

**Instruction Manual for
Paste Print Inspector
<MODEL : TD-4M>**

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INTRODUCTION

Thank you for your purchasing our Paste Print Inspector Machine <TD-4M>.

This product is a non-contact type Paste Print Inspector machine. It uses the slit beam cutting method.

It processes image data read by a color CCD camera using software and inspects and evaluates the effective thickness.

Read through this manual before using the product. Make full use of the manual for operation. Keep it in safe after reading it.

NOTICES

1. This manual is prepared with the greatest care. However, if you should find some doubtful matters or omissions, please contact us.
2. Note that our company will not bear any responsibility for damages, losses or bad influences caused by using the product.
3. Be sure to keep the packing material used for transportation, since it may be used to transport the product for maintenance, etc. in the future.
This product is a precision instrument. It may get defective if it is transported using other material than the exclusive packing material. Note that repairs become onerous even if the warranty applies to the defect or the warranty period hasn't expired in such a case.
4. Never disassemble the product.
In any cases, the warranty does not apply a disassembled product or a product that was clearly disassembled. Repairs of such a product become onerous. Please note this.

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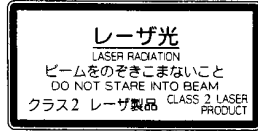
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TD-4M Packing List

Unpack the product, and check the following list first to see if all parts are supplied. Please contact our company should some parts are defective or lacking or you find some missing pages or erratic pagination of the instruction manual.

1.	Main unit:	1
2.	PC Board clamp table:	1
3.	CRT:	1
4.	Keyboard:	1
5.	Mouse:	1
6.	AC power cable:	2
7.	Flash memory:	1
8.	Gauge block:	1
9.	Windows XP (License):	1
10.	Instruction manual:	1
11.	Warranty card:	1

PRECAUTIONS



This product uses laser. It is classified to Class 2 laser danger level. Observe the following instructions and carry out safe work.

- Do not look at the laser beam directly.
- Do not look at the laser beam through an optical instrument.
- Put on protective goggles in work.
- Do not place a mirror or other reflective object on the laser radiation surface.



Never disassemble the product. Otherwise, the product may be defective or you may have electric shock or, in the worst case, you may be electrocuted.

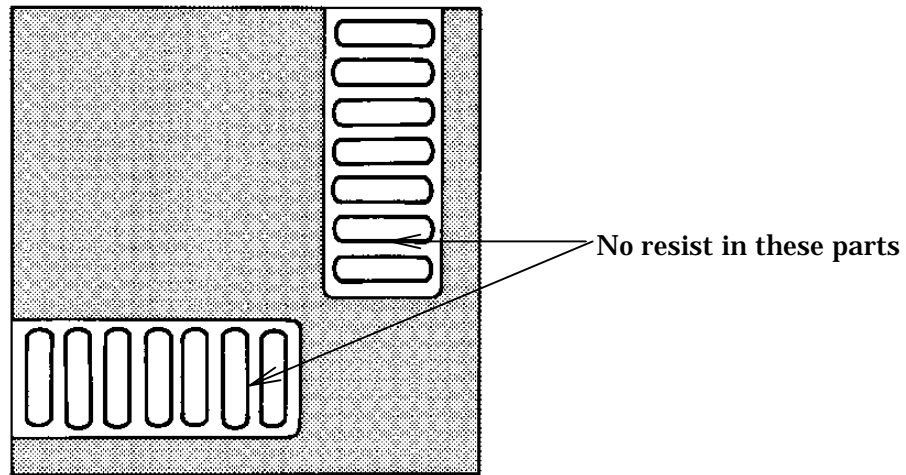


Be sure to exit the program from the main menu. Turn off the computer after a message "Ready to turn off the computer" is displayed on the screen. Disobedience to this instruction may break the hard disc.

MEASUREMENT

This is a non-contact type printed paste inspection machine with a laser system. It is subject to measurement errors in the following cases due to the instrumental characteristics.

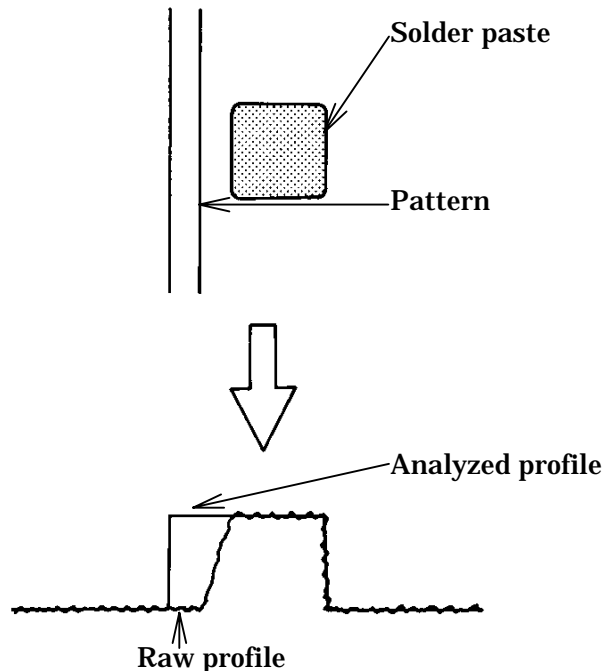
- 1) Glass epoxy PC Boards covered with no resist
- 2) Transparent PC Boards such as flexible PC Boards
- 3) Ceramic PC Boards
- 4) PC Boards with no resist around the rounds such as 0.3-mm pitch QFPs



- 5) Patterns covered with resist

The TD-4M may rarely recognize patterns on some PC Boards as the objects of measurement.

If a pattern is close to printed paste to be measured, the TD-4M may measure the printed paste and pattern together.



- 6) If you inspect the same object with several inspecting machines, you may not obtain the same value. (Instrumental errors)

Please contact us if measurements result in measurement errors and setting is disabled.

I. GENERAL

I-1 General

The TD-4M is capable of measuring the thickness of solder paste printed on PC Board at any point. As electronic parts become smaller in size and electrode pitches become finer, everyone knows the importance of thickness control of printed solder paste.

For easy inspection and convenient quality control, the TD-4M uses a computer for software control and achieves improved operator's work efficiency, automatic inspection result judgment, and simple data collection.

I-2 Features

- Non-contact measurement by means of the slit beam cutting method
- Image confirmation with a color CCD camera
- Capable of data processing and teaching in 150 fields per PC Board
- Capable of repetitive inspection of the same PC Board by means of teaching point setting
- Automatic OK/NG judgment by setting the basic judgment criteria

I-3 Specifications

I-3-1 Measurement specifications

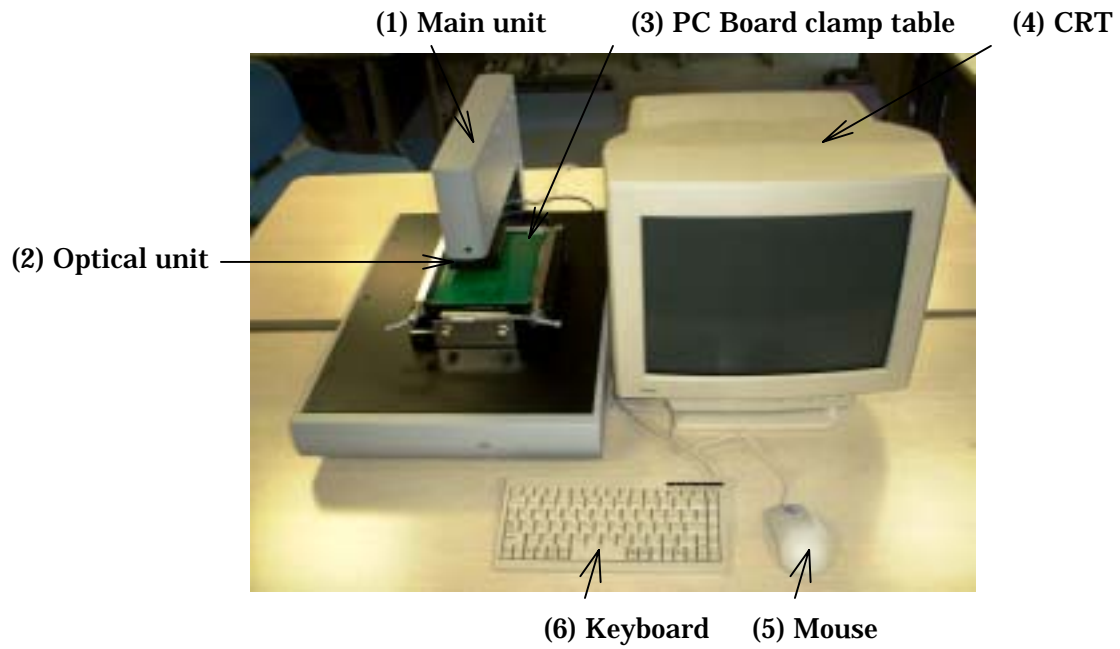
Item		Specifications
Inspection	Object	Thickness of printed solder paste
	Allowable warp	±1.5 mm
	Measurement range	2 mm long × 3 mm wide, height: 50 to 350 μm
	Measurement resolution	8 μm
	Judgment function	Automatic OK/NG judgment
	Position correction	According to PC Board fiducial (Two points)
	Speed	1 second or less/visual field (Standard)
	Data	Input method: Teaching, number of data: 150 fields
	Output	Output to printer and in text files
	Standard dimensions	Outside: 50 × 50 mm min., 250 × 330 mm max. Thickness: 0.5 to 2.0 mm
	Measurable range	240 × 320 mm
Optical	Light source	660 nm semi-conductor laser
	Camera	1/4-inch color CCD
	Visual field of camera	4 mm × 3 mm
	Measurement principle	Slit beam cutting method, = 45°
	Cut slit	20 μm × 10 mm
	Safety standard classification	classification acc. to laser danger level: Class 2

I-3-2 Main unit specifications

Item	Specifications
PC Board clamp table	PC Board clamping margin: 3 mm; Capable of both side clamping
Outside dimensions	420 mm W × 635 mm D × 350 mm H
System	High-speed image processing computer system built in
Weight	22 kg
Power source	100 to 240 VAC, 50/60 Hz, 140 W (Service AC outlet not included)
Interface	USB for printer
	USB for flash memory
	Keyboard input
	Mouse input
	Monitor output

I-4 Components

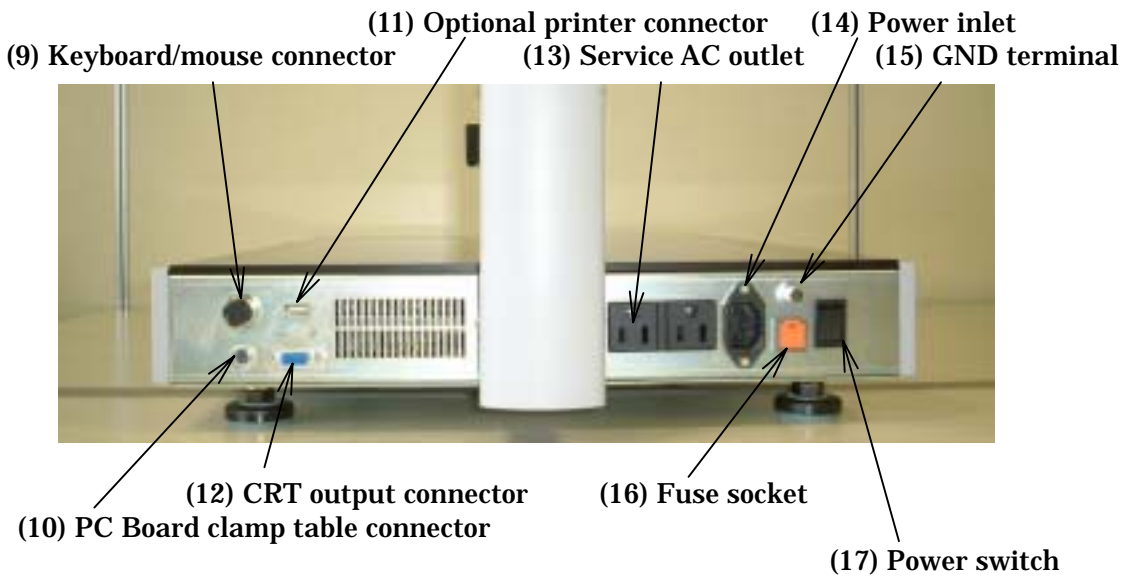
Main unit



Front Panel



Rear Panel



I-5 Functions

Main unit

(1) Main unit	The TD-4M main unit. Inspects the area and height of printed pasteed on set PC Board.
(2) Optical unit	Incorporates laser, color CCD camera, etc. Do not apply vibrations or shocks to this unit. Otherwise, the unit may become defective.
(3) PC Board clamp table	Fix PC Board on this table. Both sides may be inspected. A coordinate pointer gives the standard of the inspection position.
(4) CRT	Displays a PC Board image, inspection results, etc.
(5) Mouse	Controls the main unit.
(4) Keyboard	Controls the main unit.

Front Panel

(7) Flash memory slot	Insert flash memory for storing inspection data and inspection results, which are transferred to an external computer.
(8) Power lamp	Goes on when the TD-4M is turned on.

Rear Panel

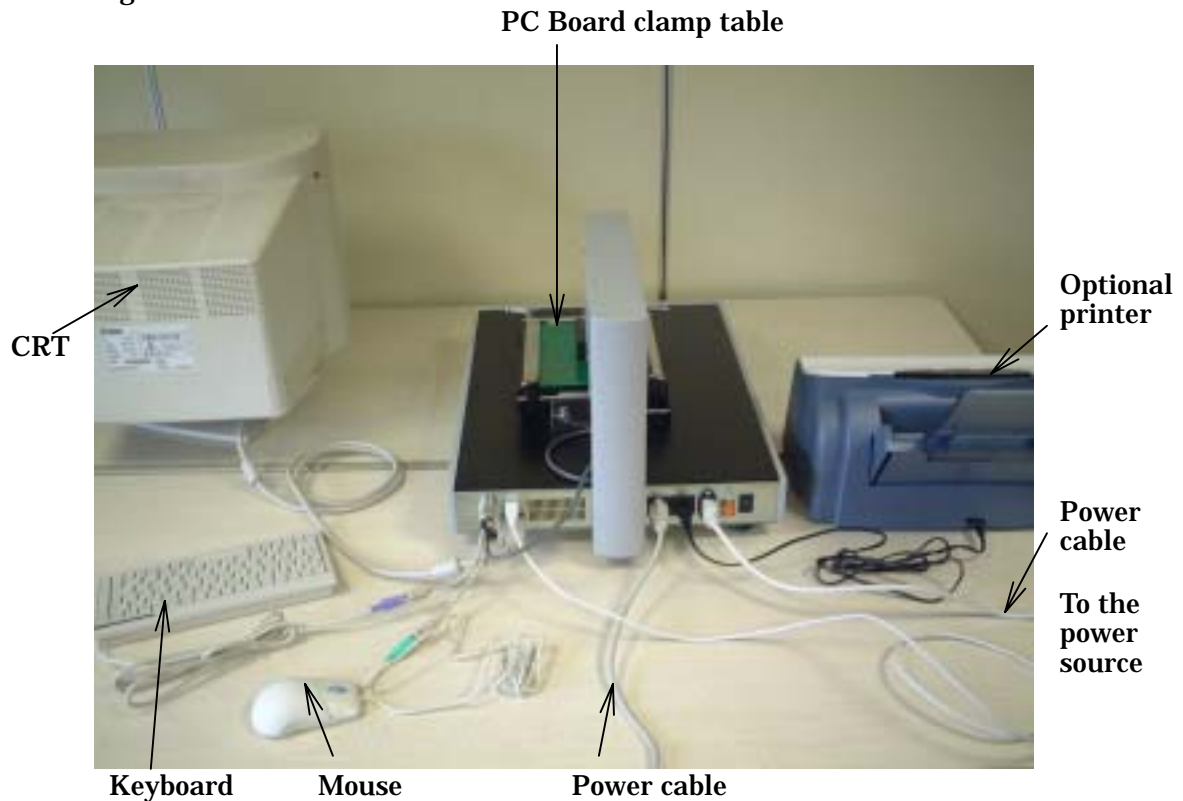
(9) Keyboard/mouse connector	Connect a keyboard or mouse.
(10) PC Board clamp table connector	Connect the PC Board clamp table.
(11) Optional printer connector	Connect an optional printer.
(12) CRT output connector	Connect the CRT.
(13) Service AC outlet	Connect the power cable of the CRT or optional printer.
(14) Power inlet	Supply commercial AC power to this inlet.
(15) GND terminal	Connect the GND wire.
(16) Fuse socket	A socket for connecting a fuse. Set a 2A fuse.
(17) Power switch	Throw this switch to turn on the TD-4M.

II. HANDLING PROCEDURES

II-1 Preparation for Measurement

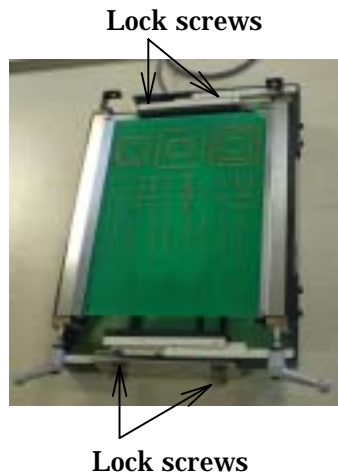
II-1-1 Connecting the cable

Disconnect the AC power cable from the outlet and shut off the power switch before installing the TD-4M.



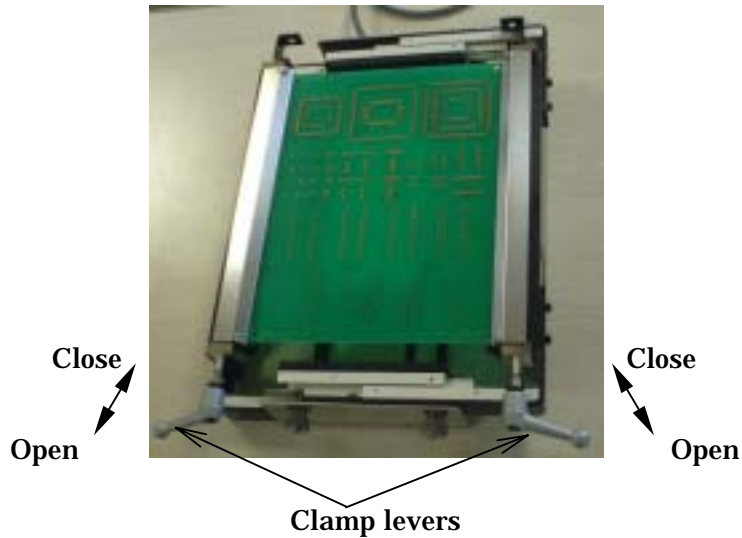
II-1-2 Setting the PC Board clamp table

Adjust the width of the PC Board clamp table to the width of PC Board to be inspected. Loosen four lock screws to adjust the width. On completion of adjustment, tighten the lock screws.



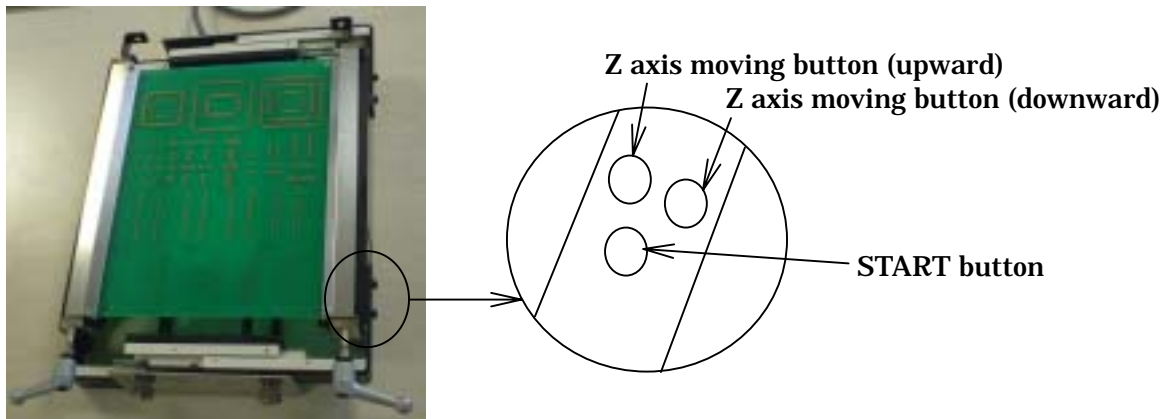
II-1-3 Setting PC Board

Turn the clamp levers in the opening direction, and set PC Board.
After setting the PC Board, turn the clamp levers in the closing direction.



II-1-4 Z axis moving and START buttons

PC Board clamp table

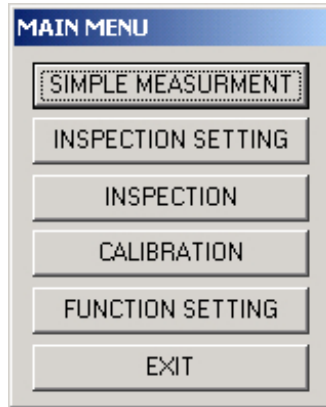


Pressing the Z axis moving buttons moves the optical unit up and down. Adjust the laser beam to the center of the screen, depending on the warp of the PC Board, before starting inspection and measurement.

Use the START button when [CHECK] is selected on the main menu. For details, see II-2-4 Inspection.

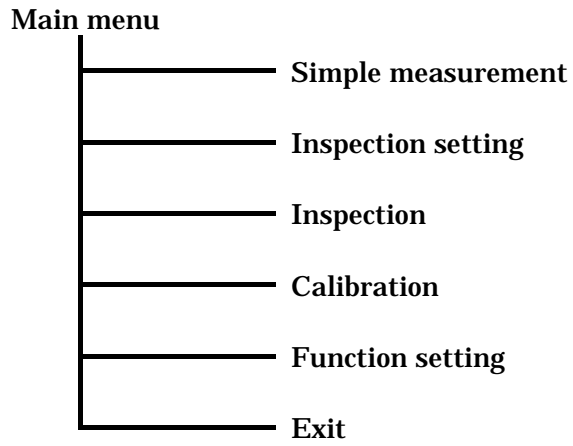
II-2 Outline of Software

Opening screen of TD-4M software



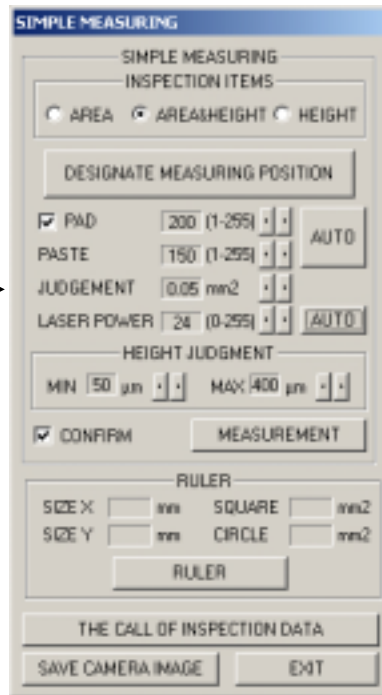
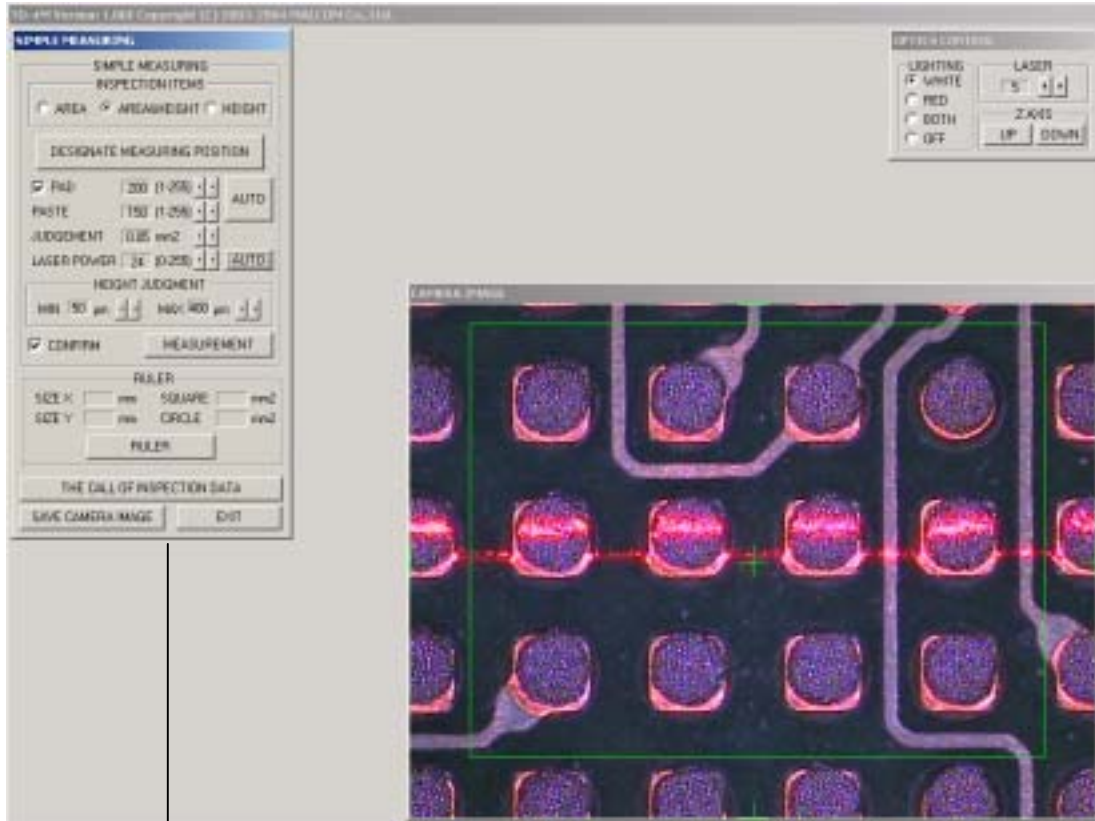
II-2-1 Basic construction

Main menu



II-2-2 Simple measurement

The simple measurement screen is displayed when the [SIMPLE MEASUREMENT] button is pressed on the main menu. This screen provides a convenient function for executing simple measurement at any position.



Inspection items

Area: Selecting this item executes measurement of the area only.

Area and height: Selecting this item executes measurement of the area and height.

Height: Selecting this item executes measurement of the height only. *1

* If the laser waveform is not accurate in the height only measurement, judgment may result in an error.

[DESIGNATE MEASURING POSITION] button

When this button is pressed, the cross cursor appears in the camera image. It is possible to specify a measurement range while holding the left mouse button.

Pad binary processing

Set a value at which the image of the copper foil rises to the surface. To disable this function, extinguish the check mark.

Paste binary processing

Set a value at which the image of the solder paste rises to the surface.

Binary processing auto

If this function is validated, the software automatically selects "pad binary processing" or "paste binary processing" and executes measurement.

Press the button, and specify the standard paste area with the cursor.

Particle judgment area

Specify the minimum area of paste. The software considers anything smaller than the area as particles.

Laser power

Set the laser power for height measurement. Set it so that the laser power is not too low and halation does not occur.

Laser power auto

If this function is validated, the software judges the laser power automatically and carries out measurement.

Height judgment

It is possible to judge whether height measurement results in OK or NG.

The software displays the judgment results (OK or NG) according to the upper limit or lower limit set here.

Image processing inspection

If this function is validated, a confirmatory message is displayed during measurement and you may inspect the binary processing and laser power.

[MEASUREMENT] button

When this button is pressed, inspection starts and the inspection results are displayed.

Ruler

It is possible to measure the distance or area in a specified area in the camera image with the left mouse button.

Click the right mouse button to exit the ruler function.

The call of inspection data

Call the saved data from the flash memory.

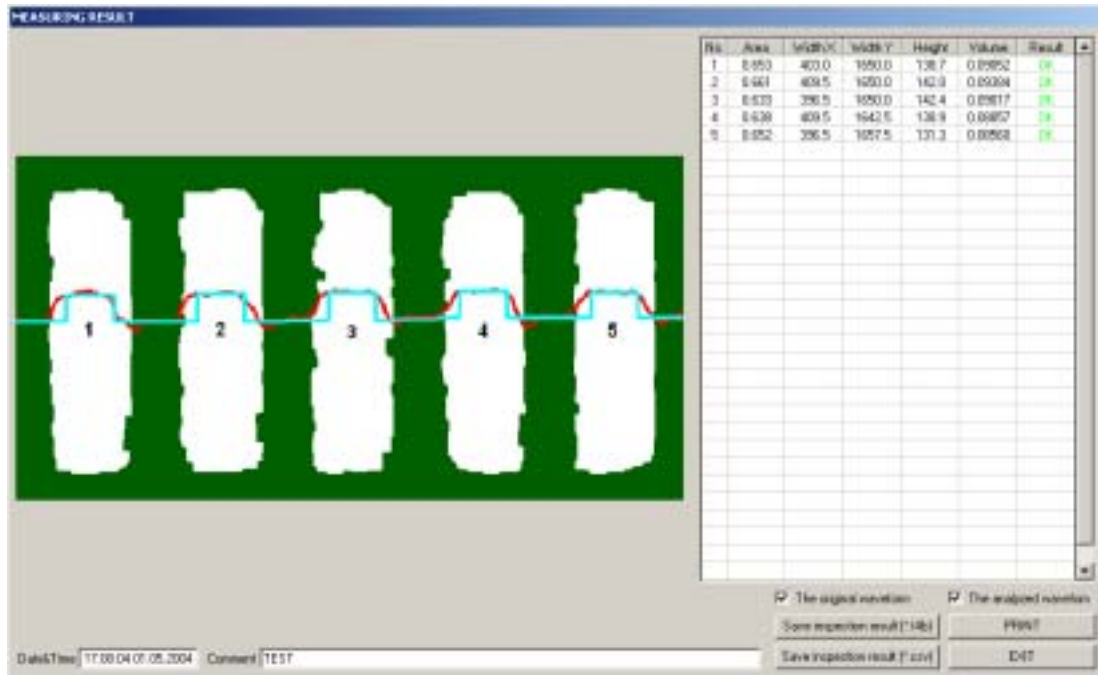
Save camera image

It is possible to save a video image in an image file in the flash memory.

[EXIT] button

Pressing this button exits the simple measurement screen and returns to the main menu.

Inspection results



Items in the table

No: The solder paste number

AREA: The area of the solder paste (In units of mm²)

HEIGHT: The height of the solder paste (In units of μm)

VOLUME: The volume of the solder paste (In units of mm³)

RESULT: Result of height OK/NG judgment

Original waveform display

If this button is ticked off, the standard laser waveform for height measurement is displayed. (Red)

Analyzed waveform display

If this button is ticked off, the average laser waveform analyzed by the computer is displayed. (Blue)

Inspection result file output (* CSV)

It is possible to save the measurement results in the flash memory.

For the output format, see II-3 "Inspection Result File Format" below.

Save inspection result (* t4b)

Save the inspection data as Malcom format. The video image and the graphic data also can be saved.

Date & Time

It is the measured date & time, can be edited.

Comment

Input the comments.

Print

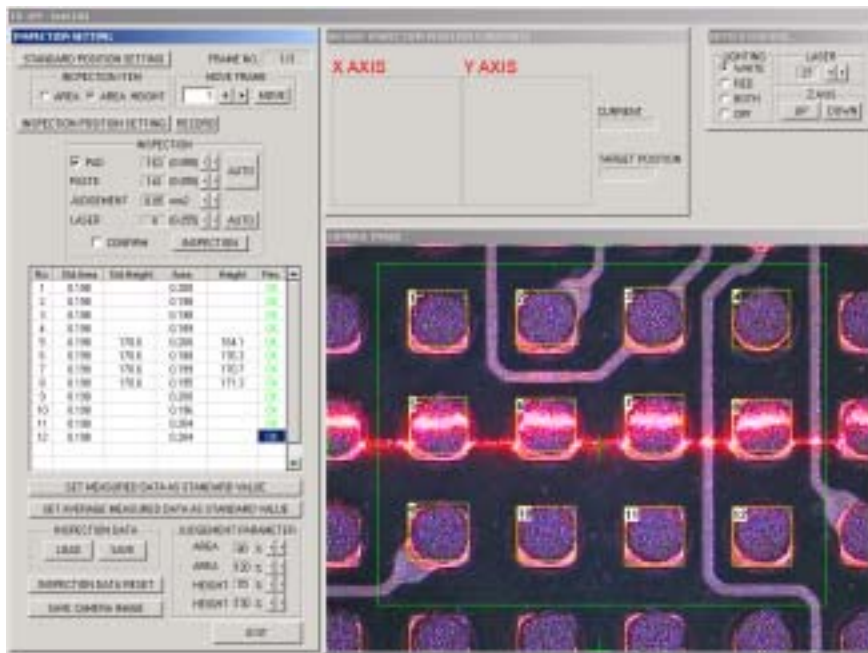
The measurement results are output to the printer.

Exit

The measurement results window closes and the simple measurement screen reappears.

II-2-3 Inspection setting

The inspection setting screen is displayed when the [INSPECTION SETTING] button is pressed on the main menu. On the inspection setting screen, use [Inspection] to create the inspection data used for semi-automatic inspection.



Move frame

The registered inspection frame moves.

[REGISTER] button

Press this button to register an inspected frame.

[Standard position setting] button

The standard position of the PC Board is set.

Set it only once before registering the inspection frame.

[Inspection position setting] button

When this button is pressed, the cross cursor appears in the camera image.

It is possible to specify an inspection range while holding the left mouse button.

Inspection items

Area: Selecting this item inspects the area only.

Area and height: Selecting this item inspects the area and height.

Inspection

Pad binary processing

Set a value at which the image of the copper foil rises to the surface.

To disable this function, extinguish the check mark.

Paste binary processing

Set a value at which the image of the solder paste rises to the surface.

Binary processing auto

If this function is validated, the software automatically selects "pad binary processing" or "paste binary processing" and executes measurement.

Press the button, and specify the standard paste area with the cursor.

Particle judgment area

Specify the minimum area of paste. The software considers anything smaller than the area as particles.

Laser power

Set the laser power for height measurement.

Set it so that the laser power is not too low and halation does not occur.

Laser power auto

If this function is validated, the software judges the laser power automatically and carries out measurement.

Image processing confirmation

If this function is validated, a confirmatory message is displayed during measurement and you may inspect the binary processing and laser power.

Judgment parameters

The OK/NG judgment parameters are used to judge whether the inspection results are OK or NG. It is possible to set the parameter of each frame independently.

Set a value in percentage with respect to the standard value.

Standard area

The standard area for OK/NG judgment is set.

Standard height

The standard height for OK/NG judgment is set.

Measured area and measured height

The actual inspection results are set.

Result

The result of comparing the measured value with the standard value according to the OK/NG judgment parameter is displayed in OK or NG.

[SET MEASURED DATA AS STANDARD VALUE] button

When this button is pressed, the measured value is set as the standard value. *2

[SET AVERAGE MEASURED DATA AS STANDARD VALUE] button

When this button is pressed, the average of the measured values is set as the standard value. *2

Inspection data

[LOAD] button

This button loads inspection data stored in the flash memory.

[SAVE] button

This button saves registered inspection data in the flash memory.

[SAVE CAMERA IMAGE] button

The video image is saved in a file in the flash memory.

[INSPECTION DATA RESET]

Inspection data currently stored in the memory are initialized, allowing the user to make data from the beginning.

[EXIT] button

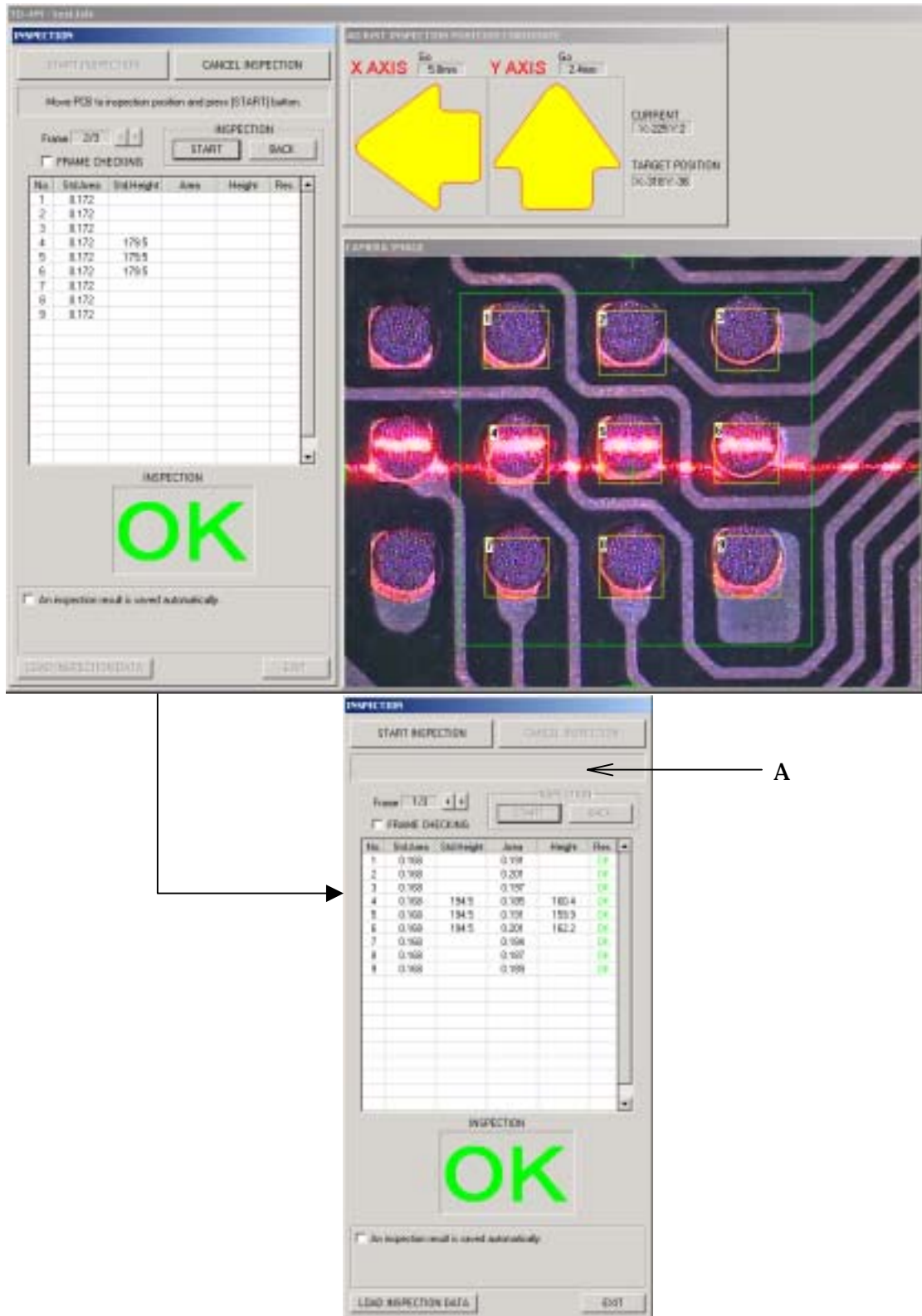
Pressing this button exits the inspection setting screen and returns to the main menu.

* Supplementary

It is possible to edit the "standard area" and "standard height" directly after executing inspection once.

II-2-4 Inspection

The inspection screen is displayed when the [INSPECTION] button is pressed on the main menu. On the inspection screen, it is possible to inspect the determined positions in order only by moving the table as specified based on the inspection data created on the "inspection setting" screen.



[START INSPECTION] button

When this button is pressed, the next instruction is displayed in the column A. Keep on operation according to the instruction, and you may carry out inspection in the positions specified on the inspection setting screen.

[CANCEL INSPECTION] button

Press this button to stop inspection halfway after pressing the [START INSPECTION] button.

Frame

It is possible to confirm the inspection result of each frame after completion of inspection.

FRAME CHECKING

When this button is ticked off, it is possible to confirm the inspection result before starting inspection of the next frame after pressing the START button.

INSPECTION (START)

This button has the same function as the START button of the PC Board clamp table (shown in II-1-4).

INSPECTION (BACK)

Pressing this button returns to the condition before the START button is pressed.

An inspection result is saved automatically.

When this button is ticked off, inspection results are saved automatically in the flash memory after completion of the inspection. For the output format, see II-3.

[LOAD INSPECTION DATA] button

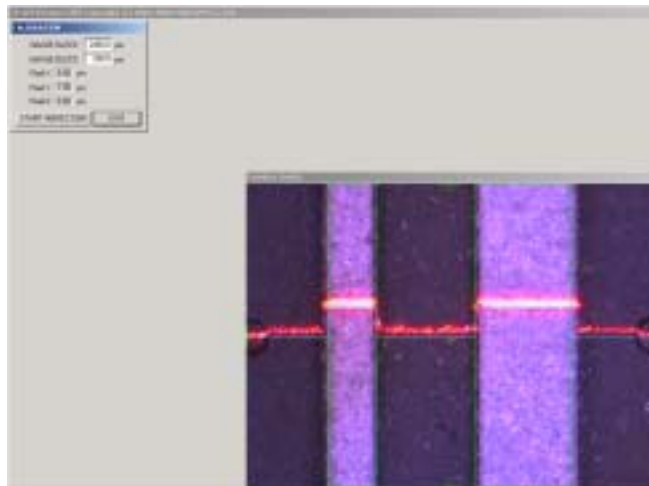
This button loads the inspection data file created on the inspection setting screen.

[Exit] button

Pressing this button exits the inspection screen and returns to the main menu.

II-2-5 Calibration

When the [CALIBRATION] button is pressed on the main menu, the calibration screen appears. On the calibration screen, it is possible to calibrate the machine using the standard gauge block.

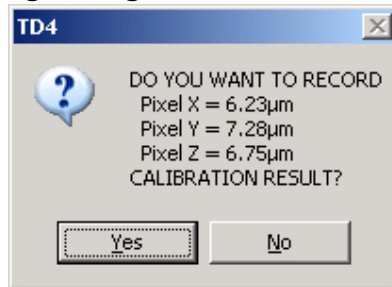


Calibration procedures

- (1) Set unprocessed PC Board on the PC Board clamp table.
- (2) Place the gauge block on the set unprocessed PC Board with the thicker convex on the right.
- (3) Adjust the position while observing the camera screen.
- (4) Adjust the Z axis so that the laser beam is positioned at the center.
- (5) Set the [GAUGE BLOCK] value.



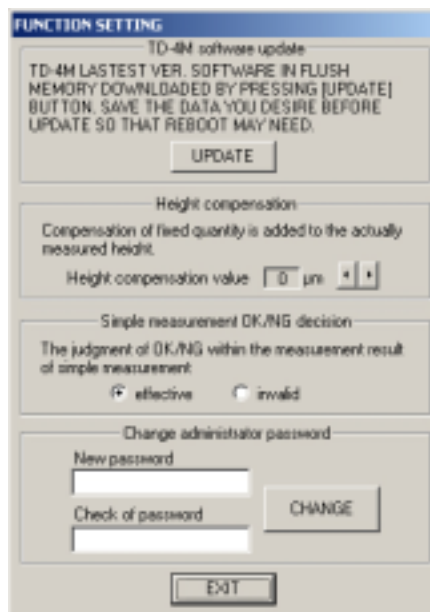
- (6) Press the [START CALIBRATION] button.
- (7) Calibration is executed automatically.
- (8) An inquiry for registering the calibration result is displayed. Make an answer.



Calibration is done in the above procedures.

II-2-6 Function setting

Function setting



TD-4M software update

These are the procedures of updating to the TD-4M software.

Updating procedures

- 1) Download the latest version software using the mail function, etc.
Contact us for acquiring the latest version software.
- 2) Make a copy of [td4.exe] downloaded in step 1) in the [D:¥Update¥] folder in the flash memory.
- 3) Set the flash memory in the TD-4M main unit.
- 4) Press the UPDATE button.

NOTE: It is impossible to update Ver. 1.04 or former version in the procedures shown above. Contact us.

Height compensation

Compensate the measured height data to the certain extent. When compensating, the all displayed data are compensated.

Simple measurement OK/NG decision

Select Simple measurement OK/NG decision function is used or not.

Change administration password

When selecting the menu, [INSPECTION SETTING], [CALIBRAION] and [FUNCTION SETTING] the password is requested, after setting the administration password. If you forget the password, contact us.

II-2-7 Exit

Press the [EXIT] button on the main menu, and you may turn off the power.

A message "Ready to turn off the computer" is displayed on the screen. Then, shut off the power switch on the left of the rear panel of the main unit.

II-3 Inspection Result File Format

The inspection result files contain text data separated with commas "," as shown below.

Frame number, pad number, area, height, volume, area judgment, height judgment, volume judgment (CR) (LF)

Frame number: The number of a frame to be inspected. (1 ~)

Pad number: Number of solder paste (1 ~)

Area: Area of solder paste (Unit: mm²)

Height: Height of solder paste (Unit: μm)

Volume: Volume of solder paste (Unit: mm³)

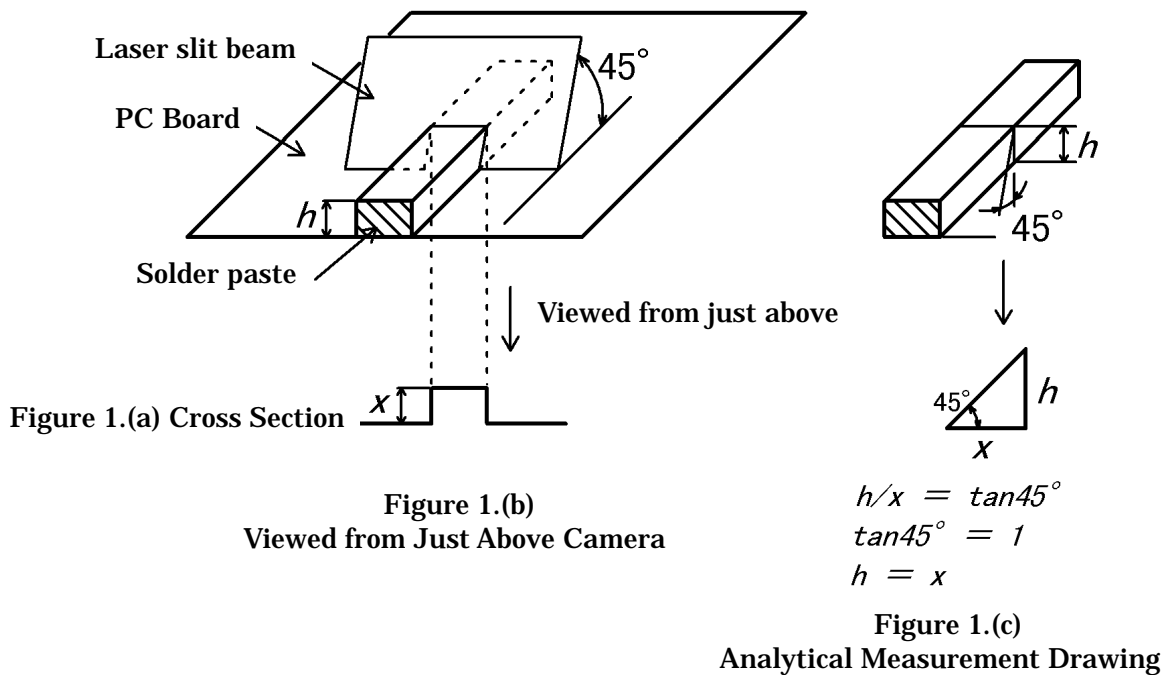
(CR) (LF): Line feed code

III. APPENDICES

III-1 Principle of Measurement

III-1-1 Height measurement

The optical system radiates laser beam, spread in a slit, from above at an angle of 45 degrees. The CCD camera installed just above reads the condition and indicates the height data. This principle is illustrated as shown below, provided the height of solder paste is h .



The laser beam emitted from above diagonally is radiated onto the paste surface as shown in Figure 1(a). Figure 1(b) shows the solder paste viewed from the camera installed just above. Figure 1(c) shows the analysis. The height of the solder paste " h " is equal to X , and the displacement viewed by the camera is the height. Therefore, the height may be found by measuring the pixels of the displacement.

One pixel of the camera corresponds to $8 \mu\text{m}$, and the magnification is 1:1. Thus, the height is found by multiplying the measured number of pixels by $8 (\mu\text{m})$.

Such a height measurement method is called the slit beam cutting method.

III-1-3 Filtering and binary processing

The TD-4M executes the image processing as shown below to find the area, etc.

Filtering: Reducing noises

Binary processing: Making images into black and white

Expansion and contraction: Reducing isolated points and projections

Figure 3 Major Flow of Image Processing

Filtering: Image data contains a lot of noises, and it is necessary to reduce these noises. This system mainly uses so-called median filters, though many types of filters are available. The median filter has the features of reducing noises without making images blurred.

The principle of the median filter is displaying adjacent images in the screen center and extracting the center value.

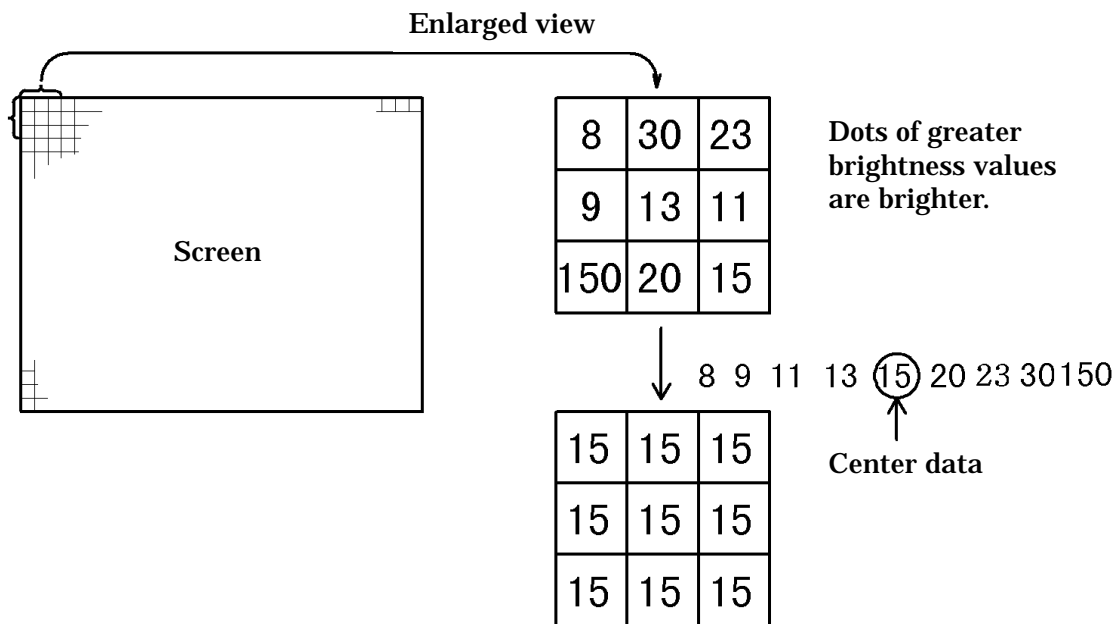


Figure 4 Principle of Median Filter

Binary processing: Dark and pale images (in 256 gradations) are made into black and white binary images, and solder paste parts are extracted. The border H of separating dark and pale images into black and white images is called the threshold level. This system determines the threshold level automatically. If it fails to determine the threshold level properly, the operator may set the binary processing concentration in environmental setting or automatic inspection setting manually. Binary processing is hardly executed for PC Boards with lustrous paste or no resist, which has little difference in reflected light.

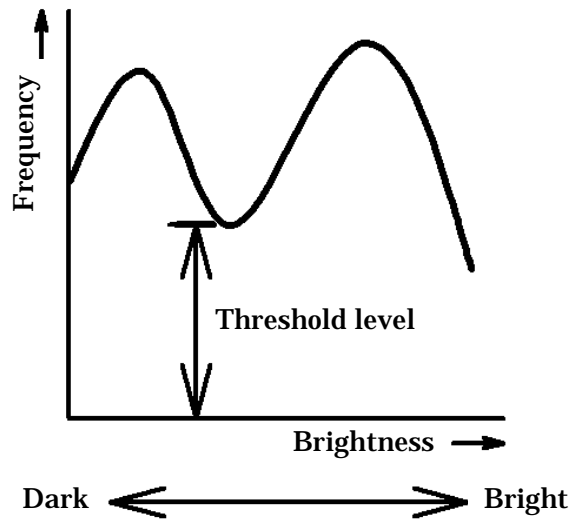


Figure 5 Brightness Histogram per Screen

Expansion and contraction: Binary-processed data may contain small islands (isolated points) and projections. Expansion and contraction are used to reduce them. They are combined to fill up small holes or remote isolated points and projections.

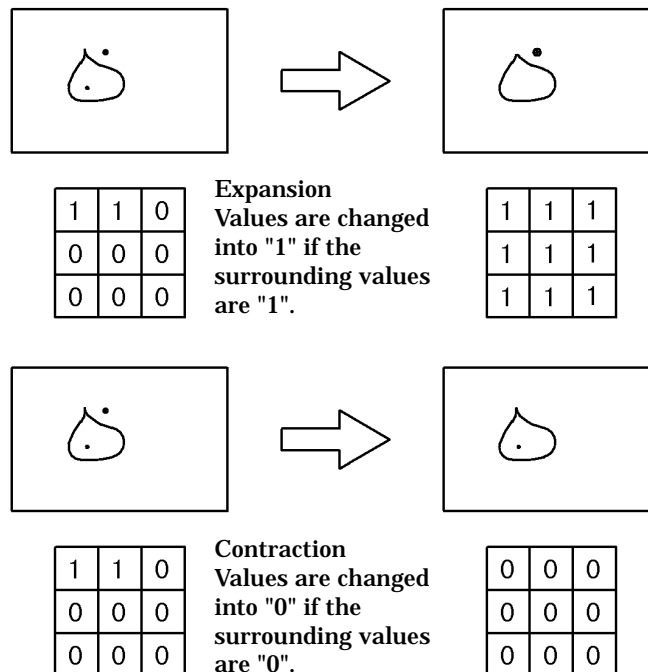


Figure 6 Principle of Expansion and Contraction

III-1-4 Inspection method and judgment

In inspection, the measured height data using the laser beam and width data obtained through image processing with the height data and width data given by teaching in order to judge the printed condition.

1) Finding the height data

The height of printed solder paste is found from the height data obtained using the laser beam and image data. The solder paste does not always have a sharp edge. Some solder paste has a sloping edge. Thus, it may sometimes be difficult to extract solder paste using the height data obtained using the laser beam only. Thus, the width of solder paste is found from image data.

Unstable parts in the leading edges are reduced to improve the stability of the height data. The height data is found from all mean values of data with the leading edges reduced.

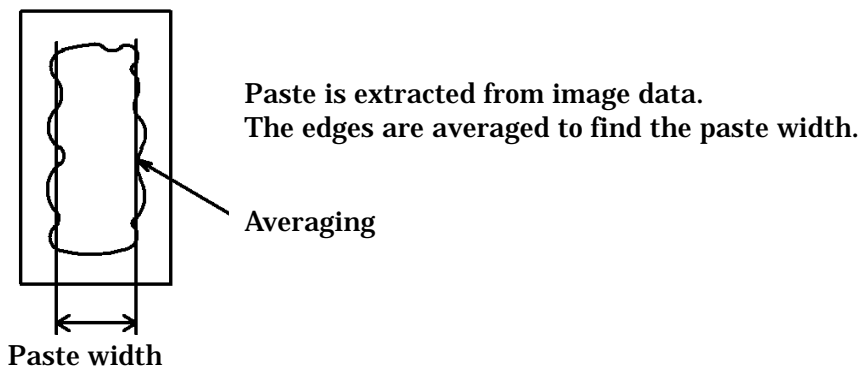


Figure 11 Finding Paste Width

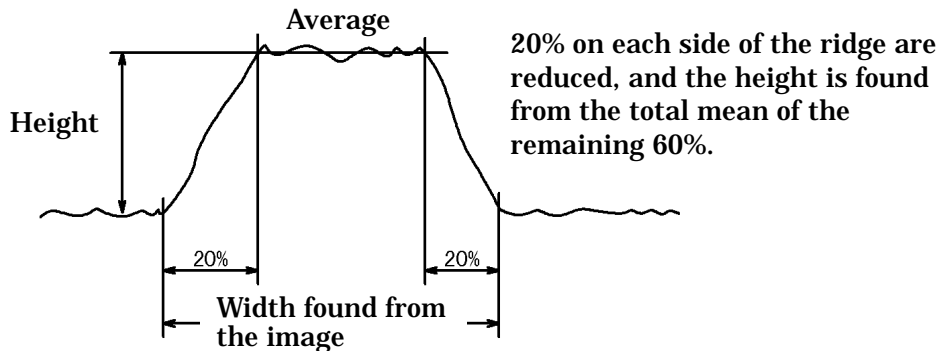


Figure 12 Finding Paste Height

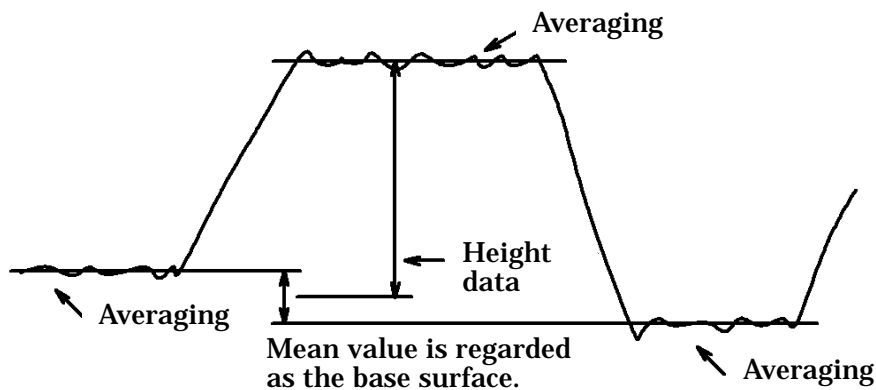
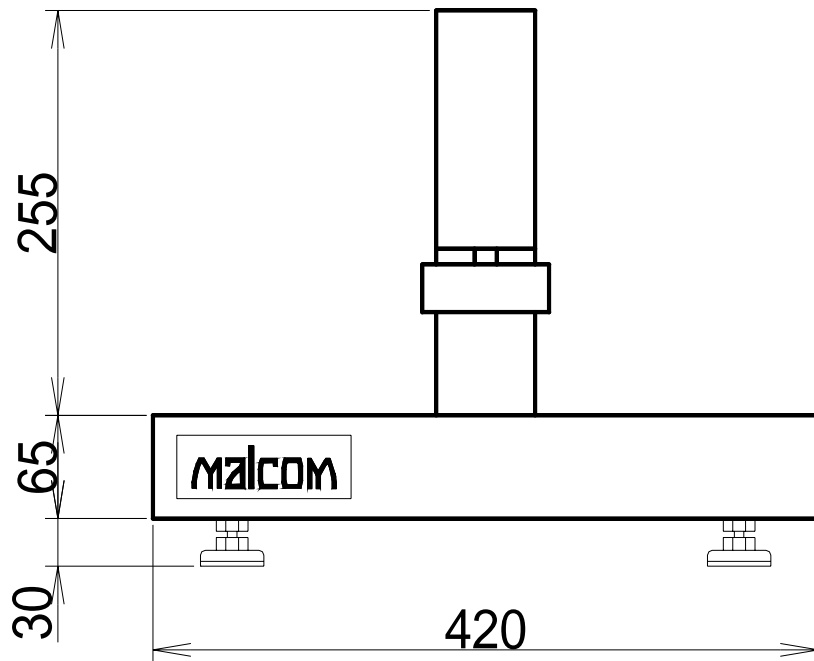
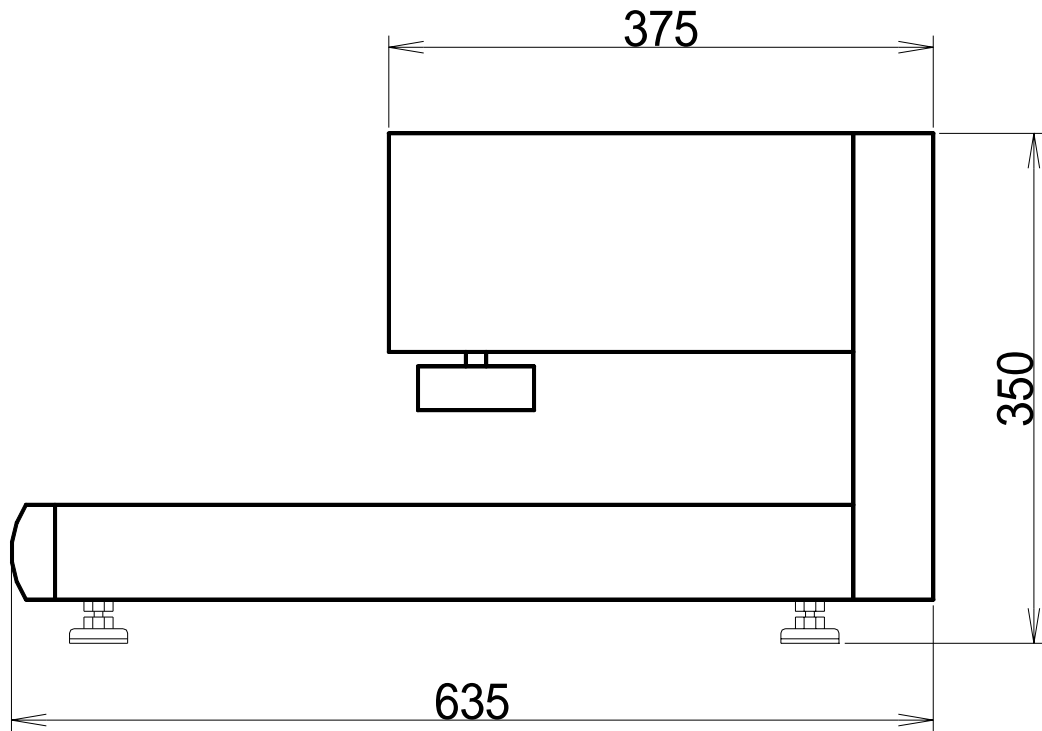


Figure 13 When Base Surfaces on Both Sides Are Different

III-2 Outside Dimensions

Main unit



Warranty card

This product is supplied with a warranty card. Check it when you purchase the product.

Write the necessary matters and check the contents. Keep the warranty card in safe. The warranty period is one year from the date of purchase.

After-Sale Services

Contact us or our distributor for purchasing optional parts and consumables, and questions, etc. concerning repairs.