United States Patent Application Publication	20250260497
Kind Code	A1
Publication Date	August 14, 2025
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MOBILE TERMINAL TESTING DEVICE AND MOBILE TERMINAL TESTING METHOD

Abstract

Provided is a mobile terminal testing device that can reduce time required for measurement. An Early Fail control unit includes a Fail condition setting unit that sets a condition for determining whether a measurement result is Fail, a Fail point management unit that manages information on a Fail point, which is a measurement position at which the measured level is below a regulated level and is determined to be Fail, and an Early Fail determination unit that determines whether a result is Fail even if the measurement is continued, based on information on the Fail points managed by the Fail point management unit. When measurement of Spherical coverage of 5G NR is performed, the Early Fail control unit determines whether the result is Early Fail in which the result is Fail even if the measurement is continued, and stops the measurement when the result is determined to be Early Fail.

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Family ID: **96660223**

Appl. No.: **19/044861**

Filed: **February 04, 2025**

Foreign Application Priority Data

JP	2024-017861	Feb. 08, 2024

Publication Classification

Int. Cl.: **H04B17/15** (20150101); **G01R29/10** (20060101); **H04B17/29** (20150101)

U.S. Cl.:

CPC H04B17/191 (20230501); G01R29/105 (20130101); H04B17/297 (20230501);

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] The Spherical coverage of Tx or Rx defined in the NR standard of 3GPP (Third Generation Partnership Project) creates a Cumulative Distribution Function (CDF) graph or a Complementary Cumulative Distribution Function (CCDF) graph from the result measured at each position as a measurement result.

[0008] It is confirmed whether the position of the X %-tile of the created graph is equal to or higher than a regulated level, and it is determined whether the measurement result is Pass or Fail.

[0009] However, since the full spherical measurement itself takes time, it is confirmed that the measurement result is Fail after the measurement is completed, and the time loss becomes large when re-measurement is required. When it becomes clear that a Fail determination will occur during the process, there is a demand to stop the measurement at that point and start the re-measurement to save time.

[0010] Therefore, an object of the present invention is to provide a mobile terminal testing device that can reduce the time required for measurement by stopping the measurement when the measurement result is determined to be Fail even if the measurement is continued as it is.

Means for Solving the Problem

[0011] According to the present invention, there is provided 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; 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 control unit that stops measurement of Spherical coverage of 5G NR when the number of measurement points at which a measurement result is Fail during the measurement becomes equal to or greater than a preset number.

[0012] With this configuration, the measurement is stopped when the number of measurement points at which a measurement result is Fail during the measurement of the Spherical coverage of the 5G NR becomes equal to or greater than a preset number. Therefore, it is possible to reduce the time required for measurement.

[0013] In the mobile terminal testing device according to the present invention, the control unit automatically executes re-measurement after the measurement is stopped.

[0014] With this configuration, after the measurement is stopped, the re-measurement is automatically executed. Therefore, it is possible to further reduce the time required for measurement.

[0015] 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, 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 accumulating the number of measurement points at which a measurement result is Fail during measurement of Spherical coverage of 5G NR; and a step of stopping the measurement when the number of the measurement points at which the measurement result is Fail becomes equal to or greater than a preset number.

[0016] In addition, the mobile terminal testing method according to the present invention further includes a step of automatically executing re-measurement after the measurement is stopped.

[0017] With this configuration, the measurement is stopped when the number of measurement points at which a measurement result is Fail during the measurement of the Spherical coverage of the 5G NR becomes equal to or greater than a preset number. Therefore, it is possible to reduce the time required for measurement.

Advantage of the Invention

[0018] The present invention can provide a mobile terminal testing device that can reduce the time required for measurement.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. **1** is a diagram showing a schematic configuration of an entire measurement device according to an embodiment of the present invention.

[0020] FIG. **2** is a block diagram showing a functional configuration of the measurement device according to the embodiment of the present invention.

[0021] 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.

[0022] 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.

[0023] FIGS. **5**A and **5**B are diagrams showing total spherical scanning images of a device under test (DUT) 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 (DUT) 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.

[0024] 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.

[0025] 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.

[0026] 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

[0027] 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.

[0028] 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.

[0029] 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**.

[0030] 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**.

[0031] 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**.

[0032] 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.

[0033] 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.

[0034] 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.

[0035] 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.

[0036] 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*.

[0037] 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).

[0038] 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**).

[0039] 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.

[0040] 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**.

[0041] In a case where the 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.

[0042] 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**.

[0043] Subsequently, configurations of the integrated control device **10** and the NR system simulator **20** will be described.

[0044] 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**.

[0045] 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**.

[0046] 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.

[0047] 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 for various information and measurement results.

[0048] 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**, an Early Fail control unit **18**, a UE control unit **18***d*, a reconnection control unit **18***e*, a measurement recovery control unit **18***f*, and a measurement status display control unit **18***g*.

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 Early Fail control unit **18**, the UE control unit **18***d*, the reconnection control unit **18***e*, the measurement recovery control unit **18***f*, and the measurement status display control unit **18***g* 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*.

[0049] 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**.

[0050] 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**.

[0051] 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*.

[0052] 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.

[0053] 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.

[0054] 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.

[0055] 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**.

[0056] 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**.

[0057] The total spherical scanning of the DUT **100** is realized by rotationally driving the azimuth axis and the roll axis the drive by 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 φ 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.
[0058] In FIG. **7**, φ.sub.0 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.
[0059] 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.
[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] 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.
[0062] For example, when the measurement of Spherical coverage of Tx or Rx is performed, the Early Fail control unit **18** determines whether the result is Early Fail in which the result is Fail even if the measurement is continued, and stops the measurement when the result is determined to be Early Fail.
[0063] Therefore, the Early Fail control unit **18** includes a Fail condition setting unit **18***a*, a Fail point management unit **18***b*, and an Early Fail determination unit **18***c*.
[0064] The Fail condition setting unit **18***a* sets a value of X %-tile of X and a regulated level, which are the conditions for determining whether the measurement result is Fail.
[0065] The Fail point management unit **18***b* manages information on a Fail point, which is a measurement position at which the measured level does not reach the regulated level and is

determined to be Fail.

[0066] The Early Fail determination unit **18***c* determines whether the result is Fail even if the measurement is continued, based on the information on the Fail point managed by the Fail point management unit **18***b*.

[0067] The Early Fail control unit **18** automatically executes re-measurement after determining that the measurement result is Early Fail and stopping the measurement. When performing the re-measurement, there is a concern that the DUT **100** malfunctions, so that the measurement result will be Fail even if the re-measurement is performed as it is. Therefore, the re-measurement is executed after taking one or more treatments such as restarting the DUT **100**, turning airplane mode on and then off, and re-call connecting.

[0068] In this way, the DUT **100** can be returned from an unintended mal function state. The determination of whether the measurement result is Early Fail and the re-measurement can be executed a plurality of times.

[0069] The UE control unit **18***d* controls the DUT **100** as a User Equipment (UE) to execute a restart of the DUT **100**, turning airplane mode on or off, re-call connecting, and the like.

[0070] The reconnection control unit **18***e* controls the re-call connection with the DUT **100** during the re-measurement after the measurement result is determined to be Early Fail, which leads to the stopping of the measurement.

[0071] The measurement recovery control unit **18***f* moves the antenna surface of the antenna **110** of the DUT **100** to face the first angular sample point PS or initializes the measurement data as preparation for the re-measurement after the measurement result is determined to be Early Fail, which leads to the stopping of the measurement.

[0072] The measurement status display control unit **18***g* displays the progress of the measurement, the status of the measurement, and the like on the display unit **13**.

[0073] 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.

[0074] 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*.

[0075] 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 for various information and measurement results.

[0076] 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, EIS 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*.

[0077] The measurement control operation when performing measurement of Spherical coverage of Tx or Rx 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**.

[0078] In step S**1**, when the measurement start operation is performed by the operation on the operation unit **12**, the control unit **11** sets the measurement parameters or the like set by the operation on the operation unit **12**. After executing the process of step S**1**, the control unit **11** executes the process of step S**2**.

[0079] In step S**2**, the control unit **11** starts the measurement. After executing the process of step S**2**, the control unit **11** executes the process of step S**3**.

[0080] In step S**3**, the control unit **11** changes the position of the DUT **100** to a regulated position. After executing the process of step S**3**, the control unit **11** executes the process of step S**4**.

[0081] In step S**4**, the control unit **11** performs the measurement at the set position. After executing the process of step S**4**, the control unit **11** executes the process of step S**5**.

[0082] In step S**5**, the control unit **11** determines whether the measurement result is Fail.

[0083] When determining that the measurement result is Fail, the control unit **11** executes the process of step S**6**. When determining that the measurement result is not Fail, the control unit **11** executes the process of step S**8**.

[0084] In step S**6**, the control unit **11** adds 1 to the Fail point and records the Fail point. After executing the process of step S**6**, the control unit **11** executes the process of step S**7**.

[0085] In step S**7**, the control unit **11** determines whether the number of Fail points is less than the number of X %-tiles. Here, the number of X %-tiles refers to the number of measurement points that correspond to X % of the total measurement points.

[0086] When determining that the number of Fail points is less than the number of X %-tiles, the control unit **11** executes the process of step S**8**. When determining that the number of Fail points is not less than the number of X %-tiles, the control unit **11** executes the process of step S**9**.

[0087] In step S**8**, the control unit **11** determines whether there are any unmeasured remaining positions.

[0088] When determining that there are unmeasured remaining positions, the control unit **11** executes the process of step S**3**. When determining that there are no unmeasured remaining positions, the control unit **11** ends the measurement control operation.

[0089] In step S**9**, the control unit **11** determines that the measurement result is Early Fail. After executing the process of step S**9**, the control unit **11** executes the process of step S**10**.

[0090] In step S**10**, the control unit **11** determines whether to execute a re-examination based on the number of re-examinations that has already been executed.

[0091] When determining that the re-examination is to be executed, the control unit **11** executes the process of step S**11**. When determining that the re-examination is not to be executed, the control unit **11** ends the measurement control operation.

[0092] In step S**11**, the control unit **11** executes a recovery process for starting the re-examination. After executing the process of step S**11**, the control unit **11** executes the process of step S**2**.

[0093] As described above, in the above-described embodiment, the control unit **11** stops the measurement when the number of measurement points at which a measurement result is Fail during measurement of spherical coverage is equal to or greater than the number that corresponds to X % of the total measurement points.

[0094] As a result, the measurement is stopped at a point in time when the result is determined to be Fail even if the measurement is continued. Therefore, it is possible to reduce the time required for measurement.

[0095] In addition, when the measurement result is Early Fail, the control unit **11** automatically performs from a recovery process for the DUT **100** to re-measurement.

[0096] As a result, when the measurement result is Early Fail, the re-measurement is automatically executed, and the time required for measurement can be further reduced.

[0097] 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

[0098] **1**: Measurement device (mobile terminal testing device) [0099] **5**: Test antenna [0100] **10**: Integrated control device [0101] **16**: DUT scanning control unit [0102] **18**: Early Fail control unit [0103] **18***a:* Fail condition setting unit [0104] **18***b:* Fail point management unit [0105] **18***c:* Early Fail determination unit [0106] **18***d:* UE control unit [0107] **18***e:* Reconnection control unit [0108] **18***f:* Measurement recovery control unit [0109] **18***g:* Measurement status display control unit [0110] **20**: NR system simulator (simulated measurement device) [0111] **50**: OTA chamber (anechoic box) [0112] **51**: Internal space [0113] **56**: DUT scanning mechanism (positioner) [0114] **56***f*, **56***g:* Drive motor [0115] **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 control unit that stops measurement of Spherical coverage of 5G NR when the number of measurement points at which a measurement result is Fail during the measurement becomes equal to or greater than a preset number.

2. The mobile terminal testing device according to claim 1, wherein the control unit automatically executes re-measurement after the measurement is stopped.

3. 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, 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 accumulating the number of measurement points at which a measurement result is Fail during measurement of Spherical coverage of 5G NR; and a step of stopping the measurement when the number of the measurement points at which the measurement result is Fail becomes equal to or greater than a preset number.

4. The mobile terminal testing method according to claim 3, further comprising: a step of automatically executing re-measurement after the measurement is stopped.