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Inventor(s) Steger; Stephen Andrew et al.

CIRCUIT SYSTEMS

Abstract

Various circuit board systems and methods of use and manufacture thereof are disclosed. A circuit board system can have a first circuit board including a substrate and a first component susceptible to electromagnetic interference carried by the substrate. The system can also include a second circuit board including a second substrate, and a shield engaged to the substrate of the first component, the shield at least partially covering the first component and being configured to protect the first component from electromagnetic interference, wherein the shield couples the substrate of the first circuit board to the substrate of the second circuit board.

Inventors: **Steger; Stephen Andrew (Los Angeles, CA), Clopp; Emily Lauren (Santa Monica, CA)**

Applicant: **Snap Inc.** (Santa Monica, CA)

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Background/Summary

CLAIM OF PRIORITY [0001] This application is a continuation of U.S. patent application Ser. No. 18/671,764, filed on May 22, 2024, which is a continuation of U.S. patent application Ser. No. 17/106,907, filed on Nov. 30, 2020, which is a continuation of U.S. patent application Ser. No. 16/903,016, filed on Jun. 16, 2020, which is a continuation of U.S. patent application Ser. No. 15/871,613, filed on Jan. 15, 2018, which are incorporated herein by reference in their entirety.

BACKGROUND
[0002] To fit electronics into certain-size enclosures, it is often necessary to create a printed circuit board (PCB) with rigid and flexible sections that can fold into a smaller footprint. Once the rigid-flexible PCB has been folded into a shape, it can be challenging to hold it in that shape during and after assembly. In some cases, the PCB is held together using tape, fasteners, or other components forming part of the PCB assembly. Yet, space on the PCB can be extremely confined in certain applications. As such, finding space for tape, fasteners, or other components can be challenging and might necessitate using a larger PCB. This can be undesirable as the particular application at hand might necessitate using a PCB of a certain size or smaller.

Description

BRIEF DESCRIPTION OF THE FIGURES
[0003] The above-mentioned and other features and advantages of this disclosure, and the manner of attaining them, will become more apparent and the disclosure itself will be better understood by reference to the following description of examples taken in conjunction with the accompanying drawings, wherein:
[0004] FIG. **1** is a perspective view of a circuit system, according to a first example of the disclosure.
[0005] FIG. **2** is a perspective view of a circuit system, according to a second example of the disclosure.
[0006] FIG. **3** is a perspective view of a circuit system, according to a third example of the disclosure.
[0007] FIG. **4** is a perspective view of a circuit system, according to a fourth example of the disclosure.
[0008] FIG. **5** is a perspective view of a circuit system, according to a fifth example of the disclosure.
[0009] Corresponding reference characters indicate corresponding parts throughout the several views. The exemplifications set out herein illustrate examples of the disclosure, and such exemplifications are not to be construed as limiting the scope of the disclosure any manner.

DETAILED DESCRIPTION

[0010] In describing the examples of the disclosure illustrated and to be described with respect to the drawings, specific terminology will be used for the sake of clarity. However, the disclosure is not intended to be limited to any specific terms used herein, and it is to be understood that each specific term includes all technical equivalents.

[0011] The present disclosure is directed to circuit systems that utilize unique protective and connective components to enable the circuit system to maintain a certain configuration, or be coupled in unique way. The circuit systems of the examples below can use an electromagnetic-resistant shield as a coupling mechanism for interlocking certain components of a circuit system together, and/or for protecting certain components from electromagnetic interference. In this way, the circuit system can be folded into a shape and retain that shape during and after assembly while maintaining a small footprint and/or protecting components from unwanted interference.

[0012] Referring to FIG. **1**, a first example of a circuit system **10** is shown. Circuit system **10** can have a first circuit board **20**. First circuit board **20** can be a printed circuit board (PCB) and can have a rigid body (e.g., a substrate, which in an example can be rigid). First circuit board **20** can have electronic components **22** on circuit board **20** to, for example, control the operation of circuit board **20**. In an example, components **22** can be any component commonly used with a circuit board, including but not limited to a battery, resistor, transistor, capacitor, inductor, diode, switch, etc. Components **22** can be connected using electrical traces (e.g., copper), as is common in circuit constructions. In addition, certain components **22** can be susceptible to electromagnetic interference (EMI). EMI in a circuit board or circuit system can cause failure of the circuit board or system and it is usually advisable to avoid or mitigate any EMI issues.

[0013] In this regard, circuit board **20** can also include a shield **26**. Shield **26** can be composed of a material that is resistant to EMI. For example, shield **26** can be composed of a metal or metal alloy (e.g., sheet metal). Shield **26** can be disposed on circuit board **20** to at least partially cover and protect one (1) or more components **22** that are susceptible to EMI. In an example, shield **26** can encapsulate one (1) or more components **22** to block EMI from affecting the component(s) **22**. In a further example, shield **26** can have a top **28** and sides **30** that can collectively form an interior cavity for receiving the one (1) or more EMI-susceptible components **22**. In addition, sides **30** can, in an example, engage with part of circuit board **20** to fix shield **26** to circuit board **20**. For instance, sides **30** can engage with a press-fit mechanism or another connection mechanism that can secure shield **26** to circuit board **20**. Shield **26** can further include an interlock tab **34** used to connect shield **26** to another component of circuit system **10**, as detailed below.

[0014] Circuit system **10** can include, as shown in FIG. **1**, a second circuit board **40**. Second circuit board **40** can be a PCB and can have a rigid body (e.g., a substrate, which in an example can be rigid). Second circuit board **40** can have electronic components **42** on circuit board **40** to, for example, control the operation of circuit board **40**. In an example, components **42** can be any component commonly used with a circuit board, including but not limited to a battery, resistor, transistor, capacitor, inductor, diode, switch, etc. Components **42** can be connected using electrical traces (e.g., copper), as is common in circuit constructions. Second circuit board **40** can also include a connection mechanism **44**. Connection mechanism **44** can constitute an arm **48** that extends from circuit board **40** (e.g., the substrate thereof). Arm **48** can define an opening **46** through which interlock tab **34** can be inserted.

[0015] Either or both of circuit boards **20**, **40** can have a flexible circuit **60** coupled thereto. Flexible circuits **60** can be any flexible circuit known in the art. In an example, flexible circuits **60** can comprise an array of conductors bonded to a thin dielectric film.

[0016] Still referring to FIG. **1**, as alluded to previously, shield **26** can act as a connection mechanism for connecting first circuit board **20** (e.g., the substrate thereof) to second circuit board **40** (e.g., the substrate thereof). As shown, interlock tab **34** of shield **26** can be inserted into opening **46** of connection mechanism **44** to connect shield **26** to second circuit board **40** (e.g., the substrate thereof). In an example, interlock tab **34** can be rigid and can contact interior walls of opening **46** of connection mechanism **44** to fix first circuit board **20** (e.g., the substrate thereof) relative to second circuit board **40** (e.g., the substrate thereof) at a certain angle. Alternatively, there can be an amount of play in the interlock between interlock tab **34** and opening **46** of connection mechanism **44**, such that first circuit board **20** (e.g., the substrate thereof) can articulate or pivot within a certain range of angles relative to second circuit board **40** (e.g., the substrate thereof). In any case, shield **26** can simultaneously act as both an EMI protection mechanism and as a connection mechanism between first circuit board **20** (e.g., the substrate thereof) and second circuit board **40** (e.g., the substrate thereof). In this way, circuit system **10** might not require additional tape, fasteners, or other connection mechanisms for joining first circuit board **20** (e.g., the substrate thereof) to second circuit board **40** (e.g., the substrate thereof). As can also be appreciated, shield **26** can permit a user to move or place first circuit board **20** (e.g., the substrate thereof) in a certain position or shape relative to second circuit board **40** (e.g., the substrate thereof), and shield **26** and connection mechanism **44** can act to substantially fix first and second circuit boards **20**, **40** (e.g., the substrates thereof) in the set position or shape. Circuit system **10** can therefore provide a circuit system that utilizes a unique connection mechanism, which can serve multiple purposes and allow circuit system **10** to maintain a small footprint during assembly and use.

[0017] A second circuit system **110** is shown in FIG. **2**. Here, like reference numerals are used to refer to like elements, except in the **100** series. It is therefore to be understood that second circuit system **110** can include any of the features or mechanisms of first circuit system **10** set forth above, and that only the differences between circuit systems **10**, **110** are discussed below.

[0018] Second circuit system **110** can include many of the same features and mechanisms as first circuit system **10** above, except that its interlock tab **134** and connection mechanism **144** can be somewhat different. As illustrated in FIG. **2**, interlock tab **134** of shield **126** can include an opening **172**, and a flexible circuit **160** can extend from second circuit board **140** (e.g., the substrate thereof). Opening **172** can be sized and shaped to receive a portion of flexible circuit **160** (e.g., the entire horizontal extent of flexible circuit **160**). In addition, flexible circuit **160** can be curved, in an example. Flexible circuit **160** can be inserted through opening **172** of interlock tab **134** so that first circuit board **120** (e.g., the substrate thereof) can be coupled to second circuit board **140** (e.g., the substrate thereof). Further, flexible circuit **160** can be bent to pivot or articulate first circuit board **120** (e.g., the substrate thereof) relative to second circuit board **140** (e.g., the substrate thereof) within a range of angles. After being bent, flexible circuit **160** can hold its shape and therefore fix first circuit board **120** (e.g., the substrate thereof) relative to second circuit board **140** (e.g., the substrate thereof) in the bent shape/orientation. In addition, in an example, flexible circuit **160** can be inserted through opening **172** of interlock tab **134** in a straight shape, and then be bent into the curved shape shown in FIG. **2** to ensure that flexible circuit **160** is locked within opening **172**.

[0019] A third circuit system **210** is shown in FIG. **3**. Here, like reference numerals are used to refer to like elements, except in the **200** series. It is therefore to be understood that third circuit system **210** can include any of the features or mechanisms of first and second circuit systems **10**, **110** set forth above, and that only the differences between circuit systems **10**, **110**, **210** are discussed below.

[0020] Third circuit system **210** can include an interlock tab **234** of its shield **226**, which can have a plurality of openings **274**. In addition, second circuit board **240** (e.g., the substrate thereof) can have a plurality of bosses **280**. Bosses **280** can be inserted into each corresponding opening **274** to connect first circuit board **220** (e.g., the substrate thereof) to second circuit board **240** (e.g., the substrate thereof). Bosses **280** can therefore be used for location purposes. In addition, in some examples, bosses **280** can be used for heat staking. In an alternate example, element **240** can be a plastic part or housing instead of a second circuit board, which can include bosses **280** that can be used for heat staking.

[0021] A fourth circuit system **310** is shown in FIG. **4**. Here, like reference numerals are used to refer to like elements, except in the **300** series. It is therefore to be understood that fourth circuit system **310** can include any of the features or mechanisms of first through third circuit systems **10**, **110**, **210** set forth above, and that only the differences between circuit systems **10**, **110**, **210**, **310** are discussed below.

[0022] Fourth circuit system **310** can include an interlock tab **334** of its shield **326**, which can utilize a laser-welding pattern **376** to connect to another circuit board or another component of system **310**. Indeed, in an example, circuit system **310** can further comprise another metal part **390** of the assembly, and laser-welding pattern **376** can connect first circuit board **320** (e.g., the substrate thereof) to metal part **390**.

[0023] A fifth circuit system **410** is shown in FIG. **5**. Here, like reference numerals are used to refer to like elements, except in the **400** series. It is therefore to be understood that fifth circuit system **410** can include any of the features or mechanisms of first through fourth circuit systems **10**, **110**, **210**, **310** set forth above, and that only the differences between circuit systems **10**, **110**, **210**, **310**, **410** are discussed below.

[0024] Fifth circuit system **410** can include an interlock tab **434** of its shield **426**, which can have a plurality of openings **474**. In an example, openings **474** can be threaded. In addition, second circuit board **440** (e.g., the substrate thereof) can include a plurality of openings (not shown) for receiving a set of screws **482**. Screws **482** can be inserted through the openings (not shown) in second circuit board **440**, and then threaded into openings **474** of interlock tab **434** of shield **426**. In this way, first circuit board **420** (e.g., the substrate thereof) can be coupled to second circuit board **440** (e.g. the substrate thereof) by inserting screws **482** through the openings (not shown) in second circuit board **440** and into threaded openings **474** of interlock tab **434** of shield **426**.

[0025] From the described example embodiments, various benefits of providing a dual-function shield component in an assembly of electronics component will be evident. One benefit is that compactness of the assembly is promoted by utilizing a single shield component to serve both shielding functions and connection and/or spatial location functions. Such space-saving benefits are further amplified in embodiments in which a shielding portion and a connective portion of the shield component is of one-piece construction, e.g., being of folded metal plate. A further benefit is that is that assembly of the device is simplified in that the shield component serves to locate one or more parts of the assembly in position during assembly, without requiring the provision of additional tooling or parts.

[0026] It will be readily understood to those skilled in the art that various other changes in the details, material, and arrangements of the parts and method stages which have been described and illustrated in order to explain the nature of the inventive subject matter can be made without departing from the principles and scope of the inventive subject matter as expressed in the subjoined claims. For example, the order of method steps or stages can be altered from that described above, as would be appreciated by a person of skill in the art. As another example, different connection mechanisms between the EMI shield of the above circuit systems and other components of the system (e.g., substrates, metal components, etc.) are contemplated, such as snap-fit connections, ultrasonic bonding, and the like.

[0027] It will also be appreciated that the various dependent claims, examples, and the features set forth therein can be combined in different ways than presented above and/or in the initial claims. For instance, any feature(s) from the above examples can be shared with others of the described examples, and/or a feature(s) from a particular dependent claim may be shared with another dependent or independent claim, in combinations that would be understood by a person of skill in the art.

SUMMARY

[0028] To better illustrate the system disclosed herein, a non-limiting list of examples is provided here:

[0029] Example 1 includes a circuit board system comprising a first circuit board comprising a substrate and a first component susceptible to electromagnetic interference carried by the substrate, a second circuit board comprising a second substrate, and a shield engaged to the substrate of the first component, the shield at least partially covering the first component and being configured to protect the first component from electromagnetic interference, wherein the shield couples the substrate of the first circuit board to the substrate of the second circuit board.

[0030] Example 2 includes the circuit board system of Example 1, wherein the substrate of the first circuit board is pivotable relative to the substrate of the second circuit board while the substrates are coupled by way of the shield.

[0031] Example 3 includes the circuit board system of any of Examples 1-2, further comprising a flexible circuit coupled to the first circuit board and/or the second circuit board.

[0032] Example 4 includes the circuit board system of any of Examples 1-3, wherein the shield non-pivotably fixes the substrate of the first circuit board relative to the substrate of the second circuit board.

[0033] Example 5 includes the circuit board system of any of Examples 1-4, further comprising a connection mechanism coupled to the shield for connecting the substrate of the first circuit board to the substrate of the second circuit board.

[0034] Example 6 includes the circuit board system of Example 5, wherein the connection mechanism comprises an opening in the shield that receives a connector.

[0035] Example 7 includes the circuit board system of any of Examples 1-6, wherein the shield substantially completely encapsulates the first component to insulate the component from electromagnetic interference.

[0036] Example 8 includes a circuit board system comprising a first circuit board comprising a substrate and a first component susceptible to electromagnetic interference carried by the substrate, and a shield engaged to the substrate, the shield at least partially covering the first component and being configured to protect the first component from electromagnetic interference, wherein the shield comprises a connection mechanism for coupling the substrate to a separate component.

[0037] Example 9 includes the circuit board system of Example 8, wherein the separate component is a second circuit board.

[0038] Example 10 includes the circuit board system of any of Examples 8-9, wherein the substrate is rigid.

[0039] Example 11 includes the circuit board system of any of Examples 8-10, further comprising a flexible circuit coupled to the first circuit board.

[0040] Example 12 includes the circuit board system of any of Examples 8-11, wherein the connection mechanism is a one-piece construction.

[0041] Example 13 includes the circuit board system of Example 12, wherein the connection mechanism comprises an opening in the shield that receives a connector.

[0042] Example 14 includes a method of assembling a circuit board system comprising providing a first circuit board comprising a substrate and a first component susceptible to electromagnetic interference carried by the substrate, and coupling the substrate of the first circuit board to a substrate of a second circuit board using a shield, wherein the shield at least partially covers the first component and is configured to protect the first component from electromagnetic interference.

[0043] Example 15 includes the method of Example 14, further comprising positioning the substrate of the first circuit board relative to the substrate of the second circuit board in a first orientation, and fixing the substrates in the first orientation.

[0044] Example 16 includes the method of Example 15, wherein the shield acts as a substantially rigid interface between the substrates of the first and second circuit boards to fix the substrates in the first orientation.

[0045] Example 17 includes the method of any of Examples 14-16, wherein the shield substantially completely encapsulates the first component to insulate the component from electromagnetic interference.

[0046] Example 18 includes the method of any of Examples 14-17, wherein the circuit board system further comprises a flexible circuit, and the method further comprises passing the flexible circuit through an opening in the shield to couple the shield to the flexible circuit.
[0047] Example 19 includes the method of any of Examples 14-18, wherein the shield is composed of metal that is resistant to electromagnetic interference.
[0048] Example 20 includes the method of Example 16, wherein the substrates of the first and second circuit boards are positioned at an angle relative to each other in the first orientation.

Claims

1. An assembly comprising: a first circuit board comprising an electronics supporting substrate; a second circuit board comprising an electronics supporting substrate separate and spaced from the substrate of the first circuit board; and a connector that mechanically couples the substrates of the first and second circuit boards together in a fixed spatial relationship, wherein the connector comprises: an elongate flexible deformable structure; and circuitry carried by the elongate deformable structure and connected to the first circuit board.
2. The assembly of claim 1, wherein the connector forms part of a coupling mechanism that physically couples the substrates of the first and second circuit boards to resist spatial separation of the first and second circuit boards, wherein the coupling mechanism comprises the connector and a locking formation integrated with the second circuit board.
3. The assembly of claim 2, wherein the locking formation defines a coupling opening through which a distal end portion of the connector is passed.
4. The assembly of claim 3, wherein the distal end portion of the connector is deformed in shape to include a non-rectilinear irregularity, withdrawal of the distal end portion from the coupling opening of the locking formation being prevented by obstruction of the irregularity against the locking formation opening.
5. The assembly of claim 4, wherein the locking formation comprises a tab that projects from the substrate of the second circuit board and that defines the coupling opening therethrough.
6. The assembly of claim 5, wherein the connector extends transversely through the coupling opening, the coupling opening being substantially complementary in shape to the connector in cross-sectional profile.
7. The assembly of claim 6, wherein the connector extends widthwise for substantially a full extent of a largest dimension of the coupling opening.
8. The assembly of claim 4, wherein the non-rectilinear irregularity comprises a curved end portion of the connector.
9. The assembly of claim 4, wherein the elongate flexible deformable structure is non-resiliently deformable such that it is capable of holding a non-linear shape manually applied thereto.
10. The assembly of claim 9, wherein physical coupling between the first and second circuit boards to retain a consistent spatial arrangement of the first and second circuit boards relative to each other is provided exclusively by engagement of the connector with the locking formation.
11. The assembly of claim 10, wherein the locking formation and the connector fixedly connect together the substrates of the first and second circuit boards, preventing relative pivotal movement about the coupling opening.
12. The assembly of claim 3, wherein the locking formation is provided by a dual-purpose connector-shield mounted on the second circuit board, the connector-shield comprising: a shield formation that is configured and positioned to at least partially shield a first component mounted on the second circuit board from electromagnetic interference; and the locking formation defining the coupling opening.
13. The assembly of claim 12, wherein the shield formation substantially encapsulates the first component on a major outer surface of the substrate of the second circuit board.

14. The assembly of claim 12, wherein the connector-shield is of one-piece construction, the shield formation and the locking formation being integrally connected together.
15. The assembly of claim 14, wherein the connector-shield is of folded metal plate.
16. A method of assembling a circuit assembly, the method comprising: positioning a first circuit board and a second circuit board in a spatial orientation relative to one another; and fixing substrates of the first and second circuit boards in the spatial orientation, wherein the fixing of the substrates comprises mechanically coupling the substrates of the first and second circuit boards together in a fixed spatial relationship using a connector that comprises: an elongate flexible deformable structure; and circuitry carried by the elongate deformable structure and connected to the first circuit board.
17. The method of claim 16, wherein the mechanically coupling comprises engaging the connector with a locking formation integrated with the second circuit board, the connector and the locking formation together forming a coupling mechanism that physically couples the substrates of the first and second circuit boards to resist spatial separation of the first and second circuit boards.
18. The method of claim 17, wherein the engaging the connector with the locking formation comprises passing a distal end portion of the connector through a coupling opening defined by the locking formation, and further comprising manually deforming the distal end portion of the connector that projects beyond the coupling opening to include a non-rectilinear irregularity, wherein withdrawal of the distal end portion from the coupling opening is prevented by obstruction of the irregularity against the locking formation opening.
19. The method of claim 18, wherein the locking formation comprises a tab that projects from the substrate of the second circuit board and that defines the coupling opening therethrough, and wherein physical coupling between the first and second circuit boards to retain a consistent spatial arrangement of the first and second circuit boards relative to each other is provided exclusively by engagement of the connector with the locking formation.
20. The method of claim 18, wherein the locking formation is provided by a dual-purpose connector-shield mounted on the second circuit board, the connector-shield comprising a shield formation that is configured and positioned to at least partially shield a first component mounted on the second circuit board from electromagnetic interference, and the locking formation defining the coupling opening, the method further comprising positioning the shield formation to at least partially shield the first component from electromagnetic interference.