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MOBILE TERMINAL TESTING DEVICE AND MOBILE TERMINAL TESTING METHOD

Abstract

There is provided a mobile terminal testing device that can improve the accuracy of measurement results. A reference position measurement control unit **18***c* that measures output power of a DUT **100** at a Reference position, which is any preset measurement position, each time a certain period of time elapses in a case where a total spherical scanning of the DUT **100** is performed, and that, in a case where the output power is equal to or less than a preset regulated Power, interrupts the measurement, excludes measurement data after the previous measurement at a Reference position from the measured value, and enables the measurement to be resumed from the excluded measurement position is provided.

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Background/Summary

TECHNICAL FIELD

[0001] The present invention relates to a mobile terminal testing device that tests a mobile terminal by exchanging signals while changing an angle of a positioner on which the mobile terminal is installed under an Over The Air (OTA) environment.

BACKGROUND ART

[0002] For a wireless terminal that has been developed in recent years and transmits and receives a radio signal corresponding to IEEE802.11ad, 5G cellular, and the like, in which a signal in a wide band of a millimeter wave band is used, a performance test is performed of measuring an output level and reception sensitivity of a transmitted radio wave determined for each communication standard with respect to a wireless communication antenna included in the wireless terminal, and determining whether or not a predetermined reference is satisfied.

[0003] For example, in a performance test in which a wireless terminal (hereinafter, referred to as a “5G wireless terminal”) for a New Radio System (NR system) of a fifth generation mobile communication system (hereinafter, also referred to as “5G”) is used as a Device Under Test (DUT), an OTA test using an anechoic box (OTA chamber) referred to as a Compact Antenna Test Range (CATR) that is not affected by a surrounding radio wave environment is performed.

[0004] As an example of a wireless terminal measurement device according to the related art capable of performing an OTA test, it is known that a wireless terminal is rotated around a reference point in a measurement space such as an anechoic box or an anechoic chamber, while radio waves transmitted from the wireless terminal are received by a measurement antenna, and radiation power characteristics (such as Equivalent Isotropic Radiated Power (EIRP), Equivalent Isotropic Sensitivity (EIS), Total Radiated Power (TRP)) of the wireless terminal are obtained from the received signal.

[0005] Patent Document 1 describes that, in the measurement of the DUT that is rotated to sequentially face all orientations of the spherical coordinate system under the OTA environment, the progress of the measurement at each measurement position is displayed.

RELATED ART DOCUMENT

Patent Document

[0006] [Patent Document 1] Japanese Patent No. 7227198

DISCLOSURE OF THE INVENTION

Problem That the Invention is to Solve

[0007] In measurements in the OTA environment, there are many time-consuming measurements such as a spherical coverage measurement, and in a case where the DUT generates heat due to the DUT continuously outputting the maximum power, the DUT may intentionally reduce the output in order to protect the DUT. In addition, the same phenomenon occurs even in a case where the remaining battery level decreases due to the long-time call connection.

[0008] Since these phenomena are not desirable measurement results that indicate the actual capabilities of the DUT, there is a demand to exclude these phenomena.

[0009] Therefore, an object of the present invention is to provide a mobile terminal testing device that can improve the accuracy of measurement results by excluding measurement data in which the output of the DUT is considered to be reduced.

Means for Solving The Problem

[0010] According to the present invention, there is provided a mobile terminal testing device of the present invention including: a positioner that is provided in an internal space of an anechoic box, has an azimuth axis and a roll axis that are each rotationally drivable by a drive motor, and rotates a mobile terminal that is a device under test so that the mobile terminal sequentially faces a plurality of preset angular sample points of a spherical coordinate system, using a center of the spherical coordinate system as a reference point; a simulated measurement device connected to a test antenna in the internal space; an integrated control device that controls the simulated measurement device so that a measurement operation of transmitting a test signal from the test antenna to the mobile terminal, receiving a signal under measurement transmitted from the mobile terminal that has received the test signal by using the test antenna, and measuring a specific measurement item related to the mobile terminal based on the received signal under measurement is performed at a measurement position corresponding to each of the plurality of angular sample points; and a Reference position measurement control unit that measures output power of the mobile terminal at a preset Reference position each time a preset regulated time elapses, and that, in a case where the measured output power is equal to or less than a preset regulated Power, interrupts the measurement, excludes measurement data after the measurement at a previous Reference position from a measured value, and enables the measurement to be resumed from the excluded measurement position.

[0011] With this configuration, the output power of the mobile terminal at the Reference position is measured each time the regulated time elapses, and in a case where the measured output power is equal to or less than the regulated power, the measurement is interrupted, the measurement data after the previous measurement at the Reference position is excluded from the measured value, and the measurement is resumable from the excluded measurement position. Therefore, it is possible to improve the accuracy of measurement results by excluding the measurement data in which the output of the DUT is considered to be reduced.

[0012] In addition, according to the present invention, there is provided a mobile terminal testing method of a mobile terminal testing device including a positioner that is provided in an internal space of an anechoic box, has an azimuth axis and a roll axis that are each rotationally drivable by a drive motor, and rotates a mobile terminal that is a device under test so that the mobile terminal sequentially faces a plurality of preset angular sample points of a spherical coordinate system, using a center of the spherical coordinate system as a reference point, a simulated measurement device connected to a test antenna in the internal space, and an integrated control device that controls the simulated measurement device so that a measurement operation of transmitting a test signal from the test antenna to the mobile terminal, receiving a signal under measurement transmitted from the mobile terminal that has received the test signal by using the test antenna, and measuring a specific measurement item related to the mobile terminal based on the received signal under measurement is performed at a measurement position corresponding to each of the plurality of angular sample points, the mobile terminal testing method including: a step of measuring output power of the mobile terminal at a preset Reference position each time a preset regulated time elapses, and a step of interrupting the measurement, excluding measurement data after the measurement at a previous Reference position from a measured value, and enabling the measurement to be resumed from the excluded measurement position, in a case where the measured output power is equal to or less than a preset regulated Power.

[0013] With this configuration, the output power of the mobile terminal at the Reference position is measured each time the regulated time elapses, and in a case where the measured output power is equal to or less than the regulated power, the measurement is interrupted, the measurement data after the previous measurement at the Reference position is excluded from the measured value, and the measurement is resumable from the excluded measurement position. Therefore, it is possible to improve the accuracy of measurement results by excluding the measurement data in which the output of the DUT is considered to be reduced.

Advantage of the Invention

[0014] The present invention can provide a mobile terminal testing device that can improve the accuracy of measurement results.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a diagram showing a schematic configuration of an entire measurement device according to an embodiment of the present invention.

[0016] FIG. **2** is a block diagram showing a functional configuration of the measurement device according to the embodiment of the present invention.

[0017] FIG. **3** is a block diagram showing functional configurations of an integrated control device of the measurement device and a controlled system element thereof according to the embodiment of the present invention.

[0018] FIG. **4** is a block diagram showing a functional configuration of an NR system simulator in the measurement device according to the embodiment of the present invention.

[0019] FIGS. **5**A and **5**B are diagrams showing total spherical scanning images of a device under test in an OTA chamber of the measurement device according to the embodiment of the present invention, in which FIG. **5**A shows a disposition mode of the device under test with respect to a center of a spherical coordinate system, and FIG. **5**B shows a distribution mode of angular sample points PS in the spherical coordinate system.

[0020] FIG. **6** is a diagram explaining a disposition mode of a test antenna **5** in the OTA chamber of the measurement device according to the embodiment of the present invention using the spherical coordinate system (r, θ, φ) shown in FIGS. **5**A and **5**B.

[0021] FIG. **7** is a diagram showing a rotation drive image around an azimuth axis and a roll axis of a biaxial positioner related to the total spherical scanning of the DUT in the measurement device according to the embodiment of the present invention.

[0022] FIG. **8** is a flowchart showing a procedure of a measurement control operation of the measurement device according to the embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0023] Hereinafter, a measurement device as a mobile terminal testing device according to an embodiment of the present invention will be described with reference to the drawings.

[0024] First, a configuration of a measurement device **1** according to the embodiment of the present invention will be described with reference to FIGS. **1** to **4**. The measurement device **1** constitutes the mobile terminal testing device of the present invention. The measurement device **1** according to the present embodiment has an external structure as shown in FIG. **1** as a whole, and includes functional blocks as shown in FIG. **2**. FIGS. **1** and **2** show a disposition mode of each component of an OTA chamber **50** in a state of being seen through from a side surface thereof.

[0025] The measurement device **1** is operated, for example, in a mode in which each of the above-described components is mounted on each rack **90***a* of a rack structure **90** having the structure shown in FIG. **1**. FIG. **1** shows an example in which each of an integrated control device **10**, an NR system simulator **20**, and an OTA chamber **50** is mounted on each rack **90***a* of the rack structure **90**.

[0026] As shown in FIG. **2**, the measurement device **1** includes the integrated control device **10**, the NR system simulator **20**, a signal processing unit **23**, and the OTA chamber **50**.

[0027] For the configuration, the OTA chamber **50** will be described first. As shown in FIGS. **1** and **2**, the OTA chamber **50** includes, for example, a metal housing main body **52** having a rectangular internal space **51**, and accommodates a DUT **100** having an antenna **110**, a test antenna **5**, a reflector **7**, and a DUT scanning mechanism **56** in the internal space **51**.

[0028] A radio wave absorber **55** is attached to a whole area of an inner surface of the OTA chamber **50**, that is, a bottom surface **52***a*, a side surface **52***b*, and a top surface **52***c* of the housing

main body **52**. As a result, in the OTA chamber **50**, each element (the DUT **100**, the test antenna **5**, the reflector **7**, and the DUT scanning mechanism **56**) disposed in the internal space **51** has an enhanced function of regulating intrusion of radio waves from the outside and radiation of the radio waves to the outside. In this way, the OTA chamber **50** realizes an anechoic box having the internal space **51** that is not affected by a surrounding radio wave environment. The anechoic box used in the present embodiment is, for example, an anechoic type.
[0029] Among those accommodated in the internal space **51** of the OTA chamber **50**, the DUT **100** is, for example, a wireless terminal such as a smartphone. Communication standards for the DUT **100** include cellular (LTE, LTE-A, W-CDMA (registered trademark), GSM (registered trademark), CDMA 2000, 1xEV-DO, TD-SCDMA, or the like), wireless LAN (IEEE 802.11b/g/a/n/ac/ad, or the like), Bluetooth (registered trademark), GNSS (GPS, Galileo, GLONASS, BeiDou, or the like), FM, and digital broadcasting (DVB-H, ISDB-T, or the like). Further, the DUT **100** may be a wireless terminal that transmits and receives a radio signal in a millimeter wave band corresponding to IEEE 802.11ad, 5G cellular, or the like.
[0030] In the present embodiment, the antenna **110** of the DUT **100** uses a radio signal in each regulated frequency band in conformity with, for example, LTE or 5G NR communication standard. The DUT **100** constitutes the device under test, that is, a mobile terminal in the present invention.
[0031] In the internal space **51** of the OTA chamber **50**, the DUT **100** is held by a part of mechanism of the DUT scanning mechanism **56**. The DUT scanning mechanism **56** is provided to extend in a vertical direction on the bottom surface **52***a* of the housing main body **52** in the internal space **51** of the OTA chamber **50**. The DUT scanning mechanism **56** performs a total spherical scanning (refer to FIGS. **5**A and **5**B and FIG. **6**), which will be described later, on the DUT **100** while holding the DUT **100** on which a performance test is performed.
[0032] As shown in FIG. **1**, the DUT scanning mechanism **56** includes a turntable **56***a*, a support column member **56***b*, a DUT mounting portion **56***c*, and a drive unit **56***e*. The turntable **56***a* includes a plate member having a disk shape, and has a configuration (refer to FIG. **3** and FIG. **7**) that rotates around an azimuth axis (a rotation axis in the vertical direction). The support column member **56***b* includes a columnar member disposed to extend in a direction perpendicular to a plate surface of the turntable **56***a*.
[0033] The DUT mounting portion **56***c* is disposed near an upper end of the support column member **56***b* to be in parallel with the turntable **56***a*, and has a mounting tray **56***d* on which the DUT **100** is mounted. The DUT mounting portion **56***c* has a configuration (refer to FIG. **3** and FIG. **7**) capable of rotating around a roll axis (a rotation axis in a horizontal direction).
[0034] As shown in FIG. **3**, the drive unit **56***e* includes, for example, a drive motor **56***f* that rotationally drives the azimuth axis, and a drive motor **56***g* that rotationally drives the roll axis. The drive unit **56***e* includes a biaxial positioner provided with a mechanism for performing rotations around the azimuth axis and the roll axis, respectively, by the drive motor **56***f* and the drive motor **56***g*. In this way, the drive unit **56***e* can rotate the DUT **100** mounted on the mounting tray **56***d* in biaxial (the azimuth axis and the roll axis) directions for each mounting tray **56***d*. Hereinafter, there is a case where the entire DUT scanning mechanism **56** including the drive unit **56***e* is referred to as the biaxial positioner (refer to FIG. **3**).
[0035] The DUT scanning mechanism (biaxial positioner) **56** performs total spherical scanning which sequentially changes a posture of the DUT **100** in a state in which the antenna **110** faces all orientations (a plurality of preset orientations) of a surface of the sphere while assuming that the DUT **100** mounted (held) on the mounting tray **56***d* is disposed, for example, at a center O**1** of a sphere (refer to a sphere B in FIGS. **5**A and **5**B). Control of the DUT scanning in the DUT scanning mechanism **56** is performed by a DUT scanning control unit **16** which will be described later. The DUT scanning mechanism **56** constitutes the positioner in the present invention.
[0036] The test antenna **5** is attached to a required position on the bottom surface **52***a* of the

housing main body **52** of the OTA chamber **50** by using an appropriate holder (not shown). An attachment position of the test antenna **5** is a position at which visibility can be secured from the reflector **7** via an opening **67***a* provided on the bottom surface **52***a*. The test antenna **5** uses a radio signal in the frequency band of the same regulation (NR standard) as the antenna **110** of the DUT **100**.

[0037] In a case where measurement related to the NR of the DUT **100** is performed in the OTA chamber **50**, the test antenna **5** transmits a test signal from the NR system simulator **20** to the DUT **100** and receives a signal under measurement transmitted from the DUT **100** that has received the test signal. The test antenna **5** is disposed so that a light reception surface thereof becomes a focal position F of the reflector **7**. The reflector **7** is not always required in a case where the test antenna **5** can be disposed so that the light reception surface thereof faces the DUT **100** and appropriate light reception can be performed.

[0038] The reflector **7** is attached to a required position on the side surface **52***b* of the OTA chamber **50** by using a reflector holder **58**. The reflector **7** realizes a radio wave path that returns the radio signal (the test signal and the signal under measurement) transmitted and received by the antenna **110** of the DUT **100** to the light reception surface of the test antenna **5**.

[0039] Subsequently, configurations of the integrated control device **10** and the NR system simulator **20** will be described.

[0040] As shown in FIG. **2**, the integrated control device **10** is communicably connected to the NR system simulator **20** via a network **19** such as Ethernet (registered trademark). Further, the integrated control device **10** is also connected to a controlled system element in the OTA chamber **50**, for example, the DUT scanning control unit **16** via the network **19**.

[0041] The integrated control device **10** comprehensively controls the NR system simulator **20** and the DUT scanning control unit **16** via the network **19**, and includes, for example, a Personal Computer (PC). The DUT scanning control unit **16** may be independently provided accompanying with the OTA chamber **50** (refer to FIG. **2**), or may be provided in the integrated control device **10** as shown in FIG. **3**. Hereinafter, description will be performed while assuming that the integrated control device **10** has the configuration shown in FIG. **3**.

[0042] As shown in FIG. **3**, the integrated control device **10** includes a control unit **11**, an operation unit **12**, and a display unit **13**. The control unit **11** includes, for example, a computer device. The computer device includes a Central Processing Unit (CPU) **11***a* that performs predetermined information processing to realize the function of the measurement device **1**, and performs comprehensive control on the NR system simulator **20**, and the DUT scanning control unit **16** as targets, a Read Only Memory (ROM) **11***b* that stores an Operating System (OS) for starting up the CPU **11***a*, the other programs, and control parameters, and the like, a Random Access Memory (RAM) **11***c* that stores execution code, data, and the like of the OS or an application which is used for an operation by the CPU **11***a*, an external I/F unit **11***d*, an input and output port (not shown), and the like.

[0043] The external I/F unit **11***d* is communicably connected to each of the NR system simulator **20** and the drive unit **56***e* of the DUT scanning mechanism (biaxial positioner) **56** via the network **19**. An operation unit **12** and a display unit **13** are connected to the input and output port. The operation unit **12** is a functional unit for inputting various information such as commands, and the display unit **13** is a functional unit for displaying various information such as an input screen, measurement results, and the like of the various information.

[0044] The computer device described above functions as the control unit **11** in such a way that the CPU **11***a* executes a program stored in the ROM **11***b* while using the RAM **11***c* as a work area. As shown in FIG. **3**, the control unit **11** includes a call connection control unit **14**, a signal transmission and reception control unit **15**, a DUT scanning control unit **16**, a signal analysis control unit **17**, a setting control unit **18***a*, a rotation speed management control unit **18***b*, a Reference position measurement control unit **18***c*, and a measurement status display control unit

18*h*. The call connection control unit **14**, the signal transmission and reception control unit **15**, the DUT scanning control unit **16**, the signal analysis control unit **17**, the setting control unit **18***a*, the rotation speed management control unit **18***b*, the Reference position measurement control unit **18***c*, and the measurement status display control unit **18***h* are also realized by executing a predetermined program stored in the ROM **11***b* in the work area of the RAM **11***c* by the CPU **11***a*.

[0045] The call connection control unit **14** drives the test antenna **5** via the NR system simulator **20** and the signal processing unit **23** to transmit and receive a control signal (radio signal) to and from the DUT **100**, thereby performing control to establish a call (a state where the radio signal can be transmitted and received) between the NR system simulator **20** and the DUT **100**.

[0046] The signal transmission and reception control unit **15** performs a control of monitoring a user operation in the operation unit **12**, transmitting a signal transmission command to the NR system simulator **20** after the call is established through call connection control, by being triggered with a predetermined measurement start operation related to the measurement of transmission and reception characteristics of the DUT **100** by the user, and transmitting the test signal from the NR system simulator **20** via the test antenna **5**, and a control of transmitting a signal reception command and receiving the signal under measurement via the test antenna **5**.

[0047] The DUT scanning control unit **16** drives and controls the drive motors **56***f* and **56***g* of the DUT scanning mechanism **56** to perform total spherical scanning of the DUT **100** mounted on the mounting tray **56***d* of the DUT mounting portion **56***c*.

[0048] Here, the total spherical scanning of the DUT **100** will be described with reference to FIGS. **5**A and **5**B to FIG. **7**. Generally, related to power measurement of a signal radiated by the DUT **100** (radiated power measurement), a method for measuring an Equivalent Isotropic Radiated Power (EIRP) and a method for measuring Total Radiated Power (TRP) are known. The EIRP is, for example, a power value measured at each measurement point (θ, φ) in a spherical coordinate system (r, θ, φ) shown in FIG. **5**A. On the other hand, the TRP is obtained by measuring the EIRP in all orientations of the spherical coordinate system (r, θ, φ), that is, at a plurality of angular sample points PS (refer to FIG. **5**B), which are regulated in advance, on a spherical surface equidistant from a center O**1** (hereinafter, a reference point) of the total spherical scanning of the DUT **100**, and obtaining a total sum thereof.

[0049] In addition, regarding the reception sensitivity measurement, it is known to measure Equivalent Isotropic Sensitivity (EIS). The EIS is, for example, a reception sensitivity value measured at each measurement point (θ, φ) in a spherical coordinate system (r, θ, φ) shown in FIG. **5**A.

[0050] The total spherical scanning of the DUT **100** means a control operation of sequentially changing the DUT **100** mounted on the mounting tray **56***d* in all orientations of a surface of a sphere B while using, for example, a center O**1** of the sphere B (refer to FIGS. **5**A and **5**B) as a reference (center), that is, sequentially changing a posture of the DUT **100** in a state in which the antenna **110** faces the angular sample point PS.

[0051] In order to measure the EIRP or EIS at each angular sample point PS in accordance with the total spherical scanning of the DUT **100**, as shown in FIG. **6**, the test antenna **5** for receiving a signal radiated by the DUT **100** is disposed at a position of a specific angular sample point PS (one point) in the spherical coordinate system (r, θ, φ), as shown in FIG. **6**.

[0052] In the total spherical scanning, the DUT **100** is driven (scanned) so that the antenna surface of the antenna **110** sequentially faces the light reception surface of the test antenna **5**. As a result, the test antenna **5** can transmit and receive a signal for the TRP measurement to and from the antenna **110** of the DUT **100** on which the total spherical scanning is performed. Here, the transmitted and received signal is a test signal that is transmitted from the NR system simulator **20** via the test antenna **5**, and a signal that is transmitted by the DUT **100**, which has received the test signal, using the antenna **110**, that is, a signal under measurement that is received via the test antenna **5**.

[0053] The total spherical scanning of the DUT **100** is realized by rotationally driving the azimuth axis and the roll axis by the drive motors **56***f* and **56***g* which constitutes the DUT scanning mechanism **56**. FIG. **7** shows a rotation drive image around the azimuth axis and the roll axis of the DUT scanning mechanism (biaxial positioner) **56** related to the total spherical scanning of the DUT **100** in the measurement device **1**. As shown in FIG. **7**, the DUT scanning mechanism **56** of the measurement device **1** according to the present embodiment moves the DUT **100** in an angular direction of o around the azimuth axis, for example, within a range of 180 degrees and moves the DUT **100** in an angular direction of θ around the roll axis, for example, within a range of 360 degrees, so that it is possible to perform the total spherical scanning (refer to FIGS. **5**A and **5**B and **6**) in which the DUT **100** is rotated in all orientations based on the center O**1** thereof.
[0054] In FIG. **7**, Po indicates a unit movement angle in a total movement angle (180 degrees) in the rotation direction (angular direction of φ) of the azimuth axis, and θ.sub.0 indicates the unit movement angle (hereinafter, step angle) in the total movement angle (360 degrees) in the rotation direction (angular direction of θ) of the roll axis. φ.sub.0 and θ.sub.0 are obtained by enabling, for example, the step angle having a desired value to be selectively set from a plurality of step angles having different values which are regulated in advance. The set φ.sub.0 and θ.sub.0 regulate an angle between the adjacent angular sample points PS shown in FIG. **5**B, and, as a result, regulates the angular sample point PS, that is, the number of measurement positions.
[0055] In order to realize control of the total spherical scanning of the DUT **100** by the DUT scanning control unit **16**, for example, a DUT scanning control table **16***a* is prepared in the ROM **11***b* in advance. The DUT scanning control table **16***a* stores, for example, coordinates of each angular sample point PS (refer to FIG. **5**B) in the spherical coordinate system (refer to FIG. **5**A) related to the total spherical scanning of the DUT **100**, drive data of the drive motors **56***f* and **56***g* associated with the coordinates of each angular sample point PS, and control data associated with a stop time (measurement time) at each angular sample point PS. In a case where the drive motors **56***f* and **56***g* are, for example, stepping motors, for example, the number of drive pulses is stored as the drive data.
[0056] The ROM **11***b* is further prepared with a rotation speed management table **16***b* for managing rotation speeds of the drive motor **56***f* and the drive motor **56***g* of the DUT scanning mechanism **56**. The rotation speed management table **16***b* manages the rotation speed of the drive motor **56***g* that rotationally drives the roll axis, and, more specifically, the rotation speed of the drive motor **56***g* in a case where the DUT scanning mechanism **56** is rotationally driven for each step angle.
[0057] Here, in a case where description is performed with reference to FIGS. **5**A and **5**B, the step angle indicates an angle between adjacent angular sample points PS (refer to FIG. **5**B) in the spherical coordinate system (refer to FIG. **5**A) related to the total spherical scanning. The angular sample point PS corresponds to the measurement position of the DUT **100**, and the number thereof can be appropriately set to be variable according to a measurement item, a measurement condition, and the like. That is, the unit step angle is obtained by regulating an angle between adjacent measurement positions and may be variable according to the measurement item, the measurement condition, and the like. For the DUT scanning mechanism **56** according to the present embodiment, it is possible to selectively set, for example, a value of 1 degree (deg), 3 degrees, 5 degrees, 7.5 degrees, 10 degrees, 15 degrees, 30 degrees, and 90 degrees for the step angle θ (refer to FIG. **7**) of the roll axis by the drive motor **56***g*.
[0058] The present embodiment is not limited thereto, instead of the rotation speed management table **16***b* (first rotation speed management table), a second rotation speed management table may be provided which manages a rotation speed of the drive motor **56***f*, which can minimize the movement time of the DUT scanning mechanism **56** in each step section to correspond to each step angle (corresponding to o in FIG. **7**) of the azimuth axis, for example, 5 degrees, 10 degrees, 15 degrees, or 30 degrees.
[0059] Further, instead of the first rotation speed management table and the second rotation speed

management table, a third rotation speed management table may be provided which manages the rotation speed of the drive motor **56***g* and the drive motor **56***f*, which can minimize the movement time of the DUT scanning mechanism **56** in each step section to correspond to each step angle θ of the roll axis and each step angle φ of the azimuth axis.

[0060] The DUT scanning control unit **16** expands the DUT scanning control table **16***a* into the work area of the RAM **11***c*, and drives and controls the drive motors **56***f* and **56***g* of the DUT scanning mechanism **56** based on the control data stored in the DUT scanning control table **16***a*. As a result, the total spherical scanning of the DUT **100** mounted on the DUT mounting portion **56***c* is performed. In the total spherical scanning, the antenna surface of the antenna **110** of the DUT **100** is stopped for a regulated time (the stop time) toward the angular sample point PS for each angular sample point PS in the spherical coordinate system, and, thereafter, an operation of moving to a next angular sample point PS (scanning of the DUT **100**) is sequentially performed while targeting all the angular sample points PS.

[0061] Further, the DUT scanning control unit **16** performs rotation speed control on the drive motor **56***g* related to the movement of the DUT scanning mechanism **56** targeting each step angle θ of the roll axis using the rotation speed management table **16***b* under the control of the rotation speed management control unit **18***b*, which will be described later, in accordance with the total spherical scanning of the DUT scanning mechanism **56** using the DUT scanning control table **16***a*.

[0062] The signal analysis control unit **17** captures a radio signal, which is related to the NR and is received by the test antenna **5** in a case where the total spherical scanning of the DUT **100** is performed, via the NR system simulator **20**, and performs an analysis process (measurement process) on the radio signal as a signal of a specific measurement item.

[0063] The setting control unit **18***a* is a functional unit for setting various information necessary to execute the rotation speed control of the drive motor **56***f* using the rotation speed management table **16***b* by the DUT scanning control unit **16**. In a case where the specific measurement item is measured, the setting control unit **18***a* can selectively set a step angle of a desired value from among step angles (θ, φ) having a plurality of different values, for example, 5 degrees, 10 degrees, 15 degrees, and 30 degrees.

[0064] For example, the rotation speed management control unit **18***b* performs the rotation speed control of the drive motor **56***f* related to the movement of the DUT scanning mechanism **56** targeting each step angle θ of the roll axis in cooperation with the DUT scanning control unit **16** using the rotation speed management table **16***b* in accordance with the total spherical scanning of the DUT scanning mechanism **56** in a case where the TRP measurement is performed.

[0065] The Reference position measurement control unit **18***c* measures the output power of the DUT **100** at a Reference position, which is any preset measurement position, each time a certain period of time elapses in a case where the total spherical scanning of the DUT **100** is performed, and the Reference position measurement control unit **18***c* interrupts the measurement in a case where the output power is equal to or less than a preset regulated Power. In a case of interruption, the Reference position measurement control unit **18***c* excludes measurement data after the measurement at the previous Reference position from the measured value, and enables the measurement to be resumed from the excluded measurement position.

[0066] Therefore, the Reference position measurement control unit **18***c* includes a condition setting unit **18***d*, a Reference position measurement unit **18***e*, a power determination unit **18***f*, and an interrupt processing unit **18***g*.

[0067] The condition setting unit **18***d* sets the Reference position, a regulated time, which is the measurement time interval at the Reference position, a regulated Power, and the like.

[0068] The Reference position measurement unit **18***e* performs measurement at the Reference position each time the set regulated time elapses.

[0069] The Power determination unit **18***f* determines whether the output power of the DUT **100** measured by the Reference position measurement unit **18***e* is equal to or less than the regulated

Power.

[0070] In a case where the measurement is interrupted due to the determination results by the Power determination unit **18***f*, the interrupt processing unit **18***g* performs interrupt processing such as interrupting the measurement, excluding the measurement data after the measurement at the previous Reference position from the measured value, and correcting the resumption position to resume the measurement from the excluded measurement position.

[0071] The measurement status display control unit **18***h* displays the progress of the measurement, the status of the measurement, and the like on the display unit **13**.

[0072] As shown in FIG. **4**, the NR system simulator **20** includes a signal generation unit **21***a*, a signal measurement unit **21***b*, a transmission and reception unit **21***c*, a control unit **21***d*, an operation unit **21***e*, and a display unit **21***f*. The NR system simulator **20** constitutes a simulated measurement device of the present invention.

[0073] The signal generation unit **21***a* generates a signal (baseband signal) that becomes a source of the test signal. The transmission and reception unit **21***c* functions as an RF unit that generates the test signal corresponding to a frequency of each communication standard from the signal generated by the signal generation unit **21***a* and sends the generated test signal to the signal processing unit **23**, and restores the baseband signal from the signal under measurement which is sent from the signal processing unit **23**. The signal measurement unit **21***b* performs a measurement process of the signal under measurement based on the baseband signal restored by the transmission and reception unit **21***c*.

[0074] The control unit **21***d* comprehensively controls each of the functional units including the signal generation unit **21***a*, the signal measurement unit **21***b*, the transmission and reception unit **21***c*, the operation unit **21***e*, and the display unit **21***f*. The operation unit **21***e* is a functional unit for inputting various information such as commands, and the display unit **21***f* is a functional unit for displaying various information such as an input screen and measurement results of the various information.

[0075] In the measurement device **1** having the above-described configuration, the DUT **100** is mounted on the mounting tray **56***d* of the DUT scanning mechanism (biaxial positioner) **56** in the internal space **51** of the OTA chamber **50**. Therefore, it is possible to perform measurement of the specific measurement item, such as measurement of the EIRP at each measurement position and measurement of the TRP over all measurement positions, while moving (rotating) the DUT **100** by a preset step angle in the biaxial (azimuth axis and roll axis) direction for each mounting tray **56***d*.

[0076] A measurement control operation when performing measurement of Spherical coverage by the integrated control device **10**, which is performed in accordance with the total spherical scanning of the DUT **100** in the OTA chamber **50** of the measurement device **1**, will be described with reference to the flowchart shown in FIG. **8**.

[0077] In step S**1**, when the measurement start operation is performed by the operation on the operation unit **12**, the control unit **11** performs measurement at the set Reference position. After executing the process of step S**1**, the control unit **11** executes the process of step S**2**.

[0078] In step S**2**, the control unit **11** changes the Position to the next measurement position. After executing the process of step S**2**, the control unit **11** executes the process of step S**3**.

[0079] In step S**3**, the control unit **11** performs measurement at one measurement position. After executing the process of step S**3**, the control unit **11** executes the process of step S**4**.

[0080] In step S**4**, the control unit **11** determines whether a regulated time has elapsed since the measurement at the previous Reference position.

[0081] When it is determined that the regulated time has elapsed, the control unit **11** executes the process of step S**5**. When it is determined that the regulated time has not elapsed, the control unit **11** executes the process of step S**8**.

[0082] In step S**5**, the control unit **11** performs measurement at the set Reference position. After executing the process of step S**5**, the control unit **11** executes the process of step S**6**.

[0083] In step S**6**, the control unit **11** determines whether the output power of the DUT **100** measured at the Reference position is equal to or less than the regulated Power.
[0084] When it is determined that the output power of the DUT **100** is equal to or less than the regulated Power, the control unit **11** executes the process of step S**7**. When it is determined that the output power of the DUT **100** is not equal to or less than the regulated Power, the control unit **11** executes the process of step S**8**.
[0085] In step S**7**, the control unit **11** performs interrupt processing such as interrupting the measurement, excluding the measurement data and correcting the resumption position. After executing the process of step S**7**, the control unit **11** ends the measurement control operation.
[0086] In step S**8**, the control unit **11** determines whether there is a remaining Position that is an unmeasured measurement position.
[0087] When it is determined that there is a remaining Position, the control unit **11** executes the process of step S**2**. When it is determined that there is no remaining position, the control unit **11** ends the measurement control operation.
[0088] As described above, in the above-described embodiment, the output power of the DUT **100** at the Reference position is measured each time a regulated time elapses, and in a case where the measured output power of the DUT **100** is equal to or less than the regulated Power, the measurement is interrupted, the measurement data after the measurement at the previous Reference position is excluded from the measured value, and the measurement is resumable from the excluded measurement position.
[0089] As a result, the measurement is performed at the Reference position each time the regulated time elapses, and in a case where the output power of the DUT **100** is equal to or less than the regulated Power, the measurement is interrupted, the measurement data after the measurement at the previous Reference position is excluded from the measured value, and the measurement is resumable from the excluded measurement position. Therefore, it is possible to improve the accuracy of measurement results by excluding the measurement data in which the output power of the DUT **100** is considered equal to or less than the regulated Power.
[0090] In addition, since the measurement is interrupted, it is possible to charge the DUT **100** or to lower the temperature of the DUT **100** during the interruption, thereby improving the test efficiency.
[0091] Hitherto, the embodiments of the present invention have been disclosed, but it is clear that changes can be made by those skilled in the art without departing from the scope of the present invention. All such modifications and equivalents are intended to be included in the claims as follows.
DESCRIPTION OF REFERENCE NUMERALS AND SIGNS
[0092] **1**: Measurement device (mobile terminal testing device) [0093] **5**: Test antenna [0094] **10**: Integrated control device [0095] **16**: DUT scanning control unit [0096] **18***c*: Reference position measurement control unit [0097] **18***d*: Condition setting unit [0098] **18***e*: Reference position measurement unit [0099] **18***f*: Power determination unit [0100] **18***g*: Interrupt processing unit [0101] **20**: NR system simulator (simulated measurement device) [0102] **50**: OTA chamber (anechoic box) [0103] **51**: Internal space [0104] **56**: DUT scanning mechanism (positioner) [0105] **56***f*, **56***g*: Drive motor [0106] **100**: DUT (mobile terminal)

Claims

1. A mobile terminal testing device comprising: a positioner that is provided in an internal space of an anechoic box, has an azimuth axis and a roll axis that are each rotationally drivable by a drive motor, and rotates a mobile terminal that is a device under test so that the mobile terminal sequentially faces a plurality of preset angular sample points of a spherical coordinate system, using a center of the spherical coordinate system as a reference point; a simulated measurement device connected to a test antenna in the internal space; an integrated control device that controls the simulated measurement device so that a measurement operation of transmitting a test signal from the test antenna to the mobile terminal, receiving a signal under measurement transmitted from the mobile terminal that has received the test signal by using the test antenna, and measuring a specific measurement item related to the mobile terminal based on the received signal under measurement is performed at a measurement position corresponding to each of the plurality of angular sample points; and a Reference position measurement control unit that measures output power of the mobile terminal at a preset Reference position each time a preset regulated time elapses, and that, in a case where the measured output power is equal to or less than a preset regulated Power, interrupts the measurement, excludes measurement data after the measurement at a previous Reference position from a measured value, and enables the measurement to be resumed from the excluded measurement position.

2. A mobile terminal testing method of a mobile terminal testing device including a positioner that is provided in an internal space of an anechoic box, has an azimuth axis and a roll axis that are each rotationally drivable by a drive motor, and rotates a mobile terminal that is a device under test so that the mobile terminal sequentially faces a plurality of preset angular sample points of a spherical coordinate system, using a center of the spherical coordinate system as a reference point, a simulated measurement device connected to a test antenna in the internal space, and an integrated control device that controls the simulated measurement device so that a measurement operation of transmitting a test signal from the test antenna to the mobile terminal, receiving a signal under measurement transmitted from the mobile terminal that has received the test signal by using the test antenna, and measuring a specific measurement item related to the mobile terminal based on the received signal under measurement is performed at a measurement position corresponding to each of the plurality of angular sample points, the mobile terminal testing method comprising: a step of measuring output power of the mobile terminal at a preset Reference position each time a preset regulated time elapses; and a step of interrupting the measurement, excluding measurement data after the measurement at a previous Reference position from a measured value, and enabling the measurement to be resumed from the excluded measurement position, in a case where the measured output power is equal to or less than a preset regulated Power.