

ARC DETECTION ANTENNA**FIELD OF INVENTION**

5 The disclosure relates generally to the field of safety in electrical utility systems, and more specifically relates to an arc detection antenna installed in an electric meter for detecting electrical arcs between electrical metering components included in a utility box at a premises.

10 BACKGROUND

15 All residential and commercial premises include electric meters to allow utility companies to monitor the consumption of electricity within the premises. To do so, an electric meter is electrically connected to a meter socket, which is usually located in a utility box positioned on an outside wall of the premises. The electric meter may include meter blades, which are received in the meter socket and held in place by a tension force applied to the blades by the meter socket.

20 In some instances, the installation of a new meter to replace an old meter if not installed properly may create a phenomenon known as "arcing" where an electrical arc is formed in a gap between a meter blade and a corresponding socket jaw of the meter socket as the meter is installed. Arcing may also occur randomly, subsequent to the installation period. For example, if the tension force of the socket is lessened, that will cause the contact resistance to increase subsequently increasing the heat at contact points and progresses into corrosion and gaps that lead to arcing. The gaps provide an environment conducive to arcing. The presence of arcing in any electrical system may cause high heat, and in some instances, a fire that may cause significant damages to the components of the electric systems, the premises, and may also injure humans, such as workers assisting with a meter replacement. Therefore, it is important to detect arcing conditions before any damage or endangerment occurs.

30 In other instances, arcing may occur elsewhere on the electricity network near the meter, for example inside the premises, and/or in the vicinity of high voltage lines supplying the premises. As in the case of the arcing described above, it is important to

detect these arcing conditions so that action may be taken by an applicable authority before any further damage or endangerment occurs.

5 To detect the arcing conditions, an electric meter can be configured with an arc detection component. However, because of the high voltage condition near the location where the arcing occurs, the arc detection component is typically placed at a location within the meter that is away from the meter blades and the meter sockets and away from the high voltage line coming into the meter. The large distance between the arc detection component and the location of the arcing can lead to inaccurate detection of
10 the arcing.

WO2021/154728 proposes an electric meter in a utility box that is capable of detecting arcing conditions within the meter socket at a premises or anywhere along the power transmission line if RF noise generated by arcing is strong enough to be detected. The
15 arc detection component is placed in an enclosed space close to the AC power connection to the meter.

SUMMARY

20 In general terms, the present disclosure improves the accuracy of arc detection by providing a multilayer circuit board having (i) a first layer hosting a first arc detection antenna that is connected to a high voltage line of an electric meter, and (ii) a second layer electrically insulated from the first layer and hosting a second arc detection antenna that is connected to an arc detection circuit.

25 Arcing typically conditions result in disturbances in the high voltage line that manifests itself as radiofrequency (RF) noise. However, known electric meters typically position circuitry including arc detection functionality as spatially far away as possible from high voltage lines and/or behind a high voltage protection systems and circuits to try to
30 minimise risk of damage to the circuitry from proximity to the high voltage conditions. This results in disturbances in the high voltage line from arcing conditions becoming attenuated when picked up by the arc detection circuit. The ability of such configurations to accurately detect arcing is accordingly reduced.

35 In contrast, in the present disclosure, the high voltage line is routed directly to the circuitry of the meter, specifically to the first layer of the multilayer circuit board and to

an antenna hosted thereon. The antenna is thus directly electrically connected to the high voltage line and thus transmits a signal corresponding to whatever signal is present in the high voltage line.

5 The second layer of the multilayer circuit board has a corresponding antenna thereon which is connected to the arc detection circuitry of and which picks up the signal transmitted by the antenna on the first layer. The first and second layers are separated and electrically isolated from each other so that there is no direct connection from the high voltage line to the layer with the rest of the circuitry of the multilayer circuit board.

10 If arcing conditions cause a disturbance in the high voltage line, the disturbance manifests itself in the signal transmitted by the first antenna and picked up by the second antenna and this can be detected by the arc detection circuitry. As the high voltage line and the arc detection circuitry are separated only by the space between the
15 antennas, the disturbance signal is not substantially attenuated and thus arc detection accuracy is substantially improved over configurations such as that shown in WO2021/154728.

20 Thus, it will be appreciated that the present disclosure is generally concerned with an arc detection circuit coupled to the AC line input of the meter providing high AC isolation to the detection circuit, yet will not degrade the RF noise generated by the arcing so to be detected by the circuit.

25 Thus, according to an aspect of the present disclosure, there is provided an electric meter for detecting electrical arcing. The electric meter comprises a baseplate assembly comprising: an electrical conductor connecting meter blades, each of the meter blades configured to be positioned in a corresponding socket jaw of a meter socket in a utility box that is connected to a power line to electrically connect the electric meter to the meter socket; and a housing assembly configured to be coupled to
30 the baseplate assembly, the housing assembly comprising: a multilayer circuit board comprising: a first layer hosting a first arc detection antenna for emitting a signal indicative of electrical arcing; and a second layer hosting a second arc detection antenna for receiving the signal, wherein the first and second layers are electrically isolated from each other.

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Advantageously, as described above, providing two separate layers, each with an antenna, facilitates detection of an arc detection signal with a stronger signal to noise ratio than is possible using known arc detection systems.

- 5 Optionally, the multilayer circuit board comprises a third layer between the first and second layer comprising an insulating material.

Advantageously, the third layer further insulates the first layer which is coupled to the high voltage line from the second layer hosting the circuitry to increase the breakdown
10 voltage between the first and second layers to avoid the risk of the circuitry on the second layer being damaged by being in close proximity to the high voltage on the first layer. Optionally, the insulating material may comprise an FR4 material. It will be understood that FR4 is a glass-reinforced epoxy laminate material which increases breakdown voltage but does not block or otherwise affect RF noise coupling between
15 the arc detection antennas.

Optionally, the electric meter comprises a bypass line configured to bypass to electrically couple the first layer of the multilayer circuit board to a circuit including the power line through the meter socket.

20 Advantageously, routing a line from the high voltage circuit including the power line directly to be in proximity to the arc detection circuit in a way that bypasses high voltage protection of the other components of the meter ensures any signal that is indicative of arcing is not attenuated by the other components of the meter, thereby
25 ensuring the signal to noise ratio is better than in known arc detection systems.

Optionally, the first antenna is configured to emit the signal indicative of electrical arcing when the electrical arcing occurs in a circuit with the bypass line.

- 30 Optionally, the first arc detection antenna is configured to emit the signal responsive to a voltage pulse in the bypass line indicative of the electrical arcing.

Advantageously, when arcing occurs, it typically results in a pulse in the voltage of the circuit. The bypass line advantageously feeds the pulse to the first arc detection
35 antenna where it can be emitted, picked up and analysed to detect arcing all in the

vicinity of the multilayer printed circuit boards without risking any interference or attenuation by other components of the meter.

5 Optionally, the bypass line is electrically coupled to the first antenna through a surge protection element.

Optionally, the surge protection element comprises a metal oxide varistor and/or a resistor

10 Advantageously, surge protection facilitates the provision of the high voltage of the bypass line to the multilayer printed circuit board in a way that is safe as the varistor is configured to increase resistance responsive to a sudden surge.

15 Optionally, the first layer and the second layer are spatially separated from each other.

Advantageously, as there is spatial and/or electrical separation between the high voltage on the first layer and the second layer which may host operational circuitry such as microprocessors and other components, the operational circuitry is protected from a risk of damage that might otherwise have been caused by proximity to a high voltage circuit.

20 Optionally, the electric meter comprises a current-transformer structure comprising: a current transformer holder and a current transformer cover forming an enclosed space; a current transformer configured to measure a current supplied to the electric meter and positioned in the enclosed space and inductively coupled to the electrical conductor, wherein the first arc detection antenna and the second arc detection antenna are external to and spaced apart from the current transformer structure.

25 Advantageously, separation from the current-transformer structure and current transformers ensures a strong signal to noise ratio of the arc detection signal as any noise and/or attenuation from these components is mitigated.

30 Optionally, the first and/or second arc detection antenna comprise one or more bent elements.

35 Optionally, a bend of the one or more bent elements is a 90 degree bend.

Optionally, the one or more bent elements have a length of between 6-7cm.

5 Advantageously, providing an antenna with one or more bent elements allows the full length of the antenna element to be provided in a smaller space, thereby reducing the space requirements of the antenna on the printed circuit board and thereby miniaturising the arc detection system in an integrated way.

10 Optionally, the meter blades are current blades, the electrical conductor is configured to connect the voltage from the meter blades to the multilayer circuit board, and the number of said meter blades is 4 or 8.

15 According to a second aspect of the present disclosure, there is provided an arc detection circuit for an electric meter, the electric meter comprising a baseplate assembly comprising an electrical conductor connecting meter blades, each of the meter blades configured to be positioned in a corresponding socket jaw of a meter socket in a utility box that is connected to a power line to electrically connect the electric meter to the meter socket; and a housing assembly configured to be coupled to the baseplate assembly, the arc detection circuit comprising: a multilayer circuit board
20 comprising: a first layer hosting a first arc detection antenna for emitting a signal indicative of electrical arcing; and a second layer hosting a second arc detection antenna for receiving the signal.

25 The advantages described in connection with the first aspect apply equally to corresponding features in the second aspect.

30 According to a third aspect of the present disclosure, there is provided a method of detecting electrical arcing between an electric meter and a meter socket in a utility box that is connected to a power line, the electric meter comprising: a baseplate assembly comprising: an electrical conductor connecting two meter blades, each of the meter blades configured to be positioned in a corresponding socket jaw of the meter socket to electrically connect the electric meter to the meter socket; and a housing assembly configured to be coupled to the baseplate assembly, the housing assembly comprising: a multilayer circuit board comprising: a first layer hosting a first arc detection antenna;
35 and a second layer hosting a second arc detection antenna, the method comprising: emitting, with the first arc detection antenna, a signal indicative of electrical arcing;

receiving, with the second arc detection antenna, the signal indicative of electrical arcing; and detecting, with an arc detection circuit the electrical arcing.

5 The advantages described in connection with the first aspect apply equally to corresponding features in the third aspect.

BRIEF DESCRIPTION OF THE DRAWINGS

10 These and other aspects will now be described with reference to the following figures in which:

Figures 1A and 1B are block diagrams depicting examples of an electrical meter, a utility box, and a meter socket according to the present disclosure.

15 Figure 2 is a block diagram depicting a simplified example of components contained in an electric meter capable of detecting arcing conditions present in a utility box, according to the present disclosure.

20 Figure 3 is a block diagram depicting a simplified example of components contained in an electric meter capable of detecting arcing conditions present in a utility box, according to the present disclosure.

25 Figure 4 shows a cutaway side view of an electric meter capable of detecting arcing conditions present in a utility box, according to the present disclosure.

Figure 5A illustratively shows a part of a circuit diagram according to the present disclosure.

30 Figure 5B illustratively shows a part of a circuit diagram according to the present disclosure.

DETAILED DESCRIPTION OF THE DRAWINGS

35 FIGS. 1A and 1B show block diagrams of an electric meter, a utility box, and a meter socket. FIG. 1A is a diagram depicting an electric meter 102 that includes one or more blades, such as blades 103, for example 4 blades (2 input and 2 output), or 8 blades (4

input and 4 output) and so on. FIG. 1A also shows a utility box 100 including a meter socket 104. The meter socket 104 includes receptacles 105, also referred to as “socket jaws” 105, into which the blades 103 may be positioned or engaged. The socket jaws 105 include utility-side socket jaws 105A and premises-side socket jaws 105B. The electric meter 102 may be fitted into the meter socket 104, as indicated by the dotted lines in FIG. 1A, such that the blades 103 are positioned in the socket jaws 105. Positioning the blades 103 within the socket jaws 105 electrically connects the electric meter 102 to the meter socket 104. The meter socket 104 may include springs or other means to provide a tension force on the blades to maintain the position of the blades within the socket jaws of the meter socket 104. The meter socket 104 and blades may each include one or more surfaces made out of a conductive material to allow electricity to flow between the meter socket 104 and the blades.

The blades 103 and the socket jaws 105 may be configured such that electrical signals are transmitted between a utility side of the meter socket 104 and the electric meter 102, and between the electric meter 102 and a premises side of the meter socket 104. For example, electrical signals received from the utility company may be transmitted to the electric meter 102 via the utility-side socket jaws 105 A and blades (not visible in FIG. 1 A) on the utility side of the electric meter 102. In addition, the electrical signals may be transmitted to the premises via the blades 103 on the premises side of the electric meter 102 and the premises-side socket jaws 105B. The electric meter 102 may perform operations as the electrical signals are transmitted between the utility side and the premises side, including generating voltage sense or current sense signals, determining measurements, and other operations. In addition, the electric meter 102 may also be configured to detect arcing conditions near the blades 103 and the socket jaws 105.

FIG. 1B is a diagram depicting an example configuration of the utility box 100 with the electric meter 102 installed. The electric meter 102 may be installed by being positioned in the meter socket 104 (not visible in FIG. 1B). The utility box 100 may be positioned proximate to a premises 180 which receives power from a utility company. Power lines 190 may be electrically connected to the utility box 100 to supply power to the premises 180 from the utility company. The power from the power lines 190 may be routed through the meter socket 104 included in the utility box 100, such as by being transmitted between utility-side and premises-side meter socket jaws via the installed electric meter 102. The installed electric meter 102 may measure various aspects of

the power supplied via the power lines 190, such as to determine an overall power usage by the premises 180. As will be described below, the installed electric meter 102 may also detect the arcing conditions between the electrical meter 102 and the meter socket 104 in the utility box 100. The detected arcing conditions can be utilized to
5 determine whether to disconnect the electric meter 102 from the meter socket 104, thereby disconnecting the electric meter 102 from the power line 190, or to instruct the electric meter 102 to open one or more disconnect switches in the electric meter 102.

FIG. 2 is a block diagram depicting a simplified example of components contained in an
10 electric meter 102 capable of detecting an electrical arc between the electric meter 102 and the meter socket 104, according to the present disclosure. The electric meter 102 shown in FIG. 2 includes a meter base 220, a metrology circuit 250, and a communication component 208 that are supported by and at least partially contained within a housing of the electric meter 102.

15 The meter base 220 includes two pairs of terminals 224A/228A and 224B/128B (such as the meter blades 103 shown in FIG. 1) that are electrically connected together by electrical conductors 226A and 226B, respectively. Each of the terminals 224A, 224B, 228A, and 228B extends from the housing of the electric meter 102 to engage a meter
20 socket (e.g., the meter socket 104 shown in FIG. 1) that is connected to a power line (e.g., the power line 192 shown in FIG. 1). Each of the terminal pairs 224A/228A and 124B/128B is configured to connect in-line with a conductor in the power line where all of the electrical signals that pass through the power line from an energy source to a load passes through the terminal pairs 224A/228A and 224B/228B to the load. The
25 terminal pairs 224A/228A and 224B/228B and the electrical conductors 226A and 226B effectively become part of the power line connected between the generation source and the load when the electric meter 102 is connected to the meter socket.

30 The meter base 220 further includes current transformers 232A and 232B that are inductively coupled to the electrical conductors 226A and 226B, respectively. The current transformers 232A and 232B are electrically connected to a measurement circuit 210 of the metrology circuits 250. The alternating current waveforms in the electrical conductors 226A and 226B induce a current in the current transformers 232A and 232B, respectively. The current can be utilized to monitor electrical current levels
35 in the power line such as by a current sense circuit in the measurement circuit 210. The measurement circuit 210 may include other circuits for measuring purposes, such as a

voltage sense circuit for measuring the voltage of the power line. The voltage sense circuit may be connected to the terminals 224A, 228A, 124B, and 128B to measure the voltage. Voltage sense signals and current sense signals generated by the voltage sense circuit and the current sense circuit, respectively, may be routed to a processing
5 device (not shown in FIG. 2) of the metrology circuits 250 to, for example, determine the power consumed by the premises. Whilst two current transformers 232A and 232B are described herein, it is envisaged that any number may be provided, depending on, for example, the meter form, such as whether it is single, two or three phase service meter.

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To detect the arcing conditions, the electric meter 102 comprises a bypass line 238A, 238B directly coupled to a circuit having the power line and a corresponding pair of blades therein to feed the high voltage signal of the power line directly to the vicinity of the metrology circuits 250, specifically to a first arc detection antenna 234A. The first
15 arc detection antenna 234A is not directly electrically connected to the arc detection circuit 262 of the metrology circuits 250 but instead is positioned adjacent a second arc detection antenna 234B. The second arc detection antenna 234B is directly electrically connected to the arc detection circuit 262. The first arc detection antenna 234A provides emits signals which are picked up by the second arc detection antenna 234B
20 and fed from the second arc detection antenna 234B to the arc detection circuit 262 for detecting arcing conditions between the terminals 224A and 228A and the corresponding socket jaws in the meter socket. Whilst not shown in FIG. 2, a corresponding arrangement may be provided for terminals 224B and 228B and their corresponding socket jaws in the meter socket. For instance, the arc detection circuit
25 262 can analyze the signals received from an arc detection antenna by filtering the received signals to focus on the signal in a certain frequency band to detect the arcing conditions. The first and second arc detection antenna 234A, 234B are accordingly spatially separated from the components of the meter base 220 including the current transformer 232A (or 232B) and any enclosed structure the transformers are enclosed
30 in, referred to herein as a current transformer structure 236A (or 236B). The bypass line 238A and 238B provided with surge protection 244, 242, for example, in the form of a metal oxide varistor (MOV) 244 and/or resistor 242 setup configured to increase resistance responsive a sudden voltage surge which might pass into the antenna and potentially risk a breakdown from the first layer of the multilayer circuit board to the
35 second layer hosting the arc detection and/or other circuitry.

The electric meter 102 may be communicatively coupled to a remote device (not shown in FIG. 2) through a communication component 208. In some aspects, the communication component 208 may include one or more communication devices, such as a communication antenna and a radio, to send and receive message signals through a network between the electric meter 102 and the remote device. For example, the electric meter 102 may send a message containing the measured power consumption or other data to the remote device. The remote device may be communicatively coupled to multiple meters and may communicate the message across a network to a central system, such as a central system associated with an operator of the power utility. In some aspects, the communication component 108 may also transmit a message indicating an arcing condition in the utility box 100. The central system may process the message and, in response, transmit a signal instructing the electric meter 102 to disconnect the power to the premises when arcing occurs.

The electric meter 102 can disconnect the power to the premises by opening disconnect switches 240A and/or 240B as shown in FIG. 2. Each of the disconnect switches 240A and 240B moves between a closed position and an opened position. In the closed position the disconnect switches 240A and 240B establish an electrical connection between the terminal pairs 224A/228A and 224B/228B, respectively. In the opened position, the disconnect switches 240A and 240B disconnect the terminal pairs 224A/228A and 224B/228B, respectively. The disconnect switches 240A and 240B move between the closed and opened positions based on control signals from the metrology circuits 250. For example, the metrology circuits 250 can include a disconnect circuit 222 which can include an actuation device or other means to control the disconnect switches 240A and 240B to move between the closed position and the opened position.

FIG. 3 is a block diagram depicting the arc detection circuit 262 and antenna 234A, 234B of FIG. 2. It will be appreciated that FIG. 3 is simplified to and accordingly does not show other components of the circuit such as those which are described in the arc detection circuit of WO2021/154728. However, these other components are envisaged to be present as will be understood by the skilled person. As is shown FIG. 3, the arc detection circuit comprises a multilayer circuit board comprising at least two layers 318A, 318B spatially separated from each other by a distance 319. The first layer 318A hosts a first arc detection antenna 234A. The first layer 318 is electrically coupled

through the bypass line 238A, 238B to the high voltage circuit i.e. a circuit directly including the power line and not behind a MELF or other high voltage protection system or other components of the meter. It will be appreciated that the bypass line 238A, 238B may comprise one or more conductors such as insulated leads, cables or wires capable of safely withstanding the typical voltages present on a power line. The bypass line 238A, 238B in FIG. 3 connects to the first layer 318A at one or more points. Surge protection 323 such as a MOV and/or a resistor and/or other components is provided ensure that any surges through the bypass line 238A, 238B can safely be guarded against.

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As described above, the first layer 318A hosts the first arc detection antenna 234A which is coupled to the surge protection with conductive traces 324. When arcing occurs and a signal indicative of arcing is present in the circuit including the bypass line 238A, 238B, for example a voltage pulse is present, the pulsing causes the first arc detection antenna 234A to emit an electromagnetic wave signal corresponding to the pulsing.

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The second layer 318B, which is spatially and electrically isolated from the first layer 318A hosts a second arc detection antenna 234B. The dotted lines in FIG. 3 indicate the corresponding component is hidden behind the first layer 318A in FIG. 3. The second arc detection antenna 234B is coupled to one or more operational components 262A of the arc detection circuit 262 including, for example, resistors, diodes, capacitors, microprocessors and/or any other components required to amplify and detect arcing signals, such as those described in WO2021/154728. These components are illustrative only and not intended to be limiting. The skilled person will appreciate other ways to implement an arc detection circuit.

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As described above, when arcing occurs, a signal is emitted by the first arc detection antenna 234A. The signal is picked up by the second arc detection antenna 234B and fed into the operational components 262A of the arc detection circuit 262 allowing the arcing to be detected. Specifically, as the first and second layers 318A, 318B are spatially separated and electrically isolated from each other, when the first layer 318A on which the first arc detection antenna 234A is hosted is coupled directly to the high voltage circuit of the power line through the bypass line 238A, 238B, there is spatial and electrical separation between the high voltage on the first layer 318A and the rest of the metrology circuits 250 on the second layer 318B. Accordingly, the operational

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components 262A of the arc detection circuit 262 such as microprocessors and other components, and the components of the metrology circuits 250 on the printed circuit boards are protected from a risk of damage that might otherwise have been caused by proximity to a high voltage circuit. At the same time, any pulsed signal in the high voltage circuit indicative of arcing remains strong (i.e. a lower signal to noise ratio compared to known systems) and not attenuated.

FIG. 4 shows a cutaway side view of an electric meter 300 capable of detecting arcing conditions in a utility box according to the present disclosure. As shown in FIG. 4, the electric meter 300 includes a baseplate assembly 302 and a housing assembly 304. The various components of the meter base 220 discussed above with respect to FIG. 2 are installed in the baseplate assembly 302. For example, in FIG. 4, two meter blades 312 and 310 are connected by an electrical conductor 314 that passes through the ring formed by a current-transformer structure 306. The meter blades 312 and 310 extend from the outer side of a baseplate 320 of the baseplate assembly 302 so that they can be positioned into the socket jaws of the meter socket when being installed into the utility box.

In FIG. 4, the housing assembly 304 of the electric meter 300 includes a register cover 308, at least two printed circuit boards 318 and other components. When the register cover 308 is connected to the baseplate 320, it encloses the printed circuit boards 318. In some examples, the printed circuit boards 318 are installed on the front end of the housing assembly 304, i.e., the end that is away from the baseplate 320. In some examples, the measurement circuit 210 and the arc detection circuit 262 discussed above with respect to FIG. 2 are placed on one printed circuit board 318. In other examples, the measurement circuit 210 and the arc detection circuit 262 may be placed on separate printed circuit boards 318.

Whilst the details of the printed circuit boards 318 are not shown in the view of FIG. 4, it is envisaged that the first arc detection antenna 234A of FIG. 2 and FIG. 3 is hosted on a first of the layers 318A and the second arc detection antenna 234B of FIG. 2 is hosted on a second of the layers 318B. As described above, the operational components of the arc detection circuit 262 such as microprocessors and other components, and the components of the metrology circuits 250 on the printed circuit boards remain protected from damage that might otherwise have been caused by proximity to a high voltage circuit while at the same time any pulsed signal in the high

voltage circuit indicative of arcing remains strong (i.e. a lower signal to noise ratio compared to known systems) and not attenuated. Specifically, compared to a system such as that provided in WO2021/154728, the signal analysed by the arc detection circuit has a much higher signal to noise ratio because: (i) the spatial and electrical
5 isolation of the antenna from the meter box and its components means that the noise that might have occurred had the arc detection antennas been in close proximity to or in the same circuits as the components of the meter base such as the transformers 232A, 232B is reduced, and (ii) the signal is not attenuated by the high voltage protection systems of the meter box, such as MELF resistors. As a result, meter box of
10 the present disclosure provides more accurate arc detection compared to the system of WO2021/154728.

FIG 5A illustratively shows a detailed, illustrative example of the part of a circuit diagram 500 according to the present disclosure showing a wide-range switch mode
15 power supply (SMPS) of the electric meter. The circuit diagram illustrates two sections: a high voltage section 501, and a low voltage section 502, separated by a transformer such as transformer 232A or 232B of FIG 2.

The high voltage section 501 comprises the bypass lines 238A, 238B, labelled as
20 VA_Line and Neutral which are directly connected to the supply voltage source (i.e. the high voltage power line). The circuit diagram further shows resistor 242 and MOV 244 corresponding to those of FIG. 2 which represent the front end protection of the SMPS. When high surge voltages appear such as during lightning strikes, the MOV 244 clamps the surge voltage to ~800-1000V and the resistor 242 will limit the surge
25 current in the MOV 244 to protect it.

The circuit diagram further shows arc detection antenna 234A connected to the bypass lines 238A, 238B between the resistor 242 and MOV 244, as well as to one or more
30 other components of the high voltage section such that in the event of a surge the voltage on the arc detection antenna 234A is limited and thereby any breakdown arising from the antenna is limited.

The low voltage section 502 comprises circuitry separated from the high voltage section by the various components of the high voltage section 501 and transformer
35 232A

At least the antenna 234A is provided on the above described first layer of the multilayer circuit board.

FIG 5B illustratively shows a detailed, illustrative example of a part of a circuit diagram 503 according to the present disclosure showing a part of an arc detection circuit 262 such as that of FIG. 2, which is provided at least partially on a second layer of the multilayer circuit board. The circuit diagram 503 shows a second antenna 234B which is in proximity to the first antenna 234A of FIG. 5A. As described above, the first antenna 234A and second antenna 234B are electrically isolated from each other, for example through a layer of FR4 material.

In the event of arcing at the meter's socket, meter, inside the premises or anywhere along the transmission line that can generate enough RF noise to be picked up by the first antenna 234A, the noise is coupled to the second antenna 234B. An average RF noise detector circuit 246 is provided in the arc detection circuit 262. Specifically, when there is high enough RF noise, the average detected voltage will be high enough to bias a transistor 248 of the arc detection circuit 262 thereby turning it on and, along with the rest of the circuit around transistor 250, results in square pulses being generated. These pulses may be converted into a digital signal and counted, as well as be used to drive an LED 252 of the arc detection circuit 262 to give a visual indication of arcing.

It should be understood that while the above figures depict a two-phase solution for the electric meter where two current-transformer structures are installed in an electric meter, the presented technique can be applied to other types of electric meters. For example, a single-phase electric meter can include the current-transformer structure presented herein to detect arc detection occurring on the single-phase line. Likewise, a three-phase electric meter can include three current-transformer structures presented herein to detect the arcing conditions in the respective phases.

While the present subject matter has been described in detail with respect to specific aspects, it will be appreciated that those skilled in the art, upon attaining an understanding of the foregoing may readily produce alterations to, variations of, and equivalents to such aspects. Accordingly, it should be understood that the present disclosure has been presented for purposes of example rather than limitation, and does not preclude inclusion of such modifications, variations, or additions to the present

subject matter as would be readily apparent to one of ordinary skill in the art. Indeed, the methods and systems described herein may be embodied in a variety of other forms. Furthermore, various omissions, substitutions and changes in the form of the methods and systems described herein may be made without departing from the spirit
5 of the present disclosure. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope of the present disclosure.

List of reference numerals:

- 10 100 utility box
102 electric meter
103 blades
104 meter socket
15 105A, 105B socket jaws
180 premises
190 power lines
208 communication component
210 measurement circuit
20 220 meter base
222 disconnect circuit
224A, 224B terminal pairs
226A, 226B electrical conductors
228A, 228B terminals
25 232A, 232B current transformers
234A, 234B arc detection antenna
236A, 236B current transformer structure
238A, 238B bypass line
240A, 240B disconnect switch
30 250 metrology circuits
262 arc detection circuit
262A operational components
300 electric meter
302 baseplate assembly
35 304 housing assembly
306 current transformer structure

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308 register cover

310 blade

312 blade

318A, 318B layers of multilayer circuit board

5 319 separation distance

320 baseplate

323 surge protection

324 conductive trace

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CLAIMS:

1. An electric meter for detecting electrical arcing, the electric meter comprising:
a baseplate assembly comprising: an electrical conductor connecting two meter
5 blades, each of the meter blades configured to be positioned in a corresponding socket
jaw of a meter socket in a utility box that is connected to a power line to electrically
connect the electric meter to the meter socket; and
a housing assembly configured to be coupled to the baseplate assembly, the
housing assembly comprising:
10 a multilayer circuit board comprising:
a first layer hosting a first arc detection antenna for emitting a signal
indicative of electrical arcing; and
a second layer hosting a second arc detection antenna for receiving the
signal.
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2. The electric meter of claim 1, wherein the multilayer circuit board comprises a
third layer between the first and second layer comprising an insulating material.
3. The electric meter of claims 1 or 2, wherein the multilayer circuit board is
20 spatially separated from the baseplate assembly.
4. The electric meter of claim 3, comprising a bypass line configured electrically
couple the first layer of the multilayer circuit board to a circuit including the power line
through the meter socket.
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5. The electric meter of claim 3 or 4, wherein the first antenna is configured to emit
the signal indicative of electrical arcing when the electrical arcing occurs in a circuit
with the bypass line.
6. The electric meter of any of claims 3-5, wherein the first arc detection antenna
30 is configured to emit the signal responsive to a voltage pulse in the bypass line
indicative of the electrical arcing.
7. The electric meter of any of claims 4-6, wherein the bypass line is electrically
35 coupled to the first antenna through a surge protection element.

8. The electric meter of claim 7, wherein the surge protection element comprises a metal oxide varistor (MOV) and/or a resistor.
- 5 9. The electric meter of any preceding claim, comprising a current-transformer structure comprising: a current transformer holder and a current transformer cover forming an enclosed space; a current transformer configured to measure a current supplied to the electric meter and positioned in the enclosed space and inductively coupled to the electrical conductor,
- 10 wherein the first arc detection antenna and the second arc detection antenna are external to and spaced apart from the current transformer structure.
10. The electric meter of any preceding claim, wherein the first and/or second arc detection antenna comprise one or more bent elements.
- 15 11. The electric meter of claim 10, wherein a bend of the one or more bent elements is a 90 degree bend.
12. The electric meter of claims 11 or 12, wherein the one or more bent elements
- 20 have a length of between 6-7cm.
13. The electric meter of any preceding claim, wherein the meter blades are current blades, wherein the electrical conductor is configured to connect the voltage from the meter blades to the multilayer circuit board, and wherein the number of said meter
- 25 blades is 4 or 8.
14. An arc detection circuit for an electric meter, the electric meter comprising a baseplate assembly comprising an electrical conductor connecting meter blades, each of the meter blades configured to be positioned in a corresponding socket jaw of a
- 30 meter socket in a utility box that is connected to a power line to electrically connect the electric meter to the meter socket; and a housing assembly configured to be coupled to the baseplate assembly, the arc detection circuit comprising:
- a multilayer circuit board comprising:
- a first layer hosting a first arc detection antenna for emitting a signal
- 35 indicative of electrical arcing; and

a second layer hosting a second arc detection antenna for receiving the signal.

15. A method of detecting electrical arcing between an electric meter and a meter
5 socket in a utility box that is connected to a power line, the electric meter comprising: a
baseplate assembly comprising: an electrical conductor connecting meter blades, each
of the meter blades configured to be positioned in a corresponding socket jaw of the
meter socket to electrically connect the electric meter to the meter socket; and a
housing assembly configured to be coupled to the baseplate assembly, the housing
10 assembly comprising a multilayer circuit board comprising: a first layer hosting a first
arc detection antenna; and a second layer hosting a second arc detection antenna, the
method comprising:
emitting, with the first arc detection antenna, a signal indicative of electrical
arcing;
15 receiving, with the second arc detection antenna, the signal indicative of
electrical arcing; and
detecting, with an arc detection circuit, the electrical arcing.
16. The method of claim 15, wherein the multilayer circuit board comprises a third
20 layer between the first and second layer comprising an insulating material.
17. The method of claims 15 or 16, wherein the multilayer circuit board is spatially
separated from the baseplate assembly.