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(54) **Title:** ELECTRIC METER BASE LEVEL PRINTED CIRCUIT BOARD

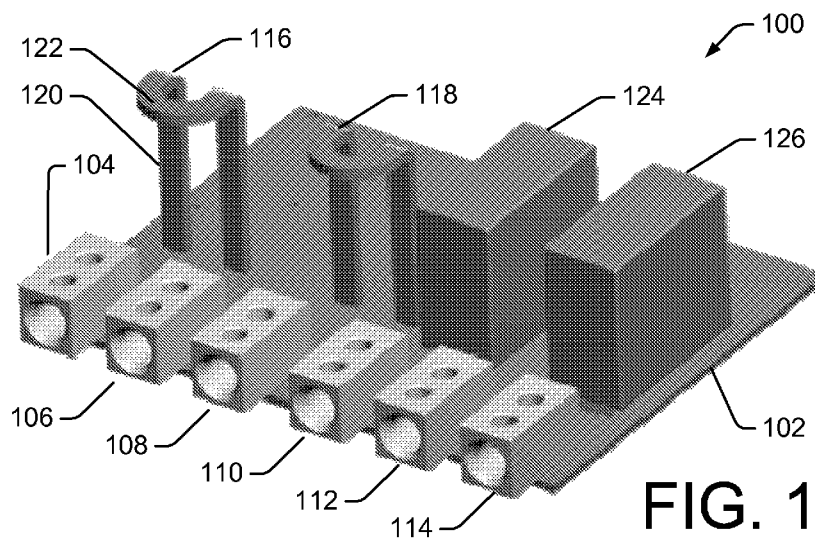


FIG. 1

(57) **Abstract:** Techniques for construction of an electric meter base level printed circuit board (PCB), such as for use in an electric consumption meter, are described herein. A plurality of heavy copper traces may be embedded in the PCB, thereby eliminating the need for heavy copper bar between connectors and components on the board. In one example, a PCB includes connectors for incoming and outgoing line and neutral conductors. The PCB may include a current measuring component, mounted on the PCB, to communicate with metrology circuitry. The PCB may include one or more switches, configured to regulate electrical service. Heavy electrical traces may be embedded in the PCB to connect the connectors and various components mounted on the PCB. The heavy electrical traces are sized to allow passage of currents that may be in excess of 100 amps.



WO 2014/099094 A1

ELECTRIC METER BASE LEVEL PRINTED CIRCUIT BOARD

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Application No. 13/717,456, filed December 17, 2012, the entire contents of which is incorporated herein by reference.

BACKGROUND

[0002] An electricity consumption-measuring meter (e.g., as provided at customer sites by a utility company) may include a base level printed circuit board (PCB). The base level PCB may include connectors for receiving incoming electricity service from the utility and providing outgoing electricity service to conductor wiring at a site. The base level PCB may include one or more current measuring components and one or more current regulating switches (e.g., to regulate electrical service). The connectors, current measuring component(s) and switch(es) are typically interconnected by use of heavy copper bar. The bar provides the connectivity required of heavy current flow (e.g., over 100 amps in the typical residential meter). However, the bar is costly and requires assembly to the PCB, and changes to the PCB often require changes to the tooling used to manufacture the copper bar.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] The detailed description is described with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The same numbers are used throughout the drawings to reference like features and

components. Moreover, the figures are intended to illustrate general concepts, and not to indicate required and/or necessary elements.

[0004] FIG. 1 is a perspective view of an example electric meter base level PCB. Six connectors for incoming and outgoing conductors, two current coils and two switches are shown, two or more of which are electrically connected via a current carrying trace of the PCB.

[0005] FIG. 2 is an orthographic plan view of the example electric meter base level PCB of FIG. 1.

[0006] FIG. 3 is an orthographic view of a further example electric meter base level PCB, having six connectors. Three high-power conducting traces are shown in dotted outline, connecting an incoming voltage connector to the current coil, the current coil to a switch, and the switch to an outgoing voltage connector.

[0007] FIG. 4 is an orthographic view of a further example of an electric meter base level PCB having four connectors.

[0008] FIG. 5 is an orthographic view of the example electric meter base level PCB of FIG. 4, showing in dotted outline a PCB trace connecting the incoming and outgoing neutral connectors.

[0009] FIG. 6 is an orthographic view of the example electric meter base level PCB of FIG. 4, showing in dotted outline three printed circuit conducting traces, connecting an incoming voltage connector to the current coil, the current coil to a switch, and the switch to an outgoing voltage connector.

[0010] FIG. 7 is an orthographic view of the example electric meter base level PCB having no switch, showing in dotted outline two printed circuit conducting traces, each connecting a connector to the current coil.

DETAILED DESCRIPTION

Overview

[0011] An electric meter base level printed circuit board (PCB), such as for use in an electric consumption meter, is described herein. The base level PCB receives incoming and outgoing power/neutral conductors, and routes the current through current measuring component(s) and (optionally) switch(es). In example designs described herein, substantial current—e.g., over 100 amps of current at 120 volts alternating current (VAC)—may be carried through conducting traces embedded in or between layers of the PCB. The circuit board traces or conductors may be heavy copper or other electrically conducting metal or alloy, and several traces (perhaps located on different PCB layers) may act in electrical parallel to distribute current and reduce electrical resistance. In one example, a plurality of heavy copper traces may be embedded in the PCB, to carry current to and from a plurality of connectors and components on the PCB. In one example, a PCB includes connectors for incoming and outgoing line and neutral conductors. The PCB may include a current measuring component, mounted on the PCB. The current measuring component—e.g., a current coil or shunt—may extend to a point adjacent to a sensor, which may be located on a different PCB having appropriate metrology circuitry. The PCB may include one or more switches, configured to regulate electrical service. Heavy electrical traces may be embedded in the PCB to connect the connectors and various components mounted on the PCB. The heavy electrical traces may be sized to allow passage of electricity service currents that may be 80 amps or more.

[0012] The discussion herein includes several sections. Each section is intended to be an example of techniques and/or structures, but is not intended to indicate elements which must be used and/or performed. A section entitled “Electric Meter Base Level Printed Circuit Board (PCB)” describes a 6-connector

version of the base level PCB. A section entitled “Example 4-Connector Base Level PCB” describes an alternative 4-connector version of the PCB. The discussion ends with a brief conclusion. This brief introduction is provided for the reader’s convenience and is not intended to describe and/or limit the scope of the claims or any section of this disclosure.

Electric Meter Base Level Printed Circuit Board (PCB)

[0013] FIG. 1 is a perspective view of an example electric meter base level PCB 100 for use in an electric meter. The base level PCB 100 may include one or more current measuring components, which may be positioned near metrology circuitry in an adjacent PCB. Also, the base level PCB 100 may include one or more switches, which may be used to turn a customer’s electric service on or off. The base level PCB 100 may include connectors for attachment to incoming and outgoing conductors (e.g., wires). In the 6-conductor version shown, three incoming and three outgoing connectors are shown, associated with two “hot” or “line voltages” (e.g., +/- 120 VAC) and neutral. Thus, in operation, current enters the base level PCB 100 through three connectors, is routed through current measuring component(s) and switch(es), and exits the base level PCB through three different connectors. The current may pass through the current measuring component and then through the switch, in the reverse order.

[0014] FIG. 1 shows an example base level PCB 100 having a multilayer PCB 102. In the example shown, six connectors 104-114 are mounted on the board, and configured to attach to incoming and outgoing conductors (e.g., wires) carrying current. For example, connector 104 may connect to an incoming conductor with +120 VAC; connector 106 may connect to an incoming conductor with -120 VAC; connector 108 may connect to an incoming neutral (return) conductor; connector 110 may connect to an outgoing neutral conductor;

connector 112 may connect to an outgoing conductor with -120 VAC; and connector 114 may connect to an outgoing conductor with +120 VAC. Note that +120 VAC and -120 VAC are different 120 VAC phases.

[0015] In the example shown, the incoming +/- 120 VAC of connectors 104, 106 may be electrically connected to current measuring components 116, 118, respectively. In the example shown, the current measuring components are current coils having a half-turn winding. Such coils may be used in combination with a Hall effect sensor in metrology circuitry. Alternatively, other current measuring components and/or technologies may be used, such as a shunt (e.g., in combination with voltage measurement circuitry in metrology circuitry), a current transformer or a mutual inductance coil, etc.

[0016] The current coils 116, 118 may include a riser portion 120, which elevates a coil portion 122 a preferred distance above the PCB 102. In particular, the riser portion 120 may position the coil portion 122 to a location adjacent to a sensor (e.g., a Hall effect sensor), which may be located on an adjacent motherboard. Thus, the field associated with the half-turn coil 122 is measurable by the sensor on the adjacent PCB. By locating the current measuring components 116, 118 on the PCB 100, they are not located on the PCB on which the sensor is located.

[0017] Current leaving the current measuring components 116, 118 may pass to switches 124, 126, respectively. The switches 124, 126 may or may not be present, depending on if service disconnection functionality is desired. The current measuring components and switches may be oriented in reverse order, with respect to current flow. The output of the switches 124, 126 (or the current measuring components 116, 118 if no switches are present) may be connected to the connectors 112, 114. The connectors 108, 110, associated with incoming and

outgoing neutral conductors, may be shorted together to provide electrical continuity.

[0018] FIG. 2 is an orthographic plan view of the example electric meter base level PCB 100 of FIG. 1.

[0019] FIG. 3 is an orthographic view of a further example of a base level PCB 300 for an electric meter. The base level PCB 300 may include a multilayer PCB 302, on which a number of components (e.g., power supply, capacitors, etc., not labeled) may be mounted. A number of connectors 304-314 are substantially as seen in FIGS. 1 and 2. Two current measuring components 316, 318 (e.g., current coils) and a dual (e.g., double-pole/double-throw) switch 320 are shown.

[0020] A terminal 322 of connector 304 may be electrically connected to a terminal 324 of current measuring component 316. The electrical connection may be made by a copper trace 326 embedded in, located on, or disposed between layers of the PCB 302.

[0021] The copper traces used in any embodiment discussed herein may be somewhat “block-shaped” (e.g., traces may be “wide,” “planar” or have “spread”) to provide a larger surface area than is present in conventional thin and wire-like traces. The larger surface area conducts electrical current with less electrical resistance and heat production than a trace of smaller dimensions. The traces may be any dimensions, but traces that are about 11 mm wide, in multiple layers of 210 microns thickness are capable of safely conducting 100 amps or more. The width (e.g., “block shape”), thickness of the trace and the number of layers are all important indicators of current carrying capacity. In one example, the conducting traces are between 13 mm and 20 mm wide. The thickness of the traces may include 1-, 3- or 6-ounce weights (in industry terminology). A 1-ounce copper trace may be approximately 33 microns of copper thickness. Additionally or alternatively, the conducting traces may not be of equal length,

and shorter traces may have less average width than longer traces. Moreover, any of the traces discussed herein may be configured together with one or more parallel traces (which may be on a same or different layer of the PCB) to further reduce electrical resistance. The parallel traces may have the same or different size, shape and/or thickness. However, the parallel trace(s) will conduct current to and from the same circuit locations. Additionally or alternatively, plated through holes in communication with one or more traces may be used to conduct heat away from the trace, and to the surface of the PCB. The plated through holes may provide a means for conductive heat transfer out of the copper trace(s) and into the atmosphere.

[0022] Two or more electrically conducting circuit board traces may be located in the same or different layers of the PCB 302, to transmit current electrically in parallel from a same first location and to a second same location. For example, the conducting trace 326 may be located in one layer of PCB 302, and a second trace may be located in a second or different layer of the PCB 302. Both traces may conduct electricity from the terminal 322 of the connector 304 to the terminal 324 of current measuring component 316. Thus, the conducting traces within the PCB may be arranged so that a first embedded conducting trace is located on a first layer of the PCB, and is located to carry current from a connector (or other component) and to the current measuring device (or other component). Additionally, a second (and optionally third, etc.) embedded conducting trace on a second or different layer of the PCB, may be arranged to carry current between the same two points. Thus, the first and second embedded conducting traces are electrically in parallel and conduct current between a same two locations and/or components or devices. In a further example, traces may cross that initiate and terminate to a different set of end points. This makes use of the inherent dielectric of the PCB to isolate opposing phases that would seem to

occupy the same space (if viewed in plan view or from an orthographic perspective).

[0023] A terminal 328 of the current measuring component 316 and a terminal 330 of a switch 320 may be electrically connected by a trace 332. Similarly, a terminal 334 of the switch 320 and a terminal 336 of the connector 314 may be electrically connected by a trace 338.

Example 4-Connector Base Level PCB

[0024] FIG. 4 is an orthographic view of a further example of an electric meter base level PCB 400 having four connectors. A PCB 402 may include multiple layers and may contain a number of high-current carrying PCB traces. A connector 404 is configured to attach to an incoming line voltage conductor, and a connector 410 is configured to attach to the outgoing line voltage conductor. A connector 406 is configured to attach to an incoming neutral conductor, and a connector 408 is configured to attach to an outgoing neutral conductor. A current measuring component, current coil 412 is configured for attachment to the incoming voltage connector 404 and switch 414. Switch 414 may also be connected to connector 410.

[0025] FIG. 5 is an orthographic view of the example electric meter base level PCB of FIG. 4, showing in dotted outline a PCB trace 500 connecting the incoming and outgoing neutral connectors 406, 408, respectively. The trace 500 may be substantially block shaped to provide for less electrical resistance than a narrow linear trace. The trace 500 may be part of a plurality of electrically parallel traces distributed on one or more layers of PCB 402. The parallel traces may have the same or different size, shape and/or thickness.

[0026] FIG. 6 is an orthographic view of the example electric meter base level PCB of FIG. 4, showing in dotted outline three printed circuit conducting

traces. A first trace 600 connects an incoming voltage connector 404 to the current coil 412. A second trace 602 connects the current coil 412 to a switch 414. A third trace 604 connects the switch 414 to an outgoing voltage connector 410.

[0027] FIG. 7 is an orthographic view of the example electric meter base level PCB 700 having a multilayer PCB 702 and no switch. Two printed circuit conducting traces are shown in dotted outline. In the example shown, a connector 704 is configured for attachment to an incoming line voltage conductor. A copper trace 706 provides electrical connectivity to a current coil 708. A second copper trace 710 provides electrical connectivity from the current coil 708 to a connector 712 connectable to an outgoing line voltage conductor.

Conclusion

[0028] Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described. Rather, the specific features and acts are disclosed as exemplary forms of implementing the claims.

CLAIMS

What is claimed is:

1. An electric consumption meter, comprising:
 - a printed circuit board (PCB);
 - connectors, attachable to incoming power and neutral conductors, mounted on the PCB;
 - connectors, attachable to outgoing power and neutral conductors, mounted on the PCB;
 - a current measuring component, mounted on the PCB, to communicate with metrology circuitry to measure current; and
 - a current conducting trace forming at least part of a path between incoming and outgoing power connectors through which an electricity service current passes.
2. The electric consumption meter of claim 1, wherein the current measuring component comprises a current coil, and the metrology circuitry includes a Hall effect sensor.
3. The electric consumption meter of claim 1, wherein the current measuring component is a shunt, and the metrology circuitry includes voltage measurement circuits.
4. The electric consumption meter of claim 1, additionally comprising:
 - a current conducting trace connecting the incoming neutral connector to the outgoing neutral connector.

5. The electric consumption meter of claim 1, additionally comprising:

at least two embedded conducting traces connected in a parallel relationship on at least two different circuit board layers.

6. The electric consumption meter of claim 1, additionally comprising:

a parallel trace, associated with the current conducting trace, the parallel trace connecting a same two circuit points as the current conducting trace.

7. The electric consumption meter of claim 1, wherein a switch is connected to the current conducting trace.

8. The electric consumption meter of claim 1, wherein the current conducting trace is substantially block shaped.

9. The electric consumption meter of claim 1, wherein the current conducting trace comprises plated through holes to provide a heat-conducting pathway to a surface of the PCB.

10. The electric consumption meter of claim 1, wherein:

the connectors, attachable to incoming power and neutral conductors, comprise two connectors connectable to two different incoming line conductors and one connector connectable to the incoming neutral conductor; and

the connectors, attachable to outgoing power and neutral conductors, comprise two connectors connectable to two different outgoing line conductors and one connector connectable to the outgoing neutral conductor.

11. A meter base level printed circuit board (PCB), comprising:

a PCB;

an incoming power connector, attachable to an incoming power conductor, mounted on the PCB;

an outgoing power connector, attachable to an outgoing power conductor, mounted on the PCB;

a current measuring component, mounted on the PCB, to communicate with metrology circuitry to measure current; and

one or more conducting traces in or on the PCB, the one or more conducting traces electrically connecting at least two of:

the incoming power connector;

the current measuring component; and

the outgoing power connector.

12. The meter base level PCB of claim 11, comprising an additional conducting trace electrically connecting the current measuring component to a switch mounted on the PCB.

13. The meter base level PCB of claim 11, wherein the one or more conducting traces are copper traces.

14. An electric consumption meter, comprising:

a second PCB

the meter base level PCB of claim 11, mounted within the electric consumption meter and proximate to the second PCB; and

metrology hardware mounted on the second PCB, including a circuit element in communication with the current measuring component of the meter base level PCB.

15. The meter base level PCB of claim 11, wherein the one or more conducting traces are sized to conduct at least 80 amps between attachment points.

16. The meter base level PCB of claim 11, wherein:

the conducting traces are formed substantially of copper;

a first set of parallel traces lead into the current measuring component and are distributed among at least two layers of the PCB;

a second set of parallel traces lead out of the current measuring component and are distributed among at least two layers of the PCB; and

each set of parallel traces is sized to conduct at least 80 amps.

17. The meter base level PCB of claim 11, wherein:

the one or more conducting traces are substantially block shaped; and

plated through holes provide a conducting pathway from the one or more conducting traces to a surface of the PCB.

18. The meter base level PCB of claim 11, wherein:

a first neutral connector, attachable to a neutral conductor, mounted on the PCB;

a second neutral connector, attachable to a second neutral conductor, mounted on the PCB; and

another conducting trace in or on the PCB electrically connects the first neutral connector and the second neutral connector.

19. The meter base level PCB of claim 11, wherein:

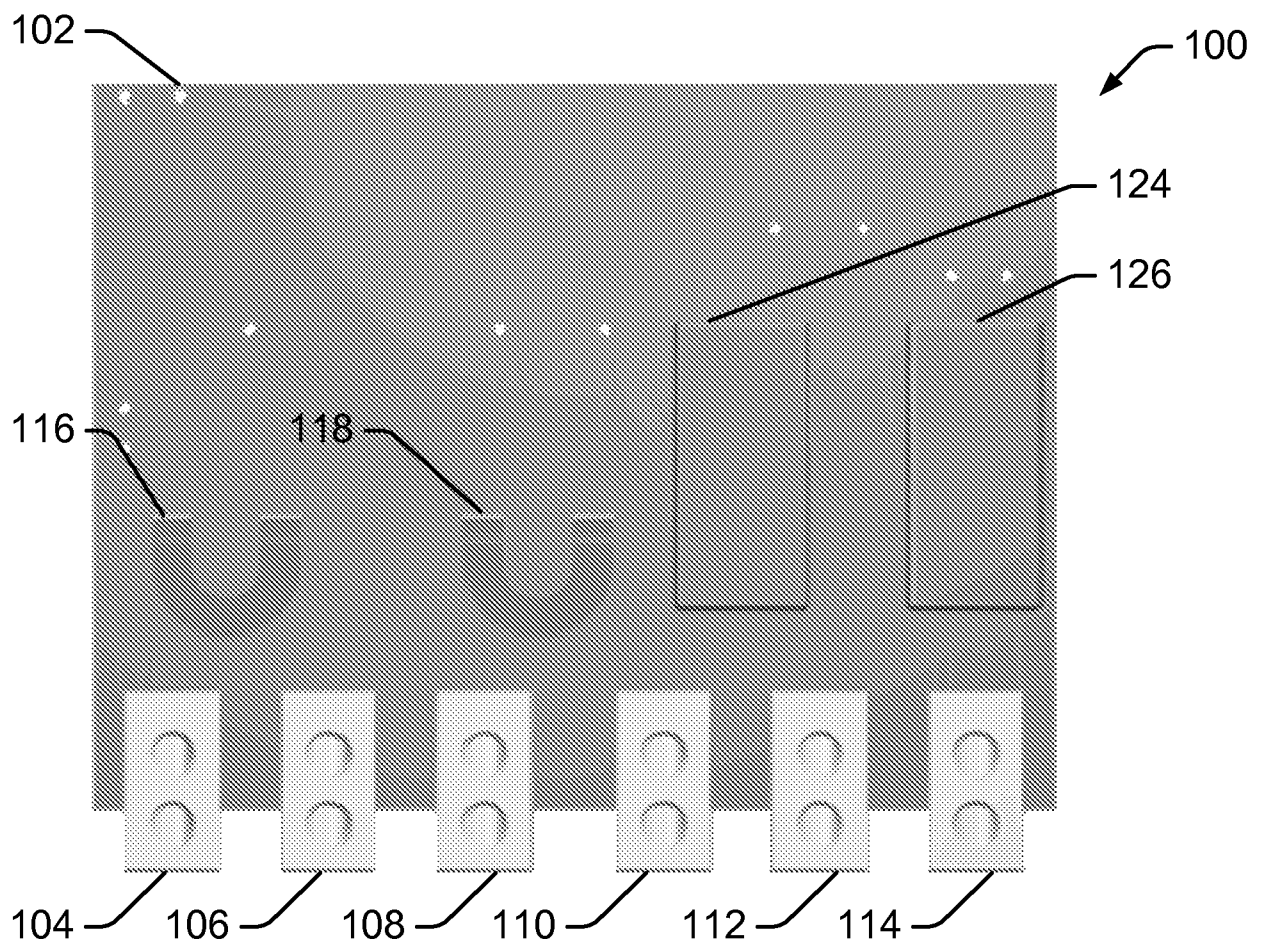
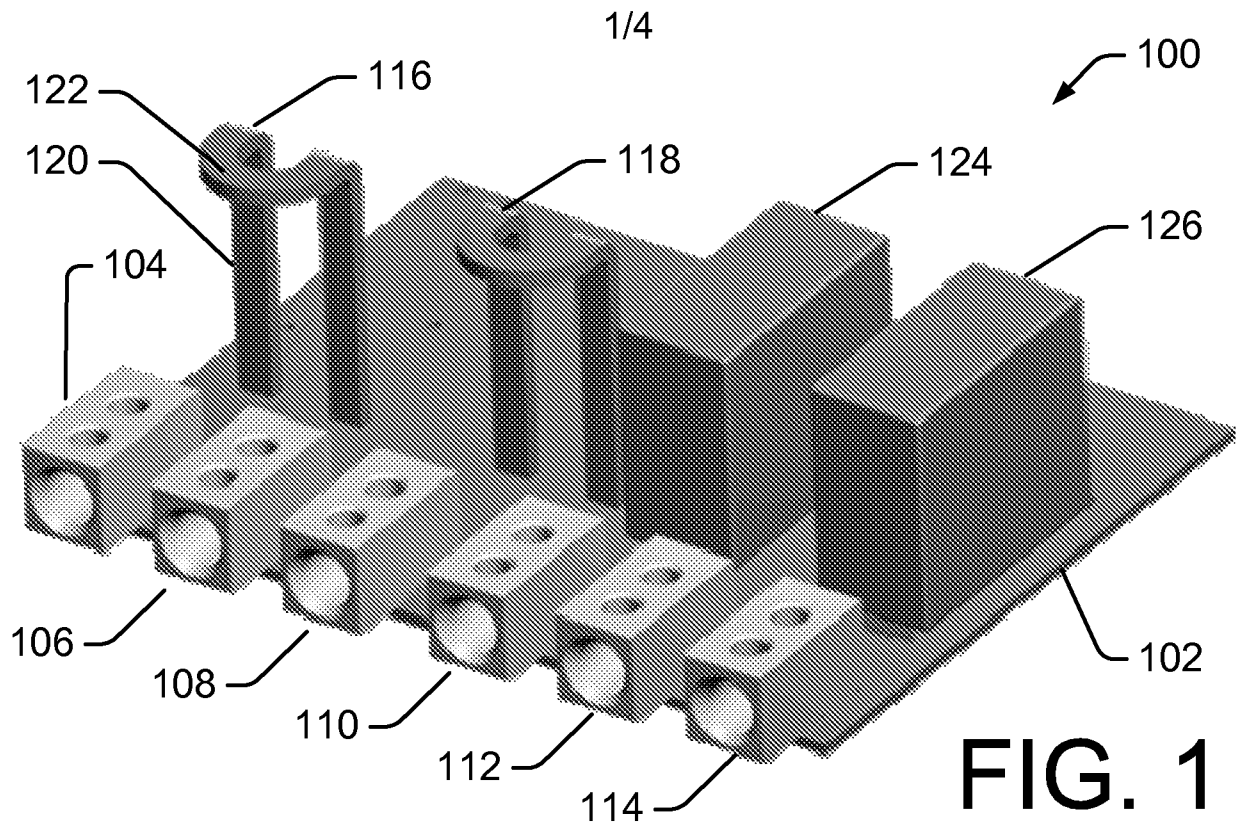
the one or more conducting traces are between 13mm and 20 mm wide; and

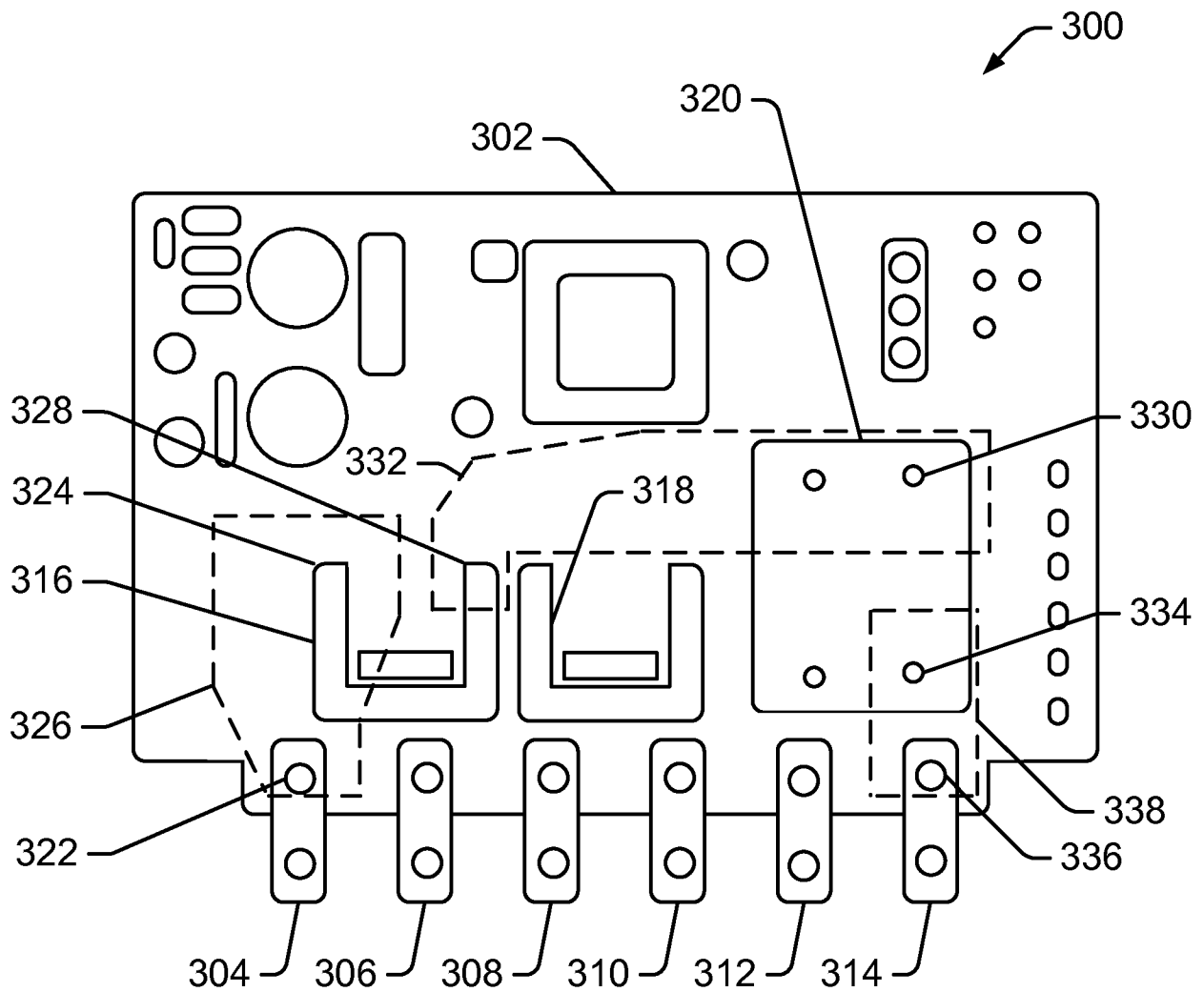
the one or more conducting traces are made substantially of copper.

20. The meter base level PCB of claim 11, wherein:

the conducting traces are not all of equal length; and

shorter conducting traces have less average width than longer conducting traces.



**FIG. 3**

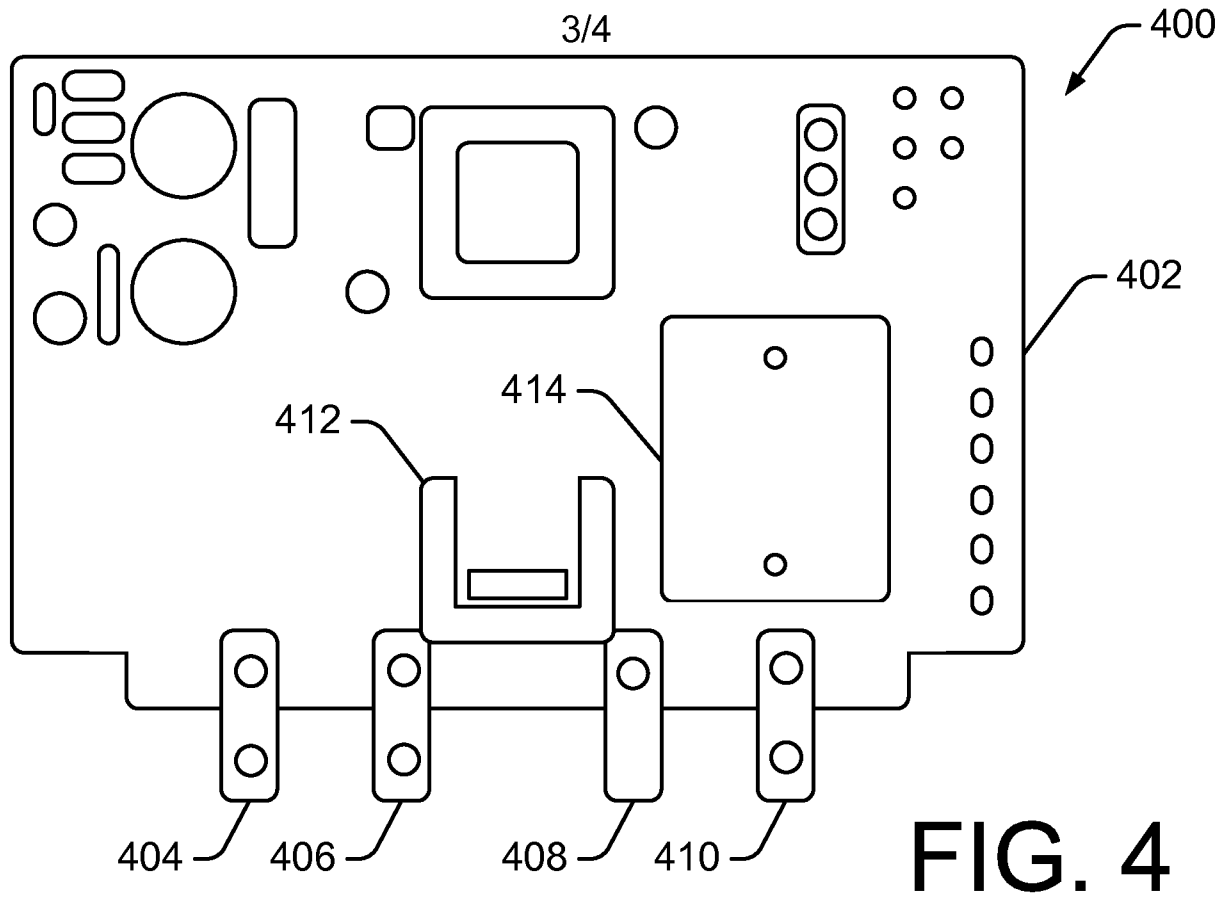


FIG. 4

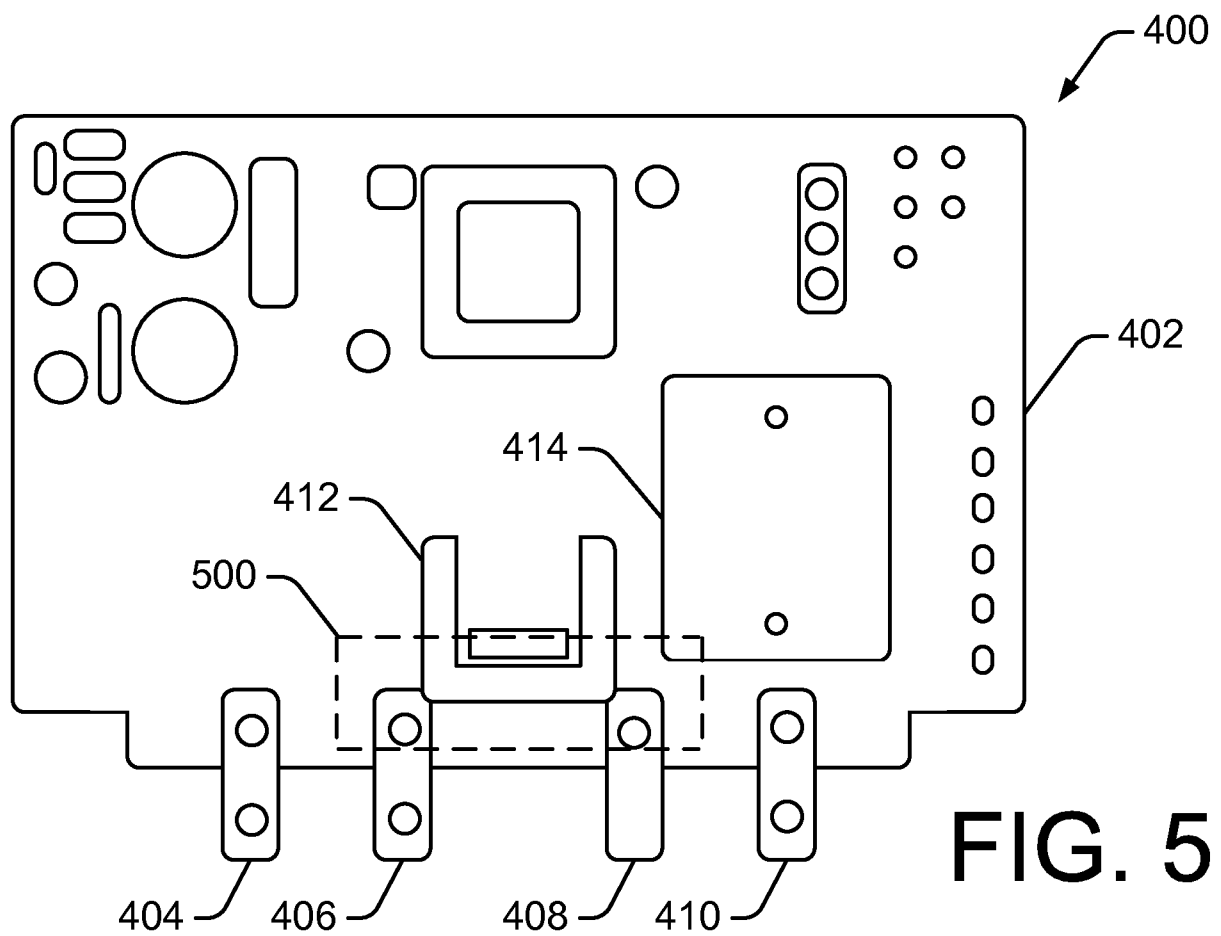


FIG. 5

4/4

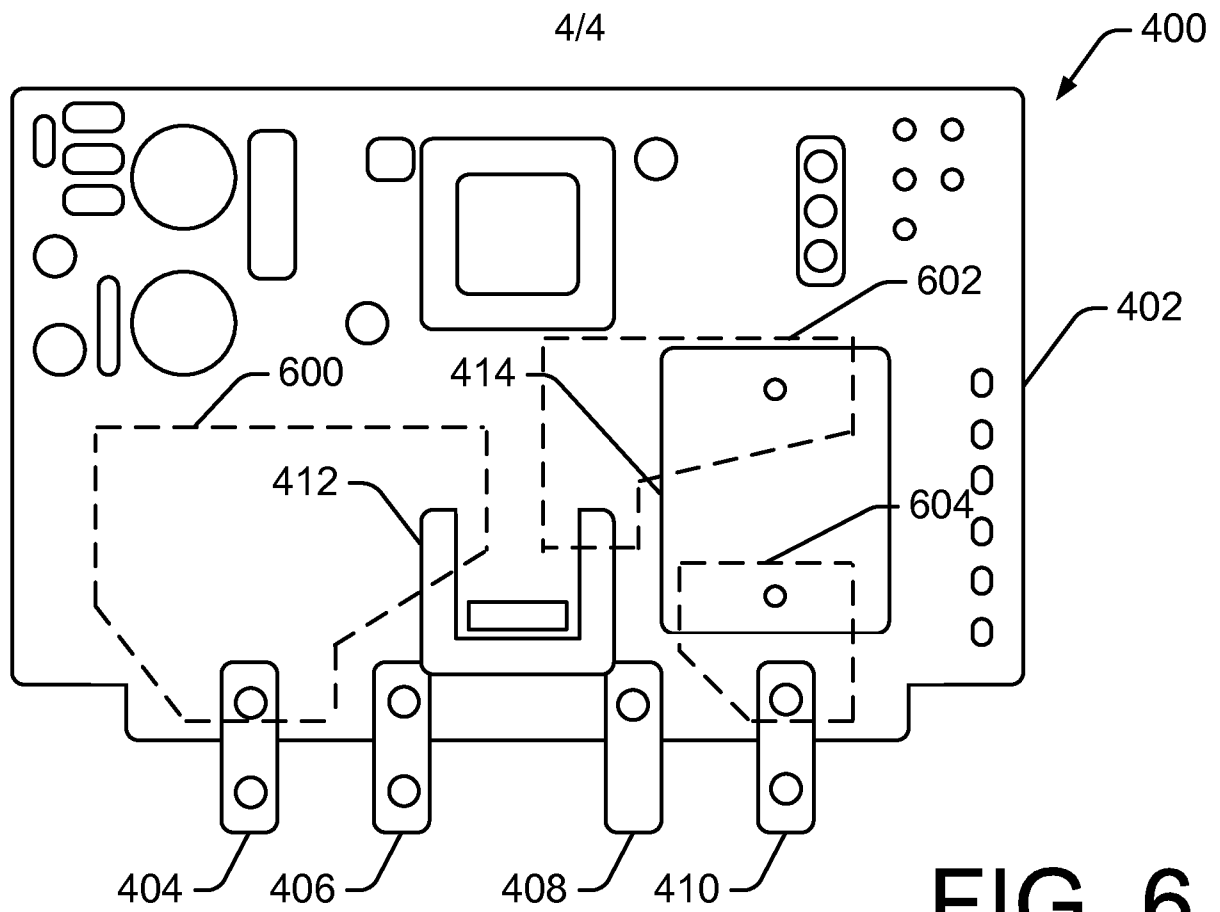


FIG. 6

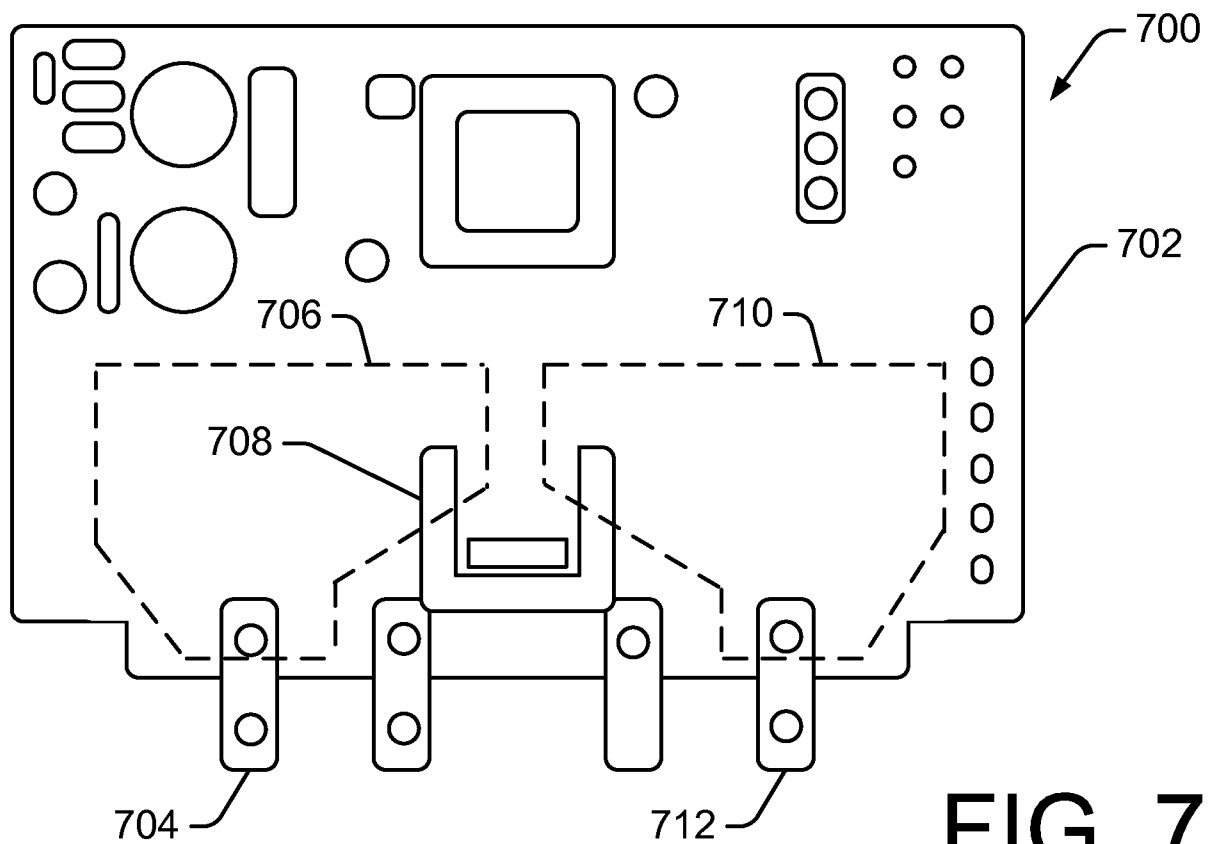


FIG. 7

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/062759

A. CLASSIFICATION OF SUBJECT MATTER

INV. H05K1/02 G01R22/06
ADD.

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)

H05K G01R

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	WO 00/33090 A1 (SCHLUMBERGER RESOURCE MANAGEME [US]) 8 June 2000 (2000-06-08) page 14, line 6 - page 41, line 9; figures ----- -/-	1,2,4-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

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"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

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Date of the actual completion of the international search

19 December 2013

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08/01/2014

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Geoghegan, C

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2013/062759

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	US 2005/270016 A1 (KARANAM RAJAIAH [US] ET AL) 8 December 2005 (2005-12-08) page 1, paragraph 24 - page 4, paragraph 50; figures -----	1-20
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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