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ADAPTABLE CLIP DESIGN FOR PRINTED CIRCUIT BOARD/PRINTED CIRCUIT BOARD ASSEMBLY LOCKING

Abstract

An apparatus for securing a board to an enclosure is provided herein. For example, an adaptable clip is operably coupled to a lid of the enclosure and configured to move from an unflexed configuration for receiving the board to a flexed configuration for securing the board to the enclosure.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of and priority to Indian Provisional Application No. 202411008491, filed on Feb. 8, 2024, the entire contents of which is incorporated herein by reference.

BACKGROUND

1. Field of the Disclosure

[0002] Embodiments of the present disclosure generally relate to printed circuit board assemblies and, for example, to adaptable clip designs for printed circuit board assembly (PCBA) locking.

2. Description of the Related Art

[0003] Conventional power conversion systems are known and can comprise a solar system that comprises one or more gateways that communicate via a wired and/or a wireless connection with one or more components (e.g., photovoltaics that can be coupled in a one-to-one correspondence to one or more microinverters, storage systems, main panels, etc.). The one or more gateways, photovoltaics, one or more microinverters, storage systems, main panels, etc. can comprise a PCB/PCBA.

[0004] During assembly, the PCB/PCBA can be connected to an enclosure of the components of the solar system using one or more connection methods. For example, sometimes the PCB/PCBA can be snapped to one or more components in the enclosure of a component (e.g., a gateway). During snapping of the PCB/PCBA in the enclosure, however, due to the PCB/PCBA thickness variations and part tolerances, there is a high probability that the PCB/PCBA will either be loosely held in place or might not snap altogether to the enclosure. Having a PCB/PCBA that is loosely held in place may contribute to an end user feeling that the end product is not robust, e.g., a PCB/PCBA that easily shakes around in the enclosure. Additionally, when the PCB/PCBA is not properly secured to the enclosure, there is a likelihood that the PCB/PCBA will slip from the original position of the PCB/PCBA, which may prevent a user from being able to access the available ports and connections on the PCB/PCBA. Moreover, snap-fit designs need numerous iterations to fine tune the tolerances, as the snap-fit designs will not accommodate the PCB/PCBA thickness variations and part tolerances. Further, using boss (screws)/standoff adds to cost and slows down an assembly process of the enclosure, and there is a likelihood that inadequate torque can crack the PCB/PCBA or again hold the PCB/PCBA loosely to the enclosure. The boss (screws)/standoff, which are, typically, made of metal, can also cause clearance creepage issues.

[0005] Therefore, described herein are improved adaptable clip designs for PCBA locking.

SUMMARY

[0006] In accordance with some aspects of the present disclosure, there is provided an apparatus for securing a board to an enclosure. The apparatus can comprise an adaptable clip that is operably coupled to a lid of the enclosure and can be configured to move from an unflexed configuration for receiving the board to a flexed configuration for securing the board to the enclosure.

[0007] Various advantages, aspects, and novel features of the present disclosure may be appreciated from a review of the following detailed description of the present disclosure, along with the accompanying figures in which like reference numerals refer to like parts throughout.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] So that the manner in which the above recited features of the present disclosure can be understood in detail, a more particular description of the disclosure, briefly summarized above, may be had by reference to embodiments, some of which are illustrated in the appended drawings. It is to be noted, however, that the appended drawings illustrate only a typical embodiment of this disclosure and are therefore not to be considered limiting of its scope, for the disclosure may admit

to other equally effective embodiments.
[0009] FIG. **1** is a block diagram of a system for power conversion, in accordance with at least some embodiments of the present disclosure;
[0010] FIG. **2** is partial diagram of an enclosure configured for use with one or more components of the system for power conversion of FIG. **1** and comprising a clip configured to secure a PCB/PCBA to the enclosure, in accordance with at least some embodiments of the present disclosure; and
[0011] FIG. **3** is the indicated area of detail **3** of FIG. **2** with some parts removed for clarity and with the clip shown prior to and after installation of the PCB/PCBA, in accordance with at least some embodiments of the present disclosure.
DETAILED DESCRIPTION
[0012] Printed circuit board (PCB) and printed circuit board assembly (PCBA) are both terms used in the electronics industry. The main difference between these two terms is that PCB, typically, refers to a blank circuit board, while PCBA, typically, refers to a board that contains all of the necessary electronic components for the board to function as needed. The methods and apparatus described herein are configured for use with both the PCB and the PCBA, and, as such, these terms will be used herein interchangeably, and, in most cases, simply referred to as a board.
[0013] In accordance with the present disclosure, described herein are improved adaptable clip designs for board locking. For example, apparatus for securing a board to an enclosure can comprise an adaptable clip that is operably coupled to a lid of the enclosure and configured to move from an unflexed configuration for receiving the board to a flexed configuration for securing the board to the enclosure. The apparatus described herein provide a simple, cost effective method for firmly securing a board to an enclosure. Accordingly, the occurrence of a user not being able to access the available ports and connections on the board is greatly reduced, if not eliminated. Moreover, the apparatus described herein accommodate many board thickness variations and part tolerances. Thus, the need for numerous iterations to fine tune the tolerances of a board is obviated. Further, as there is no need to use boss (screws)/standoff, cost of assembly of the enclosure is reduced, an assembly process of the enclosure is sped up, and the likelihood that inadequate torque cracks the board and clearance creepage issues are greatly reduced, if not eliminated.
[0014] The methods and apparatus described herein can be used with both PCB/PCBA (which can be single-layer, double-layer, multiple-layer, etc.) that can be configured for a plethora of uses/functions in the electronics industry, e.g., TVs, radios, printers, calculators, appliances, lighting systems, medical imaging systems, pacemakers, energy management systems, engine management systems, industrial controls, telecom towers, data storage equipment, satellite systems, etc.). For illustrative purposes, the boards described herein are described for use with one or more components of an energy management system.
[0015] For example, FIG. **1** is a block diagram of an energy management system (e.g., power conversion system, system **100**) in accordance with one or more embodiments of the present disclosure. The diagram of FIG. **1** only portrays one variation of the myriad of possible system configurations. The present disclosure can function in a variety of environments and systems.
[0016] The system **100** comprises a structure **102** (e.g., a user's structure), such as a residential home, commercial building, or separate mounting structure, having an associated DER **118** (distributed energy resource). The DER **118** is situated external to the structure **102**. For example, the DER **118** may be located on the roof of the structure **102** or can be part of a solar farm. Alternatively, the DER **118** can be situated internal to the structure **102**. For example, when the DER **118** is a permanent residential battery energy storage system, the DER **118** may be installed in a garage (or other suitable location inside the structure **102**). The structure **102** comprises one or more loads and/or energy storage devices **114** (e.g., portable energy systems (PES), appliances, electric hot water heaters, thermostats/detectors, boilers, electric vehicle supply equipment (EVSE), EVs, water pumps, and the like), which can be located within or outside the structure **102**, and a

DER controller **116**, each coupled to a load center **112**. Although the energy storage devices **114**, the DER controller **116**, and the load center **112** are depicted as being located within the structure **102**, one or more of these may be located external to the structure **102**.

[0017] The load center **112** is coupled to the DER **118** by an AC bus **104** and is further coupled, via a meter **152** and optionally a MID **150** (microgrid interconnect device), to a grid **124** (e.g., a commercial/utility power grid). The structure **102**, the energy storage devices **114**, DER controller **116**, DER **118**, load center **112**, generation meter **154**, the meter **152**, and the MID **150** are part of a microgrid **180**. It should be noted that one or more additional devices not shown in FIG. **1** may be part of the microgrid **180**. For example, a power meter or similar device may be coupled to the load center **112**.

[0018] The DER **118** comprises at least one renewable energy source (RES) coupled to power conditioners **122** (e.g., microinverter, power converter, power conversion units (PCUs), etc.). For example, the DER **118** may comprise a plurality of RESs **120** coupled to a plurality of power conditioners **122** in a one-to-one correspondence (or two-to-one). In embodiments described herein, each RES of the plurality of RESs **120** is a photovoltaic module (PV module), although in other embodiments the plurality of RESs **120** may be any type of system for generating DC power from a renewable form of energy, such as wind, hydro, and the like. The DER **118** may further comprise one or more batteries (or other types of energy storage/delivery devices) coupled to the power conditioners **122** in a one-to-one correspondence, where each pair of power conditioner **122** and a DC battery **141** may be referred to as an AC battery **130**.

[0019] The power conditioners **122** invert the generated DC power from the plurality of RESs **120** and/or the DC battery **141** to AC power that is grid-compliant and couple the generated AC power to the grid **124** via the load center **112**. The generated AC power may be additionally or alternatively coupled via the load center **112** to the one or more loads (e.g., EV, EVSE) and/or the energy storage devices **114**. In addition, the power conditioners **122** that are coupled to the AC batteries convert AC power from the AC bus **104** to DC power for charging the AC batteries. A generation meter **154** is coupled at the output of the power conditioners **122** that are coupled to the plurality of RESs **120** in order to measure generated power.

[0020] In at least some embodiments, the power conditioners **122** may be AC-AC converters that receive AC input and convert one type of AC power to another type of AC power. Alternatively, the power conditioners **122** may be DC-DC converters that convert one type of DC power to another type of DC power. The DC-DC converters may be coupled to a main DC-AC inverter for inverting the generated DC output to an AC output.

[0021] The power conditioners **122** may communicate with one another and with the DER controller **116** using power line communication (PLC), although additionally and/or alternatively other types of wired and/or wireless communication may be used. The DER controller **116** may provide operative control of the DER **118** and/or receive data or information from the DER **118**. For example, the DER controller **116** may be a gateway that receives data (e.g., alarms, messages, operating data, performance data, and the like) from the power conditioners **122** and communicates the data and/or other information via the communications network **126** to a cloud-based computing platform **128**, which can be configured to execute one or more application software, e.g., a grid connectivity control application, to a remote device or system such as a master controller (not shown), and the like. The DER controller **116** may also send control signals to the power conditioners **122**, such as control signals generated by the DER controller **116** or received from a remote device or the cloud-based computing platform **128**. The DER controller **116** may be communicably coupled to the communications network **126** via wired and/or wireless techniques. For example, the DER controller **116** may be wirelessly coupled to the communications network **126** via a commercially available router. In one or more embodiments, the DER controller **116** comprises an application-specific integrated circuit (ASIC) or microprocessor along with suitable software (e.g., a grid connectivity control application) for performing one or more of the functions described herein (e.g., the methods described herein).

[0022] The generation meter **154** (which may also be referred to as a production meter) may be any suitable energy meter that measures the energy generated by the DER **118** (e.g., by the power conditioners **122** coupled to the plurality of RESs **120**). The generation meter **154** measures real power flow (kWh) and, in some embodiments, reactive power flow (KVAR). The generation meter **154** may communicate the measured values to the DER controller **116**, for example using PLC, other types of wired communications, or wireless communication. Additionally, battery charge/discharge values are received through other networking protocols from the AC battery **130** itself.

[0023] The meter **152** may be any suitable energy meter that measures the energy consumed by the microgrid **180**, such as a net-metering meter, a bi-directional meter that measures energy imported from the grid **124** and well as energy exported to the grid **124**, a dual meter comprising two separate meters for measuring energy ingress and egress, and the like. In some embodiments, the meter **152** comprises the MID **150** or a portion thereof. The meter **152** measures one or more of real power flow (kWh), reactive power flow (KVAR), grid frequency, and grid voltage. The meter **152** measures power flows independently of MID state, i.e., when MID is closed and DER's are connected to the grid and when MID is open and DER's are isolated from the grid.

[0024] The MID **150**, which may also be referred to as an island interconnect device (IID), connects/disconnects the microgrid **180** to/from the grid **124**. The MID **150** comprises a disconnect component (e.g., a, relay, a contactor, or the like) for physically connecting/disconnecting the microgrid **180** to/from the grid **124**. For example, the DER controller **116** receives information regarding the present state of the system from the power conditioners **122**, and also receives the energy consumption values of the microgrid **180** from the meter **152** (for example via one or more of PLC, other types of wired communication, and wireless communication), and based on the received information (inputs), the DER controller **116** determines when to go on-grid or off-grid and instructs the MID **150** accordingly. In some alternative embodiments, the MID **150** comprises an ASIC or CPU, along with suitable software (e.g., an islanding module) for determining when to disconnect from/connect to the grid **124**. For example, the MID **150** may monitor the grid **124** and detect a grid fluctuation, disturbance or outage and, as a result, disconnect the microgrid **180** from the grid **124**. Once disconnected from the grid **124**, the microgrid **180** can continue to generate power as an intentional island without imposing safety risks, for example on any line workers that may be working on the grid **124**.

[0025] In some alternative embodiments, the MID **150** or a portion of the MID **150** is part of the DER controller **116**. For example, the DER controller **116** may comprise a CPU and an islanding module for monitoring the grid **124**, detecting grid failures and disturbances, determining when to disconnect from/connect to the grid **124**, and driving a disconnect component accordingly, where the disconnect component may be part of the DER controller **116** or, alternatively, separate from the DER controller **116**. In some embodiments, the MID **150** may communicate with the DER controller **116** (e.g., using wired techniques such as power line communications, or using wireless communication) for coordinating connection/disconnection to the grid **124**.

[0026] A user **140** can use one or more computing devices, such as a mobile device **142** (e.g., a smart phone, tablet, or the like) communicably coupled by wireless means to the communications network **126**. The mobile device **142** has a CPU, support circuits, and memory, and has one or more applications (e.g., a grid connectivity control application (an application **146**)) installed thereon for controlling the connectivity with the grid **124** as described herein. The mobile device **142** may run on commercially available operating systems, such as IOS, ANDROID, and the like.

[0027] In order to control connectivity with the grid **124**, the user **140** interacts with an icon displayed on the mobile device **142**, for example a grid on-off toggle control or slide, which is referred to herein as a toggle button. The toggle button may be presented on one or more status screens pertaining to the microgrid **180**, such as a live status screen (not shown), for various validations, checks and alerts. The first time the user **140** interacts with the toggle button, the user **140** is taken to a consent page, such as a grid connectivity consent page, under setting and will be allowed to interact with toggle button only after he/she gives consent.

[0028] Once consent is received, the scenarios below, listed in order of priority, will be managed differently. Based on the desired action as entered by the user **140**, the corresponding instructions are communicated to the DER controller **116** via the communications network **126** using any suitable protocol, such as HTTP(S), MQTT(S), WebSockets, and the like. The DER controller **116**, which may store the received instructions as needed, instructs the MID **150** to connect to or disconnect from the grid **124** as appropriate.

[0029] FIG. **2** is partial diagram of an enclosure configured for use with one or more components of the system for power conversion of FIG. **1** and comprising a clip configured to secure a board to the enclosure, and FIG. **3** is the indicated area of detail **3** of FIG. **2** with some parts removed for clarity and with the clip shown prior to and after installation (shown in phantom) of the board, in accordance with at least some embodiments of the present disclosure. For example, the enclosure is configured to house one or more components of the system **100**. The one or more components in the energy management system can comprise at least one of photovoltaics, microinverters, storage systems, or main panels. Likewise, the board comprises electronics used for one or more components in an energy management system.

[0030] For example, in at least some embodiments, an enclosure **200** is configured to house components of the DER controller **116** (e.g., a gateway). As noted above, the DER controller **116** is configured to, inter alia, receive data (e.g., alarms, messages, operating data, performance data, and the like) from the power conditioners **122** and communicates the data and/or other information via the communications network **126** to a cloud-based computing platform **128**. Accordingly, to be able to achieve such functions, the DER controller **116** comprises one or more boards **202** (PCBA shown in FIG. **2**) that are secured (firmly held in place) to the enclosure **200** via one or more adaptable clips **204** (e.g., one, two, three, four, five, . . . adaptable clips). For example, in at least some embodiments, four adaptable clips (one adaptable clip shown in FIG. **2**) can be operably coupled to a lid **206** of the enclosure **200**. The one or more adaptable clips **204**, which can be made from at least one of metal or plastic, are configured to move from an unflexed configuration **300** (FIG. **3**) for receiving the board **202** to a flexed configuration **302** (shown in phantom in FIG. **3**) for firmly (adequately) securing the board **202** to the enclosure **200**. For example, the one or more adaptable clips **204** are configured to flex at a bottom portion **207** to accommodate various/different tolerances of the board **202** as per a product need. For example, the bottom portion **207** can be configured to flex to accommodate relatively small tolerances of the board **202** (e.g., from about −0.1 mm to about +0.1 mm) and relatively large tolerances of the board **202** (e.g., from about −1.0 mm to about +1.0 mm). In at least some embodiments, the bottom portion **207** can be configured to flex to accommodate tolerances of the board **202** from about −0.4 mm to about +0.4 mm.

[0031] The one or more adaptable clips **204** are coupled to the lid **206** of the enclosure **200** via one or more suitable coupling methods/apparatus (e.g., bonding, adhesives, screws, nuts, bolts, tapes, etc.). In at least some embodiments, the one or more adaptable clips **204** are coupled to the lid **206** of the enclosure **200** via an interference fit (press fit or friction fit) using a flexible snap **304**, which can be made from metal and/or plastic, that secures the one or more adaptable clips **204** to the lid **206**. For example, the one or more adaptable clips **204** can comprise an upper portion **208** that comprises the flexible snap **304** and that is configured to be received within a space **210** defined by a wall **212** and a wall **214** in the lid **206**. When the upper portion **208** is inserted into the space **210**, the flexible snap **304** presses or pushes against the wall **212** to facilitate coupling the upper portion **208** to the lid **206** within the space **210**.

[0032] The lid **206** comprises a stopper **216** (or a ledge) that is configured to control a flexibility of the one or more adaptable clips **204**, hold the board **202** firmly in place to the enclosure **200**, and

prevent the one or more adaptable clips **204** from over flexing and breaking when the board **202** is being connected to the enclosure **200**. For example, the bottom portion **207** is configured to contact the stopper **216** to control a flexibility of the one or more adaptable clips **204**, hold the board **202** firmly in place to the enclosure **200**, and prevent the one or more adaptable clips **204** from over flexing and breaking when the board **202** is being connected to the enclosure **200**.
[0033] To couple the board **202** to the enclosure **200**, a user inserts the board **202** between the bottom portion **207** of the one or more adaptable clips **204** and a board mount **218** which causes the bottom portion **207** to move from the unflexed configuration **300** (FIG. **3**) for receiving the board **202** to the flexed configuration **302** (shown in phantom in FIG. **3**) for firmly (adequately) securing the board **202** to the enclosure **200**.
[0034] While the foregoing is directed to embodiments of the present disclosure, other and further embodiments of the disclosure may be devised without departing from the basic scope thereof, and the scope thereof is determined by the claims that follow.

Claims

1. An apparatus for securing a board to an enclosure, comprising: an adaptable clip operably coupled to a lid of the enclosure and configured to move from an unflexed configuration for receiving the board to a flexed configuration for securing the board to the enclosure.
2. The apparatus of claim 1, wherein the adaptable clip is coupled to the lid of the enclosure via an interference fit using a flexible snap that holds the adaptable clip to the lid.
3. The apparatus of claim 1, wherein the adaptable clip is configured to flex to accommodate tolerances of the board from about −0.4 mm to about +0.4 mm.
4. The apparatus of claim 1, wherein the lid comprises a stopper that is configured to control a flexibility of the adaptable clip, hold the board firmly in place to the enclosure, and prevent the adaptable clip from over flexing and breaking when the board is being connected to the enclosure.
5. The apparatus of claim 1, wherein the adaptable clip is made from at least one of metal or plastic.
6. The apparatus of claim 1, wherein the board comprises electronics used for one or more components in an energy management system.
7. The apparatus of claim 6, wherein the one or more components in the energy management system comprises at least one of photovoltaics, microinverters, storage systems, or main panels.
8. The apparatus of claim 1, wherein the board is at least one of a printed circuit board or printed circuit board assembly.