UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 8,670,722 B2
APPLICATION NO. : 13/321076
DATED : March 11, 2014
INVENTOR(S) : Miao et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Specification

In Column 4, Line 26, delete "deter mined" and insert -- determined --, therefor.

In Column 9, Line 39, delete "port 300." and insert -- bank 300. --, therefor.

In Column 15, Line 67, delete "terns" and insert -- term --, therefor.

Signed and Sealed this
Twenty-sixth Day of August, 2014

Michelle K. Lee

Michelle K. Lee
Deputy Director of the United States Patent and Trademark Office

PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 8,670,722 B2

APPLICATION NO. : 13/321,076

ISSUE DATE : March 11, 2014

INVENTOR(S) : Miao, et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In Column 4, Line 26, delete “deter mined” and insert - - determined - -, therefor.

In Column 9, Line 39, delete “port 300.” and insert - - bank 300. - -, therefor.

In Column 15, Line 67, delete “terns” and insert - - term - -, therefor.

MAILING ADDRESS OF SENDER (Please do not use customer number below):

6300 Legacy, MS EVR 1-C-11
Plano, TX 75024
972-583-8656

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF: U.S. Patent No. 8,670,722

USPTO CONFIRMATION CODE: 2274

APPLICATION NO.: 13/321,076

PCT FILED: May 20, 2009

U.S. FILED: November 17, 2011

EXAMINER: Lewis West

GROUP ART UNIT: 2648

FOR: AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS

37 CFR 1.322 & 37 CFR 1.323 REQUEST FOR CERTIFICATE OF CORRECTION FOR USPTO AND/OR APPLICANT MISTAKE

HONORABLE COMMISSIONER OF PATENTS & TRADEMARKS

SIR:

The following is a request for a certificate of correction in Serial Number 13/321,076, now Patent Number 8,670,722.

A certificate of correction under 35 USC 254 is respectfully requested in the above-identified patent.

All errors were the fault of the USPTO, no fee required. In the event that a further fee is required, please charge the amount to our Deposit Account No. 50-1379.

The exact locations where the errors appear in the patent and patent application are as follows:

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 4 of 365

In Column 4, Line 26, delete “deter mined” and insert - - determined - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED NOVEMBER 17, 2011,
PAGE 5, LINE 9)

In Column 9, Line 39, delete “port 300.” and insert - - bank 300. - -, therefor.
(AMENDMENTS TO THE SPECIFICATION DATED NOVEMBER 25, 2013,
PAGE 3 OF 14, LINE 18)

In Column 15, Line 67, delete “terns” and insert - - term - -, therefor.
(ORIGINALLY FILED SPECIFICATION DATED NOVEMBER 17, 2011,
PAGE 19, LINE 4)

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 5 of 365

The requested corrections are attached on Form PTO 1050.

Respectfully Submitted

, 2014	/Ronald J. Ward,Reg#54870/
DATE	Ronald J. Ward Registration No. 54,870 Attorney of Record

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 6 of 365

Electronic Acknowledgement Receipt

EFS ID:	19492717
Application Number:	13321076
International Application Number:	
Confirmation Number:	2274
Title of Invention:	AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS
First Named Inventor/Applicant Name:	Qingyu Miao
Customer Number:	24112
Filer:	Steven Ware Smith/Diane Taylor
Filer Authorized By:	Steven Ware Smith
Attorney Docket Number:	4015-7892 / P28266-US1
Receipt Date:	03-JUL-2014
Filing Date:	17-NOV-2011
Time Stamp:	15:06:08
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Request for Certificate of Correction	P28266-US1_2014-07-03_CoC_PTO-1050.pdf	114542 7db2017d8c1d3a6a6821f6a81366707e3e396b58	no	2

Warnings:	
Information:	

2	Transmittal Letter	P28266-US1_2014-07-03_CoC_Request_Letter.pdf	274074 91c33980f9c7fe8b0815ae68486c27083660d3bf	no	3

Warnings:	
Information:	
Total Files Size (in bytes):	388616

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/321,076	03/11/2014	8670722	4015-7892 / P28266-US1	2274

24112 7590 02/19/2014

COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 133 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Qingyu Miao, Beijing, CHINA;
Mikael Coldrey, Landvetter, SWEDEN;
Zhiheng Guo, Beijing, CHINA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24112 7590 12/12/2013
COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/321,076	11/17/2011	Qingyu Miao	4015-7892 / P28266-US1	2274

TITLE OF INVENTION: AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	~~$1780~~ $960	~~$300~~ $0	$0	~~$2080~~ $960	03/12/2014

EXAMINER	ART UNIT	CLASS-SUBCLASS
WEST, LEWIS G	2648	455-067110

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Coats and Bennett
2 PLLC
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Telefonaktiebolaget L M Ericsson (publ) Stockholm, Sweden

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:
- ☒ Issue Fee
- ☐ Publication Fee (No small entity discount permitted)
- ☐ Advance Order - # of Copies .....

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ☐ A check is enclosed.
- ☐ Payment by credit card. Form PTO-2038 is attached.
- ☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 181167 (enclose an extra copy of this form).

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 10 of 365

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

NOTE: Absent a valid certification of Micro Entity Status (see form PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /John R. Owen Reg. No. 42055/ Date 22 January 2014

Typed or printed name John R. Owen Registration No. 42055

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 11 of 365

Electronic Patent Application Fee Transmittal

Application Number:	13321076
Filing Date:	17-Nov-2011
Title of Invention:	AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS
First Named Inventor/Applicant Name:	Qingyu Miao
Filer:	John R. Owen/Cora Fedornock
Attorney Docket Number:	4015-7892 / P28266-US1

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl Issue Fee	1501	1	960	960
Publ. Fee- Early, Voluntary, or Normal	1504	1	0	0

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 12 of 365

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**960**

Electronic Acknowledgement Receipt

EFS ID:	17982776
Application Number:	13321076
International Application Number:	
Confirmation Number:	2274
Title of Invention:	AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS
First Named Inventor/Applicant Name:	Qingyu Miao
Customer Number:	24112
Filer:	John R. Owen/Cora Fedornock
Filer Authorized By:	John R. Owen
Attorney Docket Number:	4015-7892 / P28266-US1
Receipt Date:	22-JAN-2014
Filing Date:	17-NOV-2011
Time Stamp:	12:36:29
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Electronic Funds Transfer
Payment was successfully received in RAM	$960
RAM confirmation Number	8533
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (If appl.)

Proconfirm Exhibit 2015
Ericsson v. Proconfirm
IPR2025-01453, Page 14 of 365

1	Issue Fee Payment (PTO-85B)	40157892ISSUEFEETRANSMITTAL.pdf	99822 36cc60f2e9cc8d3820697817017b02f021c54182	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32634 987d038abddd29c7fa010e9b8b6d9f4a0c330b6c	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	132456	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

24112 7590 12/12/2013

COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

EXAMINER
WEST, LEWIS G

ART UNIT	PAPER NUMBER
2648	

DATE MAILED: 12/12/2013

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/321,076	11/17/2011	Qingyu Miao	4015-7892 / P28266-US1	2274

TITLE OF INVENTION: AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	03/12/2014

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24112 7590 12/12/2013
COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/321,076	11/17/2011	Qingyu Miao	4015-7892 / P28266-US1	2274

TITLE OF INVENTION: AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1780	$300	$0	$2080	03/12/2014

EXAMINER	ART UNIT	CLASS-SUBCLASS
WEST, LEWIS G	2648	455-067110

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
- ❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.
1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:
- ❑ Issue Fee
- ❑ Publication Fee (No small entity discount permitted)
- ❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
- ❑ A check is enclosed.
- ❑ Payment by credit card. Form PTO-2038 is attached.
- ❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 17 of 365

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29	NOTE: Absent a valid certification of Micro Entity Status (see form PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
❑ Applicant asserting small entity status. See 37 CFR 1.27	NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
❑ Applicant changing to regular undiscounted fee status.	NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 18 of 365

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/321,076	11/17/2011	Qingyu Miao	4015-7892 / P28266-US1	2274

24112 7590 12/12/2013

COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

EXAMINER	
WEST, LEWIS G	

ART UNIT	PAPER NUMBER
2648	

DATE MAILED: 12/12/2013

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 133 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 133 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notices of Allowance and Fee(s) Due mailed between October 1, 2013 and December 31, 2013

(Addendum to PTOL-85)

If the "Notice of Allowance and Fee(s) Due" has a mailing date on or after October 1, 2013 and before January 1, 2014, the following information is applicable to this application.

If the issue fee is being timely paid on or after January 1, 2014, the amount due is the issue fee and publication fee in effect January 1, 2014. On January 1, 2014, the issue fees set forth in 37 CFR 1.18 decrease significantly and the publication fee set forth in 37 CFR 1.18(d)(1) decreases to $0.

If an issue fee or publication fee has been previously paid in this application, applicant is not entitled to a refund of the difference between the amount paid and the amount in effect on January 1, 2014.

Notice of Allowability	Application No. 13/321,076	Applicant(s) MIAO ET AL.	
	Examiner LEWIS WEST	Art Unit 2648	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed 11/25/2013*.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on_____.
2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.
3. ☒ The allowed claim(s) is/are *21-42*. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov .
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some *c) ☐ None of the:
   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
5. ☐ Examiner's Amendment/Comment
6. ☐ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/LEWIS WEST/
Primary Examiner, Art Unit 2648

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 22 of 365

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 2274

SERIAL NUMBER	FILING or 371(c) DATE / RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/321,076	11/17/2011	455	2648	4015-7892 / P28266-US1

APPLICANTS

INVENTORS

Qingyu Miao, Beijing, CHINA;
Mikael Coldrey, Landvetter, SWEDEN;
Zhiheng Guo, Beijing, CHINA;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/SE2009/050583 05/20/2009

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

12/03/2011

Foreign Priority claimed	35 USC 119(a-d) conditions met	Verified and Acknowledged	Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ Yes ☑ No	☐ Yes ☑ No	/LEWIS G WEST/ Examiner's Signature	☐ Initials	CHINA	12	20	2

ADDRESS

COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518
UNITED STATES

TITLE

Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths

FILING FEE RECEIVED		
1280	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 23 of 365

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	Art Unit
	LEWIS WEST	2648

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	63.1, 67.11, 562.1, 575.7	05/28/2013	LW

SEARCH NOTES		
Search Notes	Date	Examiner
PALM inventor search	05/28/2013	LW
Updated search	08/26/2013	LW
Updated search	12/6/2013	LW

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner
455	67.11, 63.1	12/6/2013	LW

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	**Art Unit**
	LEWIS WEST	2648

CPC		
Symbol	**Type**	**Version**

CPC Combination Sets				
Symbol	**Type**	**Set**	**Ranking**	**Version**

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	22	
/LEWIS WEST/ Primary Examiner.Art Unit 2648	12/06/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	3B

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	**Art Unit**
	LEWIS WEST	2648

US ORIGINAL CLASSIFICATION		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
455	67.11	H 0 4 B 17 / 00 (2006.0)	

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
455	63.1				

NONE	Total Claims Allowed:	
(Assistant Examiner) (Date)	22	
/LEWIS WEST/ Primary Examiner.Art Unit 2648 12/06/2013	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner) (Date)	1	3B

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	**Art Unit**
	LEWIS WEST	2648

☒ **Claims renumbered in the same order as presented by applicant** ☐ **CPA** ☐ **T.D.** ☐ **R.1.47**

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	21	18	37												
2	22	19	38												
3	23	20	39												
4	24	21	40												
5	25	11	41												
6	26	22	42												
7	27														
8	28														
9	29														
10	30														
12	31														
13	32														
14	33														
15	34														
16	35														
17	36														

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 22	
/LEWIS WEST/ Primary Examiner.Art Unit 2648 (Primary Examiner)	12/06/2013 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 3B

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

REQUEST FOR CONTINUED EXAMINATION(RCE)TRANSMITTAL
(Submitted Only via EFS-Web)

Application Number	13321076	Filing Date	2011-11-17	Docket Number (if applicable)	4015-7892 / P28266-US1	Art Unit	2648
First Named Inventor	Miao			Examiner Name	West		

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. The Instruction Sheet for this form is located at WWW.USPTO.GOV

SUBMISSION REQUIRED UNDER 37 CFR 1.114

Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

- ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ☐ Other _____

☒ Enclosed

- ☒ Amendment/Reply
- ☐ Information Disclosure Statement (IDS)
- ☐ Affidavit(s)/ Declaration(s)
- ☒ Other Replacement Drawings

MISCELLANEOUS

☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of months _____ (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

☐ Other _____

FEES

☒ **The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.**
The Director is hereby authorized to charge any underpayment of fees, or credit any overpayments, to Deposit Account No 181167

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

☒ Patent Practitioner Signature

☐ Applicant Signature

PTO/SB/30EFS (07-09)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Signature of Registered U.S. Patent Practitioner			
Signature	/William G. Pagan Reg. No. 67192/	Date (YYYY-MM-DD)	2013-11-25
Name	William G. Pagan	Registration Number	67192

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of **Miao et al.**	)	
	)	
Serial No.: **13/321,076**	)	
	)	Examiner: Lewis G. West
Filed: **November 17, 2011**	)	
	)	Group Art Unit: 2648
For: **Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths**	)	Confirmation No.: 2274
	)	
Docket No: **4015-7892/P28266-US1**	)	

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT ACCOMPANYING REQUEST FOR CONTINUED EXAMINATION

This paper is being filed in response to the Final Office Action mailed 29 August 2013.

Reconsideration is respectfully requested in light of the amendments and/or remarks below.

The Office is hereby authorized to charge any fees required for entry of this paper to Deposit Account 18-1167.

AMENDMENTS TO THE SPECIFICATION

Please amend the 2 paragraphs beginning on page 3 line 19 as follows:

Fig. 4 depicts a diagram of exemplary components of an antenna [[port]] bank illustrated in Figs. 3A and 3B;

Fig. 5 illustrates a diagram of exemplary interactions among exemplary components of a portion of the antenna [[port]] bank depicted in Fig. 4;

Please amend the 2 paragraphs beginning on page 8 line 20 as follows:

Figs. 3A and 3B depict diagrams of further exemplary components of base station 120. As shown in Fig. 3A, base station 120 may include an antenna [[port]] bank 300 that includes eight ports 310-1 through 310-8 (referred to collectively as "ports 310" and in some instances, individually as "port 310") connected to corresponding antennas 210-1 through 210-8, and a calibration port 310-CAL. Antennas 210 may include the features described above in connection with, for example, Fig. 2.

Antenna [[port]] bank 300 may include a device that enables antennas 210 to connect to transceivers 220 (Fig. 2) of base station 120, via cables. In one embodiment, antenna [[port]] bank 300 may include an antenna [[port]] bank for a dual-polarized eight antenna system, as shown in Fig. 3A. In another embodiment, antenna [[port]] bank 300 may include an antenna [[port]] bank for a normal eight antenna system.

Please amend the paragraph beginning on page 9 line 11 as follows:

As shown in Fig. 3B, antenna [[port]] bank 300 may connect antennas 210 (omitted from Fig. 3B for clarity) to corresponding transceivers 220, via ports 310 and RF cables 320. Transceivers 220 may communicate with processing system/RRU 230. Transceivers 220 and processing system/RRU 230 may include the features described above in connection with, for

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 32 of 365

example, Fig. 2. Antenna [[port]] bank 300 and ports 310 may include the features described above in connection with, for example, Fig. 3A.

Please amend the paragraph beginning on page 10 line 6 as follows:

Fig. 4 depicts a diagram of exemplary components of antenna [[port]] bank 300. As shown, antenna [[port]] bank 300 may include antennas 210, ports 310, calibration port 310-CAL, loads 400, directional couplers 410, and power splitters 420. Antennas 210 may include the features described above in connection with, for example, Fig. 2. Ports 310 and calibration port 310-CAL may include the features described above in connection with, for example, Figs. 3A and 3B. Fig. 4 shows multiple loads 400, directional couplers 410, and power splitters 420, although only a few of them are labeled (for clarity).

Please amend the 2 paragraphs beginning on page 10 line 27 as follows:

Although Fig. 4 shows exemplary components of antenna [[port]] bank 300, in other embodiments, antenna [[port]] bank 300 may contain fewer, different, differently arranged, or additional components than depicted in Fig. 4. In still other embodiments, one or more components of antenna [[port]] bank 300 may perform one or more other tasks described as being performed by one or more other components of antenna [[port]] bank 300.

Fig. 5 illustrates a diagram of exemplary interactions among exemplary components of a portion 500 of antenna [[port]] bank 300. As shown, portion 500 of antenna [[port]] bank 300 may include antennas 210-1 and 210-2, ports 310-1 and 310-2, loads 400, and directional couplers 410. Antennas 210-1 and 210-2 may include the features described above in connection with, for example, Fig. 2. Ports 310-1 and 310-2 may include the features described above in connection with, for example, Figs. 3A and 4B. Loads 400 and directional couplers 410 may include the features described above in connection with, for example, Fig. 4.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 33 of 365

Please amend the paragraph beginning on page 11 line 22 as follows:

Although Fig. 5 shows exemplary interactions among components of antenna [[port]] bank 300, in other embodiments, components of antenna [[port]] bank 300 may perform fewer, different, or additional interactions than depicted in Fig. 5.

Please amend the paragraph beginning on page 18 line 7 as follows:

Embodiments described herein provide illustration and description, but are not intended to be exhaustive or to limit the implementations to the precise form disclosed. Modifications and variations are possible in light of the above teachings, or may be acquired from practice of the implementations. For example, while series of blocks have been described with regard to Figs. 9-11, the order of the blocks may be modified in other embodiments. Further, non-dependent blocks may be performed in parallel. In another example, although the systems and/or methods described herein have been implemented in base station 120, in other embodiments, the systems and/or methods may be implemented in any device that uses antenna [[port]] bank 300.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 34 of 365

AMENDMENTS TO THE CLAIMS

1.-20. (Canceled).

21. (Currently amended) A method in a radio network that includes a device, the method comprising:

measuring, via the device, a parameter associated with at least two ~~simultaneously active~~ antenna ports of the device, each antenna port being simultaneously connected to a respective transceiver via a respective cable;

comparing, via the device, the measured parameter with an expected parameter associated with the at least two ~~simultaneously active~~ antenna ports to determine an error;

comparing, via the device, the determined error to a threshold; and

determining, via the device:

an erroneous antenna port connection for the at least two ~~simultaneously active~~ antenna ports when the error exceeds the threshold; and

a correct antenna port connection for the at least two antenna ~~simultaneously active~~ ports when the error is less than or equal to the threshold.

22. (Currently amended) The method of claim 21, wherein the measuring, via the device, the parameter comprises:

determining a parameter associated with at least two antenna elements of the device, where the at least two ~~simultaneously active~~ antenna elements are associated with the at least two antenna ports; and

measuring, based on the determined parameter associated with the at least two antenna elements, the measured parameter.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 35 of 365

23. (Previously presented) The method of claim 22, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase.

24. (Currently amended) The method of claim 21, where the measured parameter associated with the at least two ~~simultaneously active~~ antenna ports comprises one or more of an amplitude or a phase.

25. (Currently amended) The method of claim 21, where the measured parameter associated with the at least two ~~simultaneously active~~ antenna ports comprises a difference between a signal transmitted via one of the at least two ~~simultaneously active~~ antenna ports and a signal received via another one of the at least two ~~simultaneously active~~ antenna ports.

26. (Previously presented) The method of claim 21, wherein the comparing, via the device, the measured parameter ($S_{MEASURED}$) with the expected parameter ($S_{EXPECTED}$) comprises determining a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = || S_{MEASURED} - S_{EXPECTED} ||^2.$$

27. (Previously presented) The method of claim 26, wherein the comparing, via the device, the determined error (ε) to the threshold ($\delta_{THRESHOLD}$) comprises comparing the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 36 of 365

28. (Previously presented) The method of claim 21, further comprising:

receiving antenna port permutations for a plurality of antenna ports of the device;

receiving expected information associated with the plurality of antenna ports;

calculating expected values for different antenna port permutations based on the received information;

acquiring measured values associated with the different antenna port permutations;

comparing the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations; and

determining an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

29. (Previously presented) The method of claim 21, where the device comprises a base station.

30. (Previously presented) The method of claim 21, where the device comprises a remote radio unit associated with a base station.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 37 of 365

31. (Currently amended) A device in a radio network, the device comprising:

a plurality of antenna ports;

a plurality of transceivers;

a memory configured to store a plurality of instructions; and

a processing unit to execute instructions in the memory to:

measure a parameter associated with at least two ~~simultaneously active~~ antenna ports of the plurality of antenna ports, each of the at least two antenna ports being simultaneously connected to a respective transceiver via a respective cable;

compare the measured parameter with an expected parameter associated with the at least two ~~simultaneously active~~ antenna ports to determine an error;

compare the determined error to a threshold; and

determine:

an erroneous antenna port connection for the at least two ~~simultaneously active~~ antenna ports when the error exceeds the threshold; and

a correct antenna port connection for the at least two ~~simultaneously active~~ antenna ports when the error is less than or equal to the threshold.

32. (Currently amended) The device of claim 31, where the device further comprises:

at least two antenna elements associated with the at least two ~~simultaneously active~~ antenna ports; and

where the processing unit is further configured to execute instructions in the memory

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 38 of 365

to:

determine a parameter associated with the at least two antenna elements; and

measure, based on the determined parameter associated with the at least two antenna elements, the measured parameter.

33. (Previously presented) The device of claim 32, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase.

34. (Currently amended) The device of claim 31, where the measured parameter associated with the at least two ~~simultaneously active~~ antenna ports comprises one or more of an amplitude or a phase.

35. (Currently amended) The device of claim 31, where the measured parameter associated with the at least two ~~simultaneously active~~ antenna ports comprises a difference between a signal transmitted via one of the at least two ~~simultaneously active~~ antenna ports and a signal received via another one of the at least two ~~simultaneously active~~ antenna ports.

36. (Previously presented) The device of claim 31, where, when comparing the measured parameter with the expected parameter, the processing unit is further configured to execute instructions in the memory to determine a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = || S_{MEASURED} - S_{EXPECTED} ||^2.$$

37. (Previously presented) The device of claim 36, where, when comparing the determined error to the threshold ($\delta_{THRESHOLD}$), the processing unit is further configured to execute instructions in the memory to compare the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to

determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

38. (Previously presented) The device of claim 31, where the processing unit is further configured to execute instructions in the memory to:

receive antenna port permutations for a plurality of antenna ports of the device;

receive expected information associated with the plurality of antenna ports;

calculate expected values for different antenna port permutations based on the received information;

acquire measured values associated with the different antenna port permutations,

compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations; and

determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

39. (Previously presented) The device of claim 31, where the device comprises a base station.

40. (Previously presented) The device of claim 31, where the device comprises a remote radio unit associated with a base station.

41. (New) The method of claim 21, where the expected parameter is obtained from an expected value table of the device.

42. (New) The device of claim 31, where the memory is further configured to store an expected value table comprising the expected parameter.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 40 of 365

AMENDMENTS TO THE DRAWINGS

Figs 3A and 3B have had each had the label for element 300 amended from “antenna port” to “antenna bank” for clarity.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 41 of 365

REMARKS

Specification Amendments

The specification has been amended to clarify that the object with reference number 300 is an "antenna bank" so as to distinguish from objects with reference number 310 referred to as ports. These amendments were made in: the 2 paragraphs beginning on page 3 line 19; the 2 paragraphs beginning on page 8 line 20; the paragraph beginning on page 9 line 11; the paragraph beginning on page 10 line 6; the 2 paragraphs beginning on page 10 line 27; the paragraph beginning on page 11 line 22; and the paragraph beginning on page 18 line 7. No new matter is added.

Claim Amendments

Claims 21-42 are currently pending. Independent claims 21 and 31 have been amended. Support for these amendments can be found throughout the specification and drawings, *see*, *e.g.*, page 1 line 20; page 8 line 31 to page 9 line 1; page 9 lines 22-34; Fig. 3B. Dependent claims 22, 24-25, 32, and 34-35 have been amended for consistency with their respective parent claims, without altering the scope thereof. No new matter is added.

Claims 41-42 are new. Support for these claims can be found throughout the specification and drawings, *see*, *e.g.*, page 6 lines 18-32. No new matter is added.

Drawings Amendments

Figs 3A and 3B have each had the label for element 300 amended from "antenna port" to "antenna bank" for clarity in the nomenclature. No new matter is added.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 42 of 365

§112 Claim Rejections

Claims 21-40 stand rejected under §112 for failing to comply with the written description requirement with regard to the phrase "simultaneously active." Applicant has amended the claims such that this term is no longer present. Accordingly, Applicant requests withdrawal of the corresponding §112 rejections.

§102/§103 Claim Rejections

Claims 21-25, 28, 31-35, 38 stand rejected under §102 as being anticipated by Heikkinen (WO2008023097). Claims 26-27, 29-30, 36-37, 39-40 stand rejected under §103 over Heikkinen in view of Taylor (US20030198305). Applicant requests reconsideration.

Independent claim 21 requires "at least two antenna ports of the device, each antenna port being simultaneously connected to a respective transceiver via a respective cable." Because Heikkinen does not have cabled connections between transceivers and antenna ports, and because ports are not connected to respective transceivers simultaneously, Heikkinen fails to anticipate claim 21.

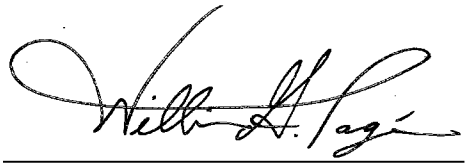
Heikkinen teaches that "[a] switching mechanism 400 operated by the processing unit 204 is provided between the circulator 306 and the antenna ports 330 to 334… the processing unit 204 controls the **switching** mechanism to connect the transmission circuit 302… to a **selected** antenna port 330, 332, or 334" (page 9 lines 27-31; *see* Fig. 4). Because Heikkinen employs a switching mechanism to make a single connection to a selected port, Heikkinen does not teach or suggest "at least two antenna ports… each antenna port being simultaneously connected." Further, because Heikkinen forms a connection by electrically switching a **circuit**,

Heikkinen also does not teach "each antenna port being simultaneously connected… via a respective cable." In addition, Taylor has not been shown to cure these defects. Accordingly, Applicant submits that independent claim 21 and its dependent claims define patentable subject matter over the cited art.

Similarly, independent claim 31 requires "each of the at least two antenna ports being simultaneously connected to a respective transceiver via a respective cable." Applicant submits that independent claim 30 and its dependent claims define over the cited art for reasons substantially similar to those discussed above with respect to claim 21.

For the foregoing reasons, it is respectfully urged that the present application is in condition for allowance and notice to such effect is respectfully requested.

Respectfully submitted,
COATS & BENNETT, P.L.L.C.



Dated: 25 November 2013

William G. Pagán
Registration No.: 67,192
Telephone: (919) 854-1844

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 44 of 365

FIG. 3A

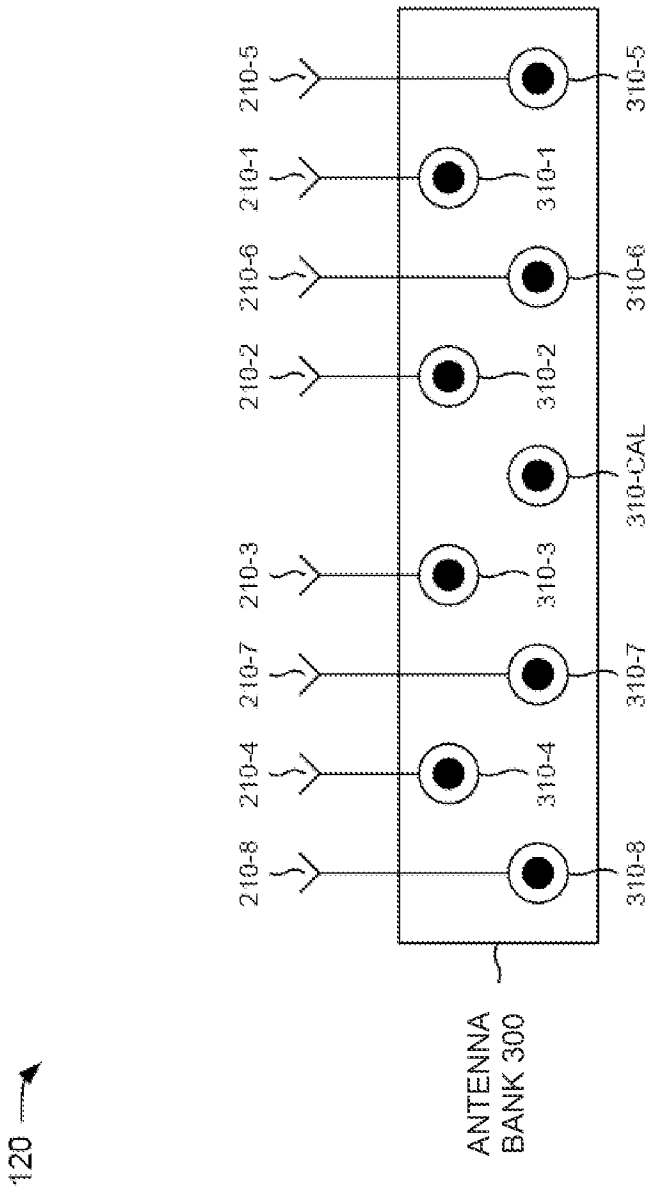
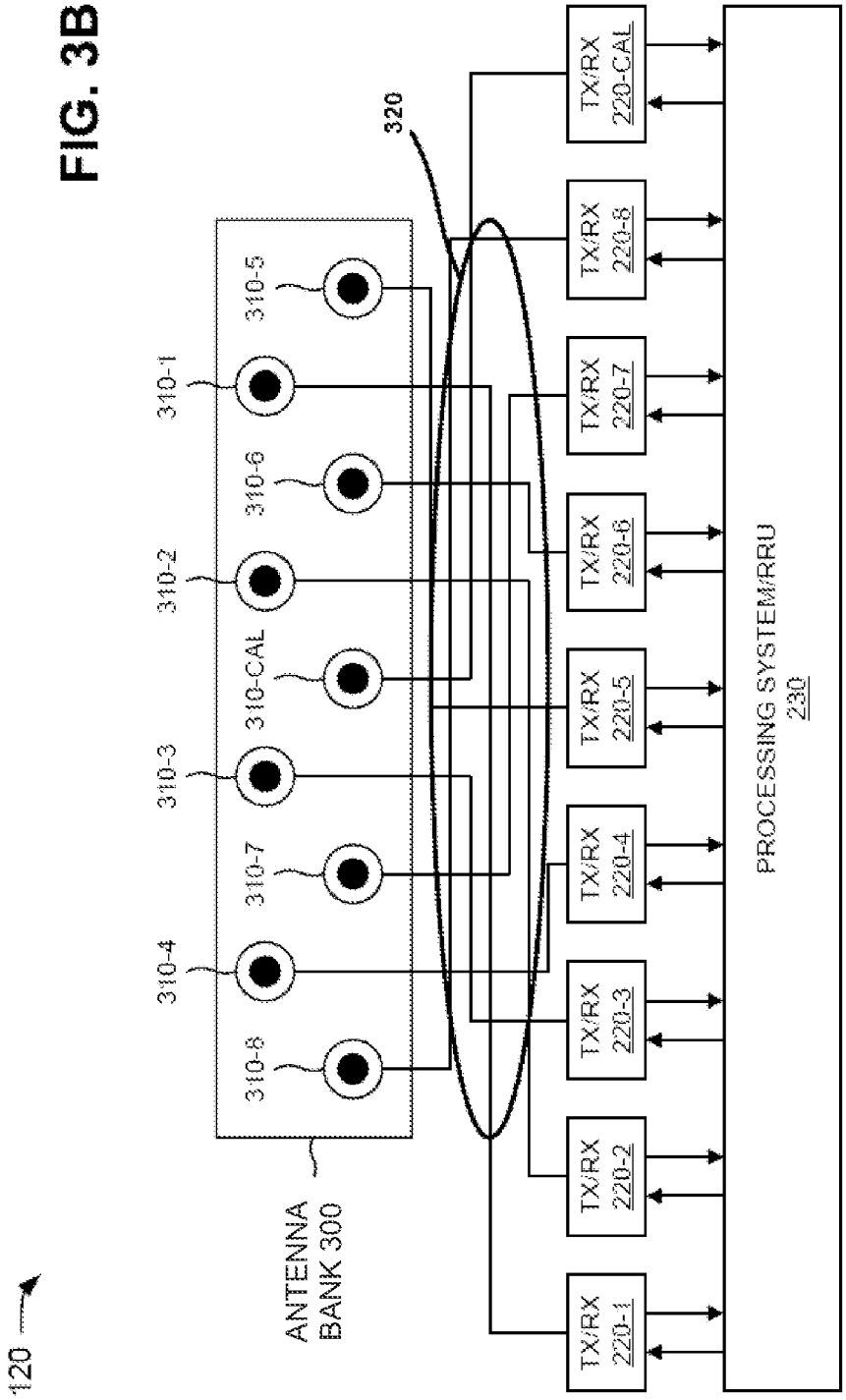

120
ANTENNA BANK 300
210-8
210-4
210-7
210-3
210-2
210-6
210-1
210-5
310-8
310-4
310-7
310-3
310-CAL
310-2
310-6
310-1
310-5

FIG. 3B


120
ANTENNA BANK 300
310-1
310-2
310-3
310-4
310-5
310-6
310-7
310-8
310-CAL
320
TX/RX 220-1
TX/RX 220-2
TX/RX 220-3
TX/RX 220-4
TX/RX 220-5
TX/RX 220-6
TX/RX 220-7
TX/RX 220-8
TX/RX 220-CAL
PROCESSING SYSTEM/RRU 230

Electronic Patent Application Fee Transmittal

Application Number:	13321076
Filing Date:	17-Nov-2011
Title of Invention:	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths
First Named Inventor/Applicant Name:	Qingyu Miao
Filer:	William G Pagan/Cora Fedornock
Attorney Docket Number:	4015-7892 / P28266-US1

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Claims in excess of 20	1615	2	80	160
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for Continued Examination	1801	1	1200	1200
		Total in USD ($)		**1360**

Electronic Acknowledgement Receipt

EFS ID:	17493443
Application Number:	13321076
International Application Number:	
Confirmation Number:	2274
Title of Invention:	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths
First Named Inventor/Applicant Name:	Qingyu Miao
Customer Number:	24112
Filer:	William G Pagan/Cora Fedornock
Filer Authorized By:	William G Pagan
Attorney Docket Number:	4015-7892 / P28266-US1
Receipt Date:	25-NOV-2013
Filing Date:	17-NOV-2011
Time Stamp:	14:24:57
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Electronic Funds Transfer
Payment was successfully received in RAM	$1360
RAM confirmation Number	804
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (If appl.)

Proconfirm Exhibit 2015
Ericsson v. Proconfirm
IPR2025-01453, Page 49 of 365

1	Request for Continued Examination (RCE)	40157892RCE.pdf	36266 1ad4ee5ace55eef98c0a25763739e1b7a42a7ad2	no	3
Warnings:					
This is not a USPTO supplied RCE SB30 form.					
Information:					
2		40157892RESPONSEWITHRCE.pdf	123505 c050fe66052a1b6a5243f82b63df71d061616ef1	yes	14

Multipart Description/PDF files in .zip description

Document Description	Start	End
Amendment Submitted/Entered with Filing of CPA/RCE	1	1
Specification	2	4
Claims	5	10
Specification	11	11
Applicant Arguments/Remarks Made in an Amendment	12	14

Warnings:					
Information:					
3	Drawings-only black and white line drawings	40157982REPLACEMENTDRAWINGS.pdf	48742 866638cff4bda79f6f9a62cf7d07bfce491c9859	no	2
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	32368 1817873bb784d01370f9c81c7fb9d2d5b3e434a4	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	240881		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/321,076	Filing Date 11/17/2011	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

	(Column 1)	(Column 2)		
FOR	NUMBER FILED	NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1)		(Column 2)	(Column 3)		
	11/25/2013	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 22	Minus	** 20	= 2	X $80 =	160
	Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $420 =	0
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	**160**

		(Column 1)		(Column 2)	(Column 3)		
		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))						
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
						TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/DELEACHES YOUNG/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/321,076	11/17/2011	Qingyu Miao	4015-7892 / P28266-US1	2274

24112 7590 08/29/2013

COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

EXAMINER	
WEST, LEWIS G	

ART UNIT	PAPER NUMBER
2648	

MAIL DATE	DELIVERY MODE
08/29/2013	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/321,076	Applicant(s) MIAO ET AL.	
	Examiner LEWIS WEST	Art Unit 2648	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *26 July 2013*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *21-40* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *21-40* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

Response to Arguments

Applicant's arguments filed 07/26/2013 have been fully considered but they are not persuasive. Heikkinen does disclose, with relation to figures 4 and 5, and the associated text on pages 11, that the test signal may be sent to multiple antenna ports during the same testing period; the antennas receiving the test signal and are thus active simultaneously.

Further the term "simultaneously active" is not in applicant's specification and is not commensurate in scope with applicant's specification and is thus new matter. Correction is required.

.

Claim Rejections - 35 USC § 112

The following is a quotation of 35 U.S.C. 112(a):
(a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), first paragraph:
The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claim 21-40 are rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor or a joint inventor, or for pre-AIA the inventor(s), at the time the application was filed, had possession of the claimed invention. The

phrase "simultaneously active" in neither found in, nor does it appear to be commensurate in scope with any related description in the specification. As such it is new matter and must be removed. Correction is required. .

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 21-25, 28, 31-35 and 38 are rejected under 35 U.S.C. 102(b) as being anticipated by Heikkinen (WO 2008/023097 A1).

21. Heikkenen discloses a method in a radio network that includes a device, the method comprising: measuring, via the device, a parameter associated with at least two simultaneously active antenna ports of the device; comparing, via the device, the measured parameter with an expected parameter associated with the at least two antenna ports to determine an error; comparing, via the device, the determined error to a threshold; and determining, via the device: an erroneous antenna port connection for the at least two simultaneously active antenna ports when the error exceeds the threshold, and a correct antenna port connection for the at least two antenna ports when the error is less than or equal to the threshold. [Fig. 4; page 9-10, as it describes figure 4 and the process of measuring each port to determine function or error, where the reflected signal is the error which exceeds the threshold]

22. The method of claim 21, where measuring, via the device, the parameter comprises: determining a parameter associated with at least two antenna elements of the device, where the at least two antenna elements are associated with the at least two antenna ports; and measuring, based on the determined parameter associated with the at least two antenna elements, the measured parameter. [page 10, the measured reflected signal is a parameter used for each of the at least two elements in determining]

23. The method of claim 22, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

24. The method of claim 21, where the measured parameter associated with the at least two antenna ports comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

25. The method of claim 21, where the measured parameter associated with the at least two antenna ports comprises a difference between a signal transmitted via one of the at least two antenna ports and a signal received via another one of the at least two antenna ports. {Fig 5; page 12}

28. The method of claim 21, further comprising: receiving antenna port permutations for a plurality of antenna ports of the device; receiving expected information associated with the plurality of antenna ports; calculating expected values for different antenna port permutations based on the received information; acquiring measured values associated with the different antenna port permutations; comparing the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine

errors for the different antenna port permutations; and determining an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.[pages 9-11, antennas are continually tested to determine proper function. of the expected values associated with a functional antenna change, the antennas may be reallocated, and thus changed to a new permutation, on the fly, if only one antenna is functioning then that is the permutation with the lowest error]

31. A device in a radio network, the device comprising: a plurality of antenna ports; a memory to store a plurality of instructions; and a processing unit to execute instructions in the memory to: measure a parameter associated with the at least two simultaneously active antenna ports of the plurality of ports, compare the measured parameter with an expected parameter associated with the at least two antenna ports to determine an error, compare the determined error to a threshold, and determine: an erroneous antenna port connection for the at least two simultaneously active antenna ports when the error exceeds the threshold, and a correct antenna port connection for the at least two antenna simultaneously active ports when the error is less than or equal to the threshold. [Fig. 4; page 9-10, as it describes figure 4 and the process of measuring each port to determine function or error]

32. The device of claim 31, where the device further comprises: at least two antenna elements associated with the at least two antenna ports, and where the processing unit is further configured to execute instructions in the memory to: determine a parameter associated with the at least two antenna elements, and measure, based on the determined parameter associated with the at least two antenna elements, the measured parameter. [page 10, the measured reflected signal is a parameter used for each of the at least two elements in determining]

33. The device of claim 32, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

34. The device of claim 31, where the measured parameter associated with the at least two antenna ports comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

35. The device of claim 31, where the measured parameter associated with the at least two antenna ports comprises a difference between a signal transmitted via one of the at least two antenna ports and a signal received via another one of the at least two antenna ports. {Fig 5; page 12}

38. The device of claim 31, where the processing unit is further configured to execute instructions in the memory to: receive antenna port permutations for a plurality of antenna ports of the device, receive expected information associated with the plurality of antenna ports, calculate expected values for different antenna port permutations based on the received information, acquire measured values associated with the different antenna port permutations, compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations, and determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error. [pages 9-11, antennas are continually tested to determine proper function. of the expected values associated with a functional antenna change, the antennas may be reallocated, and thus changed to a new

permutation, on the fly, if only one antenna is functioning then that is the permutation with the lowest error]

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 26-27, 29-30, 36-37 and 39-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heikkinen (WO 2008/023097 A1) in view of Taylor (2003/0198305).

Regarding claims 36 and 37, Heikkinen discloses the method of claim 21, but does not expressly discloses using a squared error comparison. Taylor discloses, in an analogous system, the use of Minimum mean squared error, [0054, 0103] meaning the difference between the

square of the expected and measured values would be calculated and compared to a threshold meaning equations equivalent to those used in the claims would be implicitly used. Therefore it would have been obvious to determine and compare a squared error, as this is a common statistical tool often applied to signal processing, as it helps to eliminate randomness and provide a more accurate value. .

Regarding claims 26 and 27, Heikkinen discloses the method of claim 31, but does not expressly discloses using a squared error comparison. Taylor discloses, in an analogous system, the use of Minimum mean squared error [0054, 0103], meaning the difference between the square of the expected and measured values would be calculated and compared to a threshold meaning equations equivalent to those used in the claims would be implicitly used. Therefore it would have been obvious to determine and compare a squared error, as this is a common statistical tool often applied to signal processing, as it helps to eliminate randomness and provide a more accurate value.

Regarding claim 29-30 and 39-40, Heikkinen discloses the method of claim 21 and device of claim 31 respectively, between a base reader and a tag, but not expressly a base station and associated remote unit. Taylor discloses analogous system where the devices comprise a base station and associated radio in a wide area network. [0044] Therefore it would have been obvious to one of ordinary skill in the art that the same signal processing and error detection would be identically usable on a larger scale to provide the same benefits.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to LEWIS WEST whose telephone number is (571)272-7859. The examiner can normally be reached on Monday-Friday 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Temesghen Ghebretinsae can be reached on 571-272-4177. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lewis G. West/
Primary Examiner, Art Unit 2648

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13321076
Filing Date	2011-11-17
First Named Inventor	Miao
Art Unit	2648
Examiner Name	West
Attorney Docket Number	4015-7892

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/L.W./	1	6437577	B1	2002-08-20	Fritzmann et al.	Corresponds to DE19923729A1 cited herein

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
/L.W./	1	19923729	DE	A1	2000-11-23	Nokia Mobile Phones Ltd.		☐
/L.W./	2	0102871	WO	A1	2001-01-11	Nokia Networks OY		☐
/L.W./	3	2008035286	JP	A	2008-02-14	Kyocera Corp.	Machine translation attached	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13321076
	Filing Date	2011-11-17
	First Named Inventor	Miao
	Art Unit	2648
	Examiner Name	West
	Attorney Docket Number	4015-7892

/L.W./	4	2006115267	JP	A	2006-04-27	Hitachi Comm. Tech. Ltd.	Machine translation attached	☒

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/Lewis West/	Date Considered	08/16/2013

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	Art Unit
	LEWIS WEST	2648

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	63.1, 67.11, 562.1, 575.7	05/28/2013	LW

SEARCH NOTES		
Search Notes	Date	Examiner
PALM inventor search	05/28/2013	LW
Updated search	08/26/2013	LW

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	**Art Unit**
	LEWIS WEST	2648

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	05/29/2013	08/26/2013							
	1	-	-							
	2	-	-							
	3	-	-							
	4	-	-							
	5	-	-							
	6	-	-							
	7	-	-							
	8	-	-							
	9	-	-							
	10	-	-							
	11	-	-							
	12	-	-							
	13	-	-							
	14	-	-							
	15	-	-							
	16	-	-							
	17	-	-							
	18	-	-							
	19	-	-							
	20	-	-							
	21	✓	✓							
	22	✓	✓							
	23	✓	✓							
	24	✓	✓							
	25	✓	✓							
	26	✓	✓							
	27	✓	✓							
	28	✓	✓							
	29	✓	✓							
	30	✓	✓							
	31	✓	✓							
	32	✓	✓							
	33	✓	✓							
	34	✓	✓							
	35	✓	✓							
	36	✓	✓							

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 67 of 365

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	Art Unit
	LEWIS WEST	2648

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	05/29/2013	08/26/2013							
	37	✓	✓							
	38	✓	✓							
	39	✓	✓							
	40	✓	✓							

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of **Miao et al.**	)	
	)	
Serial No.: **13/321,076**	)	
	)	Examiner: Lewis G. West
Filed: **November 17, 2011**	)	
	)	Group Art Unit: 2648
For: **Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths**	)	Confirmation No.: 2274
	)	
Docket No: **4015-7892/P28266-US1**	)	

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

26 July 2013

RESPONSE TO OFFICE ACTION

This paper is being filed in response to the Office Action mailed 30 May 2013.

Reconsideration is respectfully requested in light of the amendments and/or remarks below.

The Office is hereby authorized to charge any fees required for entry of this paper to Deposit Account 18-1167.

AMENDMENTS TO THE CLAIMS

1.-20. (Canceled).

21. (Currently amended) A method in a radio network that includes a device, the method comprising:

measuring, via the device, a parameter associated with at least two simultaneously active antenna ports of the device;

comparing, via the device, the measured parameter with an expected parameter associated with the at least two simultaneously active antenna ports to determine an error;

comparing, via the device, the determined error to a threshold; and

determining, via the device:

an erroneous antenna port connection for the at least two simultaneously active antenna ports when the error exceeds the threshold[[,]]; and

a correct antenna port connection for the at least two antenna simultaneously active ports when the error is less than or equal to the threshold.

22. (Currently amended) The method of claim 21, ~~where~~ wherein the measuring, via the device, the parameter comprises:

determining a parameter associated with at least two antenna elements of the device, where the at least two simultaneously active antenna elements are associated with the at least two antenna ports; and

measuring, based on the determined parameter associated with the at least two antenna elements, the measured parameter.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 70 of 365

23. (Previously presented) The method of claim 22, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase.

24. (Currently amended) The method of claim 21, where the measured parameter associated with the at least two simultaneously active antenna ports comprises one or more of an amplitude or a phase.

25. (Currently amended) The method of claim 21, where the measured parameter associated with the at least two simultaneously active antenna ports comprises a difference between a signal transmitted via one of the at least two simultaneously active antenna ports and a signal received via another one of the at least two simultaneously active antenna ports.

26. (Currently amended) The method of claim 21, ~~where~~ wherein the comparing, via the device, the measured parameter ($S_{MEASURED}$) with the expected parameter ($S_{EXPECTED}$) comprises determining a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = || S_{MEASURED} - S_{EXPECTED} ||^2.$$

27. (Currently amended) The method of claim 26, ~~where~~ wherein the comparing, via the device, the determined error (ε) to the threshold ($\delta_{THRESHOLD}$) comprises comparing the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 71 of 365

28. (Previously presented) The method of claim 21, further comprising:

receiving antenna port permutations for a plurality of antenna ports of the device;

receiving expected information associated with the plurality of antenna ports;

calculating expected values for different antenna port permutations based on the received information;

acquiring measured values associated with the different antenna port permutations;

comparing the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations; and

determining an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

29. (Previously presented) The method of claim 21, where the device comprises a base station.

30. (Previously presented) The method of claim 21, where the device comprises a remote radio unit associated with a base station.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 72 of 365

31. (Currently amended) A device in a radio network, the device comprising:

~~at least two~~ a plurality of antenna ports;

a memory to store a plurality of instructions; and

a processing unit to execute instructions in the memory to:

measure a parameter associated with ~~the~~ at least two simultaneously active antenna ports of the plurality of antenna ports[[,]];

compare the measured parameter with an expected parameter associated with the at least two simultaneously active antenna ports to determine an error[[,]];

compare the determined error to a threshold[[,]]; and

determine:

an erroneous antenna port connection for the at least two simultaneously active antenna ports when the error exceeds the threshold[[,]]; and

a correct antenna port connection for the at least two simultaneously active antenna ports when the error is less than or equal to the threshold.

32. (Currently amended) The device of claim 31, where the device further comprises:

at least two antenna elements associated with the at least two simultaneously active antenna ports[[,]]; and

where the processing unit is further configured to execute instructions in the memory to:

determine a parameter associated with the at least two antenna elements[[,]]; and

measure, based on the determined parameter associated with the at least two antenna elements, the measured parameter.

33. (Previously presented) The device of claim 32, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase.

34. (Currently amended) The device of claim 31, where the measured parameter associated with the at least two simultaneously active antenna ports comprises one or more of an amplitude or a phase.

35. (Currently amended) The device of claim 31, where the measured parameter associated with the at least two simultaneously active antenna ports comprises a difference between a signal transmitted via one of the at least two simultaneously active antenna ports and a signal received via another one of the at least two simultaneously active antenna ports.

36. (Currently amended) The device of claim 31, where, when comparing the measured parameter with the expected parameter, the processing unit is further configured to execute instructions in the memory to[[:]] determine a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = || S_{MEASURED} - S_{EXPECTED} ||^2.$$

37. (Currently amended) The device of claim 36, where, when comparing the determined error to the threshold ($\delta_{THRESHOLD}$), the processing unit is further configured to execute instructions in the memory to[[:]] compare the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 74 of 365

38. (Currently amended) The device of claim 31, where the processing unit is further configured to execute instructions in the memory to:

receive antenna port permutations for a plurality of antenna ports of the device[[,]];

receive expected information associated with the plurality of antenna ports[[,]];

calculate expected values for different antenna port permutations based on the received information[[,]];

acquire measured values associated with the different antenna port permutations,

compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations[[,]]; and

determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

39. (Previously presented) The device of claim 31, where the device comprises a base station.

40. (Previously presented) The device of claim 31, where the device comprises a remote radio unit associated with a base station.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 75 of 365

REMARKS

Claim Amendments

Claims 21-40 are currently pending. Independent claims 21 and 31 have been amended. Dependent claims 22, 24-27, 32, and 34-38 have been amended solely to maintain consistency of terminology with their respective parent claims and/or to correct minor typographical errors, without altering the scope thereof. No new matter has been added.

§102/§103 Claim Rejections

Claims 21-25, 28, 31-35, 38 stand rejected under §102 as being anticipated by Heikkinen (WO2008023097). Claims 26-27, 29-30, 36-37, 39-40 stand rejected under §103 over Heikkinen in view of Taylor (US20030198305). Applicant requests reconsideration.

Independent claim 21 requires, *inter alia*, "measuring… a parameter associated with at least two simultaneously active antenna ports of the device." Heikkinen does not do this. Instead, Heikkinen only uses one antenna port at a time, not two simultaneously. Specifically, Heikkinen states "[a] switching mechanism 400… is provided between the circulator 306 and the antenna ports 330 to 334" (p. 9, lines 27-29; see fig. 4). "The processing unit 204 may control the switching mechanism 400 to connect the transmission circuit 302 to each of the antenna ports 330, 332, and 334 at a time so that each antenna port is tested separately" (p. 10, lines 2-5). To perform this test, Heikkinen teaches "transmit[ting] a test signal to the first antenna port [and] receiv[ing] a reflected signal" (p. 10, lines 7-8). "If a high-power data signal were transmitted to an antenna port not connected to a properly functioning antenna, the signal would reflect almost completely back from the antenna port" (p. 10, lines 30-32). Heikkinen contemplates this test can be used on "an RFID reader [that] comprises one antenna 110 to be used in both transmission and reception" (p. 1, lines 28-29). Therefore, because the switching mechanism ensures that only one antenna port is active during measurements (for both TX and

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 76 of 365

RX), the device in Heikkinen cannot possibly be "measuring… a parameter associated with at least two simultaneously active antenna ports of the device," as claimed. Further, Taylor does not cure this defect. Taylor teaches a device for demodulating interfering signals on the same channel, and not a device measuring parameters of its antenna ports (*see* ¶0009-0012).

From the above, it is clear that neither Heikkinen nor Taylor, alone or in combination, teach or suggest "measuring… a parameter associated with at least two simultaneously active antenna ports of the device" as required by claim 21. Accordingly, Applicant submits that independent claim 21 and its dependent claims define patentable subject matter over the cited art.

Similarly, independent claim 31 requires "a processing unit to… measure a parameter associated with at least two simultaneously active antenna ports." Applicant submits that independent claim 30 and its independent claims define over the cited art for reasons substantially similar to those discussed above with respect to claim 21.

For the foregoing reasons, it is respectfully urged that the present application is in condition for allowance and notice to such effect is respectfully requested.

Respectfully submitted,
COATS & BENNETT, P.L.L.C.

/John R. Owen Reg. No. 42055/
John R. Owen
Registration No.: 42,055
Telephone: (919) 854-1844

Dated: 26 July 2013

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 77 of 365

Electronic Acknowledgement Receipt

EFS ID:	16425548
Application Number:	13321076
International Application Number:	
Confirmation Number:	2274
Title of Invention:	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths
First Named Inventor/Applicant Name:	Qingyu Miao
Customer Number:	24112
Filer:	John R. Owen/Cora Fedornock
Filer Authorized By:	John R. Owen
Attorney Docket Number:	4015-7892 / P28266-US1
Receipt Date:	26-JUL-2013
Filing Date:	17-NOV-2011
Time Stamp:	12:18:43
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		40157892RESPONSE.pdf	102066 a3f3c3ffe67aa01acee4b27e0e3d07ae7e1775cb	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	7
	Applicant Arguments/Remarks Made in an Amendment	8	9
Warnings:			
Information:			
	Total Files Size (in bytes):	102066	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 13/321,076	Filing Date 11/17/2011	☐ To be Mailed

ENTITY: ☒ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT **07/26/2013**

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $80 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $420 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
/MYRTLE LEIGH/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**
If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13321076
Filing Date	2011-11-17
First Named Inventor	Miao
Art Unit	2648
Examiner Name	West
Attorney Docket Number	4015-7892

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6437577	B1	2002-08-20	Fritzmann et al.	Corresponds to DE19923729A1 cited herein

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	19923729	DE	A1	2000-11-23	Nokia Mobile Phones Ltd.		☐
	2	0102871	WO	A1	2001-01-11	Nokia Networks OY		☐
	3	2008035286	JP	A	2008-02-14	Kyocera Corp.	Machine translation attached	☒

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13321076
	Filing Date	2011-11-17
	First Named Inventor	Miao
	Art Unit	2648
	Examiner Name	West
	Attorney Docket Number	4015-7892

	4	2006115267	JP	A	2006-04-27	Hitachi Comm. Tech. Ltd.	Machine translation attached	☒

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13321076
	Filing Date	2011-11-17
	First Named Inventor	Miao
	Art Unit	2648
	Examiner Name	West
	Attorney Docket Number	4015-7892

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☐ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David E. Bennett, Reg. No. 32,194/	Date (YYYY-MM-DD)	2013-06-05
Name/Print	David E. Bennett	Registration Number	32,194

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice

This translation is machine-generated. It cannot be guaranteed that it is intelligible, accurate, complete, reliable or fit for specific purposes. Critical decisions, such as commercially relevant or financial decisions, should not be based on machine-translation output. - Terms of use - Legal notice - Help -

ABSTRACT DE19923729

The invention relates to a circuit arrangement for testing the operational readiness of antennas (14, 20) for a radiotelephone (40).

The antennae (14, 20) each have an emitter, which projects with one end open into the room.

Independent of a signal current (IHF) flow test currents (Ic1, Ic2) through antenna wires to the antennas (14, 20).

At each radiator for returning the separate test current is (Ic1) Ic2) connected in parallel to the RF path, a secondary path having an impedance (R1, R2).

Spannungsauswerter (VE1, VE2), to monitor the functional state of the antennas (14, 20) by comparing the test currents (Ic, Ic1, Ic2) caused test voltages (Uc1, Uc2) to the antenna terminals (12, 22) with a desired value (UREF) and generate appropriate indication signals (Uo1, Uo2), which provide information about the functional state of the antennas.

No documents available for this priority number.

Espacenet

Bibliographic data: DE19923729 (A1) — 2000-11-23

Schaltungsanordnung zum Prüfen der Funktionsbereitschaft mindestens einer Antenne

Inventor(s):	FRITZMANN MARTIN [DE]; WAGNER THOMAS [DE] ± (FRITZMANN, MARTIN, ; WAGNER, THOMAS)
Applicant(s):	NOKIA MOBILE PHONES LTD [FI] ± (NOKIA MOBILE PHONES LTD., ESPOO)
Classification:	**- international:*H01Q1/32; H01Q3/26;*** (IPC1-7): G01R27/06; G01R31/02; H01Q1/32 **- cooperative: H01Q1/32; H01Q3/267**
Application number:	DE1999123729 19990522
Priority number (s):	DE1999123729 19990522
Also published as:	US6437577 (B1) EP1055931 (A2) EP1055931 (A3)

Abstract of DE19923729 (A1)

Die Erfindung betrifft eine Schaltungsanordnung zum Prüfen der Funktionsbereitschaft von Antennen (14, 20) für ein Funktelefon (40). Die Antennen (14, 20) weisen jeweils einen Strahler auf, der mit einem Ende offen in den Raum ragt. Unabhängig von einem Signalstrom (IHF) fliessen Prüfströme (Ic1, Ic2) über Antennenleitungen zu den Antennen (14, 20). An jedem Strahler ist zum Rückführen des separaten Prüfstroms (Ic1) Ic2) parallel zum HF-Pfad ein Nebenpfad angeschlossen, der eine Impedanz (R1, R2) aufweist.; Spannungsauswerter (VE1, VE2) überwachen den Funktionszustand der Antennen (14, 20) durch Vergleichen der von den Prüfströmen (Ic, Ic1, Ic2) bewirkten Prüfspannungen (Uc1, Uc2) an den Antennenanschlüssen (12, 22) mit einem Sollwert (UREF) und generieren entsprechende Indikationssignale (Uo1, Uo2), die Aufschluss über den Funktionszustand der Antennen geben.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 86 of 365

(19) BUNDESREPUBLIK DEUTSCHLAND

DEUTSCHES PATENT- UND MARKENAMT

(12) **Offenlegungsschrift**

(10) **DE 199 23 729 A 1**

(51) Int. Cl.[7]:
G 01 R 31/02
G 01 R 27/06
// H01Q 1/32

(21) Aktenzeichen: 199 23 729.8
(22) Anmeldetag: 22. 5. 1999
(43) Offenlegungstag: 23. 11. 2000

DE 199 23 729 A 1

(71) Anmelder:
Nokia Mobile Phones Ltd., Espoo, FI

(74) Vertreter:
Grasnick, H.,
Dipl.-Ing.Faching.f.Schutzrechtswesen, Pat.-Ass.,
75175 Pforzheim

(72) Erfinder:
Fritzmann, Martin, 89231 Neu-Ulm, DE; Wagner, Thomas, 87779 Trunkelsberg, DE

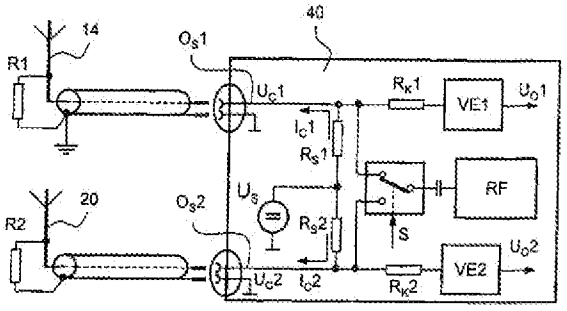
(56) Für die Beurteilung der Patentfähigkeit in Betracht zu ziehende Druckschriften:

DE	196 27 349 A1
DE	195 38 109 A1
DE	42 20 904 A1
EP	08 59 237 A1

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

(54) Schaltungsanordnung zum Prüfen der Funktionsbereitschaft mindestens einer Antenne

(57) Die Erfindung betrifft eine Schaltungsanordnung zum Prüfen der Funktionsbereitschaft von Antennen (14, 20) für ein Funktelefon (40). Die Antennen (14, 20) weisen jeweils einen Strahler auf, der mit einem Ende offen in den Raum ragt. Unabhängig von einem Signalstrom (I_{HF}) fließen Prüfströme (I_c1, I_c2) über Antennenleitungen zu den Antennen (14, 20). An jedem Strahler ist zum Rückführen des separaten Prüfstroms (I_c1) I_c2) parallel zum HF-Pfad ein Nebenpfad angeschlossen, der eine Impedanz (R_1, R_2) aufweist. Spannungsauswerter (VE1, VE2) überwachen den Funktionszustand der Antennen (14, 20) durch Vergleichen der von den Prüfströmen (I_c, I_c1, I_c2) bewirkten Prüfspannungen (U_c1, U_c2) an den Antennenanschlüssen (12, 22) mit einem Sollwert (U_{REF}) und generieren entsprechende Indikationssignale (U_o1, U_o2), die Aufschluss über den Funktionszustand der Antennen geben.



DE 199 23 729 A 1

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 87 of 365

Beschreibung

Die Erfindung betrifft eine Schaltungsanordnung zum Prüfen der Funktionsbereitschaft einer Antenne, insbesondere bei einem Fahrzeugtelefon, welches mehrere Antennen aufweist. Die Erfindung ermöglicht dem Fahrzeugtelefon jederzeit Fehler an der Antennenleitung, nicht montierte, fehlerhaft montierte, oder ausgefallene Fahrzeugantennen, beispielsweise in Folge von Beschädigung bei einem Verkehrsunfall, zu erkennen und selbsttätig auf eine funktionsfähige Antenne umzuschalten.

Da die Funktionsbereitschaft eines Funktelefons nur dann gegeben ist, wenn alle Baugruppen des Kommunikationssystems funktionieren und die Antennen wegen ihres Standorts mechanisch oft besonders empfindlich sind, erhöht die Lösung gemäß der Erfindung in einem Notfall wesentlich die Zuverlässigkeit eines Funktelefons.

Fahrzeugtelefone werden gewöhnlich mit einer Außen- oder Fensterantenne ausgestattet, deren örtliche Lage vorrangig nach den Anforderungen einer optimalen Empfangs- und Sendequalität ausgewählt wird.

Nachteilig ist jedoch, dass beim Auswählen einer solchen Lage die Wahrscheinlichkeit groß ist, dass im Falle eines Unfalls mit dem Fahrzeug oder einer anderen äußeren Krafteinwirkung die Antenne bis zum Totalausfall beschädigt wird. Insbesondere bei einer Außenantenne kommen als Krafteinwirkung beispielsweise auch eine böswillige Zerstörung durch Fremde oder Abbrechen beim Durchfahren von niedrigen Hindernissen in Betracht. Ein Totalausfall der Antenne kann bei einem Verkehrsunfall oder Fahrzeugschaden fatale Folgen haben, da das Herstellen einer Telefonverbindung nicht mehr möglich ist, um Hilfe herbeizurufen. Um diesen Mangel zu beseitigen, ist zum Beispiel aus der Druckschrift EP 0 859 237-A1 bekannt, an einem anderen Einbauort eine Not- oder Ausweichantenne anzubringen. Diese übernimmt nach einem Funktionsausfall der als Hauptantenne benutzten Außenantenne den Sende/Empfangsbetrieb. Beide Antennen sind je über ein separates Koaxialkabel mit dem Funktelefon verbunden.

Zum Erzielen einer maximalen Übertragungsqualität und Vermeiden von Interferenzen bei der Kommunikation, ist während der Funktion der Hauptantenne die Notantenne außer Betrieb. Das heißt, die selbsttätige Inbetriebnahme der Notantenne und der entsprechenden Leitung erfolgt grundsätzlich nur während eines Notfalls durch manuelles oder automatisches Aufbauen einer Notrufverbindung. Dafür wird entweder eine Notruftaste betätigt oder die Steuerung der Airbags und/oder Gurtstraffer sendet bei deren Auslösen ein entsprechendes Steuersignal an das Funktelefon, um dieses auf den zweiten Antennenanschluss umzuschalten.

Im Prinzip erfolgt das Umschalten zur Notantenne nach verschiedenen Lösungen:
Bei einfachen Lösungen löst der Aufbau einer Notrufverbindung im Funktelefon zwangsläufig ein Umschalten auf den Anschluss für die Notantenne aus, unabhängig vom Funktionszustand der Hauptantenne. Dabei wird vorausgesetzt, dass die Notantenne auf Grund ihrer geschützten Einbaulage gemeinsam mit der separaten Antennenleitung mit hoher Wahrscheinlichkeit noch funktionsfähig ist.

Dabei entsteht das Problem, dass sowohl beim Anschließen der Antenne in der Fahrzeugfertigung als auch beim Gebrauch des Fahrzeugs Fehler oder Beschädigungen an der Antennenleitung zur Notantenne auftreten können, welche unentdeckt bleiben, weil diese für den normalen Betrieb nicht benutzt wird. Somit ist im Notfall unter Umständen die Antenne nicht funktionsfähig. Ausserdem ist bei einem Inneneinbau der Notantenne die Effizienz auf Grund ihrer Einbaulage in der Regel geringer als die der Hauptantenne. Dieses führt gegebenenfalls dazu, dass in ungünstiger Fahrzeuglage ein Verbindungsaufbau zur Basisstation zwar mit einer intakten Hauptantenne möglich ist, aber nicht mit der leistungsschwächeren Notantenne.

Zum Vermeiden dieses Mangels führen Funktelefone mit mehreren Antennenanschlüssen und erweiterter Ausstattung periodisch, beispielsweise jeweils nach 10 Minuten, eine Prüfprozedur durch, bei der die Antennen nacheinander in Betrieb genommen und auf Funktionsfähigkeit geprüft werden. Dieses erfolgt beispielsweise durch Vergleich der Stärke der Empfangssignale. Dabei werden Fehler und Schäden an den Antennen und den Leitungen erkannt und gemeldet sowie rechtzeitig auf einen funktionsfähigen Antennenzweig umgeschaltet. Die Prüfprozedur wird in der Regel auch beim Auslösen eines Notrufes durchgeführt, so dass nur auf die leistungsschwächere Notantenne umgeschaltet wird, wenn die Hauptantenne beispielsweise durch Abbrechen des Antennenstabes ausgefallen ist. Wenn beide Antennen auf Grund verschiedener Ausführungsformen und Standorte auch verschiedene Empfangsergebnisse aufweisen, ist diese Methode wegen ungleicher Intensität der Empfangssignale nicht sehr zuverlässig.

Bei einer Prüfprozedur gemäß der Druckschrift EP 0 859 237 A1 erfolgt eine Messung der Antennenanpassung durch Ermitteln des Reflexionsfaktors auf der Antennenleitung mit einem bidirektionalen Messrichtkoppler und einer Schaltung zum Bilden des Qualitätssignals.

Von Nachteil dieser Lösung ist der hohe Aufwand sowohl für die Hardware als auch für die Software zum Realisieren der Prüfprozedur.

Darüber hinaus ist aus der Druckschrift DE 196 27 349-A1 bereits eine Einrichtung zum Prüfen von Fahrzeugantennen bekannt, welche in einer Stromschleife liegende Empfangsspulen von Fahrzeugantennen ständig mit einem niedrigen Ruheprüfstrom überwacht. Die Empfangsspulen nehmen bei einem Schienenfahrzeug entlang eines Linienleiters, wie den Schienen oder der Oberleitung, induktiv Signalströme auf. Der Ruheprüfstrom ist vorzugsweise ein Gleichstrom und zeigt kontinuierlich an, dass alle Antennen am Fahrzeug sowohl vorhanden als auch angeschlossen sind.

Nachteilig ist jedoch, dass diese Fahrzeugantennen keine im Kraftfahrzeugbau bevorzugte Antennenform aufweist, wie beispielsweise eine gegen Erde erregte Stabantennen, sondern Empfangsspulen zur induktiven Signalankopplung. Die Lösung ist also für Kraftfahrzeuge nur anwendbar, wenn an Stelle der bisher benutzten vorteilhaften Stab- oder Dipolantennen mit einem offenen Stabstrahler ein an sich bekannter Faltdipol mit einem geschlossenen Schleifenstrahler vorhanden ist. Dieser ist jedoch gegenüber den benutzten Lösungen aufwendig und bietet für die vorgesehene Anwendung keine wesentlichen Vorteile. Ein weiterer Nachteil der bekannten Lösung besteht darin, dass ein Kurzschluss der Antennenleitung ebenfalls als funktionsfähige Antenne angezeigt wird.

Es ist deshalb die Aufgabe der Erfindung, zum Prüfen der Funktionsbereitschaft mindestens einer Antenne für ein Funktelefon eine einfache, kostengünstige Schaltungsanordnung zu schaffen, welche die vorgenannten Mängel vermeidet und weitestgehend unabhängig von der Antennenform anwendbar ist. Darüber hinaus soll die Erfindung beim Anschluss von mehreren Antennen an einem Funktelefon mögliche Anschlussfehler eindeutig identifizieren.

Die Lösung gemäß der Erfindung enthält eine Antenne mit einem offenen Strahler, beispielsweise einem Stabstrahler. Dieser weist ein erstes Ende auf, an dem zum Abnehmen bzw. Einspeisen des Hf-Signals eine Antennenleitung angeschlossen ist, und ein zweites Ende, welches offen in den

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 88 of 365

Raum ragt, so dass eine im Raum verteilte Kapazität des Stabes einen HF-Pfad bildet, der den Signalstromkreis für die Nachrichtenkommunikation schließt. Zum Lösen der Aufgabe sendet das Funktelefon über die Antennenleitung einen Prüfstrom zur Antenne. Dieses geschieht unabhängig vom Signalstrom. Der Prüfstrom ist vorteilhaft ein Gleichstrom oder ein Wechselstrom mit einer Wellenlänge, die um ein Vielfaches größer ist als die Wellenlänge des Signalstroms.

Gemäß der Erfindung ist am Strahler ein Nebenpfad mit einer Impedanz angeschlossen, welcher für den Prüfstrom zur Antennenleitung einen rückwärtigen Strompfad bildet und der parallel zum HF-Pfad liegt. An dieser Impedanz bewirkt der Prüfstrom einen Spannungsabfall.

Im Gegensatz zur bekannten Lösung weist die Schaltungsanordnung einen Spannungsauswerter auf, welcher an den Antennenanschlüssen des Funktelefons ständig die Spannung überwacht, die infolge des Prüfstroms an der Impedanz entsteht. Damit erkennt das Funktelefon nicht nur, ob der Stabstrahler korrekt mit dem Antennenanschluss verbunden ist, sondern mindestens auch mögliche Kurzschlüsse der Antennenleitung.

Der Impedanzwert des Nebenpfades liegt sowohl für den Signalstrom als auch für den Prüfstrom um ein Vielfaches über den Strahlungswiderstand der Antenne. Die Impedanz ist am Strahler über eine im Verhältnis zur Übertragungswellenlänge kurze Anschlußleitung angeschlossen.

Nach einem speziellen Merkmal der Erfindung besteht die Impedanz des Nebenpfades aus einem Gebilde mit ausgedehnter Körperlänge, das beispielsweise als Einzelbauelement eine Länge aufweist, die in der Größenordnung des Stabstrahlers liegt, oder eine Serienschaltung mehrerer diskreter Einzelelemente, so dass die Verbindungsleitungen zu den Einzelelementen im Nebenpfad im Verhältnis zur Betriebswellenlänge kurz sind und die HF-Eigenschaften des Strahlers möglichst wenig beeinflussen.

Die Erfindung soll nachstehend an Hand von Ausführungsbeispielen erläutert werden. Die entsprechenden Zeichnungen zeigen:

Fig. 1 das Grundprinzip der Schaltungsanordnung gemäß der Erfindung

Fig. 2 eine Ausführungsform der Schaltungsanordnung gemäß der Erfindung mit mehreren Antennen

Fig. 3a bis 3c weitere Ausführungsformen der Schaltungsanordnung gemäß der Erfindung mit mehreren Antennen

Fig. 4 bis 6 verschiedene Antennenformen für die Schaltungsanordnung entsprechend der Erfindung mit Stabstrahlern

Fig. 7 eine Ausführung mit einer Wendelantenne

Fig. 8 eine Antennenform mit einem senkrecht strahlenden Dipol und

Fig. 9 eine Antennenform mit einer Flächenantenne

Ein Funktelefon **10** weist, wie **Fig.** 1 zeigt, ein Sende/Empfangsteil RF auf. Dieses ist über einen Antennenanschluss **12** mit einer Antenne **14** verbunden, welche vorzugsweise als Außenantenne ausgeführt und beispielsweise auf dem Dach eines nicht dargestellten Fahrzeuges angeordnet ist. Eine Antennenleitung **16**, im vorliegenden Fall ein Koaxialkabel, welches in der Regel unter der Innenraumverkleidung des Fahrzeugs verlegt ist, verbindet die örtlich vom Funktelefon **10** abgesetzte Antenne **14** mit dem Antennenanschluss **12**. Infolge der verdeckten Installation sind Fehler und Beschädigungen der Antennenleitung **16** und des Antennenanschlusses **12** optisch nur schwer erkennbar. Der Antennenanschluss **12** enthält einen Signalkontakt O_S und einen Massekontakt O_0.

Im vorliegenden Beispiel ist die Antenne **14** ein an sich bekannter vertikal angeordneter Stabstrahler mit einer Länge von annähernd einem Viertel der Übertragungswellenlänge λ des Sende/Empfangssignals. Die Antennenleitung **16** ist am unteren Ende des Strahlers angeschlossen. Das andere Ende ragt zur Aufnahme/Abgabe von hochfrequenter Strahlung offen in den Raum.

Bekanntlich bildet das offene Ende des Strahlers gegen die Erdoberfläche eine im Raum verteilte Kapazität C_E, welche als kapazitiver HF-Pfad den Kreis für den hochfrequenten Signalstrom I_{HF} schließt, ohne dass ein galvanischer Pfad zwischen dem offenen Strahlerende und dem Massekontakt GND besteht. Da die Antenne **14** an einer Fahrzeugkarosserie befestigt ist, besteht eine Direktverbindung zwischen dem Massekontakt GND, der Antennenleitung **16** und der leitenden Fläche der Karosserie.

Neben einem Sende/Empfangsteil RF sind am Signalkontakt O_S sowohl eine Spannungsquelle als auch ein Eingang eines Spannungsauswerters angeschlossen. Im vorliegenden Beispiel stellt die Spannungsquelle eine Quellenspannung U_S bereit und bewirkt über einen Quellenwiderstand R_S den Fluss eines Prüfstroms I_C zur Antenne **14**. An Stelle der Spannungsquelle kann jedoch eine Stromquelle benutzt werden, welche vorteilhaft einen Konstantstrom liefert. Der Spannungsauswerter ist bei dieser Ausführung ein Fensterkomparator COM, der feststellt, ob seine Eingangsspannung U_{IN} innerhalb eines vorgegebenen Bereiches liegt.

Gemäß der Erfindung ist der Stabstrahler der Antenne **14** direkt mit einem Nebenpfad verbunden, der eine Impedanz Z enthält. Der Nebenpfad schließt den Stromkreis für den Prüfstrom I_C vom Stabstrahler zum Massekontakt GND. Die Impedanz Z bildet mit dem Quellenwiderstand R_S einen Spannungsteiler. Der Prüfstrom I_C erzeugt an der Impedanz Z eine Prüfspannung U_C, deren Höhe vom Wert der Impedanz abhängt, welche zwischen dem Signalkontakt O_S und dem Massekontakt O_0 wirksam ist. Bei einer fehlenden oder nicht angeschlossenen Antenne **14** ist die Prüfspannung $U_C = U_S$, während bei einem Kurzschluss des Antennenanschlusses **12** oder der Antennenleitung **16**, die Spannung $U_C/n = 0$ beträgt. Der Fensterkomparator COM vergleicht die Prüfspannung $U_C = U_{IN}$ mit einer Referenzspannung U_{REF} und generiert für eine nicht dargestellte Steuerschaltung des Funktelefons **10** ein Indikationssignal U_O, das dem Funktionszustand von Antenne **14** entspricht.

Um den Einfluss des Nebenpfades auf die Strahlungseigenschaften der Antenne **14** möglichst gering zu halten, erfolgt der Anschluss der Impedanz Z an den Stabstrahler über eine im Verhältnis zur Übertragungswellenlänge λ kurze Anschlussleitung.

Vorteilhaft wird das Verhältnis von Impedanz Z und Quellenwiderstand R_S so gewählt, dass der Fensterkomparator COM bei funktionsfähiger Antenne **14** deutlich die Prüfspannung $U_C = U_S/n$ am Signalkontakt O_S von der Quellenspannung U_S unterscheidet, die bei einem Fehler an der Antenne **14** auftritt. Für die Funktion der Schaltungsanordnung ist wichtig, dass die Impedanz Z möglichst fest mit der Antenne **14** verbunden ist, so dass das Fehlen der Antenne **14** durch Ansteigen der Prüfspannung U_C am Signalkontakt O_S ebenso zuverlässig erkannt wird, wie eine Unterbrechung in der Antennenleitung **16**. Die Impedanz Z kann sowohl von einem diskreten ohmschen Widerstand R als auch von einer leitfähigen Struktur, wie beispielsweise einer dünnen hochohmigen Leiterbahn gebildet werden, welche im Antennenkörper oder dessen Oberfläche als Widerstandsbahn isoliert gelagert ist. Auch eine komplexe Anordnung, wie eine Induktivität mit einem entsprechend hohen Serienwiderstand, ist vorteilhaft anwendbar.

Gemäß einer besonders vorteilhaften Ausführung ist die Impedanz Z ein ohmscher Widerstand mit einem Wider-

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 89 of 365

standswert annähernd oder gleich dem Quellenwiderstand R_S, so dass wie im vorliegenden Beispiel am Signalkontakt O_S etwa die halbe Quellenspannung U_S liegt. Zwischen dem Signalkontakt O_S und dem HF-Port des Sende/Empfangsteils RF ist ein Koppelkondensator C_K angeordnet, der ein gegenseitiges Beeinflussen der Schaltungsanordnung zum Prüfen und des Sende/Empfangsteils RF verhindert. Der Entkoppelwiderstand R_K verringert die Belastung des hochfrequenten Signalstromkreises I_{HF} durch den Eingang des Fensterkomparators COM.

Fig. 2 zeigt ein Funktelefon **30** mit einem Sende/Empfangsteil RF, welches über einen Antennenwahlschalter **18**, beispielsweise in Form eines Relais, alternativ entweder mit der Antenne **14** oder mit einer Antenne **20** verbunden ist. Im Gegensatz zur zuvor beschriebenen Ausführung weist das Funktelefon **30** neben dem Antennenanschluss **12** einen weiteren Antennenanschluss **22** mit einem Signalkontakt O_S2 auf. Es sei angenommen, dass der Antennenwahlschalter **18** in seiner Ruhelage auf den Signalkontakt O_S1 des Antennenanschlusses **12** geschaltet ist. Dann ist dieser Anschluss mit der Hauptantenne belegt, welche an einem günstigen Empfangs- und Sendeort positioniert ist, und am Antennenanschluss **22** liegt eine Not- oder Ausweichantenne. Jede Antenne **14, 20** ist über eine separate Antennenleitung **16, 24** angeschlossen und enthält einen Nebenpfad mit einer eigenen Impedanz, im vorliegenden Fall die Widerstände R1 bzw. R2. Die Quellenspannung U_S ist bei dieser Ausführung am Ausgang des Antennenwahlschalters **18** angeschlossen, so dass dieser auch die Strompfade für die Prüfströme I_C1 und I_C2 zu den Antennen **14, 20** umschaltet.

Zum Aufbau einer Telefonverbindung hat der Antennenanschluss **12** gegenüber dem Antennenanschluss **22** Vorrang und der Antennenwahlschalter **18** befindet sich überwiegend in der entsprechenden Position. Während dieser Zeit fließt unabhängig von der Aktivität des Signalstroms I_{HF} ständig der Prüfstrom I_C1 zur Antenne **14**, um deren Funktionsbereitschaft zu überwachen. Bei der vorliegenden Ausführung ist der Spannungsauswerter VE eine Fenster-Detektor-Schaltung für Gleichspannungen, die ständig überprüft, ob sich die Prüfspannung U_C am Ausgang des Wahlschalters **18** innerhalb eines Sollbereichs befindet. Besteht am Antennenanschluss **12** ein Kurzschluss oder ein Leerlauf, so liegt die Prüfspannung außerhalb des Sollbereichs und signalisiert, dass die Antenne **14** mit Sicherheit nicht mehr betriebsbereit ist. Dann bewirkt der Spannungsauswerter VE mit seinem Ausgangssignal U_0 sofort ein Umschalten auf die Notantenne, die Antenne **20**, um die Funktionsbereitschaft des Systems wieder herzustellen.

Um auch die Funktionsbereitschaft der Antenne **20** zu überwachen, die bei intakter Antenne **14** nie aktiv ist, schaltet nach einem weiteren Merkmal der Erfindung während der Ruhezeit des Funktelefons **30** eine nicht dargestellte Steuerschaltung über den Steueranschluss S den Antennenwahlschalter **18** periodisch jeweils für eine kurze Dauer vom Signalkontakt O_S1 zum Signalkontakt O_S2 um, ohne dass dabei ein Signalstrom I_{HF} fließt. Dabei fließt der Prüfstrom I_C2 über den Widerstand R2. Liegt beim Umschalten auf Antenne **20** die Prüfspannung U_C wegen eines Fehlers am Antennenanschluss **22** außerhalb des Sollbereichs, so signalisiert das Funktelefon **30**, beispielsweise optisch durch Anzeige in seinem Display und/oder akustisch, dass die Notantenne nicht betriebsbereit ist, um eine Reparatur zu veranlassen. Da bei einem Fehler an der Notantenne das Kommunikationssystem noch funktioniert, wird der Telefonbetrieb unverändert über die Antenne **14** abgewickelt.

Von Vorteil ist, dass die Prüfströme I_C1, I_C2 unabhängig vom Signalstrom I_{HF} fließen, sodass ein Umschalten auf die Antenne **20** unmittelbar nach dem Ausfall der Antenne **14** möglich ist. Ein weiterer Vorteil der Schaltung nach **Fig. 2** besteht darin, dass auch die Funktionsbereitschaft des Antennenwahlschalters **18** ständig geprüft wird.

Gemäß einer Erweiterung der Erfindung weisen die Widerstände R1 und R2 in den Nebenpfaden abhängig von den Bauformen der Antennen **14, 20** verschiedene Widerstandswerte auf. Dadurch kann die Steuerschaltung des Funktelefons **30** oder eine beim Montieren der Antennen am Funktelefon angeschlossene externe Prüfvorrichtung die Antennenbauformen automatisch erkennen, die an den Antennenanschlüssen **12** und **22** angeschlossen sind. Dieses ermöglicht ein entsprechendes Anzeigen von vertauscht angeschlossenen Antennen **14** und **20** und/oder eine entsprechende interne Korrektur mit dem Antennenwahlschalter **18**. Letzteres erlaubt die Antennenanschlüsse **12** und **22** beim Montieren beliebig zu belegen. Dafür wird vorteilhaft der Antennenwahlschalter **18** als Stromstoßrelais oder Ähnliches ausgeführt, so dass nach dem Identifizieren der angeschlossenen Antennen **14, 20** ein Setzimpuls den Antennenwahlschalter **18** in diejenige von zwei Positionen setzt, in der äußerlich eine bevorzugte Antenne (**14**), also die Hauptantenne, angeschlossen ist.

Auch eine einfache Anzeige, dass eine falsche Antennenbauform montiert wurde, ist damit zu realisieren.

Da die Sendeleistung bei Autotelefonen gegenüber herkömmlichen Mobiltelefonen etwa das Vierfache beträgt, können damit ausserdem auch Maßnahmen gegen eine unzulässig hohe Sendefeldstärke im Fahrzeuginneren ausgelöst werden. Gewöhnlich wird die Hauptantenne eines Autotelefons außerhalb der Fahrzeugkarosserie in einem Abstand zu den Insassen angebracht, um bei dieser Sendeleistung unter anderem auch den Einfluss auf die Fahrzeuginsassen gering zu halten. Erhält nach dem Ausfall der Hauptantenne die Hilfsantenne im Fahrzeuginneren die gleiche Leistung, so kann dort ein starkes Sendefeld eine Gefahr für die Gesundheit der Insassen darstellen. Auch ungünstige Mehrfachreflexionen an den Innenflächen der Karosserie können die Ausbreitung des Sendesignals stören. Beim Erkennen einer solchen Antenne, veranlasst beispielsweise die Steuerschaltung das Sende/Empfangsteil RF, am aktiven Antennenanschluss die Sendeleistung zu reduzieren. Dieses erfolgt vorrangig dann, wenn beispielsweise nach einem Besuch einer Autowaschanlage vergessen wurde, die abnehmbare Außenantenne wieder zu montieren und der normale Telefonbetrieb über die Notantenne läuft. Beim Auslösen eines Notrufes sollte jedoch das Sende/Empfangsteil RF die der von der Basisstation geforderte maximale Leistung bereitstellen.

Bei dieser Erfindungsausführung weist der Spannungsauswerter VE für jede Antennenbauform ein separates Detektorfenster auf.

Es versteht sich von selbst, dass in der Praxis der Spannungsauswerter VE in der digitalen Steuerschaltung des Funktelefons enthalten sein kann. In einem solchen Fall, liegt am seinem Eingang ein Analog/Digitalwandler zum Wandeln der Prüfspannung U_C in einen Digitalwert. Die Fenster werden durch einen bzw. mehrere Wertebereiche von Digitalwerten dargestellt und der am Wandlerausgang liegende Digitalwert wird geprüft, ob er in dem bzw. einem dieser Wertebereiche liegt. Als weitere Alternative zu den genannten Spannungsauswertern VE sind auch Meßschaltungen für Wechselspannungsamplituden denkbar, sofern eine Wechselstromquelle die Prüfströme I_C1 und I_C2 generiert.

Die **Fig. 3a** bis **3c** zeigen weitere Ausführungen der Erfindung. Diese haben den Vorteil, dass die Funktionsbereitschaft beider Antennen **14** und **20** sowohl während des Funk/Sendebetriebes als auch im Stand-by des Funktelefons

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 90 of 365

40 durch die Prüfströme I_C1 und I_C2 kontinuierlich überwacht wird. Dafür weist das Funktelefon 40 im Gegensatz zum Funktelefon 30 für jeden Antennenanschluss 12, 23 einen separaten Quellenwiderstand R_S1 bzw. R_S2 auf, welcher direkt am entsprechenden Signalkontakt O_S1 und O_S2 angeschlossen ist. Die Ausführung nach Fig. 3a enthält auch für jeden Antennenanschluss 12, 22 einen separaten Spannungsauswerter VE1 und VE2, der jeweils über einen Entkoppelwiderstand R_K1 bzw. R_K2 mit dem entsprechenden Signalkontakt O_S1 und O_S2 verbunden ist.

In Abhängigkeit von den entsprechenden Prüfspannungen U_C1 und U_C2 zeigt ein Indikationssignal U_O1 ständig die Funktionsbereitschaft von Antenne 14 und ein Indikationssignal U_O2 die Funktionsbereitschaft von Antenne 20 an.

Im Gegensatz dazu, benötigen die Ausführungen nach Fig. 3b und Fig. 3c nur den Spannungsauswerter VE1. Gemäß eines weiteren Merkmals der Erfindung werden alle möglichen Kombinationen aus funktionierenden und/oder fehlerhaften Antennenanschlüssen 12 und 22 durch einen entsprechenden Spannungswert identifiziert, der nur bei der bestimmten Kombination auftritt. Dazu führen die Entkoppelwiderstände R_K1 und R_K2 die Prüfspannungen U_C1 und U_C2 bzw. U_C3 und U_C4 beider Antennenanschlüsse 12 und 22 zusammen, wobei ein Entkoppelwiderstand um ein Mehrfaches n größer ist als der andere, beispielsweise $R_K2 = 3\ R_K1$. Ausserdem sind beide Entkoppelwiderstände R_K1 und R_K2 um ein Vielfaches größer als die Widerstände R1 und R2 in den Nebenpfaden und die Eingangsschaltung des Spannungsauswerter VE1 weist einen Elektrometereingang auf, d. h. einen sehr hohen Eingangswiderstand $R_{IN} \gg R_K2$. Bei diesen Bedingungen tritt folgender nützliche Effekt auf:

- Solange an beiden Antennenanschlüssen 12 und 22 gleiche Anschlussbedingungen vorliegen, bleibt in Folge des Elektrometereingangs das Widerstandsverhältnis $R_K1 : R_K2$ ohne Einfluss auf die Höhe der Eingangsspannung U_{IN} für den Spannungsauswerter VE1. Fehlen beide Antennen 14, 20, so stellt sich die Eingangsspannung $U_{IN} = U_C$ ein. Sind beide Antennen funktionsbereit und die Widerstände $R1 = R_S1$ und $R2 = R_S2$, so ist die Eingangsspannung $U_{IN} = 0{,}5\ U_C$, und wenn beide Antennen kurzgeschlossen sind, dann stellt sich die Eingangsspannung $U_{IN} = 0$ ein.
- Liegen an den Antennenanschlüssen 12 und 22 jedoch ungleiche Impedanzen, so entsteht folglich auch eine Differenz ΔU_C zwischen den Prüfspannungen U_C1 und U_C2, welche Einfluss auf die Eingangsspannung U_{IN} hat. Die Entkoppelwiderstände R_K1 und R_K2 bilden für diese Differenz einen Spannungsteiler, und addieren die geteilte Spannungsdifferenz ΔU_C zur kleinsten Prüfspannung U_C1 oder U_C2 hinzu.

Auf Grund der ungleichen Entkoppelwiderstände R_K1 und R_K2 wird für die Differenz ΔU_C in Abhängigkeit von dem Antennenanschluss, an dem die höchste Prüfspannung U_C1 oder U_C2 liegt, jeweils ein anderes Teilerverhältnis wirksam.

Nach der Montage kann jede Antenne 14 und 20 einen von drei möglichen Anschlusszustände: "Leerlauf", "betriebsfähig" oder "kurz geschlossen" aufweisen. Damit ergeben sich neben der Möglichkeit, dass beide Antennen betriebsfähig sind, acht weitere mögliche Kombinationen, bei denen mindestens eine Antenne nicht betriebsfähig ist. Für alle diese Kombinationen nimmt die Eingangsspannung U_{IN} je nach Zuordnung der Antennen zu den Antennenanschlüssen 12, 22 einen für jede Kombination typischen, von den drei vorgenannten Fällen abweichenden Spannungswert an. Dieser ermöglicht auf Grund der typischen Höhe ein eindeutiges Zuordnen jeder Störung zum entsprechenden Antennenanschluß.

Fehlt beispielsweise die Antenne 14 und ist die Antenne 20 funktionsfähig, so beträgt die Prüfspannung $U_C1 = U_S$, die Prüfspannung $U_C2 = 0{,}5\ U_S$ und die Differenz $\Delta U_C = 0{,}5\ U_S$. Die Differenz ΔU_C wird im Teilerverhältnis $N1 = R_K2 : (R_K1 + R_K2)$ geteilt. Mit dem genannten Verhältnis der Entkoppelwiderstände $R_K2 = 3\ R_K1$ wird $N1 = 3\ R_K1 : (R_K1 + 3\ R_K1)$, d. h., $N1 = 3 : 4 = 0{,}75$. Somit ist die Eingangsspannung $U_{IN} = U_C2 + 0{,}75\ \Delta U_C$, $U_{IN} = 0{,}5\ U_S + 0{,}5 = 0{,}75\ U_S = 0{,}5\ U_S + 0{,}375\ U_S = 0{,}875\ U_S$.

Fehlt jedoch die Antenne 20 und ist die Antenne 14 funktionsfähig, so beträgt die Prüfspannung $U_C1 = 0{,}5\ U_S$, die Prüfspannung $U_C2 = U_S$ und die Differenz $\Delta U_C = 0{,}5\ U_S$. Die Differenz ΔU_C wird jetzt jedoch im Teilerverhältnis $N2 = R_K1 : (R_K1 + R_K2)$ geteilt. Dann ist $N2 = R_K1 : (R_K1 + 3\ R_K1) = 1 : 4 = 0{,}25$ und die Eingangsspannung $U_{IN} = U_C2 + 0{,}25\ \Delta U_C$, D. h. die Eingangsspannung $U_{IN} = 0{,}5\ U_S + 0{,}125\ U_S = 0{,}625\ U_S$ unterscheidet sich eindeutig von der bei der vorangegangenen Kombination.

Ist jedoch Antenne 20 kurzgeschlossen und Antenne 14 funktionsfähig, so beträgt die Prüfspannung $U_C1 = 0$, die Prüfspannung $U_C2 = 0{,}5\ U_S$ und die Differenz ebenfalls $\Delta U_C = 0{,}5\ U_S$. Da die kleinste Prüfspannung $U_C1 = 0$ beträgt und das Teilerverhältnis $N2 = 1 : 4$ wirksam ist stellt sich $U_{IN} = 0{,}125\ U_S$ ein.

Wäre jedoch die Antenne 14 kurz geschlossen und Antenne 20 funktionsfähig, so wäre wegen des Teilerverhältnisses $N2 = 1 : 4$ die Eingangsspannung $U_{IN} = 0{,}375\ U_S$.

Aus dem dargelegten ist ersichtlich, dass jede mögliche Kombinationen mit mindestens einem gestörten Antennenanschluss 12 oder 22 die Eingangsspannung U_{IN} einen für diese Kombination typischen Spannungswert annimmt. Dieses ist insbesondere bei der Montage der Antennen 14 und 20 am Funktelefon 40 vorteilhaft, weil dabei auch an beiden Antennenanschlüssen 12, 22 ein Fehler auftreten kann. Der Spannungsauswerter VE1 hat in diesem Fall als Teil der Steuerschaltung des Funktelefons 40 die Aufgabe, den digitalisierten Wert der Eingangsspannung U_{IN} mit fest gespeicherten Wertebereichen zu vergleichen und ein Datensignal DS auszugeben, welches eindeutig den aktuellen Zustand der Belegung der Antennenanschlüsse 12 oder 22 identifiziert. Dieses Signal nutzt die Steuerschaltung des Funktelefons 40 oder eine während der Montage angeschlossene Analyseeinrichtung zur Fehleranzeige. Dabei wird jedem Anschluss sein aktueller Zustand eindeutig zugeordnet. Selbst extreme Fehleranzeigen, wie zum Beispiel "Hauptantenne unterbrochen oder nicht vorhanden! - Notantenne kurzgeschlossen!" können somit realisiert werden.

Fig. 3c zeigt darüber hinaus zwei weitere Merkmale der Erfindung. Die Ausführung von Fig. 3c basiert auf der Ausführung nach Fig. 3b und berücksichtigt die Tatsache, dass die vorliegende Anzahl von insgesamt neun möglichen Kombinationen von fehlerfreien und fehlerhaften Antennenanschlüssen 12, 22 nur kostengünstig mit einem Mikrocomputer auszuwerten ist, der mit einem Analog/Digitalwandler verbunden ist. Nachteilig ist jedoch, dass viele Analog/Digitalwandler von Mikrocomputern auf Grund einer asymmetrischen Spannungsversorgung nur fehlerfrei arbeiten, wenn die Eingangsspannung U_{IN} oberhalb eines Mindestwertes liegt. Um diesen Mangel auf einfache Weise zu beheben, liegen nach einem weiteren Merkmal der Erfindung in Serie zu den Quellenwiderständen R_S1 und R_S2 Vorwiderstände R_V1 und R_V2 und die Entkoppelwiderstände R_K1 und R_K2 sind an den Verbindungspunkten der Serienschaltung angeschlossen. Dadurch enthalten die Prüfspannungen U_C3 und U_C4 selbst bei einem Kurzschluss des Antennenanschlusses 12 oder 22 den Mindestwert, den der

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 91 of 365

Prüfstrom I_C1 bzw. I_C2 an den Vorwiderständen R_V1 und R_V2 bewirkt, so dass der Analog/Digitalwandler des Spannungsauswerters VE1 fehlerfrei arbeitet.

Nach einem weiteren Merkmal der Erfindung werden diese Vorwiderstände R_V1 und R_V2 benutzt, um zusätzlich zu den genannten neun möglichen Kombinationen der Antennenzustände auch den Fall zu identifizieren, bei dem beide Antennen **14**, **20** vertauscht angeschlossen sind. Dieses wird dadurch erreicht, dass zum Einen die Antennen **14** und **20** entsprechend ihren Bauformen, wie bereits dargestellt, in den Nebenzweigen verschiedene Widerstände R1, R2 aufweisen und zum Anderen die Werte für die Vorwiderstände R_V1 und R_V2 so ausgewählt werden, dass für beide Antennenanschlüsse **12**, **22** die Summe aus dem entsprechenden Widerstand R1 bzw. R2 im Nebenzweig und dem dazu in Serie liegenden Vorwiderstand R_V1 bzw. R_V2 einander gleich sind, also $R1 + R_V1 = R2 + R_V2$ ist. Dieses hat den Vorteil, dass die genannten typischen Spannungswerte für die Eingangsspannung U_{IC} an einer intakten Antenne nur dann auftreten, wenn die Antennen **14**, **20** an den Antennenanschlüssen **12**, **22** nicht vertauscht sind. Als günstige Widerstandverhältnisse haben sich beispielsweise erwiesen: $R_S1 = R_S2$; $R_S1 = R1 + R_V1$ und $R_S2 = R2 + R_V2$, wobei in einem Nebenzweig beispielsweise $R1 = 0{,}5\ R_S1$ und $R_V1 = 0{,}5\ R_S1$ und im anderen $R2 = 0{,}75\ R_S1$ und $R_V2 = 0{,}25\ R_S1$ vorteilhafte Werte sind. Es ist offensichtlich, das beim korrekten Anschluss beider Antennen **14**, **20** die Prüfspannungen $U_C3 = U_C4 = 0{,}5\ U_S$ betragen, während bei vertauschten Antennen **14**, **20** diese sich wie das Verhältnis der Summen $(R2 + R_V1) : (R1 + R_V2) = (0{,}75 + 0{,}5) : (0{,}5 + 0{,}25) = 1{,}25 : 0{,}75 = 5 : 3$ verhalten.

Ein weiterer Vorteil der Lösung gemäß der Erfindung besteht darin, dass sowohl die Quellenwiderstände R_S1 und R_S2 als auch die Widerstände R1 und R2 in den Nebenpfaden so groß gewählt werden können, dass die Prüfströme I_C1 und I_C2 die Betriebsstromversorgung des Funktelefons **10**, **30** bzw. **40** nur unbedeutend belasten. In der Praxis liegen beispielsweise die Quellenwiderstände R_S, R_S1 und R_S2 und die Widerstände R1 und R2 bei etwa 10 kΩ und die Prüfströme I_C1 und I_C2 unter 1 mA. Darüber hinaus sind die Koppelwiderstände R_K, R_K1 und R_K2, die Quellenwiderstände R_S, R_S1 und R_S2 und die Widerstände R1 und R2 so bemessen, dass auch der Einfluss der gesamten Erkennungsschaltung auf den HF-Stromkreis des Funktelefons **10**, **30** bzw. **40** minimal ist. Ein weiterer Vorteil der Erfindung besteht darin, dass auch angezeigt wird, wenn bei der Montage des Fahrzeugs an den Antennenanschlüssen **12**, **22** ein falscher Antennentyp angeschlossen wird, Beispielsweise eine Rundfunkantenne, die keinen Nebenpfad aufweist.

Die **Fig.** 4 bis 8 zeigen verschiedene Formen von Antennen für die Schaltung gemäß der Erfindung. Die Antennen in den **Fig.** 4 bis 6 sind sogenannte λ/4-Vertikalstrahler mit einer Stablänge $l1 = \lambda/4$. Dabei bezeichnet λ die Übertragungswellenlänge.

Fig. 4 zeigt eine besonders kostengünstige Ausführung für eine Antenne mit einem Widerstand R unmittelbar zwischen dem HF-Anschluss Si und dem Masseanschluss GND. Die Box **26** stellt eine nichtleitende Umhüllung für den Bereich des Fußpunktes dar, welche den Widerstand R mechanisch fest mit dem Stabstrahler verbindet. Damit bewirkt ein Abbrechen der Antenne **14** an einer konstruktiv geplanten Sollbruchstelle im Bereich der Fußpunkthalterung oder eine Demontage auch das Fortfallen des Nebenpfades mit dem Widerstand R und führt damit zum gewünschten Erkennen durch die Schaltung im Funktelefon **10**, **30** oder **40**.

Während die Antenne gemäß der Ausführung nach **Fig.** 4 eine konstruktive Maßnahme erfordert, welche ein Abbrechen am Fußpunkt sichert, kann die Antenne gemäß **Fig.** 5 an beliebiger Stelle brechen. Dazu liegt zwischen einem Anschlusspunkt an der Antennenspitze **28** und dem Masseanschluss GND eine Impedanz mit verteilten Komponenten, im vorliegenden Fall eine Serienschaltung aus mindestens zwei Einzelwiderständen Ra und Rb. Diese Ausführung ermöglicht, außen am Antennenkörper einen Nebenpfad mit diskreten ohmschen Widerständen anzubringen. Um HF-Aktivitäten der Zuleitungen zu den verteilten Einzelwiderständen Ra und Rb als Antennenelement zu unterdrücken, können deren Zuleitungslängen l2 bis l4 so gewählt werden, dass jede kürzer als λ/10 ist. Entsprechend der gewünschten Strahlungscharakteristik der Antenne kann es auch vorteilhaft sein, die Zuleitungslänge **12** besonders kurz auszuführen und die verbleibende Restlänge:
$l_R = l_1 - l_2$ – (Länge der Einzelwiderstände Ra + Rb) auf die Zuleitungslängen l3 und l4 zu verteilen. Bei dieser Antennenausführung umschließt die nichtleitende Umhüllung den gesamten Strahlerstab mit den Einzelwiderständen Ra + Rb und deren Zuleitungen.

Fig. 6 zeigt einen Stabstrahler **32**, der als Hohlkörper ausgeführt ist. Dieser weist am freien Ende einen Kopf **34** mit einem erweiterten Durchmesser auf. Im Hohlkörper **32** ist der Nebenpfad mit einem Widerstand R untergebracht. Die Lage des Widerstandes R im Kopf **34** gewährleistet auch bei dieser Ausführung die Funktion der Schaltung, wenn der Stabstrahler **32** an beliebiger Stelle abbricht. Infolge der Innenlage des Nebenpfades ist ein Einfluss auf die Strahlungscharakteristik der Antenne nicht zu erwarten. Lediglich die Länge l1 des Stabstrahler **32** muss infolge der höheren Raumkapazität des Kopfes **34** gegen Erde etwas verkürzt werden.

Bei der Antenne gemäß **Fig.** 7 führt der Nebenpfad mit dem Widerstand R ebenfalls durch das Innere des Strahlers **36**. Als Strahler **36** wird jedoch ein für den HF-Kreis einseitiges offenes Leiterwendel benutzt, dessen Länge wesentlich kürzer ist als bei einem Stabstrahler.

An Hand von **Fig.** 8 wird gezeigt, dass das Prinzip der Erfindung auch bei λ/2-Dipolantennen anwendbar ist, die an den Enden offen sind. Die vorliegende Ausführung zeigt einen λ/2-Vertikalstrahler in Form eines axial gespeisten Dipols. Die Anordnung des Nebenpfades entspricht der Ausführung gemäß **Fig.** 5. Ebenso kann der Nebenpfad bei λ/2-Dipolantennen auch entsprechend den **Fig.** 4 und 6 ausgeführt werden.

Fig. 9 zeigt die Ausführung einer Flächenantenne, wie sie zum Beispiel im Fahrzeuginneren als Notantenne installiert sein kann. Die Dipolflächen **42** und **44** sind gemeinsam mit dem Widerstand R und einem Symmetrierglied BAL auf einer Leiterplatte PB angeordnet. Das Symmetrierglied BAL weist zwischen den Ein- und Ausgängen galvanische Verbindungen auf, zum Beispiel eine Umwegleitung, und ist damit vorteilhaft in die ständige Überwachung der Funktionsbereitschaft der Antenne einbezogen.

Patentansprüche

1. Schaltungsanordnung zum Prüfen der Funktionsbereitschaft mindestens einer Antenne (**14**, **20**) für ein Funktelefon (**10**, **30**, **40**) mit einer Steuerschaltung, einem Prüfstrom (I_C, I_C1, I_C2), den eine Spannungsquelle (U_C) unabhängig von einem Signalstrom (I_{HF}) in einem HF-Pfad über eine Antennenleitung (**16**, **24**) zur Antenne (**14**, **20**) sendet, und mit einer Auswerteeinrichtung (COM, VE) zum Überwachen der Kontinuität des Prüfstroms (I_C, I_C1, I_C2), **dadurch gekennzeichnet**, dass jede Antenne einen Strahler aufweist, welcher mit einem Ende offen in den Raum ragt, und dass an je-

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 92 of 365

dem Strahler zum Rückführen jeweils eines separaten Prüfstroms (I_C, I_C1, I_C2) parallel zum HF-Pfad ein Nebenpfad angeschlossen ist, der eine Impedanz (Z, R, R_1, R_2) aufweist, wobei das Überwachen des Prüfstroms (I_C, I_C1, I_C2) mit einem Spannungsauswerter (COM, VE, VE1, VE2) erfolgt.

2. Schaltungsanordnung nach Anspruch 1, dadurch gekennzeichnet, dass der Nebenpfad mit der Impedanz (Z, R, R_1, R_2) unlösbar mit dem Strahler verbunden ist, so dass ein Abbrechen der Antenne (**14**, **20**) oder eine Demontage auch das Fortfallen des Nebenpfades mit dem Widerstand R bewirkt.

3. Schaltungsanordnung nach Anspruch 1, dadurch gekennzeichnet, dass die Impedanz (Z, R, R_1, R_2) im Nebenpfad über eine im Verhältnis zur Übertragungswellenlänge (λ) kurze Anschlußleitung am Strahler angeschlossen ist.

4. Schaltungsanordnung nach Anspruch 1, dadurch gekennzeichnet, dass die Impedanz (Z, R, R_1, R_2) im Nebenpfad um ein Vielfaches höher ist als der Strahlungswiderstand der Antenne (**14**, **20**).

5. Schaltungsanordnung nach Anspruch 1, dadurch gekennzeichnet, dass im Nebenpfad eine Serienschaltung von separaten Widerständen (Ra, Rb) liegt mit Zuleitungen, deren Längen (**12**, **13**, **14**) kleiner sind als ein Zehntel der Übertragungswellenlänge (λ), so dass die Zuleitungen die Hochfrequenzeigenschaft des Strahlers nicht oder nur unbedeutend beeinflussen.

6. Schaltungsanordnung nach Anspruch 1, dadurch gekennzeichnet, dass der Nebenpfad mit der Impedanz (Z) im Innern des Antennenkörpers liegt.

7. Schaltungsanordnung nach Anspruch 1, dadurch gekennzeichnet, dass der Prüfstrom (I_C, I_C1, I_C2) entweder ein Gleichstrom oder ein Wechselstrom ist, mit einer Wellenlänge, die um ein Vielfaches größer ist als Übertragungswellenlänge (λ) des Signalstroms (I_{HF}).

8. Schaltungsanordnung nach Anspruch 1, gekennzeichnet durch mehrere Antennenanschlüsse (**12**, **22**) für Antennen (**14**, **20**), welche ein Antennenwahlschalter (**18**) alternativ mit einem Sende/Empfangsteil (RF) verbindet und welche von separaten Prüfströmen (I_C1, I_C2) durchflossene Nebenzweige aufweisen.

9. Schaltungsanordnung nach Anspruch 1 oder 8, dadurch gekennzeichnet, dass jeder Nebenpfad mindestens einen ohmschen Widerstand (R, R_1, R_2, Ra, Rb) enthält, und dass zum Prüfen der Funktionsfähigkeit der entsprechenden Antenne (**14**, **20**) der Spannungsauswerter (VE, VE1, VE2) am Antennenanschluss (**12**, **22**) den Ist-Wert der vom Prüfstrom (I_C, I_C1, I_C2) bewirkten Prüfspannung (U_C, U_C1, U_C2) mit einem Sollwert (U_{REF}) vergleicht.

10. Schaltungsanordnung nach Anspruch 8 und 9, dadurch gekennzeichnet, dass die Nebenpfade in Abhängigkeit von der Bauform der Antennen (**14**, **20**) Widerstände (R1, R2) mit verschiedenen Widerstandswerten aufweisen, damit die Steuerschaltung des Funktelefons (**30**, **40**) über den entsprechenden Spannungsauswerter (VE, VE1, VE2) die an den Antennenanschlüssen (**12**, **22**) angeschlossenen Antennen (**14**, **20**) nach ihrer Bauform unterscheidet und deren Belegung automatisch erkennt.

11. Schaltungsanordnung nach Anspruch 10, dadurch gekennzeichnet, dass die Steuerschaltung nach dem Erkennen der Belegung der Antennenanschlüsse (**12**, **22**) den Antennenwahlschalter (**18**) in jene Schalterposition setzt, in der intern der Antennenanschluss mit dem Sende/Empfangsteil (RF) verbunden ist, an dem äußerlich eine bevorzugte Antenne (**14**) angeschlossen ist.

12. Schaltungsanordnung nach Anspruch 10, dadurch gekennzeichnet, dass die Steuerschaltung nach dem Erkennen der Belegung der Antennenanschlüsse (**12**, **22**) eine Fehlermeldung für ein Display generiert und/oder die Ausgangs/Eingangsdaten für die Antennenanschlüsse (**12**, **22**) entsprechend konfiguriert.

13. Schaltungsanordnung nach Anspruch 8 und 9, dadurch gekennzeichnet, dass während des Wartebetriebs des Funktelefons (**30**) eine Steuerschaltung über einen Steuereingang (S) den Antennenwahlschalter (**18**) periodisch jeweils für eine kurze Dauer von einer ersten Antenne (**14**) zu einer zweiten Antenne (**20**) umschaltet, um auch die Funktionsfähigkeit der zweiten Antenne (**20**) zu prüfen.

14. Schaltungsanordnung nach Anspruch 8 und 9, dadurch gekennzeichnet, dass für die Prüfspannung (U_C1, U_C2) jedes Antennenanschlusses (**12**, **22**) je ein separater Spannungsauswerter (VE1, VE2) vorhanden ist.

15. Schaltungsanordnung nach Anspruch 8 und 9, dadurch gekennzeichnet, dass Entkoppelwiderstände R_K1 und R_K2 die Prüfspannungen (U_C1, U_C2 oder U_C3, U_C4) der Antennenanschlüsse (**12**, **22**) zusammenführen, so dass ein Spannungsauswerter (VE1) die gemeinsame Eingangsspannung (U_{IN}) von beiden Antennenanschlüssen (**12**, **22**) analysiert, und dass ein Entkoppelwiderstand größer ist als der andere, um dem Spannungsauswerter (VE1) reine eindeutige Zuordnung von Fehlern an den Antennenanschlüssen (**12**, **22**) zu ermöglichen.

16. Schaltungsanordnung nach Anspruch 15, dadurch gekennzeichnet, dass der Spannungsauswerter (VE1) entsprechend der Anzahl von möglichen Kombinationen von Fehlern an den Antennenanschlüssen (**12**, **22**) verschiedene typische Eingangsspannung (U_{IN}) durch Vergleich mit gespeicherten Wertebereichen erkennt und diese als Datensignal (DS) ausgibt und dass eine Steuerschaltung mit einem Mikrokomputer dem ausgegebenen Datensignal (DS) entsprechende detaillierte Fehlermeldungen generiert und ausgibt.

17. Schaltungsanordnung nach Anspruch 1 oder 1 S, dadurch gekennzeichnet, dass in Serie zu den Quellenwiderständen R_S1 und R_S2 Vorwiderstände R_V1 und R_V2 liegen und dass der Spannungsauswerter (VE1) über Entkoppelwiderstände R_K1 und R_K2 an den Verbindungspunkten der Serienschaltung angeschlossen ist.

18. Schaltungsanordnung nach den Ansprüchen 10 und 17, dadurch gekennzeichnet, dass die Werte für die Vorwiderstände (R_V1, R_V2) so ausgewählt werden, dass für beide Antennenanschlüsse (**12**, **22**) die Summe aus dem entsprechenden Widerstand (R1 bzw. R2) im Nebenzweig und dem dazu in Serie liegenden Vorwiderstand (R_V1 bzw. R_V2) einander gleich sind, um auch den Fall eindeutig zu identifizieren, bei dem beide Antennen **14**, **20** vertauscht angeschlossen sind.

Hierzu 3 Seite(n) Zeichnungen

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 93 of 365

Nummer: DE 199 23 729 A1
Int. Cl.[7]: G 01 R 31/02
Offenlegungstag: 23. November 2000

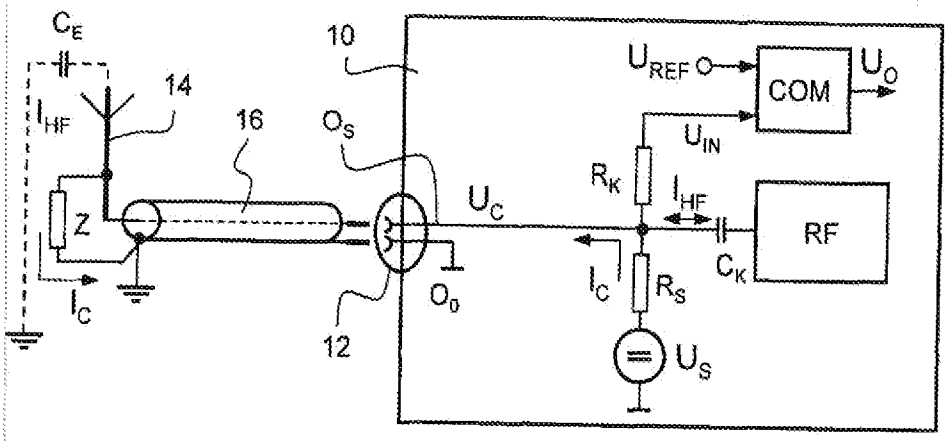


FIG. 1

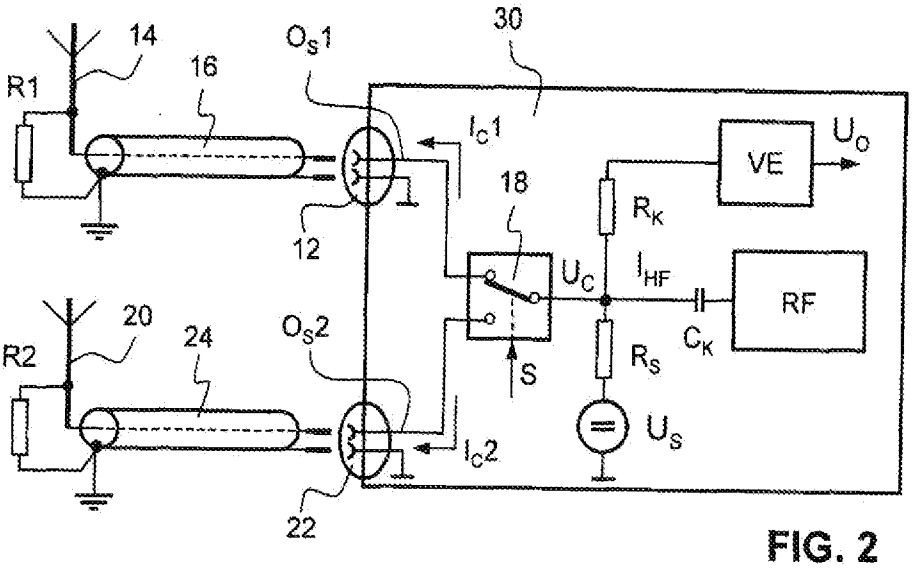


FIG. 2

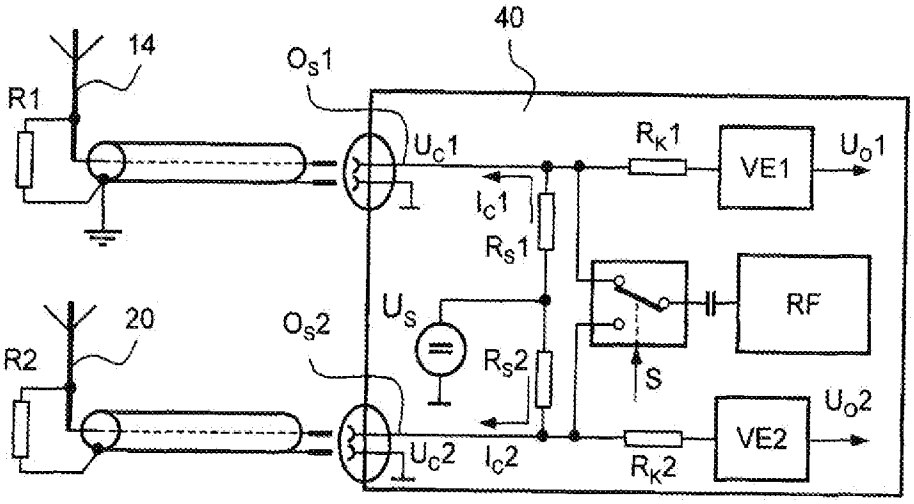


FIG. 3a

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 94 of 365

Nummer: DE 199 23 729 A1
Int. Cl.⁷: G 01 R 31/02
Offenlegungstag: 23. November 2000

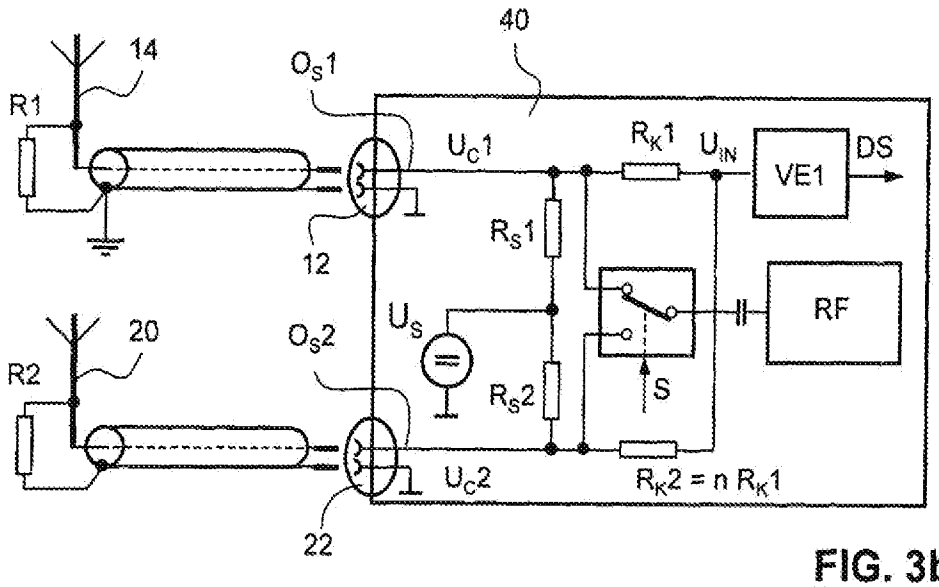


FIG. 3b

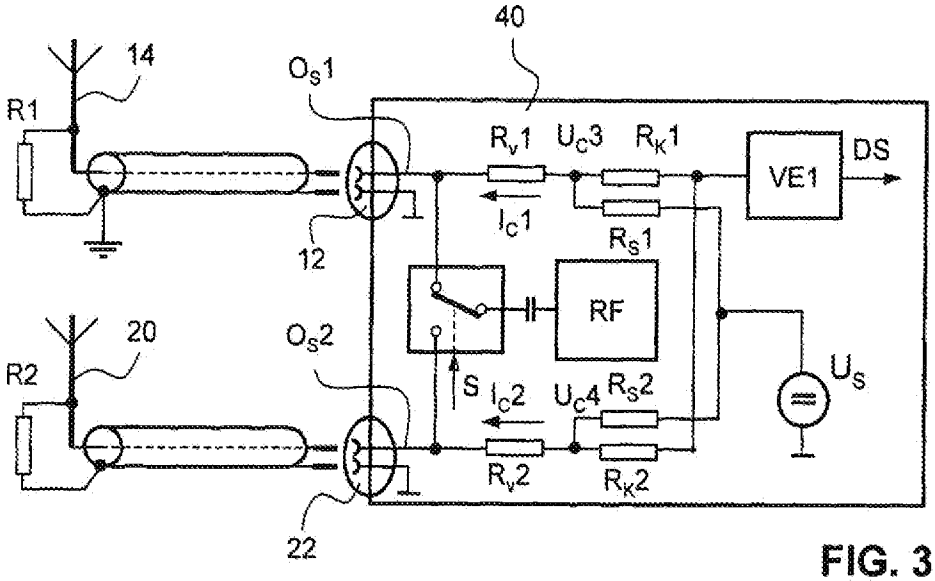


FIG. 3c

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 95 of 365

Nummer: DE 199 23 729 A1
Int. Cl.[7]: G 01 R 31/02
Offenlegungstag: 23. November 2000

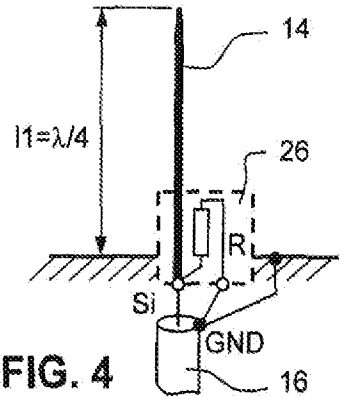


FIG. 4

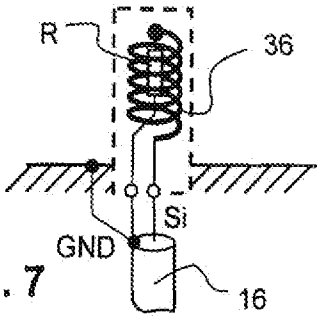


FIG. 7

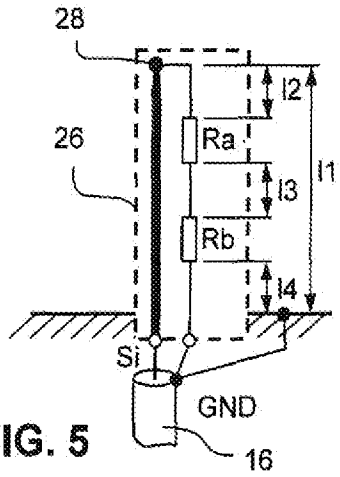


FIG. 5

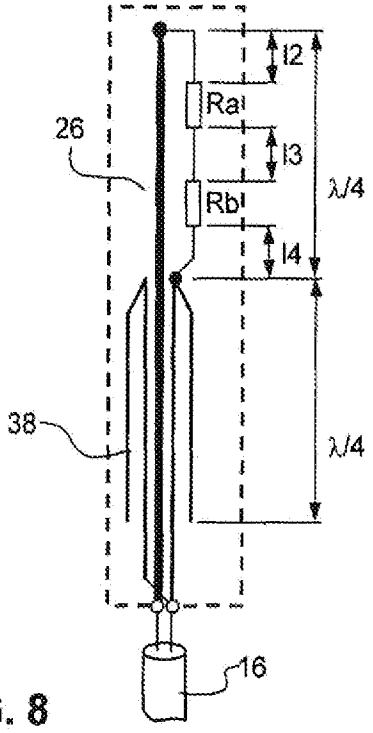


FIG. 8

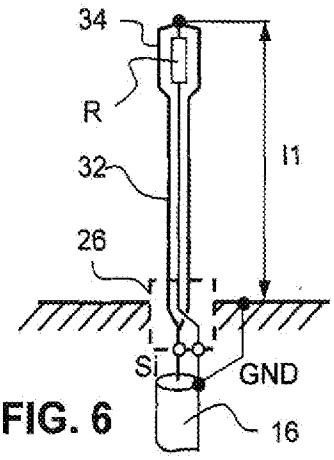


FIG. 6

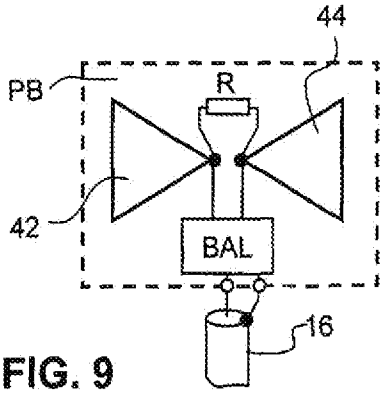


FIG. 9

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 96 of 365

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
11 January 2001 (11.01.2001)

PCT

(10) International Publication Number
WO 01/02871 A1

(51) International Patent Classification[7]: G01R 31/02, H04B 3/46, 1/38

(21) International Application Number: PCT/FI00/00582

(22) International Filing Date: 28 June 2000 (28.06.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
991496 30 June 1999 (30.06.1999) FI

(71) Applicant *(for all designated States except US)*: NOKIA NETWORKS OY [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: MATTURI, Juha [FI/FI]; Sarkkirannantie 49, FIN-90440 Kempele (FI).

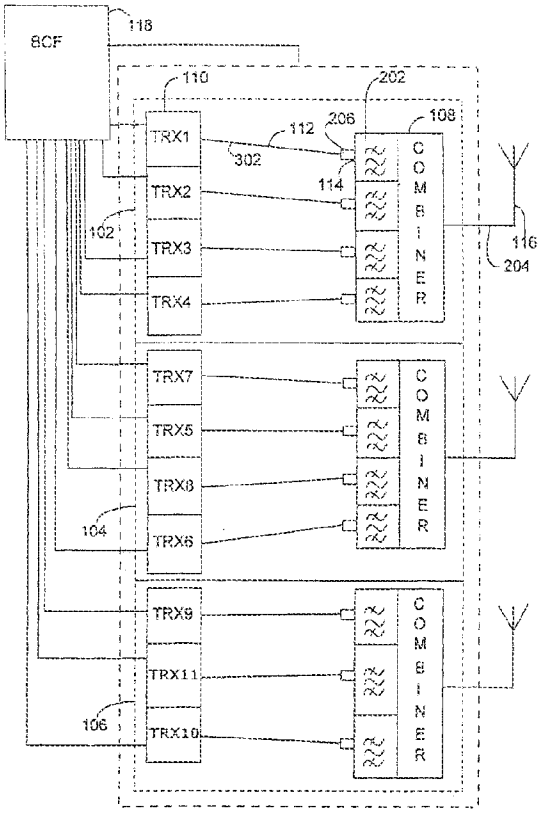
(74) Agent: PATENTTITOIMISTO TEKNOPOLIS KOLSTER OY; c/o Kolster OY AB, Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AT (utility model), AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, CZ (utility model), DE, DE (utility model), DK, DK (utility model), DM, DZ, EE, EE (utility model), ES, FI, FI (utility model), GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KR (utility model), KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (utility model), SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,

[Continued on next page]

(54) Title: METHOD AND ARRANGEMENT FOR CHECKING CABLE CONNECTIONS



(57) Abstract: The invention relates to a method and an arrangement implementing the method for checking cable connections (112) between a transceiver (110) and combiners (108) in a base station of a radio system, in which base station an output of at least two transceivers is connected to the combiner such that each transceiver has a cable connection (112) of its own to a corresponding input (114) in the combiner (108). Each transceiver (110) transmits a different signal to the corresponding input (114) in the combiner (108) by the cable (112). The transceivers (110) connected to the inputs (114) of the combiner, and thus the cable connections (112), are identified on the basis of the different signals received by said inputs.

WO 01/02871 A1

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 97 of 365

IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

--- *With international search report.*

— *Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND ARRANGEMENT FOR CHECKING CABLE CONNECTIONS

FIELD OF THE INVENTION

The invention relates to a method and an arrangement for checking cable connections, the cable connections typically being cable connections in a base station.

BACKGROUND OF THE INVENTION

Generally, base stations in a radio system are sectored. Each sector comprises at least two transceivers and a combiner. A combiner comprises a filtering structure to filter signals as desired. In addition, the combiner comprises a combining structure to combine the filtered signals to the same antenna cable. The transceivers and the combiner are combined by cables such that each transceiver has a cable connection of its own to the combiner. In a prior art method, such combinations are carried out manually, and there has been no way to check the correctness of the connections quickly and reliably. Each cable connection between the transceivers and the combiner has a unique location determined in the combiner. Usually a sector comprises a plurality of transceivers, which means that the sector also comprises a plurality of cable connections to the combiner, as well as inputs for the cables in the combiner. Hence, due to human errors, it is highly probable that the cables become incorrectly combined or do not become combined at all, particularly when a sector in the base station comprises a great number of cable connections. Cables can also be combined to wrong sectors. Since in the prior art method it has not been able to test the combinations quickly and reliably, wrong combinations have caused great financial losses due to delays when wrong or non-existent combinations have been corrected later. Combining a new transceiver to a fully accomplished sector may also have been a problematically time-consuming process.

BRIEF DESCRIPTION OF THE INVENTION

An object of the invention is thus to provide a method and an apparatus implementing the method so as to alleviate the above-mentioned problems. This is achieved by a method of the invention for checking cable connections between transceivers and combiners in a base station of a radio system. In the method, an output of at least two transceivers is connected to a combiner such that each transceiver has a cable connection of its own to a

corresponding input in the combiner. Each transceiver transmits a different signal to the corresponding input in the combiner by the cable, and the transceivers connected to the inputs of the combiner, and thus the cable connections, are identified on the basis of the different signals received by said inputs.

The invention also relates to an arrangement for checking cable connections between transceivers and combiners in a base station of a radio system. The arrangement comprises at least two transceivers, at least two cables and a combiner, each output of the transceivers being connected to an input of its own in the combiner by its own cable connection. Each transceiver is arranged to transmit a different signal to a corresponding input in the combiner by the cable, and the arrangement is arranged to identify the transceivers connected to the inputs of the combiner, and thus the cable connections, on the basis of the different signals received by said inputs.

Preferred embodiments of the invention are disclosed in the dependent claims.

The idea underlying the invention is that each transceiver transmits a different signal to the corresponding input in the combiner by the cable, and the transceivers connected to the inputs of the combiner, and thus the cable connections, are identified on the basis of the different signals received by said inputs. If no one of said different signals is received by an input of the combiner, it is assumed that no transceiver has been connected to said input. The signals can differ in frequencies, and resonators can be provided in the inputs of the combiner to the cable connections from the transceivers. A standing wave according to the frequency of a signal received from the transceiver is then formed in a resonator, and, on the basis of the standing wave, the arrangement and method of the invention are able to identify which transceiver is connected to said resonator located in an input of the combiner. If the arrangement does not find a standing wave in the resonator, no transmitter is connected to the resonator. If no standing wave according to the frequency of a signal transmitted by a transceiver can be found in any resonator, the transmitter is not connected to any resonator in the sector at issue. The arrangement also identifies a transceiver located in another sector. The cable connections are checked by the combiners. If the cable connecting the transceiver and the combiner is provided with a control wiring, the cable connections can be checked, i.e. controlled, also by the transceivers. In such a case, the trans-

ceiver receives information on the cable connection to the combiner by the control wiring. A new transceiver is connected to a fully accomplished sector such that the base station is provided with address information on the new transceiver; consequently, as described above, it can be checked either by the combiners or the transceivers that the new transceiver will be correctly connected to the combiner in its sector. The cable connections are controlled in the above-described manner either by the combiners or the transceivers typically by a base station controller.

The arrangement and method of the invention are used for checking, quickly and reliably, the cable connections between combiners and transceivers in the sectors of a base station. The invention enables the cable connections of the base station to be efficiently configured. The arrangement and method of the invention enable the cable connections between the combiners and the transceivers to be comprehensively defined. The invention can be used to find out whether a cable connection is totally missing or whether it is incorrectly combined, in which case the invention can be used to find out from which transceiver the cable connection originates and whereto the cable connection is connected in the combiner. A potential cable connection between the transceiver and the combiner between different sectors, which is always a wrong connection, can also be tracked down. A further advantage of the invention is that when a new transceiver is connected to a fully accomplished sector of the base station, the correctness of the connection can be quickly checked, which means that the connecting procedure is fast and reliable. The invention ensures quick and successful implementation of the cable connections between the combiners and transmitters in the base station, which results in saving financial resources. Additionally, the arrangement and method of the invention comprise an auto-detecting function, which can be used for monitoring all combiners and transceivers in the base station at desired intervals. Hence, if for some reason or other a cable connection disappears, it will be detected thanks to the auto-detection.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now described in closer detail in connection with preferred embodiments and with reference to the accompanying drawings, in which

Figure 1 shows a sectored structure of a base station,

Figure 2 shows a first preferred embodiment of the invention, and Figure 3 shows a second preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

Generally, base stations of a radio system are sectored, and each sector comprises a combiner and at least two transceivers, the transceivers being connected to the combiner.

Figure 1 shows an example of a sectored structure of a base station, which comprises three sectors 102 to 106, and each of the sectors has a combiner 108, transceivers 110, and cables 112 of its own. In the combiner, a unique input 114 is provided for each transceiver in the sector at issue. Each transceiver is connected to the input in the combiner by its own cable. The cable connections should all take place within the sector. Hence, cable connections from sector to sector between the combiners and the transceivers are incorrect. In addition, for transmitting and receiving, the base station comprises unique antennas 116 for each sector. The number of transceivers may vary in different sectors. A base station controller 118 comprises a configuration of the base station, in other words information indicating how the cable connections in the base station between the transceivers 110 and the combiners 108 should be arranged. When the cables are combined manually, the cables may be connected to a wrong input in the combiner in the correct sector or the cables may be connected to a combiner of another sector, or the cables may not become connected at all.

The sectors 102 to 106 in the base station transmit and receive in transmitting and receiving areas that may overlap. The transmitting and receiving areas may vary in size in the different sectors 102 to 106 in the base station.

Using the arrangement and method of the invention, each transceiver 110 in the base station shown by Figure 1 transmits a different signal by the cable 112 to the corresponding input 114 in the combiner 108. A corresponding input is an input assigned to each transceiver by the base station configuration. The transceivers 110 connected to the inputs 114 in the combiner, and thus the cable connections 112, are identified on the basis of the different signals received by said inputs.

Figure 2 shows a first preferred embodiment of the invention, which comprises similar parts to those shown in Figure 1 and, in addition, parts that

will be introduced in the following. Outputs of the transceivers are typically radio frequency outputs. The transceivers are connected to the combiner from their outputs such that each transceiver has its own cable connection to the corresponding input in the combiner. The combiner comprises filters 202, and usually each transceiver 110 in the sector has a filter of its own. Signals are filtered, typically band-pass filtered, by the filters as desired. The filtered signals are combined by a combining structure 203 of the combiner 108 to a sector-specific, common antenna cable 204. The combiner can be a summing unit, for example a GMSK transmission combiner. GMSK (Gaussian Minimum Shift Keying) transmission is typically used transmission in telecommunications, where a desired number of samples are collected during a given period of time. The samples can be divided into two groups. The samples are processed event by event, and a bit sequence is formed for the actual signal processing, such as decoding. A resonator 206 is provided for each cable connection 112 in the inputs 114 of the combiner from different transceivers 110. The resonator is preferably a cavity resonator. The combiner is preferably used in macrocells having great cell radius, in which case the combiner is used at high transmission power levels, typically being 10 - 100W. In such a case, the cell has a great transmitting and receiving range, or cell radius, which typically means 5 - 35 kilometres at the above-mentioned power range, and the cell can thus be called a macrocell.

The base station controller 118 of the base station typically has a logical structure which knows how the cable connections should be arranged between the combiner 108 and the transceiver 110 in each sector 102 to 106 of the base station. In the first preferred embodiment of the invention shown in Figure 2, the base station controller 118 finds all combiners 108 and transceivers 110 in the base station. The base station controller commands all detected transceivers to transmit a signal to the combiner. Each transceiver transmits a signal with a different frequency to the combiner by the cable 112. The different frequencies can be determined, for example, such that a constant frequency is multiplied by a bit number according to the address of each transceiver. A standing wave is thus generated for each resonator 206 in the input 114 of the combiner which has a cable connection 112 from a transceiver transmitting a frequency signal. The standing wave is a spatially constant wave. A standing wave ratio is the ratio of the maximum and the minimum of the standing wave. Typically, the standing wave is a voltage wave, in

which case, when the standing wave ratio is at issue, the ratio is a ratio of the voltage maximum and the voltage minimum. The arrangement and method of the invention measure preferably the minimum standing wave ratio that can be found in the standing wave. The base station controller 118 finds and measures the minimum standing wave ratios in the resonators 206 and, on the basis of the minimum standing wave ratios, identifies which transceiver is combined to which resonator by the cable. The cables have their unique, determined positions, or resonators, in the combiner. The base station controller thus identifies if a resonator has a cable connection from a wrong transceiver. If the base station controller does not find a standing wave in a resonator at all, and thus no minimum standing wave ratio either, no transceiver has a cable connection to the resonator. The base station controller can also identify a transceiver incorrectly connected from another sector. If the base station controller does not find, in any cavity resonator, a minimum standing wave ratio according to the frequency of a transceiver, the transceiver is not connected to any cavity resonator of the combiner in the sector at issue. In the first preferred embodiment of the invention, the standing wave minimums are searched and found, and the transceivers are identified on the basis of the standing wave minimums by the combiner of each sector. The aforementioned information on the cable connections include comprehensive information on the cable connections between the combiner and the transceiver in the different sectors of the base station. The information is collected from the combiners of the different sectors to the base station controller 118, which checks whether or not the cable connections conform with the logical configuration, i.e. the correct cable connections. The information on the cable connections is processed by microprocessors in the base station controller, and, as a result, potential incorrectly connected cable connections in the base station can be found.

In a second preferred embodiment of the invention shown by Figure 3, the cables 112 connecting the transceivers 110 in the sectors 102 to 106 of the base station and the combiner 108 are provided with a control wiring 302. The second preferred embodiment of the invention is otherwise similar to the first preferred embodiment of the invention shown in Figure 2 except that in this case, the cable connections between the transceivers and the combiners are controlled by the transceivers. The transceiver transmits by the cable a signal having, for example, a constant frequency multiplied by a bit number

according to the address of the transceiver at issue. By using the control wiring, the transceiver receives the information on the minimum standing wave ratio from the resonator 206, preferably a cavity resonator, located in the input 114 of the combiner, which thus indicates that a cable connection to the combiner exists. If, in the above-mentioned situation, the transceiver does not receive a minimum standing wave ratio according to the transmitted frequency, no cable connection to the combiner exists. Since in this embodiment the cable connections are controlled by the transceivers, the combiner 108 can be a so-called dumb unit, in other words the amount of necessary logic therein can be considerably lower than in the first preferred embodiment of the invention. The role of the base station controller in the second preferred embodiment of the invention can be similar to that in the first preferred embodiment of the invention, but the cable connections are controlled by the transceivers, as described above.

The standing wave can have combiner- and resonator-specific differences, and, consequently, the signals transmitted by the transceivers to the combiner should have sufficiently different frequencies so as to ensure that the transceivers are identified correctly. In view of the above, it can be determined that in the preferred embodiments of the invention, the signals transmitted by the transceivers should have a frequency difference of at least 1 MHz between different transceivers. In the GSM, said frequency difference of 1 MHz can be determined such that it is five times an ARFN (Absolute Radio Frequency number). In the second preferred embodiment of the invention, the necessity for the above-disclosed minimum frequency difference can also be caused by the control wiring and the properties of the transceiver side.

Using the preferred embodiments of the invention, a new transceiver can be connected to a fully accomplished sector of a base station quickly and reliably. The address of the new transceiver in the base station configuration is programmed to said new transceiver. Similarly, a configuration or an addition thereof also comprising the new transceiver is programmed to the base station, typically to the base station controller in the base station. After the new transceiver has been connected to the combiner, a checking procedure can take place to check whether or not the new transceiver is connected to the combiner of its sector according to the configuration.

The base station, typically the base station controller in the base station, may carry out auto-detection, which means that at desired intervals it

can be monitored which transceivers and combiners are interconnected in the base station. Similarly, it can also be checked how the connections are arranged. The auto-detection is important if, for example, a cable connection for some reason or other disappears. After the new transceiver has been connected to the base station, auto-detection can be used for checking whether or not the new transceiver is correctly connected to the base station, in other words according to the correct base station configuration. Also the auto-detection can be carried out by the base station controller either by the combiners or the transceivers.

Although the invention has been described above with reference to the examples in accordance with the accompanying drawings, it is obvious that the invention is not restricted thereto but can be modified in many ways within the scope of inventive idea disclosed in the attached claims.

CLAIMS

1. A method of checking cable connections (112) between transceivers (110) and combiners (108) in a base station of a radio system, in which base station an output of at least two transceivers is connected to a combiner (108) such that each transceiver has a cable connection (112) of its own to a corresponding input (114) in the combiner (108), **characterized** in that

each transceiver (110) transmits a different signal to the corresponding input (114) in the combiner (108) by the cable (112), and

the transceivers (110) connected to the inputs (114) of the combiner, and thus the cable connections (112), are identified on the basis of the different signals received by said inputs.

2. A method as claimed in claim 1, **characterized** in that if no one of said different signals is received by an input (114) of the combiner (108), it is assumed that no transceiver (110) has been connected to said input.

3. A method as claimed in claim 1 or 2, **characterized** in that the different signals differ in frequency.

4. A method as claimed in claim 3, **characterized** in that at least one transceiver (110) transmits a signal whose frequency is multiplied by a bit number according to the address of said transceiver.

5. A method as claimed in claim 3, **characterized** in that at least two inputs (114) of the combiner (108) each comprises a resonator (206), which is preferably a cavity resonator.

6. A method as claimed in claim 5, **characterized** in that the received signal forms a standing wave in the resonator (206).

7. A method as claimed in claim 6, **characterized** in that the transceiver (110) connected to the resonator (206) is identified on the basis of the standing wave, preferably on the basis of a minimum standing wave ratio.

8. A method as claimed in claim 7, **characterized** in that if no standing wave is found in the resonator (206), no transceiver (110) has been connected to said resonator.

9. A method as claimed in claim 1, **characterized** in that a transceiver (110) belonging to another sector is also identified.

10. A method as claimed in claim 6, **characterized** in that if no standing wave according to the frequency of a signal transmitted by a

transceiver (110) is found in any resonator (206), said transmitter is not connected to any resonator (206) in said sector.

11. A method as claimed in claim 1, **characterized** in that the transceivers (110) and the cable connections (112) are identified by at least one combiner (108).

12. A method as claimed in claim 1, **characterized** in that the cables (112) comprise a control wiring (302).

13. A method as claimed in claim 12, **characterized** in that the cable connections (112) are identified by the transceivers (110).

14. A method as claimed in claim 11 or 13, **characterized** in that a base station controller (118) controls the cable connections (112).

15. An arrangement for checking cable connections (112) between transceivers (110) and combiners (108) in a base station of a radio system, which arrangement comprises at least two transceivers, at least two cables and a combiner (108), each output of the transceivers being connected to an input (114) of its own in the combiner (108), each output by its own cable connection (112), **characterized** in that

each transceiver (110) is arranged to transmit a different signal to the corresponding input (114) in the combiner (108) by the cable (112), and

the arrangement is arranged to identify the transceivers (110) connected to the inputs (114) of the combiner (108), and thus the cable connections (112), on the basis of the different signals received by said inputs.

16. An arrangement as claimed in claim 15, **characterized** in that each transceiver (110) is arranged to transmit a different signal having a different frequency.

17. An arrangement as claimed in claim 16, **characterized** in that at least one transceiver (110) is arranged to transmit a signal whose frequency is multiplied by a bit number according to the address of said transceiver.

18. An arrangement as claimed in claim 16, **characterized** in that at least two of the inputs (114) of the combiner (108) each comprises a resonator (206), which is preferably a cavity resonator.

19. An arrangement as claimed in claim 18, **characterized** in that the arrangement is arranged to identify the transceiver (110) connected to the resonator (206) on the basis of a standing wave, preferably on the basis of a minimum standing wave ratio.

20. An arrangement as claimed in claim 15, **characterized** in that the arrangement is also arranged to identify a transceiver (110) belonging to another sector.

21. An arrangement as claimed in claim 15, **characterized** in that the arrangement is arranged to identify the transceivers (110) and the cable connections (112) by at least one combiner (108).

22. An arrangement as claimed in claim 15, **characterized** in that the cables (112) comprise control wirings (302).

23. An arrangement as claimed in claim 22, **characterized** in that the arrangement is arranged to identify the cable connections (112) by the transceivers (110).

24. An arrangement as claimed in claim 21 or 23, **characterized** in that the arrangement is arranged to control the cable connections (112) by a base station controller (118).

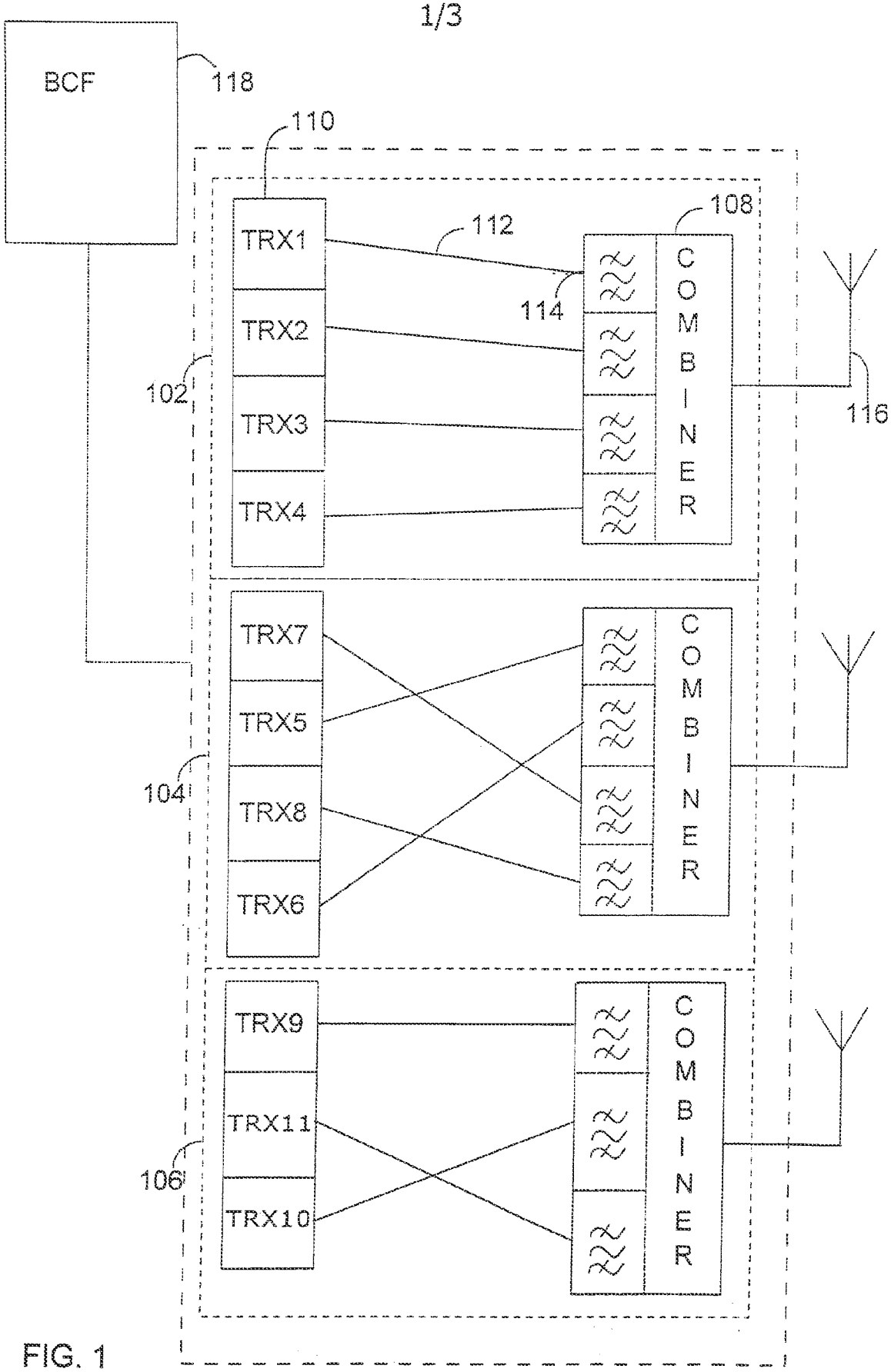

BCF
118
110
108
112
114
TRX1
TRX2
TRX3
TRX4
102
COMBINER
116
TRX7
TRX5
TRX8
TRX6
104
COMBINER
TRX9
TRX11
TRX10
106
COMBINER

FIG. 1

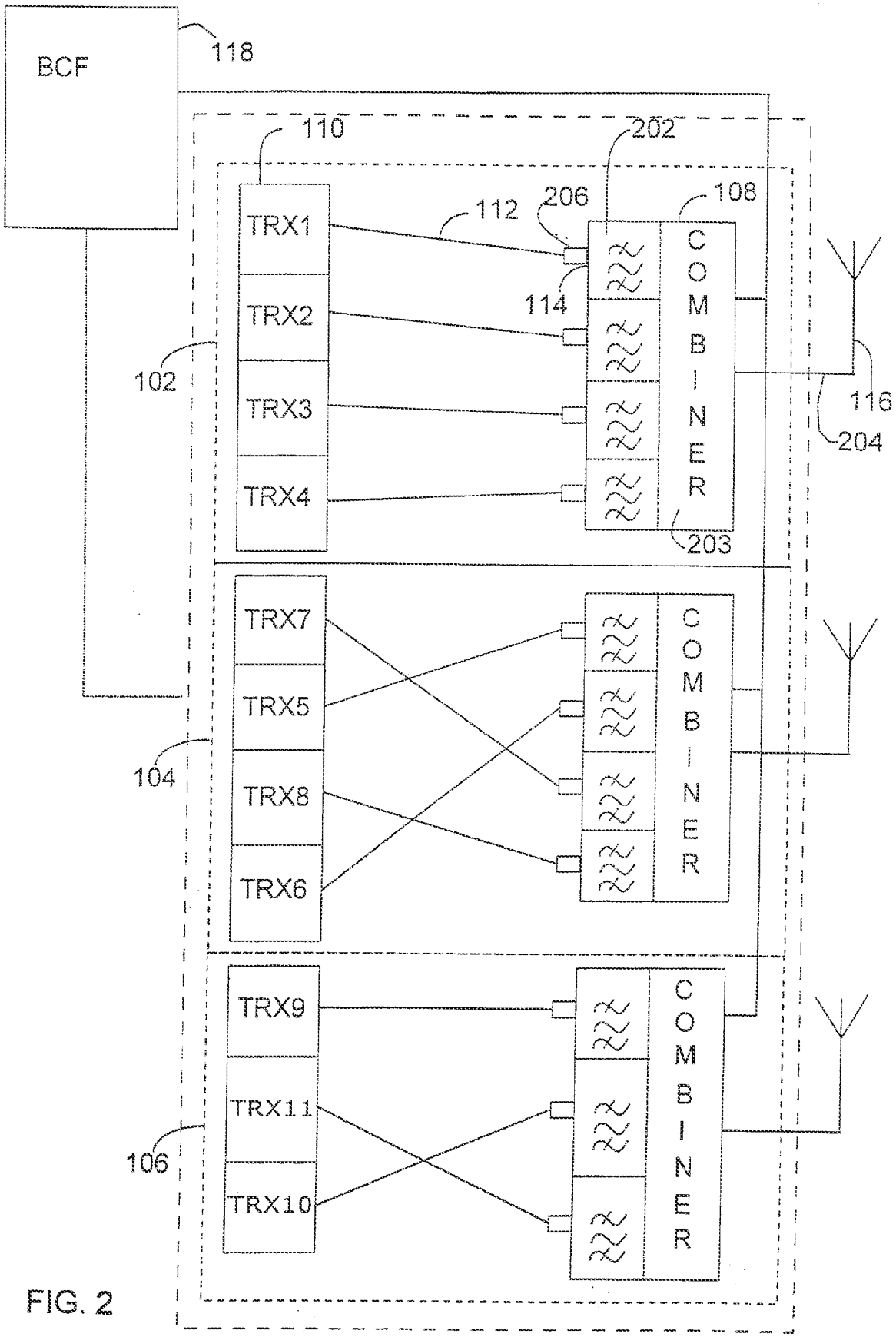


FIG. 2

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 111 of 365

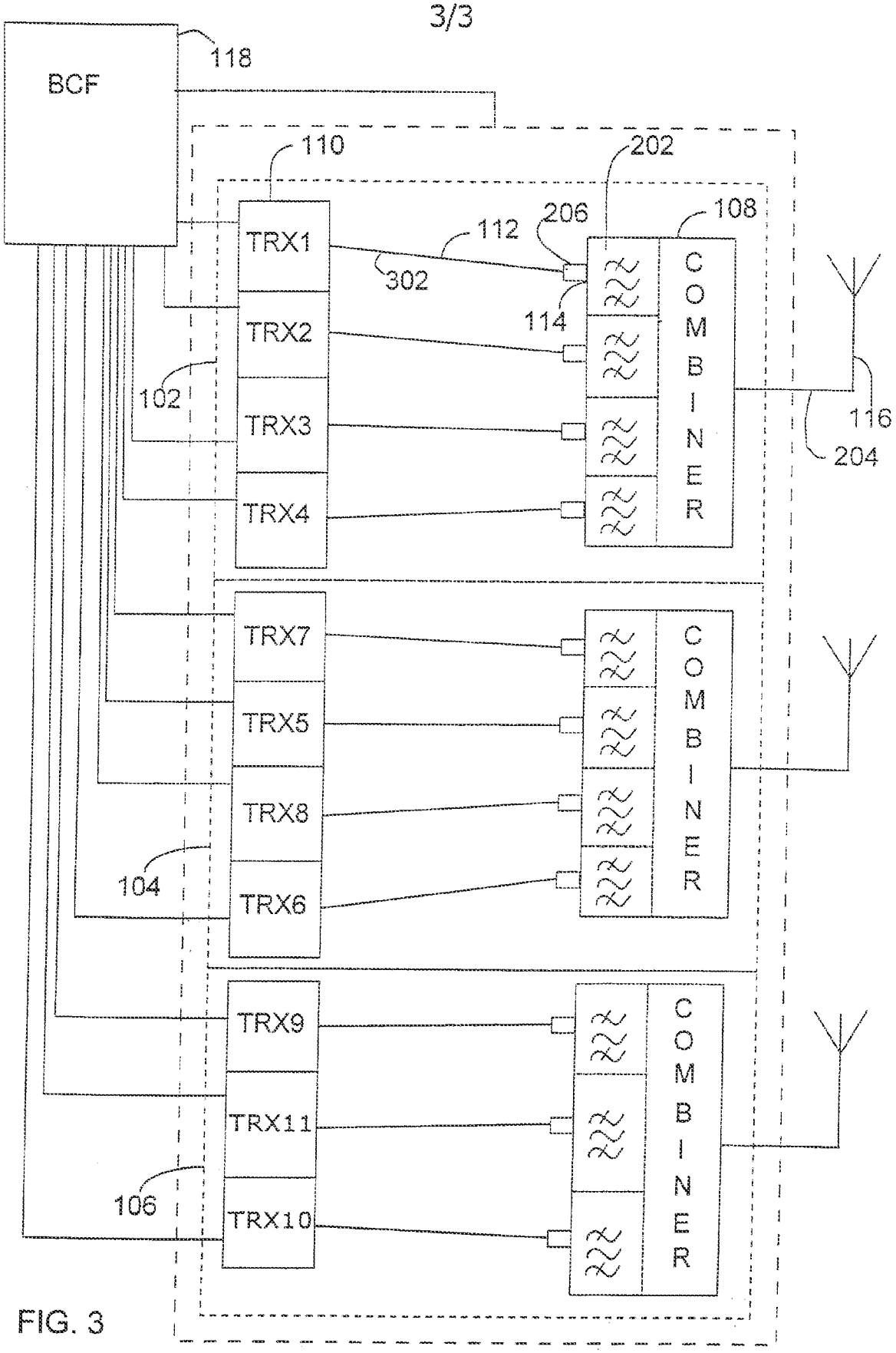

BCF
118
110
202
108
206
112
302
114
TRX1
TRX2
TRX3
TRX4
102
COMBINER
116
204
TRX7
TRX5
TRX8
TRX6
104
COMBINER
TRX9
TRX11
TRX10
106
COMBINER

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00582

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: G01R 31/02, H04B 3/46, H04B 1/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0657741 A2 (THE WHITAKER CORPORATION), 14 June 1995 (14.06.95), column 1, line 1 - column 4, line 22, figure 2, abstract --	1-24
A	US 5392454 A (HENRY J. KOWAL ET AL), 21 February 1995 (21.02.95), column 1, line 37 - column 2, line 37, figure 1, abstract --	1-24
A	US 5583874 A (MICHAEL E. SMITH ET AL), 10 December 1996 (10.12.96), column 1, line 51 - column 2, line 37, figure 5, abstract --	1-24

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 November 2000	10 -11- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer David Forneheim/MN Telephone No. +46 8 782 25 00

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 113 of 365

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00582

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5414708 A (HAROLD H. WEBBER ET AL), 9 May 1995 (09.05.95), column 4, line 31 - column 5, line 5, figure 4, abstract ---	1-24
A	US 4845736 A (EDWARD C. POSNER ET AL), 4 July 1989 (04.07.89), column 4, line 3 - line 54, figure 6, abstract --- ---	1-24

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 114 of 365

EP	0657741	A2	14/06/95	CA	2133943	A	08/06/95
				CN	1118945	A	20/03/96
				CZ	9402941	A	14/06/95
				HU	70714	A	30/10/95
				HU	214433	B	30/03/98
				HU	9403024	D	00/00/00
				JP	7245829	A	19/09/95
				PL	305950	A	12/06/95
US	5392454	A	21/02/95	DE	4335832	A	09/06/94
				GB	2271872	A,B	27/04/94
				GB	9320145	D	00/00/00
				JP	2660151	B	08/10/97
				JP	6225366	A	12/08/94
US	5583874	A	10/12/96	NONE			
US	5414708	A	09/05/95	AU	687026	B	19/02/98
				AU	692741	B	11/06/98
				AU	4691197	A	12/02/98
				AU	5734794	A	22/06/94
				CA	2148820	A	09/06/94
				EP	0672319	A	20/09/95
				US	5577023	A	19/11/96
				WO	9413072	A	09/06/94
US	4845736	A	04/07/89	NONE			

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 115 of 365

No documents available for this priority number.

Espacenet

Bibliographic data: JP2008035286 (A) — 2008-02-14

RADIO COMMUNICATION DEVICE AND THE FAILURE ESTIMATION METHOD

Inventor(s): KITAHARA MINAKO ± (KITAHARA MINAKO)

Applicant(s): KYOCERA CORP ± (KYOCERA CORP)

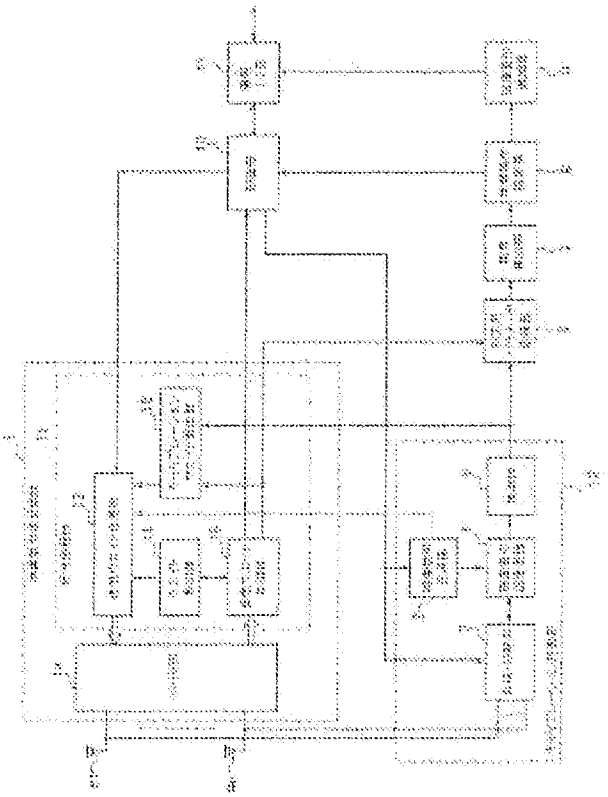
Classification: - international: ***H01Q3/26; H04B1/40; H04B17/00; H04B7/08; H04B7/10***

- cooperative:

Application number: JP20060207241 20060728

Priority number(s): JP20060207241 20060728

Abstract of JP2008035286 (A)



PROBLEM TO BE SOLVED: To allow a faulty position in a radio signal transmission/reception part to be automatically estimated. ; SOLUTION: A radio communication device provided with a plurality of antennas #1 to #n includes: a radio signal transmission/reception part 1 which uses the plurality of antennas #1 to #n to transmit/receive radio signals; a judgement parameter acquisition part 5 which acquires a judgement parameter for judging at least one of amplitude deviations and phase deviations of radio signals among antennas #1 to #n; an abnormality detection part 7 which detects abnormalities of respective antennas #1 to #n on the basis of the judgement parameter with respect to frequencies of radio signals transmitted/received by respective antennas #1 to #n; and a faulty position estimation part 8 which estimates a faulty position in the radio signal transmission/reception part 1 on the basis of correspondence between an abnormal antenna out of antennas #1 to #n and a frequency in response to detection of abnormality. ; COPYRIGHT: (C)2008,JPO&INPIT

Last updated: 18.03.2013 Worldwide Database 5.8.6.7; 83p

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 417 of 365

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2008-35286
(P2008-35286A)
(43)公開日　平成20年2月14日(2008.2.14)

(51)Int.Cl.			F I			テーマコード（参考）
H04B	7/10	(2006.01)	H04B	7/10	A	5J021
H04B	17/00	(2006.01)	H04B	17/00	K	5K011
H04B	7/08	(2006.01)	H04B	7/08	D	5K042
H04B	1/40	(2006.01)	H04B	1/40		5K059
H01Q	3/26	(2006.01)	H01Q	3/26	Z	

審査請求 未請求　請求項の数 7　OL　（全 15 頁）

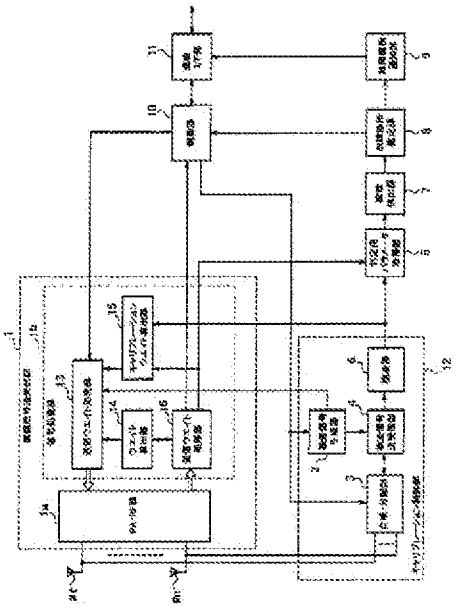
(21)出願番号　特願2006-207241 (P2006-207241)
(22)出願日　平成18年7月28日 (2006.7.28)

(71)出願人　000006633
京セラ株式会社
京都府京都市伏見区竹田鳥羽殿町６番地
(74)代理人　100149102
弁理士　松山　習
(72)発明者　北原　美奈子
神奈川県横浜市都筑区加賀原２丁目１番１号　京セラ株式会社横浜事業所内

Ｆターム(参考)　5J021 AA05 CA06 HA05 JA10
5K011 DA01 DA02 EA03 JA01 JA03 LA01
5K042 AA06 BA11 CA02 CA13 CA17 DA32 DA33 EA03 FA11 FA29 HA11
5K059 CC03 CC04 DD31 DD32 DD41

(54)【発明の名称】無線通信装置及び故障推定方法

(57)【要約】
【課題】　故障箇所を自動的に推定可能とする。
【解決手段】　複数のアンテナ＃１～＃ｎを具備する無線通信装置であって、複数のアンテナ＃１～＃ｎを用いて無線信号の送受信を行う無線信号送受信部１と、各アンテナ＃１～＃ｎ間での無線信号の振幅偏差又は位相偏差の少なくとも一方を判定するための判定用パラメータを取得する判定用パラメータ取得部５と、判定用パラメータに基づいて、各アンテナ＃１～＃ｎで送受信される無線信号の周波数について、各アンテナ＃１～＃ｎの異常を検出する異常検出部７と、異常を検出した場合、当該異常のある各アンテナ＃１～＃ｎと周波数との対応付けに基づいて、無線信号送受信部１内の故障箇所を推定する故障箇所推定部８とを備える。
【選択図】　図１



Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 118 of 365

【特許請求の範囲】
【請求項1】
複数のアンテナを具備する無線通信装置であって、
前記複数のアンテナを用いて無線信号の送受信を行う無線信号送受信部と、
各アンテナ間での前記無線信号の振幅偏差又は位相偏差の少なくとも一方を判定するための判定用パラメータを取得する判定用パラメータ取得部と、
前記判定用パラメータに基づいて、前記各アンテナで送受信される無線信号の周波数について、前記各アンテナの異常を検出する異常検出部と、
前記異常を検出した場合、当該異常のある前記各アンテナと前記周波数との対応付けに基づいて、前記無線信号送受信部内の故障箇所を推定する故障箇所推定部と
を備えることを特徴とする無線通信装置。
【請求項2】
前記故障箇所推定部は、前記異常のある前記各アンテナと前記周波数との第１の対応付けと、前記無線信号送受信部内の構成箇所と、の第２の対応付けに基づいて、前記故障箇所を推定することを特徴とする請求項１に記載の無線通信装置。
【請求項3】
前記故障箇所推定部によって前記故障箇所が推定された場合、前記無線信号送受信部内で前記故障箇所を除いた箇所である正常箇所を用いて、前記無線信号送受信部の動作を継続させる制御部を更に備えることを特徴とする請求項１又は２に記載の無線通信装置。
【請求項4】
前記故障箇所推定部によって前記故障箇所が推定された場合、前記異常が検出された旨と共に前記故障箇所を外部に通知する故障箇所通知部を更に備えることを特徴とする請求項１～３のいずれか１項に記載の無線通信装置。
【請求項5】
前記無線信号が、マルチキャリア信号且つ時分割信号であり、
前記判定用パラメータ取得部は、前記判定用パラメータをアンテナ毎、キャリア毎、及びタイムスロット毎に取得し、
前記異常検出部は、前記異常の検出をアンテナ毎、キャリア毎、及びタイムスロット毎に行うことを特徴とする請求項１～４のいずれか１項に記載の無線通信装置。
【請求項6】
前記判定用パラメータ取得部は、前記振幅偏差又は前記位相偏差の少なくとも一方を校正するアンテナキャリブレーションの際に前記判定用パラメータを取得することを特徴とする請求項１～５のいずれか１項に記載の無線通信装置。
【請求項7】
複数のアンテナを具備する無線通信装置に適用される故障推定方法であって、
前記複数のアンテナを用いて、無線信号送受信部が無線信号の送受信を行うステップと
、
各アンテナ間での前記無線信号の振幅偏差又は位相偏差の少なくとも一方を判定するための判定用パラメータを取得するステップと、
前記判定用パラメータに基づいて、前記各アンテナで送受信される無線信号の周波数について、前記各アンテナの異常を検出するステップと、
前記異常を検出した場合、当該異常のある前記各アンテナと前記周波数との対応付けに基づいて、前記無線信号送受信部内の故障箇所を推定するステップ
とを含むことを特徴とする故障推定方法。

【発明の詳細な説明】
【技術分野】

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 119 of 365

【0001】
本発明は、複数のアンテナを具備する無線通信装置、及びこの無線通信装置の故障箇所を推定する故障推定方法に関する。
【背景技術】
【0002】
デジタル通信では、伝送速度の向上や時分割多重により、周波数資源の有効利用が図られている。周波数資源を更に有効利用可能な技術として、アダプティブアレイアンテナを使用した空間分割多重（ＳＤＭＡ）方式が知られている。アダプティブアレイアンテナでは、複数のアンテナにより適応的に指向性パターンを形成することにより、特定方向の通信相手に対して電波を送受信する。
【0003】
アダプティブアレイアンテナにおいて、高精度に指向性を制御するためには、アンテナキャリブレーションを定期的に実行して、アンテナの送受信時の振幅特性及び位相特性を校正することが必要である。アンテナキャリブレーションを行うと、回路上に不具合がある場合、キャリブレーションエラーとして不具合の発生を検出できる。また、アンテナキャリブレーションを自動的に行うことで、不具合を早期に発見可能とする手法が提案されている（特許文献１参照。）。
【特許文献1】特開２００１－５３６６２号公報
【発明の開示】
【発明が解決しようとする課題】
【0004】
無線通信基地局装置においては、様々な要因によって無線通信装置の内部回路が故障することがある。特許文献１では、アンテナキャリブレーションによってアンテナの送受信の振幅特性及び位相特性を校正することを主な目的としており、故障箇所の検出のためにアンテナキャリブレーションを積極的に活用していない。このため、アンテナキャリブレーションに失敗した場合、サービスを停止し、故障箇所を判断するために人手による解析を行う必要がある。この結果、解析にコストを要し、復旧までに長時間を要するという問題があった。
【0005】
上記問題点を鑑み、本発明は、故障箇所を自動的に推定可能な無線通信装置及び故障推定方法を提供する。
【課題を解決するための手段】
【0006】
上記目的を達成するために、本発明の第１の特徴は、複数のアンテナを具備する無線通信装置であって、複数のアンテナを用いて無線信号の送受信を行う無線信号送受信部と、各アンテナ間での無線信号の振幅偏差又は位相偏差の少なくとも一方を判定するための判定用パラメータを取得する判定用パラメータ取得部と、判定用パラメータに基づいて、各アンテナで送受信される無線信号の周波数について、各アンテナの異常を検出する異常検出部と、異常を検出した場合、当該異常のある各アンテナと周波数との対応付けに基づいて、無線信号送受信部内の故障箇所を推定する故障箇所推定部とを備えることを要旨とする。
【0007】
この特徴によれば、各アンテナ間での無線信号の振幅偏差又は位相偏差の少なくとも一方を判定するための判定用パラメータを取得する判定用パラメータ取得部と、判定用パラメータに基づいて、各アンテナで送受信される無線信号の周波数について、各アンテナの異常を検出する異常検出部と、異常を検出した場合、当該異常のある各アンテナと周波数との対応付けに基づいて、無線信号送受信部内の故障箇所を推定する故障箇所推定部とを備えることによって、故障を自動的に推定できる。
【0008】
本発明の第２の特徴は、第１の特徴に係る無線通信装置において、故障箇所推定部は、

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 120 of 365

異常のある各アンテナと周波数との第１の対応付けと、無線信号送受信部内の構成箇所と、の第２の対応付けに基づいて、故障箇所を推定することを要旨とする。

【0009】

この特徴によれば、第１の特徴に係る無線通信装置において、故障箇所推定部は、異常のある各アンテナと周波数との第１の対応付けと、無線信号送受信部内の構成箇所と、の第２の対応付けに基づいて、故障箇所を推定することによって、故障を自動的に推定できる。

【0010】

本発明の第３の特徴は、第１又は第２の特徴に係る無線通信装置において、故障箇所推定部によって故障箇所が推定された場合、無線信号送受信部内で故障箇所を除いた箇所である正常箇所を用いて、無線信号送受信部の動作を継続させる制御部を更に備えることを要旨とする。

【0011】

この特徴によれば、故障箇所推定部によって故障箇所が推定された場合、無線信号送受信部内で故障箇所を除いた箇所である正常箇所を用いて、無線信号送受信部の動作を継続させることによって、正常動作系と故障系を切り分け、正常動作している系で活用できる箇所は有効利用し、故障発生時でも最善のサービスを行うことができる。

【0012】

本発明の第４の特徴は、第１～第３のいずれかの特徴に係る無線通信装置において、故障箇所推定部によって故障箇所が推定された場合、異常が検出された旨と共に故障箇所を外部に通知する故障箇所通知部を更に備えることを要旨とする。

【0013】

この特徴によれば、故障箇所推定部によって故障箇所が推定された場合、異常が検出された旨と共に故障箇所を外部に通知することによって、故障箇所を無線通信装置の外部に通知可能となる。

【0014】

本発明の第５の特徴は、第１～第４のいずれかの特徴に係る無線通信装置において、無線信号が、マルチキャリア信号且つ時分割信号であり、判定用パラメータ取得部は、判定用パラメータをアンテナ毎、キャリア毎、及びタイムスロット毎に取得し、異常検出部は、異常の検出をアンテナ毎、キャリア毎、及びタイムスロット毎に行うことを要旨とする。

【0015】

この特徴によれば、マルチキャリア信号且つ時分割信号を用いる場合に、判定用パラメータ取得部が、判定用パラメータをアンテナ毎、キャリア毎、及びタイムスロット毎に取得し、異常検出部が、異常の検出をアンテナ毎、キャリア毎、及びタイムスロット毎に行うことによって、効果的な故障箇所検出を可能とすることができる。

【0016】

本発明の第６の特徴は、第１～第５のいずれかの特徴に係る無線通信装置において、判定用パラメータ取得部は、振幅偏差又は位相偏差の少なくとも一方を校正するアンテナキャリブレーションの際に判定用パラメータを取得することを要旨とする。

【0017】

この特徴によれば、アンテナキャリブレーション動作を利用して、故障箇所を検出することができる。

【0018】

本発明の第７の特徴は、複数のアンテナを具備する無線通信装置に適用される故障推定方法であって、複数のアンテナを用いて、無線信号送受信部が無線信号の送受信を行うステップと、各アンテナ間での無線信号の振幅偏差又は位相偏差の少なくとも一方を判定するための判定用パラメータを取得するステップと、判定用パラメータに基づいて、各アンテナで送受信される無線信号の周波数について、各アンテナの異常を検出するステップと、異常を検出した場合、当該異常のある各アンテナと周波数との対応付けに基づいて、無

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 121 of 365

線信号送受信部内の故障箇所を推定するステップ　とを含むことを要旨とする。

【発明の効果】

【0019】

本発明によれば、故障箇所を自動的に推定可能な無線通信装置及び故障推定方法を提供できる。

【発明を実施するための最良の形態】

【0020】

次に、図面を参照して、本発明の実施形態を説明する。以下の実施形態における図面の記載において、同一又は類似の部分には同一又は類似の符号を付している。

【0021】

（無線通信装置の全体構成例）

以下においては無線通信装置の一例として、図１に示すように複数のアンテナ＃１～＃ｎを具備し、移動局と通信する無線基地局について説明する（ｎ：２以上の整数）。本発明の実施形態に係る無線通信装置は、複数のアンテナ＃１～＃ｎと、無線信号送受信部１と、キャリブレーション制御部１２と、判定用パラメータ取得部５と、異常検出部７と、故障箇所推定部８と、故障箇所通知部９と、制御部１０と、通信インタフェース部（以下、「通信Ｉ／Ｆ部」）１１とを備える。

【0022】

無線信号送受信部１は、複数のアンテナ＃１～＃ｎをアダプティブアレイアンテナとして使用し、移動局と通信を行う。通信Ｉ／Ｆ部１１は、外部のネットワークに接続され、ネットワーク上の基地局管理装置等と通信する。

【0023】

キャリブレーション制御部１２は、複数のアンテナ＃１～＃ｎを用いた無線信号の送受信時において、アンテナ間の振幅偏差又は位相偏差の少なくとも一方を校正するためのアンテナキャリブレーション動作を制御する。なお、アンテナキャリブレーションは各アンテナ＃１～＃ｎの送信特性情報（振幅・位相差情報）又は受信特性情報（振幅・位相差情報）、あるいはこれらの組み合わせをもとに実行される。

【0024】

判定用パラメータ取得部５は、アンテナ間での無線信号の振幅偏差又は位相偏差の少なくとも一方を判定するための判定用パラメータをアンテナ毎に取得する。異常検出部７は、判定用パラメータに基づき、複数のアンテナ＃１～＃ｎにおいて異常が発生したか否かを判定する。異常の検出は、複数のアンテナ＃１～＃ｎのそれぞれについて、振幅が安定しているか否かと、他のアンテナとの位相差が安定しているか否か等に応じて行われる。なお、判定用パラメータの詳細については後述する。

【0025】

故障箇所推定部８は、複数のアンテナ＃１～＃ｎの少なくとも１つについて異常が検出された場合に、異常の発生状態に基づいて無線信号送受信部１内の故障箇所を推定する。ここで「異常の発生状態」とは、異常のある各アンテナ＃１～＃ｎと周波数（キャリア周波数又は通信チャネルの周波数）との対応付けを意味する。例えば、各アンテナ＃１～＃ｎのうち、どのアンテナのどの周波数で異常が検出されたか、あるいはどのアンテナ群（アンテナブロック）のどの周波数で異常が検出されたか等を意味する。ただし、後述するように、無線通信装置の採用する無線通信方式に応じて、アンテナ以外の要素について発生する異常の発生状態を利用可能である。

【0026】

一例として、異常のあるアンテナが検出された場合、キャリブレーション制御部１２は、基準となるアンテナを切り替えつつ、キャリブレーション動作を複数回行う。この結果、異常検出部７は、複数回のキャリブレーションに渡って異常を判定し、故障箇所推定部８が異常の発生状態を得ることができる。更に、故障箇所推定部８は、異常の発生状態に応じて、故障箇所が、無線信号送受信部１の送信系、受信系、又は送受信両方であるのかを判断する。

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 122 of 365

【0027】
制御部１０は、無線信号送受信部１を制御すると共に、故障箇所が推定された場合に、故障箇所を除いた正常箇所を用いて無線信号送受信部１の動作を継続させる。故障箇所通知部９は、故障箇所が検出された場合、通信Ｉ／Ｆ部１１を用いて、故障箇所を基地局管理装置に自動的に通知する。
【0028】
したがって、一部のアンテナにのみ故障が発生した際に与える影響を最小限に抑え、無線通信装置の運用を続けながら、故障箇所として通知された箇所を調べることにより、故障対応を迅速に行うことが可能となる。
【0029】
なお、アンテナ＃１～＃ｎ、無線信号送受信部１、キャリブレーション制御部１２、及び通信Ｉ／Ｆ部１１は、ハードウェアとして実装されるが、判定用パラメータ取得部５、異常検出部７、故障箇所推定部８、及び故障箇所通知部９は、プログラムとして実装し、図示を省略するＣＰＵに実行させることが可能である。したがって、アンテナキャリブレーション機能を有する無線通信装置に対し、特別な装置を追加設置することなく、故障や故障発生時においても運用上の影響を最小限に抑えることが可能となる。
【0030】
（無線信号送受信部の概略構成）
次に、無線信号送受信部１の概略構成について説明する。無線信号送受信部１は、無線信号の増幅及び周波数変換等を行うパワーアンプ・高周波部（以下、「ＰＡ・ＲＦ部」）１ａと、無線信号を信号処理する信号処理部１ｂとを備える。
【0031】
信号処理部１ｂは、複数のアンテナ＃１～＃ｎから無線信号を同時に送信又は受信するときに、複数のアンテナ＃１～＃ｎのそれぞれについての無線信号に重み付けを行うように構成されている。具体的には、信号処理部１ｂは、送信ウェイト処理部１３と、ウェイト算出部１４と、キャリブレーションウェイト算出部１５と、受信ウェイト処理部１６とを備える。
【0032】
受信ウェイト処理部１６は、ＰＡ・ＲＦ部１ａからの受信信号から、振幅情報及び位相情報をアンテナ毎に取得し、ウェイト算出部１４及び判定用パラメータ取得部５に振幅情報及び位相情報を通知する。ウェイト算出部１４は、ＰＡ・ＲＦ部１ａの送受信信号に与える振幅と位相とを調整するためのウェイトをアンテナ毎に算出する。
【0033】
また、受信ウェイト処理部１６は、ウェイト算出部１４が算出した、位相及び振幅の各アンテナ間における相違量を示すウェイトを用いて、ＰＡ・ＲＦ部１ａからのアンテナ毎の受信信号を重み付けして合成する。これにより受信時の指向性パターンを形成することになる。送信ウェイト処理部１３は、受信時に算出したパラメータを送信時にも利用して、アンテナ毎の送信信号に重み付けを行う。これにより送信時のアレイアンテナパターンを形成することになる。
【0034】
（キャリブレーション制御部の構成）
次に、キャリブレーション制御部１２の構成について説明する。キャリブレーション制御部１２は、検査用信号生成部２と、合成・分配部３と、検査用信号送受信部４と、検波部６とを備える。検査用信号生成部２は、キャリブレーション時において、同一の振幅・位相の検査用信号をベースバンド帯域で生成する。なお、検査用信号としては、例えば一定周波数の信号の一種であるトーン信号（正弦波）、又は周波数が信号内容に応じて変更されるバースト信号（ビット列）等が使用できる。
【0035】
無線信号送受信部１の受信特性を検査する場合、検査用信号は、検査用信号送受信部４及び合成・分配部３を介して、ＰＡ・ＲＦ部１ａに入力される。これに対して、無線信号

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 123 of 365

送受信部１の送信特性を検査する場合、検査用信号は、送信ウェイト処理部１３を介してＰＡ・ＲＦ部１ａに入力される。

【0036】

検査用信号送受信部４は、無線周波数とベースバンド周波数との変換を行う。検波部６は、キャリブレーションに必要な各アンテナの位相情報及び振幅情報を検出する。

【0037】

合成・分配部３は、複数のアンテナ＃１～＃ｎからの信号を合成すると共に、検査用信号送受信部４からの信号を複数のアンテナ＃１～＃ｎに分配する。

【0038】

（判定用パラメータ）

次に、判定用パラメータについて詳細に説明する。判定用パラメータ取得部５は、判定用パラメータとして、以下の１）～５）のいずれか、あるいは以下の１）～５）の組み合わせを取得する。

【0039】

１）全アンテナが同一の振幅で電波を送信している際に、キャリブレーション制御部１２で検出される各アンテナについての信号振幅情報（以下、「送信振幅情報」）

２）全アンテナが同一の振幅で電波を受信している際に、受信ウェイト処理部１６で検出される各アンテナについての受信振幅情報（以下、「受信振幅情報」）

３）アンテナ間での送信信号の位相差情報（以下、「送信位相差情報」）

４）アンテナ間での受信信号の位相差情報（以下、「受信位相差情報」）

５）上記１）～４）の情報から算出される情報

ここで、上記５）としては、例えば、基準アンテナで規格化された各アンテナの送受信振幅・位相差情報等が該当する。

【0040】

異常検出部７は、上記１）～５）の判定用パラメータに対し、位相揺らぎ又は振幅揺らぎの有無を判定する。

【0041】

「振幅揺らぎ（振幅偏差）」とは、各アンテナを用いて同じ振幅の検査用信号を送信させた場合のアンテナ間に生じるばらつき、あるいは、各アンテナを用いて同じ振幅の検査用信号を受信させた場合のアンテナ間に生じるばらつきを意味する。ばらつきの大きさは、全アンテナ平均値に対して、所定の閾値内に収まっているかどうかで判定しても良いし、ある基準で判断しても良い。

【0042】

「位相差揺らぎ（位相偏差）」とは、各アンテナを用いて同じ位相の検査用信号を送信させた場合のアンテナ間に生じるばらつき、あるいは、各アンテナを用いて同じ位相の検査用信号を受信させた場合のアンテナ間に生じるばらつきを意味する。位相偏差は、連続的に同じ送受信動作をさせることによって検出可能である。

【0043】

例えば、２回同じ検査用信号の送受信動作を行ったとき、位相偏差は基準アンテナを決めて、位相差ベクトルを作り、その位相差ベクトルの内積を取ることで確認する。アンテナ数を“Ｎ”として、

１回目を$a = \{ a1, a2, \cdots, aN \}$

２回目を$b = \{ b1, b2, \cdots, bN \}$

（１番目のアンテナが基準アンテナであれば$a1 = b1$）

が送受信動作によって得られた位相・振幅ベクトルとすると、“$a \cdot b$”の結果が揺らぎの大きさに相当する。算出結果を１に規格化していれば、実部が１に近いほど揺らぎが小さいと判断できる。規格化した結果の実部の大きさが０．９９９以下であれば、異常であると判断する。このように、揺らぎを定量化して、閾値判定することで、異常が検出される。

【0044】

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 124 of 365

（無線信号送受信部の構成例）

次に、図２を用いて、無線信号送受信部１の具体的な構成例を説明する。図２の例では、ｉＢｕｒｓｔ（登録商標）規格に準拠したシステムの基地局における無線信号送受信部１の構成例を示している。ｉＢｕｒｓｔ（登録商標）規格に準拠したシステムでは、マルチキャリアを採用した時分割多元接続／時分割双方向伝送（ＴＤＭＡ／ＴＤＤ）方式が用いられている。

【0045】

マルチキャリア、マルチアンテナのＴＤＭＡ／ＴＤＤシステムでは、複数キャリアで共通の回路、キャリア毎、アンテナ毎に異なる回路を使用している箇所等が存在する。複数のキャリアで共通のチップを使用している場合、そのチップに故障が生じた場合、１つのキャリアにのみ影響するということは通常は起こりにくい。

【0046】

このように、エラー発生状態からどこのチップ（回路）に故障が生じているのかをある程度の確率で検出可能である。したがって、ハードウェア構成がどのような単位でまとめられているのか、どこで発生した故障であるのかを考慮して故障箇所が推定される。

【0047】

図２に示す構成に対しては、図１に示した判定用パラメータ取得部５は、判定用パラメータをアンテナ毎、キャリア毎、及びタイムスロット毎に取得する。異常検出部７は、異常が発生したか否かをアンテナ毎、キャリア毎、及びタイムスロット毎に判定する。また、キャリブレーション制御部１２では周波数帯はキャリブレーションを実行するキャリアに応じて設定する。

【0048】

図２に示す無線信号送受信部１は、第１～第１２アンテナ＃１～＃１２と、ＰＡ・ＲＦ部１００と、シリアライザ／デシリアライザ部（以下、「ＳＥＲ／ＤＥＳ部」）１４０と、キャリアブロック部１５０と、キャリア制御部１６０と、タイムスロット制御部１７０とを備える。

【0049】

ＰＡ・ＲＦ部１００は、ＰＡ部１１０と、ＲＦ部１２０とを備える。ＰＡ部１１０は、第１～第４ＰＡ回路１１１～１１４を備える。第１～第４ＰＡ回路１１１～１１４のそれぞれは、図示を省略する２つの送受信切替スイッチと、２つの送受信切替スイッチの間に並列に接続されたＰＡ及びローノイズアンプ（ＬＮＡ）を備える。送信時にはＰＡを用いた無線信号の増幅を行い、受信時はＬＮＡを用いた無線信号の増幅を行う。

【0050】

ＲＦ部１２０は、第１～第１２ＲＦ回路１２１～１３２を備える。第１～第１２ＲＦ回路１２１～１３２のそれぞれは、受信時には、無線周波数帯域からベースバンド帯域へのダウンコンバートと、アナログ／デジタル（Ａ／Ｄ）変換を行う。これに対して送信時には、デジタル／アナログ（Ｄ／Ａ）変換と、ベースバンド帯域から無線周波数帯域へのアップコンバートを行う。ＳＥＲ／ＤＥＳ部１４０は、ＲＦ部１２０とキャリアブロック部１５０との間で入出力される信号を授受する。

【0051】

キャリアブロック部１５０は、第１及び第２キャリアブロック回路１５１，１５２を備える。第１及び第２キャリアブロック回路１５１，１５２のそれぞれは、フィールド・プログラマブル・ゲート・アレイ（ＦＰＧＡ）により構成される。また、第１及び第２キャリアブロック回路１５１，１５２のそれぞれは、受信時には、アンテナ毎に入力される受信信号をキャリア毎に振り分け、送信時には、キャリア毎に入力される送信信号をアンテナ毎に振り分ける。

【0052】

キャリア制御部１６０は、第１～第８キャリア制御回路１６１～１６８を備える。第１～第８キャリア制御回路１６１～１６８のそれぞれは、ＦＰＧＡにより構成される。また、第１～第８キャリア制御回路１６１～１６８のそれぞれは、受信時には、キャリア毎に

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 125 of 365

入力される受信信号をタイムスロット毎に分割し、送信時には、タイムスロット毎に入力される送信信号をキャリア毎に統合する。

【0053】

タイムスロット制御部１７０は、第１～第２４タイムスロット制御回路１７１～１９４を備える。第１～第２４タイムスロット制御回路１７１～１９４のそれぞれは、デジタル・シグナル・プロセッサ（ＤＳＰ）により構成される。また、第１～第２４タイムスロット制御回路１７１～１９４のそれぞれは、受信時には、検波やキャリブレーションウェイトの演算等を行い、送信時には、ウェイトの乗算等を行う。なお、検波処理は、キャリブレーション動作時と通常通信時では異なる検波方式を採っても良い。キャリブレーション時には、受信アンテナウェイトに依存しない各アンテナの位相振幅の差の情報（受信特性情報）を得られるよう動作する。更に、通常通信時にはキャリブレーションウェイト及び受信ウェイト情報を用いて送信ウェイトが算出される。

【0054】

（異常の発生状態例）

次に、図２に示した無線信号送受信部１の構成例における異常の発生状態例について説明する。

【0055】

第１～第４ＰＡ回路１１１～１１４のそれぞれは、３つのアンテナからなるアンテナブロック毎に１つ割り当てられている。第１～第１２ＲＦ回路１２１～１３２のそれぞれは、各アンテナに対応して設けられている。ＳＥＲ／ＤＥＳ部１４０は、全アンテナ・全キャリアに共通して１つ設けられている。

【0056】

第１及び第２キャリアブロック回路（ＦＰＧＡ）１５１，１５２のそれぞれは、４つのキャリアからなるキャリアブロック毎に１つ割り当てられている。具体的には、第１～第４キャリアＣＡ１～ＣＡ４には、第１キャリアブロック回路１５１が割り当てられ、第５～第８キャリアＣＡ５～ＣＡ８には、第２キャリアブロック回路１５２が割り当てられている。

【0057】

第１～第８キャリア制御回路（ＦＰＧＡ）１６１～１６８のそれぞれは、各キャリアに対応して設けられている。

【0058】

第１～第２４タイムスロット制御回路（ＤＳＰ）１７１～１９４のそれぞれは、各タイムスロットに対応して設けられている。具体的には、第１、第４、第７、第１０、第１３、第１６、第１９、及び第２２タイムスロット制御回路（ＤＳＰ）１７１，１７４，１７７，１８０，１８３，１８６，１８９，１９２は、第１タイムスロットＴＳ１に対応している。第２、第５、第８、第１１、第１４、第１７、第１８、及び第２３タイムスロット制御回路（ＤＳＰ）１７２，１７５，１７８，１８１，１８４，１８７，１９０，１９３は、第２タイムスロットＴＳ２に対応している。第３、第６、第９、第１２、第１５、第１８、第１９、及び第２４タイムスロット制御回路（ＤＳＰ）１７３，１７６，１７９，１８２，１８５，１８８，１９１，１９４は、第３タイムスロットＴＳ３に対応している。

【0059】

このような構成において、異常の発生状態と推定故障箇所との対応付けについて図３を用いて説明する。図３では状態１～状態６の合計６パターンを例示している。

【0060】

状態１は、全キャリア・全タイムスロットで特定のアンテナに異常が検出された状態であり、特定のアンテナに対応するＰＡ回路又はＲＦ回路が故障していると推定可能である。例えば、図４に示すように、全キャリア・全タイムスロットでアンテナ１が異常を示している場合、第１ＰＡ回路１１１又は第１ＲＦ回路１２１が故障していると考えられる。

【0061】

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 126 of 365

状態２は、図５に示すように、全キャリア・全タイムスロット・全アンテナに異常が検出された状態であり、ＳＥＲ／ＤＥＳ部１４０が故障していると推定可能である。

【0062】

状態３は、全タイムスロットで特定のキャリアブロックに異常が検出された状態であり、特定のキャリアブロックについてのキャリアブロック回路が故障していると推定可能である。例えば、図６に示すように、全タイムスロットで特定のキャリアブロック（キャリア１～４）が異常を示している場合、第１キャリアブロック回路１５１が故障していると考えられる。

【0063】

状態４は、全タイムスロットで特定のキャリアに異常が検出された状態であり、特定のキャリアについてのキャリア制御回路が故障していると推定可能である。例えば、図７に示すように、全タイムスロットでキャリア１が異常を示している場合、第１キャリア制御回路１６１が故障していると考えられる。

【0064】

状態５は、特定のキャリアの特定のタイムスロットに異常が検出された状態であり、特定のタイムスロットについてのタイムスロット制御回路が故障していると推定可能である。

【0065】

状態６は、全キャリアで特定のアンテナブロックに異常が検出された状態であり、特定のアンテナブロックについてのＰＡ回路が故障していると推定可能である。例えば、図８に示すように、全タイムスロットで第１～第３アンテナ＃１～＃３が異常を示している場合、第１ＰＡ回路１１１が故障していると考えられる。

【0066】

図４～図８に示したようなテーブルを、異常検出部７が予め保持しておくことにより、エラー発生状態から故障箇所を即座に検出可能となる。

【0067】

（故障推定フロー例）

次に、図９に示すフローチャートを参照して、本発明の実施形態に係る故障推定方法の一例について説明する。

【0068】

ステップＳ１０１において、図１の検査用信号生成部２は、制御部からキャリブレーション実行要求が通知されるまで待ち状態となる。キャリブレーション実行要求が通知されると、ステップＳ１０２へ移行する。

【0069】

ステップＳ１０２において、制御部１０は、基準アンテナを選択する。

【0070】

ステップＳ１０３において、上述した手順により、キャリブレーションが実行される。この結果、基準アンテナを基準とした各アンテナのキャリブレーションベクトル情報、送信特性情報、及び受信特性情報が得られる。なお、キャリブレーションベクトルとは、基準アンテナの送受信信号振幅位相を基準とし他場合の、他アンテナの送受信信号振幅位相である。キャリブレーションの過程で、判定用パラメータ取得部５は、判定用パラメータを取得する。

【0071】

ステップＳ１０４において、異常検出部７は、異常（キャリブレーションエラー）をアンテナ毎、キャリア毎に判定する。

【0072】

ステップＳ１０５において、異常検出部７は、ステップＳ１０４で異常が検出されたか否か確認する。異常が検出されていない場合、ステップＳ１０１に処理が戻る。異常が検出された場合、ステップＳ１０６に移行する。

【0073】

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 127 of 365

ステップＳ１０６において、故障箇所推定部８は、複数キャリアに渡って異常が検出されたか否かを判定する。複数キャリアに渡って異常が検出された場合、ステップＳ１０７に移行する。特定のキャリアにのみ異常が検出された場合、ステップＳ１０８に移行する。複数のキャリアで異常が検出され、それが１つのアンテナで発生した異常であれば、該当アンテナを故障とみなすことができる。

【0074】

ステップＳ１０７において、故障箇所推定部８は、複数アンテナに渡って異常が検出されたか否かを判定する。複数アンテナに渡って異常が検出された場合、ステップＳ１０８に移行する。特定のアンテナにのみ異常が検出された場合、ステップＳ１０９に移行する。

【0075】

ステップＳ１０９では、制御部１０は、異常のあるアンテナ及びキャリアの運用を停止する。故障箇所推定部８は、ＳＥＲ／ＤＥＳ部１４０に故障が発生していると推定する。故障箇所通知部９は、異常が発生した旨（アラーム）とともに、故障箇所を外部に通知する。

【0076】

ステップＳ１０８において、制御部１０は、基準アンテナの異常の可能性があるため、基準アンテナを変更して再度キャリブレーションを行うように制御する。

【0077】

ステップＳ１１１において、故障箇所推定部８は、ステップＳ１０８の結果、異常であるアンテナが減少したか否かを判定する。異常であるアンテナが減少した場合、ステップＳ１１２に移行する。異常であるアンテナが減少しない場合、ステップＳ１１３に移行する。

【0078】

ステップＳ１１２においては、制御部１０は、基準アンテナの変更を維持し、前回まで基準としていたアンテナを運用停止とする。また、故障箇所推定部８は、運用停止としたアンテナに対応するＲＦ部１３２のＲＦ回路を故障箇所として推定する。ステップＳ１１４において、故障箇所通知部９は、異常が発生した旨と共に、故障箇所を外部に通知する。

【0079】

ステップＳ１１３においては、制御部１０は、異常のあるアンテナを運用停止し、正常動作をしているアンテナのみでサービスを続行する。故障箇所推定部８は、ＳＥＲ／ＤＥＳ部１４０に故障が発生していると推定する。ステップＳ１１５において、故障箇所通知部９は、異常が発生した旨と共に故障箇所を外部に通知する。

【0080】

一方、ステップＳ１０８において、制御部１０は、キャリブレーションを実行していたタイムスロットを変更して再度キャリブレーションを行い、異常検出部７は、異常が回避できるかどうかをステップＳ１１６にてチェックする。異常が回避できた場合、ステップＳ１１７に移行する。異常が回避できない場合、ステップＳ１１８に移行する。

【0081】

ステップＳ１１７において、故障箇所推定部８は、タイムスロット制御部１７０から故障箇所を検出する。そして、故障箇所通知部９は、異常が発生した旨と共に故障箇所を外部に通知する。

【0082】

ステップＳ１１８において、故障箇所推定部８は、キャリア制御部１６０から故障箇所を推定する。制御部１０は、異常の発生しているキャリアの運用を停止する。ステップＳ１１９において、故障箇所通知部９は、異常が発生した旨と共に故障箇所を外部に通知する。

【0083】

以上詳細に説明したように、本発明の実施形態によれば、アンテナキャリブレーション

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 128 of 365

動作を利用して、故障箇所を推定することができる。また、故障が判明した際、該当キャリアでの通信サービスを停止する代わりに、故障発生箇所と正常動作箇所を切り分け、正常動作箇所のみを使用してサービスを行うようにすることで、故障発生時にも最低限の通信サービスを確保できるようになる。修理の時には、故障箇所を切り分けていることから、迅速に修理、改善のための処置を行うことができる。

【0084】

更に、従来のキャリブレーションでは発見できなかった異常を早期に発見することが可能となることにより、無用な電波放出を防ぐことが可能となり通信品質を向上させることが可能になる。

【0085】

（その他の実施形態）

上記のように、本発明は実施形態によって記載したが、この開示の一部をなす論述及び図面はこの発明を限定するものであると理解すべきではない。この開示から当業者には様々な代替実施形態、実施例及び運用技術が明らかとなる。

【0086】

上述した実施形態においては、無線基地局の故障箇所を推定する一例を説明したが、移動通信端末の故障箇所を推定する場合に応用しても良い。

【0087】

また、ＴＤＭＡ方式を採用する無線通信装置について説明したが、複数のアンテナを具備する無線通信装置であれば、符号分割多重接続（ＣＤＭＡ）方式等の他の無線通信方式を採用する場合にも応用可能である。

【0088】

更に、上述した実施形態においては、アンテナキャリブレーションを利用して、無線信号送受信部１の故障箇所を推定する一例について説明した。しかしながら、アンテナキャリブレーションを利用せずに、故障箇所の推定動作のみを行ってもかまわない。この場合、キャリブレーションウェイト算出部１５を動作させることなく、判定用パラメータ取得部５が判定用パラメータを取得する。

【0089】

このように本発明は、ここでは記載していない様々な実施形態等を包含するということを理解すべきである。したがって、本発明はこの開示から妥当な特許請求の範囲の発明特定事項によってのみ限定されるものである。

【図面の簡単な説明】

【0090】

【図1】本発明の実施形態に係る無線通信装置の構成例を示すブロック図である。

【図2】本発明の実施形態に係る送受信部の内部構成例を示すブロック図である。

【図3】本発明の実施形態に係る故障箇所推定部の機能を説明するための表である。

【図4】本発明の実施形態に係る異常検出部が検出する異常の発生状態の一例を示す表である（その１）。

【図5】本発明の実施形態に係る異常検出部が検出する異常の発生状態の一例を示す表である（その２）。

【図6】本発明の実施形態に係る異常検出部が検出する異常の発生状態の一例を示す表である（その３）。

【図7】本発明の実施形態に係る異常検出部が検出する異常の発生状態の一例を示す表である（その４）。

【図8】本発明の実施形態に係る異常検出部が検出する異常の発生状態の一例を示す表である（その５）。

【図9】本発明の実施形態に係る無線通信装置の故障箇所推定処理の一例を示すフローチャートである。

【符号の説明】

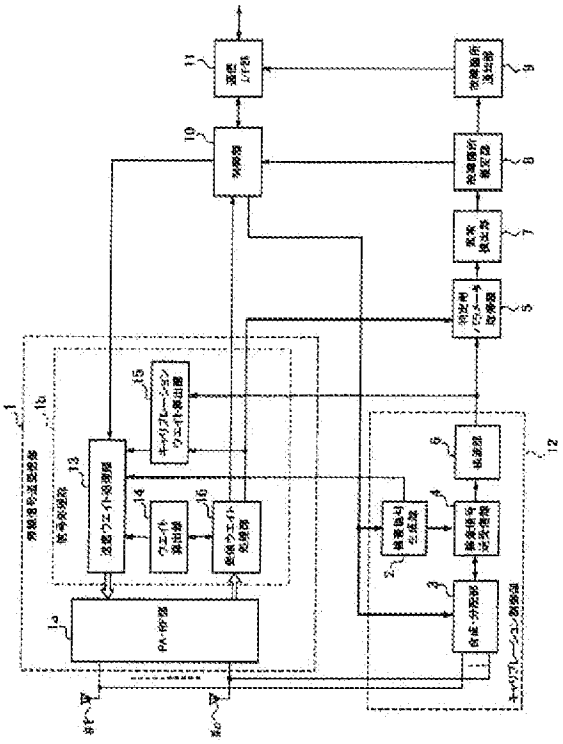
【0091】

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 129 of 365

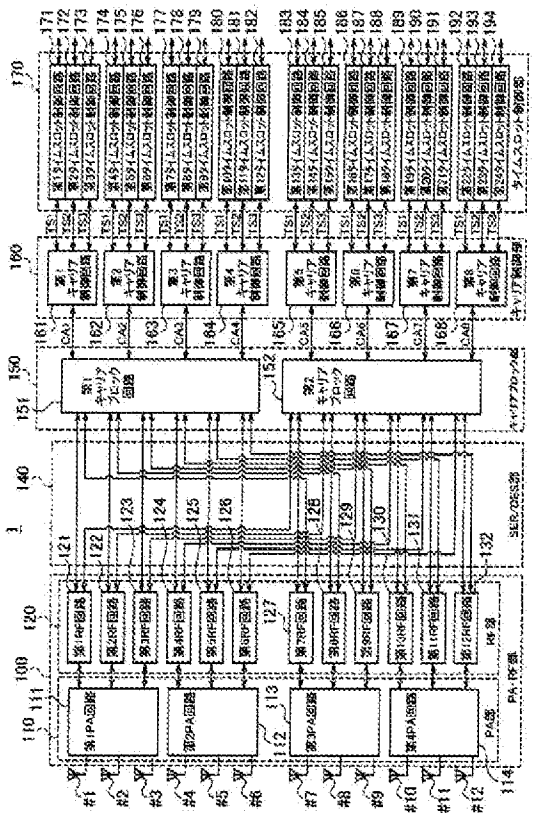
＃１～＃ｎ…アンテナ
１…無線信号送受信部
１ａ…ＰＡ・ＲＦ部
１ｂ…信号処理部
２…検査用信号生成部
３…合成・分配部
４…検査用信号送受信部
５…判定用パラメータ取得部
６…検波部
７…異常推定部
８…故障箇所推定部
９…故障箇所通知部
１０…制御部
１１…通信Ｉ／Ｆ部
１２…キャリブレーション制御部
１３…送信ウェイト処理部
１４…ウェイト算出部
１５…キャリブレーションウェイト算出部
１６…受信ウェイト処理部
１００…ＰＡ・ＲＦ部
１１０…ＰＡ部
１１１…第１ＰＡ回路
１１１～１１４…ＰＡ回路
１２０…ＲＦ部
１２１～１３２…ＲＦ回路
１４０…ＳＥＲ／ＤＥＳ部
１５０…キャリアブロック部
１５１，１５２…キャリアブロック回路
１６０…キャリア制御部
１６１～１６８…キャリア制御回路
１７０…タイムスロット制御部
１７１～１９４…タイムスロット制御回路

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 130 of 365

【図1】



【図2】



【図3】

故障の発生状態	推定故障箇所
状態1: 全キャリア 全タイムスロットで特定のアンテナに異常発生	特定のアンテナについてのPA回路・RF回路
状態2: 全キャリア・全タイムスロット・全アンテナに異常発生	SER/DES部
状態3: 全タイムスロットで特定のキャリアブロックに異常発生	特定のキャリアブロックについてのキャリアブロック回路
状態4: 全タイムスロットで特定のキャリアに異常発生	特定のキャリアについてのキャリア制御回路
状態5: 特定のキャリアの特定のタイムスロットに異常発生	特定のタイムスロットについてのタイムスロット制御回路
状態6: 全キャリアで特定のアンテナブロックに異常発生	特定のアンテナブロックについてのPA回路

【図4】

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×											
キャリア2	×											
キャリア3	×											
キャリア4	×											
キャリア5	×											
キャリア6	×											
キャリア7	×											
キャリア8	×											

【図5】

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×	×	×	×	×	×	×	×	×	×
キャリア2	×	×	×	×	×	×	×	×	×	×	×	×
キャリア3	×	×	×	×	×	×	×	×	×	×	×	×
キャリア4	×	×	×	×	×	×	×	×	×	×	×	×
キャリア5	×	×	×	×	×	×	×	×	×	×	×	×
キャリア6	×	×	×	×	×	×	×	×	×	×	×	×
キャリア7	×	×	×	×	×	×	×	×	×	×	×	×
キャリア8	×	×	×	×	×	×	×	×	×	×	×	×

【図6】

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×	×	×	×	×	×	×	×	×	×
キャリア2	×	×	×	×	×	×	×	×	×	×	×	×
キャリア3	×	×	×	×	×	×	×	×	×	×	×	×
キャリア4	×	×	×	×	×	×	×	×	×	×	×	×
キャリア5												
キャリア6												
キャリア7												
キャリア8												

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 131 of 365

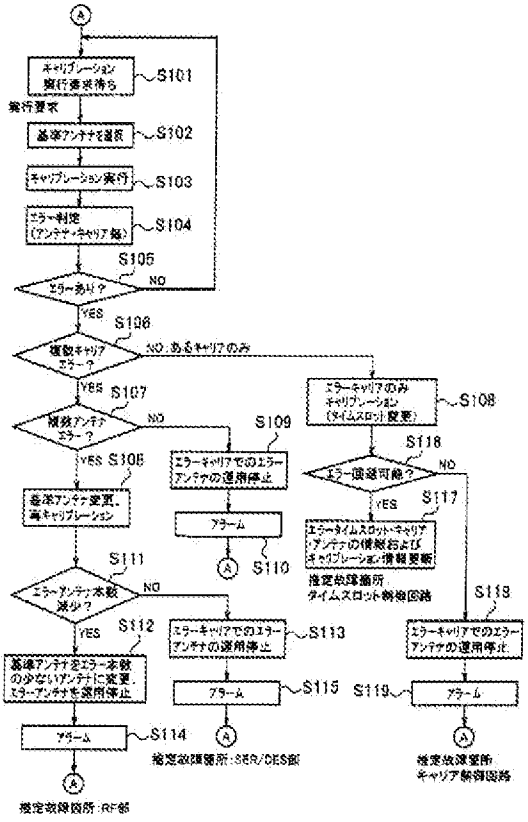
【図7】

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×	×	×	×	×	×	×	×	×	×
キャリア2												
キャリア3												
キャリア4												
キャリア5												
キャリア6												
キャリア7												
キャリア8												

【図8】

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×									
キャリア2	×	×	×									
キャリア3	×	×	×									
キャリア4	×	×	×									
キャリア5	×	×	×									
キャリア6	×	×	×									
キャリア7	×	×	×									
キャリア8	×	×	×									

【図9】



PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2008-035286
(43)Date of publication of application : 14.02.2008

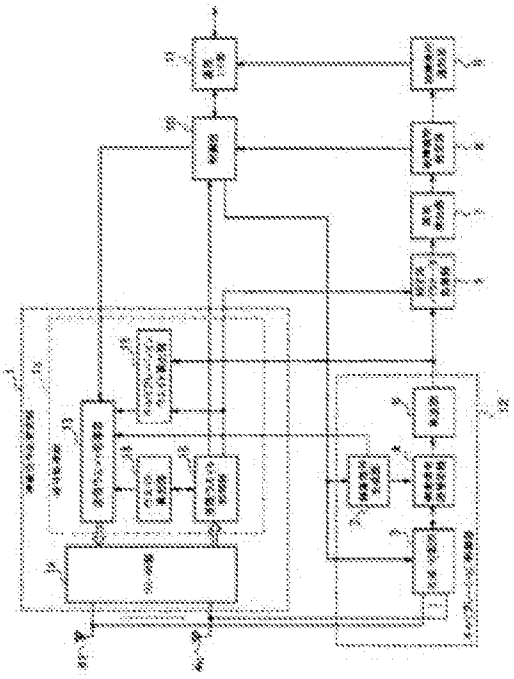
(51)Int.Cl. *H04B 7/10 (2006.01)*
H04B 17/00 (2006.01)
H04B 7/08 (2006.01)
H04B 1/40 (2006.01)
H01Q 3/26 (2006.01)

(21)Application number : 2006-207241
(22)Date of filing : 28.07.2006

(71)Applicant : KYOCERA CORP
(72)Inventor : KITAHARA MINAKO

(54) RADIO COMMUNICATION DEVICE AND THE FAILURE ESTIMATION METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To allow a faulty position in a radio signal transmission/reception part to be automatically estimated.
SOLUTION: A radio communication device provided with a plurality of antennas #1 to #n includes: a radio signal transmission/reception part 1 which uses the plurality of antennas #1 to #n to transmit/receive radio signals; a judgement parameter acquisition part 5 which acquires a judgement parameter for judging at least one of amplitude deviations and phase deviations of radio signals among antennas #1 to #n; an abnormality detection part 7 which detects abnormalities of respective antennas #1 to #n on the basis of the judgement parameter with respect to frequencies of radio signals transmitted/received by respective antennas #1 to #n; and a faulty position estimation part 8 which estimates a faulty position in the radio signal transmission/reception part 1 on the basis of correspondence between an abnormal antenna out of antennas #1 to #n and a frequency in response to detection of abnormality.



* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
The present invention relates to the radio communication equipment possessing two or more antennas, and the failure estimation method which presumes the locating fault of this radio communication equipment.
[Background of the Invention]
[0002]
Effective use of frequency resources is achieved by improvement in access speed, and Time Division Multiplexing in the digital communication. The space division multiple (SDMA) system which uses an adaptive array antenna is known by making frequency resources into the technology which can further be used effectively. In an adaptive array antenna, an electric wave is transmitted and received to the communications partner of a specific direction by forming a directivity response pattern accommodative with two or more antennas.
[0003]
In an adaptive array antenna, in order to control directivity with high precision, it is required to perform an antenna calibration periodically and to proofread the amplitude characteristic and phase characteristic at the time of transmission and reception of an antenna. When an antenna calibration is performed and fault is on a circuit, generating of fault can be detected as a calibration error. The technique of enabling discovery of fault at an early stage is proposed by performing an antenna calibration automatically (see Patent Document 1.).
[Patent document 1] JP,2001-53662,A
[Description of the Invention]
[Problem to be solved by the invention]
[0004]
Out of order [with various factors / the internal circuit of radio communication equipment] in wireless communication base station equipment. In a Patent document 1, it primarily aims to proofread the amplitude characteristic and phase characteristic of transmission and reception of an antenna by the antenna calibration, and the antenna calibration is not positively utilized for detection of a locating fault. For this reason, when an antenna calibration goes wrong, service is suspended, and in order to judge a locating fault, it is necessary to conduct analysis by a help. As a result, there was a problem of analysis having taken cost and requiring a long time by restoration.
[0005]
In view of the above-mentioned problem, the present invention provides automatically the radio communication equipment and the failure estimation method which can be presumed for a locating fault.
[Means for solving problem]

[0006]
To achieve the above objects, the first characteristics of the present invention are the radio communication equipment possessing two or more antennas, and comprise the following:
A wireless signal sender and receiver which transmits and receives a radio signal using two or more antennas.
A parameter acquisition part for a judgment which acquires a parameter for a judgment for judging at least 1 side of an amplitude deviation of a radio signal between each antenna, or a phase excursion.
A malfunction detection part which detects abnormalities of each antenna about frequency of a radio signal transmitted and received with each antenna based on a parameter for a judgment.
A locating-fault estimating part which presumes a locating fault in a wireless signal sender and receiver based on matching with each antenna and frequency with the abnormalities concerned when abnormalities are detected.

[0007]
The parameter acquisition part for a judgment which acquires the parameter for a judgment for judging at least 1 side of the amplitude deviation of the radio signal between each antenna, or a phase excursion according to these characteristics, The malfunction detection part which detects the abnormalities of each antenna about the frequency of the radio signal transmitted and received with each antenna based on the parameter for a judgment, When abnormalities are detected, failure can be automatically presumed by having a locating-fault estimating part which presumes the locating fault in a wireless signal sender and receiver based on matching with each antenna and frequency with the abnormalities concerned.
[0008]
In the radio communication equipment which requires the second characteristics of the present invention for the first characteristics, a locating-fault estimating part makes it a summary to presume a locating fault based on first matching with abnormal each antenna and frequency, and the composition part in a wireless signal sender and receiver and second matching of **.
[0009]
According to these characteristics, in the radio communication equipment concerning the first characteristics, the locating-fault estimating part can presume failure automatically by presuming a locating fault based on first matching with abnormal each antenna and frequency, and the composition part in a wireless signal sender and receiver and second matching of **.
[0010]
In the radio communication equipment which requires the 3rd characteristics of the present invention for the 1st or the second characteristics, When a locating fault is presumed by the locating-fault estimating part, let it be a summary to have further a control part which makes operation of a wireless signal sender and receiver continue using the normal part which is a part except a locating fault in a wireless signal sender and receiver.
[0011]
By making operation of a wireless signal sender and receiver continue using the normal part which is a part except a locating fault in a wireless signal sender and receiver, when a locating fault is presumed by the locating-fault estimating part according to these characteristics, The part which carves a normal operation system and a failure system and can utilize them by the system which is carrying out normal operation can be used effectively, and can offer the best service also in the time of a failure occurrence.
[0012]
In the radio communication equipment concerning the 1st - the 3rd one of the characteristics, the 4th characteristics of the present invention make it a summary to have further a locating-fault informing part which notifies a locating fault outside with the purport that abnormalities were

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 136 of 365

detected, when a locating fault is presumed by the locating-fault estimating part.
[0013]
According to these characteristics, when a locating fault is presumed by the locating-fault estimating part, the notice to the outside of radio communication equipment is attained in a locating fault by notifying a locating fault outside with the purport that abnormalities were detected.
[0014]
In the radio communication equipment concerning the 1st - the 4th one of the characteristics, the fifth characteristics of the present invention are a multi-carrier signal and time division signals, and a radio signal the parameter acquisition part for a judgment, Acquiring the parameter for a judgment for every antenna, every carrier, and every time slot, a malfunction detection part makes it a summary to detect abnormalities for every antenna, every carrier, and every time slot.
[0015]
When using a multi-carrier signal and time division signals according to these characteristics, When the parameter acquisition part for a judgment acquires the parameter for a judgment for every antenna, every carrier, and every time slot and a malfunction detection part detects abnormalities for every antenna, every carrier, and every time slot, effective locating-fault detection can be enabled.
[0016]
In the radio communication equipment which requires the sixth characteristics of the present invention for the 1st - the 5th one of the characteristics, the parameter acquisition part for a judgment makes it a summary to acquire the parameter for a judgment in the case of the antenna calibration which proofreads at least 1 side of an amplitude deviation or a phase excursion.
[0017]
According to these characteristics, a locating fault is detectable using antenna calibration operation.

[0018]
The step to which the seventh characteristics of the present invention are failure estimation methods applied to the radio communication equipment possessing two or more antennas, and a wireless signal sender and receiver transmits and receives a radio signal using two or more antennas, The step which acquires the parameter for a judgment for judging at least 1 side of the amplitude deviation of the radio signal between each antenna, or a phase excursion, The step which detects the abnormalities of each antenna about the frequency of the radio signal transmitted and received with each antenna based on the parameter for a judgment, Step which presumes the locating fault in a wireless signal sender and receiver based on matching with each antenna and frequency with the abnormalities concerned when abnormalities are detected Let it be a summary to contain.
[Effect of the Invention]
[0019]
According to the present invention, the radio communication equipment and the failure estimation method which can be presumed can be automatically provided for a locating fault.
[Best Mode of Carrying Out the Invention]
[0020]
Next, the embodiment of the present invention is described with reference to Drawings. In the description of the Drawings in following embodiments, the identical or similar code is given to the identical or similar portion.
[0021]
(Example of an entire configuration of radio communication equipment)
As shown in Fig.1 as an example of radio communication equipment below, two or more antenna #1 - #n are provided, and it describes about the base transceiver station which communicates with a mobile station (an integer greater than or equal to n; 2). Radio communication equipment concerning

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 137 of 365

an embodiment of the present invention is provided with the following.
Two or more antenna #1-#n.
The wireless signal sender and receiver 1.
Calibration control part 12.
The parameter acquisition part 5 for a judgment, the malfunction detection part 7, the locating-fault estimating part 8, the locating-fault informing part 9, the control part 10, and the communication interface section (the following, "communication I/F part") 11.

[0022]
The wireless signal sender and receiver 1 uses two or more antenna #1 - #n as an adaptive array antenna, and communicates with a mobile station. It is connected to an external network and the communication I/F part 11 communicates with the manages base station equipment on a network, etc.
[0023]
At the time of the transmission and reception of a radio signal which used two or more antenna #1 - #n, the calibration control part 12 controls the antenna calibration operation for proofreading at least 1 side of the amplitude deviation between antennas, or a phase excursion. An antenna calibration is performed based on the transmitting characteristic information (amplitude phase difference information) of each antenna #1 - #n, receiving characteristic information (amplitude phase difference information), or such combination.
[0024]
The parameter acquisition part 5 for a judgment acquires the parameter for a judgment for judging at least 1 side of the amplitude deviation of the radio signal between antennas, or a phase excursion for every antenna. The malfunction detection part 7 judges whether abnormalities occurred in two or more antenna #1 - #n based on the parameter for a judgment. Detection of abnormalities is performed about each of two or more antenna #1 - #n, corresponding [whether amplitude is stably and] to whether phase contrast with other antennas is stably. The details of the parameter for a judgment are mentioned later.
[0025]
The locating-fault estimating part 8 presumes the locating fault in the wireless signal sender and receiver 1 based on the generation state of abnormalities, when abnormalities are detected about at least one of two or more antenna #1 - the #n. "The generation state of abnormalities" means matching with abnormal each antenna #1 - #n, and frequency (carrier frequency or frequency of a communications channel) here. For example, it means on which frequency of which antenna abnormalities were detected among each antenna #1 - #n, or whether abnormalities were detected on the frequency of which antenna group (antenna block) throat. However, it is available in the generation state of the abnormalities caused about elements other than an antenna according to the wireless communication system which radio communication equipment adopts so that it may mention later.
[0026]
When an abnormal antenna is detected as an example, the calibration control part 12 performs calibration operation two or more times, switching the antenna used as a standard. As a result, the malfunction detection part 7 can judge abnormalities over the calibration of multiple times, and the locating-fault estimating part 8 can acquire the generation state of abnormalities. The locating-fault estimating part 8 judges whether a locating fault is both a transmission system of the wireless signal sender and receiver 1, a receiving system, or transmission and reception according to the generation state of abnormalities.
[0027]
The control part 10 makes operation of the wireless signal sender and receiver 1 continue using the normal part except a locating fault, when the wireless signal sender and receiver 1 is controlled and

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 138 of 365

a locating fault is presumed. The locating-fault informing part 9 notifies a locating fault to manages base station equipment automatically using the communication I/F part 11, when a locating fault is detected.

[0028]

Therefore, it becomes possible to perform failure correspondence promptly by investigating the part notified as a locating fault, suppressing the influence which it has when failure occurs only at some antennas to the minimum, and continuing employment of radio communication equipment.

[0029]

Although antenna #1-#n, the wireless signal sender and receiver 1, the calibration control part 12, and the communication I/F part 11 are mounted as hardware, The parameter acquisition part 5 for a judgment, the malfunction detection part 7, the locating-fault estimating part 8, and the locating-fault informing part 9 can perform CPU which mounts as a program and omits a graphic display. Therefore, it becomes possible to suppress the influence of [on employment] to the minimum at the time of failure or a failure occurrence, without carrying out additional installation of the special equipment to the radio communication equipment which has an antenna calibration function.

[0030]

(Schematic structure of a wireless signal sender and receiver)

Next, it describes about the schematic structure of the wireless signal sender and receiver 1. The wireless signal sender and receiver 1 has the following.

Power amplification and the radio-frequency head 1a (the following, "PA and an RF section") which performs amplification, frequency conversion, etc. of a radio signal

The signal processing part 1b which does signal processing of the radio signal.

[0031]

When transmitting or receiving a radio signal simultaneously from two or more antenna #1-#n, the signal processing part 1b is constituted so that a weighting may be carried out to the radio signal about each of two or more antenna #1 - #n. Specifically, the signal processing part 1b has the transmission weight processing part 13, the weight calculation part 14, the calibration weight calculation part 15, and the receiving weight processing part 16.

[0032]

From the input signal from PA and RF section 1a, the receiving weight processing part 16 acquires amplitude information and phase information for every antenna, and notifies amplitude information and phase information to the weight calculation part 14 and the parameter acquisition part 5 for a judgment. The weight calculation part 14 computes the weight for adjusting the amplitude and the phase which are given to the transmission and reception signals of PA and RF section 1a for every antenna.

[0033]

Using the weight which shows the phase and the amount of differences between each antenna of amplitude which the weight calculation part 14 computed, the receiving weight processing part 16 carries out the weighting of the input signal for every [from PA and RF section 1a] antenna, and synthesizes it. This will form the directivity response pattern at the time of reception. The transmission weight processing part 13 carries out a weighting to the sending signal for every antenna, using the parameter computed at the time of reception also the time of transmission. This will form the array-antennas pattern at the time of transmission.

[0034]

(Composition of a calibration control part)

Next, it describes about the composition of the calibration control part 12. The calibration control part 12 is provided with the following.

Checking signal generating part 2.

A synthesis and the distribution part 3.

Checking signal sender and receiver 4.
Detection section 6.
At the time of a calibration, the checking signal generating part 2 generates the checking signal of same amplitude and phase by a baseband zone. As a checking signal, the tone signal (sine wave) which is a kind of the signal of constant frequency, for example, or the burst signal (bit string) with which frequency is changed according to the contents of a signal can be used.
[0035]
When inspecting the receiving characteristic of the wireless signal sender and receiver 1, a checking signal is input into PA and RF section 1a via the checking signal sender and receiver 4, and a synthesis and a distribution part 3. On the other hand, when inspecting the transmitting characteristic of the wireless signal sender and receiver 1, a checking signal is input into PA and RF section 1a via the transmission weight processing part 13.
[0036]
The checking signal sender and receiver 4 performs conversion with a radio frequency and baseband frequency. The detection section 6 detects the phase information and amplitude information of each antenna required for a calibration.
[0037]
A synthesis and the distribution part 3 synthesize the signal from two or more antenna #1-#n, and it distributes the signal from the checking signal sender and receiver 4 to two or more antenna #1 - #n.
[0038]
(Parameter for a judgment)
Next, it describes in detail about the parameter for a judgment. The parameter acquisition part 5 for a judgment acquires either [following] 1-5 and the following combination of 1-5 as a parameter for a judgment.
[0039]
1) Signal amplitude information about each antenna detected by the calibration control part 12 when all the antennas have transmitted the electric wave with the same amplitude (following, "transmission amplitude information")
2) Reception amplitude information about each antenna detected by the receiving weight processing part 16 when all the antennas have received the electric wave with the same amplitude (following, "reception amplitude information")
3) Phase difference information of the sending signal between antennas (following, "transmission phase difference information")
4) Phase difference information of the input signal between antennas (following, "receive-phase-difference information")
5) Information computed from the information on the above 1-4
Here, as the above 5, the transceiver amplitude phase difference information etc. of each antenna standardized with the reference antenna correspond, for example.
[0040]
The malfunction detection part 7 judges the existence of phase fluctuation or amplitude fluctuation to the parameter for a judgment of the above 1-5.
[0041]
"Amplitude fluctuation (amplitude deviation)" means dispersion produced between the antennas at the time of [which is produced between the antennas at the time of making the checking signal of the same amplitude transmit using each antenna] varying or making the checking signal of the same amplitude receive using each antenna. The size of dispersion may judge whether it is settled in the predetermined threshold value to total antenna average value, and may judge it on a certain standard.
[0042]

"Phase contrast fluctuation (phase excursion)" means dispersion produced between the antennas at the time of [which is produced between the antennas at the time of making the checking signal of the same phase transmit using each antenna] varying or making the checking signal of the same phase receive using each antenna. A phase excursion is detectable by carrying out the same transmission and reception operations continuously.

[0043]

For example, when the transmission and reception operations of the checking signal same twice are performed, a phase excursion determines a reference antenna, phase difference vectors are made, and it checks by taking the inner product of the phase difference vectors. The number of antennas is set to "N",

It is the 1st time a = [a1, a2, ..., aN]

It is the 2nd time b = [b1, b2, ..., bN]

(It is a1=b1 if the 1st antenna is a reference antenna)

When it is the phase and amplitude vector obtained by **********, the result of "a-b" is equivalent to the size of fluctuation. If the computed result is standardized to 1, it can be judged that fluctuation is small, so that real part is [one] near. If the size of the real part of the standardized result is 0.999 or less, it will be judged that it is unusual. Thus, abnormalities are detected by turning and carrying out the threshold decision of a fixed quantity of fluctuation.

[0044]

(Configuration example of a wireless signal sender and receiver)

Next, the specific configuration example of the wireless signal sender and receiver 1 is described using Fig.2. The example of Fig.2 shows the configuration example of the wireless signal sender and receiver 1 in the base station of the system based on an iBurst (registered trademark) standard. In the system based on an iBurst (registered trademark) standard, the time division multiple access / time sharing bidirectional transmission (TDMA/TDD) system which adopted the multicarrier are used.

[0045]

In a multicarrier, and TDMA/TDD system of a multiantenna type, the part etc. which are using every common circuit, carrier, and different circuits for every antenna on two or more carriers exist. When the common chip is being used on two or more carriers and failure arises for the chip, it does not usually happen easily to influence only one carrier.

[0046]

Thus, it is detectable with a certain amount of probability for what chip (circuit) failure has arisen from the error generating state. Therefore, a locating fault is presumed in consideration of whether it is the failure generated [in what kind of unit hardware organization is summarized, and] where.

[0047]

To the composition shown in Fig.2, the parameter acquisition part 5 for a judgment shown in Fig.1 acquires the parameter for a judgment for every antenna, every carrier, and every time slot.The malfunction detection part 7 judges whether abnormalities occurred or not for every antenna, every carrier, and every time slot. In the calibration control part 12, a frequency band is set up according to the carrier which performs a calibration.

[0048]

The wireless signal sender and receiver 1 which shows Fig.2 has the following.

1st [**] - 12th antenna #1-#12.

PA and RF section 100.

A serializer / deserializer part (the following, "SER/DES part") 140.

The carrier block part 150, the carrier control part 160, and the time slot control part 170.

[0049]

PA and RF section 100 are provided with the following.

PA section 110.
RF section 120.
The PA section 110 is provided with the 1st - the 4th PA circuits 111-114. Each of the 1st - the 4th PA circuits 111-114 is provided with PA and low noise amplifier (LNA) which were connected in parallel between two transmission and reception selector switches which omit a graphic display, and two transmission and reception selector switches. The radio signal which used PA at the time of transmission is amplified, and the radio signal which used LNA is amplified at the time of reception.
[0050]
RF section 120 is provided with the 1st - 12th RF circuit 121-132. Each of the 1st - 12th RF circuit 121-132 performs analog-to-digital (A/D) conversion with the down convert from a radio frequency band to a baseband zone at the time of reception. On the other hand, at the time of transmission, up convert from a baseband zone to digital one / analog (D/A) conversion, and a radio frequency band is performed. The SER/DES part 140 delivers and receives the signal outputted and inputted between RF section 120 and the carrier block part 150.
[0051]
The carrier block part 150 is provided with the 1st and 2nd carrier block circuit 151,152. Each of the 1st and 2nd carrier block circuit 151,152 is constituted by the field-programmable gate array (FPGA). At the time of reception, each of the 1st and 2nd carrier block circuit 151,152 distributes the input signal input for every antenna for every carrier, and distributes the sending signal input for every carrier for every antenna at the time of transmission.
[0052]
The carrier control part 160 is provided with the 1st - the 8th carrier control circuits 161-168. Each of the 1st - the 8th carrier control circuits 161-168 is constituted by FPGA. At the time of reception, each of the 1st - the 8th carrier control circuits 161-168 divides the input signal input for every carrier for every time slot, and unifies the sending signal input for every time slot for every carrier at the time of transmission.
[0053]
The time slot control part 170 is provided with the 1st - the 24th time-slot control circuits 171-194. Each of the 1st - the 24th time-slot control circuits 171-194 is constituted by the digital signal processor (DSP). At the time of reception, each of the 1st - the 24th time-slot control circuits 171-194 performs detection, the operation of calibration weight, etc., and performs the multiplication of weight, etc. at the time of transmission. Detection processing may take a detection system which is usually different from the time of calibration operation in the time of communication. At the time of a calibration, it operates so that the information on the difference of the phase amplitude of each antenna independent of receiving antenna weight (receiving characteristic information) can be acquired. At the time of communication, transmission weight is usually computed using calibration weight and receiving weight information.
[0054]
(Example of a generation state of abnormalities)
Next, it describes about the example of a generation state of the abnormalities in the configuration example of the wireless signal sender and receiver 1 which showed Fig.2.
[0055]
One each of the 1st - the 4th PA circuits 111-114 is assigned for every antenna block which consists of three antennas. Each of the 1st - 12th RF circuit 121-132 is provided corresponding to each antenna. The one SER/DES part 140 is provided in common with all the antennas and all the carriers.
[0056]
One each of the 1st and 2nd carrier block circuit (FPGA) 151,152 is assigned for every carrier block consisting of four carriers. Specifically, the 1st carrier block circuit 151 is assigned to the 1st - the 4th carrier CA1-CA4, and the 2nd carrier block circuit 152 is assigned to the 5th - the 8th carrier

CA5-CA8.

[0057]

Each of the 1st - the 8th carrier control circuits (FPGA) 161-168 is provided corresponding to each carrier.

[0058]

Each of the 1st - the 24th time-slot control circuits (DSP) 171-194 is provided corresponding to each time slot. Specifically, the 1st, 4th, 7th, 10th, 13th, 16th, 19th, and 22nd time-slot control circuits (DSP) 171, 174, 177, 180, and 183,186,189,192 correspond to 1st time-slot TS1. The 2nd, 5th, 8th, 11th, 14th, 17th, 18th, and 23rd time-slot control circuits (DSP) 172, 175, 178, 181, and 184,187,190,193 correspond to 2nd time-slot TS2. The 3rd, 6th, 9th, 12th, 15th, 18th, 19th, and 24th time-slot control circuits (DSP) 173, 176, 179, 182, and 185,188,191,194 correspond to 3rd time-slot TS3.

[0059]

In such composition, it describes using Fig.3 about matching with the generation state of abnormalities, and a presumed locating fault. In Fig.3, a total of six patterns of the state 1 - the state 6 are illustrated.

[0060]

The state 1 is in the state where abnormalities were detected by the specific antenna by all the carriers and all the time slots, and if PA circuit or the RF circuit corresponding to a specific antenna is out of order, it can be presumed. For example, as shown in Fig.4, when the antenna 1 shows abnormalities by all the carriers and all the time slots, it is thought that the 1st PA circuit 111 or 1st RF circuit 121 is out of order.

[0061]

As shown in Fig.5, the state 2 is in the state where abnormalities were detected by all the carriers, all the time slots, and all the antennas, and if the SER/DES part 140 is out of order, it can be presumed.

[0062]

The state 3 is in the state where abnormalities were detected by the specific carrier block by all the time slots, and if the carrier block circuit about a specific carrier block is out of order, it can be presumed. For example, as shown in Fig.6, when the specific carrier block (carriers 1-4) shows abnormalities by all the time slots, it is thought that the 1st carrier block circuit 151 is out of order.

[0063]

The state 4 is in the state where abnormalities were detected by the specific carrier by all the time slots, and if the carrier control circuit about a specific carrier is out of order, it can be presumed. For example, as shown in Fig.7, when the carrier 1 shows abnormalities by all the time slots, it is thought that the 1st carrier control circuit 161 is out of order.

[0064]

The state 5 is in the state where abnormalities were detected by the specific time slot of the specific carrier, and if the time-slot control circuit about a specific time slot is out of order, it can be presumed.

[0065]

The state 6 is in the state where abnormalities were detected by the specific antenna block on all the carriers, and if PA circuit about a specific antenna block is out of order, it can be presumed. For example, as shown in Fig.8, when the 1st - 3rd antenna #1 - #3 show abnormalities by all the time slots, it is thought that the 1st PA circuit 111 is out of order.

[0066]

When the malfunction detection part 7 holds previously the table as shown in Fig.4 - Fig.8, a locating fault is immediately consisted of error generating states detectable.

[0067]

(Example of a failure presumption flow)

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 143 of 365

Next, with reference to the flow chart shown in Fig.9, it describes about an example of the failure estimation method concerning the embodiment of the present invention.

[0068]

In Step S101, the checking signal generating part 2 of Fig.1 will be in a waiting state until a calibration execution demand is notified from a control part. If a calibration execution demand is notified, it will shift to Step S102.

[0069]

In Step S102, the control part 10 chooses a reference antenna.

[0070]

In Step S103, a calibration is performed by the procedure mentioned above. As a result, the calibration vector information, the transmitting characteristic information, and the receiving characteristic information on each antenna on the basis of a reference antenna are acquired. A calibration vector is a transmission-and-reception-signals amplitude phase of other antennas in other cases on the basis of the transmission-and-reception-signals amplitude phase of a reference antenna. In process of a calibration, the parameter acquisition part 5 for a judgment acquires the parameter for a judgment.

[0071]

In Step S104, the malfunction detection part 7 judges abnormalities (calibration error) for every antenna and every carrier.

[0072]

In Step S105, the malfunction detection part 7 checks whether abnormalities have been detected at Step S104. When abnormalities are not detected, processing returns to Step S101. When abnormalities are detected, it shifts to Step S106.

[0073]

In Step S106, the locating-fault estimating part 8 judges whether abnormalities were detected over two or more carriers. When two or more abnormalities are detected over a carrier, it shifts to Step S107. When abnormalities are detected by only the specific carrier, it shifts to Step S108. Abnormalities are detected on two or more carriers, and if it is the abnormalities caused with one antenna, it can be considered that a corresponding antenna is failure.

[0074]

In Step S107, the locating-fault estimating part 8 judges whether abnormalities were detected over two or more antennas. When two or more abnormalities are detected over an antenna, it shifts to Step S108. When abnormalities are detected by only the specific antenna, it shifts to Step S109.

[0075]

In Step S109, the control part 10 stops operation of abnormal antenna and carrier. It is presumed that failure has generated the locating-fault estimating part 8 in the SER/DES part 140. The locating-fault informing part 9 notifies a locating fault outside with the purport (alarm) that abnormalities occurred.

[0076]

In Step S108, since there is possibility of the abnormalities of a reference antenna, the control part 10 is controlled to change a reference antenna and to perform a calibration again.

[0077]

In Step S111, the locating-fault estimating part 8 judges whether unusual antennas decreased in number as a result of Step S108. When unusual antennas decrease in number, it shifts to Step S112. When unusual antennas do not decrease in number, it shifts to Step S113.

[0078]

In Step S112, the control part 10 maintains change of a reference antenna, and makes suspension the antenna which was being made into the standard to last time. The locating-fault estimating part 8 presumes the RF circuit of RF section 132 corresponding to the antenna made into suspension as a locating fault. In Step S114, the locating-fault informing part 9 notifies a locating fault outside with

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 144 of 365

the purport that abnormalities occurred.
[0079]
In Step S113, the control part 10 carries out suspension of the abnormal antenna, and continues service only with the antenna which is carrying out normal operation. It is presumed that failure has generated the locating-fault estimating part 8 in the SER/DES part 140. In Step S115, the locating-fault informing part 9 notifies a locating fault outside with the purport that abnormalities occurred.
[0080]
On the other hand, in Step S108, the control part 10 changes the time slot which was performing the calibration, performs a calibration again, and confirms whether the malfunction detection part 7 can avoid abnormalities at Step S116. When abnormalities are able to be avoided, it shifts to Step S117. When abnormalities cannot be avoided, it shifts to Step S118.
[0081]
In Step S117, the locating-fault estimating part 8 detects a locating fault from the time slot control part 170. And the locating-fault informing part 9 notifies a locating fault outside with the purport that abnormalities occurred.
[0082]
In Step S118, the locating-fault estimating part 8 presumes a locating fault from the carrier control part 160. The control part 10 stops operation of the carrier which has caused abnormalities. In Step S119, the locating-fault informing part 9 notifies a locating fault outside with the purport that abnormalities occurred.
[0083]
As described in details above, according to the embodiment of the present invention, a locating fault can be presumed using antenna calibration operation. Instead of suspending the communications service in an applicable carrier, when failure becomes clear, a failure occurrence part and a normal operation part are carved, and minimum communications service can be secured also at the time of a failure occurrence with it being made to give its service only using a normal operation part. At the time of repair, treatment for repair and an improvement can be promptly performed from having carved the locating fault.
[0084]
When becoming possible to discover the abnormalities which were not able to be discovered in the conventional calibration at an early stage, it becomes possible to become possible to prevent unnecessary radio emission and to improve communication quality.
[0085]
(Other embodiments)
As mentioned above, although the present invention was described by the embodiment, if this invention is limited, he should not understand the statement and Drawings which make a part of this disclosure. Various alternative embodiment, an working example, and an investment technique become clear [to a person skilled in the art] from this disclosure.
[0086]
In the embodiment mentioned above, although an example which presumes the locating fault of a base transceiver station was described, when presuming the locating fault of a mobile communication terminal, it may apply.
[0087]
Although described about the radio communication equipment which adopts a TDMA system, if it is the radio communication equipment possessing two or more antennas, it can apply, also when adopting other wireless communication systems, such as a code-division-multiple-access (CDMA) system.
[0088]
In the embodiment mentioned above, it described using the antenna calibration about an example which presumes the locating fault of the wireless signal sender and receiver 1. However, only

presumed operation of a locating fault may be performed, without using an antenna calibration. In this case, the parameter acquisition part 5 for a judgment acquires the parameter for a judgment, without operating the calibration weight calculation part 15.

[0089]

Thus, the present invention should understand including various embodiments etc. which are not described here. Therefore, the present invention is limited by only matter to define the invention of appropriate Claims from this disclosure.

[Brief Description of the Drawings]

[0090]

[Drawing 1]It is a block diagram showing the configuration example of the radio communication equipment concerning the embodiment of the present invention.

[Drawing 2]It is a block diagram showing the example of an internal configuration of the transmission and reception section concerning the embodiment of the present invention.

[Drawing 3]It is a table for describing the function of the locating-fault estimating part concerning the embodiment of the present invention.

[Drawing 4]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 1).

[Drawing 5]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 2).

[Drawing 6]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 3).

[Drawing 7]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 4).

[Drawing 8]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 5).

[Drawing 9]It is a flow chart which shows an example of the locating-fault estimation processing of the radio communication equipment concerning the embodiment of the present invention.

[Explanations of letters or numerals]

[0091]

1-#n -- Antenna
1 -- Wireless signal sender and receiver
1 a--PA and an RF section
1b -- Signal processing part
2 -- Checking signal generating part
3 -- A synthesis and distribution part
4 -- Checking signal sender and receiver
5 -- Parameter acquisition part for a judgment
6 -- Detection section
7 -- Unusual estimating part
8 -- Locating-fault estimating part
9 -- Locating-fault informing part
10 -- Control part
11 -- Communication I/F part
12 -- Calibration control part
13 -- Transmission weight processing part
14 -- Weight calculation part
15 -- Calibration weight calculation part
16 -- Receiving weight processing part
100 -- PA and RF section
110 -- The PA section

111 -- The 1st PA circuit
111-114 -- PA circuit
120 -- RF section
121-132 -- RF circuit
140 -- SER/DES part
150 -- Carrier block part
151,152 -- Carrier block circuit
160 -- Carrier control part
161-168 -- Carrier control circuit
170 -- Time slot control part
171-194 -- Time-slot control circuit

[Translation done.]

* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]
It is the radio communication equipment possessing two or more antennas,
A wireless signal sender and receiver which transmits and receives a radio signal using two or more aforementioned antennas,
A parameter acquisition part for a judgment which acquires a parameter for a judgment for judging at least 1 side of an amplitude deviation of the aforementioned radio signal between each antenna, or a phase excursion,
A malfunction detection part which detects abnormalities of each aforementioned antenna about frequency of a radio signal transmitted and received with each aforementioned antenna based on the aforementioned parameter for a judgment,
A locating-fault estimating part which presumes a locating fault in said wireless signal sender and receiver based on matching with each aforementioned antenna and the aforementioned frequency with the abnormalities concerned when the aforementioned abnormalities are detected
Radio communication equipment characterized by preparation ******.
[Claim 2]
The radio communication equipment according to claim 1, wherein the aforementioned locating-fault estimating part presumes the aforementioned locating fault based on first matching with each aforementioned antenna and the aforementioned frequency with said abnormalities, and a composition part in said wireless signal sender and receiver and second matching of **.
[Claim 3]
The radio communication equipment according to claim 1 or 2 having further a control part which makes operation of said wireless signal sender and receiver continue using a normal part which is a part except the aforementioned locating fault in said wireless signal sender and receiver when the aforementioned locating fault is presumed by the aforementioned locating-fault estimating part.
[Claim 4]
Radio communication equipment of a description in any 1 item of Claims 1-3 having further a locating-fault informing part which notifies the aforementioned locating fault outside with a purport that the aforementioned abnormalities were detected when the aforementioned locating fault is presumed by the aforementioned locating-fault estimating part.
[Claim 5]
The aforementioned radio signals are a multi-carrier signal and time division signals,
The aforementioned parameter acquisition part for a judgment acquires the aforementioned parameter for a judgment for every antenna, every carrier, and every time slot,
Radio communication equipment of a description in any 1 item of Claims 1-4, wherein said malfunction detection part detects said abnormalities for every antenna, every carrier, and every time slot.
[Claim 6]

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 148 of 365

Radio communication equipment of a description in any 1 item of Claims 1-5, wherein the aforementioned parameter acquisition part for a judgment acquires the aforementioned parameter for a judgment in the case of an antenna calibration which proofreads at least 1 side of the aforementioned amplitude deviation or the aforementioned phase excursion.

[Claim 7]

It is a failure estimation method applied to radio communication equipment possessing two or more antennas,

A step to which a wireless signal sender and receiver transmits and receives a radio signal using two or more aforementioned antennas,

A step which acquires a parameter for a judgment for judging at least 1 side of an amplitude deviation of the aforementioned radio signal between each antenna, or a phase excursion,

A step which detects abnormalities of each aforementioned antenna about frequency of a radio signal transmitted and received with each aforementioned antenna based on the aforementioned parameter for a judgment,

A step which presumes a locating fault in said wireless signal sender and receiver based on matching with each aforementioned antenna and the aforementioned frequency with the abnormalities concerned when the aforementioned abnormalities are detected

A failure estimation method containing **.

[Translation done.]

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 149 of 365

* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[0090]
[Drawing 1]It is a block diagram showing the configuration example of the radio communication equipment concerning the embodiment of the present invention.
[Drawing 2]It is a block diagram showing the example of an internal configuration of the transmission and reception section concerning the embodiment of the present invention.
[Drawing 3]It is a table for describing the function of the locating-fault estimating part concerning the embodiment of the present invention.
[Drawing 4]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 1).
[Drawing 5]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 2).
[Drawing 6]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 3).
[Drawing 7]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 4).
[Drawing 8]It is a table showing an example of the generation state of the abnormalities which the malfunction detection part concerning the embodiment of the present invention detects (the 5).
[Drawing 9]It is a flow chart which shows an example of the locating-fault estimation processing of the radio communication equipment concerning the embodiment of the present invention.

[Translation done.]

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 150 of 365

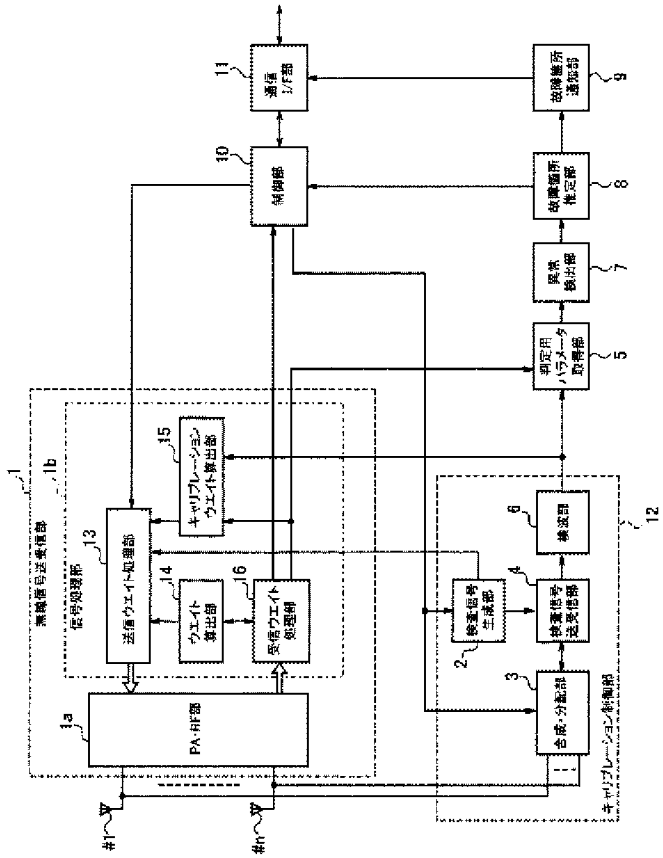
* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

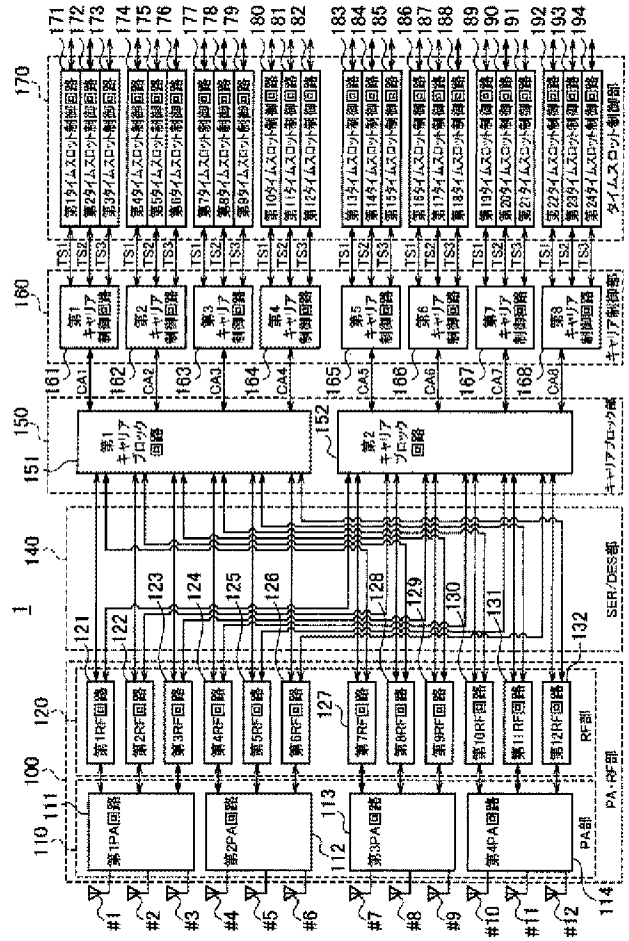
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



[Drawing 3]

異常の発生状態	推定故障箇所
状態1: 全キャリア・全タイムスロットで特定のアンテナに異常発生	特定のアンテナについてのPA回路・RF回路
状態2: 全キャリア・全タイムスロット・全アンテナに異常発生	SER/DES部
状態3: 全タイムスロットで特定のキャリアブロックに異常発生	特定のキャリアブロックについてのキャリアブロック回路
状態4: 全タイムスロットで特定のキャリアに異常発生	特定のキャリアについてのキャリア制御回路
状態5: 特定のキャリアの特定のタイムスロットに異常発生	特定のタイムスロットについてのタイムスロット制御回路
状態6: 全キャリアで特定のアンテナブロックに異常発生	特定のアンテナブロックについてのPA回路

[Drawing 4]

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×											
キャリア2	×											
キャリア3	×											
キャリア4	×											
キャリア5	×											
キャリア6	×											
キャリア7	×											
キャリア8	×											

[Drawing 5]

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×	×	×	×	×	×	×	×	×	×
キャリア2	×	×	×	×	×	×	×	×	×	×	×	×
キャリア3	×	×	×	×	×	×	×	×	×	×	×	×
キャリア4	×	×	×	×	×	×	×	×	×	×	×	×
キャリア5	×	×	×	×	×	×	×	×	×	×	×	×
キャリア6	×	×	×	×	×	×	×	×	×	×	×	×
キャリア7	×	×	×	×	×	×	×	×	×	×	×	×
キャリア8	×	×	×	×	×	×	×	×	×	×	×	×

[Drawing 6]

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×	×	×	×	×	×	×	×	×	×
キャリア2	×	×	×	×	×	×	×	×	×	×	×	×
キャリア3	×	×	×	×	×	×	×	×	×	×	×	×
キャリア4	×	×	×	×	×	×	×	×	×	×	×	×
キャリア5												
キャリア6												
キャリア7												
キャリア8												

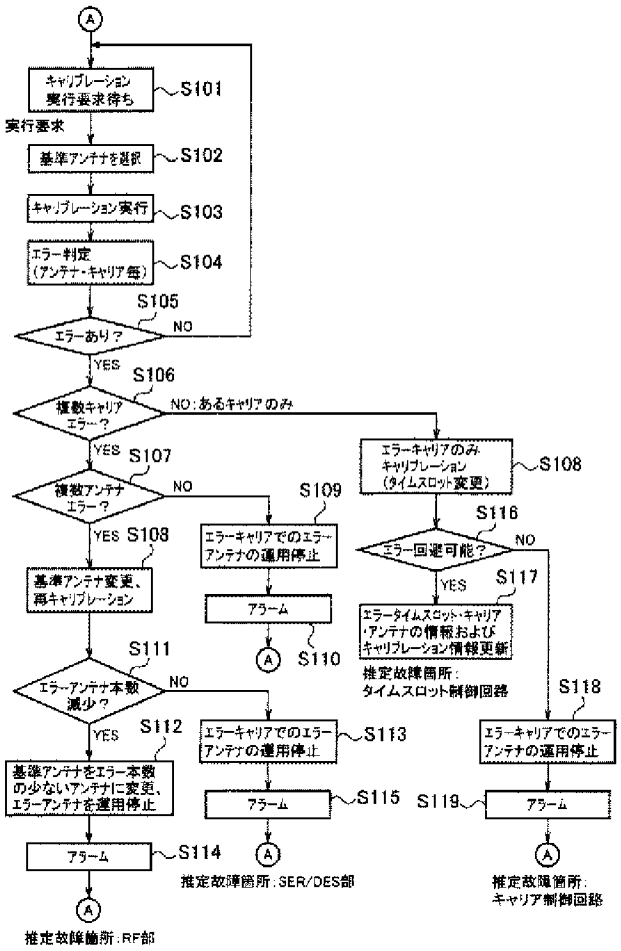
[Drawing 7]

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×	×	×	×	×	×	×	×	×	×
キャリア2												
キャリア3												
キャリア4												
キャリア5												
キャリア6												
キャリア7												
キャリア8												

[Drawing 8]

アンテナ#	1	2	3	4	5	6	7	8	9	10	11	12
キャリア1	×	×	×									
キャリア2	×	×	×									
キャリア3	×	×	×									
キャリア4	×	×	×									
キャリア5	×	×	×									
キャリア6	×	×	×									
キャリア7	×	×	×									
キャリア8	×	×	×									

[Drawing 9]



[Translation done.]

No documents available for this priority number.

Espacenet

Bibliographic data: JP2006115267 (A) — 2006-04-27

RADIO COMMUNICATION DEVICE

Inventor(s): YANAGI KENJI; FURUEDA KOICHIRO; ARAI HIDEAKI; TOTSUKA TAKAO; KAJITA KAZUTOYO ± (YANAGI KENJI, ; FURUEDA KOICHIRO, ; ARAI HIDEAKI, ; TOTSUKA TAKAO, ; KAJITA KAZUTOYO)

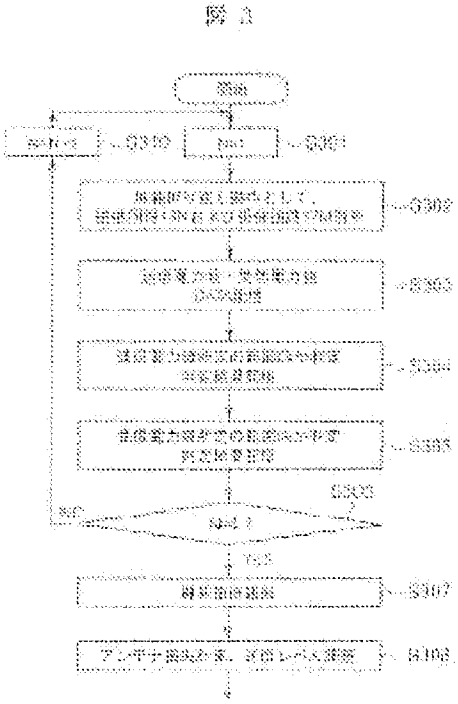
Applicant(s): HITACHI COMM TECH LTD ± (HITACHI COMMUNICATION TECHNOLOGIES LTD)

Classification: - international: ***H01Q3/26; H04B17/00; H04B7/08; H04B7/10***
- cooperative:

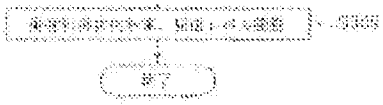
Application number: JP20040301117 20041015

Priority number (s): JP20040301117 20041015

Abstract of JP2006115267 (A)



Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 456 of 365



PROBLEM TO BE SOLVED: To make the number of parts smaller, and to detect the abnormalities of a transmitting section and a receiving section for a radio circuit section connected to an antenna. ; SOLUTION: A signal processor transmits a transmitting signal generated from one of transmitters for the radio circuit, makes the transmitting signal receive by receiving sections for a plurality of the radio circuits except the radio circuit transmitting the transmitting signal and make the back-to-back of a radio conduct. A detected sending power value and a detected receiving power value are stored, and whether or not the sending power value is kept within a specified range and whether or not the receiving power value is kept within the specified range are decided. The abnormalities of a sending and a reception are detected from the results of the decisions of a plurality of the sending power values and a plurality of the receiving power values, and a sending level and a receiving level are adjusted. ; COPYRIGHT: (C)2006,JPO&NCIPI

Last updated: 13.03.2013 Worldwide Database 5.8.6.7; 93p

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 457 of 365

(19)日本国特許庁(JP)　(12)公開特許公報(A)　(11)特許出願公開番号
特開2006-115267
(P2006-115267A)
(43)公開日　平成18年4月27日(2006.4.27)

(51)Int.Cl.			F I			テーマコード（参考）
H04B	7/10	(2006.01)	H04B	7/10	A	5J021
H01Q	3/26	(2006.01)	H01Q	3/26	Z	5K042
H04B	7/08	(2006.01)	H04B	7/08	D	5K059
H04B	17/00	(2006.01)	H04B	17/00	K	

審査請求 未請求　請求項の数 3　OL　（全 18 頁）

(21)出願番号　特願2004-301117 (P2004-301117)
(22)出願日　平成16年10月15日 (2004.10.15)

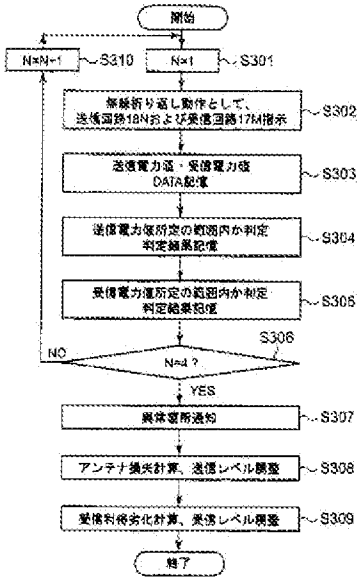
(71)出願人　000153465
株式会社日立コミュニケーションテクノロジー
東京都品川区南大井六丁目２６番３号
(74)代理人　110000198
特許業務法人湘洋内外特許事務所
(72)発明者　柳　健二
神奈川県横浜市戸塚区戸塚町２１６番地
株式会社日立コミュニケーションテクノロジーキャリアネットワーク事業部内
(72)発明者　古枝　幸一郎
神奈川県横浜市戸塚区戸塚町２１６番地
株式会社日立コミュニケーションテクノロジーキャリアネットワーク事業部内

最終頁に続く

(54)【発明の名称】無線通信装置

(57)【要約】
【課題】より部品点数を少なくし、アンテナに接続される無線回路部の送信部および受信部の異常を検出する。
【解決手段】信号処理部は、無線回路部の送信部の一つから生成した送信信号を送信させ、送信信号を送信した無線回路部以外の複数の無線回路部の受信部で送信信号を受信させ、無線折り返しをさせる。検出された送信電力値と、検出された受信電力値とを記憶し、送信電力値が所定の範囲内であるか、受信電力値が所定の範囲内であるかを判定する。複数の送信電力値および複数の受信電力値の判定結果から送受信の異常を検出し、送信レベルと受信レベルとを調整する。
【選択図】図３

図３



Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 158 of 365

【特許請求の範囲】
【請求項1】
アンテナが接続される送信部および受信部を備える、少なくとも３つの無線回路部と、信号を処理する信号処理部とを備える無線通信装置において、
前記送信部は、当該送信部で送信する送信信号の電力レベルを検出する送信電力検出手段を備え、
前記受信部は、当該受信部で受信する受信信号の電力レベルを検出する受信電力検出手段を備え、
前記信号処理部は、前記無線回路部の前記送信部の一つから生成した送信信号を送信させ、送信信号を送信した無線回路部以外の複数の無線回路部の前記受信部で前記送信信号を受信させる無線折り返し手段と、前記無線折り返し手段により無線折り返しをさせたときに、前記送信電力検出手段で検出された送信電力レベルと、前記受信電力検出手段で検出された受信電力レベルとを記憶する記憶手段と、前記記憶手段で記憶する複数の送信電力レベルおよび複数の受信電力レベルの各々について予め定めた異常レベルを検出し、異常レベルを検出した箇所の組合せにより、送受信の異常を検出する異常検出手段とを備えることを特徴とする無線通信装置。
【請求項2】
請求項１に記載の無線通信装置において、前記信号処理部は、前記記憶手段で記憶する複数の送信電力レベルおよび複数の受信電力レベルから、一つの無線回路部を基準として、他の無線回路部との間におけるアンテナ系の損失レベルの差分および受信利得劣化分における差分を求め、前記一つの無線回路部を基準として他の無線回路部の送信部における送信電力レベルの調整と、前記一つの無線回路部を基準として他の無線回路部の受信部における受信電力レベルの調整とを行う調整手段をさらに有することを特徴とする無線通信装置。
【請求項3】
請求項１に記載の無線通信装置において、前記異常検出手段は、前記記憶手段で記憶する複数の送信電力レベルおよび複数の受信電力レベルから、前記送受信の異常の発生箇所が、前記無線回路部の前記送信部、前記受信部および当該無線回路部に接続されているアンテナ部分のいずれであるかを検出することを特徴とする無線通信装置。

【発明の詳細な説明】
【技術分野】
【0001】
３つ以上のアンテナに接続される受信系および送信系を有する無線通信装置に関し、特に、異常箇所を特定し、送信電力を調整する技術に関する。
【背景技術】
【0002】
無線通信装置は、アンテナ装置が接続されるアンテナ端子を有し、製造工程ではこのアンテナ端子に専用測定装置が接続され、無線通信装置としての送信及び受信の無線特性が所定のレベル値を満足しているか否かのチェックが行われる。そして、満足していることが確認された後に出荷される。しかし、無線通信装置の施工と施工後の確認検査は施工業者にて行われる。このため、ケーブル接触不良などの施工不備による無線特性の劣化や、施工後の故障により無線特性に異常が見られた場合、故障箇所の断定を行うために、アンテナ等の接続をすべて外し、専用測定装置にて無線通信装置としての性能確認が必要である。したがって、故障箇所の断定には多くの労力と時間がかかっている。
【0003】
特許文献1には、このような問題を解決するため、運用状態において無線通信装置本体とアンテナ装置との動作確認を容易に行うことのできる自己診断方法が開示されている。特許文献１では、複数のアンテナ装置と複数の受信部及び送信部とを備えたＴＤＭＡ（Ｔｉｍｅ Ｄｉｖｉｓｉｏｎ Ｍｕｌｔｉｐｌｅ Ａｃｃｅｓｓ）－ＴＤＤ（Ｔｉｍｅ Ｄｉｖｉｓｉｏｎ Ｄｕｐｌｅｘ）方式無線通信システムに用いる無線通信装置の自己診断

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 159 of 365

方法が開示されている。この自己診断方法では、１つの無線回路の送信部に接続されたアンテナ装置を介して送信された所定の送信信号を、他のアンテナ装置に接続された無線回路の受信部を介して受信するようなループバック試験処理を行い、この試験結果をテーブルデータとして記憶する。送信部では、送信した送信信号のレベルを検出する検出手段と、アンテナ装置からの反射波の信号レベルを検出する反射波検出手段とを備える。受信部では、受信信号のレベルを検出する検出手段を備える。

【0004】

複数あるアンテナ装置、送信部及び受信部の接続の組合せを替えていき複数回のループバック試験処理を行い、この試験結果をテーブルデータとして記憶し、これらのテーブルデータが正常範囲にあるか否かを判定することよってアンテナ装置および無線回路の異常判定を行う。これらのテーブルデータは、送信部の検出手段が検出した送信信号レベルと、反射波検出手段が検出したアンテナ装置からの反射波の信号レベルと、受信部の検出手段が検出した受信信号レベルとの３種類の値から構成される。それぞれの値が所定のレベル範囲内であれば正常であり、その他の場合は異常と判断するしきい値判定法で異常診断がなされている。

【0005】

【特許文献1】特開平１０－１０７７４４号公報

【発明の開示】

【発明が解決しようとする課題】

【0006】

アダプティブアレイアンテナ方式を用いた無線通信装置は、信号処理部でアンテナ毎に位相及び振幅を調整した送信信号を生成し、この送信信号を複数の送信部を介して各アンテナから放射することにより、任意の指向性を有する送信信号を送信する機能がある。この指向性は、アンテナ間の送信及び受信の相対レベル差が所定の範囲内に揃っていないと所望の指向性が得られない。

【0007】

また、無線通信装置は、屋外等、厳しい環境下で設置されることが多いため、運用状態においてアンテナと無線回路部とを結合するアンテナ接続端子から雨水等の水分が浸入する場合があり、この水分の侵入によりアンテナと無線回路部間のインピーダンスが不整合となり、送信電力低下という無線特性の劣化を発生させる場合がある。このようにアンテナと無線回路部との間のインピーダンス不整合による無線特性の異常を検出するために、上記特許文献１では、送信部側にアンテナからの反射波を検波する反射波検出回路を設けている。

【0008】

しかし、この反射波検出回路は、部品点数が多いため実装面積が大きくなってしまうという問題がある。

【0009】

本発明は、より部品点数を少なくし、アンテナに接続される無線通信装置の送受信の異常を検出することができる技術を提供することを目的とする。

【課題を解決するための手段】

【0010】

本発明は、上記課題を解決するため、アンテナが接続される送信部および受信部を備える、少なくとも３つの無線回路部と、信号を処理する信号処理部とを備える無線通信装置において、前記送信部は、当該送信部で送信する送信信号の電力レベルを検出する送信電力検出手段を備え、前記受信部は、当該受信部で受信する受信信号の電力レベルを検出する受信電力検出手段を備え、前記信号処理部は、前記無線回路部の前記送信部の一つから生成した送信信号を送信させ、送信信号を送信した無線回路部以外の複数の無線回路部の前記受信部で前記送信信号を受信させる無線折り返し手段と、前記無線折り返し手段により無線折り返しをさせたときに、前記送信電力検出手段で検出された送信電力レベルと、前記受信電力検出手段で検出された受信電力レベルとを記憶する記憶手段と、前記記憶手

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 160 of 365

段で記憶する複数の送信電力レベルおよび複数の受信電力レベルの各々について予め定めた異常レベルを検出し、異常レベルを検出した箇所の組合せにより、送受信の異常を検出する異常検出手段とを備える。

【発明の効果】

【0011】

本発明によれば、記憶手段で記憶する複数の送信電力レベルおよび複数の受信電力レベルの各々について予め定めた異常レベルを検出し、異常レベルを検出した箇所の組合せにより、送受信の異常を検出することができる。反射波検出回路で検出していた送信異常の検出を、異常レベルを検出した箇所の組合せにより特定することで、反射波検出回路を備える必要がないので部品点数を少なくすることができ、実装面積をより小さくすることができる。また、複数の送信電力レベルおよび複数の受信電力レベルから、一つの無線回路部を基準として、他の無線回路部との間におけるアンテナ系の損失レベルの差分および受信利得劣化分における差分を求め、前記一つの無線回路部を基準として他の無線回路部の送信部における送信電力レベルの調整と、前記一つの無線回路部を基準として他の無線回路部の受信部における受信電力レベルの調整とを行うことによって、指向性を所望する方向に調整することができる。さらに、送信系、受信系もしくはアンテナ部分の異常箇所の特定を行うことができる。

【発明を実施するための最良の形態】

【0012】

以下、本発明における無線通信装置の一実施の形態を、図１～図１０に基づき説明する。

【0013】

図１は、本実施の形態における無線通信装置の構成図である。

【0014】

図１において、本実施の形態の無線通信装置１１０は、送信部及び受信部をそれぞれ有する無線回路ＲＦ１３１、ＲＦ１３２、ＲＦ１３３およびＲＦ１３４と、信号処理部１２０とを有する。無線通信装置１１０は、少なくとも３つの無線回路ＲＦを備え、それぞれの無線回路ＲＦに１または複数のアンテナが接続される。本実施の形態においては、アンテナ１０１、１０２、１０３および１０４が無線回路ＲＦ１３１、ＲＦ１３２、ＲＦ１３３およびＲＦ１３４にそれぞれ接続される場合を示す。無線回路ＲＦ１３１、１３２、１３３および１３４は、同一の回路構成および機能を備えている。

【0015】

無線回路ＲＦ１３１は、送信処理を行う送信部ＴＸ１６１と、受信処理を行う受信部ＲＸ１５１と、送信と受信とを切り替えるＳＷ１４１と、アンテナを接続させるためのアンテナ接続端子１２１とを有している。同様に、無線回路ＲＦ１３２は、送信部ＴＸ１６２、受信部ＲＸ１５２、ＳＷ１４２およびアンテナ接続端子１２２を有し、無線回路ＲＦ１３３は、送信部ＴＸ１６３、受信部ＲＸ１５３、ＳＷ１４３およびアンテナ接続端子１２３を有し、無線回路ＲＦ１３４は、送信部ＴＸ１６４、受信部ＲＸ１５４、ＳＷ１４４およびアンテナ接続端子１２４を有する。

【0016】

無線回路ＲＦ１３１のアンテナ接続端子１２１には、アンテナケーブルＡＣ１１１によりアンテナ１０１が接続される。同様に、無線回路ＲＦ１３２のアンテナ接続端子１２２には、アンテナケーブルＡＣ１１２によりアンテナ１０２が接続され、無線回路ＲＦ１３３のアンテナ接続端子１２３には、アンテナケーブルＡＣ１１３によりアンテナ１０３が接続され、無線回路ＲＦ１３４のアンテナ接続端子１２４には、アンテナケーブルＡＣ１１４によりアンテナ１０４が接続される。

【0017】

無線回路ＲＦの送信部ＴＸ１６１、ＴＸ１６２、ＴＸ１６３およびＴＸ１６４は、送信電力値を検出する送信電力検波回路ＴＤ１９５、ＴＤ１９６、ＴＤ１９７およびＴＤ１９８と、送信回路１８１、１８２、１８３および１８４とをそれぞれ有する。また、無線回

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 161 of 365

路ＲＦの受信部ＲＸ１５１、ＲＸ１５２、ＲＸ１５３およびＲＸ１５４は、受信電力値を検出する受信電力検波回路ＲＤ１９１、ＲＤ１９２、ＲＤ１９３およびＲＤ１９４と、受信回路１７１、１７２、１７３および１７４とをそれぞれ有する。

【0018】

スイッチ部ＳＷ１４１、ＳＷ１４２、ＳＷ１４３およびＳＷ１４４は、受信部ＲＸと送信部ＴＸとを時分割で切り替えてそれぞれのアンテナに接続させる。

【0019】

信号処理部１２０は、送信信号生成、送信電力制御、送信信号位相調整、変復調などのディジタル信号処理を行う。信号処理部１２０は、ＤＳＰ（Ｄｉｇｉｔａｌ　Ｓｉｇｎａｌ　Ｐｒｏｃｅｓｓｏｒ）１５０、ＣＰＵ１４０およびメモリ１３０を少なくとも備え、異常検出調査方法の手順を示すソフトウェアプログラムをメモリ１３０に記憶している。また、その他のアプリケーションプログラムを備えるようにしてもよい。

【0020】

また、信号処理部１２０は、図１に示す受信電力検波回路ＲＤ１９１、ＲＤ１９２、ＲＤ１９３およびＲＤ１９４から受信電力値を取り込み、図１に示す送信電力検波回路ＴＤ１９５、ＴＤ１９６、ＴＤ１９７およびＴＤ１９８から送信電力値を取り込み、内部に備えるメモリ１３０にそれぞれ記憶する。また、信号処理部１２０は、異常検出調査を行うときに、図１に示すアンテナ１０１、１０２、１０３および１０４と、送信部ＴＸ１６１、ＴＸ１６２、ＴＸ１６３およびＴＸ１６４と、受信部ＲＸ１５１、ＲＸ１５２、ＲＸ１５３およびＲＸ１５４との組合せを切り替えるスイッチ部ＳＷ１４１、ＳＷ１４２、ＳＷ１４３およびＳＷ１４４の制御を行うことができる。

【0021】

本実施の形態における無線通信装置１１０は、携帯電話等の基地局として動作することができる。本実施の形態においては、１台の無線通信装置において、１つの制御チャネルと３つの通信回線との運用を制御する場合の（１Ｃ＋３Ｔ）タイプと称されるものを例にする。無線通信装置１１０は、この（１Ｃ＋３Ｔ）タイプに限定するものでは無く、（１Ｃ＋１５Ｔ）等のアダプティブアレイアンテナ方式を用いた方式や、３つ以上のアンテナが接続され、アンテナと同一数以上の無線回路を有するものにおいて本実施の形態を適用することができる。また、無線通信装置１１０には、基地局制御装置などに有線接続されるための有線回路を備えるようにしてもよい。

【0022】

図１に示した（１Ｃ＋３Ｔ）タイプのアダプティブアレイアンテナ方式を用いた無線通信装置１１０は、３つの通信回線の回線制御を行い、通常、信号処理部１２０から出力される送信信号を、無線回路ＲＦ１３１、ＲＦ１３２、ＲＦ１３３およびＲＦ１３４と、スイッチ部ＳＷ１４１、ＳＷ１４２、ＳＷ１４３およびＳＷ１４４とを介して、アンテナ１０１、１０２、１０３および１０４から同時送信する。このとき、信号処理部１２０は、アンテナ１０１、１０２、１０３および１０４から送信する送信信号の振幅および位相を送信部毎に制御することで所望する指向性を備える送信信号を形成している。

【0023】

異常検出の調査は、夜間などの通話回線に余裕のある時間帯や通信エラー発生時などに、制御回線１８０により接続されている管理センタの管理装置１９０からの起動指示によって、信号処理部１２０が遠隔制御されて行われる。本実施の形態における異常とは、例えば、アンテナおよびアンテナケーブルの経年変化よる劣化やアンテナ接続端子での接続不良などによるアンテナ系の異常や、送信回路における送信系の異常や、受信回路における受信系の異常などがある。本実施の形態では、これらの異常箇所を自己無線折り返し動作により送信電力と受信電力を検出することで特定する。

【0024】

図２に、図１で示した無線通信装置の無線回路ＲＦ１３１の送信電力検波回路及び受信電力検波回路の構成図を示す。送信電力検波回路ＴＤ１９５、ＴＤ１９６、ＴＤ１９７およびＴＤ１９８は、同一の構成および機能を備える。また受信電力検波回路ＲＤ１９１、

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 162 of 365

ＲＤ１９２、ＲＤ１９３およびＲＤ１９４は、同一の構成および機能を備える。

【0025】

図２に示すように、送信電力検波回路ＴＤ１９５は、送信回路１８１の後段の方向性結合器ＣＰ２２１に接続され、この方向性結合器ＣＰ２２１から出力される高周波出力信号を整流するためのダイオードＤ２３１と、この整流された高周波出力信号をさらに平滑するためのローパスフィルタＦ２１１と、検出した低周波アナログ信号をディジタルに変換するＡ／Ｄ変換器ＡＤ２０１とを備える。送信電力検波回路ＴＤ１９５は、送信回路１８１から送信する送信信号の送信電力を検波し、信号処理部１２０に出力する。

【0026】

受信電力検波回路ＲＤ１９１は、受信回路１７１の分配器ＤＶ２４０に接続され、この分配器ＤＶ２４０から出力される高周波出力信号を整流するためのダイオードＤ２３２と、この整流された高周波出力信号をさらに平滑するためのローパスフィルタＦ２１２と、検出した低周波アナログ信号をディジタルに変換するＡ／Ｄ変換器ＡＤ２０２とを備える。受信電力検波回路ＲＤ１９１は、受信回路１７１で受信する受信信号の受信電力を検波し、信号処理部１２０に出力する。

【0027】

以下、本実施に形態における異常検出調査方法について説明をする。図３に、本実施の形態の異常検出調査方法のフローチャートを示す。また、図５に、異常検出調査を行った時に得られる送信電力値の説明図を示し、図６に、受信電力値の説明図を示し、図７および図８に、異常がある場合の判定結果を示す説明図を示す。

【0028】

信号処理部１２０は、管理装置１９０から異常検出調査の起動指示を受け付けると、図３に示すフローチャートに対応するプログラムを起動する。異常検出調査を行う対象とする無線通信装置１１０のアンテナ及び無線回路について、信号処理部１２０は、無線回路部とアンテナとの間で自己無線折り返し動作を順次実行させるために、送信信号を送信する無線回路ＲＦ１３Ｎの送信回路１８Ｎを指示し、それ以外の無線回路ＲＦ１３Ｍの受信回路１７Ｍで受信信号を受信するように指示する（Ｓ３０１、Ｓ３０２）。ここで、ＮおよびＭは、自然数であり、図１に示す送信回路および受信回路の符号の末尾をそれぞれ示している。まず、Ｎ＝１として、送信回路１８１で、送信信号を送信するように指示し、Ｍを１以外の値（Ｍ＝２、３、４）として、受信回路１７２、１７３および１７４で受信信号を受信するようにＳＷ１４１～１４４をそれぞれ切り替える。

【0029】

つぎに、送信電力検波回路ＴＤ１９５で検波された送信電力値Ｔ１を図５に示すように記憶し、受信電力検波器ＲＤ１９２、１９３および１９４でそれぞれ検波された受信電力値Ｓ１２、Ｓ１３およびＳ１４を図６に示すように、メモリ１３０に記憶する（Ｓ３０３）。図５において、項目５０１には、送信回路１８１から送信される送信電力値Ｔ１が記憶され、同様に、項目５０２には、送信回路１８２から送信される送信電力値Ｔ２が記憶され、項目５０３には、送信回路１８３から送信される送信電力値Ｔ３が記憶され、項目５０４には、送信回路１８４から送信される送信電力値Ｔ４が記憶される。また、図６において、送信側６００には、送信信号を送信するアンテナ符号を登録し、受信側６０１～６０４には、受信するアンテナ符号を登録し、受信部ＲＸの受信電力検波器ＲＤで検波された受信電力値を送信および受信アンテナが対応する（交差する）領域に記憶する。ここで、受信電力値Ｓｉｊのｉは、送信するアンテナ符号の末尾の番号を示し、ｊは、受信するアンテナ符号の末尾の番号を示している。

【0030】

例えば、図４に示す無線通信装置において、送信部ＴＸ１６１が送信を行い、受信部ＲＸ１５２、ＲＸ１５３およびＲＸ１５４が受信する場合の自己無線折り返しの動作は、信号処理部１２０より出力される送信信号がＴＸ１６１の送信回路１８１へ入力されスイッチ部ＳＷ１４１、アンテナケーブルＡＣ１１１を通過しアンテナ１０１から発射される。この時にＴＸ１６１の送信回路１８１から出力される信号を送信電力検波回路ＴＤ１９５

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 163 of 365

で検波し、その送信電力値Ｔ１を信号処理部１２０のメモリ１３０に記憶する。アンテナ１０１から送信された信号は、それぞれの経路Ａα１、Ａβ１およびＡα４を伝搬し、アンテナ１０２、アンテナ１０３およびアンテナ１０４で受信される。アンテナ１０２で受信された信号は、アンテナケーブルＡＣ１１２、スイッチ部ＳＷ１４２およびＲＸ１５２の受信回路１７１を通過し、受信電力検波器ＲＤ１９２で検波された受信電力値Ｓ１２が信号処理部１２０のメモリ１３０に記憶される。アンテナ１０３で受信された信号は、アンテナケーブルＡＣ１１３、スイッチ部ＳＷ１４３およびＲＸ１５３の受信回路１７２を通過し、受信電力検波器ＲＤ１９３で検波された受信電力値Ｓ１３が信号処理部１２０のメモリ１３０に記憶される。アンテナ１０４で受信された信号は、アンテナケーブルＡＣ１１４、スイッチ部ＳＷ１４４およびＲＸ１５４の受信回路１７４を通過し、受信電力検波器ＲＤ１９４で検波された受信電力値Ｓ１４が信号処理部１２０のメモリ１３０に記憶される。

【0031】

つぎに、図５に示すように記憶された送信電力値データが、あらかじめ定めた範囲内であるか範囲外であるかを判定し、判定の結果を図５に示すように、メモリ１３０に記憶する（Ｓ３０４）。図５において、送信電力値Ｔがあらかじめ定めた範囲内にある場合には、「１」を記憶し、範囲外にある場合には「０」を対応する領域に記憶する。例えば、送信レベルの所定の範囲を２１ｄＢｍ±５ｄＢとした場合に、送信レベルが所定の範囲を満たさない場合を範囲外とする。図５に示したＴ１が範囲外と判定された場合は、アンテナ１０１に接続されている送信部ＴＸ１６１の送信回路１８１の送信系異常が検出され、送信回路１８１に対応する領域に判定結果を「０」として信号処理部１２０のメモリ１３０に記憶する。なお、送信レベルは、運用時の送信レベルおよび異常検出調査時の送信レベルは、異なる値にしてもよい。異常検出調査時は、自己折り返し動作となるため、送信アンテナと受信アンテナとが隣接しているので、異常検出調査時の送信レベルは、例えば、－５ｄＢｍにしておくことができる。

【0032】

つぎに、受信電力値データがあらかじめ定めた範囲内であるか範囲外であるかを判定し、判定結果を図７もしくは図８に示すように記憶する（Ｓ３０５）。

【0033】

図７および図８において、送信側７００および８００に、送信信号を送信するアンテナ符号を登録し、受信側７０１～７０４および８０１～８０４には、受信するアンテナ符号を登録する。また、受信部ＲＸの受信電力検波器ＲＤで検波された受信電力値が、あらかじめ定めた範囲内にある場合には「１」を、また、範囲外にある場合には「０」を、送信および受信アンテナが対応する（交差する）領域に記憶するようにしている。例えば、受信レベルの範囲を－３８ｄＢｍ±５ｄＢとした時に受信レベルの範囲を満たさない場合を範囲外とすることができる。所定の受信レベルの範囲は、送信するアンテナと受信するアンテナの距離による伝搬損失を考慮した範囲とし、送信するアンテナと受信するアンテナの組合せによって異なった範囲となり、伝搬損失を考慮してあらかじめ定めておくようにしてもよい。

【0034】

同様に、送信回路１８Ｎの末尾番号Ｎを１ずつ加算し（Ｓ３１０）、送受信するアンテナ１０１、１０２、１０３および１０４の組合せを変更して、自己無線折り返し動作を行う（Ｓ３０１～Ｓ３０５）。これにより、送信電力値Ｔ１、Ｔ２、Ｔ３およびＴ４を図５に示すように信号処理部１２０のメモリ１３０に記憶することができる。また、受信電力値Ｓ１２、Ｓ１３、Ｓ１４、Ｓ２１、Ｓ２３、Ｓ２４、Ｓ３１、Ｓ３２、Ｓ３３、Ｓ３４、Ｓ４１、Ｓ４２およびＳ４３を、図６に示すように信号処理部１２０のメモリ１３０に記憶する。

【0035】

信号処理部１２０は、送信回路１８Ｎの末尾番号がＮ＝４であるかを判定後（Ｓ３０６）、送受信するアンテナのすべての組合せについて無線折り返し動作が終了したとして、

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 164 of 365

送信電力値データと受信電力値データが所定の範囲外である異常箇所がある場合には、管理装置１９０にその異常箇所を通知する（Ｓ３０７）、異常箇所がない場合には、信号処理部１２０は、管理装置１９０に異常検出調査の終了を通知する。

【0036】

信号処理部１２０は、異常箇所として、図５、図７もしくは図８に「０」が記憶されている領域に対応する送信回路番号もしくはアンテナ番号をすべて通知することができる。さらに、信号処理部１２０において、異常箇所が検出された送信回路番号とアンテナ番号とから異常箇所を特定するように判断してもよい。

【0037】

この場合、例えば以下に示すような手順で行う。

【0038】

図４に示すアンテナ１０１からスイッチ部ＳＷ１４１間の異常判定（ＡＮＴ１０１＿ＡＬＭとする）は、下記数１にしたがって判定する。

【0039】

ＡＮＴ１０１＿ＡＬＭ＝(S12)OR(S13)OR(S14)OR(S21)OR(S31)OR(S41)　…(数１)

【0040】

ここで、Ｓｉｊのｉは、送信するアンテナ符号の末尾の番号を示し、ｊは、受信するアンテナ符号の末尾の番号を示し、Ｓｉｊは図７もしくは図８に示すような判定結果の「０」もしくは「１」が入る。

【0041】

図７を用いて説明すると、送信側アンテナ１０１の横ラインと、受信側アンテナ１０１の縦のライン上の判定結果が、すべて範囲外の「０」となる場合に、送信も受信も異常であるので、信号処理部１２０は、アンテナ１０１からアンテナ接続端子１２１間が異常と判定し、アンテナ系異常を検出する。数１式において、一つでも「１」（範囲内）がある場合には、アンテナ系異常ではないと判定する。

【0042】

また、図５に示すような送信電力値の判定結果で、送信系異常が検出されていないときに、受信部ＲＸ１５１の異常判定（ＲＸ１５１＿ＡＬＭとする）は、下記数２のように判定する。

【0043】

ＲＸ１５１＿ＡＬＭ＝（Ｓ２１）ＯＲ（Ｓ３１）ＯＲ（Ｓ４１）…（数２）

【0044】

ここで、Ｓｉｊのｉは、送信するアンテナ符号の末尾の番号を示し、ｊは、受信するアンテナ符号の末尾の番号を示し、Ｓｉｊは図７もしくは図８に示すような判定結果の「０」もしくは「１」が入る。

【0045】

図８を用いて説明すると、受信側アンテナ１０１の縦方向のラインの判定結果がすべて範囲外の「０」となった場合に、受信側のみが異常であるので、信号処理部１２０は、受信部ＲＸ１５１を異常と判定し、受信系異常を検出する。数２式において、一つでも「１」（範囲内）がある場合には、受信系異常ではないと判定する。

【0046】

このような判定の結果、信号処理部１２０は、異常を検出した箇所を管理装置１９０に通知する。他の送信系、アンテナ系、受信系においても同様に判定することができる。このように、異常レベルを検出した箇所の組合せにより、送受信の異常を検出することができる。

【0047】

つぎに、異常検出調査後、送信レベルと受信レベルとの調整を行う（Ｓ３０８、Ｓ３０９）。送信レベルと受信レベルとの調整後、異常検出調査を終了する。

【0048】

信号処理部１２０は、図５に示すような送信電力値を基に、アンテナ損失を計算し、送

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 165 of 365

信レベルのレベル調整が必要な箇所とそのレベル調整値を算出し、信号処理部１２０から出力される送信電力をレベル調整値に従って調整することによって指向性が正しく向くように調整する。

【0049】

送信レベルの調整は、以下に示すように行う。

図４に、無線通信装置の送信電力値、受信利得劣化量、アンテナからスイッチ部ＳＷ間の損失の箇所を示している。

【0050】

各送信部間の送信電力値の差分は、図５に示すような、信号処理部１２０のメモリ１３０に記憶してある送信電力値Ｔ１、Ｔ２、Ｔ３およびＴ４から求められる。例えば、図４に示すアンテナ１０１から送信される送信電力を基準とし、他のアンテナから送信される送信電力との差分は、（Ｔ２－Ｔ１）、（Ｔ３－Ｔ１）、（Ｔ４－Ｔ１）で求められる。

【0051】

また、アンテナからスイッチ部ＳＷ間の損失（Ｃ１～Ｃ４で示す）は、主にケーブル部分の損失と考えられ、以下に示すように求める。

【0052】

アンテナからスイッチ部ＳＷ間の損失の差分は、受信部が同じ場合の送信系の２経路の差で求められる。例えば、図８に示すアンテナ１０１で送信しアンテナ１０２で受信した時の受信電力値Ｓ１２と、アンテナ１０３で送信しアンテナ１０２で受信した時の受信電力値Ｓ３２との組合せで説明する。

【0053】

受信電力値Ｓ１２は、図４に示す送信電力Ｔ１、アンテナ１０１からスイッチ部ＳＷ１４１間までの損失Ｃ１、アンテナ１０２からスイッチ部ＳＷ１４２間までの損失Ｃ２、アンテナ１０１からアンテナ１０２まで伝搬するときの伝搬損失Ａα１、受信回路１７１における受信利得劣化量Ｒ２により数３で表せる。また、受信電力値Ｓ３２は、送信電力Ｔ３、アンテナ１０２からスイッチＳＷ１４２間までの損失Ｃ２、アンテナ１０３からスイッチ部ＳＷ１４３間までの損失Ｃ３、アンテナ１０３からアンテナ１０２まで伝搬するときの伝搬損失Ａα２、受信回路１７２における受信利得劣化量Ｒ２により数４で表せる。

【0054】

（送信するアンテナ１０１→受信するアンテナ１０２）

Ｓ１２＝Ｔ１－Ｃ１－Ａα１－Ｃ２＋Ｒ２…（数３）

【0055】

（送信するアンテナ１０３→受信するアンテナ１０２）

Ｓ３２＝Ｔ３－Ｃ３－Ａα２－Ｃ２＋Ｒ２…（数４）

【0056】

Ｓ１２とＳ３２の差を数５に示す。

【0057】

Ｓ１２－Ｓ３２＝（Ｔ１－Ｔ３）＋（Ｃ３－Ｃ１）＋（Ａα２－Ａα１）…（数５）

【0058】

隣接するアンテナ間の距離が同じとした場合に、Ａα１とＡα２との損失も同じであると考えられるので数６が成り立つ。

【0059】

（Ａα２－Ａα１）＝０…（数６）

【0060】

また、送信部の送信電力値が同じとみなせる場合には数７が成り立つ。

【0061】

（Ｔ１－Ｔ３）＝０…（数７）

【0062】

この場合、アンテナからスイッチ部ＳＷ間までの損失の差分は、数８式で表せる。

【0063】

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 166 of 365

Ｃ３－Ｃ１＝Ｓ１２－Ｓ３２…（数８）。

【0064】

同様に、図４に示す他のアンテナからＳＷ間までの損失の差分の各々は、図９に示すように表せる。図９において、アンテナ１０１から送信される送信電力を基準とした場合のアンテナからＳＷ間までの損失の差分をブロック９０１に示し、アンテナ１０２から送信される送信電力を基準とした場合のアンテナからＳＷ間までの損失の差分をブロック９０２に示し、アンテナ１０３から送信される送信電力を基準とした場合のアンテナからＳＷ間までの損失の差分をブロック９０３に示し、アンテナ１０４から送信される送信電力を基準とした場合のアンテナからＳＷ間までの損失の差分をブロック９０４に示す。

【0065】

信号処理部１２０では、送信電力の差分と、アンテナからスイッチ部ＳＷ間までの損失の差分とを合計した値だけ、信号処理部１２０から出力する送信信号レベルをそれぞれ調整して送信するようにする。送信時には、送信電力とアンテナからスイッチ部ＳＷまでの損失が影響するので、一つの送信部の送信レベルを基準にして、他の送信部から送信される送信レベルを相対的に調整するようにしている。例えば、図４に示すアンテナ１０１から送信される送信電力を基準とした場合に、アンテナ１０２の送信電力Ｔ２との差分と、アンテナ１０２からスイッチ部ＳＷ１４２間までの損失Ｃ２との差分を合計した値をＯＵＴ２１とする。ＯＵＴ２１は、数９で示すようになる。

【0066】

ＯＵＴ２１＝（Ｔ２－Ｔ１）－（Ｃ２－Ｃ１）…（数９）

【0067】

アンテナ１０２からスイッチ部ＳＷ１４２間までの損失とアンテナ１０１からスイッチ部ＳＷ１４１間までの損失との差分である（Ｃ２－Ｃ１）は、数１０に示すように表せる。

【0068】

Ｃ２－Ｃ１＝（Ｓ１３－Ｓ２３）＋（Ｔ２－Ｔ１）＋（Ａβ１－Ａα２）…（数１０）

【0069】

ゆえに、数９および数１０よりＯＵＴ２１は数１１で表せる。

【0070】

ＯＵＴ２１＝－（Ｓ１３－Ｓ２３）－（Ａβ１－Ａα２）…（数１１）

【0071】

伝搬損失Ａβ１の損失は、アンテナ間の距離が大きいため伝搬損失Ａα２に対して３ｄＢ大きいとすると数１１は、数１２で表せる。

【0072】

ＯＵＴ２１＝－（Ｓ１３－Ｓ２３）－３…（数１２）

【0073】

信号処理部１２０は、図５に示すような測定した値Ｓ１３およびＳ２３を、数１２に代入してＯＵＴ２１を求め、送信回路１８１の送信レベルに対して、このＯＵＴ２１に相当する値分、送信回路１８２の送信レベルを増加させるように調整する。

【0074】

同様に、アンテナ１０１から送信される送信電力を基準とした場合に、アンテナ１０３の送信電力Ｔ３との差分と、アンテナ１０３からスイッチ部ＳＷ１４３間までの損失Ｃ３との差分を合計した値をＯＵＴ３１とする。ＯＵＴ３１は、数１３で示すようになる。

【0075】

ＯＵＴ３１＝（Ｔ３－Ｔ１）－（Ｃ３－Ｃ１）…（数１３）

【0076】

アンテナ１０３からスイッチ部ＳＷ１４３間までの損失とアンテナ１０１からスイッチ部ＳＷ１４１間までの損失との差分である（Ｃ３－Ｃ１）は、数１４に示すように表せる。

【0077】

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 167 of 365

Ｃ３－Ｃ１＝（Ｓ１２－Ｓ３２）＋（Ｔ３－Ｔ１）＋（Ａα１－Ａα２）…（数１４）

【0078】

ゆえに、数１３および数１４よりＯＵＴ３１は数１５で表せる。

【0079】

ＯＵＴ３１＝－（Ｓ１２－Ｓ３２）－（Ａα１－Ａα２）…（数１５）

【0080】

隣接するアンテナ間の距離が同じとした場合に伝搬損失Ａα１と伝搬損失Ａα２の損失も同じであると考えられるので、（Ａα２－Ａα１）＝０と見なせるため、数１５は、数１６で表せる。

【0081】

ＯＵＴ３１＝－（Ｓ１２－Ｓ３２）…（数１６）

【0082】

信号処理部１２０は、図５に示すような測定した値Ｓ１２およびＳ３２を、数１６に代入して求め、送信回路１８１の送信レベルに対して、このＯＵＴ３１に相当する値分、送信回路１８３の送信レベルを増加させるように調整する。

【0083】

また、アンテナ１０１から送信される送信電力を基準とした場合に、アンテナ１０４の送信電力Ｔ４との差分と、アンテナ１０４からスイッチ部ＳＷ１４４間までの損失Ｃ４との差分を合計した値をＯＵＴ４１とする、ＯＵＴ４１は、数１７で示すようになる。

【0084】

ＯＵＴ４１＝（Ｔ４－Ｔ１）－（Ｃ４－Ｃ１）…（数１７）

【0085】

アンテナ１０４からスイッチ部ＳＷ１４４間までの損失と、アンテナ１０１からスイッチ部ＳＷ１４１間までの損失との差分である（Ｃ３－Ｃ１）は、数１８に示すように表せる。

【0086】

Ｃ４－Ｃ１＝（Ｓ１３－Ｓ４３）＋（Ｔ４－Ｔ１）＋（Ａβ１－Ａα４）…（数１８）

【0087】

ゆえに、数１７および数１８よりＯＵＴ４１は数１９で表せる。

【0088】

ＯＵＴ４１＝－（Ｓ１３－Ｓ４３）－（Ａβ１－Ａα４）…（数１９）

【0089】

伝搬損失Ａβ１の損失は、アンテナ間の距離が大きいため伝搬損失Ａα４に対して３ｄＢ大きいとすると数１９は数２０で表せる。

【0090】

ＯＵＴ４１＝－（Ｓ１３－Ｓ４３）－３…（数２０）

【0091】

信号処理部１２０は、図５に示すような測定した値Ｓ１３およびＳ４３を、数２０に代入して求め、送信回路１８１の送信レベルに対して、このＯＵＴ４１に相当する値分、送信回路１８４の送信レベルを増加させるように調整する。

【0092】

従って、アンテナ１０１を基準としたアンテナの送信電力との差分とアンテナからスイッチ部ＳＷ間までの損失との差分を合計した値ＯＵＴ２１、ＯＵＴ３１、ＯＵＴ４１に相当する分だけ信号処理部１２０から出力される送信信号レベルを可変することで、アンテナ間での送信の相対レベルを揃えることができる。また、送信電力を同じとみなせない場合には、測定した送信電力値を考慮して送信レベルをそろえるようにしてもよい。

【0093】

次に、受信レベルの調整は、以下に示すように行う。

【0094】

受信利得劣化量の差分は、対向するアンテナ間の受信電力の差で求められる。例えば、

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 168 of 365

図４に示すアンテナ１０１から送信信号を送信し、アンテナ１０２で受信した時の受信電力値Ｓ１２と、アンテナ１０２から送信信号を送信し、アンテナ１０１で受信した時の受信電力値Ｓ２１の組合せで説明する。

【0095】

受信電力値Ｓ１２は、図４に示す送信電力Ｔ１、アンテナ１０１からスイッチ部ＳＷ１４１間までの損失Ｃ１、アンテナ１０２からスイッチ部ＳＷ１４２間までの損失Ｃ２、伝搬損失Ａα１、受信利得劣化量Ｒ２により数２１で表せる。また、受信電力値Ｓ２１は、送信電力Ｔ２、アンテナ１０２からスイッチ部ＳＷ１４２間までの損失Ｃ２、アンテナ１０１からスイッチ部ＳＷ１４１間までの損失Ｃ１、伝搬損失Ａα１、受信利得劣化量Ｒ１により数２２で表せる。

【0096】

（送信するアンテナ１０１－受信するアンテナ１０２）

Ｓ１２＝Ｔ１－Ｃ１－Ａα１－Ｃ２＋Ｒ２…（数２１）

【0097】

（送信するアンテナ１０３－受信するアンテナ１０２）

Ｓ２１＝Ｔ２－Ｃ２－Ａα１－Ｃ１＋Ｒ１…（数２２）

【0098】

Ｓ１２とＳ２１との差を数２３に示す。

【0099】

Ｓ１２－Ｓ２１＝（Ｔ１－Ｔ２）＋（Ｒ２－Ｒ１）…（数２３）

【0100】

送信部の送信電力値が同じとみなせる場合には数２４が成り立つ。

【0101】

（Ｔ１－Ｔ３）＝０…（数２４）

【0102】

この場合、受信回路１７２と受信回路１７１との受信利得劣化量の差分は、数２５で表せる。

【0103】

Ｒ２－Ｒ１＝Ｓ１２－Ｓ２１…（数２５）

【0104】

同様に、図４に示す他の受信利得劣化量の差分の各々は、図１０に示すように表せる。図１０において、アンテナ１０１で受信される受信電力を基準とした場合の受信利得劣化の差分をブロック１００１に示し、アンテナ１０２で受信される受信電力を基準とした場合の受信利得劣化の差分をブロック１００２に示し、アンテナ１０３で受信される受信電力を基準とした場合の受信利得劣化の差分をブロック１００３に示し、アンテナ１０４で受信される受信電力を基準とした場合の受信利得劣化の差分をブロック１００４に示す。

【0105】

信号処理部１２０では、受信利得劣化量の差分と、アンテナからスイッチ部ＳＷ間までの損失の差分とを合計した値だけ、受信回路で受信する受信レベルを調整する。受信時には、アンテナからスイッチ部ＳＷまでの損失と、受信利得劣化とが、受信レベルに影響するので、一つの受信部の受信レベルを基準にして、他の受信部で受信する受信レベルを相対的に調整するようにしている。例えば、図４に示したアンテナ１０１で受信される受信レベルを基準とした場合に、受信利得劣化量Ｒ２との差分と、アンテナ１０２からスイッチ部ＳＷ１４２間までの損失Ｃ２との差分を合計した値をＩＮ２１とする。ＩＮ２１は数２６で示すようになる。

【0106】

ＩＮ２１＝（Ｒ２－Ｒ１）－（Ｃ２－Ｃ１）…（数２６）

【0107】

アンテナ１０２からスイッチ部ＳＷ１４２間までの損失とアンテナ１０１からスイッチ部ＳＷ１４１間までの損失との差分である（Ｃ２－Ｃ１）は数２７のように表せる。

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 169 of 365

【0108】
Ｃ２－Ｃ１＝（Ｓ１３－Ｓ２３）＋（Ｔ２－Ｔ１）＋（Ａβ１－Ａα２）…（数２７）
【0109】
また、受信利得劣化量の差分である（Ｒ２－Ｒ１）は、数２８に示される。
【0110】
Ｒ２－Ｒ１＝（Ｓ１２－Ｓ２１）＋（Ｔ２－Ｔ１）…（数２８）
【0111】
ゆえに、数２７および数２８よりＩＮ２１は数２９で表せる。
【0112】
ＩＮ２１＝（Ｓ１２－Ｓ２１）－（Ｓ１３－Ｓ２３）－（Ａβ１－Ａα２）…（数２９）
【0113】
伝搬損失Ａβ１の損失は、アンテナ間の距離が大きいため伝搬損失Ａα２に対して３ｄＢ大きいとすると数２９は、数３０で表せる。
【0114】
ＩＮ２１＝（Ｓ１２－Ｓ２１）－（Ｓ１３－Ｓ２３）－３…（数３０）
【0115】
信号処理部１２０は、図５に示すような測定した値Ｓ１２、Ｓ２１、Ｓ１３およびＳ２３を、数３０に代入してＩＮ２１を求め、受信回路１７１の受信レベルに対して、このＩＮ２１に相当する値分、受信回路１７２の受信レベルを増加させるように調整する。
【0116】
同様に、アンテナ１０１で受信される受信電力を基準にした場合に、受信利得劣化量Ｒ３との差分と、アンテナ１０３からスイッチ部ＳＷ１４３間までの損失Ｃ３との差分を合計した値をＩＮ３１とする。ＩＮ３１は数３１で示すようになる。
【0117】
ＩＮ３１＝（Ｒ３－Ｒ１）－（Ｃ３－Ｃ１）…（数３１）
【0118】
アンテナ１０３からスイッチ部ＳＷ１４３間までの損失と、アンテナ１０１からスイッチ部ＳＷ１４１間までの損失との差分である（Ｃ３－Ｃ１）は、数３２のように表せる。
【0119】
Ｃ３－Ｃ１＝（Ｓ１２－Ｓ３２）＋（Ｔ３－Ｔ１）＋（Ａα１－Ａα２）…（数３２）
【0120】
また、受信利得劣化量の差分である（Ｒ２－Ｒ１）は、数３３に示される。
【0121】
Ｒ３－Ｒ１＝（Ｓ１３－Ｓ３１）＋（Ｔ３－Ｔ１）…（数３３）
【0122】
ゆえに、数３２および数３３よりＩＮ３１は数３４で表せる。
【0123】
ＩＮ３１＝（Ｓ１３－Ｓ３１）－（Ｓ１２－Ｓ３２）－（Ａα１－Ａα２）…（数３４）
【0124】
隣接するアンテナ間の距離が同じとした場合に、伝搬損失Ａα１と伝搬損失Ａα２の損失も同じであるので（Ａα２－Ａα１）＝０と見なせ、数３４は数３５で表せる。
【0125】
ＩＮ３１＝（Ｓ１３－Ｓ３１）－（Ｓ１２－Ｓ３２）…（数３５）
【0126】
信号処理部１２０は、図５に示すような測定した値Ｓ１３、Ｓ３１、Ｓ１２およびＳ３２を、数３４に代入してＩＮ３１を求め、受信回路１７１の受信レベルに対して、このＩＮ３１に相当する値分、受信回路１７３の受信レベルを増加させるように調整する。
【0127】
また、図４に示したアンテナ１０１で受信される受信電力を基準にした受信利得劣化量Ｒ４との差分と、アンテナ１０４からスイッチ部ＳＷ１４４間までの損失Ｃ４との差分を

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 170 of 365

合計した値をＩＮ４１とする。ＩＮ４１は数３６で示すように表せる。

【0128】

ＩＮ４１＝（Ｒ４－Ｒ１）－（Ｃ４－Ｃ１）…（数３６）

【0129】

アンテナ１０４からスイッチ部ＳＷ１４４間までの損失と、アンテナ１０１からスイッチ部ＳＷ１４１間までの損失との差分である（Ｃ４－Ｃ１）は、数３７のように表せる。

【0130】

Ｃ４－Ｃ１＝（Ｓ１３－Ｓ４３）＋（Ｔ４－Ｔ１）＋（Ａβ１－Ａα４）…（数３７）

【0131】

また、受信利得劣化量の差分である（Ｒ４－Ｒ１）は、数３８に示される。

【0132】

Ｒ４－Ｒ１＝（Ｓ１４－Ｓ４１）＋（Ｔ４－Ｔ１）…（数３８）

【0133】

ゆえに、数３７および数３８よりＩＮ４１は数３９で表せる。

【0134】

ＩＮ４１＝（Ｓ１４－Ｓ４１）－（Ｓ１３－Ｓ４３）－（Ａβ１－Ａα４）…（数３９）

【0135】

伝搬損失Ａβ１の損失は、アンテナ間の距離が大きいため伝搬損失Ａα４に対して３ｄＢ大きいとすると数３９は数４０で表せる。

【0136】

ＩＮ４１＝（Ｓ１４－Ｓ４１）－（Ｓ１３－Ｓ４３）－３…（数４０）

【0137】

信号処理部１２０は、図５に示すような測定した値Ｓ１４、Ｓ４１、Ｓ１３およびＳ４３を、数４０に代入してＩＮ４１を求め、受信回路１７１の受信レベルに対して、このＩＮ４１に相当する値分、受信回路１７４の受信レベルを増加させるように調整する。

【0138】

このように、アンテナ１０１で受信された受信電力を基準とした受信利得劣化量との差分と、アンテナからスイッチ部ＳＷ間までの損失との差分を合計した値ＩＮ２１、ＩＮ３１およびＩＮ４１だけ信号処理部１２０で受信される受信レベルに補正することで、アンテナ間での受信の相対レベルを揃えることができる。

【0139】

なお、本実施の形態では、４つのアンテナおよび無線回路を設ける場合を示したが、３つのアンテナおよび無線回路においても、同様に、一つの無線回路を基準として相対的に損失を求め、相対レベルを揃えるようにすることができる。

【0140】

以上、説明したように、送信系、アンテナからスイッチ部ＳＷ間のアンテナ系、受信系の３種類の損失の差分を算出し、この３種類の損失の差分を基に信号処理部１２０において適切な計算を施し、計算結果から送信信号レベルを信号処理部１２０で調整し、また、計算結果から受信レベルを信号処理部１２０で補正することによってアンテナ間の送信及び受信の相対レベル差が無くなり、指向性が所望する方向に正しく向くようにできる。

【0141】

本実施の形態によれば、異常レベルを検出した箇所の組合せにより、送受信の異常を検出することができる。反射波検出回路で検出していた送信異常の検出を、異常レベルを検出した箇所の組合せにより特定することで、反射波検出回路を備える必要がないので部品点数を少なくすることができ、実装面積をより小さくすることができる。また、複数の送信電力レベルおよび複数の受信電力レベルから、一つの無線回路部を基準として、他の無線回路部との間におけるアンテナ系の損失レベルの差分および受信利得劣化分における差分を求め、一つの無線回路部を基準として他の無線回路部の送信部における送信電力レベルの調整と、一つの無線回路部を基準として他の無線回路部の受信部における受信電力レベルの調整とを行うことによって、送信および受信の相対レベルを揃えることができる。

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 171 of 365

これにより、指向性を所望する方向に調整することができる。

【図面の簡単な説明】

【0142】

【図1】本実施の形態における無線通信装置の回路構成図である。

【図2】本実施の形態における送信電力検波回路及び受信電力検波回路の構成図である。

【図3】本実施の形態における異常検出調査を行う手順を示すフローチャートである。

【図4】本実施の形態における無線通信装置の送信電力値、受信利得劣化量、アンテナからスイッチ部ＳＷ間の損失の箇所を記したブロック図である。

【図5】本実施の形態における異常検出調査を行った時に得られる送信電力値の説明図。

【図6】本実施の形態における異常検出調査を行った時に得られる受信電力値の説明図。

【図7】本実施の形態における異常検出調査を行ったときのアンテナ１０１からスイッチＳＷ１４１間に異常がある場合の判定結果を示す説明図である。

【図8】本実施の形態における異常検出調査を行ったときの受信部ＲＸ１５１に異常がある場合の判定結果を示す説明図である。

【図9】本実施の形態における無線通信装置のアンテナからスイッチ部ＳＷ間までの損失の差分を示した数式の説明図である。

【図10】本実施の形態における無線通信装置の受信利得劣化量の差分を示した数式の説明図である。

【符号の説明】

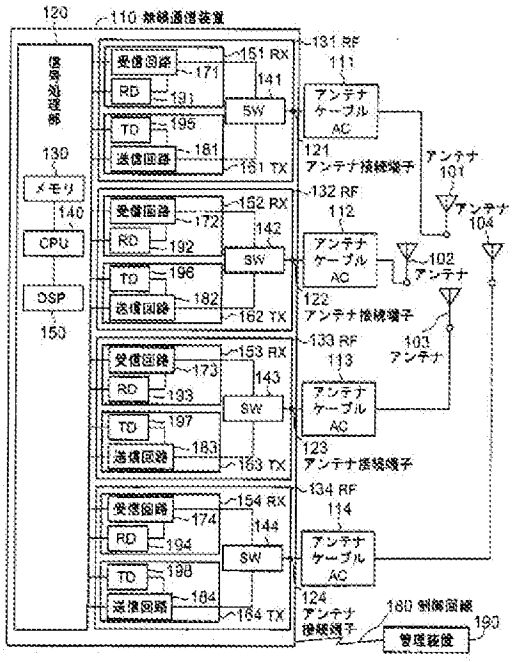
【0143】

１１０…無線通信装置、１３１・１３２・１３３・１３４…無線回路ＲＦ、１２０…信号処理部、１０１・１０２・１０３・１０４…アンテナ、１６１・１６２・１６３・１６４…送信部ＴＸ、１５１・１５２・１５３・１５４…受信部ＲＸ、１４１・１４２・１４３・１４４ＳＷ、１２１・１２２・１２３・１２４…アンテナ接続端子、１９１・１９２・１９３・１９４…受信電力検波回路ＲＤ、１７１、・１７２・１７３・１７４…受信回路、１９５・１９６・１９７・１９８…送信電力検波回路ＴＤ、１８１・１８２・１８３・１８４…送信回路、１５０…ＤＳＰ、１４０…ＣＰＵ、１３０…メモリ

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 172 of 365

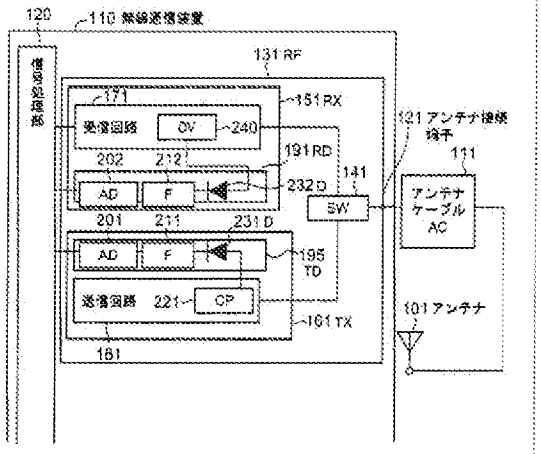
【図1】

図 1



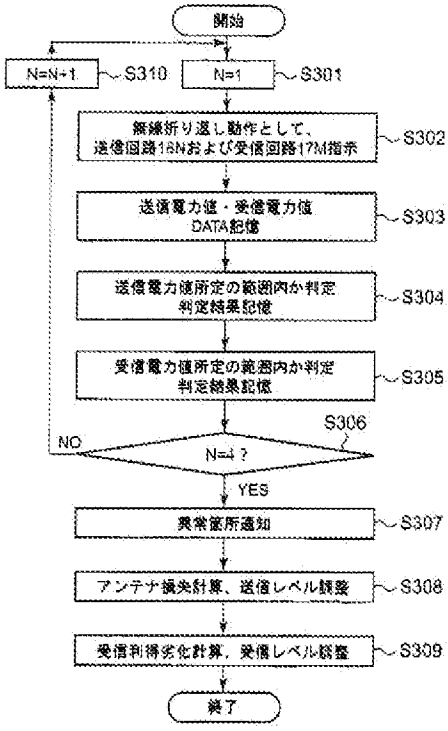
【図2】

図 2



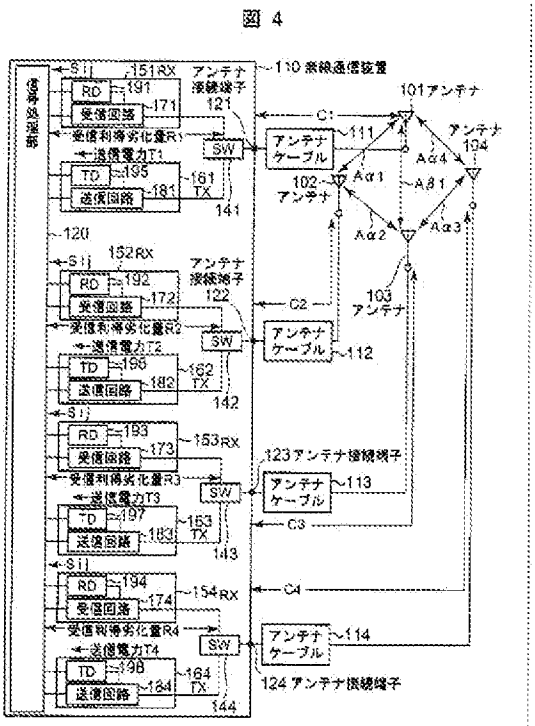
【図3】

図 3



【図4】

図 4



Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 173 of 365

【図5】

図５

500	501	502	503	504
項目	送信回路181	送信回路182	送信回路183	送信回路184
送信電力値	T1	T2	T3	T4
判定結果	0	1	1	1

【図6】

図６

600	601	602	603	604
送信＼受信	アンテナ101	アンテナ102	アンテナ103	アンテナ104
アンテナ101		S12	S13	S14
アンテナ102	S21		S23	S24
アンテナ103	S31	S32		S34
アンテナ104	S41	S42	S43	

【図7】

図７

700	701	702	703	704
送信＼受信	アンテナ101	アンテナ102	アンテナ103	アンテナ104
アンテナ101		0	0	0
アンテナ102	0		1	1
アンテナ103	0	1		1
アンテナ104	0	1	1	

【図8】

図８

800	801	802	803	804
送信＼受信	アンテナ101	アンテナ102	アンテナ103	アンテナ104
アンテナ101		1	1	1
アンテナ102	0		1	1
アンテナ103	0	1		1
アンテナ104	0	1	1	

【図9】

図９

アンテナ101を基準とした場合		901
[S12,S32]	C3-C1=S12-S32	
[S14,S34]	C3-C1=S14-S34	
[S13,S23]	C2-C1=S13-S23	
[S14,S24]	C2-C1=S14-S24	
[S12,S42]	C4-C1=S12-S42	
[S13,S43]	C4-C1=S13-S43	
アンテナ102を基準とした場合		902
[S21,S41]	C4-C2=S21-S41	
[S23,S43]	C4-C2=S23-S43	
[S21,S31]	C3-C2=S21-S31	
[S24,S34]	C3-C2=S24-S34	
[S24,S14]	C1-C2=S24-S14	
[S23,S13]	C1-C2=S23-S13	
アンテナ103を基準とした場合		903
[S34,S24]	C2-C3=S34-S24	
[S31,S21]	C2-C3=S31-S21	
[S31,S41]	C4-C3=S31-S41	
[S32,S42]	C4-C3=S32-S42	
[S34,S14]	C1-C3=S34-S14	
[S32,S12]	C1-C3=S32-S12	
アンテナ104を基準とした場合		904
[S42,S12]	C1-C4=S42-S12	
[S43,S13]	C1-C4=S43-S13	
[S41,S21]	C2-C4=S41-S21	
[S43,S23]	C2-C4=S43-S23	
[S41,S31]	C3-C4=S41-S31	
[S42,S32]	C3-C4=S42-S32	

【図10】

図１０

アンテナ101を基準とした場合		1001
[S12,S21]	R2-R1=S12-S21	
[S13,S31]	R3-R1=S13-S31	
[S14,S41]	R4-R1=S14-S41	
アンテナ102を基準とした場合		1002
[S21,S12]	R1-R2=S21-S12	
[S23,S32]	R3-R2=S23-S32	
[S24,S42]	R4-R2=S24-S42	
アンテナ103を基準とした場合		1003
[S31,S13]	R1-R3=S31-S13	
[S32,S23]	R2-R3=S32-S23	
[S34,S43]	R4-R3=S34-S43	
アンテナ104を基準とした場合		1004
[S41,S14]	R1-R4=S41-S14	
[S42,S24]	R2-R4=S42-S24	
[S43,S34]	R3-R4=S43-S34	

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 174 of 365

(72)発明者　新井　秀明
神奈川県横浜市戸塚区戸塚町２１６番地　株式会社日立コミュニケーションテクノロジーキャリアネットワーク事業部内
(72)発明者　戸塚　貴雄
神奈川県横浜市戸塚区吉田町２９２番地　株式会社日立アドバンストデジタル内
(72)発明者　梶田　和豊
神奈川県横浜市戸塚区吉田町２９２番地　株式会社日立アドバンストデジタル内

Ｆターム(参考) 5J021 AA04 AB00 DB01 EA04 FA13 FA25 FA30 FA31 GA02 HA05
5K042 AA06 BA11 CA02 CA13 DA04 DA16 DA32 EA03 FA11 GA01
JA01 NA04
5K059 CC01 CC04 DD31

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 175 of 365

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2006-115267
(43)Date of publication of application : 27.04.2006

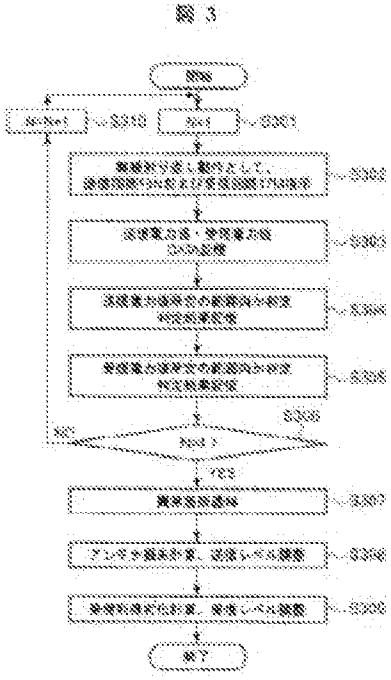
(51)Int.Cl. H04B 7/10 (2006.01)
H01Q 3/26 (2006.01)
H04B 7/08 (2006.01)
H04B 17/00 (2006.01)

(21)Application number : 2004-301117
(22)Date of filing : 15.10.2004

(71)Applicant : HITACHI COMMUNICATION TECHNOLOGIES LTD
(72)Inventor : YANAGI KENJI
FURUEDA KOICHIRO
ARAI HIDEAKI
TOTSUKA TAKAO
KAJITA KAZUTOYO

(54) RADIO COMMUNICATION DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To make the number of parts smaller, and to detect the abnormalities of a transmitting section and a receiving section for a radio circuit section connected to an antenna.
SOLUTION: A signal processor transmits a transmitting signal generated from one of transmitters for the radio circuit, makes the transmitting signal receive by receiving sections for a plurality of the radio circuits except the radio circuit transmitting the transmitting signal and make the back-to-back of a radio conduct. A detected sending power value and a detected receiving power value are stored, and whether or not the sending power value is kept within a specified range and whether or not the receiving power value is kept within the specified range are decided. The abnormalities of a sending and a reception are detected from the results of the decisions of a plurality of the sending power values and a plurality of the receiving power values, and a sending level and a receiving level are adjusted.



* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Field of the Invention]
[0001]
About the radio communication equipment which has the receiving system and transmission system which are connected to three or more antennas, especially, an abnormal spot is specified and it is related with the technology of adjusting transmission power.
[Background of the Invention]
[0002]
Radio communication equipment has an antenna terminal to which an antenna system is connected, in a manufacturing process, an exclusive measuring device is connected to this antenna terminal, and the check of whether the radio characteristic of the transmission as radio communication equipment and reception has satisfied the predetermined level value is performed. And it is shipped after it is checked that it is satisfied. However, the check inspection after construction of radio communication equipment and construction is conducted by a construction contractor. For this reason, when abnormalities are looked at by the radio characteristic by degradation of the radio characteristic by construction defects, such as cable loose connection, and failure after construction, in order to conclude a locating fault, all connection of an antenna etc. is removed and the verification of performance as radio communication equipment is required of an exclusive measuring device. Therefore, the decision of the locating fault has taken much labors and time.
[0003]
A Patent document 1 has disclosed the self-test method that operation confirming of a wireless communication main device and an antenna system can be easily performed in an operation state since such a problem is solved. In a Patent document 1, The self-test method of the radio communication equipment used for the TDMA(Time Division Multiple Access)-TDD (Time Division Duplex) system wireless communication system provided with two or more antenna systems, two or more receive sections, and a transmission section is disclosed. In this self-test method, loopback test processing which receives the predetermined sending signal transmitted via the antenna system connected to the transmission section of one wireless circuit via the receive section of the wireless circuit where it was connected to other antenna systems is performed, and this test result is memorized as table data. In a transmission section, it has a detection means to detect the level of the transmitted sending signal, and a reflected wave detection means to detect the signal level of the reflected wave from an antenna system. In a receive section, it has a detection means to detect the level of an input signal.
[0004]
Change the combination of connection of two or more antenna systems, a transmission section, and a receive section, and loopback test processing of multiple times is performed, judging whether this test result is memorized as table data, and these table data is in a normal range -- abnormality

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 177 of 365

judgement of an antenna system and a wireless circuit is performed. These table data comprises three kinds of values of the sending-signal level which the detection means of the transmission section detected, the signal level of the reflected wave from the antenna system which the reflected wave detection means detected, and the received signal level which the detection means of the receive section detected. Abnormality diagnosis is made by the threshold value diagnosis judged for it to be normal if each value is in a predetermined level range, and to be unusual in the case of others.

[0005]

[Patent document 1] JP,H10-107744,A

[Description of the Invention]

[Problem to be solved by the invention]

[0006]

There is a function which transmits the sending signal which has any directivity by the radio communication equipment using an adaptive array antenna system generating the sending signal which adjusted a phase and amplitude for every antenna in the signal processing part, and emitting this sending signal from each antenna via two or more transmission sections. Desired directivity is not obtained unless this directivity has gathered within the limits of predetermined in the relative level difference of the transmission between antennas, and reception.

[0007]

Since radio communication equipment is installed under severe environment, such as the outdoors, in many cases, The moisture of storm sewage etc. may penetrate from the aerial connection terminal which combines an antenna and a wireless circuit section in an operation state, the impedance between an antenna and a wireless circuit section serves as mismatching by entering of this moisture, and degradation of the radio characteristic of transmission power deterioration may be generated. Thus, in order to detect the abnormalities of the radio characteristic by the impedance mismatching between an antenna and a wireless circuit section, in the above-mentioned Patent document 1, the reflected wave detecting circuit which detects the reflected wave from an antenna to the transmission section side is provided.

[0008]

However, since this reflected wave detecting circuit has much number of parts, there is a problem that a packaging area will become largely.

[0009]

The present invention lessens the number of parts more, and an object of the present invention is to provide the technology in which the abnormalities of transmission and reception of the radio communication equipment connected to an antenna are detectable.

[Means for solving problem]

[0010]

In order that the present invention may solve an aforementioned problem, radio communication equipment provided with at least three wireless circuit sections provided with a transmission section and a receive section by which an antenna is connected, and a signal processing part which processes a signal is provided with the following.

The aforementioned transmission section has a transmission power detection means to detect the power level of the sending signal transmitted in the transmission section concerned, and the aforementioned receive section, Have a received power detection means to detect power level of an input signal received in the receive section concerned, and the aforementioned signal processing part, A wireless clinch means to make the aforementioned sending signal receive in the aforementioned receive section of two or more wireless circuit sections other than a wireless circuit section which made a sending signal generated from one of the aforementioned transmission sections of the aforementioned wireless circuit section transmit, and transmitted a sending signal.

A transmission power level detected by the aforementioned transmission power detection means

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 178 of 365

when carrying out a wireless clinch by above-mentioned wireless clinch means.
A memory means which memorizes a power level on reception detected by the aforementioned received power detection means.
A malfunction detection means by which combination of a part which detected an abnormal level previously defined about each of two or more transmission power levels memorized by the aforementioned memory means and two or more power levels on reception, and detected an abnormal level detects abnormalities of transmission and reception.

[Effect of the Invention]
[0011]
According to the present invention, the abnormalities of transmission and reception are detectable with the combination of the part which detected the abnormal level previously defined about each of two or more transmission power levels memorized by a memory means, and two or more power levels on reception, and detected the abnormal level. By specifying detection of the transmission anomaly detected in the reflected wave detecting circuit with the combination of the part which detected the abnormal level, since it is not necessary to have a reflected wave detecting circuit, the number of parts can be lessened, and a packaging area can be made smaller. It is based on one wireless circuit section from two or more transmission power level and two or more power levels on reception, Adjustment of a transmission power level [in / on the basis of the one aforementioned wireless circuit section / it asks for the difference in the difference and the receiving gain degraded minute of a loss level of an antenna system between other wireless circuit sections and / the transmission section of other wireless circuit sections], By performing adjustment of the power level on reception in the receive section of other wireless circuit sections on the basis of the one aforementioned wireless circuit section, directivity can be adjusted in the desired direction. A transmission system, a receiving system, or the abnormal spot of an antenna part can be pinpointed.

[Best Mode of Carrying Out the Invention]
[0012]
Hereafter, the 1 embodiment of the radio communication equipment in the present invention is described based on Fig.1 - Fig.10.
[0013]
Fig.1 is a configuration diagram of the radio communication equipment in this embodiment.
[0014]
In Fig.1, the radio communication equipment 110 of this embodiment is provided with the following.
Wireless circuit RF131 which has a transmission section and a receive section, respectively, RF132, RF133, and RF134.
Signal processing part 120.
The radio communication equipment 110 is provided with at least three wireless circuit RF, and 1 or two or more antennas are connected to each wireless circuit RF. In this embodiment, the case where the antennas 101, 102, 103, and 104 are connected to wireless circuit RF131, RF132, RF133, and RF134, respectively is shown. Wireless circuit RF 131, 132, 133, and 134 is provided with the same circuit configuration and function.
[0015]
Wireless circuit RF131 is provided with the following.
Transmission section TX161 which performs transmitting processing.
Receive section RX151 which performs reception.
SW141 to which transmission and reception are switched.
The aerial connection terminal 121 for connecting an antenna.
Similarly, wireless circuit RF132 has transmission section TX162, receive section RX152, SW142, and the aerial connection terminal 122, and wireless circuit RF133, Having transmission section

TX163, receive section RX153, SW143, and the aerial connection terminal 123, wireless circuit RF134 has transmission section TX164, receive section RX154, SW144, and the aerial connection terminal 124.

[0016]

The antenna 101 is connected to the aerial connection terminal 121 of wireless circuit RF131 by antenna cable AC111. Similarly for the aerial connection terminal 122 of wireless circuit RF132, The antenna 102 is connected by antenna cable AC112 and for the aerial connection terminal 123 of wireless circuit RF133, The antenna 103 is connected by antenna cable AC113 and the antenna 104 is connected to the aerial connection terminal 124 of wireless circuit RF134 by antenna cable AC114.

[0017]

Transmission section TX161, TX162, TX163, and TX164 of wireless circuit RF have transmission power detector circuit TD195 which detects a transmission power value, TD196, TD197 and TD198, and the transmitting circuits 181, 182, 183, and 184, respectively. Receive section RX151, RX152, RX153, and RX154 of wireless circuit RF have received power detector circuit RD191 which detects a received power value, RD192, RD193 and RD194, and the receiving circuits 171, 172, 173, and 174, respectively.

[0018]

Receive section RX and the transmission section TX are switched by time sharing, and switch part SW141, SW142, SW143, and SW144 are connected to each antenna.

[0019]

The signal processing part 120 performs digital signal processing, such as sending-signal generation, transmission power control, sending-signal phase adjustment, and a strange recovery. The signal processing part 120 had DSP(Digital Signal Processor) 150, CPU140, and the memory 130 at least, and has memorized the software program which shows the procedure of a malfunction detection examination method in the memory 130. It may be made to have other application programs.

[0020]

The signal processing part 120 incorporates a received power value from received power detector circuit RD191 shown in Fig.1, RD192, RD193, and RD194, A transmission power value is incorporated from transmission power detector circuit TD195 shown in Fig.1, TD196, TD197, and TD198, and it memorizes in the memory 130 with which an inside is equipped, respectively. The antennas 101, 102, 103, and 104 shown in Fig.1 when the signal processing part 120 conducts malfunction detection investigation, Control of switch part SW141 to which the combination of transmission section TX161, TX162, TX163 and TX164, and receive section RX151, RX152, RX153 and RX154 is switched, SW142, SW143, and SW144 can be performed.

[0021]

The radio communication equipment 110 in this embodiment can operate as base stations, such as a cellular phone. In this embodiment, what is called the type (1C+3T) in the case of controlling employment with one control channel and three communication lines is made into an example in one radio communication equipment. The radio communication equipment 110 is not what is limited to this (1C+3T) type, (1C+15T) etc. -- the system using an adaptive array antenna system and three antennas or more are connected, and this embodiment can be applied in what has a wireless circuit more than the same number as an antenna. It may be made to equip the radio communication equipment 110 with a wire circuit for wired connection to be carried out to a base station controller etc.

[0022]

The radio communication equipment 110 using the adaptive array antenna system of the type (1C+3T) shown in Fig.1, Perform line control of three communication lines and the sending signal outputted from the signal processing part 120 usually Wireless circuit RF131, RF132, RF133, and RF134, Simultaneous transmission is carried out from the antennas 101, 102, 103, and 104 via

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 180 of 365

switch part SW141, SW142, SW143, and SW144. At this time, the signal processing part 120 forms the sending signal provided with desired directivity by controlling the amplitude and the phase of the sending signal transmitted from the antennas 101, 102, 103, and 104 for every transmission section.
[0023]
Investigation of malfunction detection is conducted by carrying out remote control of the signal processing part 120 by the start instruction from the controlling device 190 of the control center connected by the control line 180 at the time zone which has a margin in lines of contact, such as night, the time of communication error generating, etc. With the abnormalities in this embodiment, there are abnormalities of the antenna system by aging **** degradation of an antenna and an antenna cable, the faulty connection in an aerial connection terminal, etc., abnormalities of a transmission system in a transmitting circuit, abnormalities of the receiving system in a receiving circuit, etc., for example. At this embodiment, these abnormal spots are specified by detecting transmission power and received power by self-radio clinch operation.
[0024]
The configuration diagram of the transmission power detector circuit of wireless circuit RF131 of radio communication equipment and a received power detector circuit shown in Fig.2 by Fig.1 is shown.Transmission power detector circuit TD195, TD196, TD197, and TD198 are provided with the same composition and function. Received power detector circuit RD191, RD192, RD193, and RD194 are provided with the same composition and function.
[0025]
As shown in Fig.2, transmission power detector circuit TD195 is provided with the following.
The diode D231 for rectifying a high frequency output signal which is connected to directional coupler CP221 of the latter part of the transmitting circuit 181, and is outputted from this directional coupler CP221.
The low pass filter F211 for carrying out smoothness of this rectified high frequency output signal further.
A/D-converterAD201 which converts a detected low frequency wave analog signal to digital one.
Transmission power detector circuit TD195 detects the transmission power of the sending signal transmitted from the transmitting circuit 181, and outputs it to the signal processing part 120.
[0026]
Received power detector circuit RD191 is provided with the following.
The diode D232 for rectifying a high frequency output signal which is connected to distributor DV240 of the receiving circuit 171, and is outputted from this distributor DV240.
The low pass filter F212 for carrying out smoothness of this rectified high frequency output signal further.
A/D-converterAD202 which converts a detected low frequency wave analog signal to digital one.
Received power detector circuit RD191 detects the received power of the input signal received in the receiving circuit 171, and outputs it to the signal processing part 120.
[0027]
Hereafter, it describes about the malfunction detection examination method in a form to this enforcement. The flow chart of the malfunction detection examination method of this embodiment is shown in Fig.3. The explanatory view of the transmission power value acquired when malfunction detection investigation is conducted to Fig.5 is shown, the explanatory view of a received power value is shown in Fig.6, and the explanatory view showing the decided result in the case of being abnormal is shown in Fig.7 and Fig.8.
[0028]
The signal processing part 120 will start a program compatible with the flow chart shown in Fig.3, if the start instruction of malfunction detection investigation is received from the controlling device 190. About the antenna and wireless circuit of the radio communication equipment 110 which are made into the object which conducts malfunction detection investigation, the signal processing part

120, In order to carry out sequential execution of the self-radio clinch operation between a wireless circuit section and an antenna, the transmitting circuit 18N of wireless circuit RF13N which transmits a sending signal is instructed, and it instructs so that an input signal may be received in the receiving circuit 17M of the other wireless circuit RF13M (S301, S302). Here, N and M are natural numbers and show the end of the code of the transmitting circuit and receiving circuit which are shown in Fig.1, respectively. First, as N= 1, it instructs in the transmitting circuit 181 so that a sending signal may be transmitted, and SW 141-144 is switched, respectively so that an input signal may be received for M as values (M= 2, 3, 4) other than one in the receiving circuits 172, 173, and 174.

[0029]

Next, the transmission power value T1 detected by transmission power detector circuit TD195 is memorized, as shown in Fig.5, and the received power value S12 detected by received power wave detector RD 192, 193, and 194, respectively, S13, and S14 are memorized in the memory 130, as shown in Fig.6 (S303).In Fig.5, the transmission power value T1 transmitted to the item 501 from the transmitting circuit 181 is memorized, and similarly in the item 502, The transmission power value T2 transmitted from the transmitting circuit 182 is memorized, transmission power value T3 transmitted to the item 503 from the transmitting circuit 183 is memorized, and the transmission power value T4 transmitted to the item 504 from the transmitting circuit 184 is memorized. In Fig.6, the antenna code which transmits a sending signal is registered into the transmitting side 600, the antenna code to receive is registered into the receiving sides 601-604, and the received power value detected by received power wave detector RD of receive section RX is memorized to the region (it crosses) to which transmission and a receiving antenna correspond. Here, i of the received power value Sij shows the number of the end of the antenna code which transmits, and j shows the number of the end of the antenna code to receive.

[0030]

For example, operation of a self-radio clinch in case transmission section TX161 transmits and receive section RX152, RX153, and RX154 receive in the radio communication equipment shown in Fig.4, The sending signal outputted by the signal processing part 120 is input into the transmitting circuit 181 of TX161, passes switch part SW141 and antenna cable AC111, and is discharged from the antenna 101. The signal outputted from the transmitting circuit 181 of TX161 at this time is detected by transmission power detector circuit TD195, and that transmission power value T1 is memorized in the memory 130 of the signal processing part 120. The signal transmitted from the antenna 101 spreads each course Aalpha1, Abeta1, and Aalpha4, and is received by the antenna 102, the antenna 103, and the antenna 104. The signal received with the antenna 102 passes through the receiving circuit 171 of antenna cable AC112 and the switch parts SW142 and RX152, and the received power value S12 detected by received power wave detector RD192 is memorized by the memory 130 of the signal processing part 120. The signal received with the antenna 103 passes through the receiving circuit 172 of antenna cable AC113 and the switch parts SW143 and RX153, and the received power value S13 detected by received power wave detector RD193 is memorized by the memory 130 of the signal processing part 120. The signal received with the antenna 104 passes through the receiving circuit 174 of antenna cable AC114 and the switch parts SW144 and RX154, and the received power value S14 detected by received power wave detector RD194 is memorized by the memory 130 of the signal processing part 120.

[0031]

It judges whether the transmission power value data memorized next as shown in Fig.5 is within the limits defined beforehand, or it is outside the range, and the result of a judgment is memorized in the memory 130, as shown in Fig.5 (S304). In Fig.5, when there is the transmission power value T within limits defined beforehand, "1" is memorized, and in being out of the range, it memorizes "0" to a corresponding region. For example, when the predetermined range of a transmission level is set to 21dBm**5dB, the case where a transmission level does not fulfill the predetermined range is carried

out the outside of the range. When T1 shown in Fig.5 is judged to be outside of the range, the abnormalities in a transmission system of the transmitting circuit 181 of transmission section TX161 connected to the antenna 101 are detected, a decided result is set to "0" to the region corresponding to the transmitting circuit 181, and it memorizes in the memory 130 of the signal processing part 120. A transmission level may make a different value the transmission level at the time of employment, and the transmission level at the time of malfunction detection investigation. Since it becomes self-clinch operation at the time of malfunction detection investigation and the transmission antenna and the receiving antenna adjoin, the transmission level at the time of malfunction detection investigation can be -5 dBm, for example.

[0032]

Next it judges whether received power value data is within the limits defined beforehand or it is outside the range, and a decided result is memorized as shown in Fig.7 or Fig.8 (S305).

[0033]

In Fig.7 and Fig.8, the antenna code which transmits a sending signal to the transmitting side 700 and 800 is registered, and the antenna code to receive is registered into the receiving sides 701-704, and 801-804.When there is a received power value detected by received power wave detector RD of receive section RX within limits defined beforehand, in being out of the range about "1" again, he is trying to memorize "0" to the region (it crosses) to which transmission and a receiving antenna correspond. For example, when the range of a reception level is set to -38dBm**5dB, the case where the range of a reception level is not fulfilled can be carried out the outside of the range. The range of a predetermined reception level is made into the range in consideration of the propagation loss by the distance of the antenna which transmits, and the antenna to receive, turns into a range which changed with combination of the antenna which transmits, and the antenna to receive, and may be beforehand defined in consideration of the propagation loss.

[0034]

Similarly, the end number N of the transmitting circuit 18N is added every [1] (S310), the combination of the antennas 101, 102, 103, and 104 transmitted and received is changed, and self-radio clinch operation is performed (S301-S305). Thereby, the transmission power value T1, T2, T3, and T4 are memorizable in the memory 130 of the signal processing part 120, as shown in Fig.5. The received power value S12, S13, S14, S21, S23, S24, S31, S32, S33, S34, S41, S42, and S43 are memorized in the memory 130 of the signal processing part 120, as shown in Fig.6.

[0035]

Noting that wireless clinch operation is completed about all the combination of the antenna transmitted and received after the signal processing part 120 judging whether the end number of the transmitting circuit 18N is N= 4 (S306), When there is an abnormal spot whose transmission power value data and received power value data are outside the predetermined range, the abnormal spot is notified to the controlling device 190 (S307). When there is no abnormal spot, the signal processing part 120 notifies the end of malfunction detection investigation to the controlling device 190.

[0036]

The signal processing part 120 can notify all the transmitting circuit numbers or antenna numbers corresponding to the region to which "0" is memorized by Fig.5, Fig.7, or Fig.8 as an abnormal spot.In the signal processing part 120, it may be judged that an abnormal spot is specified from the transmitting circuit number and antenna number from which the abnormal spot was detected.

[0037]

In this case, it carries out in a procedure as shown below, for example.

[0038]

The abnormality judgement (referred to as ANT101_ALM) between the switch parts SW141 is judged according to the one following from the antenna 101 shown in Fig.4.

[0039]

ANT101_ALM=(S12) OR(S13) OR(S14) OR(S21) OR(S31) OR (S41) -- (several 1)

[0040]
Here, i of Sij shows the number of the end of the antenna code which transmits, j shows the number of the end of the antenna code to receive, and "0" of a decided result as shows Sij to Fig.7 or Fig.8, or "1" enters.
[0041]
Since transmission and reception are unusual when all the decided results on the horizontal line of the transmitting side antenna 101 and the line of the length of the receiving side antenna 101 are set to "0" besides the range if it describes using Fig.7, The signal processing part 120 judges with between the aerial connection terminals 121 being unusual from the antenna 101, and detects the abnormalities in an antenna system. In several 1 formula, when there is one "at least 1" (within the limits), it judges with an antenna system not being unusual.
[0042]
By the decided result of a transmission power value as shown in Fig.5, when the abnormalities in a transmission system are not detected, the abnormality judgement (referred to as RX151_ALM) of receive section RX151 is judged like [with the two following].
[0043]
RX151_ALM=(S21) OR(S31) OR (S41) -- (several 2)
[0044]
Here, i of Sij shows the number of the end of the antenna code which transmits, j shows the number of the end of the antenna code to receive, and "0" of a decided result as shows Sij to Fig.7 or Fig.8, or "1" enters.
[0045]
Since only the receiving side is unusual when all the decided results of the line of the longitudinal direction of the receiving side antenna 101 are set to "0" besides the range if it describes using Fig.8, the signal processing part 120 judges that receive section RX151 is unusual, and detects the abnormalities in a receiving system. In several 2 formulas, when there is one "at least 1" (within the limits), it judges with a receiving system not being unusual.
[0046]
The signal processing part 120 notifies the part which detected abnormalities to the controlling device 190 as a result of such a judgment. In other transmission systems, an antenna system, and a receiving system, it can judge similarly. Thus, the abnormalities of transmission and reception are detectable with the combination of the part which detected the abnormal level.
[0047]
Next, adjustment with a transmission level and a reception level is performed after malfunction detection investigation (S308, S309). Malfunction detection investigation is ended after adjustment with a transmission level and a reception level.
[0048]
The signal processing part 120 calculates an antenna loss based on a transmission power value as shown in Fig.5, The part which needs the level adjustment of a transmission level, and its level adjustment values are computed, and by adjusting the transmission power outputted from the signal processing part 120 according to level adjustment values, it adjusts so that directivity may be correctly suitable.
[0049]
Adjustment of a transmission level is performed as shown below.
The part of the loss between the switch parts SW is shown in Fig.4 from the transmission power value of radio communication equipment, receiving gain deterioration quantity, and an antenna.
[0050]
The difference of the transmission power value between each transmission section is called for from the transmission power value T1 memorized in the memory 130 of the signal processing part 120 as shown in Fig.5, T2, T3, and T4. For example, the difference with the transmission power transmitted

from other antennas on the basis of the transmission power transmitted from the antenna 101 shown in Fig.4 is called for by (T2-T1), (T3-T1), and (T4-T1).
[0051]
The loss (C1-C4 show) between the switch parts SW is mainly considered to be the loss of cable parts from an antenna, and it asks to be shown below.
[0052]
The difference of the loss between the switch parts SW is called for from an antenna with the difference of two courses of a transmission system when a receive section is the same. For example, it describes in the combination of the received power value S12 when it transmits with the antenna 101 shown in Fig.8 and the antenna 102 receives, and the received power value S32 when it transmits with the antenna 103 and the antenna 102 receives.
[0053]
The received power value S12, When the transmission power T1 shown in Fig.4 and the antenna 101 to the antenna 101 to the loss C1 between the switch parts SW141, the loss C2 from the antenna 102 to between the switch parts SW142, and the antenna 102 spread. The receiving gain deterioration quantity R2 in ********** Aalpha1 and the receiving circuit 171 can express by several 3. The received power value S32, When transmission power T3 and the antenna 102 to the antenna 103 to the loss C2 between the switches SW142, the loss C3 from the antenna 103 to between the switch parts SW143, and the antenna 102 spread. The receiving gain deterioration quantity R2 in ********** Aalpha2 and the receiving circuit 172 can express by several 4.
[0054]
(The antenna 101 which transmits -> antenna 102 to receive)
S12=T1-C1-Aalpha1-C2+R2 -- (several 3)
[0055]
(The antenna 103 which transmits -> antenna 102 to receive)
S32=T3-C3-Aalpha2-C2+R2 -- (several 4)
[0056]
The difference of S12 and S32 is shown in several 5.
[0057]
S12-S32=(T1-T3)+(C3-C1)+ (Aalpha2-Aalpha1) -- (several 5)
[0058]
When the distance between adjoining antennas presupposes that it is the same, since it is thought that a loss with Aalpha1 and Aalpha2 is also the same, several 6 is realized.
[0059]
(Aalpha2-Aalpha1) =0 -- (several 6)
[0060]
Several 7 is realized when it can be considered that the transmission power value of a transmission section is the same.
[0061]
(T1-T3) =0 -- (several 7)
[0062]
In this case, the difference of a loss between the switch parts SW can be denoted by several 8 formulas from an antenna.
[0063]
C3-C1=S12-S32 -- (several 8)
[0064]
Similarly, each of the difference of the loss from other antennas shown in Fig.4 between SW(s) can be expressed as shown in Fig.9.The difference of a loss between SW(s) is shown in the block 901 from the antenna at the time of being based on the transmission power transmitted from the antenna 101 in Fig.9, The difference of a loss between SW(s) is shown in the block 902 from the

antenna at the time of being based on the transmission power transmitted from the antenna 102, The difference of a loss between SW(s) is shown in the block 903 from the antenna at the time of being based on the transmission power transmitted from the antenna 103, and the difference of a loss between SW(s) is shown in the block 904 from the antenna at the time of being based on the transmission power transmitted from the antenna 104.

[0065]

Only the value which totaled the difference of transmission power and the difference of the loss from an antenna between the switch parts SW adjusts the sending-signal level outputted from the signal processing part 120, respectively, and it is made to transmit in the signal processing part 120. Since the loss from transmission power and an antenna to the switch part SW influences at the time of transmission, he is trying to adjust relatively the transmission level transmitted from other transmission sections on the basis of the transmission level of one transmission section. For example, when based on the transmission power transmitted from the antenna 101 shown in Fig.4, the value which totaled difference with the transmission power T2 of the antenna 102 and difference with the loss C2 from the antenna 102 to between the switch parts SW142 is set to OUT21. Several 9 comes to show OUT21.

[0066]

OUT21= (T2-T1) -(C2-C1)-- (several 9)

[0067]

the difference of the loss from the antenna 102 to between the switch parts SW142, and the loss from the antenna 101 to between the switch parts SW141 -- it is (C2-C1) -- as shown in several 10, it can express.

[0068]

C2-C1=(S13-S23)+(T2-T1)+ (Abeta1-Aalpha2) -- (several 10)

[0069]

Therefore, OUT21 can be denoted by several 11 from several 9 and several 10.

[0070]

OUT21= -(S13-S23)-(Abeta1-Aalpha2)-- (several 11)

[0071]

Since the loss of the propagation loss Abeta1 has a large distance between antennas, supposing it is large 3 dB, several 11 can be denoted by several 12 to the propagation loss Aalpha2.

[0072]

OUT21=-(S13-S23)-3 -- (several 12)

[0073]

The signal processing part 120 assigns the measured values S13 and S23 as shown in Fig.5 to several 12, calculates OUT21, and it adjusts so that the transmission level of a part for the value equivalent to this OUT21 and the transmitting circuit 182 may be made to increase to the transmission level of the transmitting circuit 181.

[0074]

When similarly based on the transmission power transmitted from the antenna 101, the value which totaled difference with transmission power T3 of the antenna 103 and difference with the loss C3 from the antenna 103 to between the switch parts SW143 is set to OUT31. Several 13 comes to show OUT31.

[0075]

OUT31= (T3-T1) -(C3-C1)-- (several 13)

[0076]

the difference of the loss from the antenna 103 to between the switch parts SW143, and the loss from the antenna 101 to between the switch parts SW141 -- it is (C3-C1) -- as shown in several 14, it can express.

[0077]

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 186 of 365

C3-C1=(S12-S32)+(T3-T1)+ (Aalpha1-Aalpha2) -- (several 14)
[0078]
Therefore, OUT31 can be denoted by several 15 from several 13 and several 14.
[0079]
OUT31= -(S12-S32)-(Aalpha1-Aalpha2)-- (several 15)
[0080]
Since it is thought that the loss of the propagation loss Aalpha1 and the propagation loss Aalpha2 is also the same when the distance between adjoining antennas presupposes that it is the same and it can be regarded as =(Aalpha2-Aalpha1) 0, several 15 can be denoted by several 16.
[0081]
OUT31= -(S12-S32)-- (several 16)
[0082]
The signal processing part 120 assigns the measured values S12 and S32 as shown in Fig.5 to several 16, calculates them, and it adjusts so that the transmission level of a part for the value equivalent to this OUT31 and the transmitting circuit 183 may be made to increase to the transmission level of the transmitting circuit 181.
[0083]
When based on the transmission power transmitted from the antenna 101, the value which totaled difference with the transmission power T4 of the antenna 104 and difference with the loss C4 from the antenna 104 to between the switch parts SW144 is set to OUT41. Several 17 comes to show OUT41.
[0084]
OUT41= (T4-T1) -(C4-C1)-- (several 17)
[0085]
the difference of the loss from the antenna 104 to between the switch parts SW144, and the loss from the antenna 101 to between the switch parts SW141 -- it is (C3-C1) -- as shown in several 18, it can express.
[0086]
C4-C1=(S13-S43)+(T4-T1)+ (Abeta1-Aalpha4) -- (several 18)
[0087]
Therefore, OUT41 can be denoted by several 19 from several 17 and several 18.
[0088]
OUT41= -(S13-S43)-(Abeta1-Aalpha4)-- (several 19)
[0089]
Since the loss of the propagation loss Abeta1 has a large distance between antennas, supposing it is large 3 dB, several 19 can be denoted by several 20 to the propagation loss Aalpha4.
[0090]
OUT41=-(S13-S43)-3 -- (several 20)
[0091]
The signal processing part 120 assigns the measured values S13 and S43 as shown in Fig.5 to several 20, calculates them, and it adjusts so that the transmission level of a part for the value equivalent to this OUT41 and the transmitting circuit 184 may be made to increase to the transmission level of the transmitting circuit 181.
[0092]
By therefore, the thing for which only the part equivalent to value OUT21 which totaled the difference of difference with the transmission power of the antenna on the basis of the antenna 101 and the loss from an antenna to between the switch parts SW, OUT31, and OUT41 changes the sending-signal level outputted from the signal processing part 120, The relative level of transmission between antennas can be arranged. When it cannot consider that transmission power is the same, it may be made to arrange a transmission level in consideration of the measured transmission power

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 187 of 365

value.
[0093]
Next, adjustment of a reception level is performed as shown below.
[0094]
The difference of receiving gain deterioration quantity is called for with the difference of the received power between the antennas which oppose. For example, a sending signal is transmitted from the antenna 101 shown in Fig.4, and it describes in the combination of the received power value S12 when the antenna 102 receives, and the received power value S21 when a sending signal is transmitted from the antenna 102 and the antenna 101 receives.
[0095]
The loss C1 between the switch parts SW141, the loss C2 from the antenna 102 to between the switch parts SW142, the propagation loss Aalpha1, and the receiving gain deterioration quantity R2 can express the received power value S12 by several 21 from the transmission power T1 shown in Fig.4, and the antenna 101. The loss C2 between the switch parts SW142, the loss C1 from the antenna 101 to between the switch parts SW141, the propagation loss Aalpha1, and the receiving gain deterioration quantity R1 can express the received power value S21 by several 22 from the transmission power T2 and the antenna 102.
[0096]
(The antenna 101 which transmits -> antenna 102 to receive)
S12=T1-C1-Aalpha1-C2+R2 -- (several 21)
[0097]
(The antenna 103 which transmits -> antenna 102 to receive)
S21=T2-C2-Aalpha1-C1+R1 -- (several 22)
[0098]
The difference of S12 and S21 is shown in several 23.
[0099]
S12-S21=(T1-T2)+(R2-R1) -- (several 23)
[0100]
Several 24 is realized when it can be considered that the transmission power value of a transmission section is the same.
[0101]
(T1-T3) =0 -- (several 24)
[0102]
In this case, the difference of the receiving gain deterioration quantity of the receiving circuit 172 and the receiving circuit 171 can be denoted by several 25.
[0103]
R2-R1=S12-S21 -- (several 25)
[0104]
Similarly, each of the difference of other receiving gain deterioration quantity shown in Fig.4 can be expressed as shown in Fig.10.The difference of receiving gain degradation at the time of being based on the received power received with the antenna 101 in Fig.10 is shown in the block 1001, The difference of receiving gain degradation at the time of being based on the received power received with the antenna 102 is shown in the block 1002, The difference of receiving gain degradation at the time of being based on the received power received with the antenna 103 is shown in the block 1003, and the difference of receiving gain degradation at the time of being based on the received power received with the antenna 104 is shown in the block 1004.
[0105]
In the signal processing part 120, the reception level which receives only the value which totaled the difference of receiving gain deterioration quantity and the difference of the loss from an antenna between the switch parts SW in a receiving circuit is adjusted. Since the loss from an antenna to

the switch part SW and receiving gain degradation influence a reception level at the time of reception, he is trying to adjust relatively the reception level received on the basis of the reception level of one receive section in other receive sections. For example, when based on the reception level received with the antenna 101 shown in Fig.4, the value which totaled difference with the receiving gain deterioration quantity R2 and difference with the loss C2 from the antenna 102 to between the switch parts SW142 is set to IN21. Several 26 comes to show IN21.

[0106]

IN21= (R2-R1) -(C2-C1)-- (several 26)

[0107]

the difference of the loss from the antenna 102 to between the switch parts SW142, and the loss from the antenna 101 to between the switch parts SW141 -- it is (C2-C1) -- it can express like several 27.

[0108]

C2-C1=(S13-S23)+(T2-T1)+ (Abeta1-Aalpha2) -- (several 27)

[0109]

the difference of receiving gain deterioration quantity -- it is (R2-R1) -- it is shown in several 28.

[0110]

R2-R1=(S12-S21)+ (T2-T1) -- (several 28)

[0111]

Therefore, IN21 can be denoted by several 29 from several 27 and several 28.

[0112]

IN21= (S12-S21) -(S13-S23)-(Abeta1-Aalpha2)-- (several 29)

[0113]

Since the loss of the propagation loss Abeta1 has a large distance between antennas, supposing it is large 3 dB, several 29 can be denoted by several 30 to the propagation loss Aalpha2.

[0114]

IN21=(S12-S21)-(S13-S23)-3 -- (several 30)

[0115]

The signal processing part 120 substitutes the measured value S12 as shown in Fig.5, S21, S13, and S23 for several 30, calculates IN21, and it adjusts so that the reception level of a part for the value equivalent to this IN21 and the receiving circuit 172 may be made to increase to the reception level of the receiving circuit 171.

[0116]

When similarly based on the received power received with the antenna 101, the value which totaled difference with the receiving gain deterioration quantity R3 and difference with the loss C3 from the antenna 103 to between the switch parts SW143 is set to IN31. Several 31 comes to show IN31.

[0117]

IN31= (R3-R1) -(C3-C1)-- (several 31)

[0118]

the difference of the loss from the antenna 103 to between the switch parts SW143, and the loss from the antenna 101 to between the switch parts SW141 -- it is (C3-C1) -- it can express like several 32.

[0119]

C3-C1=(S12-S32)+(T3-T1)+ (Aalpha1-Aalpha2) -- (several 32)

[0120]

the difference of receiving gain deterioration quantity -- it is (R2-R1) -- it is shown in several 33.

[0121]

R3-R1=(S13-S31)+ (T3-T1) -- (several 33)

[0122]

Therefore, IN31 can be denoted by several 34 from several 32 and several 33.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 189 of 365

[0123]
IN31= (S13-S31) -(S12-S32)-(Aalpha1-Aalpha2)-- (several 34)
[0124]
When the distance between adjoining antennas presupposes that it is the same, since the loss of the propagation loss Aalpha1 and the propagation loss Aalpha2 is also the same (Aalpha2-Aalpha1), it can be regarded as =0, and several 34 can be denoted by several 35.
[0125]
IN31= (S13-S31) -(S12-S32)-- (several 35)
[0126]
The signal processing part 120 substitutes the measured value S13 as shown in Fig.5, S31, S12, and S32 for several 34, calculates IN31, and it adjusts so that the reception level of a part for the value equivalent to this IN31 and the receiving circuit 173 may be made to increase to the reception level of the receiving circuit 171.
[0127]
The value which totaled difference with the receiving gain deterioration quantity R4 on the basis of the received power received with the antenna 101 shown in Fig.4 and difference with the loss C4 from the antenna 104 to between the switch parts SW144 is set to IN41. IN41 can be expressed as shown in several 36.
[0128]
IN41= (R4-R1) -(C4-C1)-- (several 36)
[0129]
the difference of the loss from the antenna 104 to between the switch parts SW144, and the loss from the antenna 101 to between the switch parts SW141 -- it is (C4-C1) -- it can express like several 37.
[0130]
C4-C1=(S13-S43)+(T4-T1)+ (Abeta1-Aalpha4) -- (several 37)
[0131]
the difference of receiving gain deterioration quantity -- it is (R4-R1) -- it is shown in several 38.
[0132]
R4-R1=(S14-S41)+ (T4-T1) -- (several 38)
[0133]
Therefore, IN41 can be denoted by several 39 from several 37 and several 38.
[0134]
IN41= (S14-S41) -(S13-S43)-(Abeta1-Aalpha4)-- (several 39)
[0135]
Since the loss of the propagation loss Abeta1 has a large distance between antennas, supposing it is large 3 dB, several 39 can be denoted by several 40 to the propagation loss Aalpha4.
[0136]
IN41=(S14-S41)-(S13-S43)-3 -- (several 40)
[0137]
The signal processing part 120 substitutes the measured value S14 as shown in Fig.5, S41, S13, and S43 for several 40, calculates IN41, and it adjusts so that the reception level of a part for the value equivalent to this IN41 and the receiving circuit 174 may be made to increase to the reception level of the receiving circuit 171.
[0138]
Thus, difference with the receiving gain deterioration quantity on the basis of the received power received with the antenna 101, The relative level of reception between antennas can be arranged by correcting only value IN21 which totaled difference with a loss between the switch parts SW from the antenna, IN31, and IN41 to the reception level received in the signal processing part 120.
[0139]

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 190 of 365

Although this embodiment showed the case where four antennas and a wireless circuit were provided, in three antennas and a wireless circuit, similarly, a loss is relatively searched for on the basis of one wireless circuit, and a relative level can be arranged.

[0140]

As described, as mentioned above, a transmission system, the antenna system between [an antenna to] the switch parts SW, Compute the difference of three kinds of losses of a receiving system, and suitable calculation is performed in the signal processing part 120 based on the difference of three kinds of this loss, By adjusting a sending-signal level from a calculation result in the signal processing part 120, and correcting a reception level from a calculation result in the signal processing part 120, the relative level difference of the transmission between antennas and reception is lost, and directivity can be correctly suitable in the desired direction.

[0141]

According to this embodiment, the abnormalities of transmission and reception are detectable with the combination of the part which detected the abnormal level. By specifying detection of the transmission anomaly detected in the reflected wave detecting circuit with the combination of the part which detected the abnormal level, since it is not necessary to have a reflected wave detecting circuit, the number of parts can be lessened, and a packaging area can be made smaller. It is based on one wireless circuit section from two or more transmission power level and two or more power levels on reception, Adjustment of a transmission power level [in / on the basis of one wireless circuit section / it asks for the difference in the difference and the receiving gain degraded minute of a loss level of an antenna system between other wireless circuit sections, and / the transmission section of other wireless circuit sections], The relative level of transmission and reception can be arranged by performing adjustment of the power level on reception in the receive section of other wireless circuit sections on the basis of one wireless circuit section. Thereby, directivity can be adjusted in the desired direction.

[Brief Description of the Drawings]

[0142]

[Drawing 1]It is a circuit configuration figure of the radio communication equipment in this embodiment.

[Drawing 2]It is a configuration diagram of the transmission power detector circuit in this embodiment, and a received power detector circuit.

[Drawing 3]It is a flow chart which shows the procedure of conducting malfunction detection investigation in this embodiment.

[Drawing 4]They are a transmission power value of the radio communication equipment in this embodiment, receiving gain deterioration quantity, and the block diagram in which the part of the loss between the switch parts SW was described from the antenna.

[Drawing 5]The explanatory view of the transmission power value acquired when malfunction detection investigation in this embodiment is conducted.

[Drawing 6]The explanatory view of the received power value acquired when malfunction detection investigation in this embodiment is conducted.

[Drawing 7]It is an explanatory view showing a decided result in case abnormalities are between the switches SW141 from the antenna 101 when malfunction detection investigation in this embodiment is conducted.

[Drawing 8]It is an explanatory view showing a decided result in case receive section RX151 when malfunction detection investigation in this embodiment is conducted has abnormalities.

[Drawing 9]It is an explanatory view of the expression showing the difference of a loss between the switch parts SW from the antenna of the radio communication equipment in this embodiment.

[Drawing 10]It is an explanatory view of the expression showing the difference of the receiving gain deterioration quantity of the radio communication equipment in this embodiment.

[Explanations of letters or numerals]

[0143]
110 -- radio communication equipment, and 131, 132, 133 and 134 -- wireless circuit RF, 120 -- a signal processing part, and 101, 102, 103 and 104 -- antenna, 161, 162, 163, 164 -- The transmission section TX, 151, 152, 153, 154 -- Receive section RX, 141, 142, 143 and 144SW, 121, 122, 123, 124 -- Aerial connection terminal, 191, 192, 193, and 194 -- received power detector circuit RD, and 171, 172, 173 and 174 -- a receiving circuit, and 195, 196, 197 and 198 -- transmission power detector circuit TD, and 181, 182, 183 and 184 -- a transmitting circuit and 150 -- DSP and 140 -- CPU and 130 -- a memory

---

[Translation done.]

* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]
In radio communication equipment provided with at least three wireless circuit sections provided with a transmission section and a receive section by which an antenna is connected, and a signal processing part which processes a signal,
The aforementioned transmission section has a transmission power detection means to detect power level of a sending signal transmitted in the transmission section concerned,
The aforementioned receive section has a received power detection means to detect power level of an input signal received in the receive section concerned,
Radio communication equipment comprising:
A wireless clinch means to make the aforementioned sending signal receive in the aforementioned receive section of two or more wireless circuit sections other than a wireless circuit section which the aforementioned signal processing part made a sending signal generated from one of the aforementioned transmission sections of the aforementioned wireless circuit section transmit, and transmitted a sending signal.
A transmission power level detected by the aforementioned transmission power detection means when carrying out a wireless clinch by said wireless clinch means.
A memory means which memorizes a power level on reception detected by the aforementioned received power detection means.
A malfunction detection means by which combination of a part which detected an abnormal level previously defined about each of two or more transmission power levels memorized by the aforementioned memory means and two or more power levels on reception, and detected an abnormal level detects abnormalities of transmission and reception.

[Claim 2]
In the radio communication equipment according to claim 1, the aforementioned signal processing part, It is based on one wireless circuit section from two or more transmission power level and two or more power levels on reception which are memorized by the aforementioned memory means, Adjustment of a transmission power level [in / on the basis of the one aforementioned wireless circuit section / it asks for difference in difference and a receiving gain degraded minute of a loss level of an antenna system between other wireless circuit sections, and / a transmission section of other wireless circuit sections], Radio communication equipment having further an adjustment device which performs adjustment of a power level on reception in a receive section of other wireless circuit sections on the basis of the one aforementioned wireless circuit section.
[Claim 3]
In the radio communication equipment according to claim 1, the aforementioned malfunction detection means, Radio communication equipment detecting any of an antenna part connected to the aforementioned transmission section of the aforementioned wireless circuit section, the

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 193 of 365

aforementioned receive section, and the wireless circuit section concerned generation places of abnormalities of the aforementioned transmission and reception are from two or more transmission power level and two or more power levels on reception which are memorized by the aforementioned memory means.

[Translation done.]

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 194 of 365

* NOTICES *

JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[0142]
[Drawing 1]It is a circuit configuration figure of the radio communication equipment in this embodiment.
[Drawing 2]It is a configuration diagram of the transmission power detector circuit in this embodiment, and a received power detector circuit.
[Drawing 3]It is a flow chart which shows the procedure of conducting malfunction detection investigation in this embodiment.
[Drawing 4]They are a transmission power value of the radio communication equipment in this embodiment, receiving gain deterioration quantity, and the block diagram in which the part of the loss between the switch parts SW was described from the antenna.
[Drawing 5]The explanatory view of the transmission power value acquired when malfunction detection investigation in this embodiment is conducted.
[Drawing 6]The explanatory view of the received power value acquired when malfunction detection investigation in this embodiment is conducted.
[Drawing 7]It is an explanatory view showing a decided result in case abnormalities are between the switches SW141 from the antenna 101 when malfunction detection investigation in this embodiment is conducted.
[Drawing 8]It is an explanatory view showing a decided result in case receive section RX151 when malfunction detection investigation in this embodiment is conducted has abnormalities.
[Drawing 9]It is an explanatory view of the expression showing the difference of a loss between the switch parts SW from the antenna of the radio communication equipment in this embodiment.
[Drawing 10]It is an explanatory view of the expression showing the difference of the receiving gain deterioration quantity of the radio communication equipment in this embodiment.

[Translation done.]

* NOTICES *

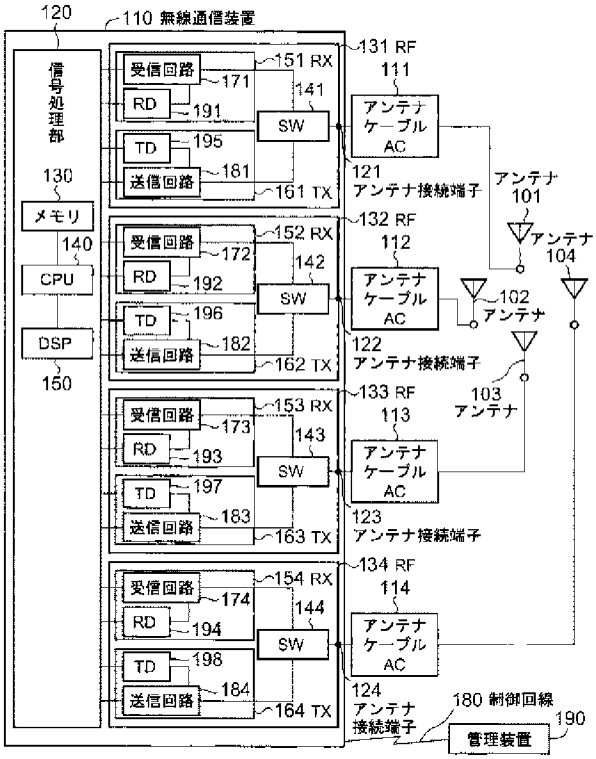
JPO and INPIT are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

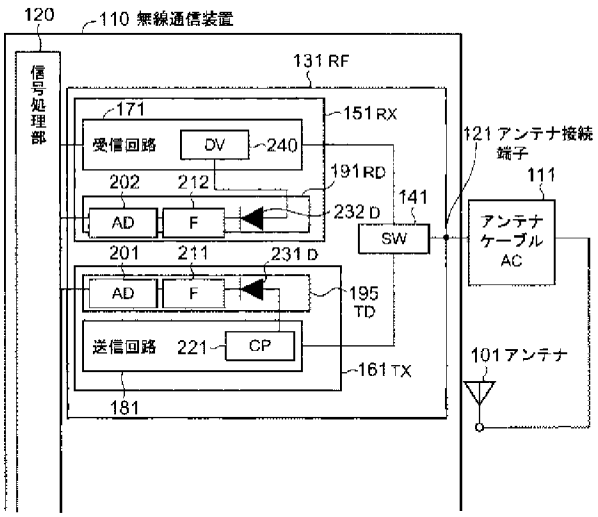
[Drawing 1]

図 1



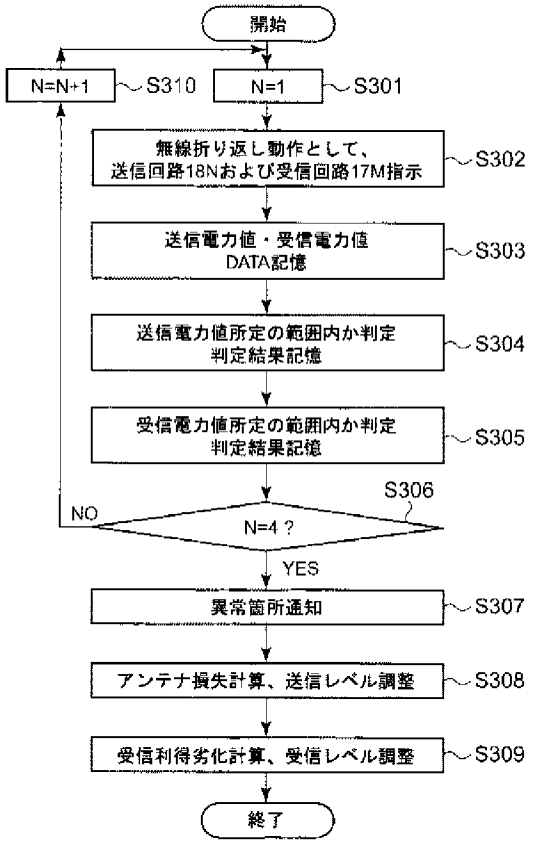
[Drawing 2]

図 2



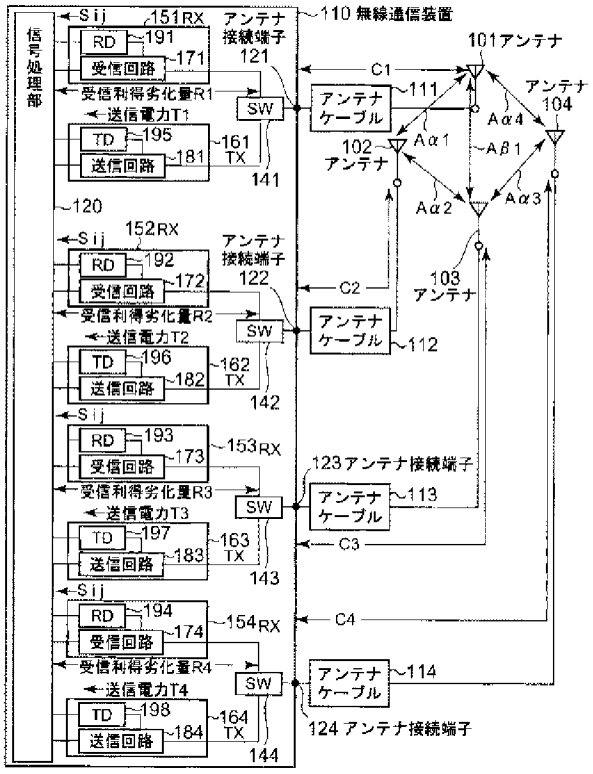
[Drawing 3]

図 3



[Drawing 4]

図 4



[Drawing 5]

図 5

500	501	502	503	504
項目	送信回路181	送信回路182	送信回路183	送信回路184
送信電力値	T1	T2	T3	T4
判定結果	0	1	1	1

[Drawing 6]

図 6

600	601	602	603	604
送信＼受信	アンテナ101	アンテナ102	アンテナ103	アンテナ104
アンテナ101		S12	S13	S14
アンテナ102	S21		S23	S24
アンテナ104	S31	S32		S34
アンテナ105	S41	S42	S43	

[Drawing 7]

図 7

700	701	702	703	704
送信 ＼ 受信	アンテナ101	アンテナ102	アンテナ103	アンテナ104
アンテナ101		0	0	0
アンテナ102	0		1	1
アンテナ103	0	1		1
アンテナ104	0	1	1	

[Drawing 8]

図 8

800	801	802	803	804
送信 ＼ 受信	アンテナ101	アンテナ102	アンテナ103	アンテナ104
アンテナ101		1	1	1
アンテナ102	0		1	1
アンテナ103	0	1		1
アンテナ104	0	1	1	

[Drawing 9]

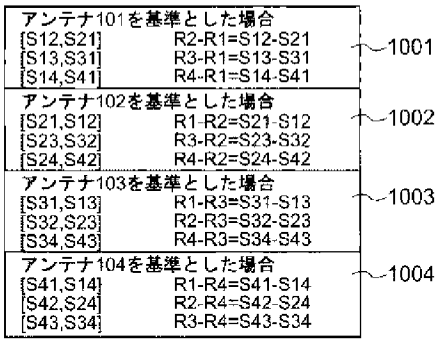
図 9

アンテナ101を基準とした場合		901
[S12,S32]	C3-C1=S12-S32	
[S14,S34]	C3-C1=S14-S34	
[S13,S23]	C2-C1=S13-S23	
[S14,S24]	C2-C1=S14-S24	
[S12,S42]	C4-C1=S12-S42	
[S13,S43]	C4-C1=S13-S43	
アンテナ102を基準とした場合		902
[S21,S41]	C4-C2=S21-S41	
[S23,S43]	C4-C2=S23-S43	
[S21,S31]	C3-C2=S21-S31	
[S24,S34]	C3-C2=S24-S34	
[S24,S14]	C1-C2=S24-S14	
[S23,S13]	C1-C2=S23-S13	
アンテナ103を基準とした場合		903
[S34,S24]	C2-C3=S34-S24	
[S31,S21]	C2-C3=S31-S21	
[S31,S41]	C4-C3=S31-S41	
[S32,S42]	C4-C3=S32-S42	
[S34,S14]	C1-C3=S34-S14	
[S32,S12]	C1-C3=S32-S12	
アンテナ104を基準とした場合		904
[S42,S12]	C1-C4=S42-S12	
[S43,S13]	C1-C4=S43-S13	
[S41,S21]	C2-C4=S41-S21	
[S43,S23]	C2-C4=S43-S23	
[S41,S31]	C3-C4=S41-S31	
[S42,S32]	C3-C4=S42-S32	

[Drawing 10]

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 199 of 365

図 10



[Translation done.]

Electronic Acknowledgement Receipt

EFS ID:	15963429
Application Number:	13321076
International Application Number:	
Confirmation Number:	2274
Title of Invention:	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths
First Named Inventor/Applicant Name:	Qingyu Miao
Customer Number:	24112
Filer:	David E. Bennett/Kristi Dunshee
Filer Authorized By:	David E. Bennett
Attorney Docket Number:	4015-7892 / P28266-US1
Receipt Date:	06-JUN-2013
Filing Date:	17-NOV-2011
Time Stamp:	09:08:51
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal Letter	7892Transmittal.pdf	87888 f1dc47a40a3e96ef1fc0f768ea228f48bf6e3c9b	no	1

Warnings:	
Information:	

2	Information Disclosure Statement (IDS) Form (SB08)	7892IDS.pdf	612495 b09e86ae184a92925b2e668c2a675bb5f68bf008	no	4
Warnings:					
Information:					
3	Foreign Reference	DE19923729A1.pdf	5427261 5e64ff4158927cf67f9381933c77ea06e50a728e	no	12
Warnings:					
Information:					
4	Foreign Reference	WO0102871A1.pdf	19361315 efb736de49298c61d97371e77a4ae0c4faf3db45	no	19
Warnings:					
Information:					
5	Foreign Reference	JP2008035286A.pdf	5513450 84b96aea2f8f1e3f0ebdf56de85bf4eeefee42c8	no	18
Warnings:					
Information:					
6	Foreign Reference	JP2008035286Translation.pdf	323857 e2e283d8a87baf9941f25edc8e574c8689d5c229	no	22
Warnings:					
Information:					
7	Foreign Reference	JP2006115267.pdf	6345242 ea1ea4b528b9a40ad1d080e4ec568b7f3dddd0c0	no	20
Warnings:					
Information:					
8	Foreign Reference	JP2006115267Translation.pdf	324321 0bda1f449c1d72ada8c22ae701c8d6ba3d42472b	no	25
Warnings:					
Information:					
			Total Files Size (in bytes):	37995829	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of **Miao** et al.	)	
	)	
Serial No.: **13/321076**	)	
	)	Examiner: Lewis G. West
Filed: **November 17, 2011**	)	
	)	Group Art Unit: 2648
For: **Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths**	)	Confirmation No.: 2274
	)	
	)	
Attorney's Docket No: **4015-7892**	)	

MS AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

INFORMATION DISCLOSURE STATEMENT

In accordance with 37 C.F.R. 1.56, counsel wishes to make of record the attached items of information for the Examiner's consideration in connection with this application.

Also attached is Form PTO/SB/08A for the Examiner's convenience in making such consideration of record. Inclusion herein of any particular item of information is not to be construed as an admission that same is prior art.

CERTIFICATION STATEMENT

☒ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

The Commissioner is hereby authorized to charge any fees that may be required or credit any overpayment to Deposit Account 18-1167.

Respectfully submitted,

COATS & BENNETT, P.L.L.C.

David E. Bennett

Dated: June 6, 2013

David E. Bennett
Registration No.: 32,194
Telephone: (919) 854-1844

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 204 of 365

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
13/321,076	11/17/2011	Qingyu Miao	4015-7892 / P28266-US1	2274

24112 7590 05/30/2013

COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

EXAMINER	
WEST, LEWIS G	

ART UNIT	PAPER NUMBER
2648	

MAIL DATE	DELIVERY MODE
05/30/2013	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 13/321,076	Applicant(s) MIAO ET AL.	
	Examiner LEWIS WEST	Art Unit 2648	AIA (First Inventor to File) Status No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

5)☒ Claim(s) *21-40* is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *21-40* is/are rejected.

8)☐ Claim(s) _____ is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *17 November 2011* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some * c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Interim copies:

a)☐ All b)☐ Some c)☐ None of the: Interim copies of the priority documents have been received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 206 of 365

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 21-25, 28, 31-35 and 38 are rejected under 35 U.S.C. 102(b) as being anticipated by Heikkinen (WO 2008/023097 A1).

21. Heikkenen discloses a method in a radio network that includes a device, the method comprising: measuring, via the device, a parameter associated with at least two antenna ports of the device; comparing, via the device, the measured parameter with an expected parameter associated with the at least two antenna ports to determine an error; comparing, via the device, the determined error to a threshold; and determining, via the device: an erroneous antenna port connection for the at least two antenna ports when the error exceeds the threshold, and a correct antenna port connection for the at least two antenna ports when the error is less than or equal to the threshold. [Fig. 4; page 9-10, as it describes figure 4 and the process of measuring each port to determine function or error, where the reflected signal is the error which exceeds the threshold]

22. The method of claim 21, where measuring, via the device, the parameter comprises: determining a parameter associated with at least two antenna elements of the device, where the at least two antenna elements are associated with the at least two antenna ports; and measuring, based on the determined parameter associated with the at least two antenna elements, the

measured parameter. [page 10, the measured reflected signal is a parameter used for each of the at least two elements in determining]

23. The method of claim 22, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

24. The method of claim 21, where the measured parameter associated with the at least two antenna ports comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

25. The method of claim 21, where the measured parameter associated with the at least two antenna ports comprises a difference between a signal transmitted via one of the at least two antenna ports and a signal received via another one of the at least two antenna ports. {Fig 5; page 12}

28. The method of claim 21, further comprising: receiving antenna port permutations for a plurality of antenna ports of the device; receiving expected information associated with the plurality of antenna ports; calculating expected values for different antenna port permutations based on the received information; acquiring measured values associated with the different antenna port permutations; comparing the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations; and determining an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.[pages 9-11, antennas are continually tested to determine proper function. of the expected values associated with a functional antenna change, the antennas may be reallocated, and thus

changed to a new permutation, on the fly, if only one antenna is functioning then that is the permutation with the lowest error]

31. A device in a radio network, the device comprising: at least two antenna ports; a memory to store a plurality of instructions; and a processing unit to execute instructions in the memory to: measure a parameter associated with the at least two antenna ports, compare the measured parameter with an expected parameter associated with the at least two antenna ports to determine an error, compare the determined error to a threshold, and determine: an erroneous antenna port connection for the at least two antenna ports when the error exceeds the threshold, and a correct antenna port connection for the at least two antenna ports when the error is less than or equal to the threshold. [Fig. 4; page 9-10, as it describes figure 4 and the process of measuring each port to determine function or error]

32. The device of claim 31, where the device further comprises: at least two antenna elements associated with the at least two antenna ports, and where the processing unit is further configured to execute instructions in the memory to: determine a parameter associated with the at least two antenna elements, and measure, based on the determined parameter associated with the at least two antenna elements, the measured parameter. [page 10, the measured reflected signal is a parameter used for each of the at least two elements in determining]

33. The device of claim 32, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

34. The device of claim 31, where the measured parameter associated with the at least two antenna ports comprises one or more of an amplitude or a phase. [page 10-level is amplitude]

35. The device of claim 31, where the measured parameter associated with the at least two antenna ports comprises a difference between a signal transmitted via one of the at least two antenna ports and a signal received via another one of the at least two antenna ports. {Fig 5; page 12}

38. The device of claim 31, where the processing unit is further configured to execute instructions in the memory to: receive antenna port permutations for a plurality of antenna ports of the device, receive expected information associated with the plurality of antenna ports, calculate expected values for different antenna port permutations based on the received information, acquire measured values associated with the different antenna port permutations, compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations, and determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error. [pages 9-11, antennas are continually tested to determine proper function. of the expected values associated with a functional antenna change, the antennas may be reallocated, and thus changed to a new permutation, on the fly, if only one antenna is functioning then that is the permutation with the lowest error]

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 26-27, 29-30, 36-37 and 39-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Heikkinen (WO 2008/023097 A1) in view of Taylor (2003/0198305).

Regarding claims 36 and 37, Heikkinen discloses the method of claim 21, but does not expressly discloses using a squared error comparison. Taylor discloses, in an analogous system, the use of Minimum mean squared error, [0054, 0103] meaning the difference between the square of the expected and measured values would be calculated and compared to a threshold meaning equations equivalent to those used in the claims would be implicitly used. Therefore it would have been obvious to determine and compare a squared error, as this is a common

statistical tool often applied to signal processing, as it helps to eliminate randomness and provide a more accurate value. .

Regarding claims 26 and 27, Heikkinen disclsoes the method of claim 31, but does not expressly discloses using a squared error comparison. Taylor discloses, in an analogous system, the use of Minimum mean squared error [0054, 0103], meaning the difference between the square of the expected and measured values would be calculated and compared to a threshold meaning equations equivalent to those used in the claims would be implicitly used. Therefore it would have been obvious to determine and compare a squared error, as this is a common statistical tool often applied to signal processing, as it helps to eliminate randomness and provide a more accurate value.

Regarding claim 29-30 and 39-40, Heikkinen discloses the method of claim 21 and device of claim 31 respectively, between a base reader and a tag, but not expressly a base station and associated remote unit. Taylor discloses analogous system where the devices comprise a base station and associated radio in a wide area network. [0044] Therefore it would have been obvious to one of ordinary skill in the art that the same signal processing and error detection would be identically usable on a larger scale to provide the same benefits.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. See the attached PTO-892 for a listing of relevant art.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to LEWIS WEST whose telephone number is (571)272-7859. The examiner can normally be reached on Monday-Friday 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Temesghen Ghebretinsae can be reached on 571-272-4177. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lewis G. West/
Primary Examiner, Art Unit 2648

Notice of References Cited	Application/Control No. 13/321,076	Applicant(s)/Patent Under Reexamination MIAO ET AL.	
	Examiner LEWIS WEST	Art Unit 2648	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2003/0198305 A1	10-2003	Taylor et al.	375/341
*	B	US-2004/0224637 A1	11-2004	Silva et al.	455/063.4
*	C	US-2006/0214837 A1	09-2006	Liu et al.	342/052
*	D	US-7,103,377 B2	09-2006	Bauman et al.	455/522
*	E	US-2008/0316990 A1	12-2008	STEER et al.	370/338
*	F	US-7,539,509 B2	05-2009	Bauman et al.	455/522
*	G	US-7,546,138 B2	06-2009	Bauman, Donald R.	455/524
*	H	US-7,561,878 B2	07-2009	Tam et al.	455/425
*	I	US-7,917,177 B2	03-2011	Bauman, Donald R.	455/562.1
*	J	US-7,965,991 B2	06-2011	Nash et al.	455/115.2
*	K	US-8,412,106 B2	04-2013	da Silva et al.	455/63.4
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	Art Unit
	LEWIS WEST	2648

CPC- SEARCHED		
Symbol	Date	Examiner

CPC COMBINATION SETS - SEARCHED		
Symbol	Date	Examiner

US CLASSIFICATION SEARCHED			
Class	Subclass	Date	Examiner
455	63.1, 67.11, 562.1, 575.7	05/28/2013	LW

SEARCH NOTES		
Search Notes	Date	Examiner
PALM inventor search	05/28/2013	LW

INTERFERENCE SEARCH			
US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 215 of 365

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	13321076 - GAU: 2648
Filing Date	
First Named Inventor	Miao
Art Unit	TBD
Examiner Name	TBD
Attorney Docket Number	4015-7892 / P28266-US1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/L.W./	1	5867123		1999-02-02	Geyh et al.	

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
/L.W./	1	20090051591	A1	2009-02-26	Nakajima et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
/L.W./	1	101154977	CN	A	2008-04-02	ZTE CORP		☐
/L.W./	2	0040050	WO	A1	2000-07-06	ARRAYCOMM INC		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	13321076 - GAU: 2648
	Filing Date	
	First Named Inventor	Miao
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	4015-7892 / P28266-US1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1		☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature	/Lewis West/	Date Considered	04/30/2013

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 2274

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
13/321,076	11/17/2011	455	2648	4015-7892 / P28266-US1

APPLICANTS

Qingyu Miao, Beijing, CHINA;
Mikael Coldrey, Landvetter, SWEDEN;
Zhiheng Guo, Beijing, CHINA;

**** CONTINUING DATA ***************************

This application is a 371 of PCT/SE2009/050583 05/20/2009

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

12/03/2011

Foreign Priority claimed ☑ Yes ☐ No 35 USC 119(a-d) conditions met ☑ Yes ☐ No Verified and Acknowledged /LEWIS G WEST/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CHINA	12	20	2

ADDRESS

COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518
UNITED STATES

TITLE

Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths

FILING FEE RECEIVED		
1120	FEES: Authority has been given in Paper No._____ to charge/credit DEPOSIT ACCOUNT No._____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 218 of 365

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	**Art Unit**
	LEWIS WEST	2648

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	05/29/2013								
	1	-								
	2	-								
	3	-								
	4	-								
	5	-								
	6	-								
	7	-								
	8	-								
	9	-								
	10	-								
	11	-								
	12	-								
	13	-								
	14	-								
	15	-								
	16	-								
	17	-								
	18	-								
	19	-								
	20	-								
	21	✓								
	22	✓								
	23	✓								
	24	✓								
	25	✓								
	26	✓								
	27	✓								
	28	✓								
	29	✓								
	30	✓								
	31	✓								
	32	✓								
	33	✓								
	34	✓								
	35	✓								
	36	✓								

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 219 of 365

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	13321076	MIAO ET AL.
	Examiner	**Art Unit**
	LEWIS WEST	2648

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	05/29/2013								
	37	✓								
	38	✓								
	39	✓								
	40	✓								

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
13/321,076	11/17/2011	Qingyu Miao	4015-7892 / P28266-US1

CONFIRMATION NO. 2274

24112
COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

PUBLICATION NOTICE



Title: Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths

Publication No.US-2012-0064838-A1
Publication Date:03/15/2012

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 221 of 365

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED APPLICANT	ATTY. DOCKET NO.
13/321,076	Qingyu Miao	4015-7892 / P28266-US1

24112
COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

INTERNATIONAL APPLICATION NO.	
PCT/SE2009/050583	
I.A. FILING DATE	PRIORITY DATE
05/20/2009	

CONFIRMATION NO. 2274
371 ACCEPTANCE LETTER

OC000000051296797

Date Mailed: 12/06/2011

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office in its capacity as a Designated / Elected Office (37 CFR 1.495), has determined that the above identified international application has met the requirements of 35 U.S.C. 371, and is ACCEPTED for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above and the relevant dates are:

11/17/2011	11/17/2011
DATE OF RECEIPT OF 35 U.S.C. 371(c)(1), (c)(2) and (c)(4) REQUIREMENTS	DATE OF COMPLETION OF ALL 35 U.S.C. 371 REQUIREMENTS

A Filing Receipt (PTO-103X) will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE " FILING DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1), (c)(2) and (c)(4) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN ABOVE.** *The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363).* Once the Filing Receipt has been received, send all correspondence to the Group Art Unit designated thereon.

The following items have been received:

- Copy of the International Application filed on 11/17/2011
- Copy of the International Search Report filed on 11/17/2011
- Preliminary Amendments filed on 11/17/2011
- Information Disclosure Statements filed on 11/17/2011
- Oath or Declaration filed on 11/17/2011
- Request for Immediate Examination filed on 11/17/2011
- U.S. Basic National Fees filed on 11/17/2011
- Assignee Statement for PGPUB filed on 11/17/2011
- Specification filed on 11/17/2011
- Claims filed on 11/17/2011
- Abstracts filed on 11/17/2011
- Drawings filed on 11/17/2011

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 222 of 365

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

DIAN S GORDON

Telephone: (571) 272-3915

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 223 of 365

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 13/321,076

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	490
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*			OR	x 60 =	0.00
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 250 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1120

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)		RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
13/321,076	11/17/2011		1120	4015-7892 / P28266-US1	20	2

CONFIRMATION NO. 2274

24112
COATS & BENNETT, PLLC
1400 Crescent Green, Suite 300
Cary, NC 27518

FILING RECEIPT

OC00000051296796

Date Mailed: 12/06/2011

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Qingyu Miao, Beijing, CHINA;
Mikael Coldrey, Landvetter, SWEDEN;
Zhiheng Guo, Beijing, CHINA;

Assignment For Published Patent Application

Telefonaktiebolaget L M Ericsson (publ), Stockholm, SWEDEN

Power of Attorney: The patent practitioners associated with Customer Number 24112

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/SE2009/050583 05/20/2009

Foreign Applications (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.)

If Required, Foreign Filing License Granted: 12/03/2011

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 13/321,076**

Projected Publication Date: 03/15/2012

Non-Publication Request: No

Early Publication Request: No

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 225 of 365

Title

Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths

Preliminary Class

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 226 of 365

license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage, facilitate, and accelerate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET

Substitute for Form PTO-1360
(For use with Form PTO/SB/06)

Application Number	Filing Date
13321076	

Applicant(s) Qingyu Miao

* May be used for additional claims or amendments

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
1	1					
2		1				
3		1				
4		1				
5		1				
6		1				
7		1				
8		1				
9		1				
10		1				
11	1					
12		1				
13		1				
14		1				
15		1				
16		1				
17		1				
18		1				
19		1				
20		1				
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
Total Indep	2		0		0	
Total Depend	18	↵	0	↵	0	↵
Total Claims	20		0		0	

	*		*		*	
	Indep	Depend	Indep	Depend	Indep	Depend
51						
52						
53						
54						
55						
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						
74						
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91						
92						
93						
94						
95						
96						
97						
98						
99						
100						

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-10)
Approved for use through 07/31/2012. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	
First Named Inventor	Miao
Art Unit	TBD
Examiner Name	TBD
Attorney Docket Number	4015-7892 / P28266-US1

U.S.PATENTS

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	5867123		1999-02-02	Geyh et al.	

If you wish to add additional U.S. Patent citation information please click the Add button.

U.S.PATENT APPLICATION PUBLICATIONS

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20090051591	A1	2009-02-26	Nakajima et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button.

FOREIGN PATENT DOCUMENTS

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	101154977	CN	A	2008-04-02	ZTE CORP		☐
	2	0040050	WO	A1	2000-07-06	ARRAYCOMM INC		☐

If you wish to add additional Foreign Patent Document citation information please click the Add button

NON-PATENT LITERATURE DOCUMENTS

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Miao
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	4015-7892 / P28266-US1

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		☐

If you wish to add additional non-patent literature document citation information please click the Add button

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	
	First Named Inventor	Miao
	Art Unit	TBD
	Examiner Name	TBD
	Attorney Docket Number	4015-7892 / P28266-US1

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

☐ That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

☐ See attached certification statement.

☐ The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/David D. Kalish, Reg. No. 42706/	Date (YYYY-MM-DD)	2011-11-17
Name/Print	David D. Kalish	Registration Number	42706

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Method for detecting cable connection of intelligent antenna outdoor unit

Application Number	200610152734	**Application Date**	2006.09.26
Publication Number	101154977	**Publication Date**	2008.04.02
Priority Information			
International Classification	H04B7/04		
Applicant(s) Name	ZTE Corporation		
Address			
Inventor(s) Name	Zeng Zhaohua;Li Bin		
Patent Agency Code	11274	**Patent Agent**	wangjing

Abstract

The present invention discloses a method for detecting the cable connecting of the outdoor unit of the intelligent antenna, which settles the problem that the connecting sequence can not be detected when the intelligent antenna array is connected with the front unit of the outdoor radio frequency by a radio frequency coaxial cable in the TD-SCDMA communication system. The invention presents a method for confirming the connecting sequence of the corresponding cable according to the estimated data of the communication channel, changing the complexor sequence in the antenna array direction, searching the maximum value of the energy in the air space, and the antennae array direction complexor sequence which corresponds with the maximum value. The present invention effectively settles the problem of detecting the connecting sequence of the of the radio frequency cable in the realizing of the intelligent antenna project; the detecting sequence of the present cable can be accurately detected while the upgoing communication channel is adopted to process the data according to the criterion that the space detecting receiving power is maximum traversing all the cables at the condition that the calculating difficulty is effectively controlled; the smooth arithmetic is adapted for the originality, the noise and disturbance are sieved and the correctness of the detecting arithmetic is increased.

¤ Machine Translation ¤ Close

SITE MAP | CONTACT US | PRODUCTS&SERVICES | RELATED LINKS

Copyright © 2007 SIPO. All Rights Reserved

[19] 中华人民共和国国家知识产权局

[51] Int. Cl.
H04B 7/04 (2006.01)

[12] 发明专利申请公布说明书

[21] 申请号 200610152734.7

[43] 公开日 2008 年 4 月 2 日

[11] 公开号 CN 101154977A

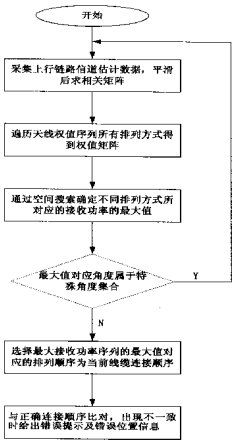
[22] 申请日 2006.9.26
[21] 申请号 200610152734.7
[71] 申请人 中兴通讯股份有限公司
地址 518057 广东省深圳市南山区高新技术产业园科技南路中兴通讯大厦 6 层法律部
[72] 发明人 曾召华 李 斌
[74] 专利代理机构 北京中博世达专利商标代理有限公司
代理人 王 晶
权利要求书 2 页 说明书 5 页 附图 2 页

[54] 发明名称

智能天线室外单元线缆连接检测方法

[57] 摘要

本发明公开了一种智能天线室外单元线缆连接检测方法，解决了 TD－SCDMA 通信系统中智能天线阵列与室外射频前端单元之间通过射频同轴电缆连接时，无法检测其连接顺序的问题。本发明给出基于信道估计数据，通过改变天线阵列方向矢量顺序，搜索空域中能量的最大值，根据最大值所对应的天线阵列方向矢量顺序从而确定对应的线缆连接顺序的方法。本发明有效的解决了智能天线工程实现中的射频线缆连接顺序检测问题；采用上行信道后处理数据，基于空间搜索接收功率最大准则遍历所有，在有效控制计算复杂度的情况下可精确检测出当前线缆的检测顺序；对原始采用平滑算法，滤除了噪声和干扰，提高了检测算法的正确性。



Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 233 of 365

1、一种智能天线室外单元线缆连接检测方法，包括如下步骤：

步骤 A，在基站端采集预定长度的上行链路信道数据，对其进行平滑处理并计算出信道相关矩阵；

步骤 B，确定智能天线系统中用户天线权系数序列；遍历用户天线权系数序列中各个元素所有可能的排列顺序，得到包括所有可能的排列顺序的权系数矩阵；

步骤 C，将波束空间均匀地划分成多个空间区域，在天线权值的每种排列情况下分别记录每一个空间区域所对应的接收功率；找出并记录每一个空间区域所对应的最大接收功率；

步骤 D，所述最大接收功率对应的角度如果属于特殊角度集合，则回到步骤 A，否则执行步骤 E；

步骤 E，在不同排列组合各自对应的空间最大接收功率序列中，找到其中的最大值所对应的位置；该位置即为智能天线系统室外单元线缆当前的连接顺序，并与默认的正确连接顺序进行比对，如果不一致则给出错误提示及错误连接位置；

步骤 F，重复步骤 A-E；将出现次数最多的排列方式确定为最终检测出的智能天线系统室外单元线缆的连接顺序。并与默认的正确连接顺序进行比对，如果不一致则给出错误提示及错误连接位置。

2、根据权利要求 1 所述的智能天线室外单元线缆连接检测方法，其特征在于，步骤 A 具体为：

在基站端采集长度为 M 的上行链路信道后处理数据序列 Ch_est；对此 M 个信道后处理数据进行平滑处理后计算其相关矩阵，用以下公式表示：

$$\overline{Ch\_est}=\frac{1}{M}\sum_{i=1}^{M}Ch\_est(i)$$
$$Rxx=\overline{Ch\_est}*\left(\overline{Ch\_est}\right)^{H} \qquad (1)$$

最终得到 1 个大小为 $Ka\times Ka$ 信道相关矩阵 Rxx，其中 Ka 为天线数目。

3、根据权利要求 1 所述的智能天线室外单元线缆连接检测方法，其特征在于，步骤 B 具体为：

智能天线系统中用户天线权系数 W 为：

$$W=\mathrm{a}(\theta)=(e^{-j\frac{2\pi r}{\lambda}\cos\theta},\mathrm{L},e^{-j\frac{2\pi r}{\lambda}\cos(\theta-\frac{2\pi(k_a-1)}{\mathrm{K}})},\mathrm{L},e^{-j\frac{2\pi r}{\lambda}\cos(\theta-\frac{2\pi(\mathrm{K}_a-1)}{\mathrm{K}})})^{\mathrm{H}} \qquad (2)$$

其中 θ 为来波方向；

遍历 W 中 Ka 个元素所有可能的排列顺序，得到重新排列的权系数矩阵 W_coff，其大小为 $Ka!\times Ka$。

4、根据权利要求 1 所述的智能天线室外单元线缆连接检测方法，其特征在于，步骤 C 具

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 234 of 365

体为：

步骤C1，将波束空间均匀地划分成L个区域，每个区域的第 l 到达角预先定义为

$$\theta_l = \frac{360 \bullet (l-1)}{L}, l = 1\mathrm{L}\ L$$

步骤C2，利用公式（2）计算出每一个 θ_l 所对应的权系数W_coff矩阵 W_l，则每一个区域所对应的接收功率

$$\sigma_l^2(k) = (W_l^{(k)})^H R_{XX} W_l^{(k)} \qquad (3)$$

其中 $k = 1,2,\mathrm{L}\ ,Ka!$，$W_l^{(k)}$ 表示 W_l 中的第k行权值，对应天线阵元的第k种排列方式；

步骤C3，在每种排列方式 $W_l^{(k)}$ 中找出最大值 $\max(\sigma_k^2(l))$，记录于序列Power_max的第k个位置，表示在该排列方式下空间区域的最大接收功率。

5、根据权利要求1所述的智能天线室外单元线缆连接检测方法，其特征在于，在步骤D中所述特殊角度集合是指：采用线阵阵列时，特殊角度集合包括 $\left\{-\frac{\pi}{6}, 0, \frac{\pi}{6}\right\}$；采用圆阵阵列时，特殊角度集合包括 $\left\{\frac{\pi}{8}, \frac{3\pi}{8}, \frac{5\pi}{8}, \frac{7\pi}{8}, \frac{9\pi}{8}, \frac{11\pi}{8}, \frac{13\pi}{8}, \frac{15\pi}{8}\right\}$。

6、根据权利要求1、4或5所述的智能天线室外单元线缆连接检测方法，其特征在于，步骤E具体为：

最大值 $\max(\sigma_k^2(l))$ 对应的角度 θ_l 如果不属于所述特殊角度集合，在长度为 $Ka!$ 的序列Power_max中找到最大值，所对应的位置记为Location，表示信道相关矩阵 Rxx 对应的当前室外单元的线缆连接顺序。

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 235 of 365

智能天线室外单元线缆连接检测方法

技术领域

本发明涉及一种无线通信系统的智能天线室外单元线缆连接检测方法，尤其涉及同步的码分多址（CDMA）通信系统中智能天线室外单元采用的线缆连接检测方法。

背景技术

智能天线利用信号传输的空间特性和数字信号处理技术，可以实现上行链路波达角（DOA）的估计以及下行波束赋形，从而达到降低干扰、增加容量、扩大覆盖、改善通信质量、降低发射功率和提高无线数据传输速率的目的。

在一定的用户移动速度条件下，对于采用时分双工（TDD）方式的同步 CDMA 通信系统，其上、下信道满足对称要求，若采用智能天线，则可以根据天线阵列对应的信道估计实现各个用户的上行 DOA 估计，进而完成下行波束赋形，较好地解决抗多径干扰和抗多址干扰等问题。

因此，在第三代移动通信系统中，时分同步码分多址（TD-SDMA）是应用智能天线技术的典型范例。

普天信息技术研究院罗海斌在 2004 年 7 月 8 日申请的中国申请号为 CN200420066374，公开号 CN2738503 的专利移动通讯基站的室外射频前端装置中提出了一种改进的移动通讯基站的室外射频前端装置，包括一组单独固装在铁塔上的智能天线阵列和两个箱柜式结构的室外射频前端单元，该两个室外射频前端单元背靠背地螺固在支撑杆两侧，智能天线阵列与室外射频前端单元之间通过射频同轴电缆实现电连接。

但该专利未能提及射频同轴电缆之间的连接检测问题。由于智能天线阵列一般采用多天线系统，因此在与室外射频前端单元的连接施工过程中，经常会出现连接顺序发生错误的情况，这将大大影响智能天线系统的性能和增益。而现有的解决方法大多局限在人工辨认检测方面，不仅在精确度上难以控制，而且严重影响了基站的建设速度。

发明内容

针对现有技术存在的缺陷和不足，本发明的目的是提供一种智能天线室外单元线缆连接检测方法，从而使得 TD-SCDMA 系统在以较小系统资源的代价下精确确认及完成室外单元电缆连接顺序的检测。

为达到上述目的，本发明采用以下技术方案：一种智能天线室外单元线缆连接检测方法，包括如下步骤：

步骤 A，在基站端采集一定长度的上行链路信道数据，对其进行平滑处理并计算出信道

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 236 of 365

相关矩阵；

步骤 B，确定智能天线系统中用户天线权系数序列；遍历用户天线权系数序列中各个元素所有可能的排列顺序，得到包括所有可能的排列顺序的权系数矩阵；

步骤 C，将波束空间均匀地划分成多个空间区域，在天线权值的每种排列情况下分别记录每一个空间区域所对应的接收功率；找出并记录每一个空间区域所对应的最大接收功率；

步骤 D，所述最大接收功率对应的角度如果属于特殊角度集合，则回到步骤 A；

步骤 E，所述最大接收功率对应的角度如果不属于特殊角度集合，在不同排列组合各自对应的空间最大接收功率序列中，找到其中的最大值所对应的位置；该位置即为智能天线系统室外单元线缆当前的连接顺序，并与默认的正确连接顺序进行比对，如果不一致则给出错误提示及错误连接位置；

步骤 F，为了降低错误概率，可以重复 P 次，每次步骤为 A-E；将出现次数最多的排列方式确定为最终检测出的智能天线系统室外单元线缆的连接顺序。并与默认的正确连接顺序进行比对，如果不一致则给出错误提示及错误连接位置。

优选的：在所述智能天线室外单元线缆连接检测方法中，步骤 A 具体为：在基站端采集长度为 M 的上行链路信道后处理数据序列 Ch_est；对此 M 个信道后处理数据进行平滑处理后计算其相关矩阵，用以下公式表示：

$$\overline{Ch\_est} = \frac{1}{M}\sum_{i=1}^{M} Ch\_est(i)$$
$$Rxx = \overline{Ch\_est} * \left(\overline{Ch\_est}\right)^{H} \qquad (1)$$

最终得到 1 个大小为 $Ka \times Ka$ 信道相关矩阵 Rxx，其中 Ka 为天线数目；

优选的：在所述智能天线室外单元线缆连接检测方法中，步骤 B 具体为：

智能天线系统中用户天线权系数 W 为：

$$W = \mathrm{a}(\theta) = (e^{-j\frac{2\pi r}{\lambda}\cos\theta}, \mathrm{L}\ , e^{-j\frac{2\pi r}{\lambda}\cos(\theta-\frac{2\pi(k_a-1)}{\mathrm{K}})}, \mathrm{L}\ ,\ e^{-j\frac{2\pi r}{\lambda}\cos(\theta-\frac{2\pi(\mathrm{K}_a-1)}{\mathrm{K}})})^{\mathrm{H}} \qquad (2)$$

其中 θ 为来波方向；

遍历 W 中 Ka 个元素所有可能的排列顺序，得到重新排列的权系数矩阵 W_coff，其大小为 $Ka! \times Ka$。

优选的：在所述智能天线室外单元线缆连接检测方法中，步骤 C 具体为：

步骤 C1，将波束空间均匀地划分成 L 个区域，每个区域的第 l 到达角预先定义为

$$\theta_l = \frac{360 \bullet (l-1)}{L}, l = 1\mathrm{L}\ L$$

步骤 C2，利用公式（2）计算出每一个 θ_l 所对应的权系数 W_coff 矩阵 W_l，则每一个区域

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 237 of 365

所对应的接收功率

$$\sigma_l^2(k)=(W_l^{(k)})^H R_{XX} W_l^{(k)} \qquad (3)$$

其中 $k=1,2,\mathrm{L}\ ,Ka!$，$W_l^{(k)}$ 表示 W_l 中的第 k 行权值，对应天线阵元的第 k 种排列方式；

步骤 C3，在每种排列方式 $W_l^{(k)}$ 中找出最大值 $\max(\sigma_k^2(l))$，记录于序列 Power_max 的第 k 个位置，表示在该排列方式下空间区域的最大接收功率。

优选的：在所述智能天线室外单元线缆连接检测方法中，在步骤 D 中所述特殊角度集合是指：采用线阵阵列时，特殊角度集合包括 $\left\{-\frac{\pi}{6},0,\frac{\pi}{6}\right\}$；采用圆阵阵列时，特殊角度集合包括 $\left\{\frac{\pi}{8},\frac{3\pi}{8},\frac{5\pi}{8},\frac{7\pi}{8},\frac{9\pi}{8},\frac{11\pi}{8},\frac{13\pi}{8},\frac{15\pi}{8}\right\}$。

优选的：在所述智能天线室外单元线缆连接检测方法中，步骤 E 具体为：

最大值 $\max(\sigma_k^2(l))$ 对应的角度 θ_l 如果不属于所述特殊角度集合，在长度为 $Ka!$ 的序列 Power_max 中找到最大值，所对应的位置记为 Location，表示信道相关矩阵 *Rxx* 对应的当前室外单元的线缆连接顺序。

本发明智能天线室外单元线缆连接检测方法，采用遍历所有天线权值排列情况，搜索空间中接收能量的最大值，根据其所对应的天线阵列方向矢量顺序确定对应的线缆连接顺序，在运算复杂度较低的基础上，可精确定位线缆的连接顺序，有利于工程实现。本发明和传统的方法相比具有如下特点：

1. 有效的解决了智能天线工程实现中的射频线缆连接顺序检测问题；

2. 采用上行信道后处理数据，基于空间搜索接收功率最大准则，遍历所有 $Ka!$ 种用户天线权系数序列组合，在有效控制计算复杂度的情况下可精确检测出当前线缆的检测顺序；

3. 对原始信道采用平滑算法，滤除了噪声和干扰，提高了检测算法的正确性。

附图说明

图 1 为智能天线室外单元天线圆阵列的排列方式（其中 Ka=8）；

图 2 为智能天线室外单元天线线阵列的排列方式（其中 Ka=8）；

图 3 为本发明智能天线室外单元线缆连接检测方法的具体实施流程图。

具体实施方式

以下结合附图，将对本发明的具体实施例进行较为详细的说明。

参照附图 1、2，分别为智能天线室外单元天线阵列的排列方式：圆阵和线阵的示意图。

本发明所述的智能天线阵列与室外射频前端单元之间的射频同轴电缆连接顺序检测方

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 238 of 365

法，分别通过在基站端采集上行链路信道后处理数据并进行平滑求相关、构造用户天线权系数遍历矩阵、波束空间搜索对应排列的最大值、检测最大值对应角度剔除特殊角度集合数据、搜索所有排列的功率最大值以得到精确排列位置等模块构成。这些模块相互联系，并可根据采集数据多次重复进行上述步骤，有效滤除噪声干扰影响，最终确定出现次数最多的排列为精确的检测结果。并与默认的正确连接顺序进行比对，如果不一致则给出错误提示及错误连接位置。

本发明方法提供了一种智能天线室外单元线缆连接检测方法，图 3 为其具体实施过程中的流程图。现以线阵阵列为具体举例说明该方法。主要包括以下步骤：

1） **采集上行链路信道后处理数据步骤**：在基站端采集长度为 M 的上行链路信道后处理数据序列 Ch_est,；对此 M 个信道后处理数据进行平滑处理后计算其相关矩阵，用以下公式表示：

$$\overline{Ch\_est} = \frac{1}{M}\sum_{i=1}^{M} Ch\_est(i)$$
$$Rxx = \overline{Ch\_est} * \left(\overline{Ch\_est}\right)^{H} \qquad (1)$$

最终得到 1 个大小为 $Ka \times Ka$ 信道相关矩阵 Rxx，其中 Ka 为天线数目；

2） **构造权系数矩阵步骤**：智能天线系统中用户天线权系数 W 为：

$$W = \mathrm{a}(\theta) = (e^{-j\frac{2\pi r}{\lambda}\cos\theta}, \mathrm{L}\ , e^{-j\frac{2\pi r}{\lambda}\cos(\theta-\frac{2\pi(k_a-1)}{\mathrm{K}})}, \mathrm{L}\ ,\ e^{-j\frac{2\pi r}{\lambda}\cos(\theta-\frac{2\pi(\mathrm{K}_a-1)}{\mathrm{K}})})^{\mathrm{H}} \qquad (2)$$

其中 θ 为来波方向；

遍历 W 中 Ka 个元素所有可能的排列顺序（共有 $Ka!$ 种可能），得到重新排列的权系数矩阵 W_coff，其大小为 $Ka! \times Ka$；

3） **空间搜索最大接收功率步骤**：将波束空间均匀地划分成 L 个区域，每个区域的第 l 到达角预先定义为

$$\theta_l = \frac{360 \bullet (l-1)}{L}, l = 1\mathrm{L}\ L$$

再利用公式（2）计算出每一个 θ_l 所对应的权系数 W_coff 矩阵 W_l，则每一个区域所对应的接收功率

$$\sigma_l^2(k) = (W_l^{(k)})^H R_{XX} W_l^{(k)} \qquad (3)$$

其中 $k = 1,2,\mathrm{L}\ , Ka!$，$W_l^{(k)}$ 表示 W_l 中的第 k 行权值，对应天线阵元的第 k 种排列方式；

在每种排列方式 $W_l^{(k)}$ 中找出最大值 $\max(\sigma_k^2(l))$，记录于序列 Power_max 的第 k 个位置，表示在该排列方式下空间区域的最大接收功率；

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 239 of 365

4） **剔除特殊角度步骤**：此时需要检查最大值对应的角度θ_l，由于某些角度所对应权值具有循环特性，即权值序列中存在相同项，从而导致接收功率的最大值不唯一。采用线阵阵列时，包括$\left\{-\frac{\pi}{6},0,\frac{\pi}{6}\right\}$等角度；圆阵阵列包括$\left\{\frac{\pi}{8},\frac{3\pi}{8},\frac{5\pi}{8},\frac{7\pi}{8},\frac{9\pi}{8},\frac{11\pi}{8},\frac{13\pi}{8},\frac{15\pi}{8}\right\}$等角度，此时需要重新采集上行链路数据，重新进行1～3步骤；如果不属于这些特殊角度，则进入5；

5） **获取精确连接顺序步骤**：在长度为$Ka!$的序列Power_max中找到最大值，所对应的位置记为Location，表示信道相关矩阵$\boldsymbol{Rxx}$对应的当前室外单元的线缆连接顺序。

6）为了降低错误概率，可以重复P次，每次步骤为1）-5）；将出现次数最多的排列方式确定为最终检测出的智能天线系统室外单元线缆的连接顺序。并与默认的正确连接顺序进行比对，如果不一致则给出错误提示及错误连接位置。

本发明方法可将整个智能天线系统室外单元线缆顺序检测方法分为以下几个步骤：①获取上行链路信道后处理数据，并通过平滑计算其相关矩阵；②利用天线权值序列遍历所有排列方式得到权值矩阵；③通过空间搜索确定每种排列情况对应的接收功率的最大值；④剔除对算法产生影响的特殊角度数据；⑤在所有排列组合中选出对应最大接收功率的最大值，记为当前线缆连接顺序；⑥将上述步骤重复P次，将出现次数最多的排列方式确定为最终检测出的智能天线系统室外单元线缆的连接顺序，并与默认的正确连接顺序进行比对，如果不一致则给出错误提示及错误连接位置。

本发明解决了智能天线系统在实际工程应用实现中急需解决的线缆顺序检测问题，并具有如下特点：①多次平滑滤除噪声干扰，计算误差小；②检验设备负责度较小；③可判断线缆连接顺序是否正确，并在发生错误时确定错误连接位置，便于及时纠正。非常适合于在工程中应用。

综上所述，本发明所提出的智能天线室外单元线缆连接检测算法稳健有效，非常利于工程中实现。

但应当理解的是，本发明的上述针对较佳实施例的描述较为具体，并不能因此而认为是对本发明专利保护范围的限制。本发明适用于所有采用智能天线技术的通讯系统，专利保护范围应以所附权利要求为准。

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 240 of 365

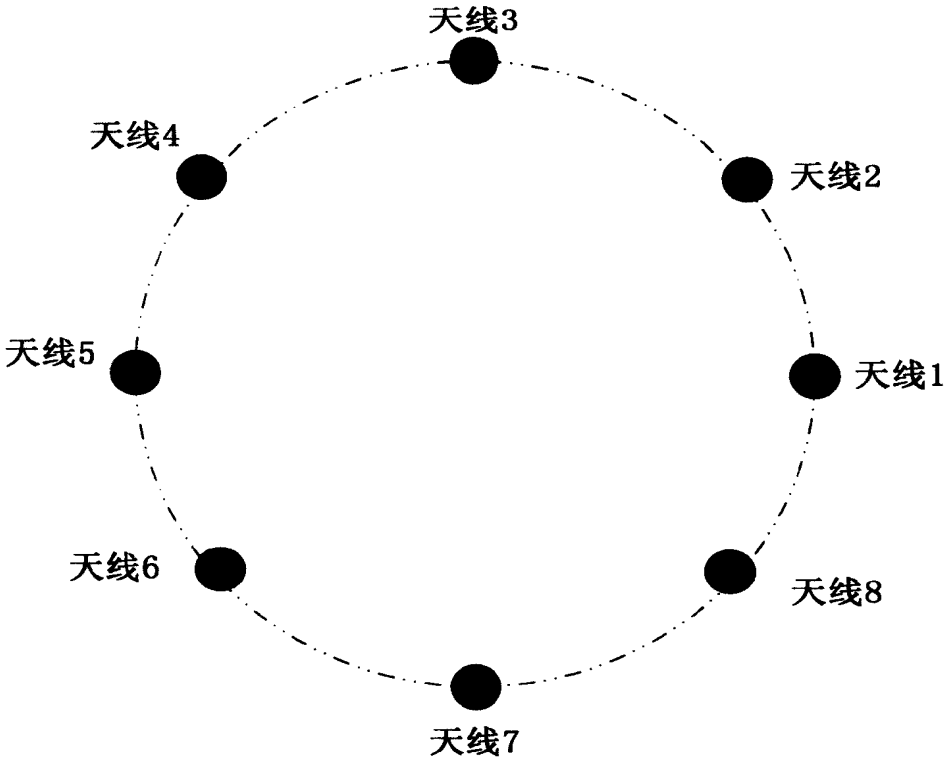


图 1

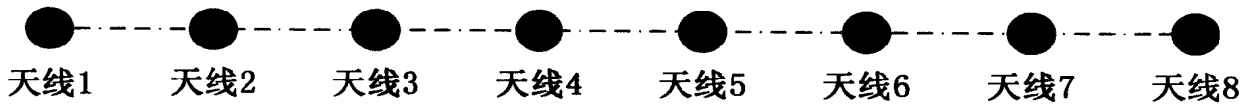


图 2

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 241 of 365

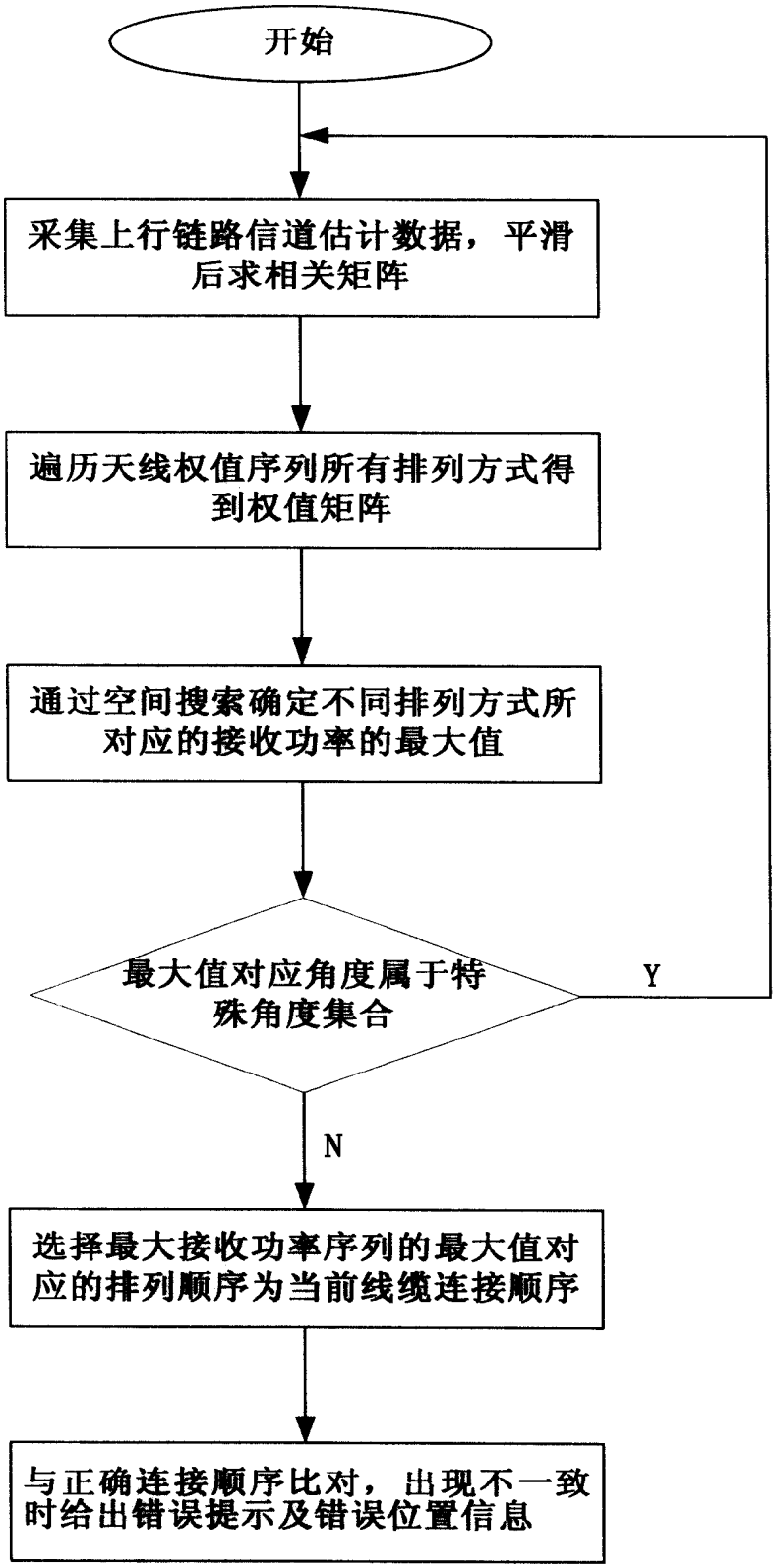


图 3

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 242 of 365

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 7 : H04Q 7/34, H04B 17/00 — A1

(11) International Publication Number: WO 00/40050

(43) International Publication Date: 6 July 2000 (06.07.00)

(21) International Application Number: PCT/US99/29144

(22) International Filing Date: 7 December 1999 (07.12.99)

(30) Priority Data:
09/219,040 23 December 1998 (23.12.98) US

(71) Applicant: ARRAYCOMM, INC. [US/US]; 3141 Zanker Road, San Jose, CA 95134 (US).

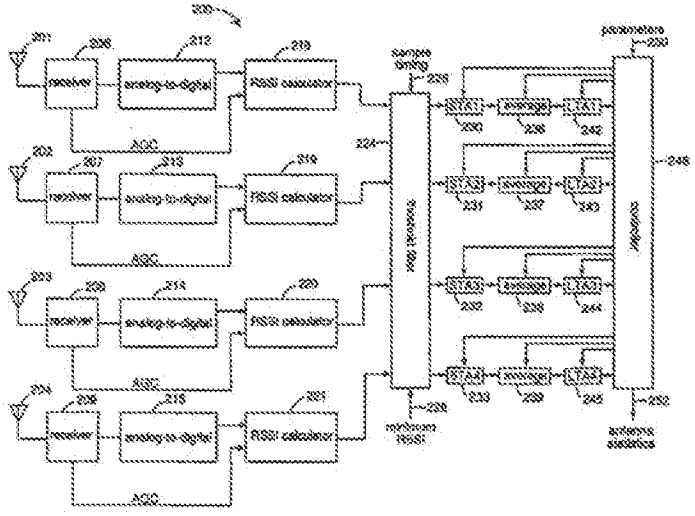
(72) Inventor: FARZANEH, Farhad; 3642 20th Street, San Francisco, CA 94110 (US).

(74) Agents: WOODWARD, Henry, K. et al.; Townsend and Townsend and Crew LLP, Two Embarcadero Center, 8th floor, San Francisco, CA 94111-3834 (US).

(81) Designated States: JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: PERFORMANCE MONITOR FOR ANTENNA ARRAYS



(57) Abstract

An antenna monitor collects statistics about the received signal strengths of each antenna in a cooperating antenna array over long periods of time. In cellular telephone base station applications for a base station using an array of antenna elements to obtain spatial diversity, samples of the received signal strength are taken during particular times whenever an active mobile subscriber is operating in the area. Periodically, such samples are averaged and added to a running total that is maintained in a long-term accumulator for each antenna. The accumulated totals are then compared after a statistically sufficient number of samples have been collected and averaged. Faulty antennas, including broken ones and ones with bad connections, will be revealed by those corresponding signal paths having relatively low accumulated totals. Given long enough collection periods, the spatial diversity of the antennas in the array will have only a minimal impact on favoring one antenna over another.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 243 of 365

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece			TR	Turkey
BG	Bulgaria	HU	Hungary	ML	Mali	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MN	Mongolia	UA	Ukraine
BR	Brazil	IL	Israel	MR	Mauritania	UG	Uganda
BY	Belarus	IS	Iceland	MW	Malawi	US	United States of America
CA	Canada	IT	Italy	MX	Mexico	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NE	Niger	VN	Viet Nam
CG	Congo	KE	Kenya	NL	Netherlands	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NO	Norway	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	NZ	New Zealand		
CM	Cameroon			PL	Poland		
CN	China	KR	Republic of Korea	PT	Portugal		
CU	Cuba	KZ	Kazakstan	RO	Romania		
CZ	Czech Republic	LC	Saint Lucia	RU	Russian Federation		
DE	Germany	LI	Liechtenstein	SD	Sudan		
DK	Denmark	LK	Sri Lanka	SE	Sweden		
EE	Estonia	LR	Liberia	SG	Singapore		

PERFORMANCE MONITOR FOR ANTENNA ARRAYS

FIELD OF INVENTION

This invention relates to devices and methods for monitoring the operational condition of individual antennas in wireless communication systems, and more specifically, to detecting on-line the apparent failure of particular antennas in an array of antennas.

BACKGROUND TO THE INVENTION

Long ago radio transceivers universally operated with single antennas because the wavelengths involved were large and multiple antennas in an array were impractical. Now at the very high frequencies that are common in cellular telephone transceivers, each antenna can be quite small and arrays of antennas can be used to great advantage. Also, signal processing technology is readily available to take advantage of performance improvements possible with multiple antenna systems. This is especially true of cellular telephone base stations that need to improve the received signal strengths and/or steer the transmitted signals in particular directions to improve performance.

Systems with an array of multiple-antenna array are therefore being proposed and implemented. In some cases, the simple difference in location of one antenna over another in the same antenna array will result in a stronger, or weaker, received signal. Such spatial "diversity" is now conventionally used to improve radio system performance and reliability. The difference in received signal strengths amongst individual antennas in an otherwise seemingly closely grouped array may result from the way reflected multipath signals arrive at each one. Smart antenna systems also are being proposed which add adaptive "spatial" processing to improve performance. Each antenna contributes to a weighted combination of received signals and the combination can then be input to a spatial processor which determines optimal weights for improved performance. This can even allow for more than one "spatial" channel to exist in a conventional (frequency, time-slot, and/or code) channel. Such multiplexing is sometimes called spatial division multiple access (SDMA). For a description of smart antenna SDMA systems that can work with more than one spatial channel per

conventional channel, see, for example, co-owned U.S. Patents 5,515,378 (issued May 7, 1996) and 5,642,353 (issued June 24, 1997) entitled *SPATIAL DIVISION MULTIPLE ACCESS WIRELESS COMMUNICATION SYSTEMS*, Roy, III, *et al.*, inventors, and co-owned U.S. Patent 5,592,490 (issued January 7, 1997) entitled *SPECTRALLY EFFICIENT HIGH CAPACITY WIRELESS COMMUNICATION SYSTEMS*, Barratt, *et al.*, inventors. For a smart antenna system that has only one spatial channel per conventional channel, see co-owned U.S. Patent Application Serial Number 08/729,390, filed on October 11, 1996, entitled *METHOD AND APPARATUS FOR DECISION DIRECTED DEMODULATION USING ANTENNA ARRAYS AND SPATIAL PROCESSING* , Barratt *et al.*, inventors.

With such systems, it therefore is important for maintenance personnel to know if one or more antennas is not functioning correctly for whatever reason. One such reason is that there is some faulty hardware in the antenna or the signal path of the output of the antenna. For example, if three out of four antennas in an array are working, the fourth antenna's failure will not usually cause an operational failure of the whole transceiver that would draw attention to the problem, so a failure of one antenna could go undetected for a long time. In the meantime, the loss of one or more antennas will degrade the performance of the base station and could result in lost revenues, decreased customer satisfaction, and even wasted maintenance efforts.

In addition to some of the hardware being faulty, it is also important to detect and quantify siting efficiency for multiple antenna systems. It is desirable for the antennas to be balanced. However, for example, there may be siting situations in which one of the antennas may be "hidden," *i.e.*, it may be in an RF shadow and so won't receive signals very well. In such a situation, all the hardware may be working correctly, but the antenna system was not placed well. This is more likely in a micro-cellular environment (like the PHS or DECT system) than in a cellular system.

The term faulty antenna will thus be understood herein to mean an antenna in which either the hardware is faulty, or which produces a low signal level because of siting inefficiency.

SUMMARY

An object of the present invention is a method and apparatus for detecting the failures of one or more particular antennas in an array antenna.

Another object of the present invention is to provide a method for quantifying siting or antenna balance efficiency.

Another object of the present invention is to create a method for monitoring possible failures of one or more particular antennas in an array antenna, the monitoring requiring very little processing overhead.

Another object of the invention is to provide a monitor that can report on the health of particular antennas in antenna arrays without having to take the receiver or transceiver off-line for maintenance.

Briefly, antenna monitor embodiments of the present invention collect statistics about the received signal strengths of each antenna in a cooperating array over long periods of time. In cellular telephone base station applications, samples of the received signal strength are taken whenever an active mobile subscriber is operating in the area. Periodically, such samples are averaged and added to a running total that is maintained in an accumulator for each antenna. The accumulated totals are then compared after a statistically sufficient number of samples have been collected and averaged. Broken antennas, or ones with bad connections, will be revealed by those corresponding signal paths having low accumulated totals. Given long enough collection periods, the spatial diversity of the antennas in the array will have only a minimal impact on favoring one antenna over another, so that truly faulty antennas will be detected rather than those that have low signal because of their spatial location relative to other antennas in the array.

An advantage of the present invention is that an antenna monitor is provided that detects broken antennas, or ones with bad connections, or ones that are badly sited.

Another advantage of the present invention is that an antenna monitor is provided that can work with a multiple antenna system with *any* type of antenna and with *any* type of receivers.

Yet another advantage of the present invention is that an antenna monitor is provided that works continuously and does not require a wireless system to be shut-down for antenna maintenance.

Yet another advantage of the present invention is that an antenna monitor is provided that requires very little processing overhead so is easy to implement in existing systems.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more fully understood from the detailed preferred embodiments of the invention, which, however, should not be taken to limit the invention to any specific embodiment but are for explanation and better understanding only. The embodiments in turn are explained with the aid of the following figures:

Fig. 1 is a functional block diagram of a multi-antenna transceiver system that may include an antenna performance monitor of the present invention;

Fig. 2 is functional block diagram of a multi-antenna receiver system antenna performance monitor of the present invention; and

Fig. 3 is a flowchart of a process embodiment of the present invention in which the antenna performance monitor of Fig. 1 is used to collect statistics that are used to identify any non-performing individual antennas in the antenna array.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The first one or two digits in a reference numeral indicate on which figure that reference numeral is first introduced. For example, reference numerals between **100** and **199** are first introduced in Fig. 1, those between **200** and **299** are first introduced in Fig. 2, and so forth.

The embodiments of the present invention are preferably implemented in wireless communication systems that include communication stations (*e.g.*, cellular base stations) that have an array of antenna elements together with adaptive smart antenna processing. For example, Fig. 1 shows a communication system **100** which includes a base station **102** with a multi-element antenna array **104** that issues time slot commands

for mobile subscriber units **106, 108** to respond-to it in an orderly manner. In one implementation, the communication system **100** operates using the personal handy phone (PHS) communications protocol which is popular in Japan. The mobile subscriber units **106, 108** may be mobile or fixed. A mobile or WLL system may be analog or digital, and may use frequency division multiple access (FDMA), code division multiple access (CDMA), or time division multiple access (TDMA) techniques, the latter usually in combination with FDMA (TDMA/FDMA). Barratt *et al.*, describe a PHS FDMA/TDMA base station having four antenna elements, in above-mentioned United States Patent Application 08/729,390, filed October 11, 1996, incorporated herein by reference. A PHS FDMA/TDMA base station for a wireless local loop (WLL) system that may have any number of antenna elements is described by Yun in United States Patent Application 09/020,049, filed February 6, 1998, incorporated herein by reference.

While the preferred embodiment describes a system that includes adaptive smart antenna processing, this invention is applicable to any communication receiver that uses more than one antenna element to achieve spatial diversity in reception.

Fig. 1 represents a typical two-way communications system **100**, for example a cell in a cellular system that includes a communications station (*e.g.*, a base station) **102**, and communication system **100** has a remote-to-communications-station uplink, and a communications-station-to-remote downlink. Communications station **102** includes an antenna array **104** which includes several discrete antenna elements each associated with a transmitter of a set of transmitters **124**, a receiver of a set of receivers **112**, and a signal processor **116** that coordinated the received signals or signals to be transmitted to take advantage of the spatial diversity of the antennas. Communications station **102** supports full-duplex radio communication with subscriber units, and two such remote units **106** and **108** are shown. In a preferred embodiment, communications station **102** uses only a single array of antenna elements for both receive and transmit. In such case, a receive/transmit (T/R) switch **110** is used. In a system that uses frequency-domain duplexing (FDD), meaning a different frequency for the uplink and downlink, T/R switch **110** is a frequency duplexer. For time-domain duplexing (TDD) in which a

different time slot is used for the uplink and the downlink to communicate with the same remote unit, an electrical switch can be used.

Uplink signals from the subscriber units (*e.g.*, **106**, **108**) and possibly from interfering co-channel users are received at each element of the antenna array **104**, and individually pass through T/R switch **110** in a "receive position" to set of receivers **112**. Each antenna element in the antenna array **104** has a receiver in set **112** associated with it. Each receiver of set of receivers **112** down-converts the radio-frequency (RF) signal from its corresponding antenna element to baseband, so that set of receivers **112** forms a corresponding set of baseband received signals **114**. In the preferred embodiment, each receiver in receiver set **112** is of conventional design and includes analog RF components, analog downconversion components, an analog to digital converter, and digital downconverter components to produce one of the digital baseband antenna signals **114**, and these baseband received antenna signals are processed by receive signal processor **116** to generate a received signal from a particular subscriber, *e.g.*, from remote unit **106** or **108**. In the preferred embodiment, the receive signal processor **116** does the signal demodulation and the spatial processing. The spatial processing uses the fact there are multiple antenna elements with spatial diversity to its advantage. Specifically, the receive signal processor **116** determines a weighted sum of complex in-phase (I) and quadrature (Q) antenna signals, according to a set of complex valued receive weights designed to achieve a maximum signal-to-noise ratio (SNR), a maximum carrier-to-interference ratio, or some other criterion. Such weights can be combined to a vector of complex-valued receive weights. Output **118** is the voice and/or data decoded by receive signal processor **116** and is coupled to a telephone network interface unit (NIU).

On the downlink side, communications-station-to-remote, communications station **102** receives data **120** representing voice and/or data from the NIU. The signal is modulated by a transmit signal processor **122** and the result weighted according to a set of complex-valued weights to generate a set of weighted modulated baseband signals. The weights of each copy are according to a transmit-weight vector of complex valued transmit weights. In the preferred embodiment, such a vector is computed by a transmit-weight generator **126** from the set of received-signal weights derived by receive signal

processor **116** for the particular remote user being transmitted to. Each weighted transmit baseband signals is fed to one of set of transmitters **124** to generate an independent RF transmit signal for each corresponding element of antenna array **104** through T/R switch **110** in the "transmit position".

Various conventional methods are known for determining the receive and transmit weights. See for example, above-cited U.S. Patents 5,515,378, and 5,592,490, and above-cited U.S. Patent Application Serial Number 08/729,390, as well as co-owned U.S. Patent Application number 08/948,772 to Parish, *et al.* (filed Oct., 10, 1997). In general, the weights are chosen so that the antenna array receives or radiates most of the energy from or towards a particular subscriber unit, *e.g.*, "beam-forming", and/or it receives or transmits minimal energy from or toward co-channel interferers , *e.g.*, "null-placing." One method of determining transmit weights, for example, is to compute the set of transmit weights **128** directly from the set of receive weights **130** generated by receive signal processor **116** for the particular remote user, the computation carried out by transmit weight generator **126** in real time. In such a case, during this computation, transmit weight generator **126** must take into account the gain and phase differences between the uplink and downlink propagation signal paths where the signal paths include both the air-path from and to a subscriber unit and the variation among the different signal parts within the receive RF electronics and also within the transmit RF electronics. This information is stored in calibration vector generator unit **132** in the form of a calibration vector **134**.

In Fig. 2, a set of receivers **200** is connected to an antenna array having four antenna elements **201–204**. Note that while Fig. 2 shows a receiving system that uses four antennas, this invention is applicable to a receiver with any number of antennas. The transmitter part and T/R switch part as shown in Fig. 1 are not included in Fig. 2 in order to simplify the following description. Set of receivers **200** is similar to the front-end parts of set **112** described for the communications station **102** in Fig. 1. Each of the four antenna elements **201–204** is independently associated with a corresponding receiver **206–209**, a corresponding analog-to-digital conversion stage **212–215**, and a corresponding received signal strength (RSSI) calculator **218–221**. The analog-to-digital conversion stages **212–215** are generally included, for example, in set of receivers **112**

(Fig. 1). Also not shown here are any digital downconversion stages that may exist after the analog to digital conversion. The configuration shown here is used as part of base station operating in a PHS wireless telephone system, but many other kinds of systems with antenna arrays could also benefit from the present invention. To determine the state of the antenna elements, one or more active mobile transmitters (subscriber units) are assumed to be operating in the vicinity. A threshold filter **224** determines if any RSSI value output by the RSSI calculators **218–221** at a time determined by a sample timing input **226** exceeds a minimum RSSI value input **228**. In cellular telephone base station applications for example, samples of the received signal strength are taken whenever an active mobile subscriber is operating in the area. If any one RSSI value output by the RSSI calculators **218–221** does exceed such minimum, then all four of the respective RSSI sample measurements are passed on to the corresponding one of a set of corresponding short term accumulators (STAs) **230–233** for accumulating short term totals.

In one aspect of the invention, the goal is to determine a measure of the average signal strength received by each antenna. A long term average is preferred, and because of hardware limitations, in preferred embodiments, two stage averaging is used, *e.g.*, short term averages are first obtained, and these are accumulated by a second accumulator to obtain a long term average (LTA). Given an accumulator with a sufficient number of bits, other implementations can go directly to a long term average. The number bits needed for accumulation, and hence the number of counting stages or storage cells within each accumulator is dependent on the receiver design, its application, and the frequency in which active mobile units operate within range. Far fewer or many more stages of accumulator and averaging are possible and all such variations fall within the scope of the present invention. Also, while the average is used as an indication in the preferred embodiment, other measures that are indicative of the average may alternately be used.

In some embodiments of the present invention, it may be preferable to convert the magnitudes of the RSSI sample measurements into a log-scale, *e.g.*, into a decibel (dB scale). This can help reduce dynamic range in the results and to eliminate spurious results and interpretations that would occur from wide variations in the measurements if

linear measurements were used directly. The RSSI-samples, in log scale, are then accumulated and averaged as described below. The conversion to log (decibel) scale need not be highly accurate, especially if such accuracy were to impose a heavy computational load. A simple-to-calculate transformation is preferred that will approximate a linear-to-log conversion. Note also that while RSSI values are accumulated in this embodiment, this is because RSSI indication is common in cellular and other wireless receivers, so no additional hardware would need to be designed to obtain such measures. This provides for the monitoring with *very* little processing overhead. Of course, any other indication of signal strength may alternately be used and using such other indication of signal strength is within the scope of the present invention.

STAs **230–233** preferably are able to accumulate at least 2^L eight-bit binary RSSI-values, where L is an integer, L=15 in the preferred embodiment. When about 2^{15} RSSI-values are accumulated, a corresponding set of averagers **236–239** determines the average RSSI-value associated with each antenna element **201–204** over the last 2^{15} samples. A simple way to do this is to have STAs **230–233** each add-in every new RSSI-value until 2^{15} samples are accumulated from the threshold filter **224** to form a running total, and then shift the grand total fifteen-bit positions (L positions in the general case of 2^L samples) toward the least significant bit to effectuate a binary divide by 2^{15}.

Each short-term-average RSSI-value in a parallel set of four are thereafter forwarded to a corresponding one of a set of long-term accumulators (LTAs) **242–245**. Such LTAs **242–245** preferably are able to store at least 2^{15} such short-term average RSSI-values. Note that in the preferred embodiment, the averaging operation of the values in the STAs may conveniently be combined with the adding to the LTAs by adding a 15-bit-position shifted version of the accumulated values to the LTAs. A controller **248** coordinates STAs **230–233**, averagers **236–239**, and LTAs **242–245**. A parameters input **250** allows the functioning of each of STAs **230–233**, averagers **236–239**, and LTAs **242–245** to be programmable. An antenna statistics output **252** allows individual data-points and totals running within the STAs **230–233**, the averagers **236–**

239, and the LTAs 242–245, to be inspected and decisions as to the state of the antennas made.

After a sufficient number of RSSI-samples have been obtained and averaged as indicated by a particular number of short term averages accumulated in LTAs 242–245, it may be evident from a relatively low RSSI average from LTAs 242–245 that one or more of the receiver signal paths has a broken or disconnected or otherwise faulty antenna of antennas 201–204. Given long enough collection periods, the spatial diversity of the antennas in the array will have only a minimal impact on favoring one antenna over another.

In alternative embodiments of the present invention, the maximum RSSI-sample values experienced during each short-term accumulation period (2^{15} sample) is recorded and tracked along with the running averages. It can happen that the peculiar spatial diversity of one antenna 201–204 has relegated it to a short-term of obtaining low RSSI-values. It might not be broken or malfunctioning at all. This would be indicated by RSSI-averages that were low compared to the other signal paths, but RSSI-maximums that were on a par with those other signal paths.

In an illustration of one embodiment of the method of the invention. Fig. 3 shows a method 300 for independently monitoring the operational condition of antennas and their connections in arrays of antennas, wherein a receiver produces a received signal strength indication (RSSI) of a single remote transmitter for each of a plurality of receivers respectively connected to each of a plurality of antennas in an antenna array. The method 300 comprises a sampling step 302 where an RSSI value is sampled, the RSSI value respectively associated with each of the plurality of antennas in the antenna array. A step 304 decides if there is an active remote transmitter operating within range. According to the established protocols for the PHS system, the remote subscriber units that are assigned time-slots by the base station report-in during expected periods that can be measured for signal strength. In a step 306, it is determined whether any of a plurality of antennas in the array are seeing a minimum value signal strength. If so, a step 308 collects "M" number of parallel samples of the RSSI values, one from each receiver, where M is the number of antennas. A step 310 checks to see if a certain number "N",

for example 2^{15} such samples have been collected. A step **312** periodically averages the RSSI values accumulated whenever N samples ($N=2^{15}$) have been accumulated. A step **314** adds these to a long-term accumulator. At some point determined by the parameters loaded into input **250** (Fig. 2), there will be sufficient data collected in the long term accumulators to make some decision of the operating health of the antennas. A step **316** asks if such sufficient data has been accumulated. If not, more data is accumulated. If so, a step **318** asks the question is any antenna not functioning. Again, the parameters needed to decide this can come from the parameters loaded into input **250** (Fig. 2). If an antenna is broken, not functioning, or otherwise faulty, a message to that effect can be annunciated. Otherwise and message stating the antennas are OK can be issued. In addition, other statistical analyses can be used to determine of the siting is efficient. Distinguishing between a faulty antenna due to some hardware problem and a faulty antenna due to inefficient siting can be determined, for example, by tracking long term data (looking at the history). If the antenna is faulty because of some broken component, then at some time in the past, it was not so, while if the siting is faulty, than the antenna would appear "faulty" over the whole history of its siting.

The decision as to whether any antenna is faulty or broken is made in general by compare the averaged results of all antennas. With sufficient spatial sampling, the mean signal levels from all antennas should be about the same. So the method is to compare the long term average values. A broken antenna is reported if any of the antennas have LTA levels that are more that a certain number of dB (*X* dB) below that of the maximum LTA value for any antenna. Other heuristics that determine is the signals received by any one antenna are out of expected range compared to other antennas also are possible, as would be clear to one of ordinary skill in the art. In the preferred embodiment, a value of 10dB for *X* was used for indicating a broken antenna. Other values would be used for indicating siting problems

Note that although the *relative* signal strengths (as indicated by comparing LTA RSSI values) are used for faulty antenna determination, the actual signal levels for any antenna element, as indicated by the LTS RSSI value, can be very useful in determining siting efficiency of the whole base station and for network analysis.

The statistics (number of samples accumulated) required for faulty antenna detection or siting analysis are a function of the environment in which the system will be deployed. For example, in a fixed location cellular system, *e.g.*, a wireless local loop (WLL) system, a lot more statistics need to be accumulated than in a mobile environment. In a mobile environment, fading provides some averaging to equalize the power at the antennas, and such fading does not occur in a stationary environment. The numbers used herein assume a mobile environment, and modifying this for a fixed (*e.g.*, WLL) environment would be straightforward to one of ordinary skill in the art. Alternatively, in order to avoid biasing by dominant users, only a maximum numbers of samples from any one user is accumulated.

Preferably the sampling of the receiver signal strength described is such that no sampling occurs until a remote transmitter is operating within range of the antenna array. Otherwise, a measurement of the background noise only would lead to spurious results. In the preferred embodiment, only samples from remote users that are actually connected to the base station are sampled. That is, samples from other users not connected to the base station are not taken. In an alternate embodiment, all samples, including those from users that are connected to other base stations are samples. Also in the preferred embodiment, only signals that have a minimum RSSI value are sampled, the minimum pre-determined to provide for a healthy margin over noise. Also, because the heuristic preferably used for broken antenna determination is to look for an antenna that has an average RSSI that is at least *X* dB, it is desirable to only log RSSI values that are at least *X* dB above the noise floor.

Referring again to Fig. 2, some receivers, including those in the preferred embodiment, use automatic gain control (AGC). The AGC values in such a case are used in RSSI calculators **218–221**, which require such scaling information.

In the receivers illustrated here in this description, it is preferred that the sampling of RSSI values occurs for a set of samples near a middle part of a burst of data for any time-slot. Because remote transmitters operating within range have a power up ramp and possibly a ramp-down at the start and end of data bursts, sampling near the center of a burst will avoid false readings in the burst ramp-up and ramp-down periods.

So in preferred embodiments, a sampler detects when a middle part of a signal burst from a received signal occurs, and outputs a corresponding received-signal-level measures unaffected by a ramping up or a ramping down of the signal burst. The averaging step **312** can be such that about 2^{15} RSSI values are collected and then averaged by having added each RSSI value as a binary value to a running total and then shifting bit positions to effectuate a division of the running total. The sampling can be such that the magnitude of each RSSI value obtained is converted to a log-scale.

While the present invention has been described in terms of RSSI values, alternate implementations may use other signal strength or signal quality measures. Thus the term signal quality measure refers to any signal strength or signal quality measure, including RSSI and log-RSSI. See for example, above referenced and incorporated herein by reference U.S. Patent application 09/020,049 to Yun for one alternate signal quality generator. Using a measure that already is available, such as RSSI which commonly already is determined in receivers, enabled the monitoring to occur with very little computational overhead.

Also, although the present invention has been described in terms of an average of signal quality measures, other statistics may be used. For example, the maximum over the period of time may be used, with any antenna whose maximum value is relatively low indicating fault.

Therefore, although the present invention has been described in terms of the presently preferred embodiments, it is to be understood that the disclosure is not to be interpreted as limiting. The present invention is useful in all communication systems in which more than one antenna is used by a single receiver or transceiver, *e.g.*, for spatial diversity. Various alterations and modifications will no doubt become apparent to those of ordinary skill in the art after having read the above disclosure. Accordingly, it is intended that the appended claims be interpreted as covering all alterations and modifications as fall within the true spirit and scope of the invention.

CLAIMS

What is claimed is:

1. A method for monitoring the operational condition of each of a plurality of antennas in an antenna array including the connection of each antenna, wherein a receiver of a plurality of receivers is respectively coupled to each of the antennas in the plurality in the antenna array, each receiver producing an output, the method comprising the steps of:

(a) for each of said plurality of antennas in the array, sampling signal-level measure indicative of the signal level that is respectively associated with the antenna;

(b) for each of the plurality of antennas, collecting a number of samples of the received-signal-level measures;

(c) for each of the plurality of antennas, periodically determining an indicator of a statistic of the received-signal-level measure obtained in the step of collecting, a high statistic indicating a high signal level; and

(d) interpreting a relatively low statistic indicator of received-signal-level measure associated with specific antenna as indicating that the specific antenna in said array is faulty.

2. The method as described in claim 1 wherein the statistic is the average:

3. The method as described in claim 2 wherein:

the step of sampling is such that no sampling occurs until a remote transmitter operates within receiving range of said antenna array.

4. The method as described in claim 2 wherein:

the step of sampling is such that no sampling occurs until the received signal level measure is above a predetermined threshold level for all receivers in the plurality.

5. The method as described in claim 2 wherein:

the step of sampling is such that such sampling occurs near a middle part of a time-slot burst.

6. The method as described in claim 2 wherein:

the step of collecting is such that a fixed number of sample values are collected first and then averaged.

7. The method as described in claim 2 wherein:

the step of collecting is such that a fixed number of sample values are collected first and then averaged to form a short term average associated with each antenna element, and then the short term averages are accumulated to form a long term average associated with each antenna element.

8. The method as described in claim 7 wherein:

the received-signal-level measure is a received signal strength indication (RSSI) value, and

the step of collecting is such that about 2^L RSSI values are collected and then averaged to form the short-term average for the associated antenna, where L has an integer value.

9. The method as described in claim 6 wherein:

the step of collecting is such that about 2^L RSSI values are collected and then averaged by having added each RSSI value as a number value to a running total and then shifting by L bit positions to effectuate a division of said running total by 2^L, where L has an integer value.

10. The method as described in claim 2 wherein:

the step of sampling is such that the received-signal-level measure is a received signal strength indication (RSSI) value converted to a log-scale.

11. An antenna monitor for detecting the state of any of a plurality of spatially diverse antenna elements of an antenna array of a radio receiving station that includes the antenna array, and set of receivers each respectively coupled to and receiving a signal from one of the antenna elements, the monitor comprising:

(a) means for producing a received-signal-level measure for the signal from each of the antenna elements;

(b) a sampler coupled to the received-signal-level measure means, for the sampling of the received-signal-level measure associated with each of said plurality of antenna elements;

(c) a plurality of accumulators with each accumulator providing for collecting the corresponding received-signal-level measures over a predetermined number of samples;

(d) a set of averagers respectively connected to each of the plurality of accumulators and providing for a set of average received-signal-level measures obtained for each of said plurality of spatially diverse antenna elements; and

(e) an interpreter coupled to the set of averagers and that provides for an indication of a particular one of said plurality of spatially diverse antenna elements that is faulty.

12. The antenna monitor as described in claim 11, wherein each of the set of averagers comprises:

a short term averager connected to the corresponding accumulator and providing for a short term average of the received-signal-level measures obtained for the associated antenna element, a long-term accumulator coupled to the short term averager for periodically receiving and accumulating the short term averages, the long-term accumulation over a statistically long period of time.

13. The antenna monitor as described in claim 11, wherein:

the signals from the antenna elements include signals transmitted by one or more remote transmitters, each transmitted signal including signal bursts,

the sampler determining the middle part of a signal burst, and outputting the corresponding received-signal-level measures unaffected by any ramping up or a ramping down of the signal burst.

14. In a communications station comprising a plurality of antennas in an antenna array, and a plurality of receivers each respectively coupled to each of the antennas in the plurality in the antenna array, each receiver producing an output, the communications station further including means of producing a signal quality measure for each of the receivers in the plurality of receivers, the signal quality measure indicative of the signal received at the antenna to which the receiver is coupled, a method for monitoring the operational condition of each of a plurality of antennas in the antenna array, including the connection of each antenna, the method comprising the steps of:

(a) for each of said plurality of receivers, collecting a number of samples of the received-signal-level measures produced by the signal quality measure producing means;

(b) for each of said plurality of receivers, periodically determining an indicator of the average of the received-signal-level measure obtained in the step of collecting; and

(c) interpreting a relatively low average indicator of received-signal-level measure associated with specific receiver as indicating that the specific antenna in said array associated with the specific receiver is faulty.

15. The method as described in claim 14,

wherein the communications station includes means of indicating when a remote transmitter operates within receiving range of the antenna array, and

wherein the step of collecting only collects samples that occur when a remote transmitter operates within receiving range of said antenna array.

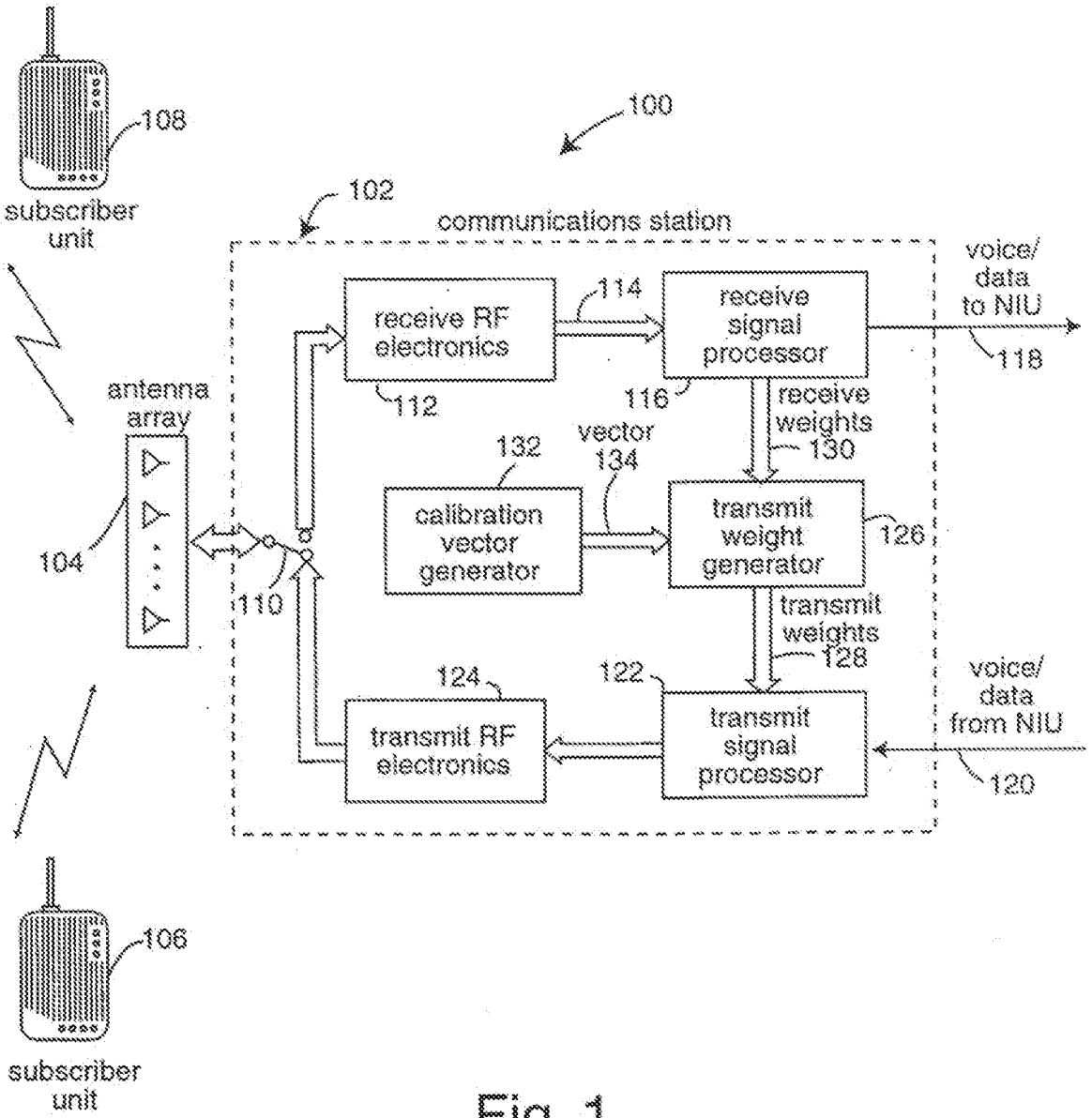

100
102
communications station
subscriber unit
108
antenna array
104
110
receive RF electronics
112
114
receive signal processor
116
voice/ data to NIU
118
receive weights
130
vector
132
134
calibration vector generator
transmit weight generator
126
transmit weights
128
124
122
transmit RF electronics
transmit signal processor
voice/ data from NIU
120
subscriber unit
106

Fig. 1

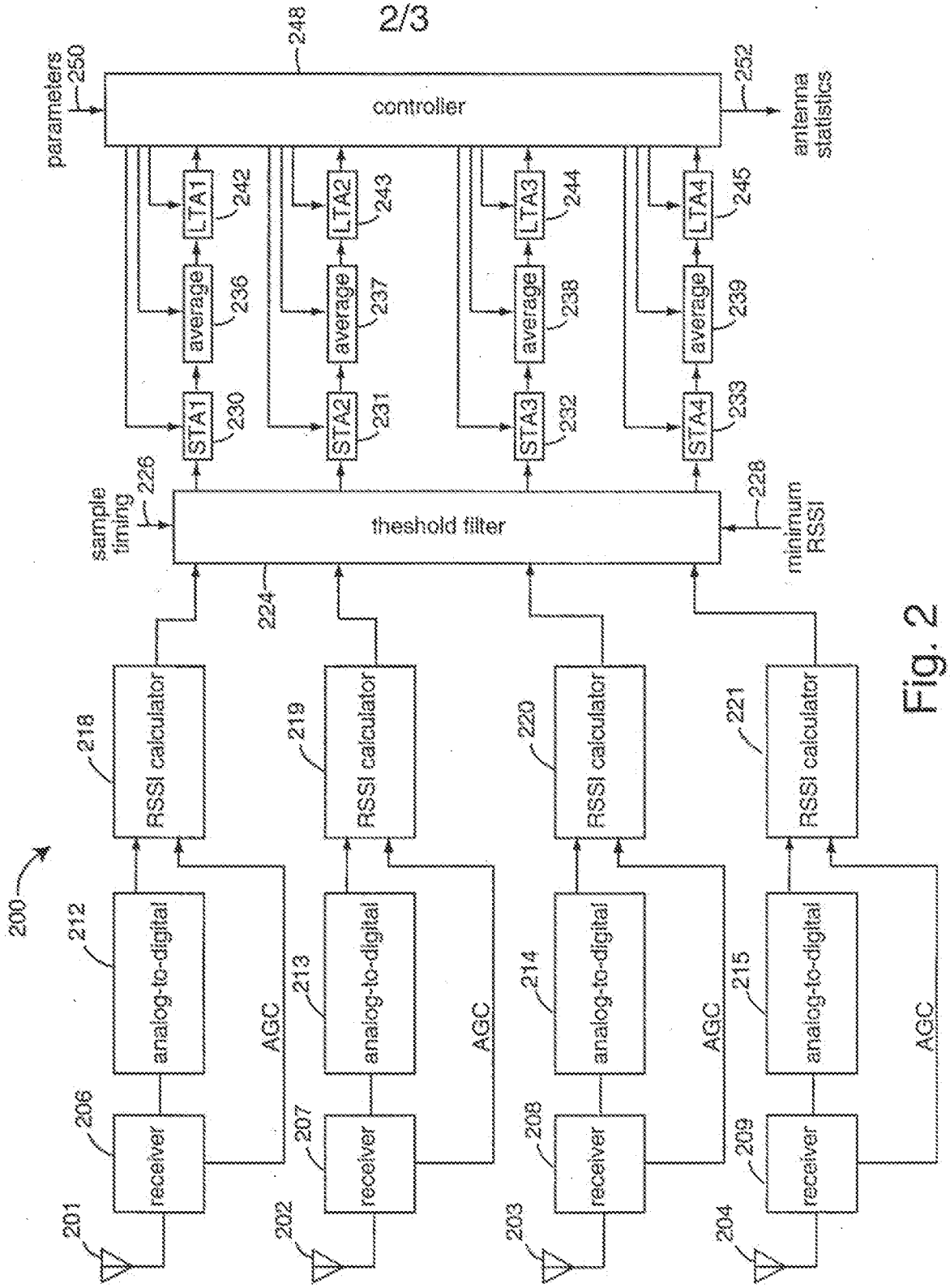

200
201
202
203
204
206
207
208
209
212
213
214
215
218
219
220
221
224
226
228
230
231
232
233
236
237
238
239
242
243
244
245
248
250
252
receiver
analog-to-digital
RSSI calculator
AGC
sample timing
theshold filter
minimum RSSI
STA1
STA2
STA3
STA4
LTA1
LTA2
LTA3
LTA4
average
controller
parameters
antenna statistics

Fig. 2

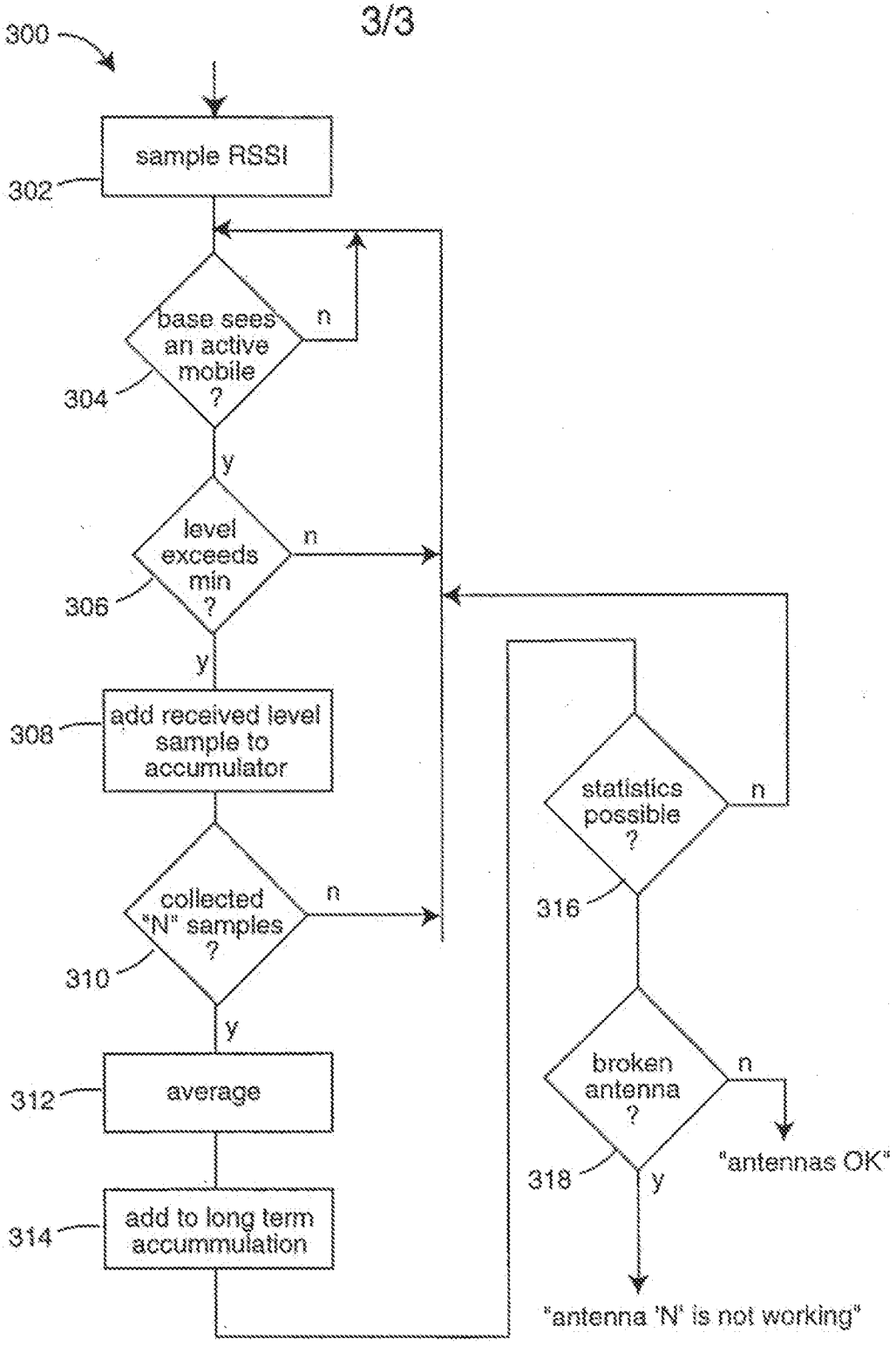

300
sample RSSI
302
base sees an active mobile ?
304
n
y
level exceeds min ?
306
n
y
add received level sample to accumulator
308
collected "N" samples ?
310
n
y
average
312
add to long term accummulation
314
statistics possible ?
316
n
broken antenna ?
318
n
"antennas OK"
y
"antenna 'N' is not working"

Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/29144

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04Q7/34 H04B17/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04Q H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 752 165 A (HOKKANEN PETRI) 12 May 1998 (1998-05-12) column 2, line 58 -column 3, line 30	1,2,4,6, 11,14,15
P,X	US 5 970 394 A (JENSEN ERIC H ET AL) 19 October 1999 (1999-10-19) column 7, line 4 -column 8, line 41	1-6, 9-11, 13-15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 March 2000	22/03/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	López-Pérez, M-C

2

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inte. Jional Application No
PCT/US 99/29144

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5752165 A	12-05-1998	FI 934052 A	16-03-1995
		AU 678528 B	29-05-1997
		AU 7616694 A	03-04-1995
		CN 1133657 A	16-10-1996
		EP 0719479 A	03-07-1996
		WO 9508223 A	23-03-1995
		JP 9504916 T	13-05-1997
		NO 961053 A	14-05-1996
US 5970394 A	19-10-1999	NONE	

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 266 of 365

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths
First Named Inventor/Applicant Name:	Qingyu Miao
Filer:	David D. Kalish/Cora Fedornock
Attorney Docket Number:	4015-7892 / P28266-US1

Filed as Large Entity

U.S. National Stage under 35 USC 371 Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
National Stage Fee	1631	1	380	380
Natl Stage Search Fee - Report provided	1642	1	490	490
National Stage Exam - all other cases	1633	1	250	250
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1120**

Electronic Acknowledgement Receipt

EFS ID:	11432576
Application Number:	13321076
International Application Number:	PCT/SE09/50583
Confirmation Number:	2274
Title of Invention:	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths
First Named Inventor/Applicant Name:	Qingyu Miao
Customer Number:	24112
Filer:	David D. Kalish/Cora Fedornock
Filer Authorized By:	David D. Kalish
Attorney Docket Number:	4015-7892 / P28266-US1
Receipt Date:	17-NOV-2011
Filing Date:	
Time Stamp:	16:13:25
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	Electronic Funds Transfer
Payment was successfully received in RAM	$1120
RAM confirmation Number	2998
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (If appl.)

Proconfirm Exhibit 2015
Ericsson v. Proconfirm
IPR2025-01453, Page 269 of 365

1	Transmittal of New Application	40157892TRANSMITTAL.pdf	167481 6df8cf269523c7b6ce95de2ff4e7aee4a8ecacd0	no	3
Warnings:					
Information:					
2	Application Data Sheet	40157892APPDATA.pdf	240164 3da3e124f40fa6e030f83ee62d5f7b694413321b	no	4
Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
3		40157892APPLICATION.pdf	5684088 bb02be54b4b6a67f0e9ed43fbf0c77426ece5882	yes	40

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Abstract	1	1
Specification	2	20
Claims	21	24
Drawings-only black and white line drawings	25	36
Documents submitted with 371 Applications	37	40

Warnings:					
Information:					
4	Oath or Declaration filed	40157892DECLARATION.pdf	102703 71e71859258bb16471202d93b0097c435790da79	no	2
Warnings:					
Information:					
5	Preliminary Amendment	40157892PRELIMAMEND.pdf	212809 167c988502724c4538f41e819d6258d3f0364e46	no	8
Warnings:					
Information:					
6	Information Disclosure Statement (IDS) Form (SB08)	40157892IDS.pdf	149478 34b4ada351058aac9f98b2cdfb22753f94c4fadd	no	3
Warnings:					
Information:					

This is not an USPTO supplied IDS fillable form					
7	Foreign Reference	40157892CNreference.pdf	594883 5efe7b1f4e75d16e1d53f248d01fce102e8468e2	no	11
Warnings:					
Information:					
8	Foreign Reference	WO0040050.pdf	3871234 6e691d59f219c5082bebbb4e73a834f7f96e3061	no	24
Warnings:					
Information:					
9	Fee Worksheet (SB06)	fee-info.pdf	33433 fa4c3abd55fb74c4328a056a8a843279b6c65d0e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	11056273		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO-1390 (09-11)
Approved for use through 4/30/2013. OMB 0651-0021
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A SUBMISSION UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
4015-7892 / P28266-US1	

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/SE2009/050583	2009-05-20	2009-05-20

TITLE OF INVENTION
Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths

APPLICANT(S) FOR DO/EO/US
MIAO, Qingyu; COLDREY, Mikael; GUO, Zhiheng

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☑ This is a **FIRST** submission of items concerning a submission under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a submission under 35 U.S.C. 371.
3. ☑ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☑ The US has been elected (Article 31).
5. ☑ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☑ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☑ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☑ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☑ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☑ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☑ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☑ A preliminary amendment.
14. ☑ An Application Data Sheet under 37 CFR 1.76.
15. ☐ A substitute specification.
16. ☐ A power of attorney and/or change of address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13*ter*.3 and 37 CFR 1.821- 1.825.
18. ☐ A second copy of the published International Application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).

This collection of information is required by 37 CFR 1.414 and 1.491-1 .492. The information is required to obtain or retain a b enefit by the public, w hich is to file (and by the USPTO to pro cess) an application . Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 15 minutes to complete, including gathering information, preparing, and submitting the completed form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEE S OR COMPLE TED FORMS TO THIS ADDRESS. **SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 272 of 365

U.S. APPLICATION NO. (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
	PCT/SE2009/050583	4015-7892 / P28266-US1

20. Other items or information:

The following fees have been submitted	CALCULATIONS	PTO USE ONLY
21. ☑ Basic national fee (37 CFR 1.492(a)) **$380**	$ 380	
22. ☑ Examination fee (37 CFR 1.492(c)) If the written opinion prepared by ISA/US or the international preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** All other situations **$250**	$250	
23. ☑ Search fee (37 CFR 1.492(b)) If the written opinion of the ISA/US or the International preliminary examination report prepared by IPEA/US indicates all claims satisfy provisions of PCT Article 33(1)-(4) ..... **$0** Search fee (37 CFR 1.445(a)(2)) has been paid on the international application to the USPTO as an International Searching Authority ..... **$120** International Search Report prepared by an ISA other than the US and provided to the Office or previously communicated to the US by the IB ..... **$490** All other situations **$620**	$ 490	
TOTAL OF 21, 22 and 23 =	1120	
☐ Additional fee for specification and drawings filed in paper over 100 sheets (excluding sequence listing in compliance with 37 CFR 1.821(c) or (e) in an electronic medium or computer program listing in an electronic medium) (37 CFR 1.492(j)). The fee is **$310** for each additional 50 sheets of paper or fraction thereof.		

Total Sheets	Extra Sheets	Number of each additional 50 or fraction thereof (round up to a whole number)	RATE	
- 100 =	/50 =		x $310	$ 1120

Surcharge of **$130.00** for furnishing any of the search fee, examination fee, or the oath or declaration after the date of commencement of the national stage (37 CFR 1.492(h)).				$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	- 20 =		x $ **60**	$	
Independent claims	- 3 =		x **$250**	$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$450**	$	
			TOTAL OF ABOVE CALCULATIONS =	$	
☐ Applicant claims small entity status. See 37 CFR 1.27. Fees above are reduced by ½.					
			SUBTOTAL =	$ 1120	
Processing fee of **$130.00** for furnishing the English translation later than 30 months from the earliest claimed priority date (37 CFR 1.492(i)). +				$	
			TOTAL NATIONAL FEE =	$ 1120	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
			TOTAL FEES ENCLOSED =	$ 1120	
				Amount to be refunded:	$
				Amount to be charged	$

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 273 of 365

a. ☐ A check in the amount of $ _____ to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees.

c. ☑ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 18-1167.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038. The PTO-2038 should only be mailed or faxed to the USPTO. However, when paying the basic national fee, the PTO-2038 may NOT be faxed to the USPTO.

ADVISORY: If filing by EFS-Web, do **NOT** attach the PTO-2038 form as a PDF along with your EFS-Web submission. Please be advised that this is **not** recommended and by doing so your **credit card information may be displayed via PAIR.** To protect your information, it is recommended paying fees online by using the electronic payment method.

NOTE: Where an appropriate time limit under 37 CFR 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the International Application to pending status.

SEND ALL CORRESPONDENCE TO:

Customer Number: 24112



SIGNATURE

David D. Kalish

NAME

42706

REGISTRATION NUMBER

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 274 of 365

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4015-7892 / P28266-US1
	Application Number	
Title of Invention	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Qingyu		Miao	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Beijing	Country Of Residence	CN
Citizenship under 37 CFR 1.41(b)	CN		

Mailing Address of Applicant:

Address 1	Room 2-302, Building 611, Bei Yuan Jia Yuan		
Address 2	Moli Yuan, Chao yang District		
City	Beijing	State/Province	
Postal Code	100012	Country	CN

Applicant 2

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Mikael		Coldrey	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Landvetter	Country Of Residence	SE
Citizenship under 37 CFR 1.41(b)	SE		

Mailing Address of Applicant:

Address 1	Prästgårdsvägen 6		
Address 2			
City	Landvetter	State/Province	
Postal Code	SE-438 36	Country	SE

Applicant 3

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Zhiheng		Guo	

Residence Information (Select One) ○ US Residency ◉ Non US Residency ○ Active US Military Service

City	Beijing	Country Of Residence	CN

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4015-7892 / P28266-US1
	Application Number	
Title of Invention	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths	

Citizenship under 37 CFR 1.41(b)	CN		
Mailing Address of Applicant:			
Address 1	3-303, Nanhuzhongyuang		
Address 2	Chao yang district		
City	Beijing	**State/Province**	
Postal Code	100102	**Country**	CN

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	24112		
Email Address	dkalish@coatsandbennett.com	Add Email	Remove Email

Application Information:

Title of the Invention	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths		
Attorney Docket Number	4015-7892 / P28266-US1	**Small Entity Status Claimed**	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		**Sub Class (if any)**	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	12	**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4015-7892 / P28266-US1
	Application Number	
Title of Invention	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths	

Customer Number	24112

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending	Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	a 371 of international	PCT/SE2009/050583	2009-05-20

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country[i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			◉ Yes ○ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1

If the Assignee is an Organization check here. ☒

Organization Name	Telefonaktiebolaget L M Ericsson (publ)		
Mailing Address Information:			
Address 1			
Address 2			
City	Stockholm	**State/Province**	
Country[i]	SE	Postal Code	SE-164 83
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button.

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	4015-7892 / P28266-US1
	Application Number	
Title of Invention	Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths	

Signature	/David D. Kalish, Reg. No. 42706/			Date (YYYY-MM-DD)	2011-11-17
First Name	David D.	Last Name	Kalish	Registration Number	42706

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 November 2010 (25.11.2010)

PCT

(10) International Publication Number
WO 2010/134861 A1

(51) International Patent Classification:
H04W 24/04 (2009.01) *H04Q 3/26* (2006.01)

(21) International Application Number:
PCT/SE2009/050583

(22) International Filing Date:
20 May 2009 (20.05.2009)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)** [SE/SE]; S-164 83 Stockholm (SE).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **MIAO, Qingyu** [CN/CN]; Room 2-302 building 611, Bei Yuan Jia Yuan, Moli Yuan, Chao yang district, Beijing 100012 (CN). **GUO, Zhiheng** [CN/CN]; 3-303, Nanhuzhongyuang, Chaoyang district, BEIJING 100102, CHINA, Beijing 100102 (CN). **COLDREY, Mikael** [SE/SE]; Kvarnhjulsvägen 4, S-SE-438 35 Landvetter (SE).

(74) Agent: **NILSSON, Charlotte**; Ericsson AB, Patent Unit 3G, Torshamnsgatan 23, S-16480 Stockholm (SE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

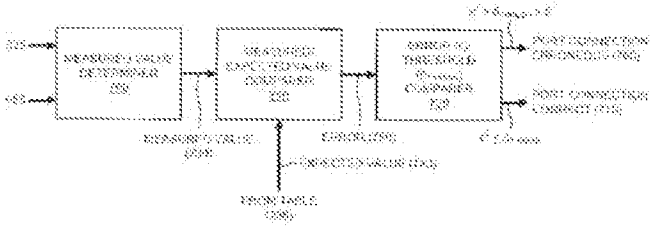
— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS

FIG. 7



(57) Abstract: A device (110) receives consecutive negative acknowledgments (NACKs) (540), measures a downlink channel quality (530) associated with the device (110), and triggers autonomous retransmission (430) when power is limited in the device (110), when the device (110) is using a minimum usable enhanced dedicated channel (E-DCH) transport format combination (ETFC), and when one of a number of consecutive NACKs (540) is greater than a predefined number, or the measured downlink channel quality (530) is less than a predefined threshold.

WO 2010/134861 A1

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 279 of 365

AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS

TECHNICAL FIELD

Embodiments described herein relate generally to wireless communication systems, and more particularly, to automatic detection of erroneous connections between antenna ports and radio frequency (RF) paths.

BACKGROUND

Smart antennas (also known as adaptive array antennas, a multi-antenna system, multiple antennas, and multiple input, multiple output (MIMO) antennas) may be used with wireless communication devices, such as base stations (also referred to as "Node Bs"). Smart antennas are antenna arrays with smart signal processing algorithms that are used to identify spatial signal information (e.g., a direction of arrival (DOA) of the signal) and to calculate beamforming vectors. The beamforming vectors are used to track and locate an antenna beam associated with a target user equipment (e.g., a mobile telephone).

Smart antennas have two main functions—DOA estimation and beamforming. During generation of a beam, each smart antenna uses weights for beamforming. Different antennas may have different weights and may transmit different data. Current time division-synchronous code division multiple access (TD-SCDMA) based devices (e.g., base stations) may include four to eight antennas. Each antenna is connected, via a cable, to the base station (e.g., a radio base station (RBS) or a remote radio unit (RRU)). In such an arrangement, if a cable is connected to an incorrect antenna, an incorrect beam is generated and performance is decreased. However, manually checking incorrect or erroneous connections is time consuming and tedious.

One proposed solution to this problem is to automatically detect an incorrect connection between an antenna port and a RF path. In the proposed solution, an uplink-received signal is collected and a channel is detected. The channel can be detected with the uplink-received signal. The uplink-received signal is used to detect a maximum energy by traveling in all possible orders of an antenna array vector and in all possible spatial directions. Specifically, the uplink-received signal is used to calculate a correlation matrix, and all possible arrangements of an antenna weighting factor sequence are traversed to obtain a weighting factor matrix. After searching through all directions of space, a maximum value of different weighting factor arrangements is determined, and an arrangement corresponding to the maximum received power is chosen to be a current connection order. However, the proposed solution requires an uplink signal, which means that the proposed solution can only be used with an operational wireless communication network or with extra equipment that generates the uplink signal.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 280 of 365

SUMMARY

It is an object of the invention to overcome at least some of the above disadvantages and to automatically detect a connection error with a base station (or a RRU) without the need for an operational wireless communication network or extra equipment that generates an uplink signal.

Embodiments described herein may automatically detect a connection error in a smart antenna (e.g., of a base station or a RRU) by measuring an amplitude and/or a phase between antenna ports of the smart antenna. In one embodiment, for example, in order to transmit and receive signals accurately, every antenna element, RF cable, and transceiver making up the smart antenna may need to operate identically. This means that every transmitting and receiving link may need to have the same amplitude and phase response. The base station may automatically implement a smart antenna calibration procedure that includes compensating the amplitude and phase of each transmitting and receiving link.

During antenna calibration, the base station (or the RRU) may measure amplitude and phase of an impulse response of a circuit between an antenna port and a calibration port. The base station (or the RRU) may also measure the amplitude and phase between any two antenna ports. A smart antenna vendor may provide a table that includes amplitude and phase information between any two antenna ports of the smart antenna. The base station (or the RRU) may compare the values provided in the antenna vendor's table with the measured amplitude and phase between two antenna ports. If there is a large difference between the table values and the measured values, the base station (or the RRU) may determine that there is an antenna connection error.

In an exemplary embodiment, a base station may determine an amplitude and/or phase between antenna elements of the base station, and may measure, based on the determined amplitude/phase, an amplitude/phase between corresponding antenna ports of the base station. The base station may compare the measured amplitude/phase with an expected amplitude/phase of the antenna ports to determine an error, and may compare the determined error to a threshold. The base station may determine an erroneous antenna port connection when the error exceeds the threshold, and may determine a correct antenna port connection when the error is less than or equal to the threshold.

In another exemplary embodiment, the base station may determine a squared error between the measured amplitude/phase and the expected amplitude/phase, and may compare the squared error to the threshold to determine whether the squared error is greater than the threshold and zero or whether the squared error is less than or equal to the threshold.

In another exemplary embodiment, the base station may receive antenna port

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 281 of 365

permutations for multiple antenna ports of the base station, and may receive expected value information associated with the multiple antenna ports. The base station may calculate expected values for different antenna port permutations based on the received information, and may acquire measured values associated with the different antenna port permutations. The base station may compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations, and may determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

Such an arrangement may ensure that connection errors are automatically and easily detected, and that performance issues, due to connection errors, are minimized. The arrangement may not require an uplink signal, and thus may not require an operational wireless communication network or extra equipment to generate an uplink signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 depicts a diagram of an exemplary network in which systems and/or methods described herein may be implemented;

Fig. 2 illustrates a diagram of exemplary components of a base station depicted Fig. 1;

Figs. 3A and 3B depict diagrams of further exemplary components of the base station illustrated in Fig. 1;

Fig. 4 depicts a diagram of exemplary components of an antenna port illustrated in Figs. 3A and 3B;

Fig. 5 illustrates a diagram of exemplary interactions among exemplary components of a portion of the antenna port depicted in Fig. 4;

Fig. 6 illustrates a diagram of additional exemplary components of the base station depicted Fig. 1;

Figs. 7 and 8 depict diagrams of exemplary functional components of the base station illustrated in Fig. 1;

Figs. 9 and 10 illustrate flow charts of an exemplary process for automatically detecting a connection error in a smart antenna according to embodiments described herein; and

Fig. 11 depicts a flow chart of an exemplary process for determining an optimal antenna port permutation in a smart antenna according to embodiments described herein.

DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description does not limit the invention.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 282 of 365

Embodiments described herein may automatically detect a connection error in a smart antenna (e.g., of a base station or a RRU) by measuring an amplitude and/or a phase between antenna ports of the smart antenna and by comparing the measured amplitude/phase to an expected amplitude/phase. The automatic detection techniques described herein may be used to quickly and easily detect connection errors in a smart antenna, and may prevent performance problems due to connection errors.

Fig. 1 depicts a diagram of an exemplary network 100 in which systems and/or methods described herein may be implemented. As shown, network 100 may include two user equipment (UEs) 110-1 and 110-2 (referred to collectively, and in some instances individually, as "user equipment 110") and a base station 120. Two pieces of user equipment 110 and a single base station 120 have been illustrated in Fig. 1 for simplicity. In practice, there may be more UEs 110 and/or base stations 120. Also, in some instances, a component in network 100 (e.g., one or more of user equipment 110 and/or base station 120) may perform one or more functions described as being performed by another component or group of components in network 100.

User equipment 110 may include one or more devices capable of sending/receiving voice and/or data to/from base station 120. In one embodiment, user equipment 110 may include, for example, a wireless telephone, a personal digital assistant (PDA), a laptop computer, etc. User equipment 110 may receive information from base station 120, and may generate and provide information to base station 120.

In one embodiment, base station 120 (also referred to as a "Node B") may be associated with a radio access network (RAN) (not shown). The RAN may include one or more devices for transmitting voice and/or data to user equipment 110 and a core network (not shown). The RAN may include a group of base stations 120 and a group of radio network controllers (RNCs). The RNCs may include one or more devices that control and manage base station 120. The RNCs may also include devices that perform data processing to manage utilization of radio network services. The RNCs may transmit/receive voice and data to/from base station 120, other RNCs, and/or the core network.

A RNC may act as a controlling radio network controller (CRNC), a drift radio network controller (DRNC), or a serving radio network controller (SRNC). A CRNC may be responsible for controlling the resources of base station 120. On the other hand, an SRNC may serve particular user equipment 110 and may manage connections towards that user equipment 110. Likewise, a DRNC may fulfill a similar role to the SRNC (e.g., may route traffic between a SRNC and particular user equipment 110).

Base station 120 may include one or more devices that receive voice and/or data from the

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 283 of 365

RNCs (not shown) and transmit that voice and/or data to user equipment 110 via an air interface. Base station 120 may also include one or more devices that receive voice and/or data from user equipment 110 over an air interface and transmit that voice and/or data to the RNCs or other user equipment 110.

In one embodiment, base station 120 may determine an amplitude and/or phase between antenna elements of base station 120, and may measure, based on the determined amplitude/phase, an amplitude/phase between corresponding antenna ports of base station 120. Base station 120 may compare the measured amplitude/phase with an expected amplitude/phase of the antenna ports to determine an error, and may compare the determined error to a threshold. Base station 120 may determine an erroneous antenna port connection when the error exceeds the threshold, and may determine a correct antenna port connection when the error is less than or equal to the threshold.

In another embodiment, base station 120 may receive antenna port permutations for multiple antenna ports of base station 120, and may receive expected information associated with the multiple antenna ports. Base station 120 may calculate expected values for different antenna port permutations based on the received information, and may acquire measured values associated with the different antenna port permutations. Base station 120 may compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations, and may determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

Fig. 2 illustrates a diagram of exemplary components of base station 120. As shown in Fig. 2, base station 120 may include a group of antennas 210-1 through 210-8 (referred to collectively as "antennas 210" and in some instances, individually as "antenna 210"), a group of transceivers (TX/RX) 220-1 through 220-8 (referred to collectively as "transceivers 220" and in some instances, individually as "transceiver 220"), a processing system/RRU 230, and an Iub interface (I/F) 240.

Antennas 210 may include one or more directional and/or omni-directional antennas. In one embodiment, antennas 210 may be associated with a smart antenna of base station 120. Although eight antennas 210 are shown in Fig. 2, in other embodiments, base station 120 may include more or less than eight antennas 210.

Transceivers 220 may be associated with corresponding antennas 210 and may include transceiver circuitry for transmitting and/or receiving symbol sequences in a network, such as network 100, via antennas 210.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 284 of 365

Processing system/RRU 230 may control the operation of base station 120. Processing system/RRU 230 may also process information received via transceivers 220 and Iub interface 240. Processing system/RRU 230 may further measure quality and strength of connection, may determine the frame error rate (FER), and may transmit this information to a RNC (not shown). In one embodiment, processing system 230 may be part of a RRU that is associated with base station 120. As illustrated, processing system/RRU 230 may include a processing unit 232 and a memory 234 (e.g., that includes an expected value table 236).

Processing unit 232 may include one or more processors, microprocessors, application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), or the like. Processing unit 232 may process information received via transceivers 220 and Iub interface 240. The processing may include, for example, data conversion, forward error correction (FEC), rate adaptation, Wideband Code Division Multiple Access (WCDMA) spreading/dispreading, quadrature phase shift keying (QPSK) modulation, etc. In addition, processing unit 232 may generate control messages and/or data messages, and may cause those control messages and/or data messages to be transmitted via transceivers 220 and/or Iub interface 240. Processing unit 232 may also process control messages and/or data messages received from transceivers 220 and/or Iub interface 240.

Memory 234 may include a random access memory (RAM), a read-only memory (ROM), and/or another type of memory to store data and instructions that may be used by processing unit 232. As further shown in Fig. 2, memory 234 may include an expected value table 236. Expected value table 236 may be a table (e.g., provided by a vendor or a manufacturer of base station 120) that includes amplitude and/or phase information between any two antenna ports of base station 120. As shown in an exemplary embodiment of expected value table 236 (provided below), the amplitude between two antennas (e.g., two of antennas 210) may be different. Amplitude may be provided in decibels (dB) and phase may be provided in degrees (deg). Parameter "S12" may represent antenna port "1" as an input port and antenna port "2" as an output port. Base station 120 may measure amplitude/phase between two particular antennas and may compare the measured values with corresponding values provided in expected value table 236 (e.g., for the two particular antennas). If there is a large difference (e.g., greater than a particular threshold) between the measured values and the values provided in expected value table 236, base station 120 may determine that there is an antenna connection error.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 285 of 365

Expected Value Table

Parameter		Frequency					
		1880	1900	1920	2018	2018	2025
S11	Amplitude[dB]	32.42	27.73	21.2	20.49	19.89	19.95
	Phase[deg]	60.44	17.67	-148.27	6.51	-19.83	-53.81
S12	Amplitude[dB]	20.73	20.99	21.26	21.62	21.66	21.64
	Phase[deg]	-90.77	151.7	34.94	-126.48	-174.91	143.09
S13	Amplitude[dB]	27.8	29.71	30.43	29.75	29.91	30.25
	Phase[deg]	73.64	-43.67	-166.86	22.2	-27.41	-69.84
S14	Amplitude[dB]	35.38	33.61	34.32	35.9	38.18	40.83
	Phase[deg]	-127.64	106.61	7.69	177.5	132.83	88.39
S15	Amplitude[dB]	32.97	34.53	36.41	36.92	38.17	39.6
	Phase[deg]	-81.33	174.69	53.5	-83.76	-123.12	-160.59
S16	Amplitude[dB]	34.1	32.46	31.41	29.63	30.33	31.21
	Phase[deg]	68.84	-80.64	-145.01	40.11	-4.94	-46.26
S17	Amplitude[dB]	34.1	35.06	39.57	39.79	39.8	38.83
	Phase[deg]	110.02	5.61	-135.61	75.77	15.1	-34.45
S18	Amplitude[dB]	32.75	32.57	32.82	34.31	34.59	34.94
	Phase[deg]	-107.36	126.67	9.76	-175.88	136.23	93.41
S1cal	Amplitude[dB]	26.03	25.99	25.95	25.58	25.51	25.41
	Phase[deg]	134.94	115.65	96.72	12.53	5.2	-1.44
S22	Amplitude[dB]	28.94	26.21	17.56	17.06	18.78	21.24
	Phase[deg]	83.67	-62.23	-147.6	105.45	64.93	18.2
S23	Amplitude[dB]	21.49	21.56	21.74	22.64	22.75	22.87
	Phase[deg]	-73.63	165.77	49.22	-118.43	-165.95	152.11
S24	Amplitude[dB]	27.89	29.38	30.06	30.3	30.29	30.48
	Phase[deg]	60.22	-62.74	166.26	-7.96	-56.5	-99.25
S25	Amplitude[dB]	31.61	31.68	31.76	33.08	33.33	33.59
	Phase[deg]	115.27	-66.65	-115.9	62.3	15.88	-25.2
S26	Amplitude[dB]	26.71	28.25	28.63	26.6	26.82	26.89
	Phase[deg]	-59.76	170.94	40.38	-124.01	-174.69	141.46
S27	Amplitude[dB]	28.33	29.73	31.28	28.78	29.27	29.9
	Phase[deg]	88.08	-37.85	-152.45	42.32	-7.34	-47.57
S28	Amplitude[dB]	35.99	36.3	36.51	36.9	36.59	36.16
	Phase[deg]	93.27	-20.23	-146.15	60.79	15.59	-24.07
S2cal	Amplitude[dB]	26.3	26.26	26.14	25.32	25.26	25.3
	Phase[deg]	137.11	116.41	98.33	12.91	4.61	-2.33
S33	Amplitude[dB]	16.47	20	28.62	24.77	27.31	33.8
	Phase[deg]	-129.33	161.77	-171.52	113.47	80.98	26.54
S34	Amplitude[dB]	21.09	21.14	21.37	21.89	21.89	21.84
	Phase[deg]	-97.45	144.5	24.71	-141.86	168.66	125.85
S35	Amplitude[dB]	36.5	36.56	36.92	38.47	38.2	38.14
	Phase[deg]	64.79	-53.85	-174.55	34.34	-9.47	-47.73
S36	Amplitude[dB]	29.97	30.37	32.47	32.05	31.94	32
	Phase[deg]	129.78	18.06	-108.25	82.51	33.59	-8.47
S37	Amplitude[dB]	25.66	26.42	27.65	29.64	30.88	32
	Phase[deg]	-78.74	169.76	50.16	-98.08	-146.41	169.01

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 286 of 365

Parameter		Frequency					
		1880	1900	1920	2010	2018	2025
S38	Amplitude[dB]	31.71	31.44	31.51	29.22	29.36	29.67
	Phase[deg]	78.9	-36.28	-150.27	42	-4.52	-45.92

Iub interface 240 may include one or more line cards that allow base station 120 to transmit data to and receive data from a RNC.

As described herein, base station 120 may perform certain operations in response to processing unit 232 executing software instructions of an application contained in a computer-readable medium, such as memory 234. In one example, a computer-readable medium may be defined as a physical or logical memory device. A logical memory device may include memory space within a single physical memory device or spread across multiple physical memory devices. The software instructions may be read into memory 234 from another computer-readable medium or from another device via antennas 210 and transceivers 220. The software instructions contained in memory 234 may cause processing unit 232 to perform processes described herein. Alternatively, hardwired circuitry may be used in place of or in combination with software instructions to implement processes described herein. Thus, embodiments described herein are not limited to any specific combination of hardware circuitry and software.

Although Fig. 2 shows exemplary components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional components than depicted in Fig. 2. In still other embodiments, one or more components of base station 120 may perform one or more other tasks described as being performed by one or more other components of base station 120.

Figs. 3A and 3B depict diagrams of further exemplary components of base station 120. As shown in Fig. 3A, base station 120 may include an antenna port 300 that includes eight ports 310-1 through 310-8 (referred to collectively as "ports 310" and in some instances, individually as "port 310") connected to corresponding antennas 210-1 through 210-8, and a calibration port 310-CAL. Antennas 210 may include the features described above in connection with, for example, Fig. 2.

Antenna port 300 may include a device that enables antennas 210 to connect to transceivers 220 (Fig. 2) of base station 120, via cables. In one embodiment, antenna port 300 may include an antenna port for a dual-polarized eight antenna system, as shown in Fig. 3A. In another embodiment, antenna port 300 may include an antenna port for a normal eight antenna system.

Each of ports 310-1 through 310-8 may include a port capable of connecting one of

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 287 of 365

antennas 210 to one of transceivers 220 (Fig. 2), via a cable. Each of ports 310-1 through 310-8 may be capable of connecting to a variety of cable connector types, including male connectors, female connectors, optical connectors, electrical connectors, SubMiniature version A (SMA) connectors, threaded Neill-Concelman (TNC) connectors, Bayonet Neill-Concelman (BNC) connectors, etc.

Calibration port 310-CAL may include a port capable of connecting antenna port 300 to one of transceivers 220 (Fig. 2), via a cable. Calibration port 310-CAL may be capable of connecting to a variety of cable connector types, including male connectors, female connectors, optical connectors, electrical connectors, SMA connectors, TNC connectors, BNC connectors, etc.

As shown in Fig. 3B, antenna port 300 may connect antennas 210 (omitted from Fig. 3B for clarity) to corresponding transceivers 220, via ports 310 and RF cables 320. Transceivers 220 may communicate with processing system/RRU 230. Transceivers 220 and processing system/RRU 230 may include the features described above in connection with, for example, Fig. 2. Antenna port 300 and ports 310 may include the features described above in connection with, for example, Fig. 3A.

Each of RF cables 320 may include a cable that transmits high frequency signals. RF cables 320 may include cables capable of connecting ports 310 to corresponding transceivers 220. RF cables 320 may include a variety of cable connector types, including male connectors, female connectors, optical connectors, electrical connectors, SMA connectors, TNC connectors, BNC connectors, etc.

As further shown in Fig. 3B, port 310-1 (and antenna 210-1) may connect to transceiver 220-1 via one of RF cables 320, port 310-2 (and antenna 210-2) may connect to transceiver 220-2 via one of RF cables 320, port 310-3 (and antenna 210-3) may connect to transceiver 220-3 via one of RF cables 320, port 310-4 (and antenna 210-4) may connect to transceiver 220-4 via one of RF cables 320, port 310-5 (and antenna 210-5) may connect to transceiver 220-5 via one of RF cables 320, port 310-6 (and antenna 210-6) may connect to transceiver 220-6 via one of RF cables 320, port 310-7 (and antenna 210-7) may connect to transceiver 220-7 via one of RF cables 320, port 310-8 (and antenna 210-8) may connect to transceiver 220-8 via one of RF cables 320, and port 310-CAL may connect to transceiver 220-CAL via one of RF cables 320. In such an arrangement there is a possibility that one of RF cables 320 may be incorrectly connected to one of ports 310 (e.g., one of antennas 210), which may generate an incorrect beam and may decrease performance of base station 120. Embodiments described automatically detect and enable correction of such connection errors.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 288 of 365

Although Figs. 3A and 3B show exemplary components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional components than depicted in Figs. 3A and 3B. In still other embodiments, one or more components of base station 120 may perform one or more other tasks described as being performed by one or more other components of base station 120.

Fig. 4 depicts a diagram of exemplary components of antenna port 300. As shown, antenna port 300 may include antennas 210, ports 310, calibration port 310-CAL, loads 400, directional couplers 410, and power splitters 420. Antennas 210 may include the features described above in connection with, for example, Fig. 2. Ports 310 and calibration port 310-CAL may include the features described above in connection with, for example, Figs. 3A and 3B. Fig. 4 shows multiple loads 400, directional couplers 410, and power splitters 420, although only a few of them are labeled (for clarity).

Each of loads 400 may include a device connected to an output (e.g., one of ports 310) of a circuit. In one embodiment, each of loads 400 may include a device where power is consumed.

Each of directional couplers 410 may include a passive device that couples a portion of transmission power in a transmission line (e.g., a line connected to antenna 210-1) by a particular amount out through another port. In one embodiment, each of directional couplers 410 may use two transmission lines set close enough together such that energy passing through one transmission line (e.g., a line connected to antenna 210-1) is coupled to the other transmission line (e.g., a line connecting two loads 400).

Each of power splitters 420 may include a passive device that receives an input signal and generates multiple output signals with specific phase and amplitude characteristics. In one embodiment, each of power splitters 420 may include a "T" connection, which has one input and two outputs. If the "T" connection is mechanically symmetrical, a signal applied to the input may be divided into two output signals, equal in amplitude and phase.

Although Fig. 4 shows exemplary components of antenna port 300, in other embodiments, antenna port 300 may contain fewer, different, differently arranged, or additional components than depicted in Fig. 4. In still other embodiments, one or more components of antenna port 300 may perform one or more other tasks described as being performed by one or more other components of antenna port 300.

Fig. 5 illustrates a diagram of exemplary interactions among exemplary components of a portion 500 of antenna port 300. As shown, portion 500 of antenna port 300 may include antennas 210-1 and 210-2, ports 310-1 and 310-2, loads 400, and directional couplers 410.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 289 of 365

Antennas 210-1 and 210-2 may include the features described above in connection with, for example, Fig. 2. Ports 310-1 and 310-2 may include the features described above in connection with, for example, Figs. 3A and 4B. Loads 400 and directional couplers 410 may include the features described above in connection with, for example, Fig. 4.

As further shown in Fig. 5, antennas 210-1 and 210-2 may be internally coupled together via a circuit that includes loads 400 and directional couplers 410. For example, an input signal 510 may be input at port 310-1, may travel through the circuit, and may be received as an output signal 520 at port 310-2. Antennas 210-1 and 210-2 may be externally coupled together via wireless wave propagation between antennas 210-1 and 210-2. For example, input signal 510 may cause antenna 210-1 to transmit a wireless signal 530 that may be received by antenna 210-2 and provided to port 310-2. The external coupling of antennas 210-1 and 210-2 may depend on a physical environment (e.g., a very site specific environment) of base station 120 and antennas 210-1 and 210-2. In one embodiment, a filter may be provided (e.g., with antennas 210-1 and 210-2) that filters out surrounding objects of the physical environment.

Base station 120 may use signals 510-530 to measure an amplitude and/or a phase between antennas 210-1 and 210-2 (and ports 310-1 and 310-2). Base station 120 may compare the values provided in expected value table 236 (Fig. 2) with the measured amplitude and/or measured phase between antennas 210-1 and 210-2 (and ports 310-1 and 310-2). If there is a large difference (e.g., greater than a particular threshold (e.g., +/- ten percent)) between the table values and the measured amplitude and/or phase, base station 120 may determine that there is an antenna connection error.

Although Fig. 5 shows exemplary interactions among components of antenna port 300, in other embodiments, components of antenna port 300 may perform fewer, different, or additional interactions than depicted in Fig. 5.

Fig. 6 illustrates a diagram of additional exemplary components of base station 120. As shown base station 120 may include a first transceiver 220-1 that includes digital-to-analog converter (DAC) circuitry 600, a power amplifier 605, and a filter unit (FU) 610; a second transceiver 220-2 that includes a filter unit 615 and analog-to-digital converter (ADC) circuitry 620; and processing unit 232. Transceivers 220-1 and 220-2 and processing unit 232 may include the features described above in connection with, for example, Fig. 2.

DAC circuitry 600 may include a device or circuitry that converts a digital signal (e.g., binary code or numbers) to an analog signal (e.g., current, voltage, or electric charge). In one embodiment, DAC circuitry 600 may include one or more of a pulse width modulator DAC, an oversampling DAC, an interpolating DAC, a binary weighted DAC, etc.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 290 of 365

Power amplifier 605 may include a device that changes (e.g., increases) an amplitude of a signal (e.g., a voltage, a current, etc.). In one embodiment, power amplifier 605 may include one or more of a transistor amplifier, an operational amplifier, a fully differential amplifier, etc.

Each of filter units 610 and 615 may include an electronic circuit that performs signal processing functions to remove unwanted frequency components from a signal, to enhance desired frequency components in the signal, or both. In one embodiment, each of filter units 610 and 615 may include one or more of a passive filter unit, an active filter unit, an analog filter unit, a digital filter unit, a high-pass filter unit, a low-pass filter unit, a bandpass filter unit, band-reject filter unit, an all-pass filter unit, a discrete-time filter unit, a continuous-time filter unit, a linear filter unit, a non-linear filter unit, an infinite impulse response filter unit, a finite impulse response filter unit, etc.

ADC circuitry 620 may include a device or circuitry that converts an analog signal (e.g., current, voltage, or electric charge) to a digital signal (e.g., binary code or numbers). In one embodiment, ADC circuitry 620 may include one or more of a linear ADC, a non-linear ADC, a direct conversion ADC, a successive-approximation ADC, a ramp-compare ADC, etc.

As further shown in Fig. 6, in order to calibrate antennas 210 associated with transceivers 220-1 and 220-2, processing unit 232 may provide a digital transmission (TX) signal 625 to transceiver 220-1, and DAC circuitry 600 may receive digital TX signal 625. DAC circuitry 600 may convert digital TX signal 625 to an analog TX signal 630, and may provide analog TX signal 630 to power amplifier 605. Power amplifier 605 may amplify analog TX signal 630 to produce an amplified, analog TX signal 635, and may provide amplified, analog TX signal 635 to filter unit 610. Filter unit 610 may filter amplified, analog TX signal 635 to produce a signal 640 (e.g., which is a filtered, amplified, and analog TX signal), and may provide signal 640 to a coupling network. The coupling network may include, for example, the internally and externally coupled antennas 210-1 and 210-2 and ports 310-1 and 310-2 shown in Fig. 5.

Signal 640 may be input to port 310-1 as input signal 510 (Fig. 5), and may travel through the coupling network until it reaches port 310-2 as output signal 520 (Fig. 5). Output signal 520 may be provided to transceiver 220-2 as an analog reception (RX) signal 645, and filter unit 615 may receive analog RX signal 645. Filter unit 615 may filter analog RX signal 645 to produce a filtered, analog RX signal 650, and may provide filtered, analog RX signal 650 to ADC circuitry 620. ADC circuitry 620 may convert filtered, analog RX signal 650 to a digital RX signal 655, and may provide digital RX signal 655 to processing unit 232.

Processing unit 232 may compare digital TX signal 625 and digital RX signal 655 to

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 291 of 365

determine a measured value (e.g., a difference between digital TX signal 625 and digital RX signal 655) of amplitude and/or phase. Since the amplitude and phase provided by transceivers 220-1 and 220-2 may be known, processing unit 232 may calculate an amplitude and/or phase between antenna ports (e.g., ports 310-1 and 310-2, which are associated with antennas 210-1 and 210-2) based on the measured value and the known amplitude and phase provided by transceivers 220-1 and 220-2. Processing unit 232 may compare the values provided in expected value table 236 (Fig. 2) with the measured amplitude and/or phase between the antenna ports (e.g., ports 310-1 and 310-2). If there is a large difference (e.g., greater than a particular threshold (e.g., +/- ten percent)) between the table values and the measured amplitude and/or phase, processing unit 232 may determine that there is an antenna connection error.

Although Fig. 6 shows exemplary components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional components than depicted in Fig. 6. In still other embodiments, one or more components of base station 120 may perform one or more other tasks described as being performed by one or more other components of base station 120.

Fig. 7 depicts a diagram of exemplary functional components of base station 120. As shown, base station 120 may include a measured value determiner 700, a measured/expected value comparer 710, and an error/threshold comparer 720. In one embodiment, the functions described in connection with Fig. 7 may be performed by processing unit 232 (Fig. 2).

Measured value determiner 700 may include any hardware, software, or combination of hardware and software that may receive digital TX signal 625 and digital RX signal 655. Measured value determiner 700 may compare digital TX signal 625 and digital RX signal 655 to determine a difference between the amplitude and/or the phase of digital TX signal 625 and digital RX signal 655. Since the amplitude and phase provided by transceivers 220 may be known, measured value determiner 700 may calculate a measured value ($S_{measured}$) 730 (e.g., an amplitude and/or phase between two antenna ports 310) based on the determined difference and the known amplitude and phase provided by transceivers 220. Measured value determiner 700 may provide measured value 730 to measure/expected value comparer 710.

Measured/expected value comparer 710 may include any hardware, software, or combination of hardware and software that may receive measured value 730 from measured value determiner 700, and may receive an expected value ($S_{expected}$) 740 from expected value table 236. Measured/expected value comparer 710 may compare measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740. In one embodiment, measured/expected value comparer 710 may determine a difference between measured value ($S_{measured}$) 730 and expected value ($S_{expected}$)

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 292 of 365

740 (i.e., $S_{measured} - S_{expected}$) to be an error ($\varepsilon$) 750, and may square error (ε) 750 according to the following squared matrix norm (e.g., the squared Frobenius norm):

$$\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2,$$

where $S_{measured}$ and $S_{expected}$ may denote measured and expected complex value S-matrices. A complex S-matrix may contain all the S-parameters (e.g., an (i, j) element of the S-matrix may contain a parameter (Sij), which may represent an amplitude and phase between ports i and j in complex form).

Error/threshold comparer 720 may include any hardware, software, or combination of hardware and software that may receive error (ε) 750 from measured/expected value comparer 710, and may compare the squared error 750 to a threshold (δ_{THRESH}). Since a measurement error may always be present, a few decibels (e.g., one to five decibels) or few degree (e.g., one to five degrees) margin may be added as the threshold. Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is erroneous (as indicated by reference number 760) if the squared error 750 is greater than the threshold (e.g., $\varepsilon^2 > \delta_{THRESH} > 0$). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is correct (as indicated by reference number 770) if the squared error 750 is less than or equal to the threshold (e.g., $\varepsilon^2 \leq \delta_{THRESH}$).

Although Fig. 7 shows exemplary functional components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional functional components than depicted in Fig. 7. In still other embodiments, one or more functional components of base station 120 may perform one or more other tasks described as being performed by one or more other functional components of base station 120.

Fig. 8 illustrates a diagram of exemplary functional components of base station 120. As shown, base station 120 may include an expected values calculator 800 and a measured/expected values comparer 810. In one embodiment, the functions described in connection with Fig. 8 may be performed by processing unit 232 (Fig. 2).

Expected values calculator 800 may include any hardware, software, or combination of hardware and software that may receive port permutations 820 (e.g., different combinations of antennas 210, ports 310, and RF cables 320) for multiple antenna ports 310 of base station 120, and may receive table information 830 (e.g., expected values from expected value table 236 (Fig. 2)) associated with the multiple antenna ports 310. Expected values calculator 800 may calculate expected values 840 (e.g., S-matrices) for different antenna port permutations based on port permutations 820 and table information 830. Expected values calculator 800 may provide expected values 840 to measured/expected values comparer 810.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 293 of 365

Measured/expected values comparer 810 may include any hardware, software, or combination of hardware and software that may receive expected values 840 from expected values calculator 800, and may acquire measured values 850 associated with the different antenna port permutations. Measured/expected values comparer 810 may compare expected values 840 with measured values 850 to determine errors for the different antenna port permutations. Measured/expected values comparer 810 may determine an optimal antenna port permutation (i.e., a correct port order 860) to be one of the different antenna port permutations with a smallest determined error 870 (e.g., as determined by: $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2$).

Although Fig. 8 shows exemplary functional components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional functional components than depicted in Fig. 8. In still other embodiments, one or more functional components of base station 120 may perform one or more other tasks described as being performed by one or more other functional components of base station 120.

Figs. 9 and 10 illustrate flow charts of an exemplary process 900 for automatically detecting a connection error in a smart antenna according to embodiments described herein. In one embodiment, process 900 may be performed by base station 120. In other embodiments, some or all of process 900 may be performed by base station 120 in combination with another device (e.g., a RRU) or group of devices (e.g., communicating with base station 120).

As illustrated in Fig. 9, process 900 may include determining an amplitude/phase between antenna elements of a base station (block 910), and measuring, based on the determined amplitude/phase, an amplitude/phase ($S_{measured}$) between corresponding antenna ports of the base station (block 920). For example, in embodiments described above in connection with Fig. 7, measured value determiner 700 of base station 120 may receive digital TX signal 625 and digital RX signal 655. Measured value determiner 700 may compare digital TX signal 625 and digital RX signal 655 to determine a difference between the amplitude and/or the phase of digital TX signal 625 and digital RX signal 655. Since the amplitude and the phase provided by transceivers 220 may be known, measured value determiner 700 may calculate measured value ($S_{measured}$) 730 (e.g., an amplitude and/or phase between two antenna ports 310) based on the determined difference and the known amplitude and phase provided by transceivers 220.

Returning to Fig. 9, the measured amplitude/phase ($S_{measured}$) may be compared with an expected amplitude/phase ($S_{expected}$) of the antenna ports to determine an error (block 930), and the determined error may be compared to a threshold (block 940). For example, in embodiments described above in connection with Fig. 7, measured/expected value comparer 710 of base station 120 may receive measured value 730 from measured value determiner 700, and may

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 294 of 365

receive expected value ($S_{expected}$) 740 from expected value table 236. Measured/expected value comparer 710 may compare measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740. In one example, measured/expected value comparer 710 may determine a difference between measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740 (i.e., $S_{measured}$ - $S_{expected}$) to be an error (ε) 750. Error/threshold comparer 720 of base station 120 may receive error (ε) 750 from measured/expected value comparer 710, and may compare the squared error 750 to a threshold (δ_{THRESH}). In one example, the threshold (e.g., for the amplitude and phase values) may be set equal to a product of a particular percentage (e.g., ten percent) and the amplitude and phase values provided in expected value table 236.

As further shown in Fig. 9, an erroneous antenna port connection may be determined when the error exceeds the threshold (block 950), and a correct antenna port connection may be determined when the error is less than or equal to the threshold (block 960). For example, in embodiments described above in connection with Fig. 7, error/threshold comparer 720 of base station 120 may determine that a port connection (e.g., in base station 120) is erroneous (as indicated by reference number 760) if the squared error 750 exceeds the threshold (δ_{THRESH}). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is correct (as indicated by reference number 770) if the squared error 750 is less than or equal to the threshold (δ_{THRESH}).

Process blocks 930 and 940 may include the process blocks depicted in Fig. 10. As shown in Fig. 10, process blocks 930 and 940 may include determining a squared error (ε^2) between the measured amplitude/phase ($S_{measured}$) and the expected amplitude/phase ($S_{expected}$) according to $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2$ (block 1000), and comparing the squared error (ε^2) to the threshold (δ_{THRESH}) to determine whether $\varepsilon^2 > \delta_{THRESH} > 0$ or $\varepsilon^2 \leq \delta_{THRESH}$ (block 1010). For example, in embodiments described above in connection with Fig. 7, measured/expected value comparer 710 of base station 120 may determine a difference between measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740 (i.e., $S_{measured}$ - $S_{expected}$) to be error (ε) 750, and may square error (ε) 750 according to the following squared matrix norm (e.g., the squared Frobenius norm): $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2$. Error/threshold comparer 720 of base station may compare the squared error 750 to a threshold (δ_{THRESH}). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is erroneous (as indicated by reference number 760) if the squared error 750 greater than the threshold (e.g., $\varepsilon^2 > \delta_{THRESH} > 0$). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is correct (as indicated by reference number 770) if the squared error 750 is less than or equal to the threshold

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 295 of 365

(e.g., $\varepsilon^2 \leq \delta_{THRESH}$).

Fig. 11 illustrates a flow chart of another exemplary process 1100 for determining an optimal antenna port permutation in a smart antenna according to embodiments described herein. In one embodiment, process 1100 may be performed by base station 120. In other embodiments, some or all of process 1100 may be performed by base station 120 in combination with another device (e.g., a RRU) or group of devices (e.g., communicating with base station 120).

As illustrated in Fig. 11, process 1100 may include receiving antenna port permutations and amplitudes/phases for antenna ports of a base station (block 1110), and calculating expected amplitudes/phases for different antenna port permutations based on the received information (block 1120). For example, in embodiments described above in connection with Fig. 8, expected values calculator 800 of base station 120 may receive port permutations 820 (e.g., different combinations of antennas 210, ports 310, and RF cables 320) for multiple antenna ports 310 of base station 120, and may receive table information 830 (e.g., expected values from expected value table 236 (Fig. 2)) associated with the multiple antenna ports 310. Expected values calculator 800 may calculate expected values 840 (e.g., S-matrices) for different antenna port permutations based on port permutations 820 and table information 830.

As further shown in Fig. 11,measured amplitudes/phases associated with the antenna port permutations may be acquired (block 1130), the expected amplitudes/phases may be compared with the measured amplitudes/phases to determine errors (block 1140), and an optimal antenna port permutation may be determined to be a permutation with the smallest error (block 1150). For example, in embodiments described above in connection with Fig. 8, measured/expected values comparer 810 of base station 120 may acquire measured values 850 associated with the different antenna port permutations, and may compare expected values 840 with measured values 850 to determine errors for the different antenna port permutations. Measured/expected values comparer 810 may determine an optimal antenna port permutation (i.e., a correct port order 860) to be one of the different antenna port permutations with a smallest determined error 870 (e.g., as determined by: $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_p^2$).

Embodiments described herein may automatically detect a connection error in a smart antenna (e.g., of a base station or RRU) by measuring an amplitude and/or a phase between antenna ports of the smart antenna. In one embodiment, for example, in order to transmit and receive signals accurately, every antenna element, RF cable, and transceiver making up the smart antenna may need to operate identically. This means that every transmitting and receiving link may need to have the same amplitude and phase response. The base station may

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 296 of 365

automatically implement a smart antenna calibration procedure that includes compensating the amplitude and phase of each transmitting and receiving link.

Such an arrangement may ensure that connection errors are automatically and easily detected, and that performance issues due to connection errors are minimized. The arrangement may not require an uplink signal, and thus may not require an operational wireless communication network or extra equipment to generate an uplink signal.

Embodiments described herein provide illustration and description, but are not intended to be exhaustive or to limit the implementations to the precise form disclosed. Modifications and variations are possible in light of the above teachings, or may be acquired from practice of the implementations. For example, while series of blocks have been described with regard to Figs. 9-11, the order of the blocks may be modified in other embodiments. Further, non-dependent blocks may be performed in parallel. In another example, although the systems and/or methods described herein have been implemented in base station 120, in other embodiments, the systems and/or methods may be implemented in any device that uses antenna port 300.

The exemplary embodiments, as described above, may be implemented in many different forms of software, firmware, and hardware in the implementations illustrated in the figures. The actual software code or specialized control hardware used to implement the exemplary embodiments described herein is not limiting of the invention. Thus, the operation and behavior of the exemplary embodiments were described without reference to the specific software code – it being understood that one would be able to design software and control hardware to implement the exemplary embodiments based on the description herein.

Further, certain portions of the invention may be implemented as "logic" that performs one or more functions. This logic may include hardware, such as an application specific integrated circuit, a field programmable gate array, a processor, or a microprocessor, or a combination of hardware and software.

Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the invention. In fact, many of these features may be combined in ways not specifically recited in the claims and/or disclosed in the specification.

It should be emphasized that the terms "comprises / comprising" when used in the this specification are taken to specify the presence of stated features, integers, steps, or components, but do not preclude the presence or addition of one or more other features, integers, steps, components, or groups thereof.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 297 of 365

No element, act, or instruction used in the description of the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items. Where only one item is intended, the term "one" or similar language is used. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 298 of 365

WHAT IS CLAIMED IS:

1. A method in a radio network (100) that includes a device (120), the method comprising:

measuring, via the device (120), a parameter ($S_{MEASURED}$) associated with at least two antenna ports (310) of the device (120);

comparing, via the device (120), the measured parameter ($S_{MEASURED}$) with an expected parameter ($S_{EXPECTED}$) associated with the at least two antenna ports (310) to determine an error (ε);

comparing, via the device (120), the determined error (ε) to a threshold ($\delta_{THRESHOLD}$); and

determining, via the device (120):

an erroneous antenna port connection for the at least two antenna ports (310) when the error (ε) exceeds the threshold ($\delta_{THRESHOLD}$), and

a correct antenna port connection for the at least two antenna ports (310) when the error (ε) is less than or equal to the threshold ($\delta_{THRESHOLD}$).

2. The method of claim 1, where measuring, via the device (120), the parameter ($S_{MEASURED}$) comprises:

determining a parameter associated with at least two antenna elements (210) of the device (120), where the at least two antenna elements (210) are associated with the at least two antenna ports (310); and

measuring, based on the determined parameter associated with the at least two antenna elements (210), the measured parameter ($S_{MEASURED}$).

3. The method of claim 2, where the determined parameter associated with the at least two antenna elements (210) comprises one or more of an amplitude or a phase.

4. The method of claim 1, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises one or more of an amplitude or a phase.

5. The method of claim 1, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises a difference between a signal (625) transmitted via one of the at least two antenna ports (310) and a signal (655) received via another one of the at least two antenna ports (310).

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 299 of 365

6. The method of claim 1, where comparing, via the device (120), the measured parameter ($S_{MEASURED}$) with the expected parameter ($S_{EXPECTED}$) comprises determining a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = \| S_{MEASURED} - S_{EXPECTED} \|^2.$$

7. The method of claim 6, where comparing, via the device (120), the determined error (ε) to the threshold ($\delta_{THRESHOLD}$) comprises comparing the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$
$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

8. The method of claim 1, further comprising:

receiving antenna port permutations (820) for a plurality of antenna ports (310) of the device (120);

receiving expected information (830) associated with the plurality of antenna ports (310);

calculating expected values (840) for different antenna port permutations based on the received information;

acquiring measured values (850) associated with the different antenna port permutations;

comparing the expected values (840) for the different antenna port permutations with the measured values (850) for the different antenna port permutations to determine errors for the different antenna port permutations; and

determining an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

9. The method of claim 1, where the device (120) comprises a base station.

10. The method of claim 1, where the device (120) comprises a remote radio unit (230) associated with a base station.

11. A device (120) in a radio network (100), the device (120) comprising:

at least two antenna ports (310);

a memory (234) to store a plurality of instructions; and

a processing unit (232) to execute instructions in the memory (234) to:

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 300 of 365

measure a parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310),

compare the measured parameter ($S_{MEASURED}$) with an expected parameter ($S_{EXPECTED}$) associated with the at least two antenna ports (310) to determine an error (ε),

compare the determined error (ε) to a threshold ($\delta_{THRESHOLD}$), and

determine:

an erroneous antenna port connection for the at least two antenna ports (310) when the error (ε) exceeds the threshold ($\delta_{THRESHOLD}$), and

a correct antenna port connection for the at least two antenna ports (310) when the error (ε) is less than or equal to the threshold ($\delta_{THRESHOLD}$).

12. The device (120) of claim 11, where the device (120) further comprises:

at least two antenna elements (210) associated with the at least two antenna ports (310), and

where the processing unit (232) is further to execute instructions in the memory (234) to:

determine a parameter associated with the at least two antenna elements (210), and

measure, based on the determined parameter associated with the at least two antenna elements (210), the measured parameter ($S_{MEASURED}$).

13. The device (120) of claim 12, where the determined parameter associated with the at least two antenna elements (210) comprises one or more of an amplitude or a phase.

14. The device (120) of claim 11, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises one or more of an amplitude or a phase.

15. The device (120) of claim 11, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises a difference between a signal (625) transmitted via one of the at least two antenna ports (310) and a signal (655) received via another one of the at least two antenna ports (310).

16. The device (120) of claim 11, where, when comparing the measured parameter ($S_{MEASURED}$) with the expected parameter ($S_{EXPECTED}$), the processing unit (232) is further to

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 301 of 365

execute instructions in the memory (234) to:

determine a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = \| S_{MEASURED} - S_{EXPECTED} \|^2.$$

17. The device (120) of claim 16, where, when comparing the determined error (e) to the threshold ($\delta_{THRESHOLD}$), the processing unit (232) is further to execute instructions in the memory (234) to:

compare the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

18. The device (120) of claim 11, where the processing unit (232) is further to execute instructions in the memory (234) to:

receive antenna port permutations (820) for a plurality of antenna ports (310) of the device (120),

receive expected information (830) associated with the plurality of antenna ports (310),

calculate expected values (840) for different antenna port permutations based on the received information,

acquire measured values (850) associated with the different antenna port permutations,

compare the expected values (840) for the different antenna port permutations with the measured values (850) for the different antenna port permutations to determine errors for the different antenna port permutations, and

determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

19. The device (120) of claim 11, where the device (120) comprises a base station.

20. The device (120) of claim 11, where the device (120) comprises a remote radio unit (230) associated with a base station.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 302 of 365

FIG. 1

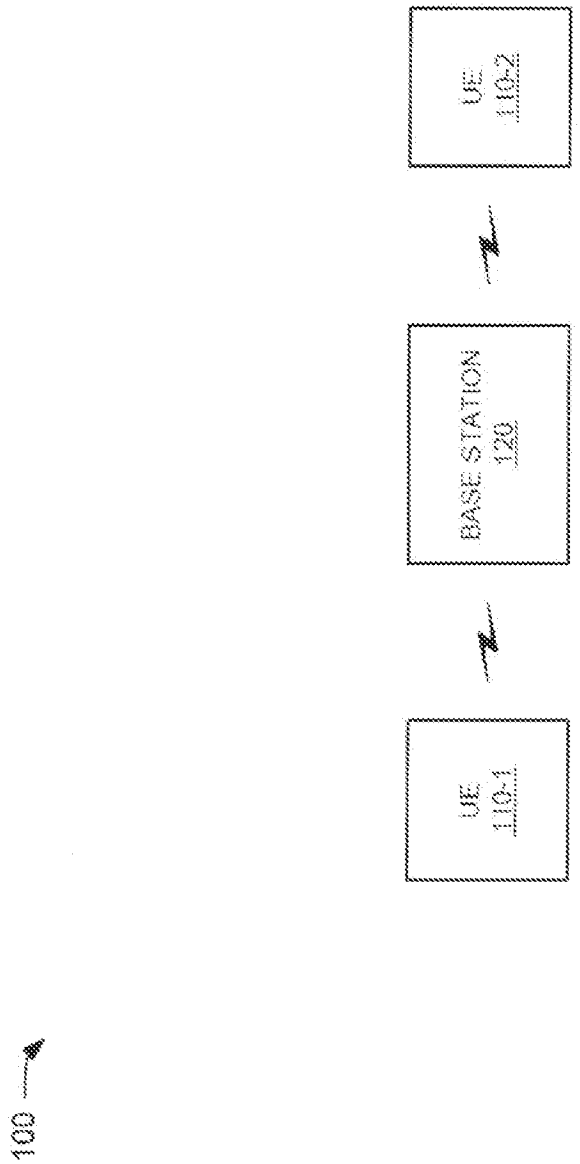


FIG. 2

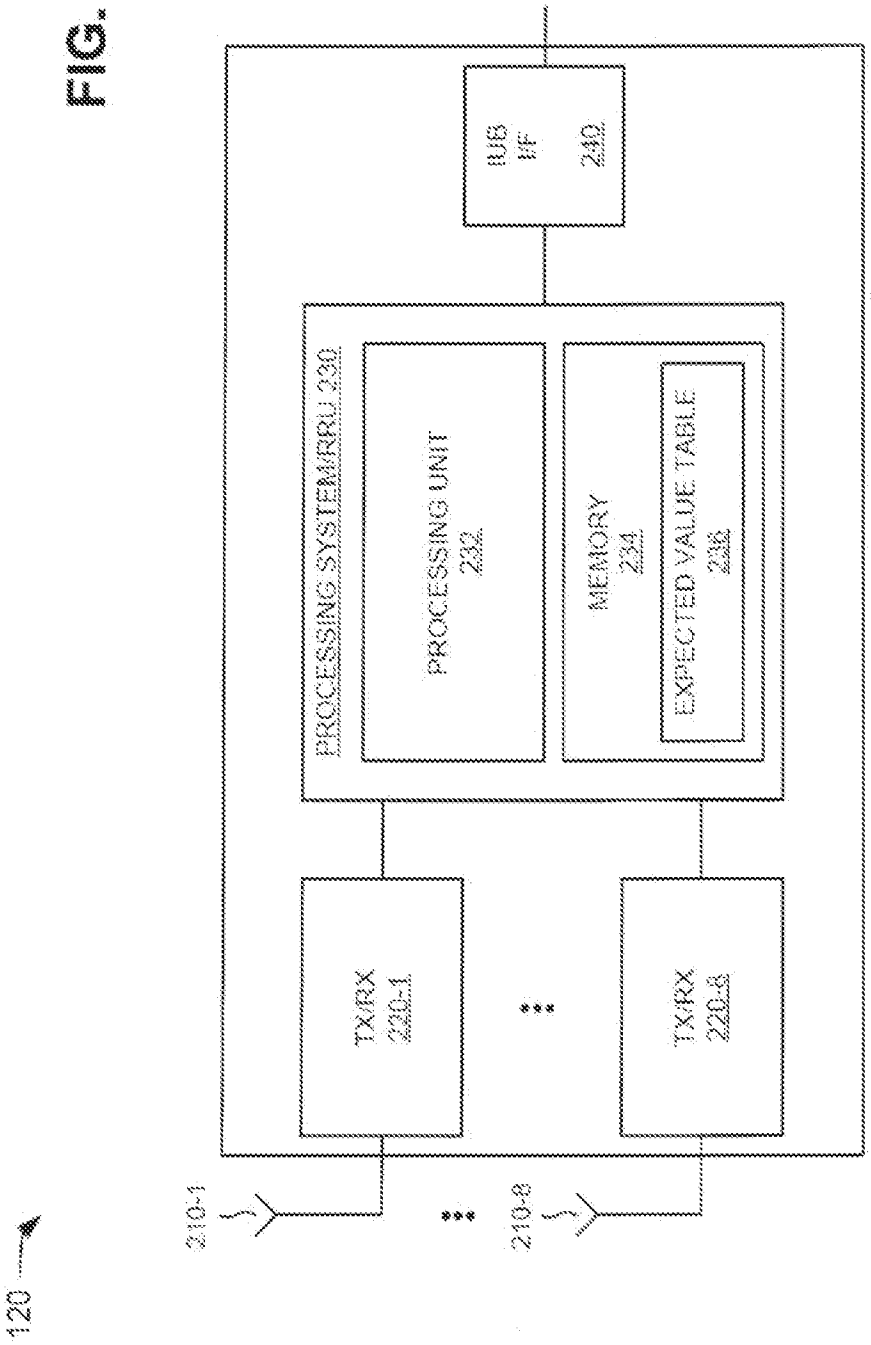

120
210-1
210-8
TX/RX 220-1
TX/RX 220-8
PROCESSING SYSTEM/RRU 230
PROCESSING UNIT 232
MEMORY 234
EXPECTED VALUE TABLE 238
IUB I/F 240

FIG. 3A

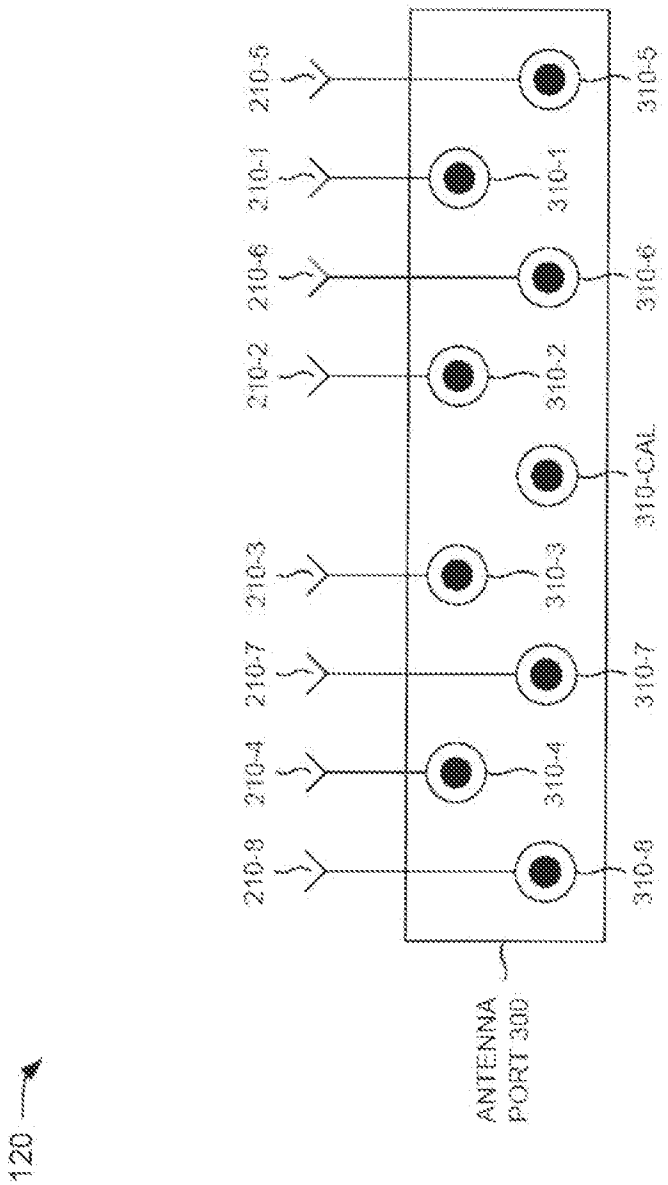

120
ANTENNA PORT 300
210-8
210-4
210-7
210-3
210-2
210-6
210-1
210-5
310-8
310-4
310-7
310-3
310-CAL
310-2
310-6
310-1
310-5

FIG. 3B

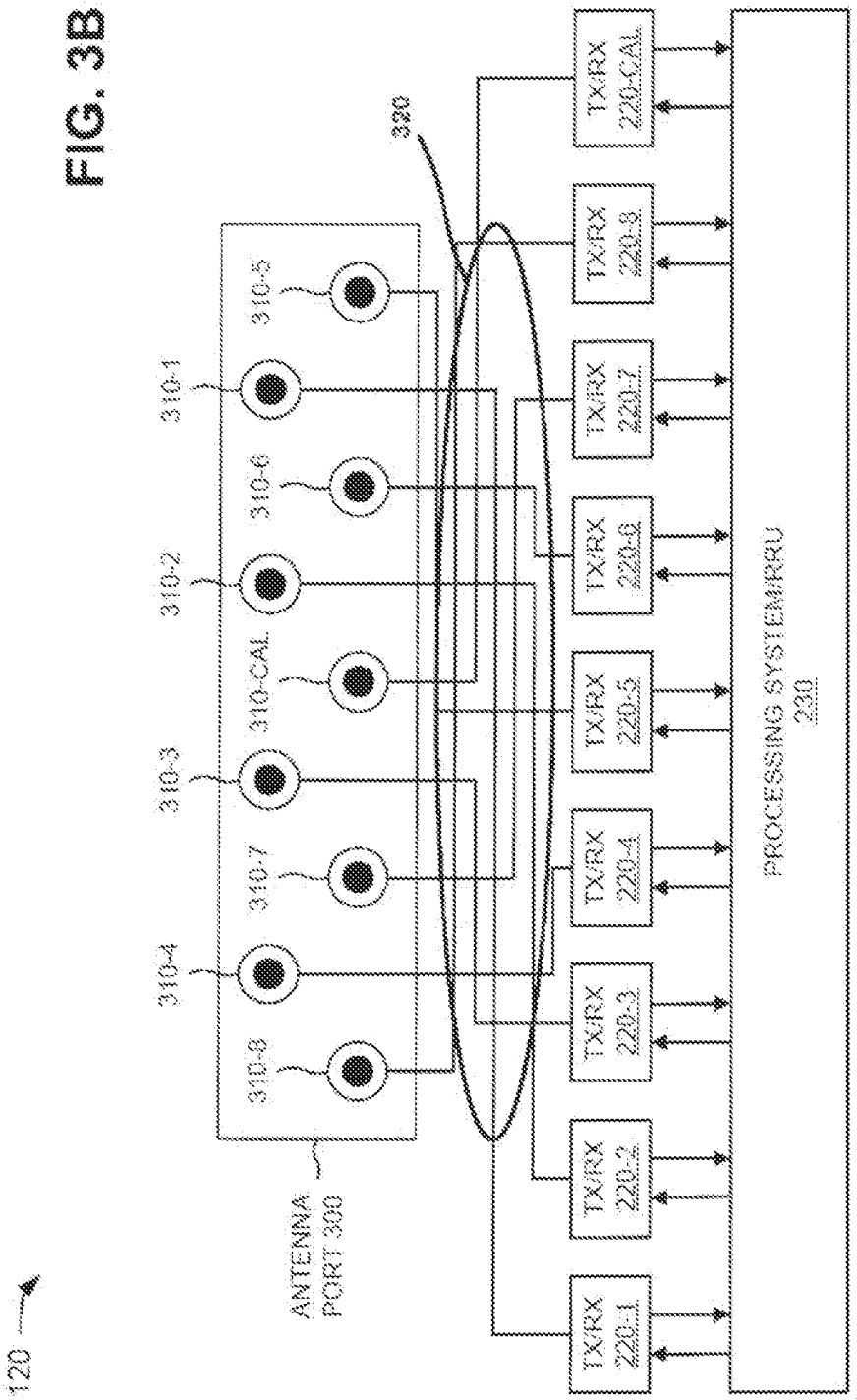

120
ANTENNA PORT 300
310-1
310-2
310-3
310-4
310-5
310-6
310-7
310-8
310-CAL
320
TX/RX 220-1
TX/RX 220-2
TX/RX 220-3
TX/RX 220-4
TX/RX 220-5
TX/RX 220-6
TX/RX 220-7
TX/RX 220-8
TX/RX 220-CAL
PROCESSING SYSTEM/RRU 230

FIG. 4

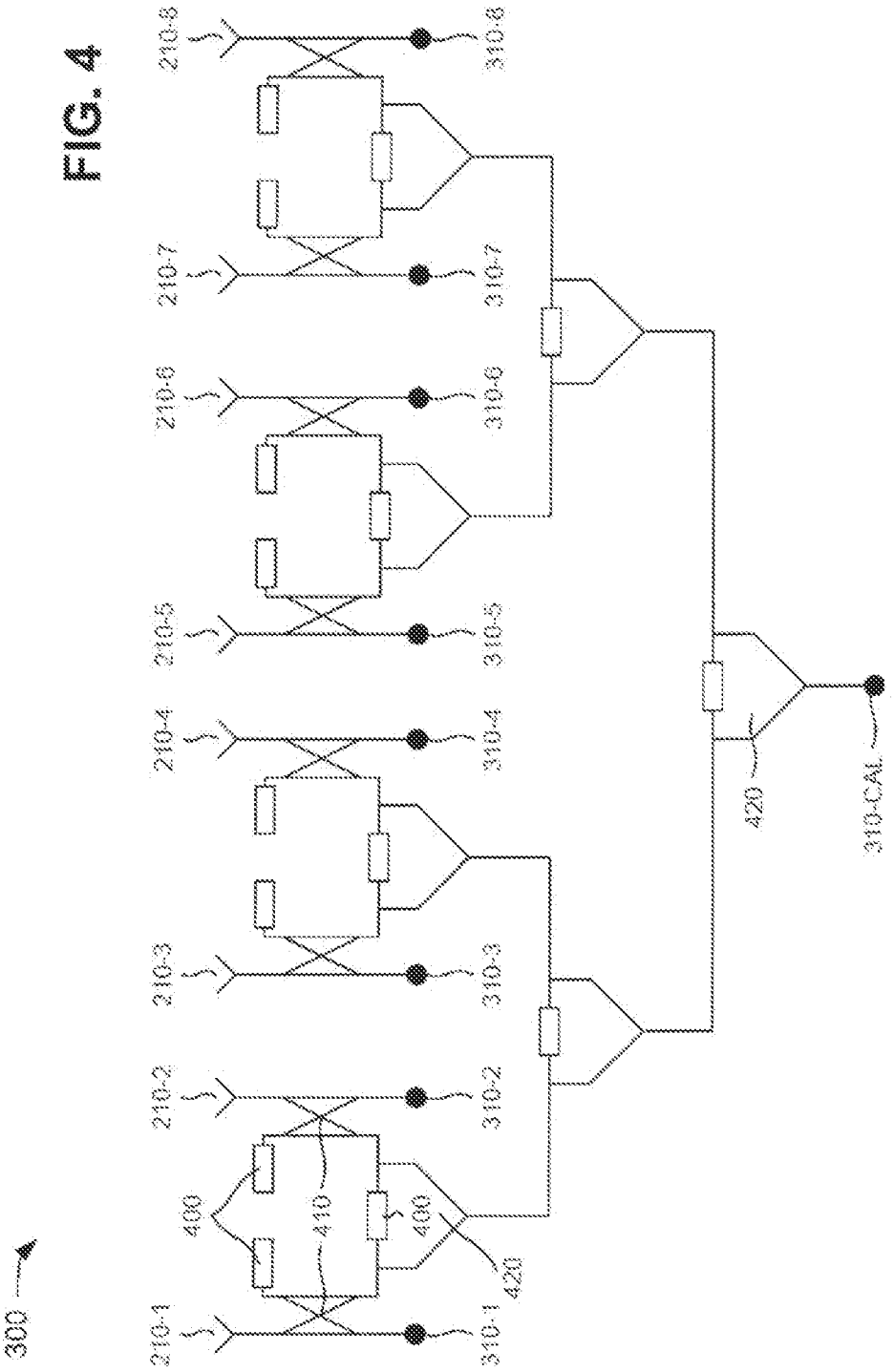

300
210-1
210-2
210-3
210-4
210-5
210-6
210-7
210-8
310-1
310-2
310-3
310-4
310-5
310-6
310-7
310-8
310-CAL
400
410
420

FIG. 5

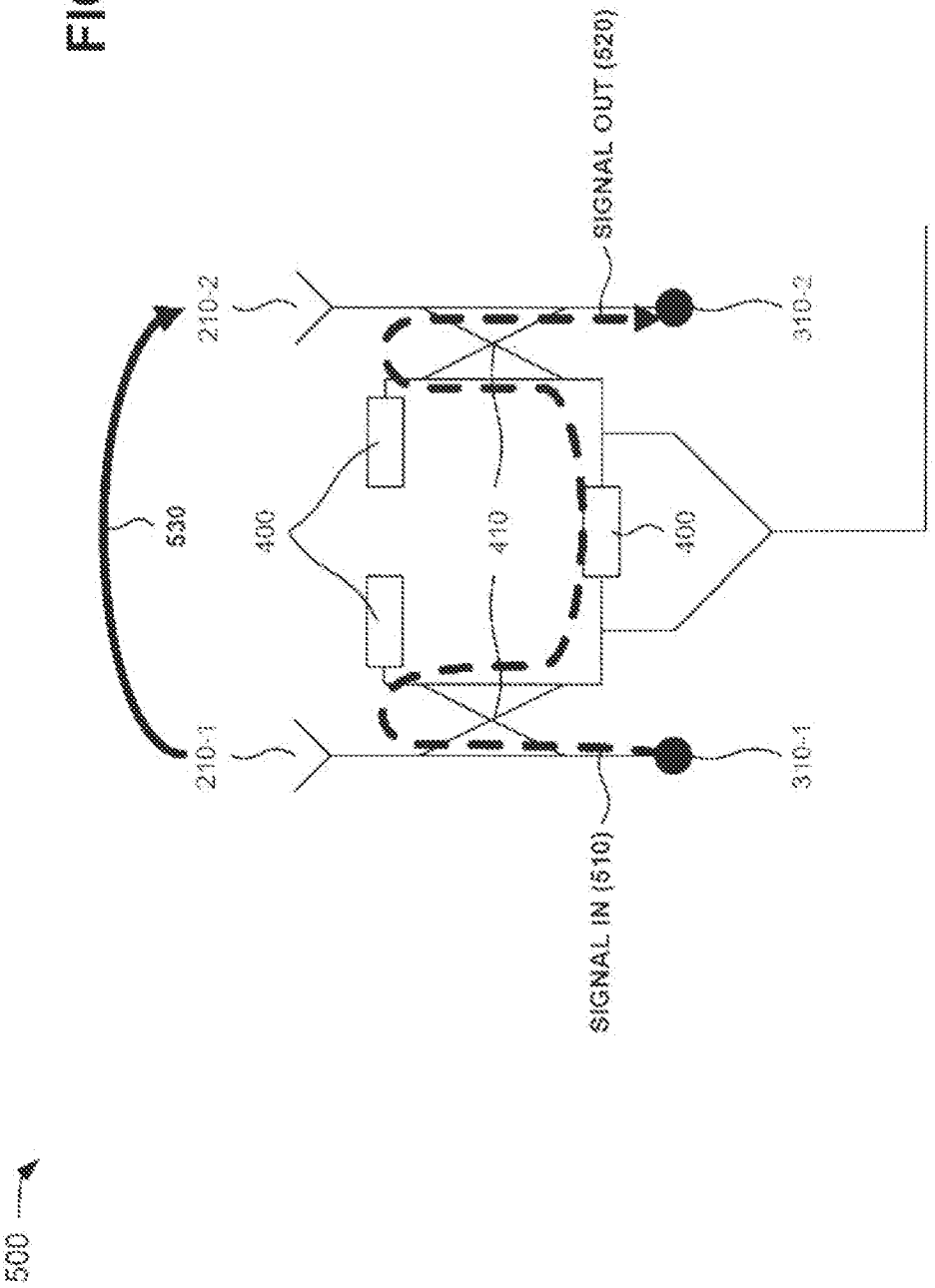

500
SIGNAL IN (510)
SIGNAL OUT (520)
210-1
210-2
310-1
310-2
530
400
410
400

FIG. 6

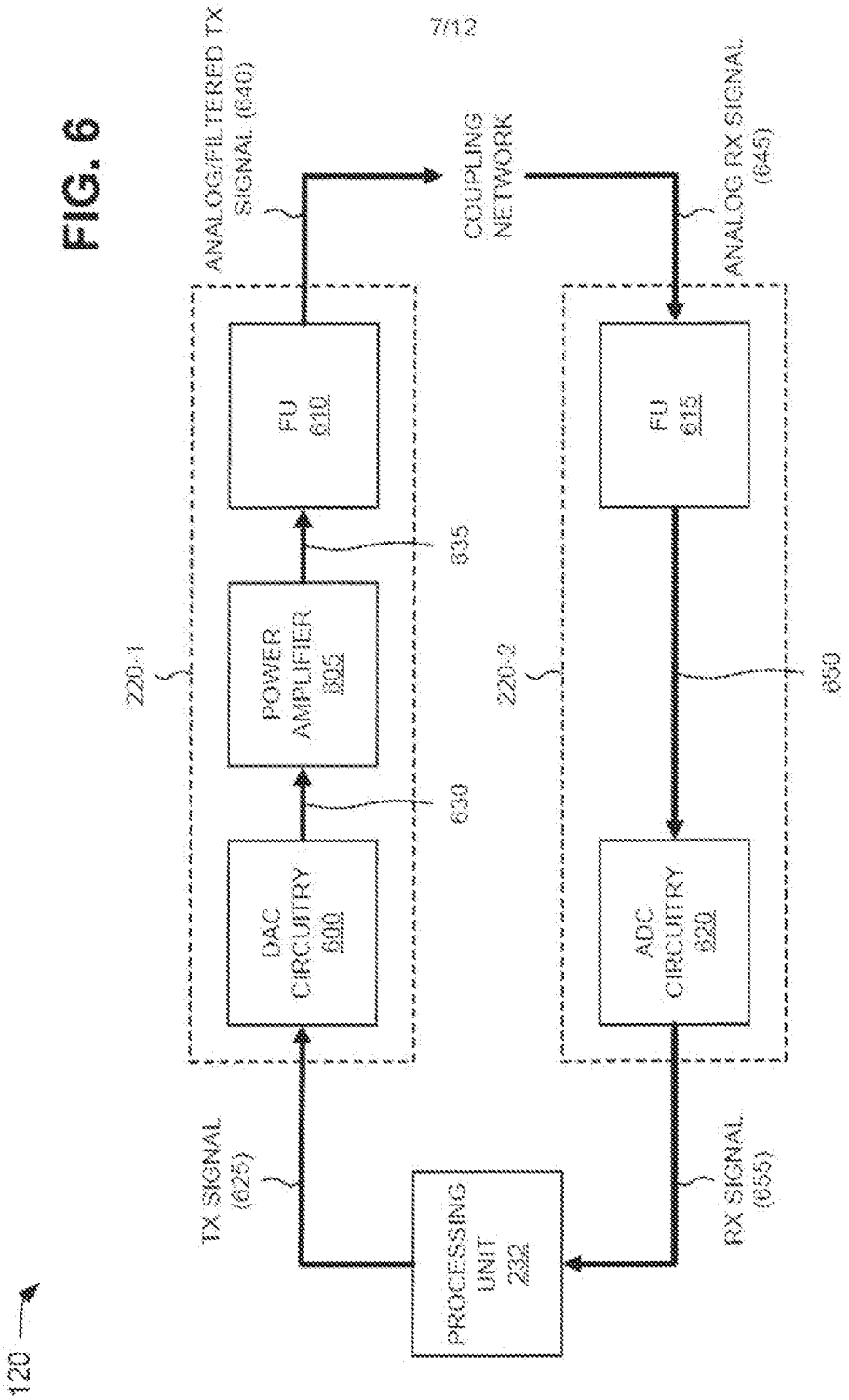
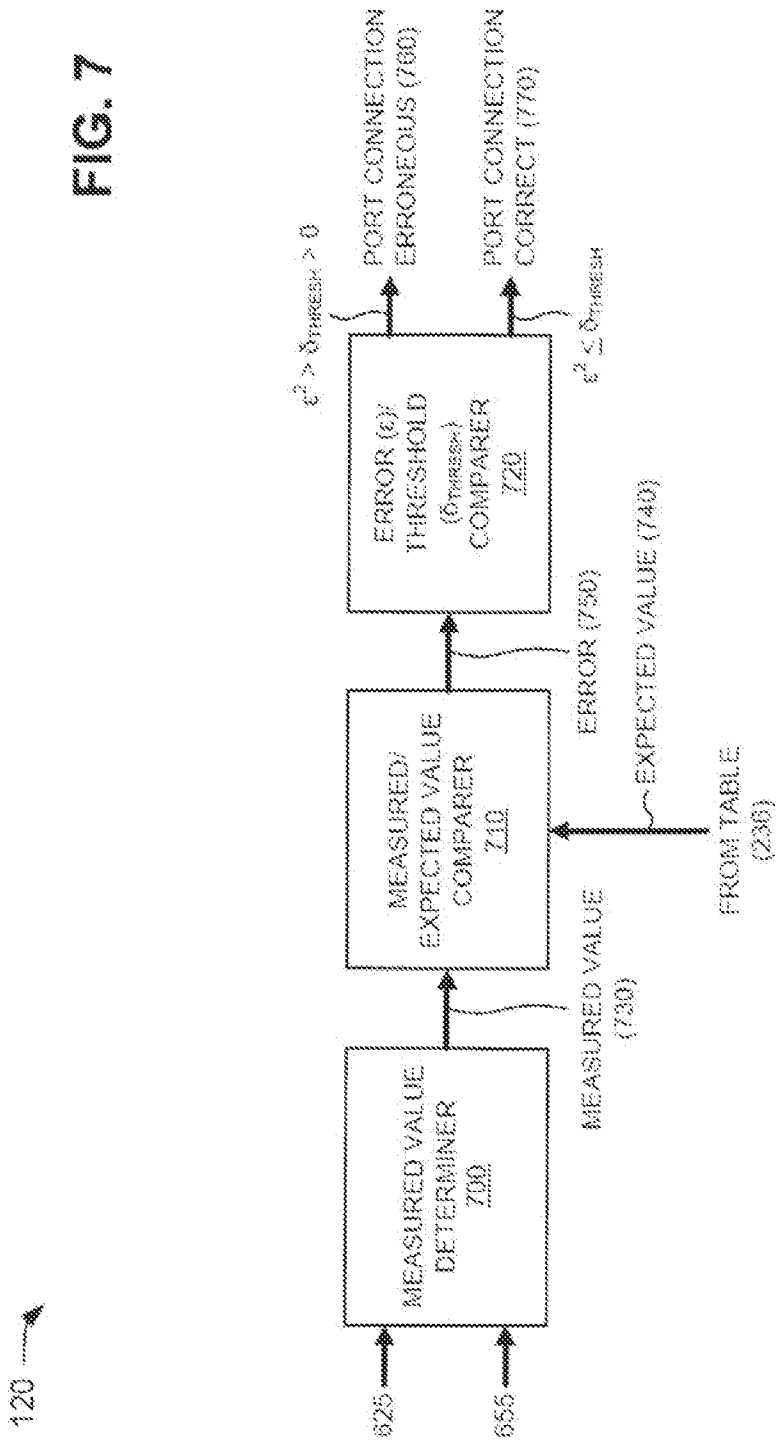

7/12
120
PROCESSING UNIT 232
TX SIGNAL (625)
RX SIGNAL (655)
220-1
220-2
DAC CIRCUITRY 600
POWER AMPLIFIER 605
FU 610
ADC CIRCUITRY 620
FU 615
630
635
660
ANALOG/FILTERED TX SIGNAL (640)
ANALOG RX SIGNAL (645)
COUPLING NETWORK

FIG. 7



Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 310 of 365

FIG. 8

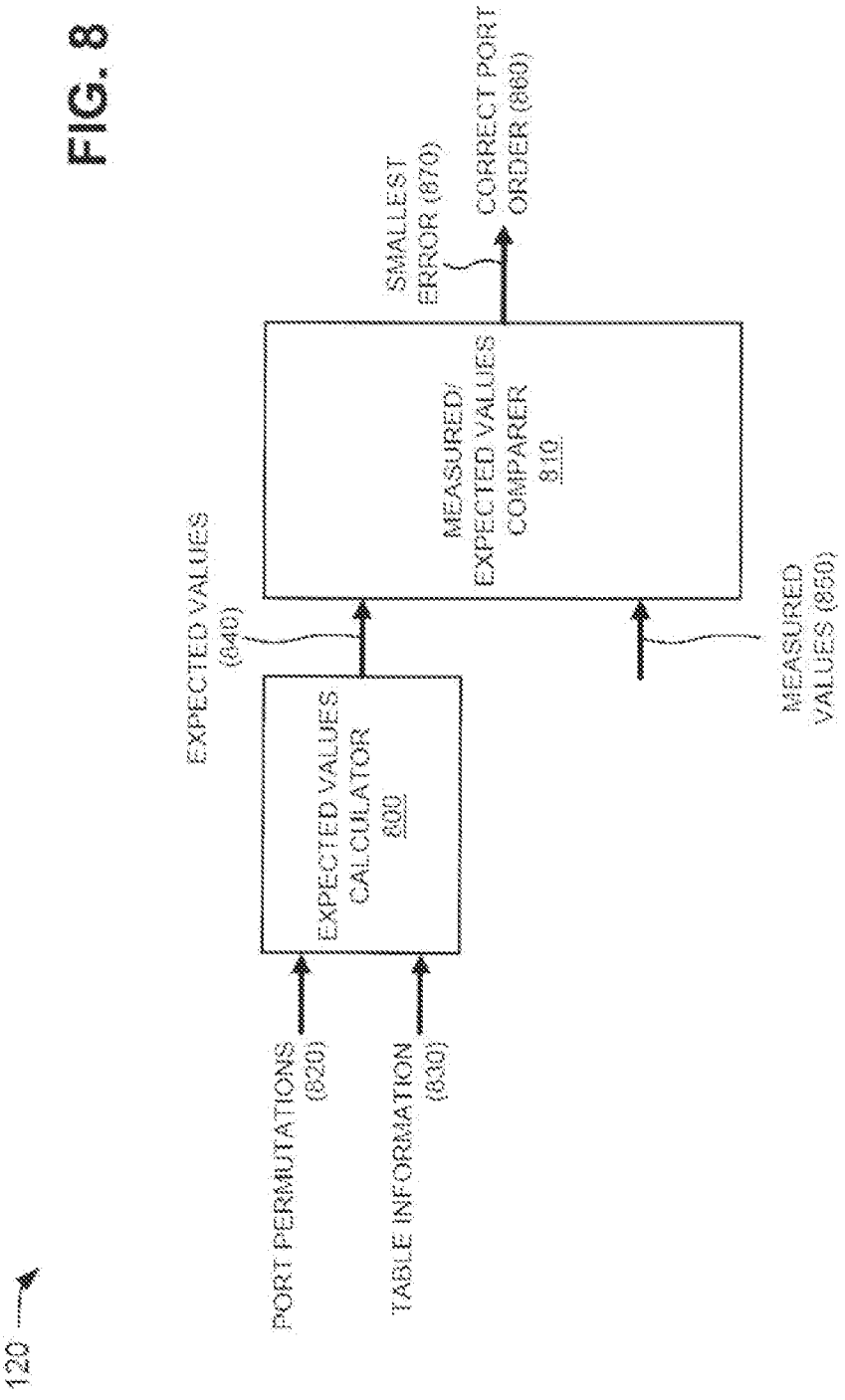

120
PORT PERMUTATIONS (820)
TABLE INFORMATION (830)
EXPECTED VALUES CALCULATOR 800
EXPECTED VALUES (840)
MEASURED VALUES (850)
MEASURED/ EXPECTED VALUES COMPARER 810
SMALLEST ERROR (870)
CORRECT PORT ORDER (860)

FIG. 9

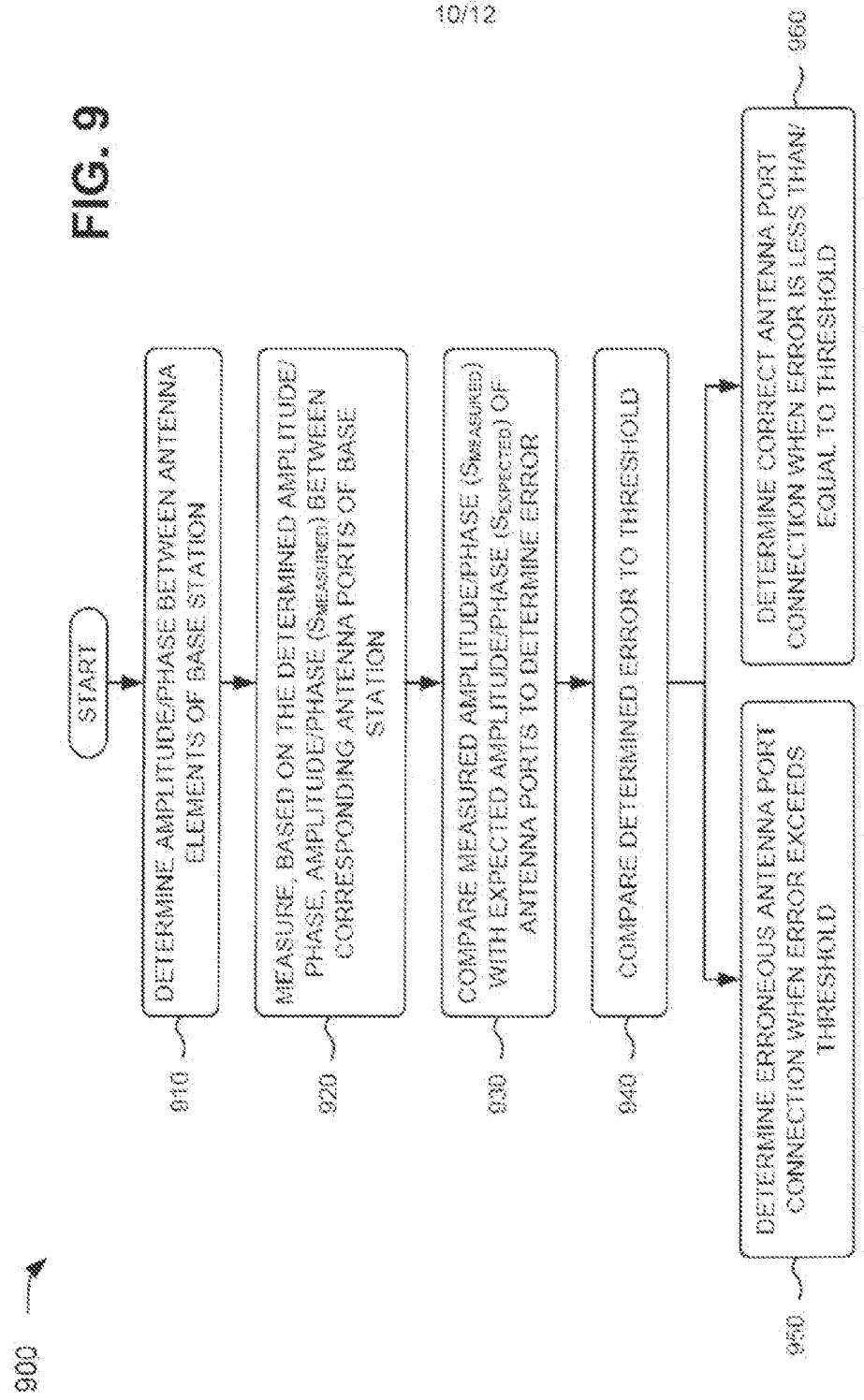

900
START
910
DETERMINE AMPLITUDE/PHASE BETWEEN ANTENNA ELEMENTS OF BASE STATION
920
MEASURE, BASED ON THE DETERMINED AMPLITUDE/PHASE, AMPLITUDE/PHASE ($S_{MEASURED}$) BETWEEN CORRESPONDING ANTENNA PORTS OF BASE STATION
930
COMPARE MEASURED AMPLITUDE/PHASE ($S_{MEASURED}$) WITH EXPECTED AMPLITUDE/PHASE ($S_{EXPECTED}$) OF ANTENNA PORTS TO DETERMINE ERROR
940
COMPARE DETERMINED ERROR TO THRESHOLD
950
DETERMINE ERRONEOUS ANTENNA PORT CONNECTION WHEN ERROR EXCEEDS THRESHOLD
960
DETERMINE CORRECT ANTENNA PORT CONNECTION WHEN ERROR IS LESS THAN/EQUAL TO THRESHOLD

FIG. 10

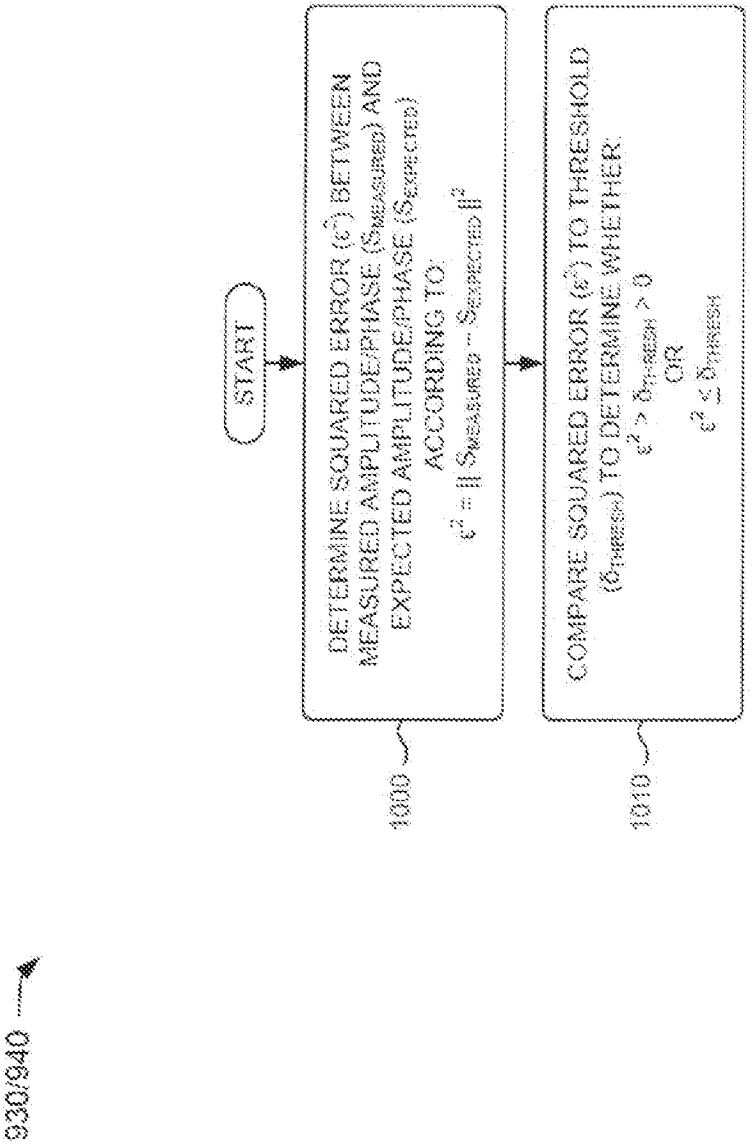
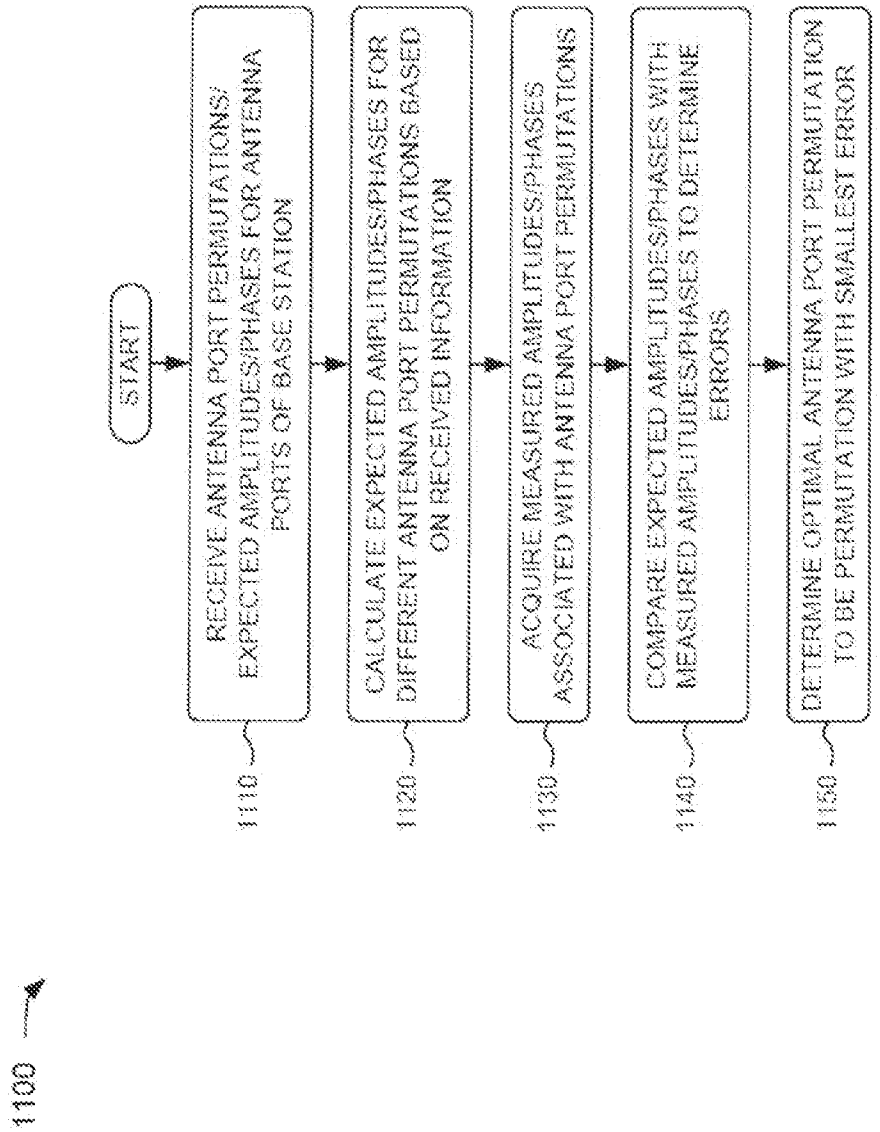

930/940
START
DETERMINE SQUARED ERROR (ε^2) BETWEEN MEASURED AMPLITUDE/PHASE ($S_{MEASURED}$) AND EXPECTED AMPLITUDE/PHASE ($S_{EXPECTED}$) ACCORDING TO:
$\varepsilon^2 = \| S_{MEASURED} - S_{EXPECTED} \|^2$
1000
COMPARE SQUARED ERROR (ε^2) TO THRESHOLD (δ_{THRESH}) TO DETERMINE WHETHER:
$\varepsilon^2 > \delta_{THRESH}$
OR
$\varepsilon^2 \leq \delta_{THRESH}$
1010

FIG. 11



Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 314 of 365

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2009/050583

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01Q, H04W, H07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101154977 A, (ZTEC) ZTE COMMUNICATION CO LTD, 2008-04-02; Retrieved from: WPI database, WEEK 200840, AN 2008-G27750 --	1-20
A	WO 0040050 A1 (ARRAYCOMM, INC.), 6 July 2000 (06.07.2000), page 2, line 11 - page 6, line 4, figures 1-3, claims 1-15, abstract --	-20
A	US 20090051591 A1 (N. NAKAJIMA ET AL), 26 February 2009 (26.02.2009), figure 2, abstract, paragraphs (0068)-(0073), (0080)-(0083) --	1-20

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 January 2010	14-01-2010
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Elisabet Aselius / MRo Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 2009)

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 315 of 365

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2009/050583

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5867123 A (E. GEYH ET AL), 2 February 1999 (02.02.1999), column 1, line 56 - column 2, line 36; column 4, line 5 - line 17, figure 3, claims 1-20, abstract -- --------	1-20

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 316 of 365

International patent classification (IPC)

H04W 24/04 (2009.01)
H01Q 3/26 (2006.01)

Download your patent documents at www.prv.se

The cited patent documents can be downloaded:

- From "Cited documents" found under our online services at www.prv.se (English version)
- From "Anförda dokument" found under "e-tjänster" at www.prv.se (Swedish version)

Use the application number as username. The password is **JOKJGALGRR**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 317 of 365

WO	0040050	A1	06/07/2000	JP	2002534871	T	15/10/2002
				US	6266528	B	24/07/2001
US	20090051591	A1	26/02/2009	NONE			
US	5867123	A	02/02/1999	NONE			

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 318 of 365

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)

The declaration must conform to the following standardized wording provided for in Section 214; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (iv). If this Box is not used, this sheet should not be included in the request.

Declaration of inventorship (Rules 4.17(iv) and 51*bis*.1(a)(iv)) for the purposes of the designation of the United States of America:

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/SE2009/050583 (if furnishing declaration pursuant to Rule 26*ter*).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications:

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name: MIAO, Qingyu

Residence: Beijing, China
(city and either US state, if applicable, or country)

Mailing Address: Room 2-302 building 611, Bei Yuan Jia Yuan, Moli Yuan
Chao yang district
BEIJING 100012

Citizenship: China

Inventor's Signature: Miao Qingyu Date: 2009-05-20
(The signature must be that of the inventor, not that of the agent)

Name: COLDREY, Mikael

Residence: Landvetter, Sweden
(city and either US state, if applicable, or country)

Mailing Address: Kvarnhjulsvägen 4
SE-438 35 Landvetter
SWEDEN

Citizenship: Sweden

Inventor's Signature: Mikael C. Date: 2009-05-26
(The signature must be that of the inventor, not that of the agent)

☒ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iv)".

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 319 of 365

Continuation of Box No. VIII (i) to (v) DECLARATION

If the space is insufficient in any of Boxes Nos. VIII (i) to (v) to furnish all the information, including in the case where more than two inventors are to be named in Box No. VIII (iv), in such case, write "Continuation of Box No. VIII ..." (indicate the item number of the Box) and furnish the information in the same manner as required for the purposes of the Box in which the space was insufficient. If additional space is needed in respect of two or more declarations, a separate continuation box must be used for each such declaration. If this Box is not used, this sheet should not be included in the request.

"Continuation of Box. No VIII (iv)"

Name: GUO, Zhiheng

Residence: Beijing, China

(city and either US state, if applicable, or country)

Mailing Address:
3-303, Nanhuzhongyuang
Chaoyang district
BEIJING 100102
CHINA

Citizenship: China

Inventor's signature: Guo Zhiheng Date: 2009-05-20
(The signature must be that of the inventor, not that of the agent)

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 320 of 365

Client Ref. P28266-US1
Attorney Ref. 4015-7892

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: **Miao** *et al.*	)	
Serial No.: TBA	)	Examiner (Unknown)
Filed: TBA	)	Group Art Unit (Unknown)
For: **Automatic Detection of Erroneous Connections Between Antenna Ports and Radio Frequency Paths**	)	
Attorney Docket No. 4015-7892	)	

Mail Stop PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Please be advised that this is a **U.S. National Stage Filing of PCT Application PCT/SE2009/050583.**

Prior to examination, please amend the application as indicated below.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 321 of 365

AMENDMENTS TO THE CLAIMS

1.-20 (Canceled).

21. (New) A method in a radio network that includes a device, the method comprising:

measuring, via the device, a parameter associated with at least two antenna ports of the device;

comparing, via the device, the measured parameter with an expected parameter associated with the at least two antenna ports to determine an error;

comparing, via the device, the determined error to a threshold; and

determining, via the device:

an erroneous antenna port connection for the at least two antenna ports when the error exceeds the threshold, and

a correct antenna port connection for the at least two antenna ports when the error is less than or equal to the threshold.

22. (New) The method of claim 21, where measuring, via the device, the parameter comprises:

determining a parameter associated with at least two antenna elements of the device, where the at least two antenna elements are associated with the at least two antenna ports; and

measuring, based on the determined parameter associated with the at least two antenna elements, the measured parameter.

23. (New) The method of claim 22, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 322 of 365

24. (New) The method of claim 21, where the measured parameter associated with the at least two antenna ports comprises one or more of an amplitude or a phase.

25. (New) The method of claim 21, where the measured parameter associated with the at least two antenna ports comprises a difference between a signal transmitted via one of the at least two antenna ports and a signal received via another one of the at least two antenna ports.

26. (New) The method of claim 21, where comparing, via the device, the measured parameter ($S_{MEASURED}$) with the expected parameter ($S_{EXPECTED}$) comprises determining a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = || S_{MEASURED} - S_{EXPECTED} ||^2.$$

27. (New) The method of claim 26, where comparing, via the device, the determined error (ε) to the threshold ($\delta_{THRESHOLD}$) comprises comparing the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

28. (New) The method of claim 21, further comprising:

receiving antenna port permutations for a plurality of antenna ports of the device;

receiving expected information associated with the plurality of antenna ports;

calculating expected values for different antenna port permutations based on the received information;

acquiring measured values associated with the different antenna port permutations;

comparing the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations; and

determining an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

29. (New) The method of claim 21, where the device comprises a base station.

30. (New) The method of claim 21, where the device comprises a remote radio unit associated with a base station.

31. (New) A device in a radio network, the device comprising:

at least two antenna ports;

a memory to store a plurality of instructions; and

a processing unit to execute instructions in the memory to:

measure a parameter associated with the at least two antenna ports,

compare the measured parameter with an expected parameter associated with the at least two antenna ports to determine an error,

compare the determined error to a threshold, and

determine:

an erroneous antenna port connection for the at least two antenna ports when the error exceeds the threshold, and

a correct antenna port connection for the at least two antenna ports when the error is less than or equal to the threshold.

32. (New) The device of claim 31, where the device further comprises:

at least two antenna elements associated with the at least two antenna ports, and

where the processing unit is further configured to execute instructions in the memory to:

determine a parameter associated with the at least two antenna elements, and

measure, based on the determined parameter associated with the at least two antenna elements, the measured parameter.

33. (New) The device of claim 32, where the determined parameter associated with the at least two antenna elements comprises one or more of an amplitude or a phase.

34. (New) The device of claim 31, where the measured parameter associated with the at least two antenna ports comprises one or more of an amplitude or a phase.

35. (New) The device of claim 31, where the measured parameter associated with the at least two antenna ports comprises a difference between a signal transmitted via one of the at least two antenna ports and a signal received via another one of the at least two antenna ports.

36. (New) The device of claim 31, where, when comparing the measured parameter with the expected parameter, the processing unit is further configured to execute instructions in the memory to:

determine a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$\varepsilon^2 = || S_{MEASURED} - S_{EXPECTED} ||^2$.

37. (New) The device of claim 36, where, when comparing the determined error to the threshold ($\delta_{THRESHOLD}$), the processing unit is further configured to execute instructions in the memory to:

compare the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

38. (New) The device of claim 31, where the processing unit is further configured to execute instructions in the memory to:

receive antenna port permutations for a plurality of antenna ports of the device,

receive expected information associated with the plurality of antenna ports,

calculate expected values for different antenna port permutations based on the received information,

acquire measured values associated with the different antenna port permutations,

compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations, and

determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

39. (New) The device of claim 31, where the device comprises a base station.

40. (New) The device of claim 31, where the device comprises a remote radio unit associated with a base station.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 327 of 365

REMARKS

Applicant submits the foregoing amendments prior to examination on the merits for consideration by the Office. The claim amendments cancel claims 1-20, and add new claims 21-40. New claims 21-40 are substantially similar to now canceled claims 1-20.

The claims are not amended for reasons of patentability. Instead, the claims are amended to eliminate multiple dependent claims, and to ensure that the language of the claims comports with U.S. practice. No new matter has been added by any change.

Applicant respectfully requests that the Office enter the amendments prior to examination on the merits.

Respectfully submitted,

COATS & BENNETT P.L.L.C.

Date: November 17, 2011

David D. Kalish
Registration No. 42,706
Telephone: (919) 854-1844

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 328 of 365

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
25 November 2010 (25.11.2010)

PCT

(10) International Publication Number
WO 2010/134861 A1

(51) International Patent Classification:
H04W 24/04 (2009.01) *H01Q 3/26* (2006.01)

(21) International Application Number:
PCT/SE2009/050583

(22) International Filing Date:
20 May 2009 (20.05.2009)

(25) Filing Language: English

(26) Publication Language: English

(71) Applicant *(for all designated States except US)*: **TELEFONAKTIEBOLAGET L M ERICSSON (PUBL)** [SE/SE]; S-164 83 Stockholm (SE).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **MIAO, Qingyu** [CN/CN]; Room 2-302 building 611, Bei Yuan Jia Yuan, Moli Yuan, Chao yang district, Beijing 100012 (CN). **GUO, Zhiheng** [CN/CN]; 3-303, Nanhuzhongyuang, Chaoyang district, BEIJING 100102, CHINA, Beijing 100102 (CN). **COLDREY, Mikael** [SE/SE]; Kvarnhjulsvägen 4, S-SE-438 35 Landvetter (SE).

(74) Agent: **NILSSON, Charlotte**; Ericsson AB, Patent Unit 3G, Torshamnsgatan 23, S-16480 Stockholm (SE).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

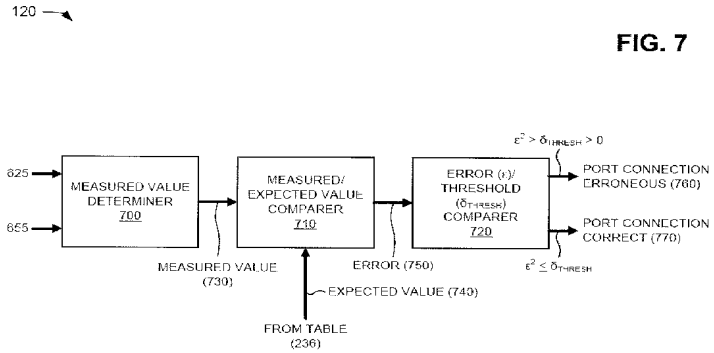
Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

(54) Title: AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS



(57) Abstract: A device (110) receives consecutive negative acknowledgments (NACKs) (540), measures a downlink channel quality (530) associated with the device (110), and triggers autonomous retransmission (430) when power is limited in the device (110), when the device (110) is using a minimum usable enhanced dedicated channel (E-DCH) transport format combination (ETFC), and when one of a number of consecutive NACKs (540) is greater than a predefined number, or the measured downlink channel quality (530) is less than a predefined threshold.

WO 2010/134861 A1

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 329 of 365

AUTOMATIC DETECTION OF ERRONEOUS CONNECTIONS BETWEEN ANTENNA PORTS AND RADIO FREQUENCY PATHS

TECHNICAL FIELD

Embodiments described herein relate generally to wireless communication systems, and more particularly, to automatic detection of erroneous connections between antenna ports and radio frequency (RF) paths.

BACKGROUND

Smart antennas (also known as adaptive array antennas, a multi-antenna system, multiple antennas, and multiple input, multiple output (MIMO) antennas) may be used with wireless communication devices, such as base stations (also referred to as "Node Bs"). Smart antennas are antenna arrays with smart signal processing algorithms that are used to identify spatial signal information (e.g., a direction of arrival (DOA) of the signal) and to calculate beamforming vectors. The beamforming vectors are used to track and locate an antenna beam associated with a target user equipment (e.g., a mobile telephone).

Smart antennas have two main functions—DOA estimation and beamforming. During generation of a beam, each smart antenna uses weights for beamforming. Different antennas may have different weights and may transmit different data. Current time division-synchronous code division multiple access (TD-SCDMA) based devices (e.g., base stations) may include four to eight antennas. Each antenna is connected, via a cable, to the base station (e.g., a radio base station (RBS) or a remote radio unit (RRU)). In such an arrangement, if a cable is connected to an incorrect antenna, an incorrect beam is generated and performance is decreased. However, manually checking incorrect or erroneous connections is time consuming and tedious.

One proposed solution to this problem is to automatically detect an incorrect connection between an antenna port and a RF path. In the proposed solution, an uplink-received signal is collected and a channel is detected. The channel can be detected with the uplink-received signal. The uplink-received signal is used to detect a maximum energy by traveling in all possible orders of an antenna array vector and in all possible spatial directions. Specifically, the uplink-received signal is used to calculate a correlation matrix, and all possible arrangements of an antenna weighting factor sequence are traversed to obtain a weighting factor matrix. After searching through all directions of space, a maximum value of different weighting factor arrangements is determined, and an arrangement corresponding to the maximum received power is chosen to be a current connection order. However, the proposed solution requires an uplink signal, which means that the proposed solution can only be used with an operational wireless communication network or with extra equipment that generates the uplink signal.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 330 of 365

SUMMARY

It is an object of the invention to overcome at least some of the above disadvantages and to automatically detect a connection error with a base station (or a RRU) without the need for an operational wireless communication network or extra equipment that generates an uplink signal.

Embodiments described herein may automatically detect a connection error in a smart antenna (e.g., of a base station or a RRU) by measuring an amplitude and/or a phase between antenna ports of the smart antenna. In one embodiment, for example, in order to transmit and receive signals accurately, every antenna element, RF cable, and transceiver making up the smart antenna may need to operate identically. This means that every transmitting and receiving link may need to have the same amplitude and phase response. The base station may automatically implement a smart antenna calibration procedure that includes compensating the amplitude and phase of each transmitting and receiving link.

During antenna calibration, the base station (or the RRU) may measure amplitude and phase of an impulse response of a circuit between an antenna port and a calibration port. The base station (or the RRU) may also measure the amplitude and phase between any two antenna ports. A smart antenna vendor may provide a table that includes amplitude and phase information between any two antenna ports of the smart antenna. The base station (or the RRU) may compare the values provided in the antenna vendor's table with the measured amplitude and phase between two antenna ports. If there is a large difference between the table values and the measured values, the base station (or the RRU) may determine that there is an antenna connection error.

In an exemplary embodiment, a base station may determine an amplitude and/or phase between antenna elements of the base station, and may measure, based on the determined amplitude/phase, an amplitude/phase between corresponding antenna ports of the base station. The base station may compare the measured amplitude/phase with an expected amplitude/phase of the antenna ports to determine an error, and may compare the determined error to a threshold. The base station may determine an erroneous antenna port connection when the error exceeds the threshold, and may determine a correct antenna port connection when the error is less than or equal to the threshold.

In another exemplary embodiment, the base station may determine a squared error between the measured amplitude/phase and the expected amplitude/phase, and may compare the squared error to the threshold to determine whether the squared error is greater than the threshold and zero or whether the squared error is less than or equal to the threshold.

In another exemplary embodiment, the base station may receive antenna port

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 331 of 365

permutations for multiple antenna ports of the base station, and may receive expected value information associated with the multiple antenna ports. The base station may calculate expected values for different antenna port permutations based on the received information, and may acquire measured values associated with the different antenna port permutations. The base station may compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations, and may determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

Such an arrangement may ensure that connection errors are automatically and easily detected, and that performance issues, due to connection errors, are minimized. The arrangement may not require an uplink signal, and thus may not require an operational wireless communication network or extra equipment to generate an uplink signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 depicts a diagram of an exemplary network in which systems and/or methods described herein may be implemented;

Fig. 2 illustrates a diagram of exemplary components of a base station depicted Fig. 1;

Figs. 3A and 3B depict diagrams of further exemplary components of the base station illustrated in Fig. 1;

Fig. 4 depicts a diagram of exemplary components of an antenna port illustrated in Figs. 3A and 3B;

Fig. 5 illustrates a diagram of exemplary interactions among exemplary components of a portion of the antenna port depicted in Fig. 4;

Fig. 6 illustrates a diagram of additional exemplary components of the base station depicted Fig. 1;

Figs. 7 and 8 depict diagrams of exemplary functional components of the base station illustrated in Fig. 1;

Figs. 9 and 10 illustrate flow charts of an exemplary process for automatically detecting a connection error in a smart antenna according to embodiments described herein; and

Fig. 11 depicts a flow chart of an exemplary process for determining an optimal antenna port permutation in a smart antenna according to embodiments described herein.

DETAILED DESCRIPTION

The following detailed description refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description does not limit the invention.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 332 of 365

Embodiments described herein may automatically detect a connection error in a smart antenna (e.g., of a base station or a RRU) by measuring an amplitude and/or a phase between antenna ports of the smart antenna and by comparing the measured amplitude/phase to an expected amplitude/phase. The automatic detection techniques described herein may be used to quickly and easily detect connection errors in a smart antenna, and may prevent performance problems due to connection errors.

Fig. 1 depicts a diagram of an exemplary network 100 in which systems and/or methods described herein may be implemented. As shown, network 100 may include two user equipment (UEs) 110-1 and 110-2 (referred to collectively, and in some instances individually, as "user equipment 110") and a base station 120. Two pieces of user equipment 110 and a single base station 120 have been illustrated in Fig. 1 for simplicity. In practice, there may be more UEs 110 and/or base stations 120. Also, in some instances, a component in network 100 (e.g., one or more of user equipment 110 and/or base station 120) may perform one or more functions described as being performed by another component or group of components in network 100.

User equipment 110 may include one or more devices capable of sending/receiving voice and/or data to/from base station 120. In one embodiment, user equipment 110 may include, for example, a wireless telephone, a personal digital assistant (PDA), a laptop computer, etc. User equipment 110 may receive information from base station 120, and may generate and provide information to base station 120.

In one embodiment, base station 120 (also referred to as a "Node B") may be associated with a radio access network (RAN) (not shown). The RAN may include one or more devices for transmitting voice and/or data to user equipment 110 and a core network (not shown). The RAN may include a group of base stations 120 and a group of radio network controllers (RNCs). The RNCs may include one or more devices that control and manage base station 120. The RNCs may also include devices that perform data processing to manage utilization of radio network services. The RNCs may transmit/receive voice and data to/from base station 120, other RNCs, and/or the core network.

A RNC may act as a controlling radio network controller (CRNC), a drift radio network controller (DRNC), or a serving radio network controller (SRNC). A CRNC may be responsible for controlling the resources of base station 120. On the other hand, an SRNC may serve particular user equipment 110 and may manage connections towards that user equipment 110. Likewise, a DRNC may fulfill a similar role to the SRNC (e.g., may route traffic between a SRNC and particular user equipment 110).

Base station 120 may include one or more devices that receive voice and/or data from the

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 333 of 365

RNCs (not shown) and transmit that voice and/or data to user equipment 110 via an air interface. Base station 120 may also include one or more devices that receive voice and/or data from user equipment 110 over an air interface and transmit that voice and/or data to the RNCs or other user equipment 110.

In one embodiment, base station 120 may determine an amplitude and/or phase between antenna elements of base station 120, and may measure, based on the determined amplitude/phase, an amplitude/phase between corresponding antenna ports of base station 120. Base station 120 may compare the measured amplitude/phase with an expected amplitude/phase of the antenna ports to determine an error, and may compare the determined error to a threshold. Base station 120 may determine an erroneous antenna port connection when the error exceeds the threshold, and may determine a correct antenna port connection when the error is less than or equal to the threshold.

In another embodiment, base station 120 may receive antenna port permutations for multiple antenna ports of base station 120, and may receive expected information associated with the multiple antenna ports. Base station 120 may calculate expected values for different antenna port permutations based on the received information, and may acquire measured values associated with the different antenna port permutations. Base station 120 may compare the expected values for the different antenna port permutations with the measured values for the different antenna port permutations to determine errors for the different antenna port permutations, and may determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

Fig. 2 illustrates a diagram of exemplary components of base station 120. As shown in Fig. 2, base station 120 may include a group of antennas 210-1 through 210-8 (referred to collectively as "antennas 210" and in some instances, individually as "antenna 210"), a group of transceivers (TX/RX) 220-1 through 220-8 (referred to collectively as "transceivers 220" and in some instances, individually as "transceiver 220"), a processing system/RRU 230, and an Iub interface (I/F) 240.

Antennas 210 may include one or more directional and/or omni-directional antennas. In one embodiment, antennas 210 may be associated with a smart antenna of base station 120. Although eight antennas 210 are shown in Fig. 2, in other embodiments, base station 120 may include more or less than eight antennas 210.

Transceivers 220 may be associated with corresponding antennas 210 and may include transceiver circuitry for transmitting and/or receiving symbol sequences in a network, such as network 100, via antennas 210.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 334 of 365

Processing system/RRU 230 may control the operation of base station 120. Processing system/RRU 230 may also process information received via transceivers 220 and Iub interface 240. Processing system/RRU 230 may further measure quality and strength of connection, may determine the frame error rate (FER), and may transmit this information to a RNC (not shown). In one embodiment, processing system 230 may be part of a RRU that is associated with base station 120. As illustrated, processing system/RRU 230 may include a processing unit 232 and a memory 234 (e.g., that includes an expected value table 236).

Processing unit 232 may include one or more processors, microprocessors, application specific integrated circuits (ASICs), field programmable gate arrays (FPGAs), or the like. Processing unit 232 may process information received via transceivers 220 and Iub interface 240. The processing may include, for example, data conversion, forward error correction (FEC), rate adaptation, Wideband Code Division Multiple Access (WCDMA) spreading/dispreading, quadrature phase shift keying (QPSK) modulation, etc. In addition, processing unit 232 may generate control messages and/or data messages, and may cause those control messages and/or data messages to be transmitted via transceivers 220 and/or Iub interface 240. Processing unit 232 may also process control messages and/or data messages received from transceivers 220 and/or Iub interface 240.

Memory 234 may include a random access memory (RAM), a read-only memory (ROM), and/or another type of memory to store data and instructions that may be used by processing unit 232. As further shown in Fig. 2, memory 234 may include an expected value table 236. Expected value table 236 may be a table (e.g., provided by a vendor or a manufacturer of base station 120) that includes amplitude and/or phase information between any two antenna ports of base station 120. As shown in an exemplary embodiment of expected value table 236 (provided below), the amplitude between two antennas (e.g., two of antennas 210) may be different. Amplitude may be provided in decibels (dB) and phase may be provided in degrees (deg). Parameter "S12" may represent antenna port "1" as an input port and antenna port "2" as an output port. Base station 120 may measure amplitude/phase between two particular antennas and may compare the measured values with corresponding values provided in expected value table 236 (e.g., for the two particular antennas). If there is a large difference (e.g., greater than a particular threshold) between the measured values and the values provided in expected value table 236, base station 120 may determine that there is an antenna connection error.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 335 of 365

Expected Value Table

Parameter		Frequency					
		1880	1900	1920	2010	2018	2025
S11	Amplitude[dB]	32.42	27.73	21.2	20.49	19.89	19.95
	Phase[deg]	60.44	17.67	-148.27	6.51	-19.83	-53.81
S12	Amplitude[dB]	20.73	20.99	21.26	21.62	21.66	21.64
	Phase[deg]	-90.77	151.7	34.94	-126.48	-174.91	143.09
S13	Amplitude[dB]	27.8	29.71	30.43	29.75	29.91	30.25
	Phase[deg]	73.64	-43.67	-166.86	22.2	-27.41	-69.84
S14	Amplitude[dB]	35.38	33.61	34.32	35.9	38.18	40.83
	Phase[deg]	-127.64	106.61	7.69	177.5	132.83	88.39
S15	Amplitude[dB]	32.97	34.53	36.41	36.92	38.17	39.6
	Phase[deg]	-81.33	174.69	53.5	-83.76	-123.12	-160.59
S16	Amplitude[dB]	34.1	32.46	31.41	29.63	30.33	31.21
	Phase[deg]	68.84	-50.64	-145.01	40.11	-4.94	-46.26
S17	Amplitude[dB]	34.1	35.06	39.57	39.79	39.8	38.83
	Phase[deg]	110.02	5.61	-135.61	75.77	15.1	-34.45
S18	Amplitude[dB]	32.75	32.57	32.82	34.31	34.59	34.94
	Phase[deg]	-107.36	126.67	9.76	-175.88	136.23	93.41
S1cal	Amplitude[dB]	26.03	25.99	25.95	25.58	25.51	25.41
	Phase[deg]	134.94	115.65	96.72	12.53	5.2	-1.44
S22	Amplitude[dB]	28.94	26.21	17.56	17.06	18.78	21.24
	Phase[deg]	83.67	-62.23	-147.6	105.45	64.93	18.2
S23	Amplitude[dB]	21.49	21.56	21.74	22.64	22.75	22.87
	Phase[deg]	-73.63	165.77	49.22	-118.43	-165.95	152.11
S24	Amplitude[dB]	27.89	29.38	30.06	30.3	30.29	30.48
	Phase[deg]	60.22	-62.74	166.26	-7.96	-56.5	-99.25
S25	Amplitude[dB]	31.61	31.68	31.76	33.08	33.33	33.59
	Phase[deg]	115.27	-66.65	-115.9	62.5	15.88	-25.2
S26	Amplitude[dB]	26.71	28.25	28.63	26.6	26.82	26.89
	Phase[deg]	-59.76	170.94	40.38	-124.01	-174.69	141.46
S27	Amplitude[dB]	28.33	29.73	31.28	28.78	29.27	29.9
	Phase[deg]	88.08	-37.85	-152.45	42.32	-7.34	-47.57
S28	Amplitude[dB]	35.99	36.3	36.51	36.9	36.59	36.16
	Phase[deg]	93.27	-20.23	-146.15	60.79	15.59	-24.07
S2cal	Amplitude[dB]	26.3	26.26	26.14	25.32	25.26	25.3
	Phase[deg]	137.11	116.41	98.33	12.91	4.61	-2.33
S33	Amplitude[dB]	16.47	20	28.62	24.77	27.31	33.8
	Phase[deg]	-129.33	161.77	-171.52	113.47	80.98	26.54
S34	Amplitude[dB]	21.09	21.14	21.37	21.89	21.89	21.84
	Phase[deg]	-97.45	144.5	24.71	-141.86	168.66	125.85
S35	Amplitude[dB]	36.5	36.56	36.92	38.47	38.2	38.14
	Phase[deg]	64.79	-53.85	-174.55	34.34	-9.47	-47.73
S36	Amplitude[dB]	29.97	30.37	32.47	32.05	31.94	32
	Phase[deg]	129.78	18.06	-108.25	82.51	33.59	-8.47
S37	Amplitude[dB]	25.66	26.42	27.65	29.64	30.88	32
	Phase[deg]	-78.74	169.76	50.16	-98.08	-146.41	169.01

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 336 of 365

Parameter		Frequency					
		1880	1900	1920	2010	2018	2025
S38	Amplitude[dB]	31.71	31.44	31.51	29.22	29.36	29.67
	Phase[deg]	78.9	-36.28	-150.27	42	-4.52	-45.92

Iub interface 240 may include one or more line cards that allow base station 120 to transmit data to and receive data from a RNC.

As described herein, base station 120 may perform certain operations in response to processing unit 232 executing software instructions of an application contained in a computer-readable medium, such as memory 234. In one example, a computer-readable medium may be defined as a physical or logical memory device. A logical memory device may include memory space within a single physical memory device or spread across multiple physical memory devices. The software instructions may be read into memory 234 from another computer-readable medium or from another device via antennas 210 and transceivers 220. The software instructions contained in memory 234 may cause processing unit 232 to perform processes described herein. Alternatively, hardwired circuitry may be used in place of or in combination with software instructions to implement processes described herein. Thus, embodiments described herein are not limited to any specific combination of hardware circuitry and software.

Although Fig. 2 shows exemplary components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional components than depicted in Fig. 2. In still other embodiments, one or more components of base station 120 may perform one or more other tasks described as being performed by one or more other components of base station 120.

Figs. 3A and 3B depict diagrams of further exemplary components of base station 120. As shown in Fig. 3A, base station 120 may include an antenna port 300 that includes eight ports 310-1 through 310-8 (referred to collectively as "ports 310" and in some instances, individually as "port 310") connected to corresponding antennas 210-1 through 210-8, and a calibration port 310-CAL. Antennas 210 may include the features described above in connection with, for example, Fig. 2.

Antenna port 300 may include a device that enables antennas 210 to connect to transceivers 220 (Fig. 2) of base station 120, via cables. In one embodiment, antenna port 300 may include an antenna port for a dual-polarized eight antenna system, as shown in Fig. 3A. In another embodiment, antenna port 300 may include an antenna port for a normal eight antenna system.

Each of ports 310-1 through 310-8 may include a port capable of connecting one of

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 337 of 365

antennas 210 to one of transceivers 220 (Fig. 2), via a cable. Each of ports 310-1 through 310-8 may be capable of connecting to a variety of cable connector types, including male connectors, female connectors, optical connectors, electrical connectors, SubMiniature version A (SMA) connectors, threaded Neill-Concelman (TNC) connectors, Bayonet Neill-Concelman (BNC) connectors, etc.

Calibration port 310-CAL may include a port capable of connecting antenna port 300 to one of transceivers 220 (Fig. 2), via a cable. Calibration port 310-CAL may be capable of connecting to a variety of cable connector types, including male connectors, female connectors, optical connectors, electrical connectors, SMA connectors, TNC connectors, BNC connectors, etc.

As shown in Fig. 3B, antenna port 300 may connect antennas 210 (omitted from Fig. 3B for clarity) to corresponding transceivers 220, via ports 310 and RF cables 320. Transceivers 220 may communicate with processing system/RRU 230. Transceivers 220 and processing system/RRU 230 may include the features described above in connection with, for example, Fig. 2. Antenna port 300 and ports 310 may include the features described above in connection with, for example, Fig. 3A.

Each of RF cables 320 may include a cable that transmits high frequency signals. RF cables 320 may include cables capable of connecting ports 310 to corresponding transceivers 220. RF cables 320 may include a variety of cable connector types, including male connectors, female connectors, optical connectors, electrical connectors, SMA connectors, TNC connectors, BNC connectors, etc.

As further shown in Fig. 3B, port 310-1 (and antenna 210-1) may connect to transceiver 220-1 via one of RF cables 320, port 310-2 (and antenna 210-2) may connect to transceiver 220-2 via one of RF cables 320, port 310-3 (and antenna 210-3) may connect to transceiver 220-3 via one of RF cables 320, port 310-4 (and antenna 210-4) may connect to transceiver 220-4 via one of RF cables 320, port 310-5 (and antenna 210-5) may connect to transceiver 220-5 via one of RF cables 320, port 310-6 (and antenna 210-6) may connect to transceiver 220-6 via one of RF cables 320, port 310-7 (and antenna 210-7) may connect to transceiver 220-7 via one of RF cables 320, port 310-8 (and antenna 210-8) may connect to transceiver 220-8 via one of RF cables 320, and port 310-CAL may connect to transceiver 220-CAL via one of RF cables 320. In such an arrangement there is a possibility that one of RF cables 320 may be incorrectly connected to one of ports 310 (e.g., one of antennas 210), which may generate an incorrect beam and may decrease performance of base station 120. Embodiments described automatically detect and enable correction of such connection errors.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 338 of 365

Although Figs. 3A and 3B show exemplary components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional components than depicted in Figs. 3A and 3B. In still other embodiments, one or more components of base station 120 may perform one or more other tasks described as being performed by one or more other components of base station 120.

Fig. 4 depicts a diagram of exemplary components of antenna port 300. As shown, antenna port 300 may include antennas 210, ports 310, calibration port 310-CAL, loads 400, directional couplers 410, and power splitters 420. Antennas 210 may include the features described above in connection with, for example, Fig. 2. Ports 310 and calibration port 310-CAL may include the features described above in connection with, for example, Figs. 3A and 3B. Fig. 4 shows multiple loads 400, directional couplers 410, and power splitters 420, although only a few of them are labeled (for clarity).

Each of loads 400 may include a device connected to an output (e.g., one of ports 310) of a circuit. In one embodiment, each of loads 400 may include a device where power is consumed.

Each of directional couplers 410 may include a passive device that couples a portion of transmission power in a transmission line (e.g., a line connected to antenna 210-1) by a particular amount out through another port. In one embodiment, each of directional couplers 410 may use two transmission lines set close enough together such that energy passing through one transmission line (e.g., a line connected to antenna 210-1) is coupled to the other transmission line (e.g., a line connecting two loads 400).

Each of power splitters 420 may include a passive device that receives an input signal and generates multiple output signals with specific phase and amplitude characteristics. In one embodiment, each of power splitters 420 may include a "T" connection, which has one input and two outputs. If the "T" connection is mechanically symmetrical, a signal applied to the input may be divided into two output signals, equal in amplitude and phase.

Although Fig. 4 shows exemplary components of antenna port 300, in other embodiments, antenna port 300 may contain fewer, different, differently arranged, or additional components than depicted in Fig. 4. In still other embodiments, one or more components of antenna port 300 may perform one or more other tasks described as being performed by one or more other components of antenna port 300.

Fig. 5 illustrates a diagram of exemplary interactions among exemplary components of a portion 500 of antenna port 300. As shown, portion 500 of antenna port 300 may include antennas 210-1 and 210-2, ports 310-1 and 310-2, loads 400, and directional couplers 410.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 339 of 365

Antennas 210-1 and 210-2 may include the features described above in connection with, for example, Fig. 2. Ports 310-1 and 310-2 may include the features described above in connection with, for example, Figs. 3A and 4B. Loads 400 and directional couplers 410 may include the features described above in connection with, for example, Fig. 4.

As further shown in Fig. 5, antennas 210-1 and 210-2 may be internally coupled together via a circuit that includes loads 400 and directional couplers 410. For example, an input signal 510 may be input at port 310-1, may travel through the circuit, and may be received as an output signal 520 at port 310-2. Antennas 210-1 and 210-2 may be externally coupled together via wireless wave propagation between antennas 210-1 and 210-2. For example, input signal 510 may cause antenna 210-1 to transmit a wireless signal 530 that may be received by antenna 210-2 and provided to port 310-2. The external coupling of antennas 210-1 and 210-2 may depend on a physical environment (e.g., a very site specific environment) of base station 120 and antennas 210-1 and 210-2. In one embodiment, a filter may be provided (e.g., with antennas 210-1 and 210-2) that filters out surrounding objects of the physical environment.

Base station 120 may use signals 510-530 to measure an amplitude and/or a phase between antennas 210-1 and 210-2 (and ports 310-1 and 310-2). Base station 120 may compare the values provided in expected value table 236 (Fig. 2) with the measured amplitude and/or measured phase between antennas 210-1 and 210-2 (and ports 310-1 and 310-2). If there is a large difference (e.g., greater than a particular threshold (e.g., +/- ten percent)) between the table values and the measured amplitude and/or phase, base station 120 may determine that there is an antenna connection error.

Although Fig. 5 shows exemplary interactions among components of antenna port 300, in other embodiments, components of antenna port 300 may perform fewer, different, or additional interactions than depicted in Fig. 5.

Fig. 6 illustrates a diagram of additional exemplary components of base station 120. As shown base station 120 may include a first transceiver 220-1 that includes digital-to-analog converter (DAC) circuitry 600, a power amplifier 605, and a filter unit (FU) 610; a second transceiver 220-2 that includes a filter unit 615 and analog-to-digital converter (ADC) circuitry 620; and processing unit 232. Transceivers 220-1 and 220-2 and processing unit 232 may include the features described above in connection with, for example, Fig. 2.

DAC circuitry 600 may include a device or circuitry that converts a digital signal (e.g., binary code or numbers) to an analog signal (e.g., current, voltage, or electric charge). In one embodiment, DAC circuitry 600 may include one or more of a pulse width modulator DAC, an oversampling DAC, an interpolating DAC, a binary weighted DAC, etc.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 340 of 365

Power amplifier 605 may include a device that changes (e.g., increases) an amplitude of a signal (e.g., a voltage, a current, etc.). In one embodiment, power amplifier 605 may include one or more of a transistor amplifier, an operational amplifier, a fully differential amplifier, etc.

Each of filter units 610 and 615 may include an electronic circuit that performs signal processing functions to remove unwanted frequency components from a signal, to enhance desired frequency components in the signal, or both. In one embodiment, each of filter units 610 and 615 may include one or more of a passive filter unit, an active filter unit, an analog filter unit, a digital filter unit, a high-pass filter unit, a low-pass filter unit, a bandpass filter unit, band-reject filter unit, an all-pass filter unit, a discrete-time filter unit, a continuous-time filter unit, a linear filter unit, a non-linear filter unit, an infinite impulse response filter unit, a finite impulse response filter unit, etc.

ADC circuitry 620 may include a device or circuitry that converts an analog signal (e.g., current, voltage, or electric charge) to a digital signal (e.g., binary code or numbers). In one embodiment, ADC circuitry 620 may include one or more of a linear ADC, a non-linear ADC, a direct conversion ADC, a successive-approximation ADC, a ramp-compare ADC, etc.

As further shown in Fig. 6, in order to calibrate antennas 210 associated with transceivers 220-1 and 220-2, processing unit 232 may provide a digital transmission (TX) signal 625 to transceiver 220-1, and DAC circuitry 600 may receive digital TX signal 625. DAC circuitry 600 may convert digital TX signal 625 to an analog TX signal 630, and may provide analog TX signal 630 to power amplifier 605. Power amplifier 605 may amplify analog TX signal 630 to produce an amplified, analog TX signal 635, and may provide amplified, analog TX signal 635 to filter unit 610. Filter unit 610 may filter amplified, analog TX signal 635 to produce a signal 640 (e.g., which is a filtered, amplified, and analog TX signal), and may provide signal 640 to a coupling network. The coupling network may include, for example, the internally and externally coupled antennas 210-1 and 210-2 and ports 310-1 and 310-2 shown in Fig. 5.

Signal 640 may be input to port 310-1 as input signal 510 (Fig. 5), and may travel through the coupling network until it reaches port 310-2 as output signal 520 (Fig. 5). Output signal 520 may be provided to transceiver 220-2 as an analog reception (RX) signal 645, and filter unit 615 may receive analog RX signal 645. Filter unit 615 may filter analog RX signal 645 to produce a filtered, analog RX signal 650, and may provide filtered, analog RX signal 650 to ADC circuitry 620. ADC circuitry 620 may convert filtered, analog RX signal 650 to a digital RX signal 655, and may provide digital RX signal 655 to processing unit 232.

Processing unit 232 may compare digital TX signal 625 and digital RX signal 655 to

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 341 of 365

determine a measured value (e.g., a difference between digital TX signal 625 and digital RX signal 655) of amplitude and/or phase. Since the amplitude and phase provided by transceivers 220-1 and 220-2 may be known, processing unit 232 may calculate an amplitude and/or phase between antenna ports (e.g., ports 310-1 and 310-2, which are associated with antennas 210-1 and 210-2) based on the measured value and the known amplitude and phase provided by transceivers 220-1 and 220-2. Processing unit 232 may compare the values provided in expected value table 236 (Fig. 2) with the measured amplitude and/or phase between the antenna ports (e.g., ports 310-1 and 310-2). If there is a large difference (e.g., greater than a particular threshold (e.g., +/- ten percent)) between the table values and the measured amplitude and/or phase, processing unit 232 may determine that there is an antenna connection error.

Although Fig. 6 shows exemplary components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional components than depicted in Fig. 6. In still other embodiments, one or more components of base station 120 may perform one or more other tasks described as being performed by one or more other components of base station 120.

Fig. 7 depicts a diagram of exemplary functional components of base station 120. As shown, base station 120 may include a measured value determiner 700, a measured/expected value comparer 710, and an error/threshold comparer 720. In one embodiment, the functions described in connection with Fig. 7 may be performed by processing unit 232 (Fig. 2).

Measured value determiner 700 may include any hardware, software, or combination of hardware and software that may receive digital TX signal 625 and digital RX signal 655. Measured value determiner 700 may compare digital TX signal 625 and digital RX signal 655 to determine a difference between the amplitude and/or the phase of digital TX signal 625 and digital RX signal 655. Since the amplitude and phase provided by transceivers 220 may be known, measured value determiner 700 may calculate a measured value ($S_{measured}$) 730 (e.g., an amplitude and/or phase between two antenna ports 310) based on the determined difference and the known amplitude and phase provided by transceivers 220. Measured value determiner 700 may provide measured value 730 to measure/expected value comparer 710.

Measured/expected value comparer 710 may include any hardware, software, or combination of hardware and software that may receive measured value 730 from measured value determiner 700, and may receive an expected value ($S_{expected}$) 740 from expected value table 236. Measured/expected value comparer 710 may compare measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740. In one embodiment, measured/expected value comparer 710 may determine a difference between measured value ($S_{measured}$) 730 and expected value ($S_{expected}$)

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 342 of 365

740 (i.e., $S_{measured}$ - $S_{expected}$) to be an error (ε) 750, and may square error (ε) 750 according to the following squared matrix norm (e.g., the squared Frobenius norm):

$$\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2,$$

where $S_{measured}$ and $S_{expected}$ may denote measured and expected complex value S-matrices. A complex S-matrix may contain all the S-parameters (e.g., an (i, j) element of the S-matrix may contain a parameter (Sij), which may represent an amplitude and phase between ports i and j in complex form).

Error/threshold comparer 720 may include any hardware, software, or combination of hardware and software that may receive error (ε) 750 from measured/expected value comparer 710, and may compare the squared error 750 to a threshold (δ_{THRESH}). Since a measurement error may always be present, a few decibels (e.g., one to five decibels) or few degree (e.g., one to five degrees) margin may be added as the threshold. Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is erroneous (as indicated by reference number 760) if the squared error 750 is greater than the threshold (e.g., $\varepsilon^2 > \delta_{THRESH} > 0$). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is correct (as indicated by reference number 770) if the squared error 750 is less than or equal to the threshold (e.g., $\varepsilon^2 \leq \delta_{THRESH}$).

Although Fig. 7 shows exemplary functional components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional functional components than depicted in Fig. 7. In still other embodiments, one or more functional components of base station 120 may perform one or more other tasks described as being performed by one or more other functional components of base station 120.

Fig. 8 illustrates a diagram of exemplary functional components of base station 120. As shown, base station 120 may include an expected values calculator 800 and a measured/expected values comparer 810. In one embodiment, the functions described in connection with Fig. 8 may be performed by processing unit 232 (Fig. 2).

Expected values calculator 800 may include any hardware, software, or combination of hardware and software that may receive port permutations 820 (e.g., different combinations of antennas 210, ports 310, and RF cables 320) for multiple antenna ports 310 of base station 120, and may receive table information 830 (e.g., expected values from expected value table 236 (Fig. 2)) associated with the multiple antenna ports 310. Expected values calculator 800 may calculate expected values 840 (e.g., S-matrices) for different antenna port permutations based on port permutations 820 and table information 830. Expected values calculator 800 may provide expected values 840 to measured/expected values comparer 810.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 343 of 365

Measured/expected values comparer 810 may include any hardware, software, or combination of hardware and software that may receive expected values 840 from expected values calculator 800, and may acquire measured values 850 associated with the different antenna port permutations. Measured/expected values comparer 810 may compare expected values 840 with measured values 850 to determine errors for the different antenna port permutations. Measured/expected values comparer 810 may determine an optimal antenna port permutation (i.e., a correct port order 860) to be one of the different antenna port permutations with a smallest determined error 870 (e.g., as determined by: $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2$).

Although Fig. 8 shows exemplary functional components of base station 120, in other embodiments, base station 120 may contain fewer, different, differently arranged, or additional functional components than depicted in Fig. 8. In still other embodiments, one or more functional components of base station 120 may perform one or more other tasks described as being performed by one or more other functional components of base station 120.

Figs. 9 and 10 illustrate flow charts of an exemplary process 900 for automatically detecting a connection error in a smart antenna according to embodiments described herein. In one embodiment, process 900 may be performed by base station 120. In other embodiments, some or all of process 900 may be performed by base station 120 in combination with another device (e.g., a RRU) or group of devices (e.g., communicating with base station 120).

As illustrated in Fig. 9, process 900 may include determining an amplitude/phase between antenna elements of a base station (block 910), and measuring, based on the determined amplitude/phase, an amplitude/phase ($S_{measured}$) between corresponding antenna ports of the base station (block 920). For example, in embodiments described above in connection with Fig. 7, measured value determiner 700 of base station 120 may receive digital TX signal 625 and digital RX signal 655. Measured value determiner 700 may compare digital TX signal 625 and digital RX signal 655 to determine a difference between the amplitude and/or the phase of digital TX signal 625 and digital RX signal 655. Since the amplitude and the phase provided by transceivers 220 may be known, measured value determiner 700 may calculate measured value ($S_{measured}$) 730 (e.g., an amplitude and/or phase between two antenna ports 310) based on the determined difference and the known amplitude and phase provided by transceivers 220.

Returning to Fig. 9, the measured amplitude/phase ($S_{measured}$) may be compared with an expected amplitude/phase ($S_{expected}$) of the antenna ports to determine an error (block 930), and the determined error may be compared to a threshold (block 940). For example, in embodiments described above in connection with Fig. 7, measured/expected value comparer 710 of base station 120 may receive measured value 730 from measured value determiner 700, and may

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 344 of 365

receive expected value ($S_{expected}$) 740 from expected value table 236. Measured/expected value comparer 710 may compare measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740. In one example, measured/expected value comparer 710 may determine a difference between measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740 (i.e., $S_{measured}$ - $S_{expected}$) to be an error (ε) 750. Error/threshold comparer 720 of base station 120 may receive error (ε) 750 from measured/expected value comparer 710, and may compare the squared error 750 to a threshold (δ_{THRESH}). In one example, the threshold (e.g., for the amplitude and phase values) may be set equal to a product of a particular percentage (e.g., ten percent) and the amplitude and phase values provided in expected value table 236.

As further shown in Fig. 9, an erroneous antenna port connection may be determined when the error exceeds the threshold (block 950), and a correct antenna port connection may be determined when the error is less than or equal to the threshold (block 960). For example, in embodiments described above in connection with Fig. 7, error/threshold comparer 720 of base station 120 may determine that a port connection (e.g., in base station 120) is erroneous (as indicated by reference number 760) if the squared error 750 exceeds the threshold (δ_{THRESH}). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is correct (as indicated by reference number 770) if the squared error 750 is less than or equal to the threshold (δ_{THRESH}).

Process blocks 930 and 940 may include the process blocks depicted in Fig. 10. As shown in Fig. 10, process blocks 930 and 940 may include determining a squared error (ε^2) between the measured amplitude/phase ($S_{measured}$) and the expected amplitude/phase ($S_{expected}$) according to $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2$ (block 1000), and comparing the squared error (ε^2) to the threshold (δ_{THRESH}) to determine whether $\varepsilon^2 > \delta_{THRESH} > 0$ or $\varepsilon^2 \leq \delta_{THRESH}$ (block 1010). For example, in embodiments described above in connection with Fig. 7, measured/expected value comparer 710 of base station 120 may determine a difference between measured value ($S_{measured}$) 730 and expected value ($S_{expected}$) 740 (i.e., $S_{measured}$ - $S_{expected}$) to be error (ε) 750, and may square error (ε) 750 according to the following squared matrix norm (e.g., the squared Frobenius norm): $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2$. Error/threshold comparer 720 of base station may compare the squared error 750 to a threshold (δ_{THRESH}). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is erroneous (as indicated by reference number 760) if the squared error 750 greater than the threshold (e.g., $\varepsilon^2 > \delta_{THRESH} > 0$). Error/threshold comparer 720 may determine that a port connection (e.g., in base station 120) is correct (as indicated by reference number 770) if the squared error 750 is less than or equal to the threshold

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 345 of 365

(e.g., $\varepsilon^2 \leq \delta_{THRESH}$).

Fig. 11 illustrates a flow chart of another exemplary process 1100 for determining an optimal antenna port permutation in a smart antenna according to embodiments described herein. In one embodiment, process 1100 may be performed by base station 120. In other embodiments, some or all of process 1100 may be performed by base station 120 in combination with another device (e.g., a RRU) or group of devices (e.g., communicating with base station 120).

As illustrated in Fig. 11, process 1100 may include receiving antenna port permutations and amplitudes/phases for antenna ports of a base station (block 1110), and calculating expected amplitudes/phases for different antenna port permutations based on the received information (block 1120). For example, in embodiments described above in connection with Fig. 8, expected values calculator 800 of base station 120 may receive port permutations 820 (e.g., different combinations of antennas 210, ports 310, and RF cables 320) for multiple antenna ports 310 of base station 120, and may receive table information 830 (e.g., expected values from expected value table 236 (Fig. 2)) associated with the multiple antenna ports 310. Expected values calculator 800 may calculate expected values 840 (e.g., S-matrices) for different antenna port permutations based on port permutations 820 and table information 830.

As further shown in Fig. 11,measured amplitudes/phases associated with the antenna port permutations may be acquired (block 1130), the expected amplitudes/phases may be compared with the measured amplitudes/phases to determine errors (block 1140), and an optimal antenna port permutation may be determined to be a permutation with the smallest error (block 1150). For example, in embodiments described above in connection with Fig. 8, measured/expected values comparer 810 of base station 120 may acquire measured values 850 associated with the different antenna port permutations, and may compare expected values 840 with measured values 850 to determine errors for the different antenna port permutations. Measured/expected values comparer 810 may determine an optimal antenna port permutation (i.e., a correct port order 860) to be one of the different antenna port permutations with a smallest determined error 870 (e.g., as determined by: $\varepsilon^2 = \left\| S_{measured} - S_{expected} \right\|_F^2$).

Embodiments described herein may automatically detect a connection error in a smart antenna (e.g., of a base station or RRU) by measuring an amplitude and/or a phase between antenna ports of the smart antenna. In one embodiment, for example, in order to transmit and receive signals accurately, every antenna element, RF cable, and transceiver making up the smart antenna may need to operate identically. This means that every transmitting and receiving link may need to have the same amplitude and phase response. The base station may

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 346 of 365

automatically implement a smart antenna calibration procedure that includes compensating the amplitude and phase of each transmitting and receiving link.

Such an arrangement may ensure that connection errors are automatically and easily detected, and that performance issues due to connection errors are minimized. The arrangement may not require an uplink signal, and thus may not require an operational wireless communication network or extra equipment to generate an uplink signal.

Embodiments described herein provide illustration and description, but are not intended to be exhaustive or to limit the implementations to the precise form disclosed. Modifications and variations are possible in light of the above teachings, or may be acquired from practice of the implementations. For example, while series of blocks have been described with regard to Figs. 9-11, the order of the blocks may be modified in other embodiments. Further, non-dependent blocks may be performed in parallel. In another example, although the systems and/or methods described herein have been implemented in base station 120, in other embodiments, the systems and/or methods may be implemented in any device that uses antenna port 300.

The exemplary embodiments, as described above, may be implemented in many different forms of software, firmware, and hardware in the implementations illustrated in the figures. The actual software code or specialized control hardware used to implement the exemplary embodiments described herein is not limiting of the invention. Thus, the operation and behavior of the exemplary embodiments were described without reference to the specific software code – it being understood that one would be able to design software and control hardware to implement the exemplary embodiments based on the description herein.

Further, certain portions of the invention may be implemented as "logic" that performs one or more functions. This logic may include hardware, such as an application specific integrated circuit, a field programmable gate array, a processor, or a microprocessor, or a combination of hardware and software.

Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the invention. In fact, many of these features may be combined in ways not specifically recited in the claims and/or disclosed in the specification.

It should be emphasized that the terms "comprises / comprising" when used in the this specification are taken to specify the presence of stated features, integers, steps, or components, but do not preclude the presence or addition of one or more other features, integers, steps, components, or groups thereof.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 347 of 365

No element, act, or instruction used in the description of the present application should be construed as critical or essential to the invention unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items. Where only one item is intended, the term "one" or similar language is used. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 348 of 365

WHAT IS CLAIMED IS:

1. A method in a radio network (100) that includes a device (120), the method comprising:

measuring, via the device (120), a parameter ($S_{MEASURED}$) associated with at least two antenna ports (310) of the device (120);

comparing, via the device (120), the measured parameter ($S_{MEASURED}$) with an expected parameter ($S_{EXPECTED}$) associated with the at least two antenna ports (310) to determine an error (ε);

comparing, via the device (120), the determined error (ε) to a threshold ($\delta_{THRESHOLD}$); and

determining, via the device (120):

an erroneous antenna port connection for the at least two antenna ports (310) when the error (ε) exceeds the threshold ($\delta_{THRESHOLD}$), and

a correct antenna port connection for the at least two antenna ports (310) when the error (ε) is less than or equal to the threshold ($\delta_{THRESHOLD}$).

2. The method of claim 1, where measuring, via the device (120), the parameter ($S_{MEASURED}$) comprises:

determining a parameter associated with at least two antenna elements (210) of the device (120), where the at least two antenna elements (210) are associated with the at least two antenna ports (310); and

measuring, based on the determined parameter associated with the at least two antenna elements (210), the measured parameter ($S_{MEASURED}$).

3. The method of claim 2, where the determined parameter associated with the at least two antenna elements (210) comprises one or more of an amplitude or a phase.

4. The method of claim 1, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises one or more of an amplitude or a phase.

5. The method of claim 1, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises a difference between a signal (625) transmitted via one of the at least two antenna ports (310) and a signal (655) received via another one of the at least two antenna ports (310).

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 349 of 365

6. The method of claim 1, where comparing, via the device (120), the measured parameter ($S_{MEASURED}$) with the expected parameter ($S_{EXPECTED}$) comprises determining a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = \| S_{MEASURED} - S_{EXPECTED} \|^2.$$

7. The method of claim 6, where comparing, via the device (120), the determined error (ε) to the threshold ($\delta_{THRESHOLD}$) comprises comparing the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

8. The method of claim 1, further comprising:

receiving antenna port permutations (820) for a plurality of antenna ports (310) of the device (120);

receiving expected information (830) associated with the plurality of antenna ports (310);

calculating expected values (840) for different antenna port permutations based on the received information;

acquiring measured values (850) associated with the different antenna port permutations;

comparing the expected values (840) for the different antenna port permutations with the measured values (850) for the different antenna port permutations to determine errors for the different antenna port permutations; and

determining an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

9. The method of claim 1, where the device (120) comprises a base station.

10. The method of claim 1, where the device (120) comprises a remote radio unit (230) associated with a base station.

11. A device (120) in a radio network (100), the device (120) comprising:

at least two antenna ports (310);

a memory (234) to store a plurality of instructions; and

a processing unit (232) to execute instructions in the memory (234) to:

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 350 of 365

measure a parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310),

compare the measured parameter ($S_{MEASURED}$) with an expected parameter ($S_{EXPECTED}$) associated with the at least two antenna ports (310) to determine an error (ε),

compare the determined error (ε) to a threshold ($\delta_{THRESHOLD}$), and

determine:

an erroneous antenna port connection for the at least two antenna ports (310) when the error (ε) exceeds the threshold ($\delta_{THRESHOLD}$), and

a correct antenna port connection for the at least two antenna ports (310) when the error (ε) is less than or equal to the threshold ($\delta_{THRESHOLD}$).

12. The device (120) of claim 11, where the device (120) further comprises:

at least two antenna elements (210) associated with the at least two antenna ports (310), and

where the processing unit (232) is further to execute instructions in the memory (234) to:

determine a parameter associated with the at least two antenna elements (210), and

measure, based on the determined parameter associated with the at least two antenna elements (210), the measured parameter ($S_{MEASURED}$).

13. The device (120) of claim 12, where the determined parameter associated with the at least two antenna elements (210) comprises one or more of an amplitude or a phase.

14. The device (120) of claim 11, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises one or more of an amplitude or a phase.

15. The device (120) of claim 11, where the measured parameter ($S_{MEASURED}$) associated with the at least two antenna ports (310) comprises a difference between a signal (625) transmitted via one of the at least two antenna ports (310) and a signal (655) received via another one of the at least two antenna ports (310).

16. The device (120) of claim 11, where, when comparing the measured parameter ($S_{MEASURED}$) with the expected parameter ($S_{EXPECTED}$), the processing unit (232) is further to

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 351 of 365

execute instructions in the memory (234) to:

determine a squared error (ε^2) between the measured parameter ($S_{MEASURED}$) and the expected parameter ($S_{EXPECTED}$) according to:

$$\varepsilon^2 = \| S_{MEASURED} - S_{EXPECTED} \|^2.$$

17. The device (120) of claim 16, where, when comparing the determined error (ε) to the threshold ($\delta_{THRESHOLD}$), the processing unit (232) is further to execute instructions in the memory (234) to:

compare the squared error (ε^2) to the threshold ($\delta_{THRESHOLD}$) to determine whether:

$$\varepsilon^2 > \delta_{THRESHOLD} > 0, \text{ or}$$

$$\varepsilon^2 \leq \delta_{THRESHOLD}.$$

18. The device (120) of claim 11, where the processing unit (232) is further to execute instructions in the memory (234) to:

receive antenna port permutations (820) for a plurality of antenna ports (310) of the device (120),

receive expected information (830) associated with the plurality of antenna ports (310),

calculate expected values (840) for different antenna port permutations based on the received information,

acquire measured values (850) associated with the different antenna port permutations,

compare the expected values (840) for the different antenna port permutations with the measured values (850) for the different antenna port permutations to determine errors for the different antenna port permutations, and

determine an optimal antenna port permutation to be one of the different antenna port permutations with the smallest determined error.

19. The device (120) of claim 11, where the device (120) comprises a base station.

20. The device (120) of claim 11, where the device (120) comprises a remote radio unit (230) associated with a base station.

Procomm Exhibit 2015
Ericsson v. Procomm
IPR2025-01453, Page 352 of 365

FIG. 1

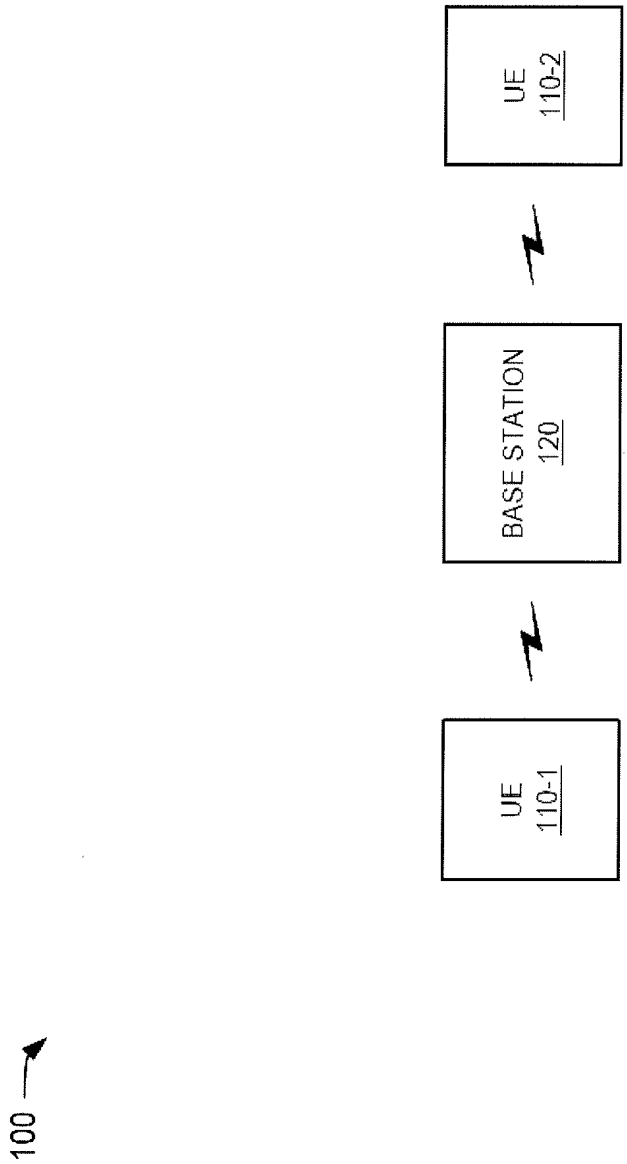


FIG. 2

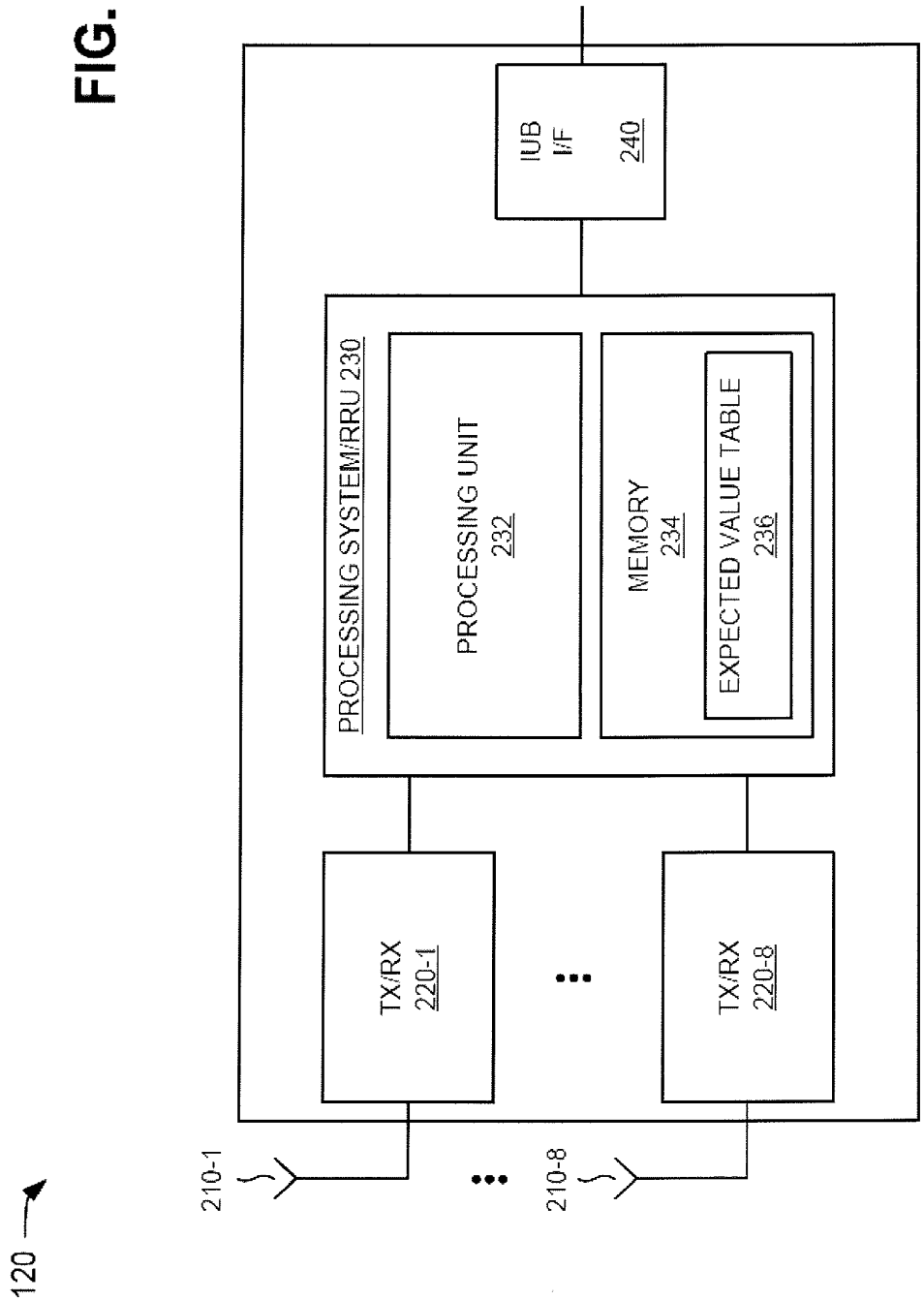

120
210-1
210-8
TX/RX 220-1
TX/RX 220-8
PROCESSING SYSTEM/RRU 230
PROCESSING UNIT 232
MEMORY 234
EXPECTED VALUE TABLE 236
IUB I/F 240

FIG. 3A

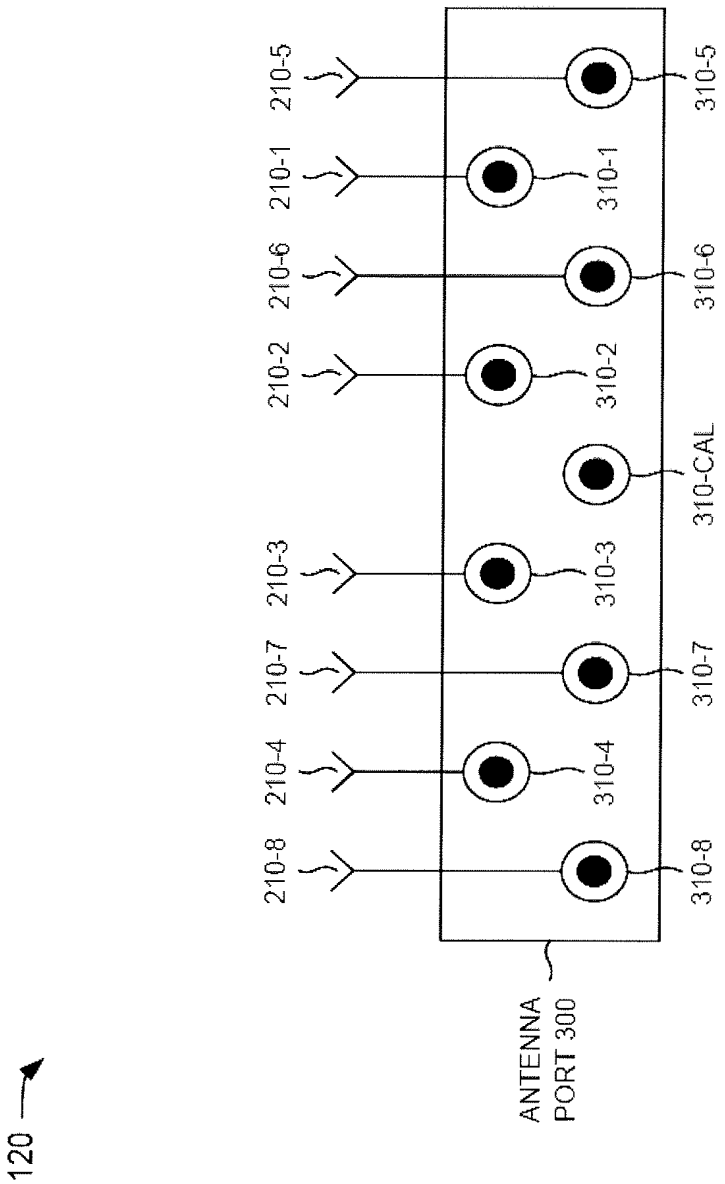

120
ANTENNA PORT 300
210-8
210-4
210-7
210-3
210-2
210-6
210-1
210-5
310-8
310-4
310-7
310-3
310-CAL
310-2
310-6
310-1
310-5

FIG. 3B

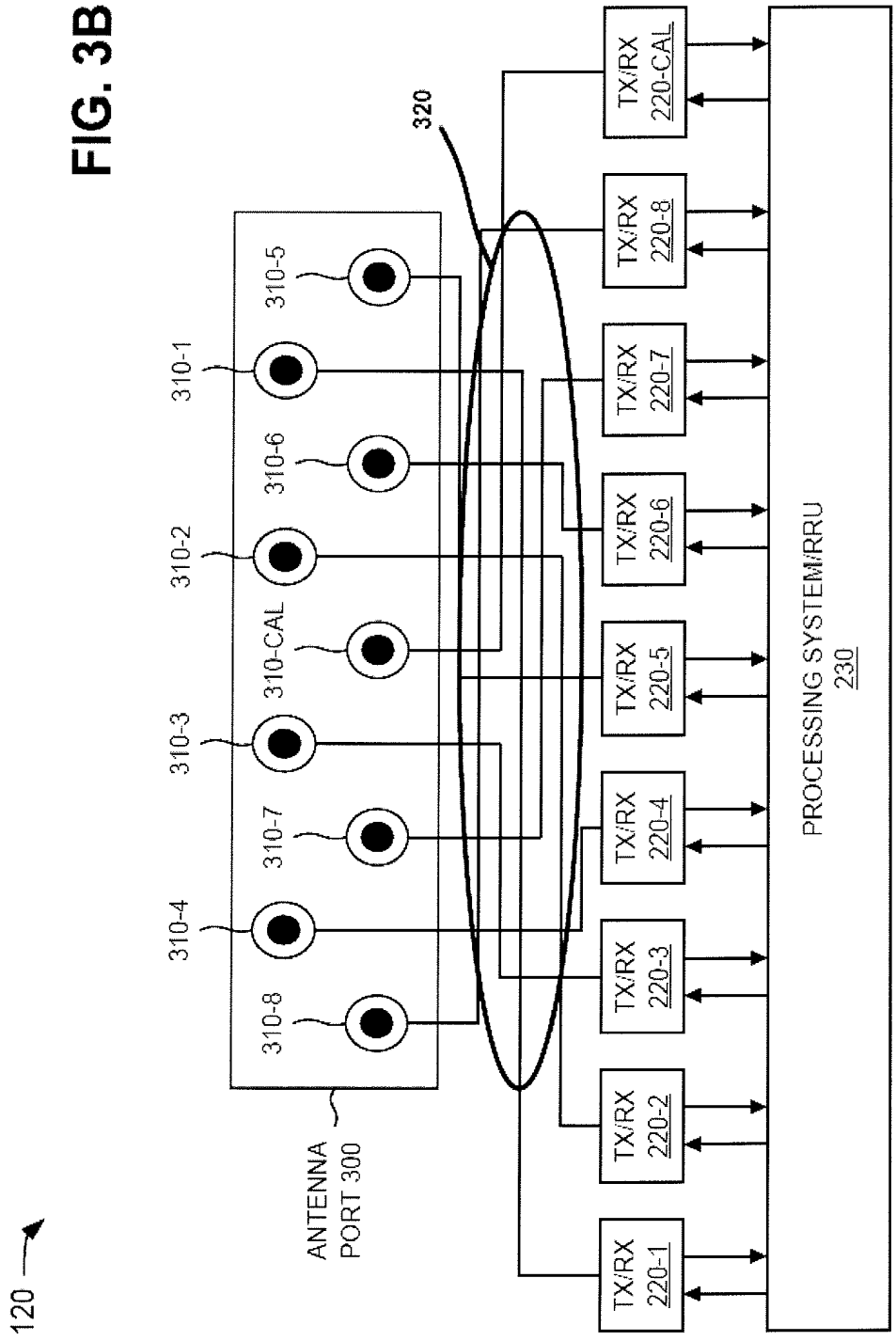

120
ANTENNA PORT 300
310-1
310-2
310-3
310-4
310-5
310-6
310-7
310-8
310-CAL
320
TX/RX 220-1
TX/RX 220-2
TX/RX 220-3
TX/RX 220-4
TX/RX 220-5
TX/RX 220-6
TX/RX 220-7
TX/RX 220-8
TX/RX 220-CAL
PROCESSING SYSTEM/RRU 230

FIG. 4

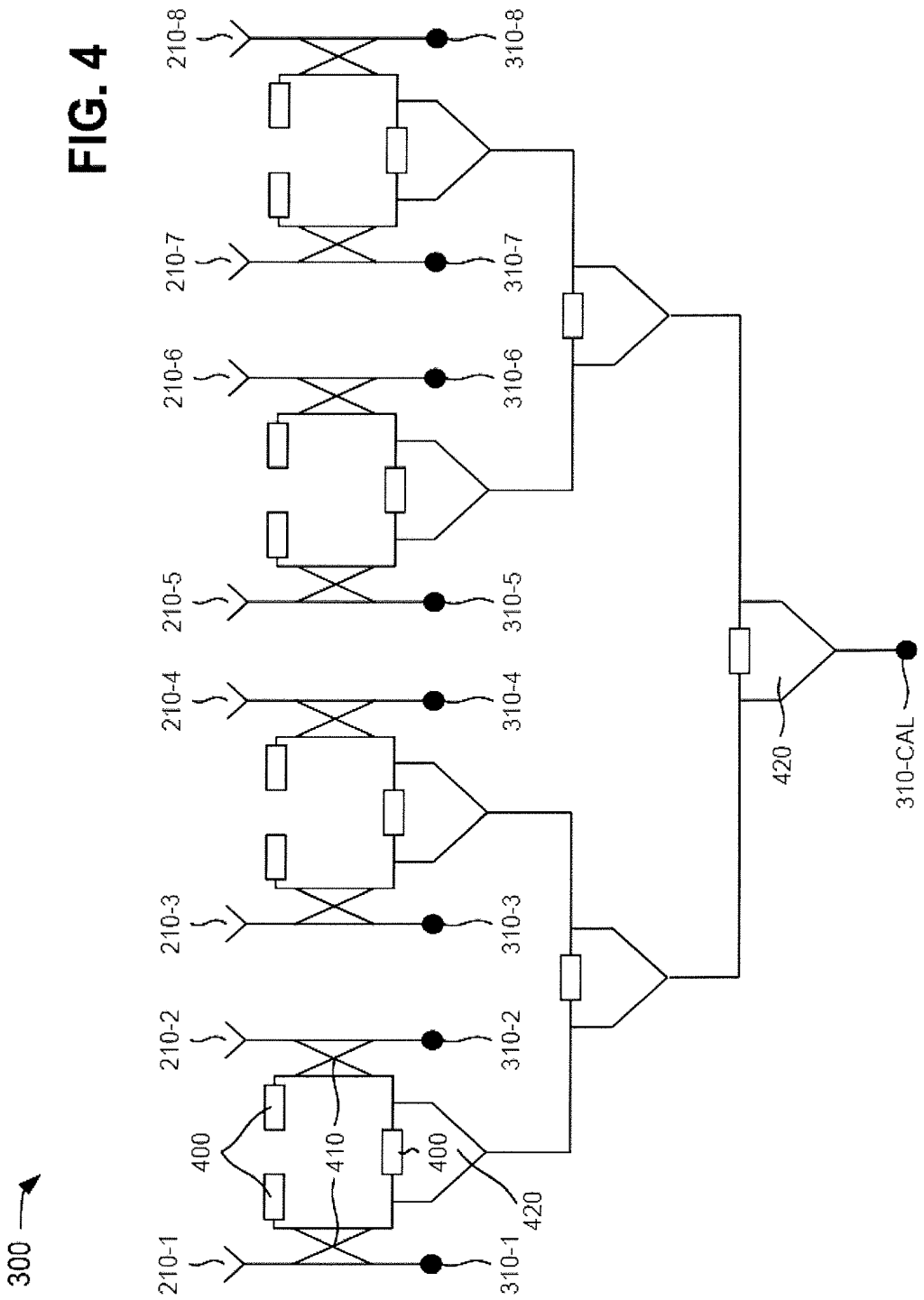

300
210-1
210-2
210-3
210-4
210-5
210-6
210-7
210-8
310-1
310-2
310-3
310-4
310-5
310-6
310-7
310-8
310-CAL
400
410
400
420
420

FIG. 5

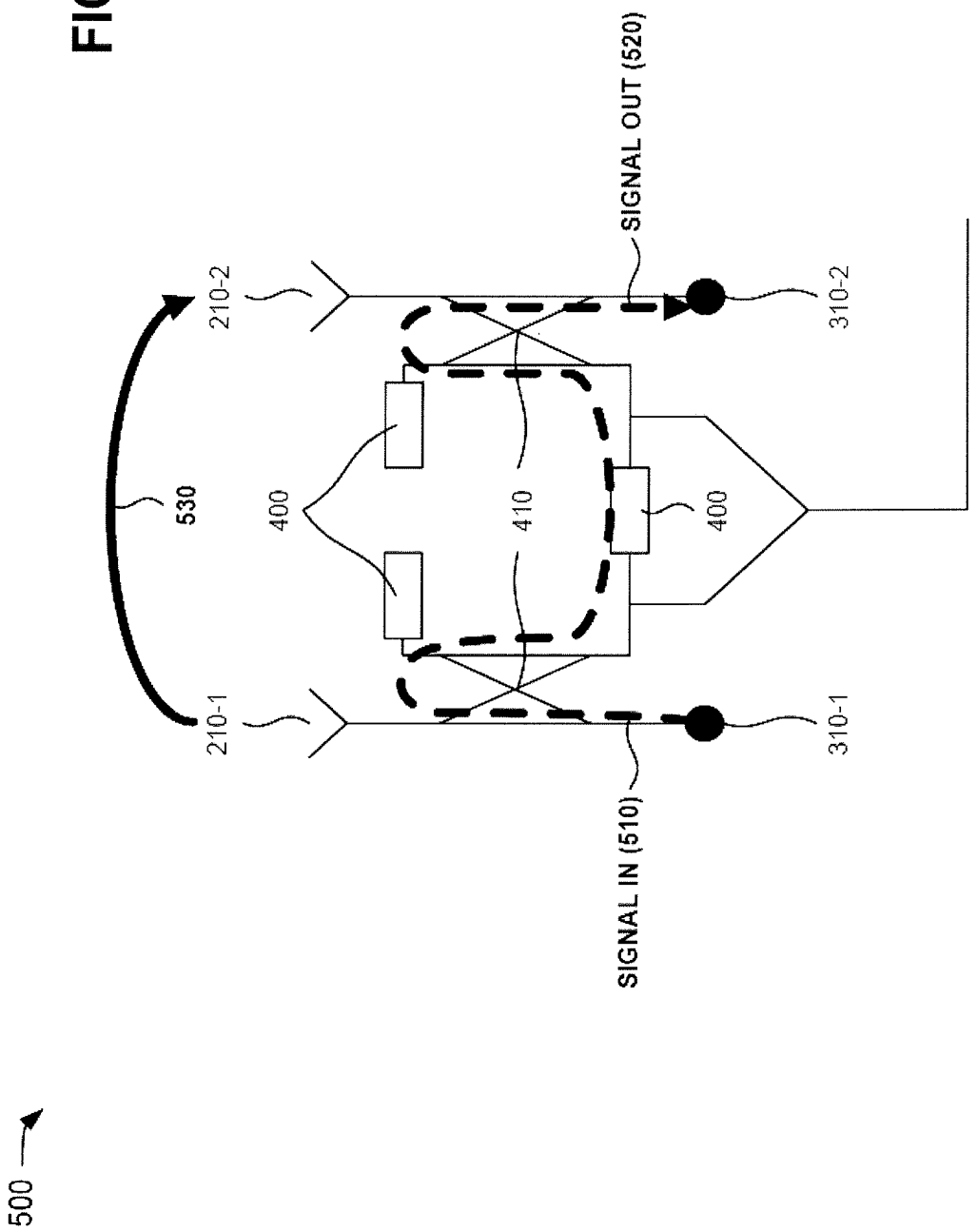

500
210-1
210-2
530
400
410
400
310-1
310-2
SIGNAL IN (510)
SIGNAL OUT (520)

FIG. 6

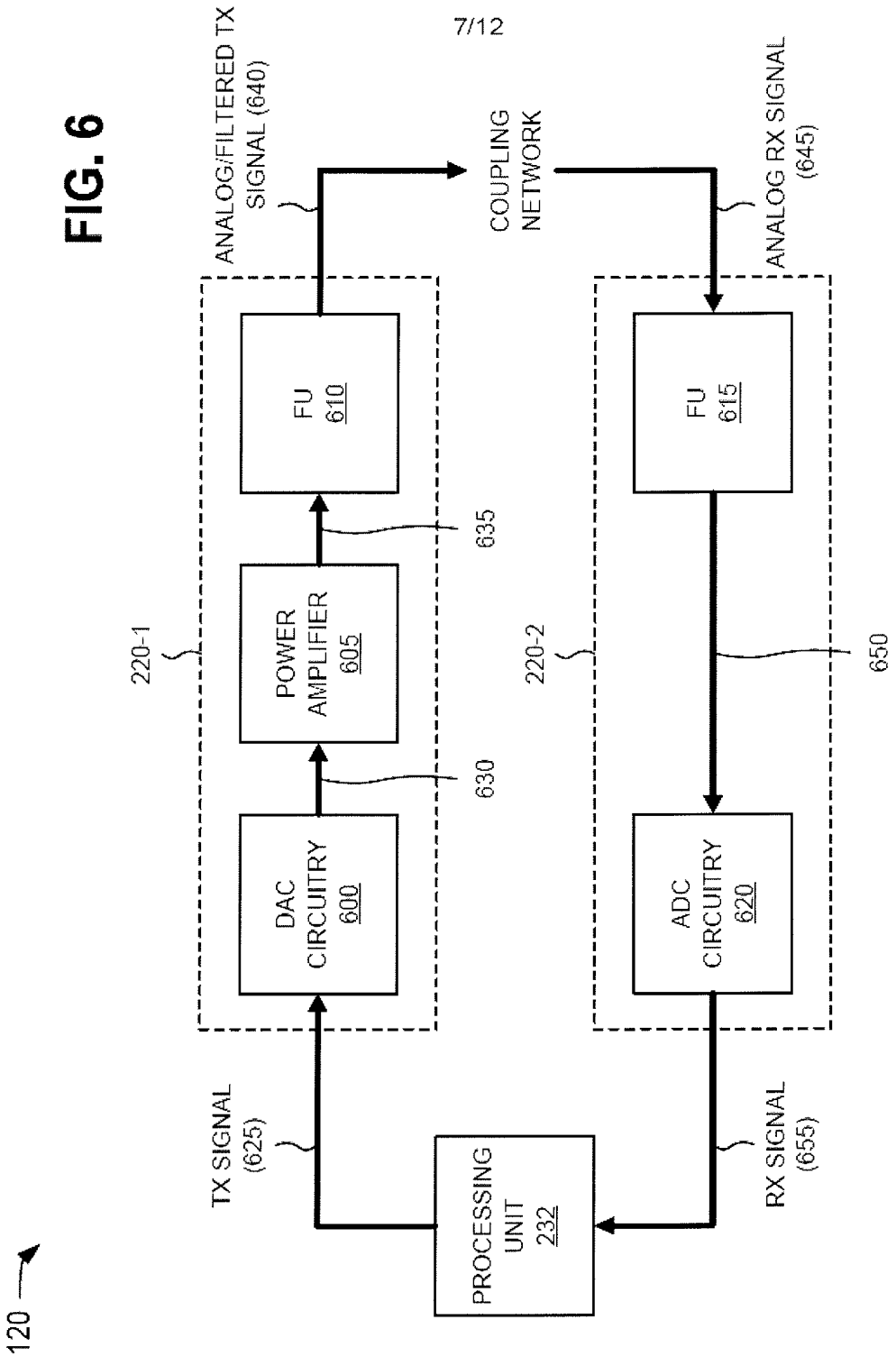

120
PROCESSING UNIT 232
TX SIGNAL (625)
RX SIGNAL (655)
220-1
220-2
DAC CIRCUITRY 600
POWER AMPLIFIER 605
FU 610
ADC CIRCUITRY 620
FU 615
630
635
650
ANALOG/FILTERED TX SIGNAL (640)
COUPLING NETWORK
ANALOG RX SIGNAL (645)

FIG. 7

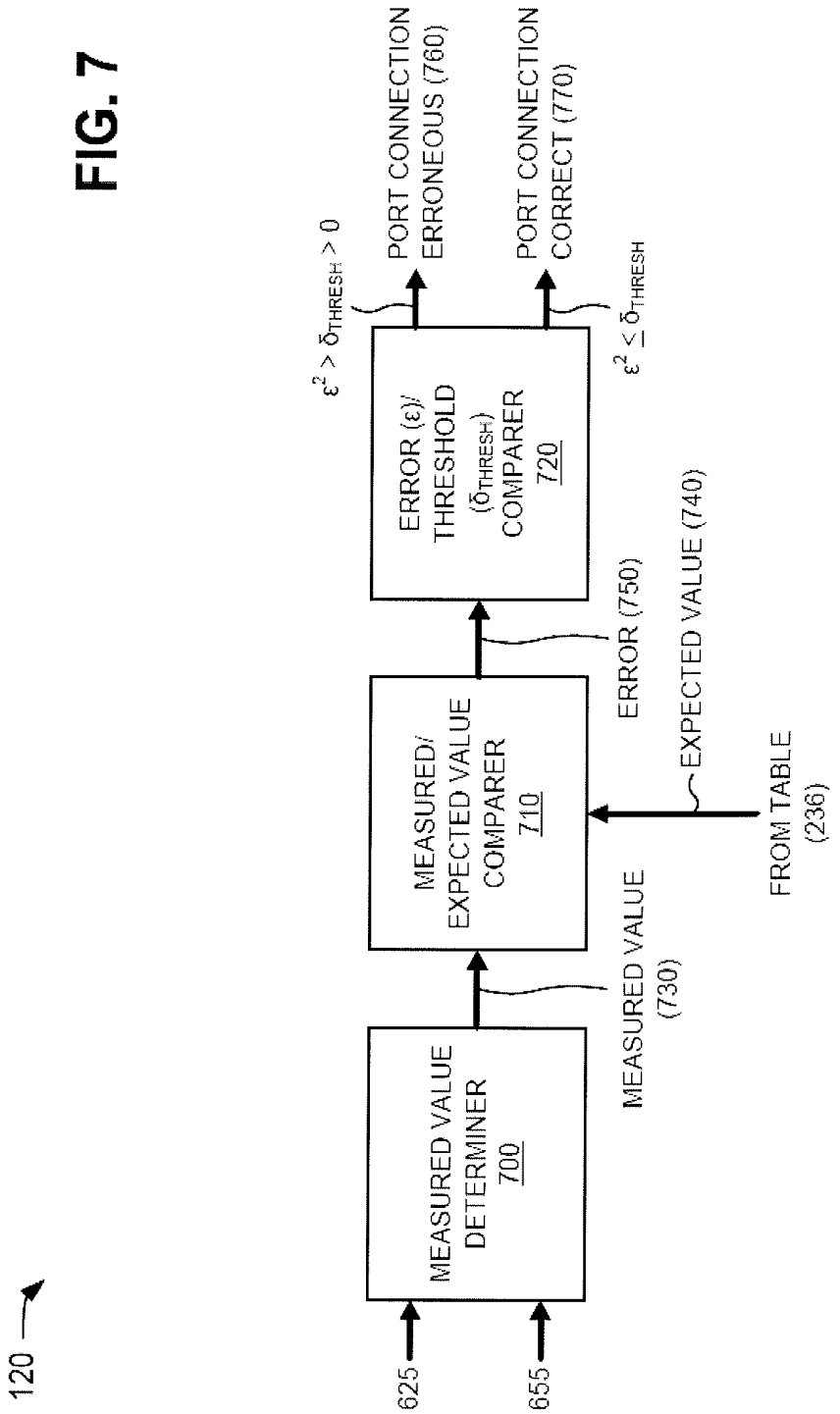

120
625
655
MEASURED VALUE DETERMINER 700
MEASURED VALUE (730)
MEASURED/ EXPECTED VALUE COMPARER 710
FROM TABLE (236)
EXPECTED VALUE (740)
ERROR (750)
ERROR (ε)/ THRESHOLD (δ_{THRESH}) COMPARER 720
$\varepsilon^2 > \delta_{THRESH} > 0$
$\varepsilon^2 \leq \delta_{THRESH}$
PORT CONNECTION ERRONEOUS (760)
PORT CONNECTION CORRECT (770)

FIG. 8

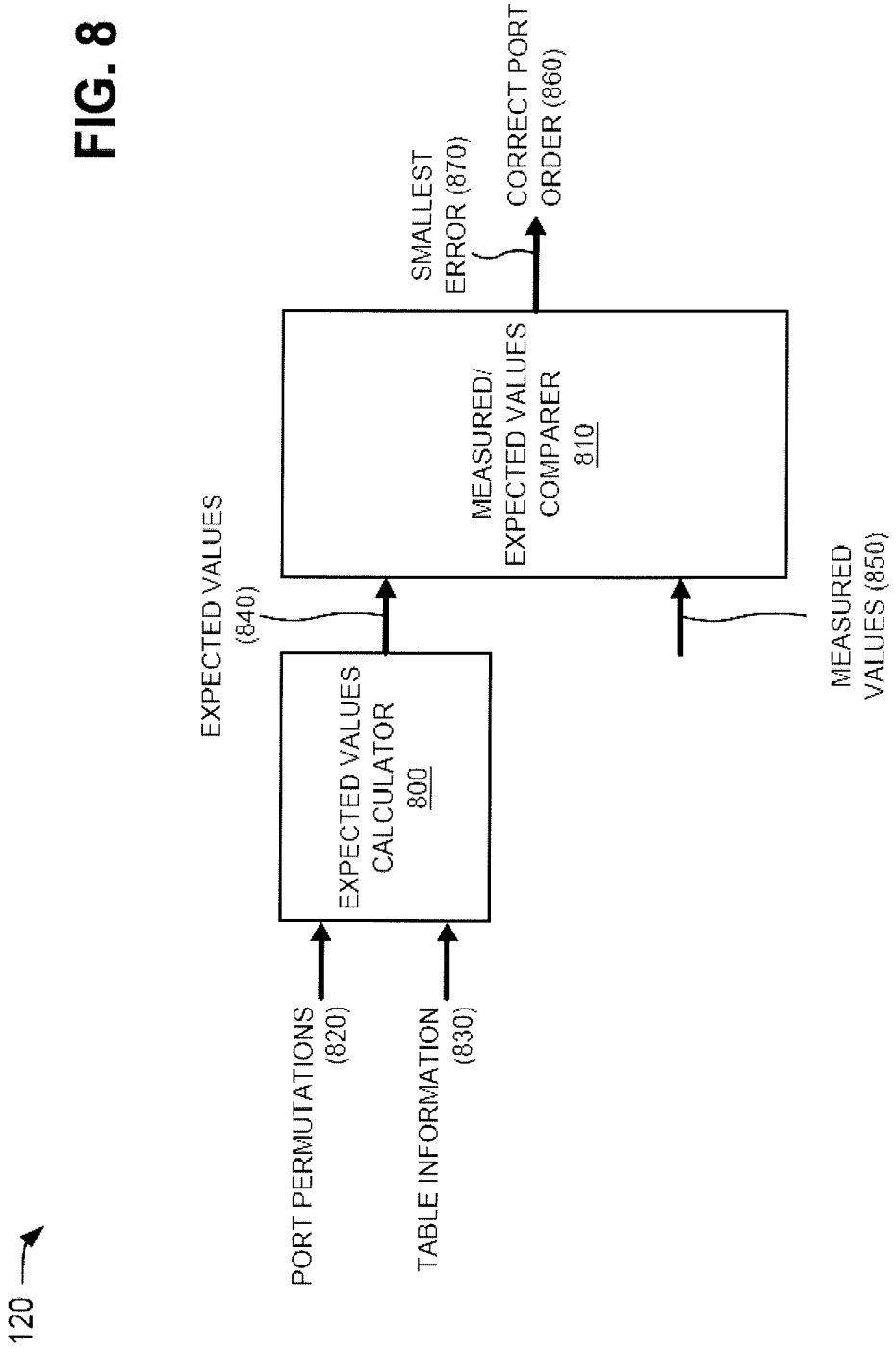

120
PORT PERMUTATIONS (820)
TABLE INFORMATION (830)
EXPECTED VALUES CALCULATOR 800
EXPECTED VALUES (840)
MEASURED VALUES (850)
MEASURED/ EXPECTED VALUES COMPARER 810
SMALLEST ERROR (870)
CORRECT PORT ORDER (860)

FIG. 9

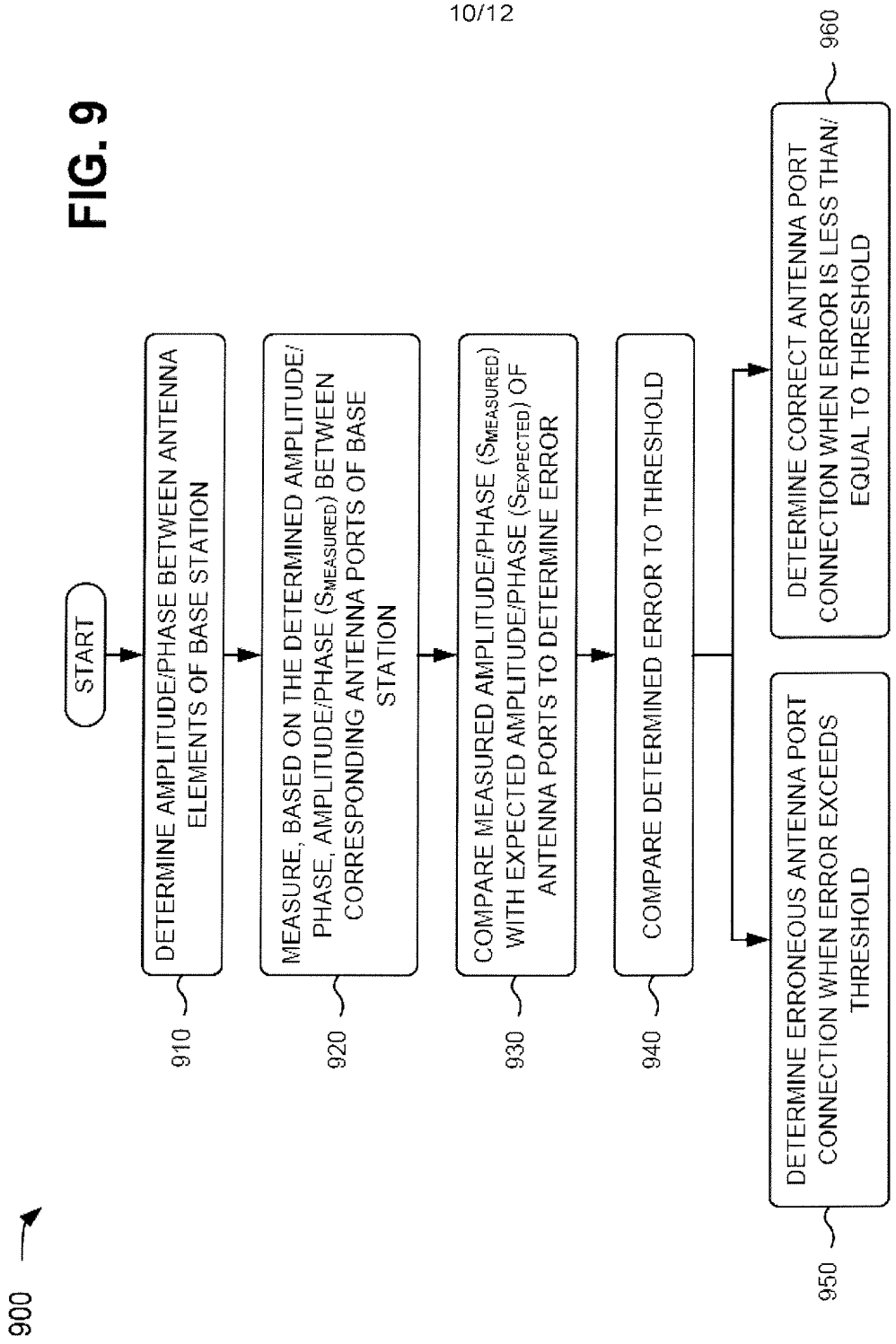

900
START
DETERMINE AMPLITUDE/PHASE BETWEEN ANTENNA ELEMENTS OF BASE STATION
910
MEASURE, BASED ON THE DETERMINED AMPLITUDE/PHASE, AMPLITUDE/PHASE ($S_{MEASURED}$) BETWEEN CORRESPONDING ANTENNA PORTS OF BASE STATION
920
COMPARE MEASURED AMPLITUDE/PHASE ($S_{MEASURED}$) WITH EXPECTED AMPLITUDE/PHASE ($S_{EXPECTED}$) OF ANTENNA PORTS TO DETERMINE ERROR
930
COMPARE DETERMINED ERROR TO THRESHOLD
940
DETERMINE ERRONEOUS ANTENNA PORT CONNECTION WHEN ERROR EXCEEDS THRESHOLD
950
DETERMINE CORRECT ANTENNA PORT CONNECTION WHEN ERROR IS LESS THAN/ EQUAL TO THRESHOLD
960

FIG. 10

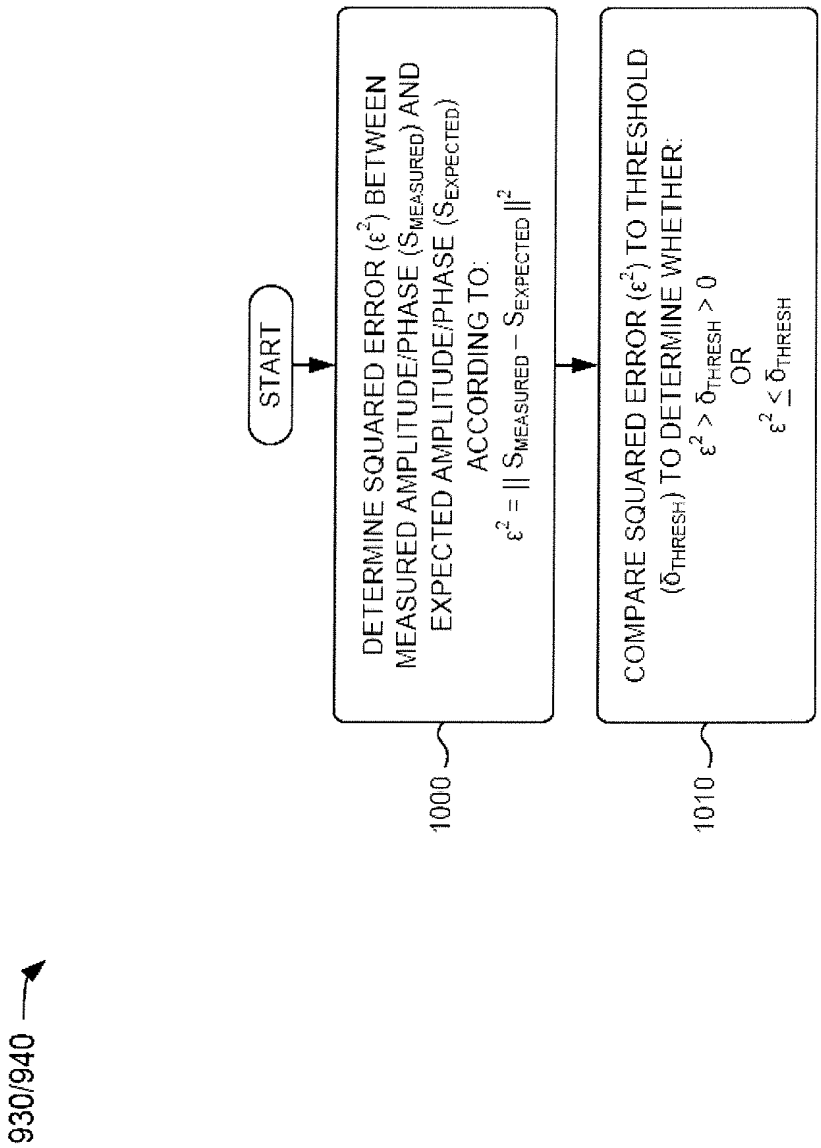
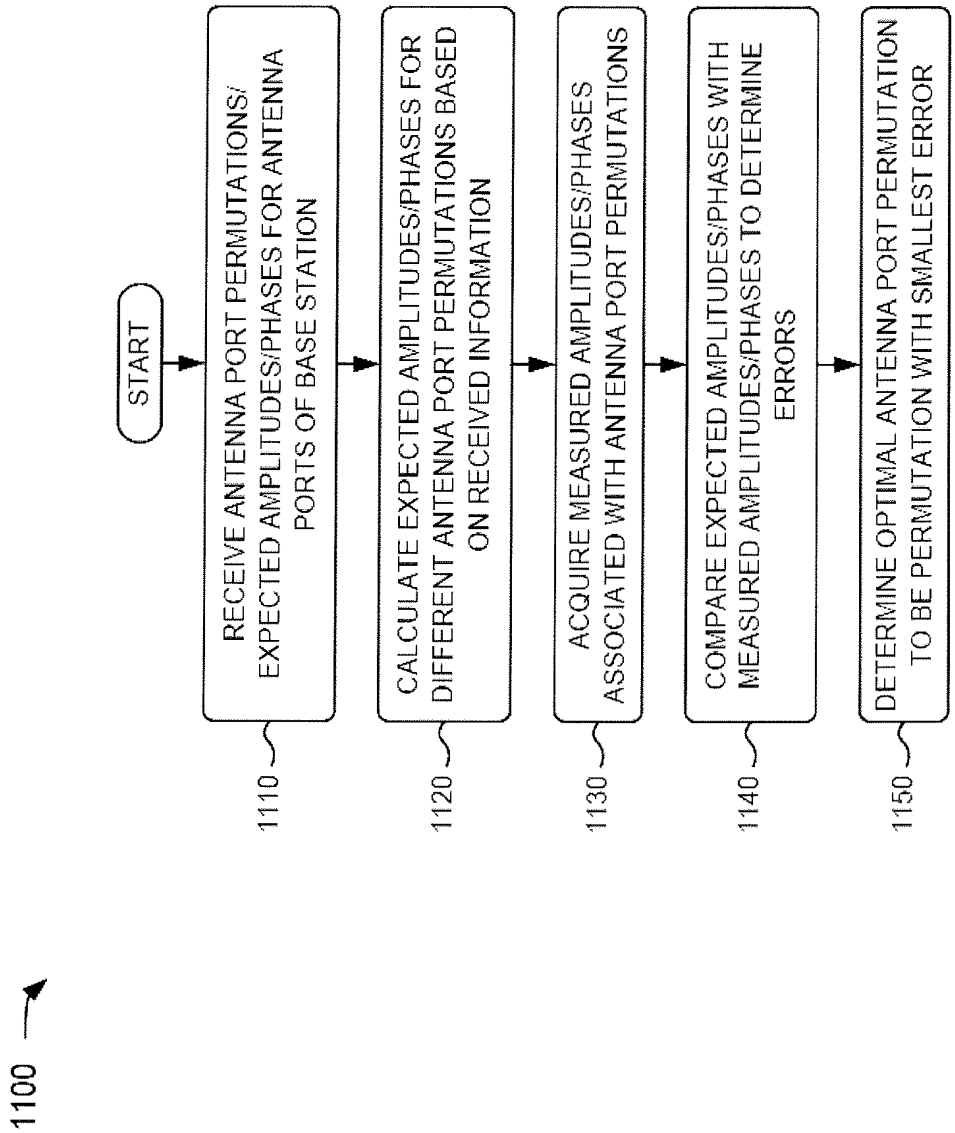

930/940
START
DETERMINE SQUARED ERROR (ε^2) BETWEEN MEASURED AMPLITUDE/PHASE ($S_{MEASURED}$) AND EXPECTED AMPLITUDE/PHASE ($S_{EXPECTED}$) ACCORDING TO:
$\varepsilon^2 = \| S_{MEASURED} - S_{EXPECTED} \|^2$
1000
COMPARE SQUARED ERROR (ε^2) TO THRESHOLD (δ_{THRESH}) TO DETERMINE WHETHER:
$\varepsilon^2 > \delta_{THRESH} > 0$
OR
$\varepsilon^2 \leq \delta_{THRESH}$
1010

FIG. 11


1100
START
RECEIVE ANTENNA PORT PERMUTATIONS/ EXPECTED AMPLITUDES/PHASES FOR ANTENNA PORTS OF BASE STATION
1110
CALCULATE EXPECTED AMPLITUDES/PHASES FOR DIFFERENT ANTENNA PORT PERMUTATIONS BASED ON RECEIVED INFORMATION
1120
ACQUIRE MEASURED AMPLITUDES/PHASES ASSOCIATED WITH ANTENNA PORT PERMUTATIONS
1130
COMPARE EXPECTED AMPLITUDES/PHASES WITH MEASURED AMPLITUDES/PHASES TO DETERMINE ERRORS
1140
DETERMINE OPTIMAL ANTENNA PORT PERMUTATION TO BE PERMUTATION WITH SMALLEST ERROR
1150

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
13/321,076	11/17/2011	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☒ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	380
☒ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	620
☒ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	250
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	* 0	X $ =		OR	X $60 =	0
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	* 0	X $ =			X $250 =	0
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1250

APPLICATION AS AMENDED – PART II

AMENDMENT 11/17/2011	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 20	= 0	X $ =		OR	X $60=	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $ =		OR	X $250=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/MARCUS MONROE/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.