CLAIMS

1/ A method for testing an electronic device, in which the magnetic field emitted by at least one circulation of electric current in the electronic device (39) is measured by a monodirectional measurement probe (46) adapted to be able to deliver a signal representative of the value of a component Bz of said magnetic field along a predetermined axis ZZ' which is fixed with respect to said probe,

wherein:

- the probe (46) being brought to a distance d0 in front of one face of the electronic device, and the electronic device being supplied with electrical energy and with predetermined input signals applied to input terminals of the electronic device, for each position (x, y) of the axis ZZ' with respect to said face, a first value Bz1 of the component of the magnetic field Bz along the axis ZZ' is measured by the probe (46) and recorded,

- then the probe (46) and the electronic device are displaced with respect to one another by relative pivoting about an axis XX' orthogonal to the axis ZZ' according to an angular amplitude α of less than 90°, the probe (46) being kept at the same distance d0 in front of the same face of the electronic device, and, the electronic device being supplied with electrical energy and with predetermined input signals, for each position (x, y) of the axis ZZ' with respect to said face, a second value Bz2 of the component Bz of the magnetic field along the axis ZZ' is measured by the probe (46) and recorded,

- then the value of a component By of the magnetic field along an axis YY' orthogonal to the axes ZZ' and XX' is determined and recorded for each position (x, y) of the axis ZZ' on the basis of the first value Bz1 and the second value Bz2 which have been obtained.

2/ - The method as claimed in claim 1, wherein the value of the component By of the magnetic field is calculated according to the formula:

~~By = (Bz1.cosα – Bz2)/sinα.~~

3/ - The method as claimed in one of claims 1 and 2, wherein:

- the probe (46) and the electronic device are displaced with respect to one another by relative pivoting about the axis YY' according to an angular amplitude β of less than 90°, the probe (46) being kept at the same distance d0 in front of the same face of the electronic device, and, the electronic device being supplied with electrical energy and with predetermined input signals, for each position (x, y) of the axis ZZ' with respect to said face, a third value Bz3 of the component Bz of the magnetic field along the axis ZZ' is measured by the probe (46) and recorded,

- then the value of a component Bx of the magnetic field along an axis XX' is determined and recorded for each position (x, y) of the axis ZZ' on the basis of the first value Bz1 and the third value Bz3 which have been obtained.

4/ - The method as claimed in claim 3, wherein the value of the component Bx of the magnetic field is calculated according to the formula:

$$Bx = (Bz1.\cos\beta - Bz3)/\sin\beta$$

5/ - The method as claimed in one of claims 1 to 4, wherein:

- an image, called a measured image (34), of at least a part of the electronic device (39) is formed on the basis of one of the three components Bx, By, Bz of the magnetic field emitted by this electronic device, as determined on the basis of the measurements provided by said probe (46) for different positions (x, y) of the axis ZZ' of the probe with respect to said face,

- a plurality of simulated images (32) of said part of the electronic device (39) are formed by simulation, each simulated image corresponding to an image capable of being obtained in the same way as the measured image, on the basis of values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field as would be emitted by this electronic device (39) in the presence of at least one

~~fault of the circulation of current in said part of the electronic device (39),~~

- the simulated images (32) are compared with the measured image (34).

6/ - The method as claimed in claim 5, wherein the measured image of said part of the electronic device (39), which is used for the comparison, corresponds to subtraction of an image obtained on the basis of the corresponding component Bx, By, Bz of the magnetic field emitted by the entirety of a reference electronic device corresponding to the electronic device (39) to be tested but free of faults, this component being measured for each position (x, y) of the axis ZZ' with respect to said face, and of an image obtained on the basis of the corresponding component Bx, By, Bz of the magnetic field emitted by the entirety of the electronic device (39) to be tested, this component also being measured for each position (x, y) of the axis ZZ' with respect to said face, and wherein each simulated image is formed by subtraction of an image obtained on the basis of values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field as would be emitted by the entirety of the reference electronic device, and of an image obtained on the basis of values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field as would be emitted by the entirety of the electronic device (39) in the presence of at least one fault.

7/ - The method as claimed in one of claims 1 to 6, wherein a measurement probe (46) comprising a sensor selected from a SQUID sensor and a magnetoresistive sensor is used.

8/ - The method as claimed in one of claims 1 to 7, wherein, the electronic device (39) being an electronic assembly in three dimensions, in order to measure said first value Bz1 the probe (46) is oriented with the axis ZZ' ~~orthogonal to one of the external faces of this electronic assembly.~~

~~9/ The method as claimed in one of claims 1 to 8, wherein~~ the probe (46) and the electronic device (39) are displaced with respect to one another by relative pivoting according to an angular amplitude of more than 10° and less than 45° - in particular lying between 10 and 30°.

10/ - A machine for testing an electronic device (39), comprising:

- a monodirectional measurement probe (46) adapted to be able to deliver a signal representative of the value of a component Bz, along a predetermined axis ZZ' which is fixed with respect to said probe, of the magnetic field emitted in the vicinity of the probe (46) by at least one circulation of electric current in the electronic device (39),

- a support (44) for receiving an electronic device (39), and means (53,54) for supplying this electronic device (39) with electrical energy and with predetermined input signals applied to input terminals of the electronic device (39),

- a mechanism suitable for placing the probe (46) and an electronic device (39) received in the reception support (44) with respect to one another,

- means (40) for recording values corresponding to the signals delivered by the probe (46),

wherein:

- said mechanism is configured to make it possible to modify, for each position (x, y) of the axis ZZ' with respect to the electronic device, the orientation of the probe (46) and the electronic device (39) with respect to one another, by relative pivoting about an axis XX' orthogonal to the axis ZZ' according to an angular amplitude of less than 90°, the probe (46) being kept at a distance d0 in front of the same face of the electronic device (39),

~~- said test machine comprises calculation means (40)~~

configured to determine and record, for each position (x, y) of the axis ZZ', the value of a component By of the magnetic field along an axis YY' orthogonal to the axes ZZ' and XX', on the basis of a first value Bz1 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a first relative angular position of the probe (46) and of the electronic device (39) with respect to the axis XX', and of a second value Bz2 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a second relative angular position of the probe (46) and of the electronic device (39) with respect to the axis XX', and at the same distance d0, said first and second angular positions with respect to the axis XX' being separated from one another by an angle of less than 90°.

11/ - The machine as claimed in claim 10, wherein said mechanism is configured to make it possible to modify the orientation of the probe (46) and the electronic device (39) with respect to one another, by relative pivoting about the axis YY' according to an angular amplitude of less than 90°, the probe (46) being kept at the same distance d0 in front of the same face of the electronic device (39), and wherein said calculation means (40) are configured to determine and record, for each position (x, y) of the axis ZZ', the value of a component Bx of the magnetic field along the axis XX', on the basis of a first value Bz1 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a first relative angular position of the probe (46) and of the electronic device (39) with respect to the axis YY', and of a third value Bz3 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a second relative angular position of the probe (46) and of the electronic device (39) with respect to the axis YY', and at the same distance d0, said first and second angular positions with respect to the axis YY' being separated from one another by an angle of less than 90°.

12/ - The machine as claimed in one of claims 10 and 11, which furthermore comprises:

- means for generating an image, called a measured image on the basis of one of the three components Bx, By, Bz of the magnetic field emitted by this electronic device (39), as determined on the basis of the measurements provided by said probe (46) for different positions (x, y) of the axis ZZ' of the probe with respect to said face,

- means (40) for calculating calculated values by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the three components Bx, By, Bz of the magnetic field as would be emitted by said part of the electronic device (39) in the presence of at least one fault of the circulation of current in said part of the electronic device (39),

- means for generating a plurality of simulated images of said part of the electronic device (39) by simulation, each simulated image corresponding to an image capable of being obtained in the same way as the measured image, on the basis of a set of said values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field.

13/ - The machine as claimed in one of claims 10 to 12, wherein said probe (46) comprises a sensor selected from a SQUID sensor and a magnetoresistive sensor.

14/ - The machine as claimed in one of claims 10 to 13, wherein:

- the reception support (44) is arranged to be able to receive an electronic device (39) formed by an electronic assembly in three dimensions,

- the mechanism is configured to make it possible to orientate the probe (46) with the axis ZZ' orthogonal to one of the external faces of an electronic assembly received in said support (44).

15/ - The machine as claimed in one of claims 10 to 14, wherein the support (44) for receiving the electronic device (39) is fixed with respect

~~to a frame (41), and wherein said mechanism is configured to make it possible to~~ pivot the probe (46) with respect to this frame (41).

16/ - The machine as claimed in ~~one~~ of claims 10 to 14, wherein the probe (46) is mounted with respect to a frame (41) so as to have a fixed orientation of the axis ZZ' with respect to the frame (41), wherein the mechanism is configured to make it possible to pivot the support (44) for receiving the electronic device (39) with respect to the frame (41), and wherein the electronic device (39) ~~received in the support (44) is supplied by means of a twisted cable (54).~~

Replaced by New Claims 1 to 16.

CLAIMS

1. A method for testing an electronic device, in which the magnetic field emitted by at least one flow of electric current in the electronic device (39) is measured by a monodirectional measurement probe (46) adapted to be able to deliver a signal representative of the value of a component Bz of said magnetic field along a predetermined axis ZZ' which is fixed with respect to said probe, wherein:

- the probe (46) being brought to a distance d0 in front of one face of the electronic device, and the electronic device being supplied with electrical energy and with predetermined input signals applied to input terminals of the electronic device, for each position (x, y) of the axis ZZ' with respect to said face, a first value Bz1 of the component of the magnetic field Bz along the axis ZZ' is measured by the probe (46) and recorded,
- then the probe (46) and the electronic device are displaced with respect to one another by relative pivoting about an axis XX' orthogonal to the axis ZZ' according to an angular amplitude α of less than 90°, the probe (46) being kept at the same distance d0 in front of the same face of the electronic device, and, the electronic device being supplied with electrical energy and with predetermined input signals, for each position (x, y) of the axis ZZ' with respect to said face, a second value Bz2 of the component Bz of the magnetic field along the axis ZZ' is measured by the probe (46) and recorded,
- then the value of a component By of the magnetic field along an axis YY' orthogonal to the axes ZZ' and XX' is determined and recorded for each position (x, y) of the axis ZZ' on the basis of the first value Bz1 and the second value Bz2 which have been obtained.

2. The method as claimed in claim 1, wherein the value of the component By of the magnetic field is calculated according to the formula:

$$By = (Bz1.\cos\alpha - Bz2)/\sin\alpha.$$

3. The method as claimed in one of claims 1 and 2, wherein:

- the probe (46) and the electronic device are displaced with respect to one another by relative pivoting about the axis YY' according to an angular amplitude β of less than 90°, the probe (46) being kept at the same distance d0 in front of the same face of the electronic device, and, the electronic device being supplied with electrical energy and with predetermined input signals, for each position (x, y) of the axis ZZ' with respect to said face, a third value Bz3 of the component Bz of the magnetic field along the axis ZZ' is measured by the probe (46) and recorded,
- then the value of a component Bx of the magnetic field along an axis XX' is determined and recorded for each position (x, y) of the axis ZZ' on the basis of the first value Bz1 and the third value Bz3 which have been obtained.

4. The method as claimed in claim 3, wherein the value of the component Bx of the magnetic field is calculated according to the formula:

$$Bx = (Bz1.\cos\beta - Bz3)/\sin\beta$$

5. The method as claimed in one of claims 1 to 4, wherein:

- an image, called a measured image (34), of at least a part of the electronic device (39) is formed on the basis of one of the three components Bx, By, Bz of the magnetic field emitted by this electronic device, as determined on the basis of the measurements provided by said probe (46) for different positions (x, y) of the axis ZZ' of the probe with respect to said face,
- a plurality of simulated images (32) of said part of the electronic device (39) are formed by simulation, each simulated image corresponding to an image capable of being obtained in the same way as the measured image, on the basis of values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field as would be emitted by this electronic device (39) in the presence of at least one fault of the flow of current in said part of the electronic device (39),
- the simulated images (32) are compared with the measured image (34).

6. The method as claimed in claim 5, wherein the measured image of said part of the electronic device (39), which is used for the comparison, corresponds to subtraction of an image obtained on the basis of the corresponding component Bx, By, Bz of the magnetic field emitted by the entirety of a reference electronic device corresponding to the electronic device (39) to be tested but free of faults, this component being measured for each position (x, y) of the axis ZZ' with respect to said face, and of an image obtained on the basis of the corresponding component Bx, By, Bz of the magnetic field as would be emitted by the entirety of the electronic device (39) to be tested, this component also being measured for each position (x, y) of the axis ZZ' with respect to said face, and wherein each simulated image is formed by subtraction of an image obtained on the basis of values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field as would be emitted by the entirety of the reference electronic device, and of an image obtained on the basis of values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field as would be emitted by the entirety of the electronic device (39) in the presence of at least one fault.

7. The method as claimed in one of claims 1 to 6, wherein a measurement probe (46) comprising a sensor selected from a SQUID sensor and a magnetoresistive sensor is used.

8. The method as claimed in one of claims 1 to 7, wherein, the electronic device (39) being an electronic assembly in three dimensions, in order to measure said first value Bz1 the probe (46) is oriented with the axis ZZ' orthogonal to one of the external faces of this electronic assembly.

9. The method as claimed in one of claims 1 to 8, wherein the probe (46) and the electronic device (39) are displaced with respect to one another by relative pivoting according to an angular amplitude of more than 10° and less than 45°.

10. A machine for testing an electronic device (39), comprising:

- a monodirectional measurement probe (46) adapted to be able to deliver a signal representative of the value of a component Bz, along a predetermined axis ZZ' which is fixed with respect to said probe, of the magnetic field emitted in the vicinity of the probe (46) by at least one flow of electric current in the electronic device (39),
- a support (44) for receiving an electronic device (39), and means (53,54) for supplying this electronic device (39) with electrical energy and with predetermined input signals applied to input terminals of the electronic device (39),
- a mechanism suitable for placing the probe (46) and an electronic device (39) received in the reception support (44) with respect to one another,
- means (40) for recording values corresponding to the signals delivered by the probe (46),

wherein:

- said mechanism is configured to make it possible to modify, for each position (x, y) of the axis ZZ' with respect to the electronic device, the orientation of the probe (46) and the electronic device (39) with respect to one another, by relative pivoting about an axis XX' orthogonal to the axis ZZ' according to an angular amplitude of less than 90°, the probe (46) being kept at a distance d0 in front of the same face of the electronic device (39),
- said test machine comprises calculation means (40) configured to determine and record, for each position (x, y) of the axis ZZ', the value of a component By of the magnetic field along an axis YY' orthogonal to the axes ZZ' and XX', on the basis of a first value Bz1 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a first relative angular position of the probe (46) and of the electronic device (39) with respect to the axis XX', and of a second value Bz2 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a second relative angular position of the probe (46) and of the electronic device (39) with respect to the axis XX', and at the same distance d0, said first and second angular positions with respect to the axis XX' being separated from one another by an angle of less than 90°.

11. The machine as claimed in claim 10, wherein said mechanism is configured to make it possible to modify the orientation of the probe (46) and the electronic device (39) with respect to one another, by relative pivoting about the axis YY' according to an angular amplitude of less than 90°, the probe (46) being kept at the same distance d0 in front of the same face of the electronic device (39), and wherein said calculation means (40) are configured to determine and record, for each position (x, y) of the axis ZZ', the value of a component Bx of the magnetic field along the axis XX', on the basis of a first value Bz1 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a first relative angular position of the probe (46) and of the electronic device (39) with respect to the axis YY', and of a third value Bz3 of the component Bz of the magnetic field along the axis ZZ' as measured by the probe (46) in a second relative angular position of the probe (46) and of the electronic device (39) with respect to the axis YY', and at the same distance d0, said first and second angular positions with respect to the axis YY' being separated from one another by an angle of less than 90°.

12. The machine as claimed in one of claims 10 and 11, which furthermore comprises:
- means for generating an image, called a measured image on the basis of one of the three components Bx, By, Bz of the magnetic field emitted by this electronic device (39), as determined on the basis of the measurements provided by said probe (46) for different positions (x, y) of the axis ZZ' of the probe with respect to said face,
- means (40) for calculating calculated values by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the three components Bx, By, Bz of the magnetic field as would be emitted by said part of the electronic device (39) in the presence of at least one fault of the flow of current in said part of the electronic device (39),
- means for generating a plurality of simulated images of said part of the electronic device (39) by simulation, each simulated image corresponding to an image capable of being obtained in the same way as the measured image, on the basis of a set of said values calculated by simulation, for each position (x, y) of the axis ZZ' with respect to said face, of the corresponding component Bx, By, Bz of the magnetic field.

13. The machine as claimed in one of claims 10 to 12, wherein said probe (46) comprises a sensor selected from a SQUID sensor and a magnetoresistive sensor.

14. The machine as claimed in one of claims 10 to 13, wherein:
- the reception support (44) is arranged to be able to receive an electronic device (39) formed by an electronic assembly in three dimensions,
- the mechanism is configured to make it possible to orientate the probe (46) with the axis ZZ' orthogonal to one of the external faces of an electronic assembly received in said support (44).

15. The machine as claimed in one of claims 10 to 14, wherein the support (44) for receiving the electronic device (39) is fixed with respect to a frame (41), and wherein said mechanism is configured to make it possible to pivot the probe (46) with respect to this frame (41).

16. The machine as claimed in one of claims 10 to 14, wherein the probe (46) is mounted with respect to a frame (41) so as to have a fixed orientation of the axis ZZ' with respect to the frame (41), wherein the mechanism is configured to make it possible to pivot the support (44) for receiving the electronic device (39) with respect to the frame (41), and wherein the electronic device (39) received in the support (44) is supplied by means of a twisted cable (54).