CLAIMS

1. A system for calibration of a phased array antenna, the antenna comprising a plurality of mutually electro-magnetically coupled antenna elements, the system being operative to determine, per antenna element, a calibration ratio adapted to accommodate for presence of at least one interfering structure electromagnetically interfering with a signal transmitted from an RF source and received by the antenna, the system comprising:

a network of auxiliary channels internally injecting internal signals to the antenna,

an RF source external to the antenna, operative to project external signals toward the antenna when disposed at a near-by distance therefrom;

an RF simulation unit operative to generate simulated first electro-magnetic coupling -zero far-field zone external fields projected toward the antenna from an RF source located at a far- field zone distance from the antenna, assuming that first electro-magnetic coupling between the mutually electro-magnetically coupled antenna elements to be zero, and also operative to generate simulated first electro-magnetic coupling -zero near field zone external fields projected toward the antenna from an RF source located at said near-by distance from the antenna were the first electro-magnetic coupling between said mutually electro-magnetically coupled antenna elements to be zero; and

a electro-magnetically coupled structure-accommodating calibration ratio computer operative to compute a Modified Calibration ratio by computing a function of said internal signals, said external signals as received by the antenna, and a correction factor based on an output of said RF simulation unit.

2. A system according to claim 1 wherein said RF source comprises an RF point source.

3. A system according to claim 1 wherein said RF source is spherical.

4. A system according to claim 1 wherein said RF source is non-spherical.

5. A system according to claim 1 wherein said antenna calibrator is operative to combine said calibration ratio and said correction factor by adding the phases of the calibration ratio and said correction factor to obtain a phase value of the Modified Calibration ratio and adding decibel representations of the amplitudes of the calibration ratio and said correction factor to obtain a decibel representation of an amplitude of the Modified Calibration ratio.

6. A system according to claim 1 wherein said RF simulation tool computes the correction factor by computing electromagnetic fields generated in and propagating within a non-continuous medium.

7. A system according to claim 1 wherein said antenna comprises a cellular antenna.

~~8. A system according to claim 1 and also comprising a platform upon which the antenna is mounted and wherein said interfering member is part of said platform.~~

~~9. A system according to claim 1 and also comprising a signal measurement and recording device which measures amplitude and phase of the samples of said internal and external signals.~~

1~~0~~. A method for calibrating an antenna comprising a phased array of antenna elements connected to plurality of transceivers, the method comprising:

providing an RF source of externally injected signals operative when located close to the antenna to be synchronized with the transceivers;

determining, per antenna element, a calibration ratio adapted to accommodate for presence of at least one interfering structure electromagnetically interfering with a signal transmitted from said RF source and received by the antenna; and

calibrating the antenna using the per-antenna element calibration ratios adapted to accommodate for presence of at least one interfering structure;~~.~~ and

~~11. A method according to claim 10~~ wherein said determining includes:

generating simulated far field and near field signals so as to simulate a signal transmitted by an RF source located at infinity and located near the RF source respectively;

internally injecting an internal signal into the antenna via an internal injection network synchronized with the transceivers, wherein said interfering structure interferes with said internal signal;

using said RF source to externally inject an external signal into the antenna; and

for each individual antenna element, computing said calibration ratio by combining information characterizing said internal and external signals as received by said individual antenna element with a correction factor characterizing said simulated far field and near field signals and representing, per antenna element, the ratio of said simulated far field and near field signals.

~~12. A method according to claim 10 wherein at least one physical object which is electromagnetically coupled to radiation emitted by the RF source thereby to define unwanted radiation in context of said calibration, is present in the course of said determining and calibrating and is absent in a subsequent operational stage, the method also comprising screening said unwanted radiation.~~

~~13. A method according to claim 12 wherein said screening comprises covering said at least one physical object with RF-radiation absorbing material.~~

14. A method according to claim 13 wherein said determining and calibrating occurs on the ground, said operational stage is airborne and said physical object is fixed to the ground.

15. A method according to claim 10 wherein said determining comprises determining the calibration ratio a plurality of times thereby to obtain a plurality of interim calibration ratio results and averaging said plurality of interim calibration ratio results to obtain said calibration ratio adapted to accommodate for presence of at least one interfering structure.

16. A method according to claim 15 wherein said determining the calibration ratio a plurality of times includes re-positioning said RF source a plurality of times, thereby to compensate for artifactual noise generated by said at least one interfering structure during calibration ratio measurement.

17. A method according to claim 15 wherein said calibration ratio is determined a plurality of times for a single position of said RF source, thereby to compensate for white noise during calibration ratio measurement.

18. A method according to claim 10 wherein said at least one interfering structure comprises a plurality of interfering structures and wherein generating at least one simulated signal comprises performing the following operations for a near field configuration and for a far field configuration:

a. simulating a plurality of simulated first electromagnetic fields generated at the plurality of interfering structures respectively due to radiation emitted by the RF source;

b. simulating a plurality of simulated induced currents generated at the plurality of interfering structures respectively due to radiation emitted by the RF source;

c. for each antenna element in the phased array of antenna elements:

1. simulating a second electromagnetic field generated at the antenna element due to radiation emitted by the RF source;

2. simulating a plurality of simulated third electromagnetic fields generated at the antenna element due to said plurality of simulated induced currents respectively; and

3. generating a total field by summing said plurality of simulated third electromagnetic fields and said second electromagnetic field;

d. for each antenna element in the phased array of antenna elements:

1. computing a correction factor by computing a ratio of the total field as computed for the far field configuration divided by the total field as computed for the near field configuration; and

2. computing said phase and amplitude of said calibration ratio by measuring phase and amplitude for each of said internal and external signals as received by each of said antenna elements; and

e. for each individual antenna element, computing said calibration ratio adapted to accommodate for presence of at least one interfering structure by computing a difference between said phases of said external and internal signals as received by said individual antenna element, and adding the phase of the correction factor.

19. A method according to claim 18 and also comprising providing said plurality of interfering structures, wherein said antenna is installed on an aircraft and said plurality of interfering structures include a fuselage, a first wing, a second wing, an engine, a stabilizer and a rudder.

20. A method according to claim 18 and also comprising providing said plurality of interfering structures, wherein said antenna is installed on an ship and said plurality of interfering structures include a hull, at least one mast and a bridge.

21. A method according to claim 18 and also comprising providing said plurality of interfering structures, wherein said antenna is installed on a tank and said plurality of interfering structures include a hull, a turret and a cannon.

22. A computer program product, comprising a computer usable medium having a computer readable program code embodied therein, said computer readable program code adapted to be executed to implement a method for calibrating an antenna comprising a phased array of antenna elements connected to plurality of transceivers, the method comprising:

providing an RF source operative when located close to the antenna to be synchronized with the transceivers;

determining, per antenna element, a calibration ratio adapted to accommodate for presence of at least one interfering structure electromagnetically interfering with a signal transmitted from an RF source, the RF source being located close to the antenna and being synchronized with the transceivers, the signal being received by the antenna, wherein said determining includes:

generating simulated far field and near field signals so as to simulate a signal transmitted by an RF source located at infinity and located near the RF source respectively;

internally injecting an internal signal into the antenna via an internal injection network;

using said RF source to externally inject an external signal into the antenna; and

for each individual antenna element, computing said calibration ratio by combining information characterizing said internal and external signals as received by said individual antenna element with a correction factor characterizing said simulated far field and near field signals; and

~~calibrating the antenna using the per-antenna element calibration ratios adapted to accommodate for presence of at least one interfering structure.~~

~~23. A method according to claim 10 wherein said method is carried out in field conditions in which no anechoic chamber is available.~~

~~24. A system according to claim 1 wherein the external signals are affected by first electro-magnetic coupling between the plurality of mutually electro-magnetically coupled antenna elements and by second electro-magnetic coupling between the source and the interfering structure,~~

~~the system also comprising:~~

~~a signal measuring and recording device measuring and recording samples of the internal signals and said external signals; and~~

~~a correction factor computation unit operative to compute a correction factor for the calibration ratio which factor corrects for presence of the interfering structure and has a phase and an amplitude, by comparing said simulated first electro-magnetic coupling-zero far- field zone external electromagnetic fields and said simulated first electro-magnetic coupling-zero near field zone external electromagnetic fields,~~

~~and wherein said electro-magnetically coupled structure-accommodating calibration ratio computer is operative to compute the modified Calibration ratio by computing a function of the ratio of said internal and external signals as received by the antenna and said correction factor.~~

~~25. A method according to claim 18 and also comprising computing (in dB) a difference between said amplitudes of said external and internal signals as received by said individual antenna element, and adding the amplitude (in DB) of the correction factor.~~

~~26. A system according to claim 1 and wherein the antenna elements are connected to plurality of transceivers, the system also comprising an internal injection network synchronized with the transceivers and operative for internally injecting internal signals to the antenna.~~

2~~27~~. An antenna calibration method comprising:

Covering all interfering elements which are present during calibration ration acquisition but absent during operation, with RF radiation absorbing materials;

Injecting an internal calibration signal into antennae and using an RF source nearby the antenna to inject an external calibration signal into the antennae;

Measuring the amplitude and phase of the internal and external calibration signals as received and using an electro-magnetically coupled structure-accommodating calibration ratio computer to process the internal and external calibration signals;

Using an RF simulation tool to create the same near field zone configuration set-up as was used for Measuring the amplitude and phase of the external calibration signal as received;

Using an RF simulation tool to create a far-field zone configuration setup fulfilling far-field conditions for each element of an interfering structure;

Computing induced currents on the interfering structure for the near and far-field zone configurations, for each significant portion of the interfering structure;

Computing electromagnetic fields resulting from near-field zone configuration induced currents for each said significant element;

Computing total fields for far field zone configuration and, by summing all induced fields, over all of said significant elements, and the fields from the RF source, for near field zone configuration;

Sampling total fields at the spatial position of each antenna element in said antennae for near-field zone configuration and for far-field zone configuration;

Computing correction factor as ratio of total fields computed at near and far-field zone configurations, sampled at spatial position of each antenna element in said antennae;

Computing phase and amplitude, respectively, of the calibration ratio for each antenna element in said antennae by subtracting measured values of the internal calibration signal from measured values of the external calibration signal and adding phase and amplitude, respectively, of the correction factor; and

Calibrating the antenna using the phase and amplitude of the calibration ratio.

~~28. A system according to claim 10 and wherein the calibration ratio is computed by decomposing a correction factor into two contributions one comprising a non electro-magnetically coupled component and the other one comprising a correction component due to the electro-magnetic coupling.~~

~~29. A system according to claim 1 wherein the RF simulation unit is operative to solve Maxwell equations to compute electromagnetic fields which propagate through discontinuous media, obeying specific boundary conditions.~~