

Radio Frequency (RF) Field Sensor Mast

5 The invention relates to a sensor mast system for positioning a sensor, especially a microwave sensor, in predefined positions of a test setup.

In standardization processes for electrical and electronic
10 equipment numerous tests are required. This includes generating a uniform electric field within at least a single vertical plane by means of a suitable test system to measure the electromagnetic susceptibility of the equipment. For this purpose at least one radio frequency
15 field sensor is used to measure the field strength at different positions on the at least one vertical plane. To achieve a spatial resolution of the field geometry several sensor positions are realized. To reduce costs and to increase the comparability of the results a single sensor
20 is typically used for these measurements. The single sensor therefore has to be positioned at the several sensor positions with great accuracy.

In the past the accurate positioning of the field sensor
25 was a difficult and menial task. The field sensor mast has to be carried to the correct position. Afterwards the correct height of the sensor has to be adjusted typically by use of a clamp connecting the sensor to the sensor mast. Since there are no height indicators on the typical
30 sensor mast, the correct height of the sensor has to be checked by use of a tape measure.

Additionally typical sensor masts are constructed from strong materials, with relatively high dielectric

constants. Especially the clamp used to fix the sensor to the sensor mast is typically made from such a material. This results in reflections from these structures which influence the measurements. Even the dielectric constant of fiberglass, which is often used, is high enough for these unwanted reflections to occur.

The WO 2005/099029 A1 shows a sensor mast comprising several mast elements and a sensor. The mast elements extend in a telescoping manner. The sensor is connected to the topmost mast element. The manufacturing of this sensor mast though requires a great deal of labor and material. For controlling the height of the sensor additional means like a control processor have to be provided. Furthermore this sensor mast is not intended for measurement purposes to verify electronic devices but for mobile surveillance purposes.

Accordingly, the object of the invention is to create a field sensor mast system which provides easy positioning of the field sensor and enables measurements with very low distortions.

The object is solved by the features of claim 1 for the device. The dependent claims contain further developments.

A Sensor mast system for positioning a sensor in predefined heights comprises a base, a sensor and at least two mast elements. A sensor mast is comprised of the base, at least one of the mast elements and the sensor. All but one mast elements are of fixed height. The sensor is interchangeably connectable to the top of any of the mast elements. A number of different heights of the sensor can be achieved by this sensor mast system. The mounting is

easy. Furthermore it is not necessary to check the sensor height, since the mast elements are of predefined height.

Preferably the mast elements are interchangeably
5 connectable to the base and to each other.

Preferably each mast element comprises a lower end and an upper end. Advantageously a lower end of any mast element but one mast element is variably connectable to an upper
10 end of any mast element. An upper end and an upper end of any two mast elements are advantageously not connectable. A lower end and a lower end of any two mast elements are preferably not connectable. This increases the ease of assembly of the sensor mast. Furthermore it reduces
15 errors.

Preferably each mast element comprises a lower end and an upper end. Preferably the lower ends of all mast elements but one mast element comprise lower end connection
20 elements and the upper ends of the mast elements preferably comprise upper end connection elements. Lower end connection elements are advantageously connectable to upper end connection elements. Upper end connection elements are preferably not connectable to upper end
25 connection elements and lower end connection elements are preferably not connectable to lower end connection elements. This further increases the ease of assembly of the sensor mast. Assembly errors occur less likely.

30 Advantageously at least one mast element or all mast elements and/or the base consist of a nonmetallic material, especially of a material of low dielectric constant, especially of Rohacell. This reduces reflections.

and thereby increases the signal quality generated by the sensor.

The sensor is preferably mountable in predefined heights
5 by connecting a number of mast elements to each other and to the base and by connecting the sensor to the top end of the top mast element. A great number of sensor positions can easily be achieved in a short time.

10 Advantageously the base comprises at least two positions in which the mast elements are connectable to the base and the at least two positions are preferably horizontally separated. Preferably the sensor can be positioned in at least two predefined horizontal positions. Horizontal
15 sensor displacement is therefore possible. It is not necessary to move the entire sensor mast assembly, but only the sensor and some of the sensor mast elements. The base remains in position. This additionally increases the accuracy of the positioning.

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The base preferably comprises at least two wheels and is movable by use of the wheels. This increases the ease of handling and the accuracy of positioning.

25 Advantageously the height of the base or the height of the mast element of non-fixed height or the combined height of the base and a connected mast element is accurately adjustable. Ground unevenness can now be compensated. Furthermore differing sensor dimensions can be
30 compensated.

Preferably at least one of the mast elements and/or the base comprises a slot in which a cable, especially a fiberoptic cable, connected to the sensor is mountable.

This reduces reflections caused by the cable and thereby increases the quality of the signal generated by the sensor.

5 Exemplary embodiments of the invention are now further explained with respect to the drawings, in which

Fig. 1 desired positions of a sensor for an exemplary test;

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Fig. 2 an exemplary field sensor mast;

Fig. 3 a first embodiment of the inventive field sensor mast system;

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Fig. 4 a second embodiment of the inventive field sensor mast system;

Fig. 5 a third embodiment of the inventive field sensor mast system;

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Fig. 6 a fourth embodiment of the inventive field sensor mast system;

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Fig. 7 a fifth embodiment of the inventive field sensor mast system;

Fig. 8 a sixth embodiment of the inventive field sensor mast system;

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Fig. 9 an seventh embodiment of the inventive field sensor mast system;

Fig. 10 a eighth embodiment of the inventive field sensor mast system, and

Fig. 11 a ninth embodiment of the inventive field sensor mast system

are depicted.

First we demonstrate the aim of positioning by use of an exemplary field sensor mast with respect to Fig. 1 - 2. In a second step the function of several exemplary inventive devices is shown with respect to Fig. 3 to 11.

Similar entities and reference numbers in different figures have been partially omitted.

Fig. 1 shows desired positions of a sensor for an exemplary test. In a two-dimensional diagram the required positions 13 of the sensor for a certain standardized test are shown. In this example the distance 11 of the lowest sensor position from the reference plane (the floor) is 0,8m. The horizontal distance 12 between adjacent positions is 0,5m. The vertical distance between adjacent positions is also 0,5m.

In Fig. 2 an exemplary field sensor mast is depicted. A mast 22 is mounted on a base 23. A sensor 30 is connected to the mast 22 by a clamp 21. The clamp 21 is adjustable in height along the mast 22. For positioning the sensor 30 in a specified height it is necessary to verify the height of the sensor 30 with an external measuring device. The mast 22, the base 23 and the clamp 21 are made of a strong material which results in a high dielectric constant. Reflexions detected by the sensor 30 occur. Especially the

clamp 21 needs to be made of a strong material, since it carries the weight of the sensor 30 and is crucial for accurate alignment of the sensor 30.

5 Fig. 3 shows a first embodiment of the inventive field sensor mast system. The field sensor mast system is comprised of a base 33, a sensor 30 and a number of mast elements. For setting up a field sensor mast at least one of the mast elements is selected. In this example two mast
10 elements 31, 32 are selected. By selecting the mast elements 31, 32 the height 34 of the sensor 30 is adjusted. The mast element 32 is mounted on the base 33. The mast element 31 is mounted on the mast element 32. The sensor 30 is mounted on top of the upper end of the top
15 mast element 31. An optional sensor holder could further connect the sensor 30 to the topmost mast element 31.

In Fig. 4 a second embodiment of the inventive field sensor mast system is depicted. In this second example
20 only one mast element 32 is selected. The sensor 30 is mounted directly on top of the upper end of the one mast element 32. The one mast element 32 is mounted directly on the base 33. This results in only a small height 40 of the sensor 30 over the ground. This setup is especially useful
25 for placing the sensor mast on top of a table.

Fig. 5 shows a third embodiment of the inventive field sensor mast system. In this figure the sensor mast elements 52, 53 are shown in greater detail. The mast
30 elements 52, 53 each comprise an upper end connection element 54, 55 and a lower end connection element 56, 57. Upper end connection elements 54, 55 and the lower end connection elements 56, 57 are able to interlock and form a secure connection. In this example the mast elements 52,

53 are connected through the connection elements 55 and 56. The heights 50, 51 of the mast elements 52, 53 are combined to one total height 58. Since the connection elements 54, 55, 56, 57 interlock, they do not influence the height 50, 51 of the mast elements 52, 53 or the total height 58. A sensor connected to the mast element 52 could also comprise a lower end connection element which would then interlock with the upper end connection element 54. Alternatively the sensor could be mounted on top of an upper end connection element without comprising a lower end connection element and without interlocking.

In Fig. 6 a fourth embodiment of the inventive field sensor mast system is depicted. The positioning of the sensor 30 in a great height 70 is demonstrated in this example. The base 74 is connected to a first mast element 71. Further mast elements 65, 66, 67, 68 are mounted on top of the first mast element 71. The great height is achieved by combining the heights 60 - 64 of the mast elements 65 - 68, 71 and the base 74. The sensor 30 is mounted on top of the topmost mast element 65. The combined height 64 of the base 74 and the first mast element 71 is adjustable. To achieve this, the first mast element 71 comprises an external screw thread 72. The base 74 comprises a compatible internal screw thread 75. The first mast element 71 is inserted into the base 74 and held in place by the interlocking screw threads 72, 75. To lock the first mast element 71 and the base 74 into position a locking mechanism 73 is employed. This mechanism is shown in further detail in Fig. 7 - 9.

Fig. 7 shows a fifth embodiment of the inventive field sensor mast system. A first mast element 80 is depicted here. This first mast element 80 is comparable to the mast

element 71 from Fig. 6. The first mast element 80 comprises an external screw thread 83, an upper connection element 81 and a brace 82. It does not comprise a lower connection element.

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In Fig. 8 a sixth embodiment of the inventive field sensor mast system is depicted. A base 85 is depicted here. The base 85 comprises a body 84, a locking mechanism 88 at least two wheels 89 and a boring 87, which comprises an
10 internal screw thread 86.

The at least two wheels 89 enable to base 85 to be moved over the floor easily. Furthermore the wheels 89 give the movement of the base 85 over the floor a direction. This
15 increases the ease of the repositioning of the field sensor mast. To increase the stability of the field sensor mast the wheels can be locked in position. Alternatively the wheels can be retracted, resulting in the body 84 of the base 85 being in direct contact with the floor.

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Instead of wheels 89 alternatively fixed supports can be used. These enable great stability while reducing the cost of manufacture.

25 Fig. 9 shows a seventh embodiment of the inventive field sensor mast system. The interlocking of the first mast element 80 from Fig. 7 and the base 85 from Fig. 8 is depicted here. The external screw thread 83 of the mast element 80 interlocks with the internal screw thread 86 of
30 the base 85. The two parts are held in position by the locking mechanism 88. The locking mechanism 88 is a screw with an external screw thread inserted into a boring with an internal screw thread in the body 84 of the base 85. The tip of the screw is in contact with the external screw

thread 83 of the mast element 80 when in a locked position. The friction between the tip of the screw and the screw thread 83 prevents the mast element 80 from moving in the base 85. In the unlocked position the tip of this rule is not in contact with the external screw thread 83. Now the mast element 80 can move in the base 85. The brace 82 prevents the mast element 80 to move too far down within the base 85. By moving the mast element 80 further up or down inside the base 85 the combined height 90 can be adjusted.

In Fig. 10 an eighth embodiment of the inventive field sensor mast system is depicted. Here an alternative base 100 is depicted with a field sensor mast comparable to the field sensor mast from Fig. 6. The alternative base 100 comprises several borings 102. Each boring 102 is fitted with an internal screw thread 103. In this example each boring 102 is further fitted with a first mast element 80. The further mast elements 65 - 68 are connected to one of the first mast elements 80. By choosing one of the first mast elements 80 the horizontal position of the sensor 30 can be set. Alternatively only one first mast element 80 is used. In this case the first mast element 80 stays connected to the remaining mast elements 65 - 68 when the horizontal position of the sensor 30 is set. The remaining borings 102 remained empty. The borings 102 are spaced apart horizontally by a predefined distance 101. Furthermore the use of wheels with this alternative base 100 is possible. By orienting the wheels along with the long side of this base 100 more horizontal positions of the field sensor mast can be realized. By orienting the wheels at 90° from the long side of the base 100 a great number of measurement positions within a three-dimensional volume can easily be set.

In Fig. 11 a ninth embodiment of the inventive field sensor mast system is depicted. In this example four different possible mast configurations 110, 111, 112 and 113 are shown in one diagram. These four configurations 110, 111, 112 and 113 are alternative configurations. Mounting four sensor masts on one base 100 at the same time is not intended. In this example the lengths of the sensor mast elements 66, 67 and 68 are identical. Since the upper end connection elements and the lower end connection elements of all sensor mast elements 65 - 68, 80 are identical the positions of the sensor mast elements 66, 67 and 68 can be switched. An exchange of the mast elements 67, 68 can be seen in the configuration 112. By using sensor mast elements of different lengths and by using the different mounting positions offered by the base 100 a great number of a sensor locations can be achieved.

The invention is not limited to the examples and especially not to the number of mast elements. Also a use of several sensor mast systems for mounting parts of an active sensing system is possible. The characteristics of the exemplary embodiments can be used in any combination.

Claims

1. Sensor mast system for positioning a sensor (30) in predefined heights comprising a base (33, 74, 85, 100), a
5 sensor (30) and at least two mast elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80),
wherein a sensor mast is comprised of the base (33, 74, 85, 100), at least one of the mast elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80) and the sensor (30),
10 wherein the mast elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80) are interchangeably connectable to the base (33, 74, 85, 100) and to each other, and
wherein the sensor (30) is interchangeably connectable to the top of any of the mast elements (31, 32, 52, 53, 65,
15 66, 67, 68, 71, 80).

2. Sensor mast system according to claim 1,
characterized in that
all mast elements (31, 52, 53, 65, 66, 67, 68) but one
20 mast element (32, 71, 80) are of fixed height.

3. Sensor mast system according to claim 1 or 2,
characterized in that
each mast element (31, 32, 52, 53, 65, 66, 67, 68, 71, 80)
25 comprises a lower end and an upper end,
that a lower end of any mast element (31, 52, 53, 65, 66, 67, 68) but one mast element (32, 71, 80) is variably
connectable to an upper end of any mast element (31, 32,
52, 53, 65, 66, 67, 68, 71, 80),
30 that an upper end and an upper end of any two mast
elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80) are not
connectable, and

that a lower end and a lower end of any two mast elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80) are not connectable.

- 5 4. Sensor mast system according to any of claims 1 to 3,
characterized in that
each mast element (31, 32, 52, 53, 65, 66, 67, 68, 71, 80)
comprises a lower end and an upper end,
that the lower ends of all mast elements (31, 52, 53, 65,
10 66, 67, 68) but one mast element (32, 71, 80) comprise
lower end connection elements (56, 57),
that the upper ends of all mast elements (31, 32, 52, 53,
65, 66, 67, 68, 71, 80) comprise upper end connection
elements (54, 55),
15 that lower end connection elements (56, 57) are
connectable to upper end connection elements (54, 55),
that upper end connection elements (54, 55) are not
connectable to upper end connection elements (54, 55), and
that lower end connection elements (56, 57) are not
20 connectable to lower end connection elements (56, 57).

5. Sensor mast system according to any of the claims 1 to
4,
characterized in that
25 at least one mast element (31, 32, 52, 53, 65, 66, 67, 68,
71, 80) consists of a nonmetallic material, especially of
a material of low dielectric constant, especially of
Rohacell.

- 30 6. Sensor mast system according to any of the claims 1 to
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characterized in that
all mast elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80)
consist of a nonmetallic material, especially of a

material of low dielectric constant, especially of Rohacell.

7. Sensor mast system according to any of the claims 1 to

5 6,

characterized in that

the base (33, 74, 85, 100) consists of a nonmetallic material, especially of a material of low dielectric constant, especially of Rohacell.

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8. Sensor mast system according to any of the claims 1 to

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characterized in that

the sensor (30) is mountable in predefined heights by

15 connecting a number of mast elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80) to each other and to the base (33, 74, 85, 100) and by connecting the sensor (30) to the top end of the top mast element (31, 32, 65, 66, 68).

20 9. Sensor mast system according to any of the claims 1 to

8,

characterized in that

the base (100) comprises at least two positions in which the mast elements (31, 32, 52, 53, 65, 66, 67, 68, 71, 80)

25 are connectable to the base (100),

that the at least two positions are horizontally separated, and

that the sensor (30) can be positioned in at least two predefined horizontal positions.

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10. Sensor mast system according to any of the claims 1 to

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characterized in that

the base (85) comprises at least two wheels (89), and

that the base (85) is movable by use of the at least two wheels (89).

11. Sensor mast system according to any of the claims 1 to
5 10,

characterized in that

the height of the base (33, 74, 85, 100) or the height of
the mast element (32, 71, 80) of non-fixed height or the
combined height of the base (33, 74, 85, 100) and a
10 connected mast element (32, 67, 68, 71, 80) is accurately
adjustable.

12. Sensor mast system according to any of the claims 1 to
11,

15 **characterized in that**

at least one of the mast elements (31, 32, 52, 53, 65, 66,
67, 68, 71, 80) and/or the base (33, 74, 85, 100)
comprises a slot in which a cable, especially a fiberoptic
cable, connected to the sensor (30) is mountable.

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