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Electronic assembly carrier with built-in shunt

Abstract

A carrier (**220**) for insertion of a device under test (**210**) into a tester (**110**) includes engagement structures (**226, 234**) and an integrated activator (**236**). The engagement structures (**226, 234**) are shaped to engage and hold the device under test (**210**) in the carrier (**220**) for insertion in tester (**110**). The activator (**236**) is positioned to automatically contact and activate a configuration component on the device under test (**210**). The activator (**236**) may particularly include a shunt positioned to electrically contact and short together configuration pins (**216**). The shorting or other activation sets an operating mode of the device under test (**210**) during testing.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION (1) This application is a 371 National Stage Entry of International Application No. PCT/US21/38469, filed Jun. 22, 2021, which in turn claims priority to U.S. Provisional Application No. 63/043,069, filed Jun. 23, 2020, both titled ELECTRONIC ASSEMBLY CARRIER WITH BUILT-IN SHUNT.

BACKGROUND

(1) Devices being manufactured commonly require testing to prove the devices are working properly before the devices may be sold. Manufactures commonly test devices in bulk in dedicated test systems that may be able to test many devices at the same time. Testing of a batch of electronic assemblies such as printed circuit assemblies, for example, often includes installing one or more electronic assemblies into one or more carriers to create modules that are easily plugged into or removed from the test equipment. Testing may be complex for electronic assemblies that operate in different modes, particularly if the modes are selected through configuration of jumpers, switches,

or similar manually installed or operated features. In such cases, testing of each electronic assembly during manufacture may require a tester to correctly set switches or jumpers for a test mode of the assembly or to set and reset the switches and jumpers for testing all operating modes of the assembly. The setting jumpers or switches for testing takes time and creates a risk that a jumper or switch could be set incorrectly during all or a portion of a test. Also, an assembly set to operate in a test mode for a test or diagnostic procedure needs to be switched back to a normal operational mode after the test or diagnostic procedure is complete. A failure to reset a device to an operational mode can result in a product that may be unready for sale or consumer use.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a perspective view of test modules and a test system in accordance with an example of the present disclosure.

(2) FIG. **2-1** is an exploded view of a test module in accordance an example of the present disclosure.

(3) FIG. **2-2** shows in more detail of the portion of a device under test that is used to switch the device under test to between functional modes.

(4) FIG. **2-3** is a perspective view of an assembled test module in accordance with an example of the present disclosure.

(5) FIG. **3** is a top view of a test system and particularly illustrates test sockets and guides in accordance with an example of the present disclosure.

(6) FIG. **4** is a perspective view illustrating insertion of a carrier end fitting into a tester guide in accordance with one example of the present disclosure.

(7) FIG. **5** is a perspective view showing a carrier and a tester guide in accordance with an example of the present disclosure.

(8) The drawings illustrate examples for the purpose of explanation and are not of the invention itself. Use of the same reference symbols in different figures indicates similar or identical items.

DETAILED DESCRIPTION

(9) In accordance with an aspect of the present disclosure, a carrier for an electronic assembly automatically configures the assembly to operate in a specific mode, e.g., a test mode, while the assembly is attached to the carrier and automatically returns the assembly to a unconfigured state when the assembly is removed from the carrier. In one example, the carrier includes a retainer that engages with an assembly, i.e., a device under test, to hold the assembly as part of a module suitable for insertion into a tester, and the retainer may include an activator such as a shunt that automatically contacts a configuration component of the assembly to set the assembly in a test mode while the carrier engages and holds the assembly.

(10) Primary functions of a carrier are to protect a product during handling and to provide a compatible structure for insertion and removal the product in a test system. Conventionally, jumpers or switches on the product may need to be set to control the behavior of the product during testing or normal use, and conventional setting of the jumpers and switches is unrelated to and independent of whether the product is held in a carrier. A unique feature disclosed herein is the integration of one or more shunts in a carrier, so that mounting of an electronic assembly in the carrier automatically positions the shunt(s) to interact with a header of the electronic assembly and set the operating mode of the electronic assembly for testing.

(11) In accordance with one aspect of the present disclosure, a carrier for insertion of a device under test into a test system includes engagement structures with an integrated activator such as a shunt. The engagement structures may be shaped to engage and hold the device under test in the carrier for insertion in a test system. The activator is integrated into the carrier and positioned to

contact and activate a configuration component on the device under test, thereby setting an operating mode of the device under test during testing.

(12) In accordance with a further aspect of the present disclosure, a carrier for a device under test includes a spine, an end fitting attached to the spine, and a retention clip mounted on the spine. The end fitting may include an engagement feature shaped to engage one portion of the device under test. The retention clip may be slide mounted on the spine and may include an engagement feature shaped to engage another portion of the device under test so that that carrier holds the device under test between the retention clip and the end fitting. The carrier further has an integrated activator such as shunt, e.g., on the end fitting or retention clip, at a position causing the activator to contact and activate a configuration component on the device under test when the carrier is engaged with the device under test.

(13) A product such as an electronic assembly may operate under different modes for different applications or uses of the product or at different times during the life cycle of the product. During manufacturing, for example, the product may need to operate in a test mode so that all functions of the product may be tested in a test system. During customer use, the product may operate in one or more different normal operational modes. During troubleshooting, a defective or malfunctioning product may need to operate in the test mode or a diagnostic mode when the product undergoes analysis. Systems and methods disclosed herein may employ a carrier that holds or mounts a product such as an electronic assembly for testing and automatically configures a product for the proper testing mode without the need to attach a jumper or configure a switch. The product automatically returns to a normal operational mode when removed from the carrier.

(14) FIG. **1** shows a test system **100** in accordance with one example of the present disclosure. Test system **100** includes a tester **110** with connectors **116** adapted to connect to test modules **120**A to **120**Z. Each of test modules **120** and **120**A to **120**Z includes an electronic assembly **210**, which is the device under test. Electronic assemblies **210** may, for example, be computer or add-in cards, e.g., PCI-e cards, or other systems including printed circuit boards with connectors or contacts that, during normal operations, electrically connect to a host device, e.g., plug into slots in a standard peripheral interface such as a PCI bus in a host server or computer. In one specific example, connectors **116** include sockets or slots, and each electronic assembly **210** has a blind mate connector, where the blind mate connector has self-alignment features that tolerate small misalignments of electronic assembly **210** when mating, e.g., sliding or snapping, into a socket or slot in a connector **116**.

(15) Each electronic assembly **210** is mounted in a carrier **220** for testing, and the combination of electronic assembly **210** and carrier **220** forms test module **120**. For bulk testing as shown in FIG. **1**, multiple electronic assemblies **210** are mounted in respective carriers **220** to form multiple test modules **120** and **120**A to **120**Z, that may be simultaneously connected to tester **110**.

(16) Tester **110** may be a specialized test system that includes a large number or connectors **116** for testing many electronic assemblies **210**. Tester **110** may test multiple assemblies **210** in parallel (simultaneously) or test connected assemblies **210** sequentially during a single test procedure. In the illustrated example, tester **110** includes a chassis **118** containing a motherboard **114**, and motherboard **114** has connectors **116**, e.g., sockets or slots, capable of accepting respective test modules **120** and **120**A to **120**Z. (FIG. **4**, which is described further below, shows a top view of an example of tester **110** without any devices under test inserted to better illustrate some components in an example of tester **110**.) Motherboard **114** may include test circuitry, e.g., one or more processors with interface circuits for connection to electronic assemblies **210** through connectors **116**. The processors on motherboard **114** may execute a test program for testing the functions of electronic assemblies **210**. To facilitate the installation and removal of test modules **120**, chassis **118** of tester **110** may include a frame or mechanical guide **112** with guide features **113** (FIG. **4**) that complement mechanical guiding features on carriers **220**. For example, a guide feature may, for example, be a pad or tab **225** having a uniform or slightly tapered width. Tabs **225** are located at

opposite ends of the carrier **220**, and the tabs **225** on opposite ends of the carrier **220** may respectively engage or fit into a pair of uniform width or slightly tapered tracks or slots **113**. A carrier **220** having tabs **225** engaged with slots **113** aligns the held electron assembly **210** to an associated connector **116** into which the test module **120** may be inserted. Tabs **225** of carrier **220** and tracks **113** of frame **112** may guide modules **112** and **120**A to **120**Z and may particularly align contacts on assemblies **210** for vertical insertion into respective connectors **116** in tester **100**.

(17) FIG. **2-1** and FIG. **2-3** respectively show exploded and assembled views of a test module **120** including an electronic assembly **210** and a carrier **220**. Electronic assembly **210** is the device under test and in an example system, may be a PCI-e card for use in a server. A PCI card may be any type of device including, for example, a disk drive, a solid-state storage device, a storage controller, or a storage processing unit. Carrier **220** includes a main spine **222** with end fittings **223** and **224**. The length of carrier **220** from end fitting **223** to end fitting **224** matches the available length in a tester, e.g., matches the distance between a pair of tracks **113** in tester **110** of FIGS. **1** and **3**. End fitting **223** at one end of spine **222** includes a product retention feature **226** that is shaped to engage and hold a corresponding feature **212** of electronic assembly **210**. For example, product retention feature **226** may include a slot, and feature **212** at one end of electronic assembly **210** may include a metal projection or tab that fits into the slot of retention feature **226**. The length of carrier **220** is generally greater than a length of electronic assembly **210**, and a retention clip **230**, which may be slid along main spine **222** to as needed according to the length of the device under test, includes an opposing product retention feature **234** the engages a feature **214** at the other end of electronic assembly **210**.

(18) End fittings **223** and **224** include guide features **225** that are shaped to engage complementary guide features **113** on the tester **110**, e.g., so that the carrier **220** in a test module **120** automatically positions and aligns contacts **218** of electronic assembly **210** to plug into a connector **116** in tester **110** as guide features **225** slide in guide features **113** of tester **110**. Guide features **225** may, for example, be rectangular or slightly tapered (trapezoidal) pads sized to slide into tracks **113** in frame **112** of tester **110**.

(19) Injector/ejector features **228** on end fittings **223** and **224** may engage features of tester **110**, e.g., when contacts **218** begin to engage a connector **116**. In the example shown in FIGS. **4** and **5**, injector/ejector feature **228** include a lever **410** that pivots relative to a fulcrum or axel on an end fitting **223** or **224**, and a slot or slots **412** in lever **410** engage projections or ridges **422** on a slot insert **420** on the tester. Each insert **420** attaches to the frame of the tester and includes or forms at least a portion of a guide feature **113**. A pair of levers **410** at opposite ends of the carrier **220** can lock a test module **120** in place in tester **110** and provide a mechanical advantage when pushing contacts **218** into a connector **116** in tester **110** or when pulling or prying an electronic assembly **210** out of tester **110**. Levers **410** may also provide a convenient and effective grip for removing an assembly **210** from the tester **110**.

(20) In accordance with an aspect of the present disclosure shown in FIGS. **2-1** and **2-3**, retention clip **230** of a carrier **220** engages an end (e.g., the back or header) of electronic assembly **210** opposite from where end fitting **223** engages the electronic assembly **210**. In the illustrated example, retention chip **230** and main spine **222** are shaped to provide an adjustable mount for mounting of retention clip **230** anywhere along the length of main spine **222** of carrier **220**. For example, the adjustable mount may be a slide mount resulting from a projection **232** on retention clip **230** that fits into a track running along main spine **222** of carrier **220**, so that retention clip **230** is able to slide along the track. A retaining screw or other structure may releasably lock retention clip **230** in place on main spine **222**.

(21) A process for mounting electronic assembly **210** in carrier **220**, in one example of the present disclosure, includes engaging feature **212** of electronic assembly **210** with product retention feature **226** of end fitting **223** while main spine **222** extends along a length of electronic assembly **210**, placing projection **232** in the track in main spine **222**, and sliding retention clip **230** along main

spine **222** until product retention feature **234** of retention clip **230** mechanically engages and holds feature **214** of electronic assembly **210** illustrated in FIGS. **2-1** and **2-3**. At which point, retention clip **230** may be locked in place on main spine **222**, and electronic assembly **210** is securely held in carrier **220**.

(22) In accordance with another aspect of the present disclosure, retention clip **230** includes an integrated activator **236** positioned to contact or engage a configuration component on electronic assembly **210** when retention feature **234** contacts electronic assembly **210**, and retention clip **230** thereby automatically activates the configuration component and configures the operating mode of electronic assembly **210** for testing. Activator **236** in one example is a shunt, which may be a compliant conductive structure that electrically shorts a gap between configuration pins **216** on electronic assembly **210**. In one example, retention clip **230** includes a rigid, insolating member **238** made of plastic or a metal with an insulating coating, and activator or shunt **236** includes a compliant, conductive member attached to rigid member **238** with a fastener or adhesive. A compliant shunt **236** could be constructed using a piece of thin metal formed into a leaf spring or using a foam block wrapped in electrically conductive fabric.

(23) FIG. **2-2** shows an enlarged view of a pair of electrical configuration pins **216** on an electronic assembly **210**. For the example using configuration using pins **216**, activator **236** is a shunt integrated into retention clip **230**, and rigid member **238** of retention clip **230** is shaped to automatically apply shunt **236** to configuration pins **216** when electronic assembly **210** is mounted in carrier **220**. In one example of the present disclosure, retention clip **230** shorts pins **216** together to put electronic assembly **210** into a test or diagnostic mode. More generally, retention clip **230** and activator **236** may be shaped to automatically position one or more shunts in contact with one or more set of pins **216** on an electronic assembly **210** mounted in carrier **220** to place the mounted electronic assembly **210** in any mode desired for testing. Further, carrier **210** may employ different versions of retention clip **230** with different shapes to position one or more shunts **236** in different locations, for example, to short different sets of configuration pins on the same electronic assembly **210** for testing of different operating modes of the electronic assembly **210**. Further, different versions of retention clip **230** may be shaped for testing of different types of electronic assembly **210** that have configuration pins **216** in different locations. When the retention clip **230** is installed to hold an electronic assembly **210**, retention clip **230** secures the electronic assembly **210** to carrier **220** and automatically electrically shorts two or more pins **216** on the header of electronic assembly **210** without the need of a worker to separately set a jumper or switch to select the operating mode of the electronic assembly **210**.

(24) In an alternative example, a retention clip may be shaped to contact and depress or activate a bottom or switch that may be provided on an electronic assembly. In this case for carrier **220**, activator **236** may not require a shunt, and activator **236** at the end of rigid member **238** may be shaped according to the location and shape of one or more configuration switches or buttons that need to be set to control the operating mode of electronic assembly **210**.

(25) Removal of electronic assembly **210** from the carrier **220** automatically removes activator **236** from electronic assembly **210**, e.g., removes the shunt from the header pins **216** or removes pressure from configuration switches or buttons, so that electronic assembly **210** defaults back to a normal operating mode when testing is complete. A worker is not needed to separately set a jumper or switch to return electronic assembly **210** to the default operating mode. Accordingly, manufacturing failures where electronic assemblies **210** are unintentionally left in a test mode after testing may be automatically avoided.

(26) Although example implementations have been disclosed to illustrate aspects of the present disclosure, these implementations are only examples and should not be taken as limitations. Other implementations of the disclosed examples may be employed. For example, although the illustrated configuration employs a shunt or shunts on a retention clip with a slide mounting, an alternative configuration may employ a shunt fixed on a structure such as an end fitting that is fixed relative to

the main spine of the carrier. Various other adaptations and combinations of features of the implementations disclosed are within the scope of the following claims.

Claims

1. A carrier for insertion of a device under test into a tester, the carrier comprising: a first engagement structure and a second engagement structure shaped to engage and hold the device under test in the carrier; and a shunt integrated into the carrier and positioned to electrically contact and short together pins on the device under test, the pins being shorted setting an operating mode to enable an operation to be performed using a circuit of the device under test.
2. The carrier of claim 1, wherein: the first engagement structure comprises a first end fitting and a spine extending from the first end fitting, the first end fitting including a first engagement feature shaped to engage a first portion of the device under test; and the second engagement structure comprises a retention clip with a slide mount on the spine, the retention clip including: a second engagement feature shaped to engage a second portion of the device under test; and the shunt, the shunt being positioned on the retention clip to contact and short the pins on the device under test when the second engagement feature is engaged with the device under test.
3. The carrier of claim 2, wherein the retention clip comprises a rigid member with a projection shaped to engage a track on the spine.
4. The carrier of claim 3, wherein: the shunt is mounted on the retention clip; the retention clip electrically insulates the shunt from the spine; and the retention clip extends is shaped to position the shunt to contact the pins on the device under test when the second engagement feature is engaged with the device under test.
5. The carrier of claim 2, wherein the first engagement structure further comprises a second end fitting on a side of the spine opposite from the first end fitting.
6. The carrier of claim 5, where the first end fitting and the second end fitting comprise respective guide features shaped to couple with respective tracks in the tester, the guide features coupled with the tracks to align contacts on the device under test with an electrical connector of the tester.
7. The carrier of claim 5, where each of the first end fitting and the second end fitting comprises a fulcrum and a lever that pivots on the fulcrum, each of the levers including a feature shaped to engage the tester and provide a mechanical advantage when the device under test is being inserted into or removed from the tester.
8. The carrier of claim 1, wherein the device under test comprises a printed circuit board with contacts shape for insertion into a slot in a computer.
9. The carrier of claim 1, wherein the device under test is selected from a group consisting of a PCI card, a disk drive, a solid-state storage device, a storage processing unit, a printed circuit board with a blind-mate connector or contact shapes that is part of a larger assembly that functions as a pluggable module, and a device or subassembly of a device with a blind-mate connector and configurable jumpers that are used during testing of the device.
10. A carrier comprising: a spine; a first fitting attached to the spine, the first fitting including a first engagement feature shaped to engage a first portion of a device under test; and a retention clip with a slide mount on the spine, the retention clip including: a second engagement feature shaped to engage a second portion of the device under test to hold the device under test between the retention clip and the first fitting; and an activator positioned on the retention clip to contact and activate a configuration component on the device under test when the second engagement feature is engaged with the second portion of the device under test, wherein the activation of the configuration component enables an operation to be performed using a circuit of the device under test.
11. The carrier of claim 10, further comprising a second fitting attached to the spine, wherein the first fitting and the second fitting are shaped to engage a tester during testing of the device under test.

12. The carrier of claim 11, wherein each of the first fitting and the second fitting comprises a guide feature shaped to engage respective tracks in the tester to thereby align the device under test for electrical connection to a connector in the tester.
13. The carrier of claim 10, wherein the activator comprises a shunt and the configuration component comprises pins that the shunt contacts and shorts together to thereby configure the device under test for testing.
14. A method comprising: engaging a first portion of a device under test with a first engagement feature on a carrier; moving a retention clip on the carrier until a second engagement feature on the carrier engages a second portion of the device under test and a shunt on the carrier contacts and shorts together configuration pins on the device under test; installing a module including the carrier and the device under test in a tester; and operating the tester to test the device under test while the shunt shorts together the configuration pins, wherein the tester enables an operation to be performed using a circuit of the device under test.
15. The method of claim 14, wherein moving the retention clip comprises sliding the retention clip along a track that extends toward the first engagement feature.
16. The method of claim 14, wherein shorting together the configuration pins together places the device under test into a test mode in which the device under test operates while the tester tests the device under test.
17. The method of claim 16, further comprising after the tester tests the device under test, removing the device under test from the carrier, wherein removing the device removes the shunt from contact with the configuration pins thereby placing switching the device under test out of the test mode.