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(54) Title: EQUIPMENT FOR PERFORMING ELECTRICAL AND ENVIRONMENTAL TESTS ON SEMICONDUCTOR ELECTRONIC DEVICES

(57) Abstract

Equipment (100) for performing electrical and environmental tests on semiconductor electronic devices comprising means (125) for simulating a work condition of the electronic devices, the equipment (100) having a work zone (102) in which means (105) are arranged for housing the electronic devices and means (110) for controlling at least one status quantity of the electronic devices (205), in which the simulation means (125) are arranged on the outside of the work zone (103), the equipment (100) further comprising means (130a, 135a, 140a) for removably connecting the simulation means (125) to the housing means (105).
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EQUIPMENT FOR PERFORMING ELECTRICAL AND ENVIRONMENTAL TESTS ON SEMICONDUCTOR ELECTRONIC DEVICES

This invention relates to equipment for performing electrical and environmental tests on semiconductor electronic devices, and in particular to equipment according to the preamble of the first claim.

Semiconductor electronic devices, when their manufacture is complete, are generally submitted to a test process in which their functional parameters are checked and in which a set of electrical and environmental stresses are applied to the electronic devices to eliminate those devices which have immediately identifiable defects or which are potentially defective. Typically the electronic devices are submitted to a heat type test, called burn-in test, which consists in making the electronic devices work for tens of hours at very high or very low temperature (for example, ranging from -50°C to +300°C) in order to simulate a long period of operation of the electronic devices at ambient temperature (25°C-50°C).

The electronic devices to be tested are arranged on a test board (called Burn-In Board, or BIB), on which circuit elements are housed which simulate a working condition of the electronic devices and enable the test
board to be interfaced with a driver module. In particular, the test board is provided with suitable sockets, each of which holds one electronic device in place and electrically connects it to the simulation circuit elements; this structure enables the electronic device to be accommodated for the time needed to execute the test and at the same time also enables the electronic device to be removed at the end of the test process without damaging it.

While the test is being executed, the board is inserted in a suitable heat chamber (oven). The oven consists of a zone at very high (or very low) temperature, in which the electronic devices to be tested are placed, and a zone at ambient temperature, where the driver is located. The high temperature zone is separated from the ambient temperature zone by means of a separator wall, in which slots, generally provided with a seal, have been made for connection purposes.

One drawback that the known test equipment has is that it is very expensive. In particular, each test board may be used solely for a specific type of electronic device for which the test board has been designed and made. This requires the manufacture of a new test board whenever there is a variation of any, even the slightest, characteristic of the electronic devices to be tested. Accordingly, the cost of the test process is extremely
high and cannot be depreciated in the short term; this drawback restricts use of the test process, prevents its widespread application and accordingly lowers the level of quality and reliability in the production of semiconductor electronic devices.

The object of this invention is to eliminate the abovementioned drawbacks. To attain this object, equipment is proposed for performing electrical and environmental testing on semiconductor electronic devices as described in the main claim.

In addition, this invention also proposes a corresponding test method.

Further characteristics and the advantages of the equipment according to this invention will become clearer from the following description of the preferred embodiments, illustrated indicatively and not exclusively, with reference to the accompanying drawings, where:

Fig. 1 is a schematic view of an example of test equipment according to this invention;

Fig. 2 illustrates a package with lead frame for use in the test equipment;

Fig. 3 is an illustrative example of the structure housing the lead frame;

Fig. 4 is a schematic view of a different embodiment of the test equipment of this invention.
With reference in particular to Fig. 1, equipment 100 is illustrated for performing heat tests on semiconductor electronic devices; similar remarks also apply in cases where the equipment is used to perform different electrical and environmental tests, for instance pressure tests, humidity tests and so on. The test equipment 100 consists of a heat chamber comprising a work zone at high, or very low, temperature 102 (in which the electronic devices to be tested are placed) and a zone at ambient temperature 103, separated from each other by a wall 104.

The work zone 102 includes various microchambers 105 (of which one only is depicted in the figure), in each of which one or more electronic devices are placed, so that their temperature can be controlled by means of a corresponding device 110, as described in detail below. Preferably the test equipment 100 includes several tens of microchambers 105, for example arranged on two opposite walls between which a robot moves to automatically load/unload the electronic devices. Similar remarks also apply in cases where arrangements have been made for a different number of microchambers (including one only, as a limit case), devices for housing boards provided with mounting sockets, and in general any test equipment having a work zone wherein means for
controlling at least one status quantity and means for housing the electronic devices are provided.

The microchambers 105 are affixed to a front surface of the wall 104. Each microchamber 105 electrically connects the electronic devices to a multipoint communication channel, or bus, 120, also arranged on the front surface of the wall 104.

Arranged in the zone at ambient temperature 103 are configuration boards 125 on which circuit elements are housed (such as, for example, passive electronic components, such as resistors, diodes, and the like) and which simulate a work condition of the electronic devices to be tested. One end of each configuration board 125 is inserted in a slot 130a made in the wall 104 and provided with a seal 135a in order to isolate the configuration boards 125 from the work zone 102; the configuration board 125 is connected electrically to the front bus 120 by means of suitable sliding contacts 140a arranged inside the slot 130a. Similar remarks also apply when the boards are connected differently, and so on; in more general terms, means are provided for simulating a work condition of the electronic devices arranged on the outside of the work zone and means for removably connecting the simulation means to the electronic device housing means.

The solution of this invention provides test
equipment easily configurable for electronic devices of different types (with an identical or similar outer structure). This drastically reduces the cost of the investments needed for the test processes. In fact, the same test equipment may be used for different electronic devices simply by substituting the configuration boards. This solution also reduces the delay times in setting up a test environment as it is sufficient to make the configuration boards, for which the production time is extremely low. Furthermore, where problems arise with the configuration boards, they can be replaced with other reserve boards, costing little and without interrupting the test process.

Preferably, one or more corresponding configuration boards 125 are associated with each microchamber 105 (or each battery of microchambers 105). As a result, the test equipment is particularly flexible as electronic devices of different types can be tested simultaneously. Alternatively a single group of configuration boards is provided for all the microchambers (the structure is simpler, but only electronic devices of the same kind can be tested simultaneously), and so on.

The test equipment 100 also includes one or more driver boards 145 (or other equivalent means) which perform the operations of controlling the electronic devices. The driver boards 145 are connected together
through a rear bus 150; one end of the driver board 145, arranged towards the top, is inserted in a further slot 130b (provided with a seal 135b) and is connected electrically and removably to the front bus 120 by means of sliding contacts 140b.

With reference now to Fig. 2, in the process for manufacture of the electronic devices to be tested, there is an intermediate stage in which a package 200 is available consisting of numerous electronic devices 205, the number of which varies from a few to a few hundred (thirty in the example illustrated), joined together by means of a lead frame 206.

The lead frame 206 consists of a plate of metal (for example, of tin-plated copper) generally having standard dimensions of 60 x 120 mm. Typically the lead frame 206 is provided with centring holes 207, arranged for example in two parallel rows in the vicinity of the greater edges of the metal plate. Tabs 210 are made (typically by shearing) in the lead frame 206, forming the leads of each electronic device 205. Supporting areas 220 are also provided in the lead frame 206, each of which bears a wafer of semiconductor material 225 in which an integrated circuit is made; the supporting area 220 is joined to the rest of the lead frame 206 by means of interconnection strips 230, extending for example from each edge of the supporting area 220.
The wafer of semiconductor material 225 is affixed (typically by welding) to the corresponding supporting area 220 and is connected electrically to the leads 210 through metal wires 235 (wire bonding). The structure accordingly obtained is fitted in an appropriate mould, into which plastic material in the liquid state is injected (for example, a heat hardening epoxy resin). After polymerization of the resin, the package 200 is obtained comprising, for each electronic device 205, an isolating body 245 encapsulating the elements described above and from which part of the leads 210 and of the interconnection strips 230 protrude.

The process for manufacture of electronic devices at this point normally includes shearing of the leads 210 and of the interconnection strips 230, in order to separate the various electronic devices 205. The leads 210 are also bent (lead forming), generally by using suitable moulds driven by presses.

In a preferred embodiment of this invention, the electronic devices 205 are tested before being separated from each other. In particular, the leads 210 of each electronic device 205 are separated from the rest of the lead frame 206, for instance by means of a laser cutting process, so that they are electrically isolated from each other. The electronic devices 205, however, are still connected to the lead frame 206 through the
interconnection strips 230. The package 200 is then placed in the test equipment so as to establish an electric connection with the leads 210 of each electronic device 205 (as described in detail below). Similar remarks also apply where the lead frame is of a different structure, of different dimensions, the electronic devices are of another type, for example of the Ball Grid Array (or BGA) type, with their leads already electrically isolated from each other, and so on.

The solution described above further reduces the cost of the investments needed for the test process, as it does not require a board for housing the electronic devices. The fact that the electronic devices to be tested are arranged in this package and are never handled directly lowers the risks of the electronic devices breaking. This also allows the electronic devices to be placed in and removed from the test equipment with automatic loading/unloading procedures, for example using robots. The package of electronic devices is in fact very easy to handle in view of its rather large dimensions, and the automatic procedures are also facilitated by the fact that the package of electronic devices is generally of fixed standard dimensions.

With the solution described above, it is not necessary for the electronic devices to be submitted to any lead verification and reconditioning process, as the
leads are bent following the test process, thus reducing the production costs. Furthermore, the testing of the electronic devices is performed directly in the production line, which considerably simplifies the electronic device production process and duly increases productivity.

The embodiment described above is of particular advantage in that it uses an element already present (the lead frame) and does not require any additional structure to keep the electronic devices joined together during the test process. Alternatively the electronic devices are stuck to a common board and the leads and interconnection strips are then cut (with the electronic devices remaining joined together by means of the common board). At the end of the test process, the electronic devices are detached from the common board. More generally, provision is made for any equivalent package, obtained during an intermediate stage of manufacture of the electronic devices and consisting of a plurality of electronic devices joined together by means of a support element and having leads electrically isolated from each other.

Note also that the solution described above may also be used in test equipment different from that of this invention, for example with fixed simulation boards.

To take Fig. 3 now (where the elements already shown
in Fig. 1 and Fig. 2 are identified with the same reference numerals), the microchamber 105 has a box-like structure consisting of a base 305, attached vertically to the wall 104. A closing lid 310 is hinge-mounted to a bottom edge of the fixed base 305. The package 200 is placed against a back wall of the fixed base 305, from which centring pins 315 (arranged in two horizontal lines) extend perpendicularly, corresponding to the holes 207 in the lead frame 206. In a particular embodiment of this invention, each microchamber 105 is also provided with a delivery hole and an exhaust hole (not shown in the figure) for injecting dry air (or nitrogen) inside the microchamber 105. This is a means of avoiding oxidation of the leads of the electronic devices 205, while also simultaneously increasing the heat exchange inside the microchamber 105.

The package 200 is preferably placed in the fixed base 305 by a robot (not shown in the figure), provided for example with a vacuum gripper. To this effect, self-centring holes 320 (or other equivalent structures) are made on an outer frame of the fixed base 305, in the vicinity of two opposite edges. Elastic rocking tabs 325 extend from the centre of an upper inside edge and of a lower inside edge in the frame of the fixed base 305. These elastic tabs 325 enable the lead frame 206 to be held in the fixed base 305 even when the lid 310 is open.
(after the package 200 has been released from the robot gripper, during insertion, or before the package 200 has been gripped by the robot gripper, during removal). Similar remarks also apply where balls that extend by elastic means into the frame of the fixed base, or other equivalent means, are used.

The structure described above is particularly compact and allows the electronic devices to be automatically placed in and removed from the microchamber very simply and quickly. Alternatively, the microchambers have a different configuration, are not provided with the elastic rocking tabs (in cases of manual loading/unloading) and consist of horizontal boxes, and so on.

Arranged on the bottom of the fixed base 305 are batteries 330 of elastically yielding electric contacts for the leads of the electronic devices 205. Each contact (not shown in the figure) consists of a conducting pin (arranged horizontally) having a telescopic structure, which shortens under the action of an external force in opposition to an inner spring. The pins are made of a material (for example, copper) having a thermal expansion coefficient substantially the same as that of the material used for the leads of the electronic devices 205, in order to guarantee a sound contact at all temperatures during the test stage. Preferably the
electric contacts are of an extremely large number (in their thousands, for example), a subset of which is activated on each occasion (under the control of the configuration boards), in relation to the number and disposition of the leads present in the package 200. This enables the same test equipment to be used for any type of electronic device having a structure of leads in the lead frame compatible with these electric contacts. Alternatively, the electric contacts and the leads of the electronic devices are made of different materials, the pins are rigid and assembled on a yielding support, elements hinge-mounted on a structure of elastic material are used, the electric contacts are of the same number as the leads of the electronic devices in the lead frame, and so on.

In a preferred embodiment of this invention, each battery of contacts 330 is associated with the leads of a column of electronic devices 205 and is removable from the fixed base 305. Accordingly a single battery of contacts 330 may be replaced easily (for maintenance operations, for example), without requiring the complete substitution of all of the electric contacts of the microchamber (extremely expensive). Similar remarks also apply where each battery of contacts is associated with a line of electronic devices, and in general with two or more adjacent electronic devices. This solution is an
excellent compromise between flexibility of the structure and its construction simplicity. Alternatively, each battery is associated with a single electronic device, or each electric contact may be removed singly; however, this invention is also suitable for production with fixed, non-replaceable electric contacts.

The lid 310 has a generically flat structure. From an internal surface of the lid 310, thrust beads 335 extend, consisting of a frame on the inside of which are arranged strips corresponding to the electric contacts of the batteries 330. When the package 200 is inserted in the fixed base 305 and the lid 310 is closed, the beads 335 hold the lead frame 206 pressed (by means of the external frame) against the back of the fixed base 305. At the same time, the beads 335 push (through the inner strips) the leads of the electronic devices 205 against the corresponding electric contacts of the batteries 330, causing them to yield elastically and guaranteeing a good electric connection.

The temperature control device 110 consists of a metallic heating board 340, on the inside of which is arranged, for example, a spiral (in the vicinity of an inside surface), not shown in the figure, which produces heat through the Joule effect. A cooling fan 342 is affixed to an outer surface of the heating board 340. The heating board 340 and the cooling fan 342 are moved by a
hydraulic system 345 (or other equivalent means) between an idle position (not shown in the figure), in which they permit access to the microchamber for insertion or removal of the package 200, and a work position, in which the inner surface of the heating board 340 is arranged against an outer surface of the lid 310 (when closed), in order to heat or cool the electronic devices of the package 200.

To this effect, the lid 310 is advantageously made of a metal plate (or of another, excellent heat conducting material), covered on the inside by a thin layer, for example, of plastic, in order to ensure electrical isolation from the leads of the electronic devices 205; alternatively, the lid is made of a different material, it is fastened directly to the inner surface of the heating board, and so on. Suitable temperature sensors (not shown in the figure) are also provided in the lid 310, in order to control (under the control of the driver boards) the operation of the heating board 340 and of the cooling fan 342.

This solution reduces the thermal inertia of the structure, enabling the temperature of the various electronic devices to be controlled extremely precisely. The almost-closed system described above is preferable to the traditional, hot air heating systems, on account of the large number of electronic devices crammed into a
small space on the lead frame, which does not permit a sufficient exchange of heat with the air. In fact, by controlling the temperature of the air, poor precision is obtained, this temperature being different from that of the electronic devices; on the contrary, by controlling the temperature of the electronic devices, thermal oscillations are generated, in the sense that the electronic devices continue to heat even after the heating of the air has been interrupted and, vice versa, the electronic devices continue to cool for a certain time even after heating of the air has been activated.

Preferably one heating board 340 (with a corresponding cooling fan 342), controlled independently (by the driver and configuration boards), is associated with each microchamber 105. This enables different temperatures to be used for each package 200, making the test equipment extremely flexible. However, this invention is still suitable for production even with the heating boards and the cooling fans controlled in common (by the driver boards), with a single heating board and relative cooling fan for all the microchambers, with different heating and cooling systems, for example using Peltier cells, and so on.

In a different embodiment of this invention, as illustrated in Fig. 4, test equipment 400 consists of a main body 405 having a substantially parallelepiped
shape, in which a work chamber 410 and an ambient temperature chamber 415 are made, each comprising an aperture (with horizontal axis) opening into the body 405. The work chamber 410 is kept at high (or very low) temperature by dry air (or nitrogen) injected into the work chamber 410 through appropriate hoses (not depicted in the figure). Cooling of the chamber 415 is produced by a fan 417 (or other equivalent means), guaranteeing an adequate exchange of air with the outside (through the delivery and exhaust holes, not depicted in the figure).

A lid 420a and a lid 420b are hinge-mounted on a front surface and on a rear surface respectively of the body 405. The lid 420a (similar remarks also apply to the lid 420b) is of dimensions such that, when it is closed on the front surface of the body 405, it entirely covers the apertures corresponding to the chambers 410 and 415. Provided on an inner surface of the lid 420a are a battery of mounting sockets 425 for the electronic devices (or equivalent means for housing one or more packages with lead frame as described above) and a driver 430, connected together by means of a bus 435. When the lid 420a is closed, the mounting sockets 425 and the driver 430 are disposed on the inside respectively of the work chamber 410 and of the ambient temperature chamber 415. Preferably the lid 420a is hinge-mounted under the chambers 410 and 415, so that when the lid 420a is open,
its inner surface is facing upwards, facilitating insertion and removal of the electronic devices from the mounting sockets 425. Slots 440 (or other equivalent means) are provided in an outer surface of the lid 420a for assembly of configuration boards 445 provided with edge connectors; the slots 440 connect the configuration boards to the mounting sockets 425, at the same time permitting easy removal and replacement of the configuration boards 445.

The embodiment described above of the test equipment of this invention is extremely compact. In addition, this test equipment has a modular structure that is easy to build according to various application requirements; for example, it is possible to use numerous identical equipment items set on top of one another vertically, or side by side. The two opposite lids make it possible to optimize the space available, using a single work chamber for two batteries of mounting sockets. Alternatively the driver is arranged on the outer surface of the lid (without the ambient temperature chamber), a single lid is used (with the work chamber and the ambient temperature chamber made from blind cavities), numerous work chambers (with corresponding lids) are provided, and so on.

Obviously, those acquainted with the sector art may make numerous changes and variants to the equipment
described above for performing electrical and environmental tests on semiconductor electronic devices, in order to satisfy contingent and specific requirements, and this without exiting from the scope of the present invention, as defined by the main claims.
CLAIMS

1. Equipment (100;400) for performing electrical and environmental tests on semiconductor electronic devices (205) comprising means (125;445) for simulating a work condition of the electronic devices (205), the equipment (100;400) having a work zone (102;410) in which means (105;425) are arranged for housing the electronic devices (205) and means (110) for controlling at least one status quantity of the electronic devices (205), characterized in that the simulation means (125;445) are arranged on the outside of the work zone (102;410), the equipment (100;400) further comprising means (130a,135a,140a;440) for removably connecting the simulation means (125;445) to the housing means (105;425).

2. Equipment (100;400) according to claim 1, in which the housing means (105) are suitable for housing at least one package (200), obtained during an intermediate stage of manufacture of the electronic devices (205), consisting of a plurality of electronic devices (205) joined together by means of a support element (206) and having leads (210) electrically isolated from each other.

3. Equipment (100;400) according to claim 2, in
which the support element is a lead frame (206) having interconnection strips (230) for the electronic devices (205), the leads (210) having been separated from a remaining part of the frame (206).

4. Equipment (100) according to any of the claims from 1 to 3, comprising a wall (104) for separation of the work zone (102), in which the simulation means include at least one board (125) and in which the removable connecting means (130a, 135a, 140a) include at least one slot (130a) made in the separation wall (104) having a seal (135a) for isolating the work zone (102) and on the inside of which sliding contacts (140a) are arranged for connecting one end of a corresponding simulation board (125).

5. Equipment (100) according to claim 4, in which the housing means include a plurality of box-like structures (105) each of which houses one of said packages (200), the box-like structures (105) being affixed to the separation wall (104).

6. Equipment (100) according to claim 5, in which the control means (110) include a plurality of temperature control devices (340, 342), each associated with a corresponding box-like structure (105) and having
a heating board (340) and a cooling fan (342), the equipment (100) further comprising means (345) for moving each temperature control device (340, 342) between an idle position, in which it permits access to the box-like structure (105) for inserting or removing said package (200) and a work position, in which it is arranged against an outer surface of the box-like structure (105) for heating or cooling the electronic devices (205) of said package (200).

7. Equipment (100) according to claim 5 or 6, in which each box-like structure (105) includes a fixed base (305) wherein said package (200) is housed, the fixed base (305) being disposed substantially vertically, and a closing lid (310) hinge-mounted on the fixed base (305), in which the fixed base (305) is provided with means (325) for holding said package (200) in the fixed base (305) when the lid (310) is open.

8. Equipment (100) according to any of the claims from 5 to 7, in which the simulation boards (125) are divided into groups, each comprising at least one board, and each group of simulation boards (125) being associated with at least one corresponding box-like structure (105).
9. Equipment (100) according to claim 8, in which each group of simulation boards (125) independently controls the temperature control devices (340,342) associated with the at least one corresponding box-like structure (105).

10. Equipment (100) according to any of the claims from 5 to 9, further comprising a plurality of elastically yielding leads (330) each suitable for electrically contacting a corresponding lead (210) of the electronic devices (205), the elastically yielding leads (330) and the leads (210) of the electronic devices (205) being made, respectively, of a first and of a second material having a substantially similar thermal expansion coefficient.

11. Equipment (100) according to claim 10, in which the simulation means (125) selectively activate a subset of the elastically yielding leads (330) in relation to a number and a disposition of the leads (210) in said package (200).

12. Equipment (100) according to claim 10 or 11, in which the elastically yielding leads are divided into a plurality of batteries (330) each comprising at least one elastically yielding lead, each battery (330) being
removable from the housing means (105).

13. Equipment (100) according to claim 12, in which each battery (330) is associated with the leads (210) of a plurality of adjacent electronic devices (205).

14. Equipment (400) according to any of the claims from 1 to 3, in which the work zone includes a main body (405) wherein a cavity (410) is made and at least one lid (420a) hinge-mounted on the main body (405) to close the cavity (410), in which the housing means (425) are arranged on an inner surface of the at least one lid (420a) so as to be inside the cavity (410) when the at least one lid (420a) is closed and in which the removable connecting means (440) are arranged on an outer surface of the at least one lid (420a).

15. Equipment (400) according to claim 14, in which the cavity (410) is arranged with a substantially horizontal axis, the at least one lid (420a) being hinge-mounted on the main body (405) under the cavity (410) so that the inner surface of the at least one lid (420a) is facing upwards when the at least one lid (420a) is open.

16. Equipment (400) according to claim 14 or 15, in which the cavity (410) comprises an aperture opening into
the main body (405), the at least one lid (420a,420b) being a first (420a) and a second (420b) lid, hinge-mounted on a first and on a second opposite surface of the main body (405).

17. Equipment (400) according to any of the claims from 14 to 16, in which a further cavity (415) adjacent to said cavity (410) is made in the main body (405), the equipment (400) comprising ventilating means (417) for cooling the further cavity (415) and driving means (430) of the electronic devices arranged on an inner surface of the at least one lid (420a) so as to be inside the further cavity (415) when the at least one lid (420a) is closed.

18. Method for performing electrical and environmental tests on semiconductor electronic devices (205), comprising the steps of housing the electronic devices (205) in housing means (105;425) arranged in a work zone (102;410) of test equipment (100;400), controlling at least one status quantity of the electronic devices (205), and simulating a work condition of the electronic devices (205) through simulation means (125;445), the method being characterized by the steps of arranging the simulation means (125;445) on the outside of the work zone (102;410),
removably connecting the simulation means (125;445) to the housing means (105;425).

19. Method according to claim 18, further comprising the steps of

providing at least one package (200), obtained during an intermediate stage of manufacture of the electronic devices (205), and consisting of a plurality of electronic devices (205), joined together by means of a support element (206) and having leads (210) electrically isolated from each other,

housing the at least one package (200) in the housing means (105).

20. Method according to claim 19, in which the support element is a lead frame (206) having interconnection strips (230) for the electronic devices (205), the method further comprising the step of separating the leads (210) from a remaining part of the lead frame (206).
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6  G01R31/316

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6  G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>X</td>
<td>US 4 900 948 A (HAMILTON HAROLD E) 13 February 1990 see abstract see column 4, line 50 - column 5, line 34 see column 5, line 57 - line 69 see column 6, line 57 - column 7, line 4 see figures 4,5 see claim 1</td>
<td>1,2,18, 19</td>
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<td>Y</td>
<td>US 5 402 078 A (HAMILTON HAROLD E) 28 March 1995 see abstract see column 1, line 14 - line 26 see column 1, line 46 - column 2, line 13 see figures 1,2,4</td>
<td>3,20</td>
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Further documents are listed in the continuation of box C. Patent family members are listed in annex.

* Special categories of cited documents:
  "A" document defining the general state of the art which is not considered to be of particular relevance
  "E" earlier document but published on or after the international filing date
  "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
  "O" document referring to an oral disclosure, use, exhibition or other means
  "D" document published prior to the international filing date but later than the priority date claimed
  "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
  "S" document member of the same patent family

Date of the actual completion of the international search 15 April 1999

Date of mailing of the international search report 07.07.99

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Authorized officer
Lopez-Carrasco, A

Form PCT/ISA/210 (second sheet) (July 1992)
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<td><strong>US 5 479 105 A (KIM IL UNG ET AL)</strong>&lt;br&gt;26 December 1995&lt;br&gt;see column 1, line 11 - line 21&lt;br&gt;see column 2, line 17 - line 44</td>
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<td><strong>see figures 1,2</strong></td>
<td>10-13</td>
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<td><strong>PATENT ABSTRACTS OF JAPAN</strong>&lt;br&gt;vol. 017, no. 514 (E-1433),&lt;br&gt;16 September 1993&lt;br&gt;&amp; JP 05 136229 A (FUJITSU LTD),&lt;br&gt;1 June 1993&lt;br&gt;see abstract&lt;br&gt;see figures</td>
<td>5-9</td>
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</table>
INTERNATIONAL SEARCH REPORT

Box I  Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.☐ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2.☐ Claims Nos.:
   because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3.☐ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II  Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2.☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3.☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4.☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
   1-13, 18-20

Remark on Protest
☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.
1. Claims: 1-13, 18-20
   Test equipment housings adaptable to different test boards configurations

2. Claims: 14-17
   Burn in compact test equipment
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