissions

This system is pre-loaded with three User/Permission levels: [Operator], [Administrator], & [Engineer]. Users can select what each permission can do in the user permission configuration.

- Click on the icon in the upper right corner of the main interface [] to enter permission selection interface as shown below:

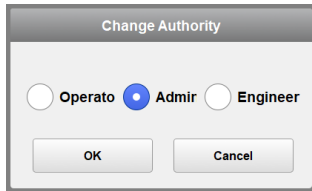


Change Authority

Current Authority Level: Operator

OK

- Click [OK] to show the 3 permission levels: [Operator] [Administrator] [Engineer].

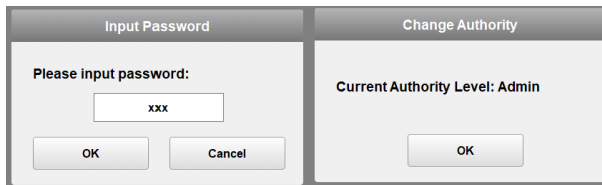


Change Authority

☐ Operato ☒ Admir ☐ Engineer

OK Cancel

- When selecting the [Administrator] or [Engineer], the user will need to enter a password. These users have more access to various settings functions of the software and therefore are password protected. Default passwords are set at the factory but can be changed based on customer needs.



Input Password

Please input password:

xxx

OK Cancel

Change Authority

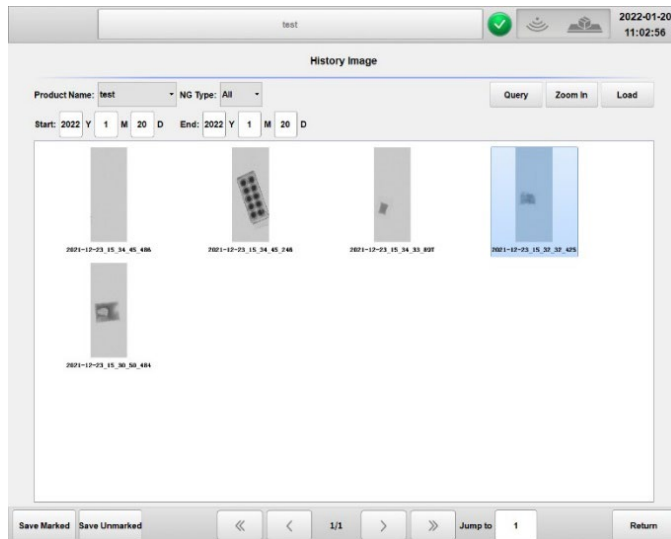
Current Authority Level: Admin

OK

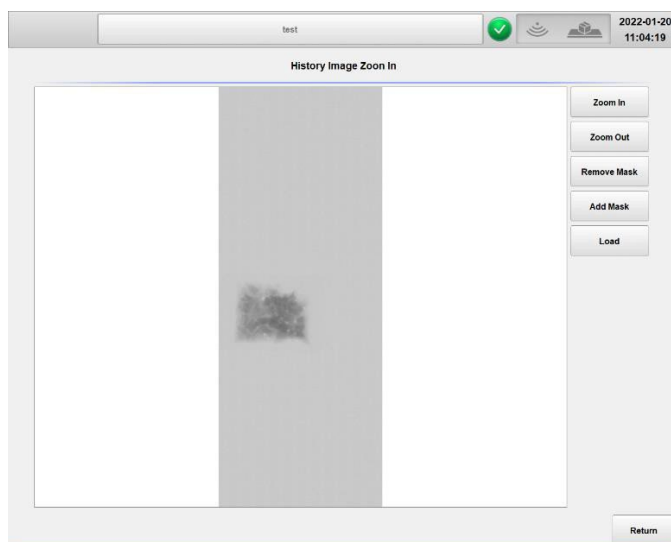


The initial password for [Administrator] and [Engineer] is provided to the customer during commissioning. These passwords can be changed for/by the customer. If the user changes the password and it is lost, please contact our service department.

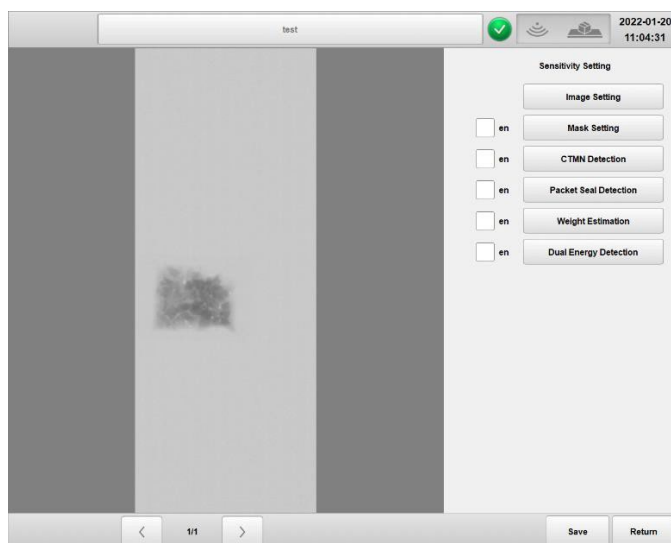
3-3 Historical Images



The detected/rejected NG product images can be viewed in the [Historical image] function. Users can select the NG product image to view according to the product name, time range, and NG type. You can also select to save the alarm box image [save mark map] or no alarm box image [save no mark image] according to your needs.



Select the picture you want to view and click [Query] to enter the image viewing interface. The user can click the right [Zoom in]/[Zoom out] to view the image in more detail. Click [Add mark] to display the alarm box in the image to highlight where the contaminant was detected, and [remove mark] to remove this from the image.



Click the [Load] button to enter the [Debug Settings] interface. The user can now view the image using the different algorithms and image settings. This is useful when determining if the contaminant is a false positive and adjusting sensitivities to accommodate customer inspection needs.

Chapter 4: Main Menu

4-1 Product Management

The main functions completed in the product interface are:

1. Addition of new products
2. Modifying existing product parameters
3. Deleting/Removing products

Click [Product Management] in the Menu interface of the program and the product information interface will appear as shown below. On the left is the list of products that have already been entered. The right side shows the parameter information of the selected product, including X-Ray Parameters, Detector Parameters, Motor Parameters, Imaging Parameters, Exclusion Parameters, etc.

If you need to modify these parameters of the product, you can click on the [Product Settings] and [NG Settings] in the lower right corner of the interface to set the corresponding parameters, followed by pressing 'Save' to save the updates. When the interface is returned from the [Product Settings] or [NG Settings] interface, the product parameter information will also be updated.

The screenshot displays the Product Management interface. At the top, there is a header bar with a search field containing 'test', a green checkmark icon, a signal icon, a printer icon, and a timestamp '2022-01-20 10:47:09'. The main area is divided into two panels. The left panel, titled 'Product List Table', contains a table with one entry: 'test'. Below the table are buttons for '+ New', 'Delete', 'Copy', 'Edit', 'Export', and 'Import'. The right panel, titled 'Selected Product Parameters', shows the parameters for 'product name: test2'. It includes sections for '<XRAY PARAMS>' (xray0, voltage(kv): 50, current(ua): 1000), '<DT PARAMS>' (dt0, scan ratio: 1.00), '<MOTION PARAMS>' (motion0, dir: 0, speed: 15), and '<IMAGE PARAMS>' (assamble mode: static package, static lines: 160(mm), enable dynamic track: No). At the bottom right, there are buttons for 'Prod Setting', 'NG Setting', and 'Apply'.

ProductName
test

Selected Product Parameters

product name: test2

<XRAY PARAMS>
xray0 voltage(kv): 50 current(ua): 1000

<DT PARAMS>
dt0 scan ratio: 1.00

<MOTION PARAMS>
motion0 dir: 0 speed: 15

<IMAGE PARAMS>
assamble mode: static package
static lines: 160(mm)
enable dynamic track: No

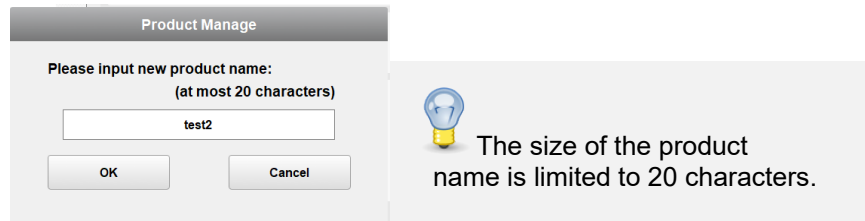
+ New Delete Copy Edit Export Import

Prod Setting NG Setting Apply

4-1-1 Adding and Deleting Products

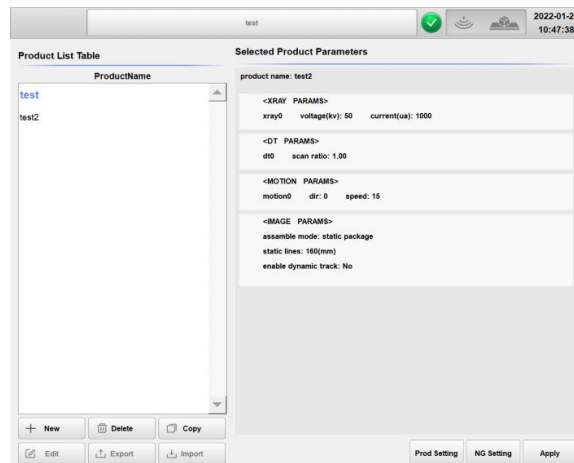
4-1-1-1 Adding a Product

Click the [New] icon to bring up the naming window, and press on the white box. A keyboard will appear; use to enter the product name. Click [Enter] to accept the product name, and add it to the product list.



4-1-1-2 Deleting a Product

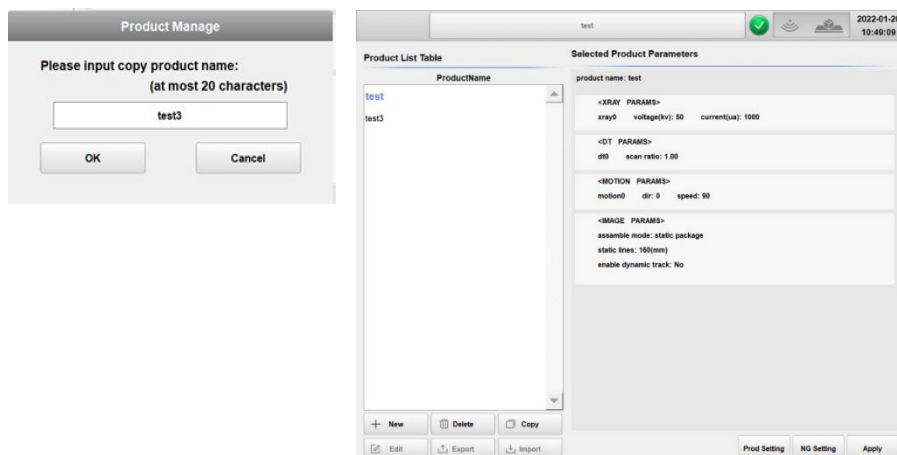
Select product to be deleted from the list; click the [Delete] icon. Product will be removed from the list.



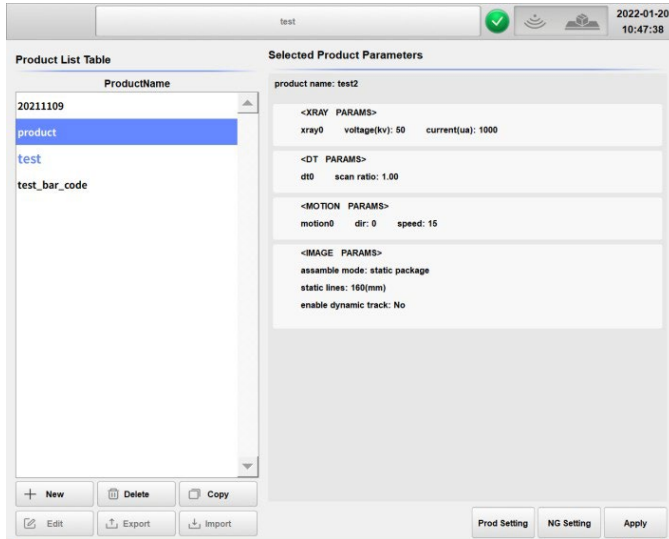
4-1-2 Copying Products

Existing product parameters and settings can be copied, and the product name can be modified to use the same detection requirements for similar products.

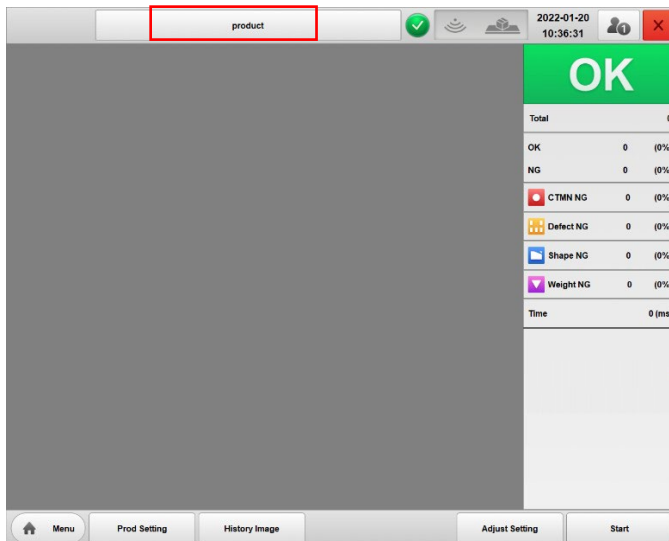
In the product list, select the product you wish to copy and press the [Copy] button. The naming window will appear where you can change the name to the new product and press [Ok] to add it to the list.



4-1-3 Applying the Product



In the product list, click to highlight the product you wish to run. The product selected in the figure below is "product". Click [Apply] in the lower right corner to load the product and the software will return to the main interface of the program.



The product name in the gray box above the main interface changes from "test" to "product", indicating that the product application is successful and you can now press 'Start' to run this program.

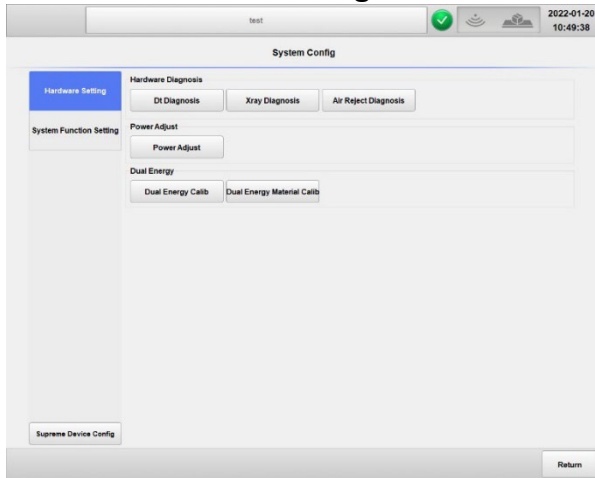
4-2 System Settings

The System Settings include hardware settings and system function settings.

4-2-1 Hardware Settings

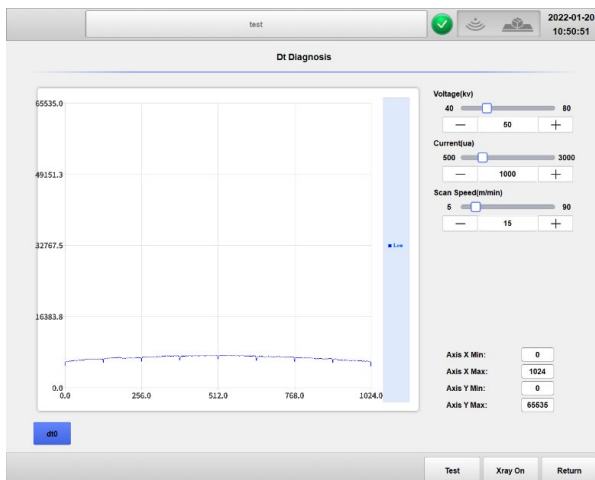
Hardware settings include hardware diagnosis, power correction, and dual energy. These are used to diagnose the detector and the X-Ray source.

4-2-1-1 Hardware Diagnosis



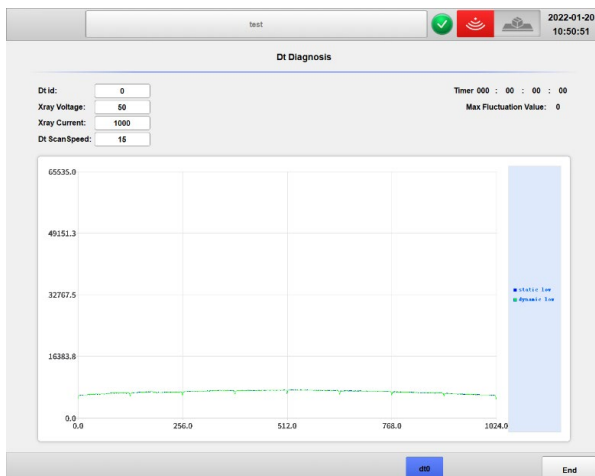
Hardware diagnosis enables the diagnosis of key components such as the detector, X-Ray source, air reject, and dual energy calibrations.

1) Detector Diagnosis



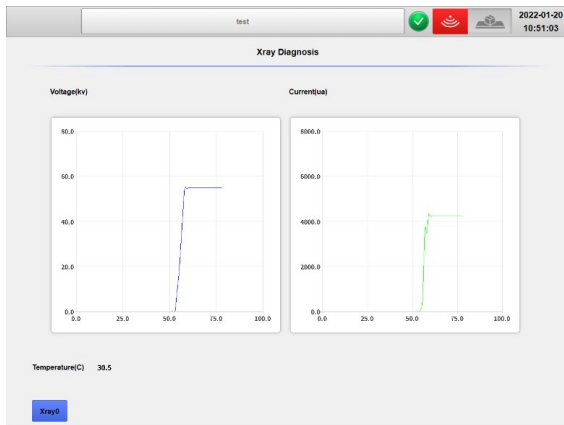
Detector (DT) diagnosis is used for the evaluation of the detector data curves and their stability. Click [Open Light Source] to show the detector curve.

The voltage, current, and scan speed on the right are used to observe the change of the detector curve under different settings. By changing these values, it can be observed that the curve of the detector will also change dynamically. The X/Y axis maximum/minimum is used to adjust the curve range to observe subtle changes in the curve.



Click the [Test] button in the lower right corner of the detector diagnosis interface to begin testing. The parameters in the upper left show the current, voltage, and the scan speed that the system is running. The timer of the detector stability test can be seen in the upper right corner. After the X-Ray source is turned on normally and the voltage and current are stable, one curve will show the actual detector curve while the other curve will show the detector curve in real time. Comparing these allows you to see the changes of the detector curve caused by the X-ray source drift over time.

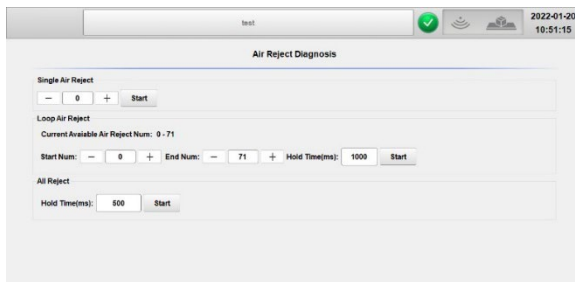
2) X-Ray Source Diagnosis



The X-Ray source diagnostic interface is used to observe the voltage and current stability time and the stability of the X-Ray source. Click [open the light source] and you can see the fluctuation curve of the current and voltage of the X-Ray source. You can also monitor the temperature of the X-Ray source from this screen. Some X-Ray sources have a long stability time after opening which can be seen below.

3) Air Reject Diagnosis

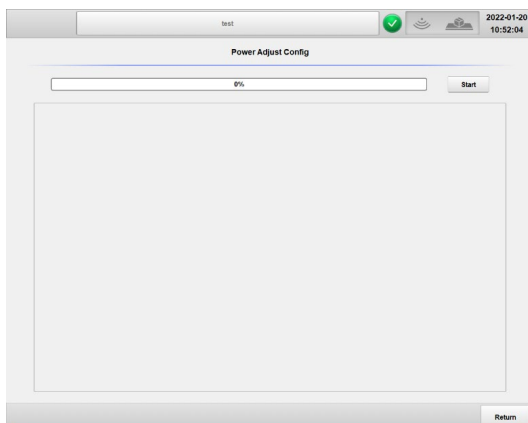
Air reject diagnostics is mainly divided into three modes: single air reject, circulating/loop air reject, and all reject. These are used for the functional testing of air rejects for the foreign body detection of bulk material products. The Single Air Reject allows you to choose a single output air valve to test. Circulating/Loop Air Reject allows you to cycle through a specific set or choose all air outputs to cycle through and check if any are not operating correctly. You can set the interval at which they will cycle from this function as well. All reject will turn on the air to all outputs to ensure they are all properly blowing.



Hardware diagnosis functions are mainly used for debugging by TDI service engineers. Users should only operate under the direction of a TDI Packsys service engineer.

4-2-1-2 Power Correction

Power correction is used to limit the voltage, current, and scan speed set by the automatic detection function. After clicking the [Start] button, the status of the power correction will be shown in the progress bar and the corresponding power correction file can be generated to limit the voltage, current, and scan speed before automatic detection.

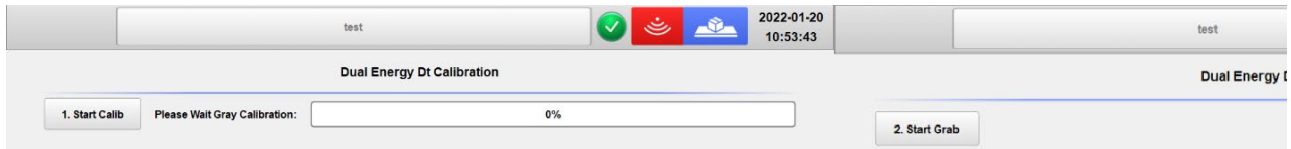


The power correction has been completed before the machine leaves the factory. Users do not operate without permission or under direction of TDI Packsys service personnel.

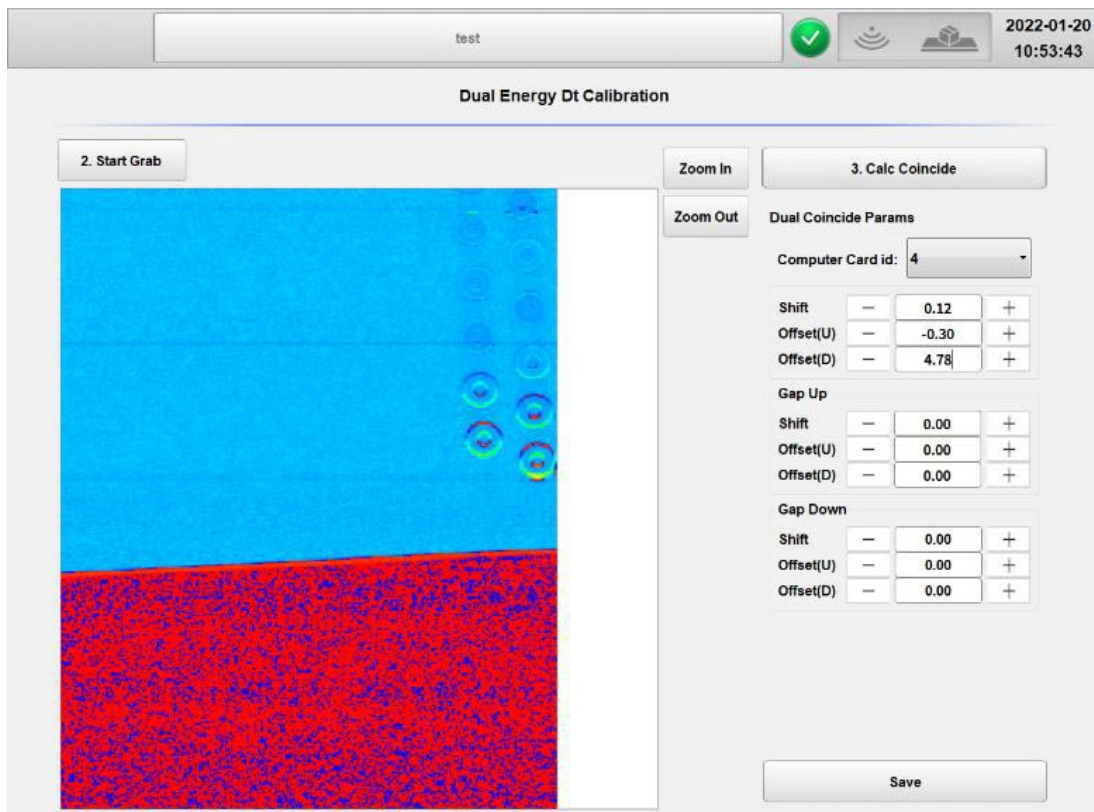
4-2-1-3 Dual Energy

1) Dual-Energy Calibration

Click [Dual Energy Calibration] to enter the calibration interface for dual energy detectors. Click [1. Start Calibration] as seen below. After the gray scale correction is completed, the interface will automatically change, and then click [2. Start Grab].



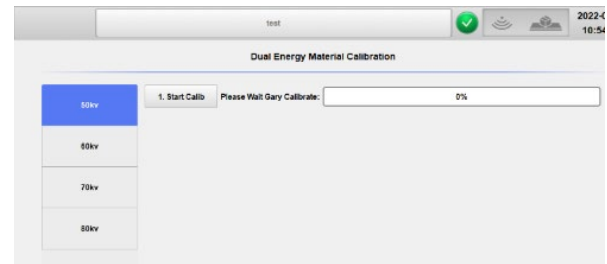
After the image grab, click [3. overlap] for the system to automatically calculate the general dual energy calibration parameters. Click [Zoom] to enlarge the image to see whether the gasket area in the picture, the inside of the gasket, and outer edges are red or blue, showing the gasket area is not completely overlapped. Adjust the displacement of the Shift, Gap Up, and Gap Down area until they completely overlap. Select different cards and adjust the gasket area on each card until the spacers on all cards completely overlap to complete the dual energy calibration.



2) Dual-Energy Material Calibration

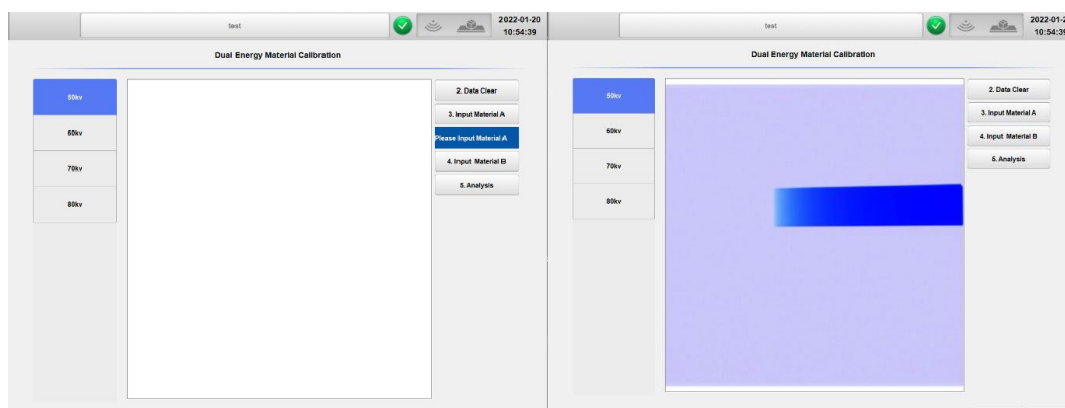
Dual-energy material calibration needs to be done at 50 kV, 60 kV, 70 kV, & 80 kV steps.

First, start the 50 kV material calibration, click [1. Start correction]; wait for the gray scale correction to complete, and jump to the next interface after completion.

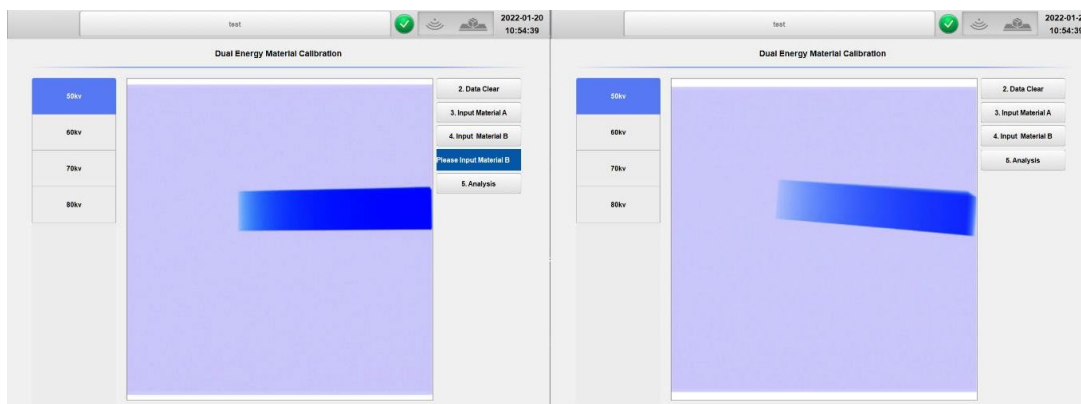


[2. Data emptying] This button will empty any stored data. If the calibration material is wrong in the 3 / 4 / 5 step, click this button to empty the data and restart the material calibration at the current voltage.

Click [3. Place Material A] to place the calibrated material A on the belt and wait for the image.



Click [4. Place Material B] to place the calibrated material B on the belt and wait for the image.



Click [5. Analysis] and the software will automatically calculate the material calibration parameters at 50 kV. The software will then automatically jump to the dual energy material calibration interface for 60 kV after the calculation. Repeat the steps above for the remaining voltages to complete the material calibration process, then click [Save] to save the material calibration settings.



The Dual Energy procedures have been completed at the factory prior to use (if applicable). Users should not perform these actions without a service engineer present or under the guidance of TDI Packsys service personnel.

4-2-2 System Function Setting

System Function settings include signal lights, historical image saving, user permissions, activation configuration, language, shutdown configuration, network communication, and other functions.

4-2-2-1 Signal Lamp Configuration

The screenshot shows the 'Tower Signal Config' window. The top bar includes a 'test' button, a green status icon, and a timestamp of 2022-01-20 10:55:13. The 'Enable Config' section contains four rows of settings: Ready, Running, Exception, and NG Alarm. Each row has four checkboxes for 'red', 'yellow', 'green', and 'buzzer'. The 'Param Config' section contains five rows: Red, Yellow, Green, Buzzer, and Xray Lamp. Each row has an 'Enable' checkbox, a 'port' input field (all set to 0), and a 'polarity' checkbox. The bottom of the window has 'Save' and 'Return' buttons.

The signal tower lamp configuration can set the operation, number of lights, lamp color, and buzzer to their corresponding actions. In the Enable Config area, you can select the indicator color or buzzer for Ready, Running, Exception (fault), and NG alarm. The Parameter Config area below allows you to choose whether to turn on the red, yellow, or green indicator, the buzzer, and light indicator, and set the corresponding port number, and the polarity based on when an action occurs.

4-2-2-2 Historical Image Saving Configuration

The screenshot shows the 'History Save Image Config' window. The top bar includes a 'test' button, a green status icon, and a timestamp of 2022-01-20 10:56:17. The 'Enable save good data', 'Enable save ng data', and 'Enable save image' checkboxes are all checked. The 'image type' section has four radio buttons: 'JPG', 'PNG' (selected), 'BMP', and 'PNG16'. The 'Max save image num' input field is set to 1000. The 'Min disk free space(GB)' input field is set to 20.00. A label 'Current disk free space: 27GB' is displayed. The bottom of the window has 'Save' and 'Return' buttons.

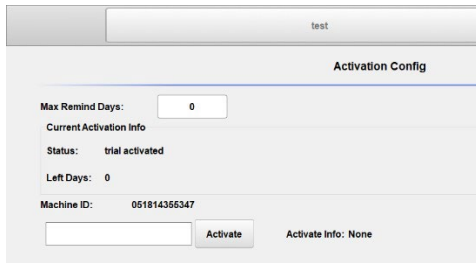
In the historical image save configuration, you can choose whether to enable the saving of good/OK images, NG images, or all images. You can also choose the format in which these are saved. This screen also lets you choose how many images to store and shows how much space is remaining on the hard disk drive.

4-2-2-3 User Authority configuration

The screenshot shows the 'User Authority Config' window. The top bar includes a 'test' button, a green status icon, and a timestamp of 2022-01-20 10:56:37. The 'User Password' section has two input fields: 'Admin' (set to 'sss') and 'Engineer' (set to 'xxx'). Below this is a table with 13 rows and 3 columns: 'Admin', 'Operator', and 'Engineer'. Each row has a checkbox for each user level. The bottom of the window has 'Save' and 'Return' buttons.

In the user authority configuration, different operational configurations can be made for different authority levels to meet the specific requirements in the customer production process. Above the interface, you can modify the user passwords for the Admin and Engineer user levels. This menu is only accessible using the Engineer permission.

4-2-2-4 Activation configuration



The screenshot shows a software window titled "test" with a sub-header "Activation Config". Below the header, there are several fields and buttons: "Max Remind Days:" with a value of "0"; "Current Activation Info" section containing "Status: trial activated" and "Left Days: 0"; "Machine ID:" with the value "051814355347"; an "Activate" button; and "Activate Info: None".

The activation configuration can view the current activation information, the device number, and perform the activation operation.

4-2-2-5 Language configuration

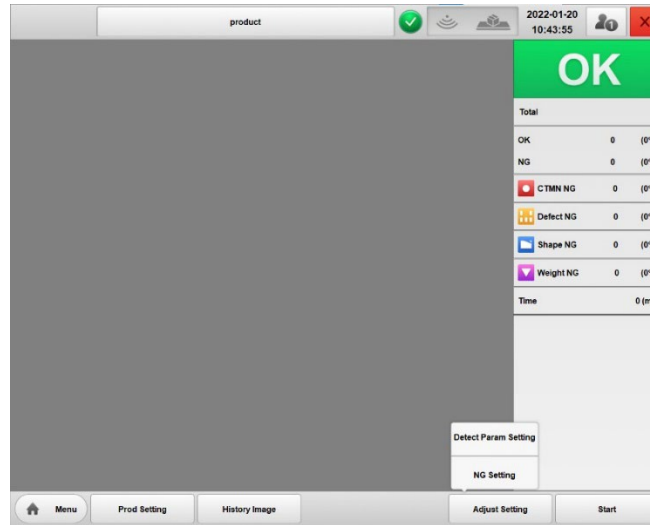
In the language configuration, you can switch the language type, click Save, and restart to switch the system language.

4-2-2-6 Shutdown configuration

The shutdown configuration includes three options that control which permissions are allowed to shut down the machine or software. The default settings allow only the Admin or Engineer levels to perform a shutdown or exit the inspection software.

Chapter 5: Product Settings Interface

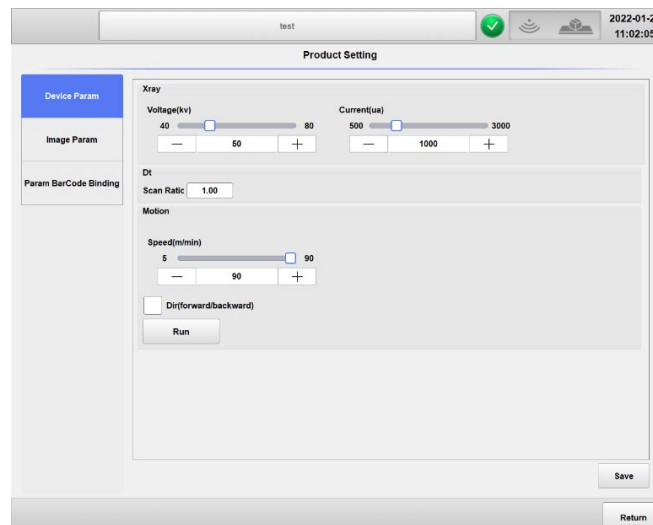
In the Product/Adjust Settings interface, the device parameters, image parameters, barcode setting, NG settings, and other information of the product can be modified.



5-1 Device Parameter

Enter the "Device Parameters" interface to view and modify the voltage and current of the X-ray source, detector sampling rate, motor speed and running direction of the current applied product.

The voltage corresponds to the quality of the X-ray image. The higher the voltage, the stronger the X-ray penetration ability and brighter the image. The current corresponds to the amount of X-rays supplied. The amount of X-rays that penetrate is proportional to the current. These two values will be limited by the maximum and minimum power/wattage of the X-Ray source, so they may not be set to the maximum value on the slider at the same time. Users can adjust the speed and direction of the motor according to the product and their own needs. The speed and rotation direction of the motor can be tested through the [Run] button below these options. The default sampling rate is 1, and this rarely needs to be changed.



5-2 Image Parameter

Product image parameters are used to modify product mode, product effective grayscale, effective pixel length, and whether to enable dynamic tracking. Product modes include package and bulk modes. The package mode is used when the products are passing individually. This is divided into fixed size packaging and non-fixed/dynamic size packaging. In bulk mode, the products pass through the belt at random and may be overlapping. These are divided into bulk packed and bulk unpacked. [Product length] refers to the detected product length. [Maximum Length] is the maximum length of the image displayed during detection in the Dynamic Size Package option. [Interval Length] is the image interval length within this value range and is regarded as a product. [Ignore Area] is the image area within this value that is not regarded as a product using the Bulk Package option. [Slice length] is the display length of the image in Bulk mode and [Overlap length] refers to the overlap size of the two grayscale images during this type of detection so that any contaminants that fall on the edge of the images are not missed.

The screenshot shows the 'Product Setting' window with the 'Image Param' tab selected. The interface is divided into four quadrants for different product modes: 'Static Size Package' (selected), 'Dynamic Size Package', 'Bulk Package', and 'Bulk'. Each quadrant contains specific parameter fields and a small 3D product illustration. At the bottom, there are global settings for 'Prod Valid Thres', 'Valid Pixel lines', and 'Enable Dynamic Track'. A 'Save' button is located at the bottom right of the main settings area.

Product Mode	Parameter	Value	
Static Size Package (Selected)	static lines(mm)	160	
	max lines(mm)	160	
Dynamic Size Package	Interval lines(mm)	20	
	max lines(mm)	160	
Bulk Package	lines max(mm)	400	
	ignore area(cm²)	4.00	
	Prod Valid Thres	43520	
Bulk	slice lines(mm)	100	
	overlap lines(mm)	20	
	Valid Pixel lines(mm)	2	
Enable Dynamic Track			☐

5-3 Barcode Setting

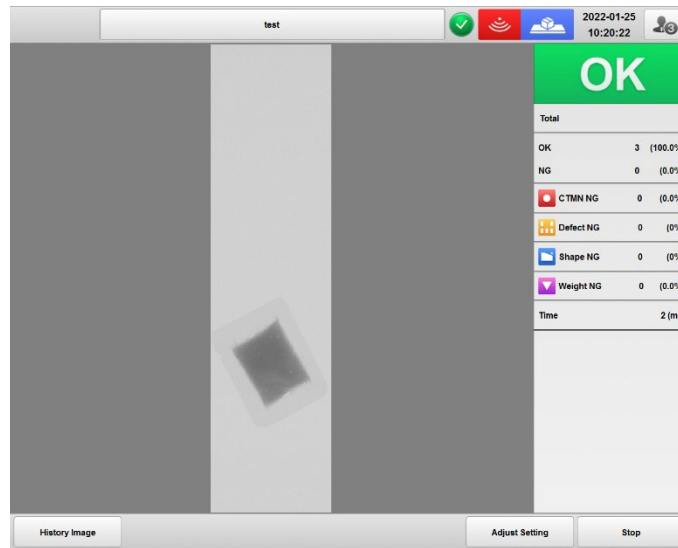
Enter the barcode setting interface to add barcode information. Different products can be identified through barcodes, and different detection parameters can be applied for different products.

The screenshot shows the 'Product Setting' window with the 'Param BarCode Binding' tab selected. It features a 'Bar Code Info List' table with columns for '<1>' and '()'. Below the table is an 'Add Bar Code Info' dialog box with fields for 'Code' and 'Remark', and 'OK'/'Cancel' buttons. At the bottom of the main window are 'Add', 'Delete', 'Modify', and 'Save' buttons.

Bar Code Info List
<1> ()

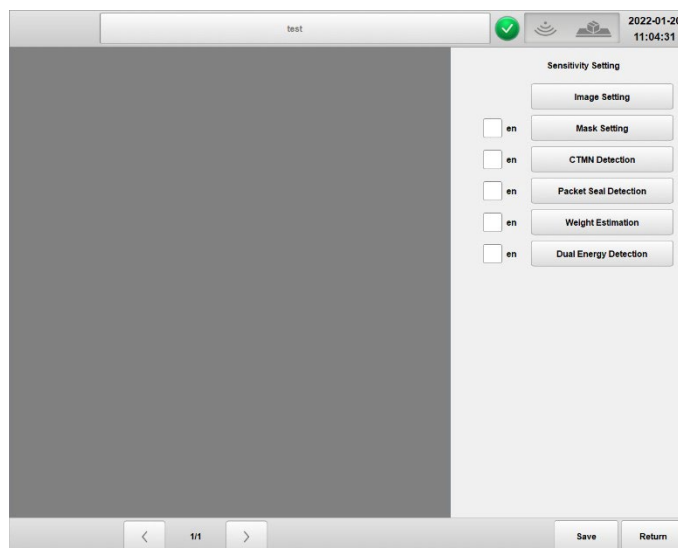
Chapter 6: Adjust/Debug Settings

Click [Start] to initialize the detector, and the conveyor belt will start to run. During the initialization process, ensure that the conveyor belt remains empty until the initialization is complete. There is no foreign body in the picture below and the detection result shows OK. If foreign body is detected, the detection result shows NG, marks the contaminant in the image, and the system issues an alarm.



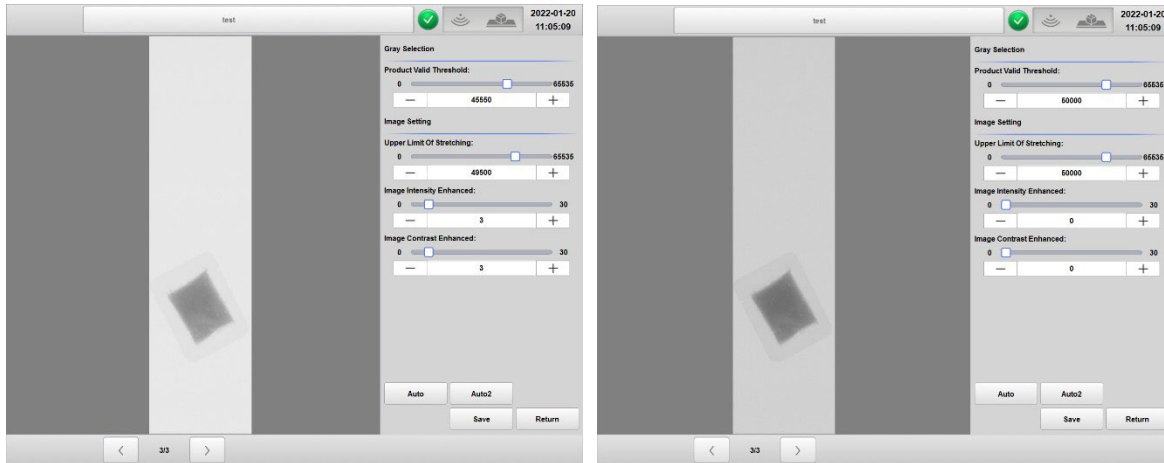
6-1 Detection Parameter Setting

The detection parameter setting is mainly divided into two parts: product display image and product inspection. Product inspection includes five detection algorithms such as Mask setting, Foreign Body/CTMN detection, Product Seal detection, Weight Evaluation and Dual-Energy Detection. Check the box in front of each algorithm to enable the corresponding algorithm.



6-1-1 Image Setting

Click Image Setting to enter the product image setting interface. [Product Valid Threshold] is used to select the product area. [Upper Limit of Stretching] is used to select the image area that needs to be optimized, generally the product area. [Image Intensity Enhanced] is used to enhance the gray value of the image, and [Image Contrast Enhanced] is used to improve the clarity/contrast of the image.

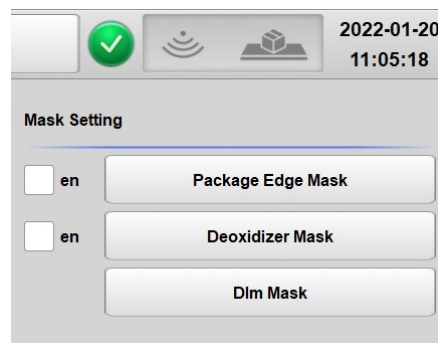


[Auto] and [Auto 2] are two different optimization algorithms which optimize the image display effect by modifying the brightness and intensity parameters. Click [Auto] or [Auto 2] and the system will automatically optimize the image. The users can adjust the parameters to suit their own needs.

The optimization function of [Image Settings] in this section is used to display the detection picture on the main screen, which is only used for the picture display effect, and is not used in the CTMN detection process.

6-1-2 Mask Setting

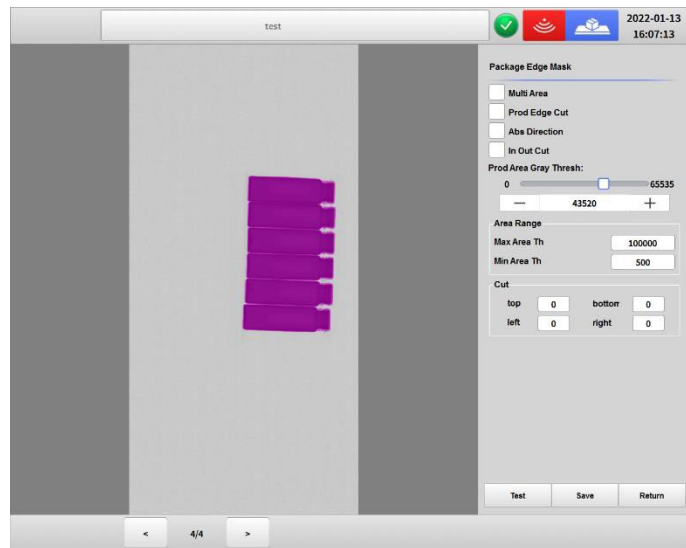
When testing certain products, there may be some areas which do not need to be inspected and the mask settings can be performed to mask these areas. Mask settings include Package Edge and Desiccant. Package Edge mask is suitable for products that require masking at the edge of the package, such as metal, glass, or other high-density materials that are prone to false alarms on the packaging material. Desiccant masking is for products containing desiccant or deoxidizer packs in product.



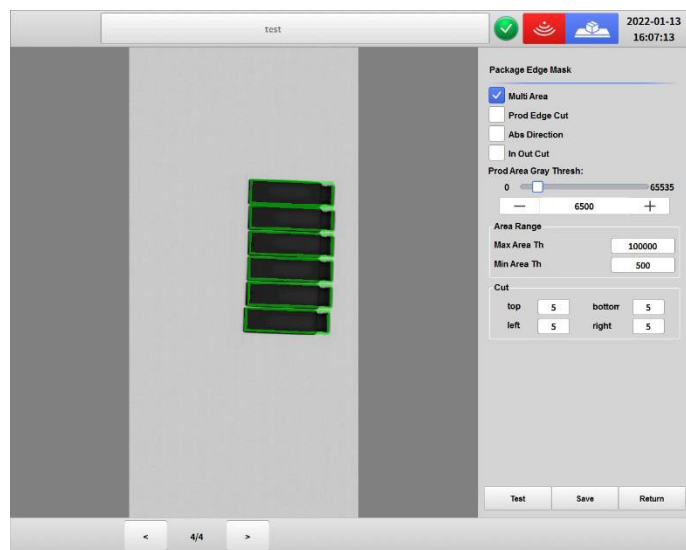
6-1-2-1 Package Edge Mask

Check the box by Package Edge mask to enable this function. [Product area grayscale threshold] is used to select the entire product area, and the area range is used to select the product area that needs to be masked. Users can modify the parameter values according to the product size. The top, bottom, left, and right in the Cut section set the width of the corresponding masked area.

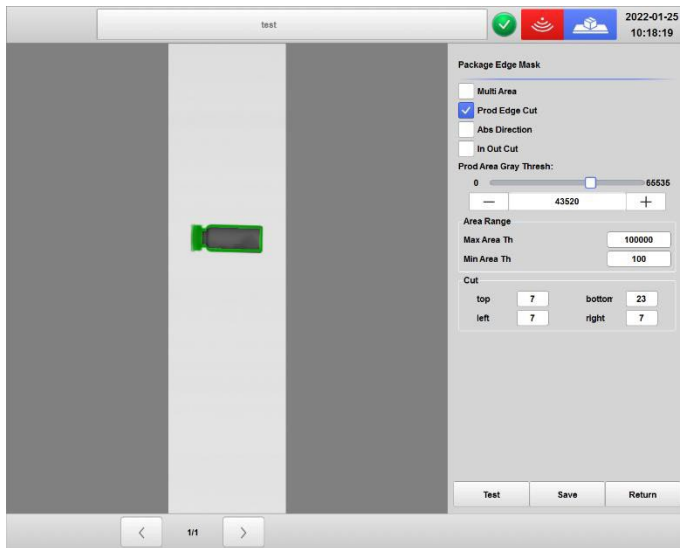
There are four algorithms for Package Edge masking. Users can choose different algorithms based on their product to select the edge area that needs to be masked or they can open multiple algorithms at the same time. When setting the product masking area, it is often necessary to debug different algorithms together to accurately select the area to be masked.



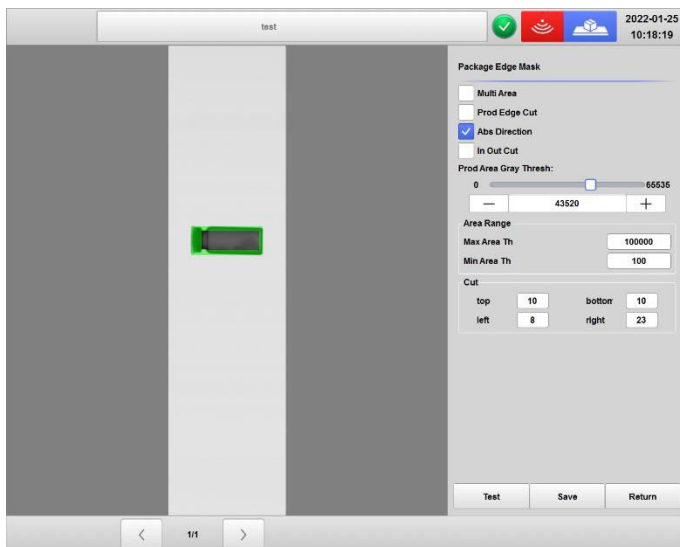
Multi area masking is suitable for products that are divided into multiple areas or multiple products in a single package. Adjust the [product area grayscale threshold] to select the product area, as shown:



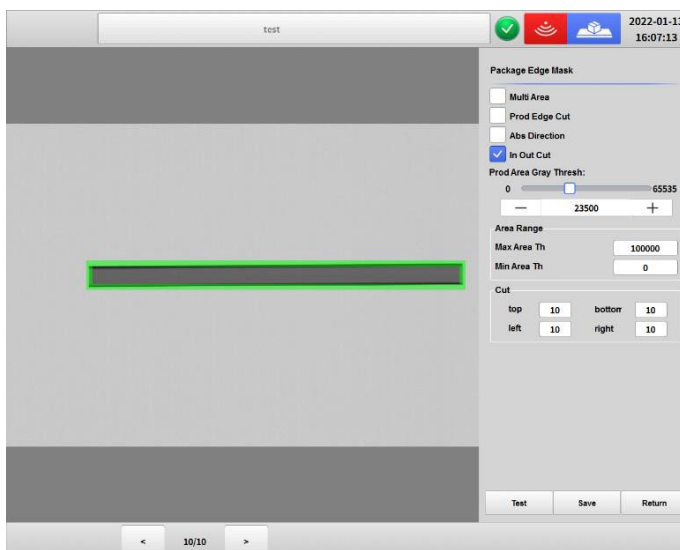
Select the multi-area masking and set the appropriate product area grey threshold, area range, and cut range of the product area to select the product area that needs to be masked. The masking range is shown in green in the figure:



Product Edge Cut masking is used to mask along the edge of the product area selected by the user. After selecting the product area, set the appropriate mask width in the Cut options, click Test, and you can see the set edge masking area.



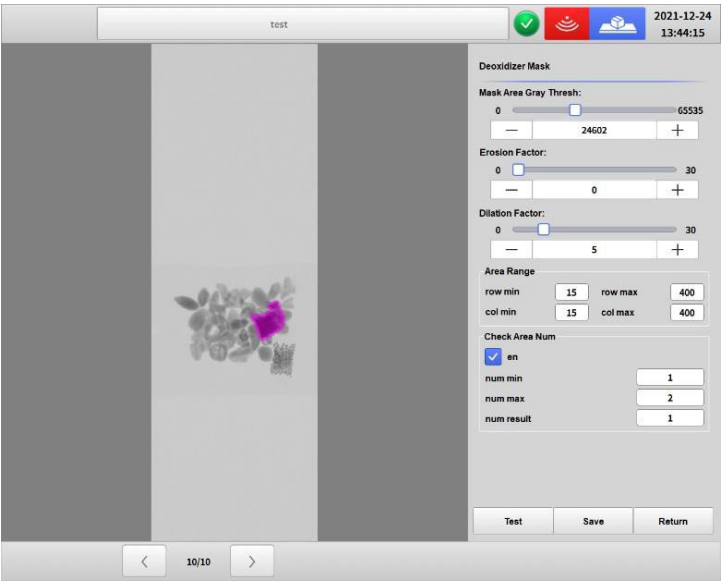
Absolute Direction masking is to determine the absolute direction according to the left, right, top and bottom ranges of the product area selected by the user. Set the appropriate masking width in the cut area, click Test, and you can see the set edge masking area. This stretches the mask direction straight up, down, right, or left in the image and can be used when the product is always entering the X-Ray tunnel directly parallel/perpendicular to the belt direction.



Simultaneous inner and outer cut masking is to set the product edge masking range inward and outward at the same time. Set the appropriate masking width in the Cut area, click Test, and you can see the set edge masking area.

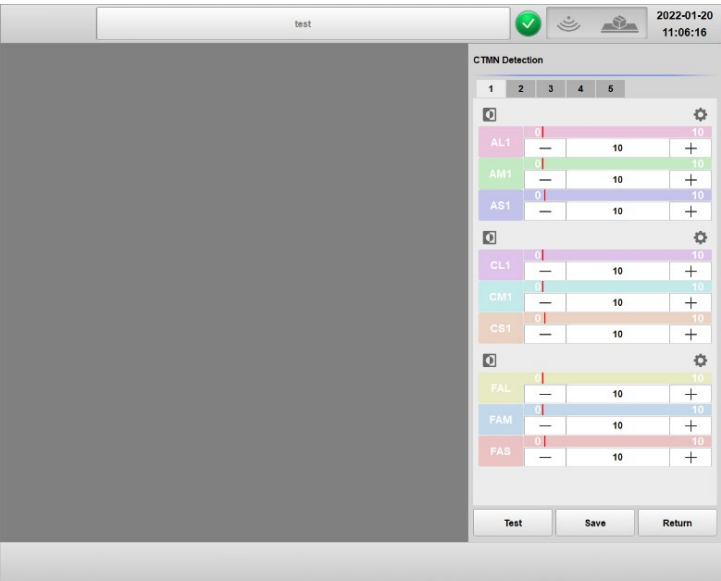
6-1-2-2 Desiccant Mask

Click [Desiccant Mask] to enter the desiccant mask setting interface. [Mask Area Gray Threshold] is used to select the desiccant area that needs to be masked and the area range is used to set the range of the desiccant area. Adjust the [Erosion factor] and [Dilation factor] so that the desiccant area is accurately wrapped, as shown in the pink area in the figure below. Check [EN] in the Check Area Num to enable the detection of desiccant quantity and set the maximum and minimum quantity. If the desiccant quantity is higher than the maximum or lower than the minimum, an alarm will be displayed and the actual detected quantity will display the current detected desiccant quantity.



6-1-3 Foreign Body Detection

There are five pages of algorithms for foreign body detection. The fifth page is the intelligent detection algorithm/AI which can be set up on request for difficult to detect contaminants. Algorithms for each page are independent of each other and can be turned on or off separately.



The following figures show the first four pages of algorithms available when inspecting products. Each color represents a different algorithm. The image below shows them all disabled and this is noticeable as the colors are dim. When debugging foreign body detection users can enable/disable the detection algorithm by clicking algorithm name and use the left and right buttons or the number value to adjust the threshold and adjust the sensitivity of each algorithm.

CTMN Detection

12345

0

AL2

0

10

+

AM2

0

10

+

AS2

0

10

+

0

CL2

0

10

+

CM2

0

10

+

CS2

0

10

+

0

FCL

0

10

+

FCM

0

10

+

FCS

0

10

+

Test

Save

Return

CTMN Detection

12345

0

AL3

0

10

+

AM3

0

10

+

AS3

0

10

+

0

CL3

0

10

+

CM3

0

10

+

CS3

0

10

+

0

AL4

0

10

+

AM4

0

10

+

AS4

0

10

+

Test

Save

Return

CTMN Detection

12345

0

B1

0

10

+

G1

0

10

+

0

P1

0

10

+

P2

0

10

+

0

W1

0

10

+

W2

0

10

+

Test

Save

Return

CTMN Detection

12345

0

DLM0

0

50

+

limit num

min

0

max

0

result

0

0

DLM1

0

50

+

limit num

min

0

max

0

result

0

0

DLM2

0

50

+

limit num

min

0

max

0

result

0

0

DLM3

0

50

+

limit num

min

0

max

0

result

0

0

DLM4

0

50

+

limit num

min

0

max

0

result

0

Test

Save

Return

12

Upper Limit Of Stretching:

0

65535

50000

+

Image Intensity Enhanced:

0

30

0

+

Image Contrast Enhanced:

0

30

0

+

Auto

Auto2

Similar

Save

Return

Clicking the icon  in the upper left corner of each algorithm grouping opens up the group Image Optimization settings. The first page is the image optimization interface. This page is consistent with the parameter settings of [Image Setting] in Section 6-1-1. Users can refer to the content in Section 6-1-1 for parameter settings. From this page, users can press the [Similar] button to synchronize the optimization parameters of this group of algorithms to the image optimization settings of other groups of algorithms with one click.

Click on second page to enter product detection area setting, [Upper Limit of Detection] and [Lower Limit of Detection] are used to select product area to be detected. Clicking [Auto Gray] allows system to automatically optimize these parameters, and the user can adjust the optimized parameters manually. [Denoising factor] is used to remove any noise points at the edge of the picture that are prone to false alarms, as well as any obvious dark areas that exist independently outside the product due to residual substances on the belt or outer packaging of the product. [Filling factor] is used to fill any holes in the detection area, and at the same time, it will expand the area of detection.

[Shielding factor] further optimizes the picture and shields non-product area at the edge to prevent false alarms at the edge of the product. Adjust [Denoising Factor] [Filling Factor] [Shielding Factor] appropriately to wrap the detected product area more accurately for thorough inspection. Check [Ignore Mask Area] to ignore the set masked area. The [Similar] button will synchronize the optimization parameters of this group of algorithms to the image optimization

settings of other groups of algorithms with one click. Click [Save] to save the modified parameters as they are and [Return] to go back to the algorithm interface.

Click  on the upper right corner of the algorithm to enter the parameter sensitivity setting interface. It is recommended that users do not modify the parameters on this page unless directed to do so by TDI personnel.

When the sensitivity of the algorithm group is appropriate, different groups of algorithms can detect the corresponding foreign objects in the product. As shown in the FAL algorithm in the figure below, 31 represents the inspected value of the product in the current image. 32 represents the threshold set for that algorithm. The smaller the threshold, the higher the sensitivity. The +/- value shown to the right of the inspected value shows the difference between the inspected value and the threshold. A positive value shows how much lower the inspected value is than the threshold. A negative value will show how far over the value is than the threshold.

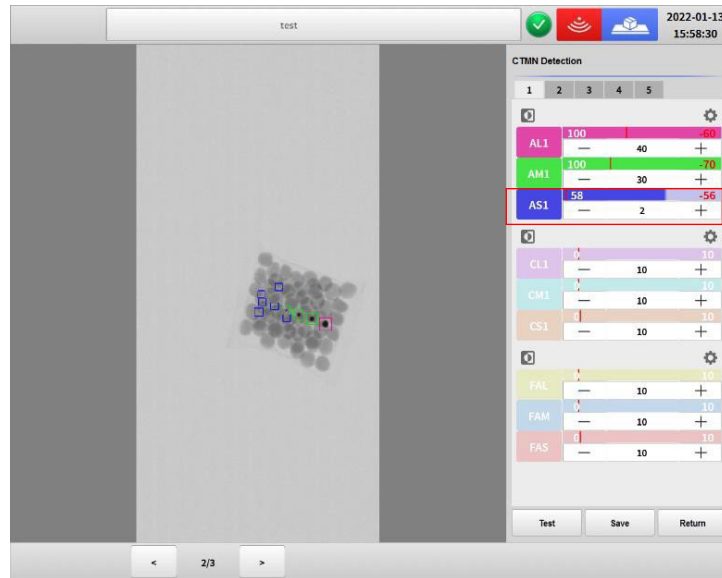


6-1-6-1 Adjusting algorithm threshold and sensitivity

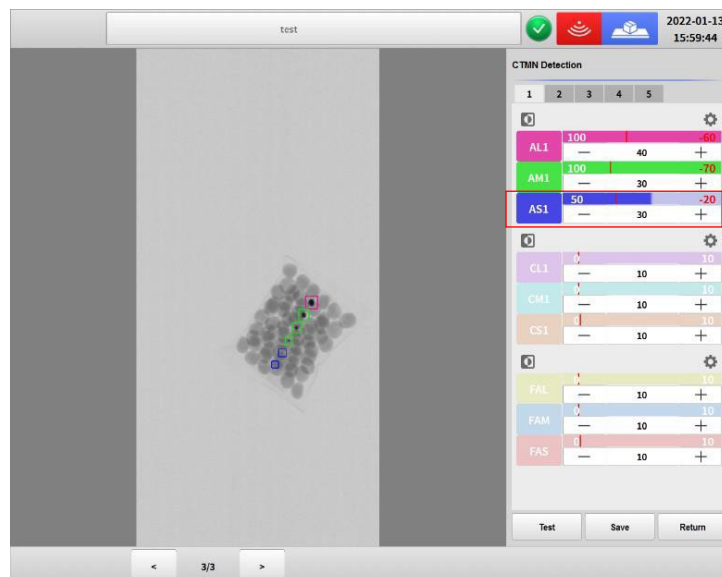
Generally, the algorithm threshold and sensitivity need to be adjusted in the following two situations:

1) The sensitivity is too high:

When the sensitivity of the algorithm is too high, it is easy to cause false alarms. As shown in the figure below, click the [Test] button, and the edge of the product is also marked as foreign objects, causing false alarms.

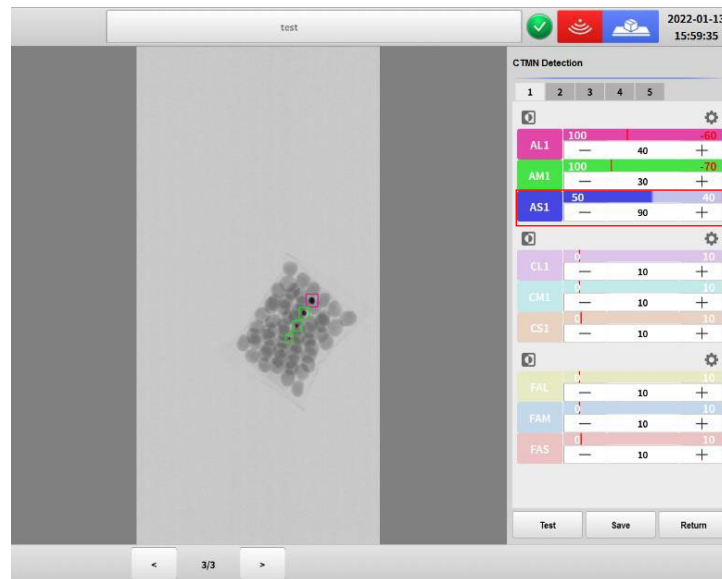


The corresponding test buttons and results of a single group are shown in the mark above. In the algorithm on the first page, algorithm AS1 is found according to the color of the false alarm box. The inspected value is 58 and the threshold is 2. The threshold is far too small and this is causing a false alarm. Click the AS1 algorithm threshold value or the left and right buttons to adjust the value to 30 then click the [Test] button to observe whether the false alarm is eliminated, as shown in the figure below. When the threshold is increased to 30, the false alarm is eliminated and only the test piece is marked. Click [Save] then [Return] to get back to the inspection interface where you can pass the product again to confirm proper sensitivity settings.

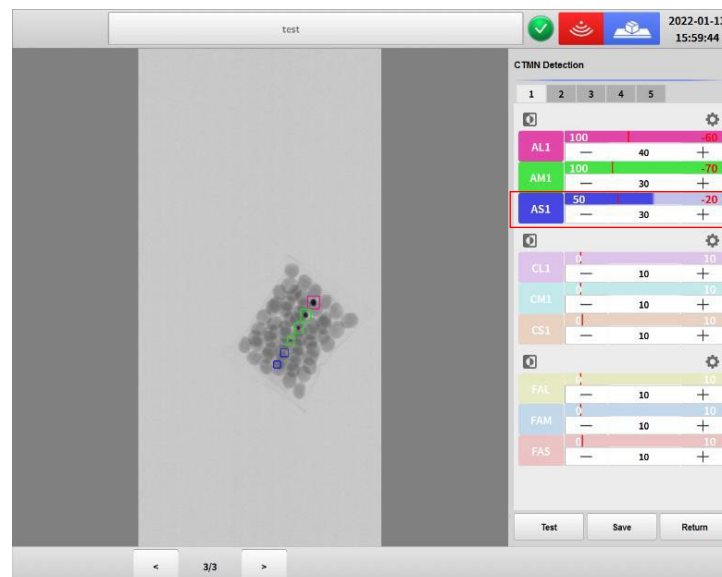


2) The sensitivity is too low:

When the sensitivity of the algorithm is too low, it is easy to cause missed detection of contaminants. As shown in the figure below, with the [Test] button pressed you can see that there are 6 foreign objects in the product, but only 4 are marked in the figure.



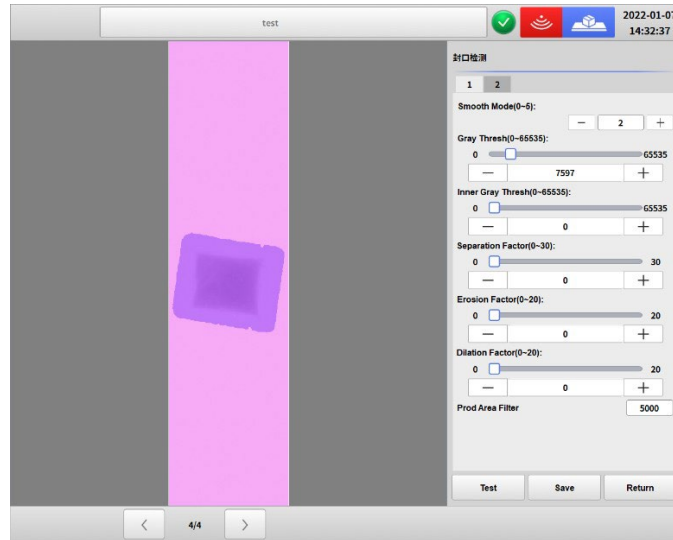
First observe the algorithm in the figure, the threshold value of AS1 is too large at 90 and needs to be lowered. Adjust the threshold value to 30 through the left and right buttons and the numeric keyboard, click the [Test] button, and confirm detection of all test contaminants. Click [Save] then [Return] to get back to the inspection interface where you can pass the product again to confirm proper sensitivity settings.



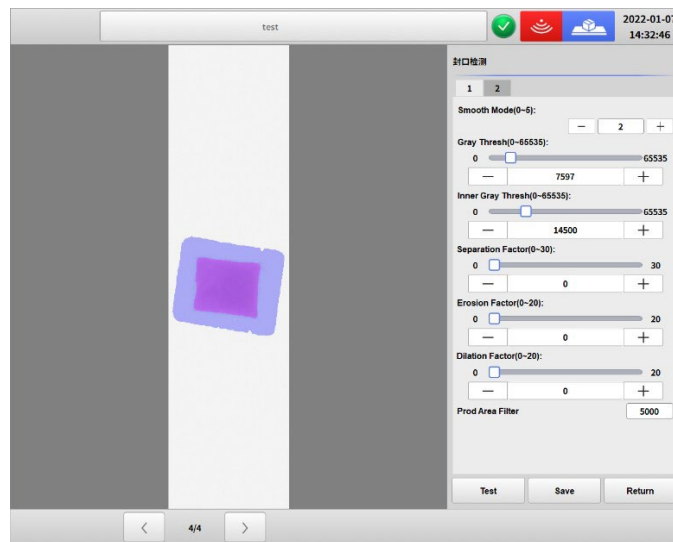
6-1-4 Sealing Detection

Sealing detection is used for the detection of an abnormal seal of a packaged product, such as poor sealing material, seal leakage, etc.

[Smooth Mode] highlights the edge area of the product image and weakens the internal area of the product image. Adjusting the value of [Smooth Mode] can better identify the seal portion of the product. Select the entire product area by setting the [Grayscale Threshold] and you can see in the image that the entire product packaging area is shown in blue. When the products overlap, adjust the [Separation Factor] to separate the product packaging area. Adjust [Separation Factor] [Corrosion Factor] [Expansion Factor] appropriately to wrap the product packaging area more accurately.



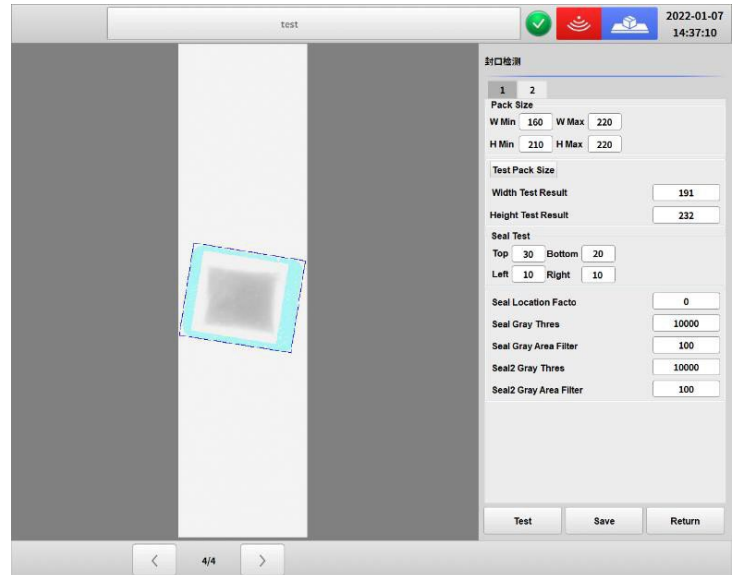
Adjust [Inner Product Grayscale Threshold] to select the internal product area, and the internal product area is shown in purple. Enter a suitable value in [Product Area Filter] and the software will ignore the product packaging area that falls below this value.



[Width test result] [Height test result] are automatically identified and generated by the system. Input the appropriate min. width and height and max. width and height according to the generated detection width and height. Click Test to check whether the product package size is within the set parameters.

[Top] [Bottom] [Left] [Right] is used to select the sealing area, as indicated by light blue in the picture below. [Seal Location Factor] is used to set the area within this value that will be ignored by the system, such as oil stains and oil spots. [Seal Grayscale Threshold] [Seal Grayscale Area Filtering] and [Sealing Grayscale Threshold 2] [Seal Grayscale Area Filter 2] are the detection algorithms used to determine seal integrity. [Seal Grayscale Threshold] and [Seal Grayscale Area Filter] are used for detecting products with low grayscale and large area, such as oil leaks from the seal.

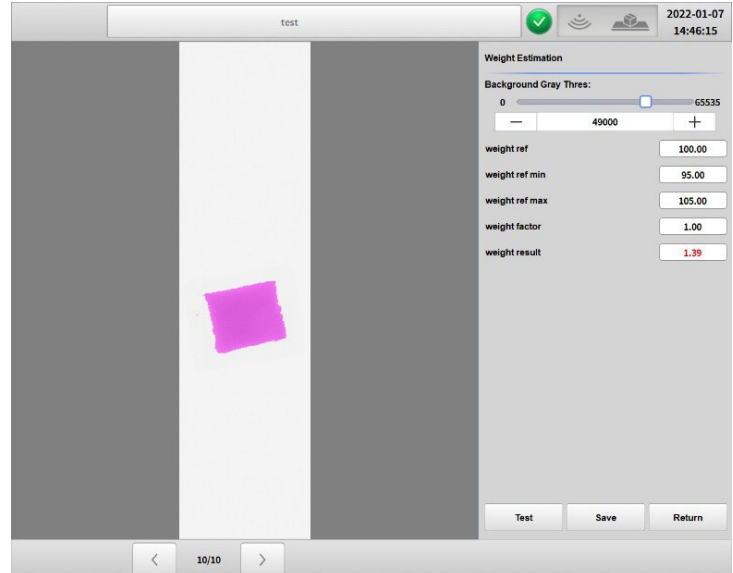
Set the appropriate grayscale value and area and the algorithm will detect seal defects larger than this grayscale value and area. [Seal Grayscale Threshold 2] [Sealing Grayscale Area Filter 2] are used for detecting products with higher grayscale area and small area, such as sealing clips. Set the appropriate grayscale value and area and the algorithm will detect a sealing defect greater than this grayscale value and area. Set the appropriate parameters and click [Save].



6-1-5 Mass Weigh

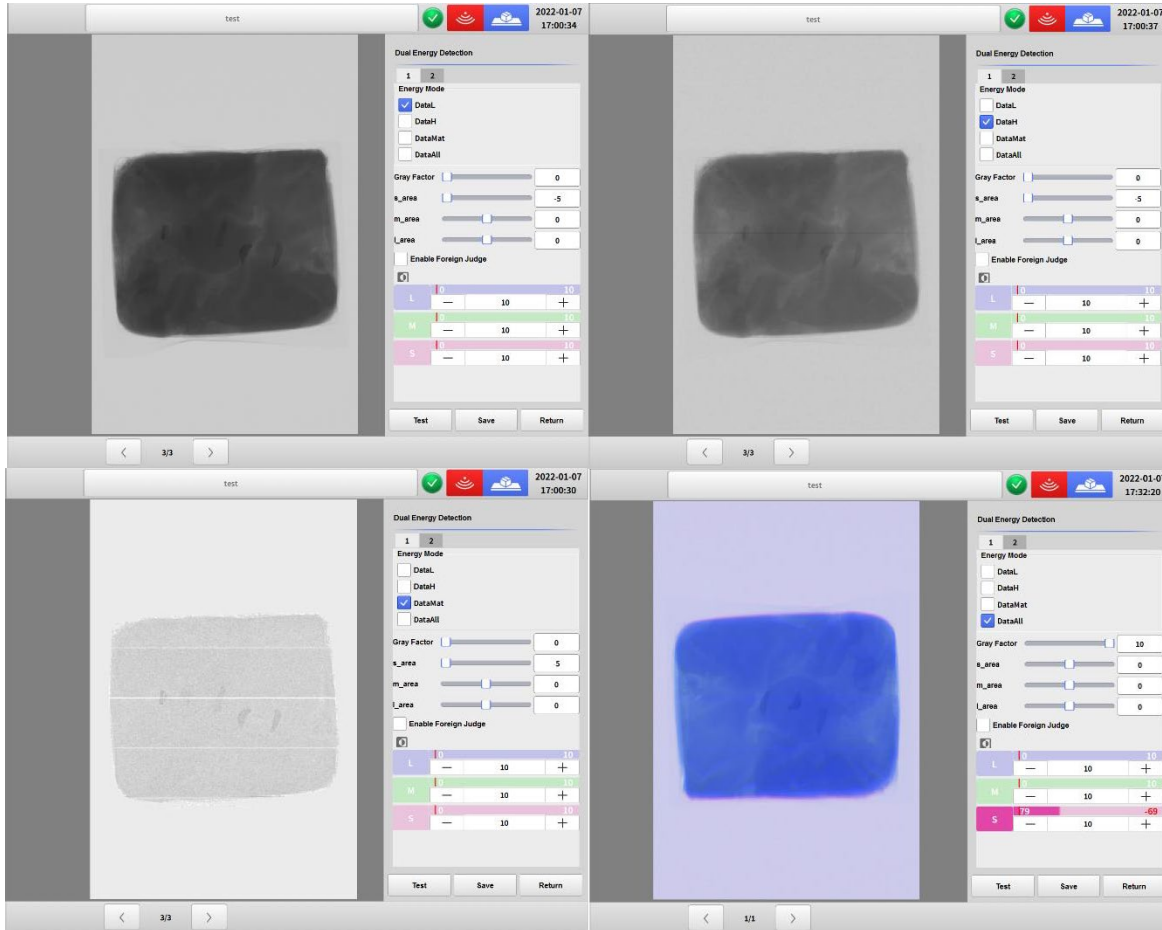
Weight evaluation is the parameter setting used for the weight detection of the product. Click on the weight evaluation to enter the parameter setting interface. When the product does not meet the maximum and minimum weight allowed, it will give a weight alarm. Select the product area by setting the [Background Gray Threshold] to highlight the product.

[Reference Weight] is the static weighing result of the current test product. [Weight Factor] is automatically generated based on the image values. [Reference Weight], [Minimum Allowable Weight] and [Maximum Allowable Weight] are the limits used to determine acceptable weights. [Weight Result] is the weight result of the current product after X-ray detection. If the [Current Test Weight] is not within the set allowable range, an alarm will be prompted and the product will be rejected.

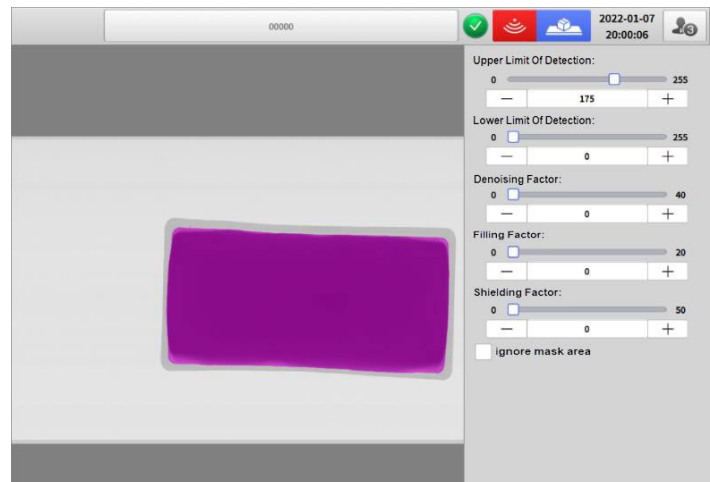


6-1-6 Dual Energy Detection

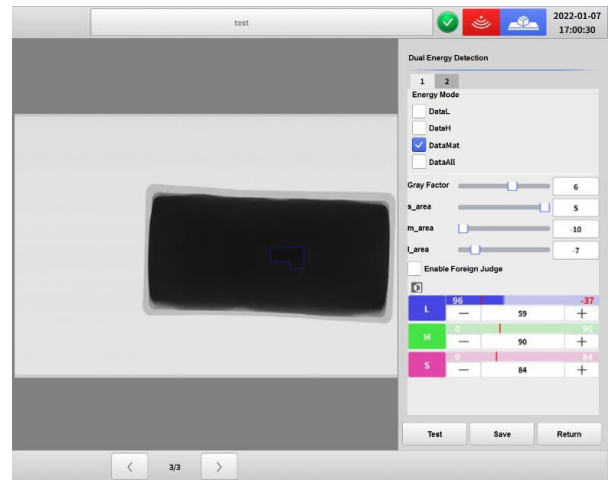
Dual-energy mode has four modes for viewing images: low-energy (DataL), high-energy (DataH), dual-energy (DataMat), and product map (DataAll). After the dual-energy detector calibration and material calibration has been completed, pass product and check the image of the product through the picture. The system defaults to viewing images in low energy mode.



The gray factor is used to appropriately increase the gray value of the image. The foreign object range S, M, L can adjust the pixel area of the S, M, L detection algorithms. Click the icon  on the detection algorithm to enter the product detection area setting. [Upper Limit of Detection] and [Lower Limit of Detection] are used to select the product area to be detected. Adjust the [Denoising Factor], [Filling Factor], and [Shielding Factor] to wrap the detected product area more accurately. Check [Ignore Mask Area] to ignore the set masked area. Click [Optimize] and the system will automatically optimize the above parameters. The user can manually adjust the optimized parameters and press [Save] to store the parameter settings.



After setting the product detection area, go back to the first page of the dual-energy detection algorithm to set the algorithm. Algorithms S, M, and L are algorithms for detecting small foreign bodies, medium foreign bodies and large foreign bodies respectively. The algorithm debugging is the same as the foreign body detection algorithm debugging. When the threshold value is less than or equal to the feature value, the foreign body corresponding to the algorithm will be detected.

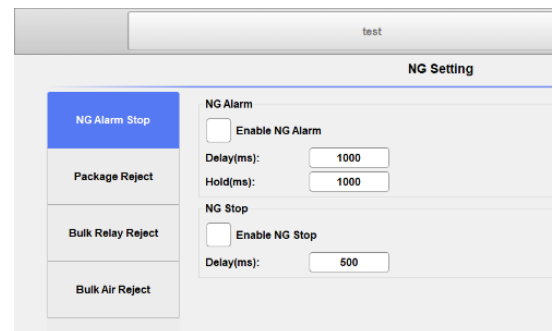


6-2 NG/Reject Settings

In the NG/Reject settings, the user can choose the NG alarm form and exclusion settings according to their own needs and reject devices.

6-2-1 NG Alarm and Stop

When there is NG product, you can choose to enable NG alarm or NG stop. [Delay time] refers to the time delay between the detection of foreign objects and the start of the alarm or stop action, [Duration time] refers to the time from the start of alarm action to the end of the alarm action. All units are in ms.



6-2-2 Package Reject

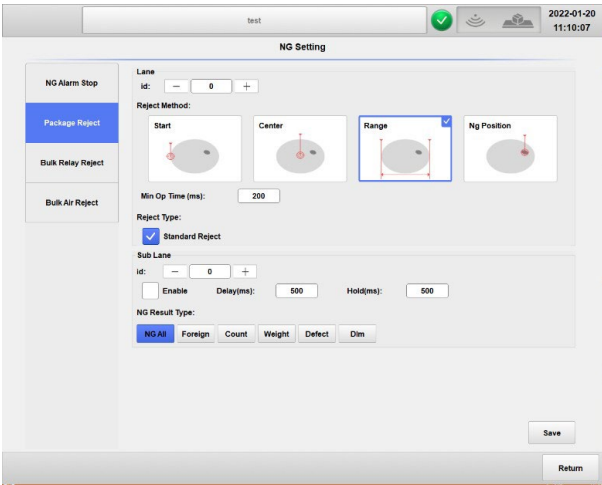
The reject mode and type of each channel can be set in the package reject settings.

There are four reject modes:

- Start – reject based on the beginning of the product, used for large packages
- Center – reject based on center of the product, used for all sizes of packaged products
- Range – reject based on the product range for packaged products, used for flap, drop down, or swing-arm rejectors
- Position – reject based on contaminant position in the product; used for bulk material operations

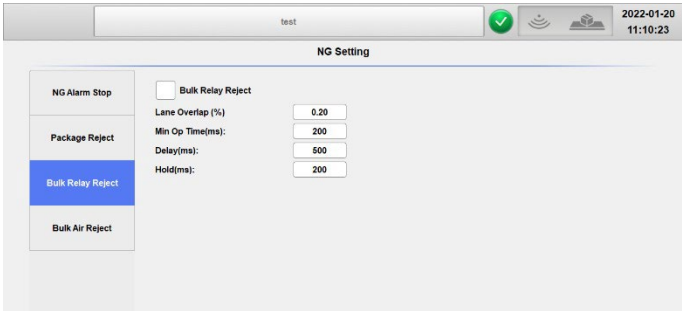
The accuracy of the Start and Position modes is low. In order to ensure the safe rejection of contaminated products, it is necessary to increase the reject parameters (specifically, the duration) but this will increase the amount of rejected product and can lead to larger amounts of wasted product. The accuracy of the Range and Center is high, but there are specific requirements for the way products are passed. This is useful where products are passing single file with a fair amount of space between products and a low probability of contaminants. The user can select the reject mode according to the product shape, size, weight, and other characteristics to accurately reject foreign objects.

[Minimum Operating time] means that when there is a continuous foreign body detection that needs to be rejected, and the interval time is within a certain range, the rejector system will act continuously to eject the foreign body products. This is useful with deflection, drop table, or belt retract rejects. The reject will remain open if there is more than one contaminant within the Minimum Operating Time to ensure all contaminants are rejected. The reject system of the subchannel can also be set, and each reject system can set the delay time and duration separately. Six types of NG result reject types can be selected: all NG, foreign body NG, count, weight NG, defect NG and intelligent/AI NG. If multiple reject systems are being used, each of these reject types can be set up to reject to specific areas. For example, a contaminant reject can be sent to reject bin 1 and a weight reject could be sent to reject bin 2.



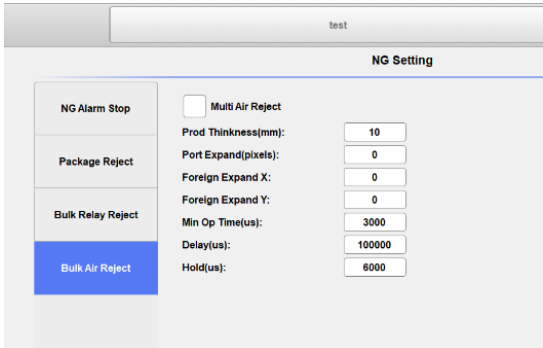
6-2-3 Bulk Relay Reject

Check the box for bulk relay reject to use the bulk relay reject function. There will be some overlap between each group of reject channels to prevent any contaminated products from passing. The Lane Overlap percentage between channels can be set between different reject channels. [Minimum Operating time] is the time setting used to keep the reject relay open if multiple contaminants are detected in close proximity to each other. [Delay time] refers to the time between the detection of foreign body and the start of reject action and [Duration] refers to the time from the start to the end of reject action.



6-2-4 Bulk Air Reject

【Bulk Air Reject】 is used for the air blow settings of bulk material products. Set the Port expansion (pixels), the lateral expansion (X) of foreign body, and the vertical expansion (Y) of foreign body to expand the range of air blowing to prevent excess waste. Set product thickness as needed according to the product, the Minimum Operating Time (same definition as Bulk Relay Reject setting), delay time, and hold time to accurately remove foreign bodies during air blowing reject.



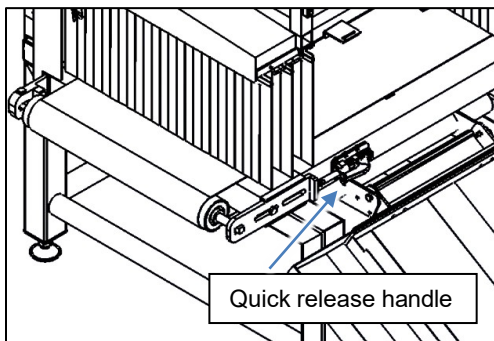
Chapter 7: Equipment Maintenance and Sanitation

This section describes the maintenance and sanitation of XR series equipment, focusing on the replacement and maintenance of the protective curtains and conveyor belt, as well as exterior washdown procedures.

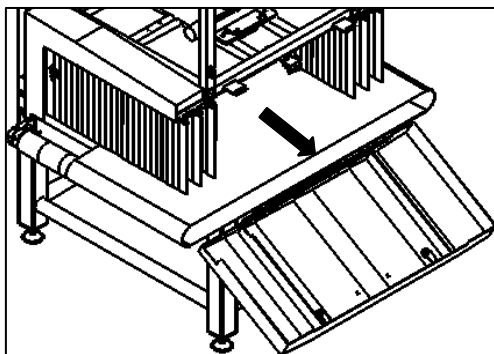
7-1 Conveyor Belt Installation and Maintenance

To ensure normal working and sanitary conditions of the conveyor belt, the user must clean the conveyor belt regularly and replace it as needed due to wear or damage to ensure optimal X-ray performance.

7-1-1 Conveyor Belt Removal

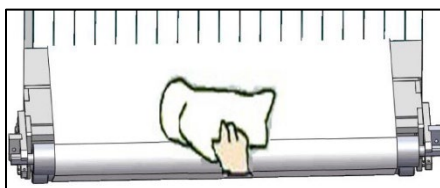


1) Open front cover, disengage quick release handle, and loosen belt; position shown in the figure below.



2) Pull out the belt from the side as shown in the figure below.

7-1-2 Conveyor Belt Cleaning



The conveyor belt can be cleaned either while installed or after removal. While the belt is running at its slowest setting, a damp cloth, with or without cleaning agents (e.g. alcohol) can be used to remove dirt and debris from the belt. The user should apply light pressure to the belt until dirt is no longer present. The system must not be in X-ray

generating mode when using this quick-cleaning method.

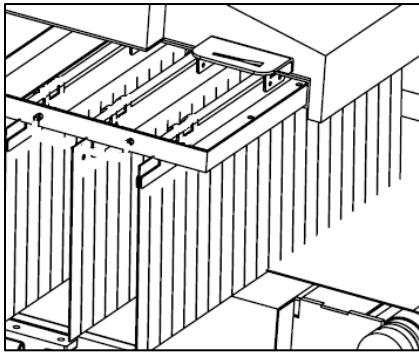
For more thorough sanitation, belt should be removed and washed using commonly available sanitation or cleaning products. The belt is also resistant to high temperature and high-pressure cleaning methods.

7-2 Protective Curtain Installation and Maintenance

When the inspected product is unpackaged or in bulk flow form, the protective curtains will require more frequent removal and cleaning.

7-2-1 Protective Curtain Removal

Open front cover and pull out protective curtain racks at both ends. If any curtains are damaged or worn, unfasten screws to remove individual protective curtain sheets from holding brackets for replacement.



7-2-2 Protective Curtain Installation and Cleaning

After removal from the X-ray, clean the curtains using normal disinfecting and sanitation procedures, including high temperature and pressure.

To reinstall the protective curtain racks into the X-ray tunnel chassis, reverse the curtain removal steps.

7-2-3 Tunnel Cleaning

Prior to tunnel cleaning, the conveyor belt and curtain racks should be removed. The X-ray inspection tunnel is completely sealed and can be cleaned using high pressure, high temperature water as well as standard disinfecting solutions. The tunnel should be thoroughly rinsed and allowed to dry before reinstallation of belts and curtains.

7-2-4 Exterior Cleaning

Please refer to your equipment specifications to determine the washdown capabilities of your machine. TDI X-ray series machines are built to IP54, IP66, or IP69K systems based on request. The IP54 rated systems can withstand a light exterior washdown but ideally, these systems should be covered and cleaned/sanitized by hand. The IP66 systems can withstand a heavier washdown but are not designed for heavy/high pressure cleaning. The IP69K systems are built to withstand harsh washdown conditions. In any case, be mindful of the HMI Touchscreen as that is not suited for direct spray or heavy cleaning (IP69K systems include a clear plastic shield for this component).