CLAIMS

1. A method of digital sampling of a current or group of currents in an electrical system having at least one observation point, said at least one observation point comprising, a single conductor or a group of conductors, the method comprising the steps of:

a) using in said sampling, sufficient bandwidth to reconstruct an amplitude and phase of a synthesized power frequency and its harmonics and a fundamental carrier frequency of switching electronics and modulation sidebands;

b) measuring relative branch impedences in a cabled earth current in combination with a three phase residual current to infer the current flowing in a physical earth;

c) converting signals into a frequency domain, wherein frequency domain data uses a signal processing technique selected from discrete Fourier transforms or fast Fourier transforms; wherein the spectrum of said frequency domain data generated by the discrete or fast Fourier transform is limited to reject a broadband noise floor;

d) converting a signal to yield a magnitude and phase of each frequency component in sampled data in said frequency domain; and

e) activating protection equipment to open circuit a power supply if power frequency or power harmonic leakage currents exceed specified levels and durations.

2. The method according to claim 1, wherein:
depending upon where a fundamental power frequency is identified, power frequency harmonics are identified in magnitude and frequency which are integer multiples of the fundamental power frequency.

3. The method of digital sampling according to claim 2, wherein:
said bandwidth includes direct current.

4. The method of digital sampling according to claim 3, comprising the further step of:

leaving only significant spectral lines associated with specific component frequencies of interest.

5. The method of digital sampling according to claim 4, comprising the further step of:

analyzing frequency domain data to determine a fundamental power frequency.

6. The method of digital sampling according to claim 5, wherein:

analysis of said frequency domain data analysis identifies spectra in signal analyses, and identifies the presence of electrical arcing in power system applications.

7. The method of digital sampling according to claim 6, wherein:

if a direct current component exists, it is identified.

8. The method of digital sampling according to claim 7, comprising the further step of:

where, if multiple switching electronic modules exist, multiple power frequency and harmonics of that frequency may be detected.

9. The method of digital sampling according to claim 8, wherein:

a fundamental switching or carrier frequency is identified for loads that include either direct current or variable synthesized power frequency alternating currents from switching electronics.

10. The method of digital sampling according to claim 9, wherein:

where multiple carrier frequencies are detected, they are distinguished by identifying sideband components against the fundamental switching or carrier frequency identified.

11. The method of digital sampling according to claim 10, comprising a further step of:
using measured information to activate protection equipment to open circuit the power supply if high frequency leakage currents are at excessive levels.

12. The method of digital sampling according to claim 11, comprising a further step of:
using measured information to ascertain that high frequency currents exist at a location and to provide diagnostic information to assist in locating a source of an unwanted current.

13. The method of digital sampling according to claim 12, wherein:
the single conductor is selected from an earth, neutral or individual phase conductor.

14. The method of digital sampling according to claim 12, comprising the further step of:
simultaneously sampling three individual phase conductors, to directly measure a residual or leakage current across a three phase bundle.

15. The method of digital sampling according to claim 12, comprising the step of:
directly measuring one current in a parallel branch to infer a current flowing in a second parallel branch.

16. A method for detection and interpretation of DC and higher frequency signals to enable provision of diagnostic information assisting identification,

resolution, or repair of equipment generating a leakage current, according to the steps of:

a) sampling an electrical signal naturally generated from a switching power electronic loads connected to an electrical system;

b) analyzing data from the sampled naturally generated signal to obtain data characteristics which uniquely identify a source of the signal;

c) comparing said data characteristics with data characteristics from known equipment, with equivalent data taken from the known equipment at another time;

d) interpreting the sampled signal to ascertain if an electrical hazard is indicated by the data; and

e) activating protection equipment to open circuit a power supply if high frequency signals exceed specified levels and durations.

17. A method for detection and interpretation of electrical signals naturally emanating from switching power electronics operating as connected loads in an electrical system, to enable an analysis of those signals to determine an earth leakage or fault, the method comprising the steps of:

a) sampling a signal generated by an electrical device;

b) taking a measurement from at least one measure points in the electrical system supplying said device;

c) sampling a current or group of currents flowing in the electrical system;

d) converting sampled signals into a data form suitable for analysis;

e) analyzing the data to determine its indications of faults or potential faults in connected power electronic equipment;

f) interpreting the data to ascertain if an electrical hazard is indicated;

g) a step selected from the group consisting of activating protection equipment to open the power supply if power frequency or power harmonic leakage currents exceed specified levels and durations, and activating protection equipment to open circuit the power supply if DC or higher frequency leakage currents are at excessive levels; and

h) providing diagnostic information as to characteristics of the equipment likely to have caused detected leakage signals.

18. The method according to claim 17, wherein:
the measurement is undertaken from at least one observation point in an electrical system.

19. The method according to claim 18, wherein:
the observation point is a single conductor.

20. The method according to claim 19, wherein:
the observation point is a group of conductors.

21. The method according to claim 19, wherein:
the observation point is a point of direct measurement of one current in a parallel branch.

22. The method according to claim 21, wherein:
an observation of direct measurement of one current in a parallel branch allows an inference of the current flowing in a second parallel branch.

23. The method according to claim 22, wherein:
sampled time domain data is converted into a frequency domain using discrete Fourier transforms.

24. The method according to claim 22, wherein:
said sampled time domain data is converted into a frequency domain using fast Fourier transforms.

25. The method according to claim 23, wherein:

said sampled time domain data is converted into a frequency domain using a signal processing technique.

26. The method according to claim 25, wherein:

interpretation of identified currents in a given assumed operating topology and state enables inference of at least one of the following events and/or parameters:

(i) leakage of direct current into physical or conducted earths;

(ii) leakage of fundamental and harmonic components of mains frequency currents into physical or conducted earths;

(iii) relative amplitudes of respective power frequency harmonics;

(iv) leakage of fundamental and harmonic switching converter currents into physical or conducted earths;

(v) nominal switching frequency of power converter; and

(vi) ineffective or faulty common mode filters on switching converters or equipment supplied by switching converters.