

DESCRIPTION

PRINTED CIRCUIT BOARD AND METHOD FOR MOUNTING COMPONENTS ON PRINTED CIRCUIT BOARD

TECHNICAL FIELD

[0001] The present invention relates to a printed circuit board on which electronic components can be mounted accurately and to a method for mounting components on the printed circuit board.

BACKGROUND TECHNOLOGY

[0002] In recent years, as various electronic apparatuses are requested to be higher in performance, smaller in size and lighter in weight, electronic components to be mounted on printed circuit boards are being miniaturized. Furthermore, various methods for mounting electronic components so as to meet the needs for higher density of wiring patterns on printed circuit boards have been proposed.

[0003] A conventional method for mounting electronic components on a printed circuit board will be described below briefly.

FIG. 7 is a plan view showing a printed circuit board in an electronic component mounting apparatus, disclosed in

Japanese Patent Application Laid-open No. Sho 62-214692
(hereafter, described as conventional example 1). In the electronic component mounting apparatus according to the conventional example 1, a printed circuit board 101 is provided with positioning holes 102 being used to dispose the printed circuit board 101 at a predetermined position on the apparatus and is also provided with mounting reference marks 103. The mounting reference marks 103 are formed simultaneously with the wiring pattern of the printed circuit board by etching or the like. The positional relationship between the wiring pattern and the mounting reference marks 103 on the printed circuit board 101 is maintained constant for each printed circuit board 101.

[0004] In the production method of the electronic component mounting apparatus according to the conventional example 1, pins (not shown) provided in the electronic component mounting apparatus are inserted into the positioning holes 102 of the printed circuit board 101, and the printed circuit board 101 is disposed at a predetermined position on the electronic component mounting apparatus. The mounting reference marks 103 on the printed circuit board 101 disposed at the predetermined position are then photographed using a camera. After centering operation and rotation operation in a given direction, the lead wires of an electronic component to be mounted are photographed using

another camera. On the basis of the results of image processing using these cameras, the movement amounts and the like of the mounting head are corrected. After the movement amounts and the like of the mounting head are corrected as described above, an electronic component 104 is mounted on the printed circuit board 101. Hence, this method eliminates errors in the mounting positions on electronic components due to the displacement in the positional relationship between the wiring pattern of the printed circuit board 101 and the positioning holes 102 and due to variation and the like in the centering operation and the rotation operation in a given direction.

[0005] As described above, the production method of the electronic component mounting apparatus according to the conventional example 1 is configured to correct the displacement between the mounting reference marks 103 and the lead wires of the electronic component 104 to be mounted under the conditions that the printed circuit board 101 is disposed accurately at the predetermined position on the apparatus and that the positional relationship between the wiring pattern and the mounting reference marks 103 is maintained constant for each printed circuit board.

[0006] FIG. 8 is a plan view showing a printed circuit board in an electronic component mounting apparatus, disclosed in Japanese utility model Application Laid-open No.

Sho 62-128665 (hereafter, described as conventional example 2). A mark 106 consisting of a square fringe having a width around a positioning hole 105 is formed on the printed circuit board according to the conventional example 2. The positioning hole 105 is a hole that is used as a reference when the printed circuit board 101 is placed on the electronic component mounting apparatus. Because the mark 106 is formed in the same production process as that for the mounting lands of the wiring pattern for mounting electronic components, the positional relationship between the mark and the mounting lands of the wiring pattern is maintained constant. In the method for producing the printed circuit board according to the conventional example 2, a visual check is carried out to determine whether the positioning hole 105 is disposed at the center of the square mark 106, thereby judging whether the printed circuit board is proper or not.

[0007] As described above, in the method for producing the printed circuit board according to the conventional example 2, the displacement between the positioning hole 105 and the mark 106 is detected visually when the printed circuit board is produced. Hence, a clearance being large to some extent is required between the positioning hole 105 and the mark 106, and a displacement of appropriately 0.2 mm is taken as an example in the conventional example 2. As

described above, a clearance being large to the extent that it can be detected visually is required for the printed circuit board 101 according to the conventional example 2.

[0008] FIG. 9 is a partially enlarged plan view of a printed circuit board disclosed in Japanese utility model Application Laid-open No. Sho 61-123564 (hereafter, described as conventional example 3). A guide hole 107 having a circular shape and a mark 108 consisting of a square fringe having a width are formed on the printed circuit board 101 according to the conventional example 3. The guide hole 107 is formed simultaneously with through holes 110 into which the connection terminals of electronic components are inserted, and is used as a guide for an automatic electronic component insertion apparatus. The mark 108 consisting of a square fringe having a width is formed on the printed circuit board 101, simultaneously with the wiring pattern 111. In addition, a positioning mark 109 is formed on the printed circuit board 101 according to the conventional example 3. This positioning mark 109 is used to position the printed circuit board 101 when the outer fringes of the printed circuit board, the through holes 110 for the connection terminals of electronic components and the guide hole 107 are formed. In the method for producing the printed circuit board 101 configured as described above, as in the case of the conventional example 2 described above,

a visual check is carried out to determine whether the guide hole 107 is disposed at the center of the square mark 108, thereby judging whether the printed circuit board 101 is proper or not.

[0009] As described above, in the method for producing the printed circuit board according to the conventional example 3, the guide hole 107 and the through holes 110 are formed on the basis of the positioning mark 109, and the connection terminals of the electronic components are inserted into the through holes 110 corresponding thereto. The displacement between the through holes 110 and the wiring pattern is checked using the positional relationship between the guide hole 107 and the mark 108.

Patent document 1: Japanese Patent Application Laid-open No. Sho 62-214692

Patent document 2: Japanese utility model Application Laid-open No. Sho 62-128665

Patent document 3: Japanese utility model Application Laid-open No. Sho 61-123564

DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0010] The printed circuit boards disclosed in the conventional examples 1, 2 and 3 described above have relatively large wiring patterns, and electronic components

to be mounted thereon are also relatively large. Hence, in the printed circuit board 101 according to the conventional example 1, no serious problems occur even if electronic components are mounted on the basis of the mounting reference marks 103 formed simultaneously with the wiring pattern. The printed circuit board 101 according to the conventional example 2 has placement accuracy wherein the displacement between the reference hole 105 serving as the reference for placement on the apparatus and the mark 106 formed simultaneously with the wiring pattern can be detected by visual check. Similarly, the printed circuit board 101 according to the conventional example 3 also has placement accuracy wherein the displacement between the guide hole 107 and the mark 108 can be detected by visual check.

[0011] In printed circuit boards having been developed in recent years, very small components are mounted to meet the needs for higher density and miniaturization of wiring patterns. For example, very small limit switches and the like are mounted on the printed circuit boards. These very small components are required to be disposed accurately at predetermined positions on the printed circuit boards and also disposed firmly so as not to move after mounting. For this purpose, very small holes are formed at the component mounting positions on the printed circuit boards, and the

protrusions of the very small components are fitted into the holes, thereby preventing displacements and movements of the components. The above-mentioned process for fitting the protrusions of the components into the very small holes in the printed circuit boards and for mounting the components thereon is referred to as insertion mounting in the description given below, and the component being mounted as described above is referred to as an insertion mount component. Furthermore, in the printed circuit boards, the process for mounting components by connecting the terminals thereof to the mounting lands of the wiring patterns is referred to as surface mounting, and the component being mounted as described above is referred to as a surface mount component.

In such an insertion mount component being configured as described above, because mounting being high in positional accuracy is necessary, the protrusion of the component is fitted into a very small hole. However, even when a very small insertion mount component is disposed accurately at the position of a predetermined mounting land of a wiring pattern, if there is a slight displacement between the wiring pattern and the very small hole, the protrusion of the insertion mount component is not inserted into the very small hole, and the printed circuit board having the component being in this state is transferred to

the next process. This causes a problem of damaging the component and the printed circuit board in some cases.

[0012] The present invention is intended to provide a printed circuit board being capable of meeting the needs for higher density and miniaturization of wiring patterns and for reliable mounting of very small components and capable of attaining significant reduction in production cost, and more particularly, to provide a printed circuit board capable of allowing very small components to be disposed securely at accurate positions and ensuring excellent productivity and workability, and a method for mounting components on the printed circuit board.

MEANS FOR SOLVING PROBLEM

[0013] For the purpose of attaining the object described above, a printed circuit board according to the present invention as set forth in claim 1, comprises:

- a wiring pattern having mounting lands to be connected to the connection terminals of a surface mount component,

- a mounting hole formed in the area of the wiring pattern so as to be fitted with protrusions formed on an insertion mount component,

- an insertion mount reference mark formed substantially simultaneously with the mounting hole and having a reference hole serving as a reference at the time when the insertion

mount component is mounted, and

a surface mount reference mark formed substantially simultaneously with the mounting lands of the wiring pattern and serving as a reference at the time when the surface mount component is mounted. With the printed circuit board configured as described above, very small components can be disposed securely at accurate positions, excellent productivity and workability are obtained, and significant reduction in production cost can be attained.

[0014] In addition, a printed circuit board according to the present invention as set forth in claim 2 is the printed circuit board according to claim 1, wherein the surrounding area of the reference hole of the insertion mount reference mark may be composed of a metal foil area formed by etching at the time when the wiring pattern is formed.

Furthermore, a printed circuit board according to the present invention as set forth in claim 3 is the printed circuit board according to claim 1, wherein the surrounding area of the reference hole of the insertion mount reference mark can be colored to a color that can be distinguished from that of the light passed through the reference hole.

Moreover, a printed circuit board according to the present invention as set forth in claim 4 is the printed circuit board according to claim 2, wherein the insertion

mount reference mark may have a through hole formed at the substantially central position of the metal foil area.

[0015] Additionally, a printed circuit board according to the present invention as set forth in claim 5 is the printed circuit board according to any one of claims 1 to 4, wherein the surface mount reference mark and the insertion mount reference mark can be formed on throw-away portions formed around the outer fringes of the printed circuit board.

Still further, a printed circuit board according to the present invention as set forth in claim 6 is the printed circuit board according to claim 2, wherein a mounting reference mark may comprise a through hole formed in the metal foil area having a predetermined shape and the surrounding area of the metal foil area being colored to a color that can be distinguished from that of the metal foil area so as to be used as an insertion mount reference mark and a surface mount reference mark.

[0016] A method for mounting components on a printed circuit board according to an aspect of the present invention as set forth in claim 7, comprises:

 a step of substantially simultaneously forming a mounting hole for an insertion mount component and a reference hole serving as a reference at the time when the insertion mount component is mounted, in an insertion mount reference mark area on the printed circuit board, and

a step of calculating the center point of the reference hole serving as an insertion mount reference mark and mounting an insertion mount component at a predetermined position on the printed circuit board on the basis of the calculated center point. With the method for mounting components on the printed circuit board configured as described above, very small components can be disposed securely at accurate positions, and excellent productivity and workability are obtained.

[0017] A method for mounting components on a printed circuit board according to another aspect of the present invention as set forth in claim 8, comprises:

a step of forming a metal foil mark in a surface mount reference mark area and forming a metal foil mark in an insertion mount reference mark area simultaneously at the time when a wiring pattern is formed on the printed circuit board,

a step of simultaneously forming mounting hole for an insertion mount component and a reference hole serving as references at the time when the insertion mount component is mounted, in the metal foil of the insertion mount reference mark area on the printed circuit board,

a step of calculating the center point of the metal foil mark located in the surface mount reference mark area and serving as a surface mount reference mark, and mounting

a surface mount component at a predetermined position on the printed circuit board on the basis of the calculated center point, and

a step of calculating the center point of the reference hole serving as an insertion mount reference mark and mounting an insertion mount component at a predetermined position on the printed circuit board on the basis of the calculated center point.

The method for mounting components on the printed circuit board configured as described above can meet the needs for higher density and miniaturization of wiring patterns and for reliable mounting of very small components, and can attain significant reduction in production cost.

[0018] Furthermore, a method for mounting components on a printed circuit board according to the present invention as set forth in claim 8 is the method for mounting components on a printed circuit board according to claim 7 or 8, wherein the surface mount reference mark and the insertion mount reference mark are formed on throw-away portions formed around the outer fringes of the printed circuit board, and the throw-away portions are eliminated after the surface mount component and the insertion mount component are mounted.

While the novel features of the invention are set forth particularly in the appended claims, the invention,

both as to organization and content, will be better understood and appreciated, along with other objects and features thereof, from the following detailed description taken in conjunction with the drawings.

EFFECT OF THE INVENTION

[0019] The printed circuit board according to the present invention can meet the needs for higher density and miniaturization of wiring patterns and for reliable mounting of very small components, and can attain significant reduction in production cost. Furthermore, the present invention can allow very small components to be disposed securely at accurate positions, and can provide a printed circuit board being excellent in productivity and workability and a method for mounting components on the printed circuit board.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020]

FIG. 1 is a plan view showing a printed circuit board according to Embodiment 1 of the present invention;

FIG. 2 is an enlarged plan view of the printed circuit board portion A of the printed circuit board according to Embodiment 1;

FIG. 3 is a partially enlarged plan view of the

printed circuit board 1 according to Embodiment 1;

FIG. 4 is a side view showing a specific example of an insertion mount component;

FIG. 5 is a plan view showing component mounting holes and mounting lands for the specific insertion mount component shown in FIG. 4;

FIG. 6 is a plan view showing the vicinity of a mounting reference mark on a printed circuit board according to Embodiment 2;

FIG. 7 is the plan view showing the printed circuit board in the conventional electronic component mounting apparatus;

FIG. 8 is the plan view showing the printed circuit board in another conventional electronic component mounting apparatus; and

FIG. 9 is the partially enlarged plan view of the conventional printed circuit board.

EXPLANATIONS OF NUMERALS

[0021]

1 printed circuit board

2 surface mount reference mark

2a metal foil

3 insertion mount reference mark

3a first insertion mount reference mark

3b second insertion mount reference mark
4 board positioning hole
5a, 5b through holes
6a, 6b metal foils
10 mounting land
20 component mounting hole
30 limit switch
31 contact lever
32 first protrusion
33 second protrusion
34 terminal
35 first component mounting hole
36 second component mounting hole
37 mounting land
40 mounting reference mark
41 reference hole
42 metal foil
43 outer fringe
50 printed circuit board

BEST MODES FOR CARRYING OUT THE INVENTION

[0022] Printed circuit boards and methods for mounting components on the printed circuit boards according to preferred embodiments of the present invention will be described below referring to the accompanying drawings.

[0023] <<Embodiment 1>>

FIG. 1 is a plan view showing a printed circuit board according to Embodiment 1 of the present invention. As shown in FIG. 1, the printed circuit board 1 shown herein is a set of four printed circuit boards A, B, C and D, and the printed circuit boards A, B, C and D have the same shape and configuration. FIG. 2 is an enlarged plan view of the printed circuit board A. FIG. 3 is a partially enlarged plan view of the printed circuit board 1, and shows a surface mount reference mark 2 and an insertion mount reference mark 3 on the printed circuit board 1 according to Embodiment 1.

[0024] As shown in FIG. 1, the printed circuit board 1 is partitioned at the outer fringes of the four printed circuit boards A, B, C and D using multiple grooves. On each of the printed circuit boards A, B, C and D, multiple mounting lands 10, component mounting holes 20, etc. are formed according to a wiring pattern. Although the mounting lands, the component mounting holes, etc. are formed on the entire face of each of the printed circuit boards A, B, C and D according to Embodiment 1, only some of the mounting lands 10 and the component mounting holes 20 are shown in FIGS. 1 and 2.

The surface mount reference marks 2, the insertion mount reference marks 3 and board positioning holes 4 are

formed at the outer fringes and the like of the printed circuit board 1 according to Embodiment 1. The outer fringes are thrown away when the printed circuit boards A, B, C and D are removed from the printed circuit board 1.

[0025] The reference positioning holes 4 are holes that are used as references to position the printed circuit board 1 on a component mounting apparatus. The holes are engaged with the pins (not shown) provided on the component mounting apparatus, whereby the printed circuit board 1 is disposed at the desired position on the apparatus.

As shown in FIGS. 1 and 2, the surface mount reference marks 2 are formed at multiple positions on the printed circuit board 1, for example, at positions near the nearly diagonal corners of the printed circuit board 1 and at nearly diagonal positions around surface mount components. By the use of the pair of surface mount reference marks 2 formed diagonally as described above around the surface mount component to be mounted, the positioning of the surface mount component in the X-axis direction and the Y-axis direction with respect to the printed circuit board 1 can be carried out on the basis of the surface mount reference marks 2 formed near the surface mount component. The X-axis direction is herein the horizontal direction on the printed face of the printed circuit board 1 (the lengthwise direction of the printed circuit board 1 shown in

FIG. 1), and the Y-axis direction is the perpendicular direction on the printed face of the printed circuit board 1.

[0026] The surface mount reference marks 2 are formed in the same production process (for example, the pattern-baking and etching process) as that for the wiring pattern on the printed circuit board 1. As shown in FIG. 3, the surface mount reference mark 2 consists of a metal foil 2a, such as a copper film, and an outer fringe 2b formed therearound. The center of the metal foil 2a serves as the reference point of the surface mount reference mark 2. For this reason, no displacement occurs in the positional relationship between the metal foil 2a serving as the reference point of the surface mount reference mark 2 and the wiring pattern. In the surface mount reference mark 2, the outer fringe 2b formed around the metal foil 2a indicating the surface mount reference point is colored to a color different from that of the metal foil 2a, for example, black, and is configured so that the center of the metal foil 2a can be calculated easily by processing an image taken using a camera. Although the metal foil 2a according to Embodiment 1 is formed into a square shape, it may also be formed into a circular shape.

[0027] As shown in FIG. 2, the insertion mount reference mark 3 is formed near the upper diagonal corner of the printed circuit board 1, adjacent to the surface mount

reference mark 2. In the printed circuit board 1 according to Embodiment 1, the insertion mount reference mark 3 consists of two kinds of marks: a first insertion mount reference mark 3a and a second insertion mount reference mark 3b.

As shown in FIG. 3, the first insertion mount reference mark 3a consists of a through hole 5a and an outer fringe 6a formed therearound. The outer fringe 6a of the first insertion mount reference mark 3a is formed of a square metal foil 6a, such as a copper film, that is the same metal foil as that of the wiring pattern and formed simultaneously therewith. The second insertion mount reference mark 3b consists of a through hole 5b and an outer fringe 6b formed therearound. The outer fringe 6b of the second insertion mount reference mark 3b is colored to black, for example.

[0028] The through holes 5a and 5b serving as the reference holes in the first insertion mount reference mark 3a and the second insertion mount reference mark 3b configured as described above are formed simultaneously during the drilling process (NC drilling) for the printed circuit board 1, for example, the drilling of mounting holes for allowing electronic components to be mounted. Hence, the through holes 5a and 5b are formed without displacement in the positional relationship between the through holes 5a

and 5b and the electronic component mounting holes in the printed circuit board 1. In Embodiment 1, the through holes 5a and 5b have a diameter of 1.0 mm, and the metal foil 6a is formed into a square shape with one side measuring 3.0 mm. The through holes 5a and 5b should only have shapes such that their circumferential portions can be detected by image recognition, and they should only have a diameter of 0.5 mm or more.

[0029] Although an example wherein the two kinds of insertion mount reference marks 3a and 3b formed on the printed circuit board 1 according to Embodiment 1 has been described above, one kind of insertion mount reference mark should only be provided depending on two kinds of mark recognition methods described below in the method for producing the printed circuit board 1.

A first mark recognition method is, for example, a method wherein light is applied to the insertion mount reference mark 3 from above the printed circuit board 1, the light reflected therefrom is photographed using a camera provided above to take an image, and the center position of the through hole 5a is calculated using the taken image. A second mark recognition method is, for example, a method wherein light is applied to the insertion mount reference mark 3 from below the printed circuit board 1, the light passed through the through hole 5b is photographed using a

camera provided above to take an image, and the center position of the through hole 5b is calculated using the taken image. Hence, in the first mark recognition method, the center position of the through hole 5a is calculated using the first insertion mount reference mark 3a and using the light reflected therefrom. In the second mark recognition method, the center position of the through hole 5b is calculated using the second insertion mount reference mark 3b and using the light past through the through hole 5b. In the second mark recognition method, when the first insertion mount reference mark 3a is used, the boundary between the passing light and the metal foil 6a cannot be recognized, and the center position of the through hole 5a cannot be calculated in some cases. For this reason, a desired insertion mount reference mark is selected depending on the recognition method from the two kinds of marks included in the insertion mount reference mark 3 on the printed circuit board.

[0030] Mounting of very small insertion mount components on the printed circuit board 1 configured as described above will be described below specifically.

FIG. 4 is a side view showing a limit switch 30 being used as an odd-shaped component, an example of an insertion mount component. FIG. 5 is a plan view showing a mounting portion of the printed circuit board 1, on which the limit

switch 30 shown in FIG. 4 is mounted.

As shown in FIG. 4, the limit switch 30 is provided with a contact lever 31 that is movable so as to turn on or off a circuit, multiple terminals 34 that are connected to the mounting lands 37 of the wiring pattern, and two kinds of protrusions 32 and 33. As shown in FIG. 5, two kinds of component mounting holes 35 and 36 corresponding to the two kinds of protrusions 32 and 33 are formed at the mounting portion of the printed circuit board 1, on which the limit switch 30 is mounted, and the mounting lands 37 are provided on both sides thereof. The diameter of the first protrusion 32 of the limit switch 30 being used in Embodiment 1 is 0.75 mm, and the diameter of the second protrusion 33 is 0.55 mm. In addition, the diameter of the first component mounting hole 35 is 0.85 mm, and the diameter of the second component mounting hole is 0.65 mm. Hence, in Embodiment 1, a small clearance of only 0.05 mm at the both sides of the first protrusion 32 is provided between the first protrusion 32 (0.75 mm in diameter) and the first component mounting hole 35 (0.85 mm in diameter). Furthermore, a clearance having the same value is also provided between the second protrusion 33 (0.55 mm in diameter) and the second component mounting hole 36 (0.65 mm in diameter).

[0031] The printed circuit board 1 according to Embodiment 1 is transferred to a component mounting

apparatus and disposed at the desired position on the component mounting apparatus using the board positioning holes 4. However, because the board positioning holes 4 and the mounting lands 10 (for example, the portions indicated by numeral 37 in FIG. 5) of the wiring pattern on the printed circuit board 1 are not formed in the same production process, displacement may occur in the positional relationship therebetween.

Hence, in the method for mounting components on the printed circuit board 1 according to Embodiment 1, in the case of a surface mount component, the surface mount reference mark 2 is photographed using a camera, its image is processed to calculate the center point of the metal foil 2a, and the calculated center point is used as the reference point for surface mounting. The surface mount component is mounted at the predetermined position on the printed circuit board 1 on the basis of the reference point for surface mounting using the component mounting apparatus.

On the other hand, in the case of an insertion mount component, the insertion mount reference mark 3 is photographed using a camera, its image is processed to calculate the center point of the through hole 5a or 5b serving as a reference hole, and the calculated center point is used as the reference point for insertion mounting. The insertion mount component is mounted at the predetermined

position on the printed circuit board 1 on the basis of the reference point for insertion mounting using the component mounting apparatus.

In the printed circuit board 1 according to Embodiment 1, because the through hole (5a or 5b) serving as the reference hole of the insertion mount reference mark 3 is formed in the same production process as that for the component mounting holes 20 (35, 36) for the insertion mount component using an NC machine tool, for example, there is no displacement in the positional relationship therebetween in the printed circuit board 1, and the same distance is maintained therebetween. Therefore, in the mounting process, the protrusions of the insertion mount component is inserted securely into the predetermined component mounting holes 20 (35, 36), and the insertion mount component is mounted securely.

[0032] According to an experiment conducted by the inventors, the fraction defective in the case of the method for mounting components on the printed circuit board 1 according to Embodiment 1 was 0.001% or less. On the other hand, the fraction defective in the case of the conventional method for mounting surface mount components and insertion mount components using only the surface mount reference marks was different significantly for each production lot of the printed circuit board. In some cases, the fraction

defective exceeded 1.0%. It is assumed that, in the case that a large displacement, such as a displacement of 0.15 mm or more, occurred in the positional relationship between the mounting lands 10 of the wiring pattern and the component mounting hole 20 during the experiment, component mounting was unable to be carried out properly. In the conventional printed circuit board, because the clearance between the protrusion of the insertion mount component and the component mounting hole was set at 0.2 mm or more, no problem occurred. However, in the present invention, because the clearance described above was set at a very small value to attain higher density and miniaturization of wiring patterns and miniaturization of components, it is assumed that the fraction defective became high.

However, in the method for mounting components on the printed circuit board according to Embodiment 1, because an insertion mount component is mounted on the basis of the center point of the reference hole of the insertion mount reference mark, even if the clearance between the protrusions 32 and 33 of the insertion mount component and the component mounting holes 35 and 36 is 0.05 mm, for example, the insertion mount component is disposed accurately at the desired position on the printed circuit board 1 and then mounted thereon.

[0033] In the printed circuit board 1 according to

Embodiment 1, an example wherein the pair of insertion mount reference marks 3 is formed at the diagonal fringe portions of the printed circuit board is described. However, the present invention is not limited to this kind of embodiment. Multiple pairs of insertion mount reference marks may be formed in an open space inside the printed circuit board, or a pair of insertion mount reference marks may be formed diagonally near the insertion mount component to be mounted.

In Embodiment 1, an example wherein the surface mount reference marks 2 and the insertion mount reference marks 3 are formed on the throw-away portions of the printed circuit board 1 is described. However, it is possible to form the surface mount reference marks 2 and/or the insertion mount reference marks 3 in the same area as that for the wiring pattern depending on the configuration of the printed circuit board.

Furthermore, in Embodiment 1, the reference hole is shown as a through hole having a circular shape. However, the reference hole is not limited to this shape, and the reference hole should only be formed into a shape that is processed simultaneously with the component mounting holes for insertion mount components and is configured such that the reference point can be calculated by image recognition. For example, in the case of the first mark recognition method, the reference hole is not required to be a through

hole but may be a non-through hole. Moreover, the reference hole should only be formed into a shape being configured such that the center point can be calculated, and the reference hole may have a polygonal shape, for example.

[0034] As described above, with the method for mounting components on the printed circuit board according to Embodiment 1, in the printed circuit board intended for higher density and miniaturization of the wiring pattern and for miniaturization of components, even if the positional relationship between the wiring pattern and the component mounting holes is displaced owing to a change in the production lot of the printed circuit board, insertion mount components can be mounted securely at desired positions, and the production cost can be reduced significantly. Hence, with the method for mounting components on the printed circuit board according to Embodiment 1, very small components can be disposed securely at accurate positions, and excellent productivity and workability are obtained. Furthermore, because the production cost of the printed circuit board according to Embodiment 1 is reduced significantly, product prices can be lowered.

[0035] <<Embodiment 2>>

FIG. 6 is a plan view showing the vicinity of a mounting reference mark on a printed circuit board according to Embodiment 2. The printed circuit board according to

Embodiment 2 is provided with a mounting reference mark 40 that is a combination of the surface mount reference mark 2 and the insertion mount reference mark 3 provided on the printed circuit board 1 according to Embodiment 1 described above. The configuration of the printed circuit board according to Embodiment 2 is the same as that of the printed circuit board according to Embodiment 1 except for the mounting reference mark.

As shown in FIG. 6, the mounting reference mark 40 consists of a reference hole 41 serving as the mounting reference for insertion mount components, a metal foil 42 formed around this reference hole 41, and an outer fringe 43 formed around this metal foil 42 and colored to a color different from that of the metal foil 42, for example, black. The reference hole 41 is formed in the same production process as that for the component mounting holes into which the protrusions of insertion mount components are fitted, and there is no displacement between the reference hole 41 and the component mounting holes, but a predetermined positional relationship is maintained therebetween. Hence, the center point of the reference hole 41 is calculated by image processing and used as the reference point for insertion mounting, whereby each insertion mount component is disposed accurately at a desired position on a printed circuit board 50 and then mounted.

[0036] In the printed circuit board 50 according to Embodiment 2, the metal foil 42 having a circular shape and made of a copper foil, for example, is formed in the same production process as that for the wiring pattern, and there is no displacement between the wiring pattern and the metal foil 42, whereby a predetermined positional relationship is maintained therebetween. Furthermore, the outer fringe 43 colored to a color different from that of the metal foil 42 is formed around the metal foil 42. With this configuration, the outer circumferential portion of the metal foil 42 having a circular shape can be detected by image recognition.

In the process for mounting components on the printed circuit board 50 according to Embodiment 2, light is applied to the mounting reference mark 40, the light reflected therefrom is photographed using a camera, and image processing is carried out to calculate the center point of the reference hole 41. The center point is used as the reference point for insertion mounting. In addition, the boundary between the metal foil 42 and the outer fringe 43 is recognized by the image processing using the light reflected from the mounting reference mark 40, and the center point of the metal foil 42 having a circular shape is calculated. The center point is used as the reference point for surface mounting. Hence, the displacement between the reference point for insertion mounting and the reference

point for surface mounting becomes the displacement distance between the component mounting holes for insertion mount components and the mounting lands of the wiring pattern. If the displacement distance exceeds a predetermined value, the printed circuit board being in this state is automatically ejected from the production line as a defective product.

[0037] As described above, the printed circuit board according to Embodiment 2 is configured so that component mounting can be carried out using one mounting reference mark 40 having a function obtained by combining the surface mount reference mark and the insertion mount reference mark. Hence, the mounting reference mark can be formed even on the limited mounting face of the printed circuit board that is required to be miniaturized. Furthermore, with the method for mounting components on the printed circuit board according to Embodiment 2, components can be mounted securely at desired positions, and significant reduction in production cost can be attained.

INDUSTRIAL APPLICABILITY

[0038] The present invention can meet the needs for higher density and miniaturization of wiring patterns and for reliable mounting of very small components, and can attain significant reduction in production cost, thereby being widely applicable to and useful for printed circuit

boards.

CLAIMS

1. A printed circuit board comprising:

a wiring pattern having mounting lands to be connected to connection terminals of both mount components of at least an insertion mount component having a connection terminal for surface mounting and a protrusion for positioning, and at least a surface mount component having a connection terminal for surface mounting,

a mounting hole formed in the area of the wiring pattern in which the protrusion of the insertion mount component is to be inserted,

an insertion mount reference mark which has a reference hole serving as a reference for deciding an inserting position for the insertion mount component at the time when the insertion mount component is mounted by a component mounting apparatus, and which is formed simultaneously with the mounting hole in a drilling process for the mounting hole to have a predetermined positional relationship between the mounting hole and the reference hole, and

a surface mount reference mark which serves as a reference for deciding a mounting position of the surface mount component at the time when the surface mount component is mounted by a component mounting apparatus, and which is

formed simultaneously with the wiring pattern in a forming process for the wiring pattern by using the same metal foil as the wiring pattern to have a predetermined positional relationship between the surface mount reference mark and the wiring pattern.

2. The printed circuit board according to claim 1, wherein the surrounding area of the reference hole of the insertion mount reference mark is composed of a metal foil area formed by etching at the time when the wiring pattern is formed.

3. The printed circuit board according to claim 1, wherein the surrounding area of the reference hole of the insertion mount reference mark is colored to a color that can be distinguished from that of the light passed through the reference hole.

4. The printed circuit board according to claim 2, wherein the insertion mount reference mark has a through hole formed as a reference hole at the central position of the metal foil area.

5. The printed circuit board according to any one of

claims 1 to 4, wherein the surface mount reference mark and the insertion mount reference mark are formed on throw-away portions formed around the outer fringes of the printed circuit board.

6. The printed circuit board according to claim 2, wherein a mounting reference mark comprises a through hole as a reference hole formed in the metal foil area having a predetermined shape and the surrounding area of the metal foil area being colored to a color that can be distinguished from that of the metal foil area so as to be used as an insertion mount reference mark and a surface mount reference mark.

7. A method for mounting components on a printed circuit board, the components including at least an insertion mount component having a connection terminal for surface mounting and a protrusion for positioning, and at least a surface mount component having a connection terminal for surface mounting, the method comprising:

a step of simultaneously forming a surface mount reference mark, which serves as a reference at the time when the surface mount component is mounted, with a wiring pattern in a forming process,

the wiring pattern having mounting lands to be

connected to the connection terminals of the insertion mount component and the surface mount component, wherein the surface mount reference mark is formed in a surface mount reference mark area on the printed circuit board by using the same metal foil as the wiring pattern so as to have a predetermined positional relationship between the surface mount reference mark and the wiring pattern,

a step of simultaneously forming a reference hole, which serves as a reference at the time when the insertion mount component is mounted, with a mounting hole in a drilling process, the mounting hole being for the insertion of the protrusion for positioning, wherein the reference hole is formed in an insertion mount reference mark area on the printed circuit board so as to have a predetermined positional relationship between the mounting hole and the reference hole,

a step of deciding an inserting position for the protrusion of the insertion mount component to have a predetermined positional relationship between the reference hole of the insertion mount reference mark area and the inserting position for the insertion mount component at the time when the insertion mount component is mounted by a component mounting apparatus, and mounting the insertion mount component by inserting the protrusion into the decided inserting position on the printed circuit board, and

a step of deciding a mounting position for the surface mount component to have a predetermined positional relationship between the surface mount reference mark and the mounting position in the mounting land at the time when the surface mount component is mounted by a component mounting apparatus, and mounting the surface mount component at the decided mounting position on the printed circuit board.

8. The method for mounting components on a printed circuit board, according to claim 7, wherein

in the step of forming the metal foil mark as the surface mount reference mark in the surface mount reference mark area, the metal foil mark is formed simultaneously in the insertion mount reference mark area by using the same metal foil as that of the wiring pattern ,

in the step of forming the reference hole in the insertion mount reference mark area, the reference hole is formed in the metal foil mark of the insertion mount reference mark area,

in the step of mounting the insertion mount component, a center point of the reference hole located in the insertion mount reference mark area is calculated, and the insertion mount component is mounted at a predetermined position on the printed circuit board on the basis of the

calculated center point of the reference hole,

in the step of mounting the surface mount component, a center point of the metal foil mark located in the surface mount reference mark area is calculated, and the surface mount component is mounted at a predetermined position on the printed circuit board on the basis of the calculated center point of the metal foil mark.

9. The method for mounting components on a printed circuit board according to claim 7 or 8, wherein the surface mount reference mark and the insertion mount reference mark are formed on throw-away portions formed around the outer fringes of the printed circuit board, and the throw-away portions are eliminated after the surface mount component and the insertion mount component are mounted.