CLAIMS

1. A device releasably couplable to an electric asset, the device comprising:

a sensor configured to detect partial discharge from the electric asset and generate a pulsed signal representative of a presence or absence of the detected partial discharge; and

a time-domain based RFID tag electrically coupled to the sensor, the time-domain based RFID tag configured to provide an ID code uniquely representative of a location of the device when coupled to the electric asset,

wherein the device is configured to generate, upon interrogation by an external interrogator, a backscattered signal comprising the ID code and the pulsed signal, and the generated backscattered signal is to be read by an external reader,

the sensor comprises:

at least one sensing coil for detecting the partial discharge; and

at least one state-change component connected in parallel to the at least one sensing coil and operable to generate the pulsed signal, the at least one sensing coil comprising a plurality of sensing coils configured to operate at different resonant frequencies, each resonant frequency separated apart from another, and to provide an extended bandwidth for the sensor, the extended bandwidth being dependent on a spread of the different resonant frequencies, and

the sensor forms a terminating end of the device.

2. The device as claimed in claim 1, wherein the generated pulsed signal including a phase change represents the presence of the detected partial discharge from the electric asset, and the generated pulsed signal including no change in phase represents the absence of partial discharge detected from the electric asset.

3. The device as claimed in claim 1 or 2, wherein the at least one state-change component comprises a non-linear component.

4. The device as claimed in any one of claims 1 to 3, wherein the time-domain based RFID tag comprises a delay line comprising one or more discontinuities, each discontinuity configured to provide one or more unique codes, wherein a unique code from the one or more discontinuities is used as the ID code.

5. The device as claimed in claim 4, wherein each discontinuity comprises one of the following:

a split ring resonator, or

a complementary split ring resonator, or

a combination of a split ring resonator and a complementary split ring resonator.

6. The device as claimed in claim 4, wherein the discontinuity comprises one of:

reconfigurable stub lines; or

reconfigurable stub lines and a phase shifter.

7. The device as claimed in any one of claims 4 to 6, wherein a case of more than one discontinuity, each discontinuity is arranged spaced apart from one another.

8. The device as claimed in any one of claims 4 to 7, wherein the delay line is a composite right/left-handed transmission line.

9. The device as claimed in any one of claims 4 to 8, wherein the time-domain based RFID tag further comprises a power divider coupled to the discontinuity and arranged along the delay line in a manner such that the discontinuity is indirectly coupled to the delay line through the power divider, wherein the power divider is configured to at least reduce excess signal reflection from the discontinuity, thereby ensuring only one signal reflection is performed by the discontinuity.

10. The device as claimed in any one of claims 4 to 9, wherein a distal end of the delay line is coupled to the sensor, thereby enabling a time lapse to be provided between the ID code and the pulsed signal.

11. The device as claimed in claim 10, wherein the time-domain based RFID tag further comprises an antenna coupled to a proximal end of the delay line, the proximal end being opposite to the distal end, the antenna configured to receive an interrogation signal from the external interrogator.

12. The device as claimed in any one of claims 1 to 10, further comprising an antenna coupled in series with the time-domain based RFID tag, the antenna configured to receive an interrogation signal from the external interrogator.

13. The device as claimed in any one of claims 1 to 12, further comprising at least one parameter sensor, each electrically coupled to the time-domain based RFID tag, wherein the at least one parameter sensor is configured to detect at least one parameter experienced by the electric asset for determining an abnormal change in the at least one parameter.

14. The device as claimed in any one of claims 1 to 13, wherein the time-domain based RFID tag is a time-domain based chipless RFID tag.

15. The device as claimed in any one of claims 1 to 12, wherein the time-domain based RFID tag is a time-domain chipped based RFID tag, and the device further comprises at least one parameter sensor electrically coupled to the time-domain based chipped RFID tag, the at least one parameter sensor being configured to detect at least one parameter experienced by the electric asset for determining an abnormal change in the at least one parameter.

16. The device as claimed in any one of claims 13 to 15, wherein the at least one parameter sensor comprises at least one of: a temperature sensor, a humidity sensor, a vibration sensor, or a strain sensor.

17. An apparatus comprising:

at least one device as claimed in any one of claims 1 to 16, each device releasably couplable to each corresponding electric asset;

an external interrogator configured to interrogate the at least one device to generate a backscattered signal; and

an external reader configured to read the backscattered signal to obtain identification of the corresponding electric asset and information on partial discharge experienced by the corresponding electric asset.

18. The apparatus as claimed in claim 17, wherein the external interrogator and the external reader are integrated within a single external interrogator cum reader.

19. A method for obtaining identification of at least one electric asset and information on partial discharge experienced by the at least one electric asset, the method comprising:

sending, by an external interrogator, an interrogation signal to at least one device, each device releasably coupled to each corresponding electric asset;

detecting, by each device, the partial discharge from the corresponding electric asset;

generating, by each device, a backscattered signal comprising an ID code uniquely representative of a location of the device coupled to the corresponding electric asset and a pulsed signal representative of a presence or absence of the detected partial discharge; and

reading, by an external reader, the backscattered signal to obtain identification of the corresponding electric asset and information on partial discharge experienced by the corresponding electric asset, wherein

the step of detecting the partial discharge comprises capturing energy of the partial discharge over an extended bandwidth of a sensor forming a terminating end of the device, the sensor comprising:

a plurality of sensing coils operating at different resonant frequencies, and the extended bandwidth being dependent on a spread of the different resonant frequencies, and

a state-change component connected in parallel to the plurality of sensing coils to generate the pulsed signal.

20. The method as claimed in claim 19, wherein in the step of generating the backscattered signal, the state-change component remains at a first state when substantially no partial discharge is detected such that the phase of the pulsed signal remains unchanged, and the state-change component is turned to a second state by an induced pulsed voltage of the detected partial discharge to provide a phase change in the pulsed signal.

21. The method as claimed in claim 19 or 20, wherein the device comprises a time-domain based RFID tag comprising a delay line, and wherein the step of generating the backscattered signal comprises providing, by one or more discontinuities of the delay line, one or more unique codes; and using a unique code as the ID code.

22. The method as claimed in claim 21, wherein the step of providing the one or more unique codes comprises generating the one or more unique codes based on phase shift keying modulations.

23. The method as claimed in claim 22, wherein the phase shift keying modulations is one of: quadrature phase shift keying modulations, or 16 phase shift keying modulations.

24. The method as claimed in any one of claims 21 to 23, further comprising at least reducing, by a power divider, excess signal reflection from the discontinuity, wherein the power divider is electrically coupled to the discontinuity and arranged along the delay line in a manner such that the discontinuity is indirectly coupled to the delay line through the power divider.

25. The method as claimed in any one of claims 21 to 24, further comprising receiving, by an antenna of the at least one device, the interrogation signal.

26. The method as claimed in any one of claims 21 to 25, further comprising detecting, by at least one parameter sensor of each device, at least one parameter experienced by the corresponding electric asset for determining an abnormal change in the at least one

parameter, wherein each of the at least one parameter sensor is electrically coupled to the time-domain based RFID tag.

27. The method as claimed in any one of claims 21 to 26, wherein the time-domain based RFID tag is a time-domain based chipless RFID tag.

28. The method as claimed in any one of claims 21 to 25, wherein the time-domain based RFID tag is a time-domain chipped based RFID tag, and the method further comprises detecting, by at least one parameter sensor of each device, at least one parameter experienced by the corresponding electric asset for determining an abnormal change in the at least one parameter, wherein the at least one parameter sensor is electrically coupled to the time-domain based chipped RFID tag.

29. The method as claimed in any one of claims 19 to 28, wherein the external interrogator and the external reader are integrated within a single external interrogator cum reader.