

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
28 August 2003 (28.08.2003)

PCT

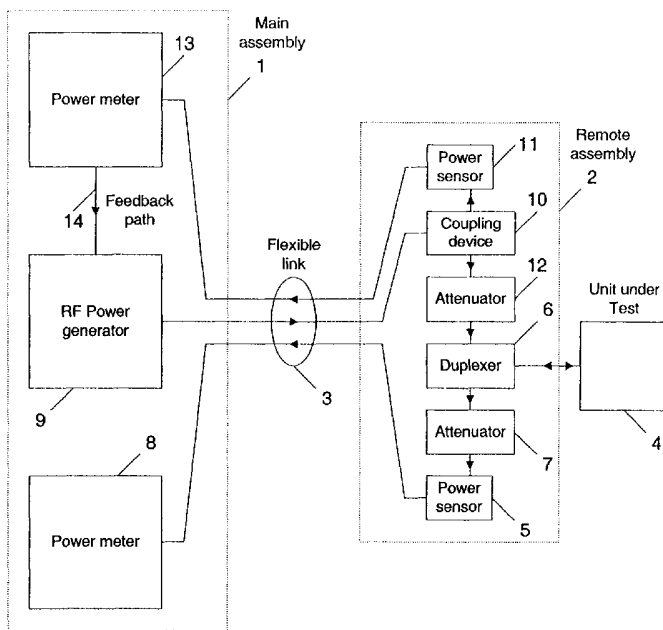
(10) International Publication Number  
**WO 03/071296 A1**

- (51) International Patent Classification<sup>7</sup>: **G01R 31/28**
- (21) International Application Number: PCT/GB03/00701
- (22) International Filing Date: 18 February 2003 (18.02.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:  
0204013.7      20 February 2002 (20.02.2002)      GB
- (71) Applicant (for all designated States except US): **RACAL INSTRUMENTS LIMITED** [GB/GB]; 480 Bath Road, Slough, Berkshire SL1 6BE (GB).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **ROSE, Ian, Michael** [GB/GB]; 262 Courthouse Road, Maidenhead, Berkshire SL6 6HE (GB).
- (74) Agent: **MATHISEN, Macara & Co.**; The Coach House, 6-8 Swakeleys Road, Ickenham, Uxbridge, Middlesex UB10 8BZ (GB).
- (81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**  
— with international search report

[Continued on next page]

(54) Title: RADIO FREQUENCY POWER GENERATION AND POWER MEASUREMENT



(57) Abstract: Power sensors to measure both the radio frequency (RF) power transmitted by radio equipment under test, and the RF power received by the radio equipment under test, are mounted in a separate assembly (2) remote from the main means of power measurement and generation (1). The RF power sensors and other components in the remote assembly (2) are interconnected so as to allow measurement of both received and transmitted RF power at the Rf connector or connectors of the radio equipment under test (4). The main assembly and the remote assembly are connected by a flexible link (3).



WO 03/071296 A1



---

*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.*

## **RADIO FREQUENCY POWER GENERATION AND POWER MEASUREMENT**

This invention relates to the generation and measurement of radio frequency (RF) power.

When measuring RF power, it is necessary to define the physical point in the system at which the measurement is made. This is because the transmission of RF power, whether through space, waveguide, or coaxial transmission lines is subject to loss. RF power measured in one place is only an accurate measure of RF power at another place to the extent that the transmission losses are known.

For this reason, equipment for measuring RF power often separates the RF power sensing element from the measuring equipment, so that the sensing element can be remote. The advantage of this arrangement is that whilst the full RF power measurement equipment may be large, the power sensing element can be made small and connected directly to the unit under test.

Figure 1 shows a known example of this technique.

When generating RF power, it is also necessary to define the physical point in the system at which the output power is specified. As stated before, the transmission of

RF power is subject to loss. RF power generated at one place is only an accurate measure of RF power generated at another place to the extent that the transmission losses are known.

For this reason, equipment for generating known RF power is sometimes used with a remote RF power sensing element, which may be connected to a separate means of power measurement, or may form part of a feedback loop which controls the RF power generation equipment. Such a system provides a signal source whose RF power at a defined point is determined by the accuracy of the remote sensor and the coupling device. The advantage is that whilst the full RF power generation equipment may be large, the power sensing element and coupling device can be made small, and connected directly to the unit under test.

Figure 2 shows a known example of this technique.

Radio communication equipment often has either a single RF connector for transmission and reception, or one RF connector for transmission and another for reception. When characterising such equipment it is required both to measure the RF power transmitted by the unit under test, and to set the RF power received by the unit under test. It is usual to specify both powers at the RF connector or connectors of the unit under test.

According to the invention there is provided an RF power generation and measurement system for supplying RF power to, and measuring RF power transmitted by a unit under test via at least one RF connector of the unit, the system comprising, a main part, and a remote part connected to the main part by a link and being connectable to said RF connector of the unit under test, wherein said main part includes RF power generation means for supplying RF power to said unit under test via said link, said remote part and said RF connector, said remote part includes sensor means for sensing RF power received from said unit under test via said RF connector and for sensing RF power indicative of said RF power supplied to the unit under test at said RF connector, and said RF power generation means is controlled in response to an output of said sensor means whereby RF power supplied to the unit under test at said RF connector has a predetermined value.

Embodiments of the invention enable both measurement of RF power transmitted by the unit under test at the RF connector and setting of the RF power received by the unit under test at the RF connector. Those components of the system which need to be near the RF connector or connectors are fitted in a small remote assembly. The majority of the system components are in a larger main assembly, allowing freedom in the location of this part. The two parts of the system are connected by a link, preferably a flexible link.

A specific embodiment of the invention will now be described, by way of example, with reference to Figure 3 of the accompanying drawings which shows an RF power generation and measurement system according to the invention.

Referring to Figure 3, the system comprises a main assembly part 1 including an RF power generator 9 and power meters 8,13, and a remote assembly part 2 connectable to the RF connector of a unit under test 4 (which may be a mobile communications terminal, for example). The main and remote assembly parts are interconnected by a flexible link 3. RF power is supplied to, and received from the unit under test by a duplexer 6 in the remote assembly part 2. The remote assembly part 2 also includes a first RF power sensor 5 connected to duplexer 2 via an attenuator 7 and a second RF power-sensor 11 connected to an RF coupling device 10, for example a directional coupler or a power splitter, which is also connected to duplexer 6 via a fixed or settable attenuator 12.

RF power transmitted by the unit under test 4 is measured using the first RF power sensor 5. The duplexer 6 directs at least some of the power transmitted by the unit under test 4 to the power sensor 5 via the attenuator 7. The attenuator 7 is chosen so that the power sensor 5 receives RF power within its measurement range. The duplexer 6, the attenuator 7 and the power sensor 5 are all fitted within the remote assembly 2, to allow them to be connected close to the RF connector of the unit under test 4. The electrical output of the power sensor 5 is connected via the flexible link 3 to the power meter 8 fitted within the main assembly part 1. Transmission loss through the duplexer 6 and the attenuator 7 can be characterised, and is used by power meter 8 to give a measurement of RF power transmitted by the unit under test 4 at its RF connector.

The signal to be received by the unit under test is supplied by the RF power generator

9 in the main assembly part 1. It passes through the flexible link 3, and into the coupling device 10. The coupling device 10 allows a predetermined fraction of the RF power to reach the power sensor 11, and another predetermined fraction to reach the RF connector of the unit under test 4 via the attenuator 12 and the duplexer 6. The coupling device 10, the attenuator 12 and the power sensor 11 are all fitted within the remote assembly part 2, to allow them to be connected close to the RF connector of the unit under test 4. The electrical output of the power sensor 11 is connected via the flexible link 3 to the power meter 13 fitted within the main assembly part 1. The RF transmission characteristics of the coupling device 10, and loss through the attenuator 12 and the duplexer 6 can be characterised and used by power meter 13 to give a measurement of RF power received by the unit under test 4 at its RF connector. The value reported by power meter 13 is used to correct the output level of the RF power generator 9 via a feedback path 14.

The characteristics of the duplexer 6 and the coupling device 10, and the value of the attenuator 12, are chosen so that the power sensor 11 is not significantly affected by the RF power transmitted by the unit under test 4. Likewise the characteristics of the duplexer 6 and the value of the attenuator 7 are chosen so that the power sensor 5 is not significantly affected by the RF power transmitted by the RF power generator 9.

It will be appreciated that the electrical outputs of one or both power sensors 5,11 need not necessarily be supplied to power meters located in the main assembly part 1. Alternatively, these outputs could be supplied to separate metering apparatus remote from the main assembly part 1.

In an alternative implementation, a single power sensor means may be used to perform the functions of power sensor 5 and power sensor 11, for example by being switched between the output of attenuator 7 and the coupling device 10.

**CLAIMS**

1. An RF power generation and measurement system for supplying RF power to, and measuring RF power transmitted by a unit under test via at least one RF connector of the unit, the system comprising,

a main part,

and a remote part connected to the main part by a link and being connectable to said RF connector of the unit under test,

wherein said main part includes RF power generation means for supplying RF power to said unit under test via said link, said remote part and said RF connector,

said remote part includes sensor means for sensing RF power received from said unit under test via said RF connector and for sensing RF power indicative of said RF power supplied to the unit under test at said RF connector, and

said RF power generation means is controlled in response to an output of said sensor means whereby RF power supplied to the unit under test at said RF connector has a predetermined value.

2. A system as claimed in claim 1 wherein said sensor means comprises a first RF power sensor for sensing said RF power received from said unit under test via said RF connector and a second RF power sensor for sensing said RF power indicative of said RF power supplied to the unit under test at said RF connector.

3. A system as claimed in claim 1 or claim 2 wherein said remote part includes means for routing to said unit under test a predetermined fraction of RF power

received from said RF power generation means via said link.

4. A system as claimed in claim 3 wherein said means for routing is a power splitter.

5. A system as claimed in claim 3 wherein said means for routing is a directional coupler.

6. A system as claimed in any one of claims 3 to 5 wherein said remote part includes a first attenuator and said means for routing is arranged to route said predetermined fraction of RF power to said unit under test via said first attenuator.

7. A system as claimed in any one of claims 3 to 6 wherein said means for routing is arranged to route to said sensor means another predetermined fraction of said RF power received from said RF power generation means via said link.

8. A system as claimed in any one of claims 1 to 5 wherein said remote part includes a second attenuator and said sensor means receives said RF power from said unit under test via said second attenuator.

9. A system as claimed in any one of claims 1 to 8 wherein said remote part includes a duplexer for both supplying RF power to, and receiving RF power from said unit under test via the same RF connector of the unit.

10. A system as claimed in any one of claims 1 to 9 wherein said main part

includes first power metering means for receiving via said link an output of said sensor means and processing said output to derive a measure of RF power transmitted by the unit under test at said RF connector.

11. A system as claimed in any one of claims 1 to 10 wherein said main part includes second power metering means for receiving via said link an output of said sensor means and processing said output to derive a measure of RF power supplied to said unit under test at said RF connector.

12. A system as claimed in claim 11 wherein said second power metering means is operative to control said RF power generation means in response to the received output of said sensor means whereby said RF power supplied to the unit under test at said RF connector has said predetermined value.

13. A system as claimed in any one of claims 1 to 12 wherein said link is a flexible link.

14. A system as claimed in claim 1 substantially as herein described with reference to Figure 3 of the accompanying drawings.

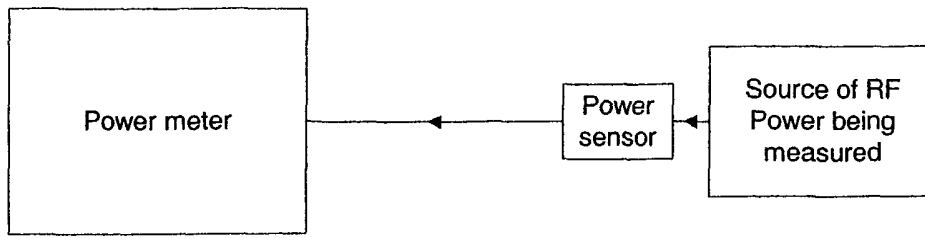


Figure 1

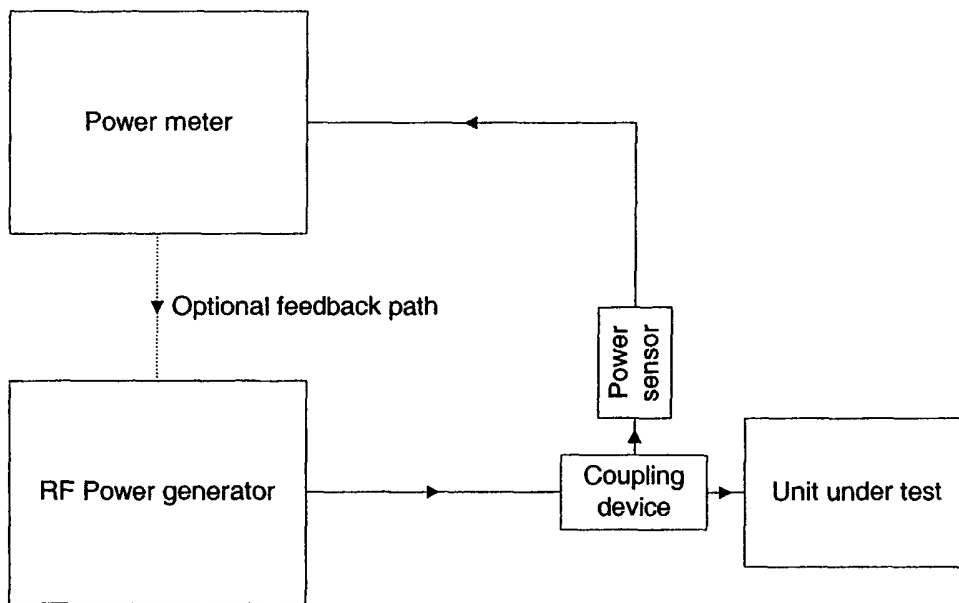


Figure 2

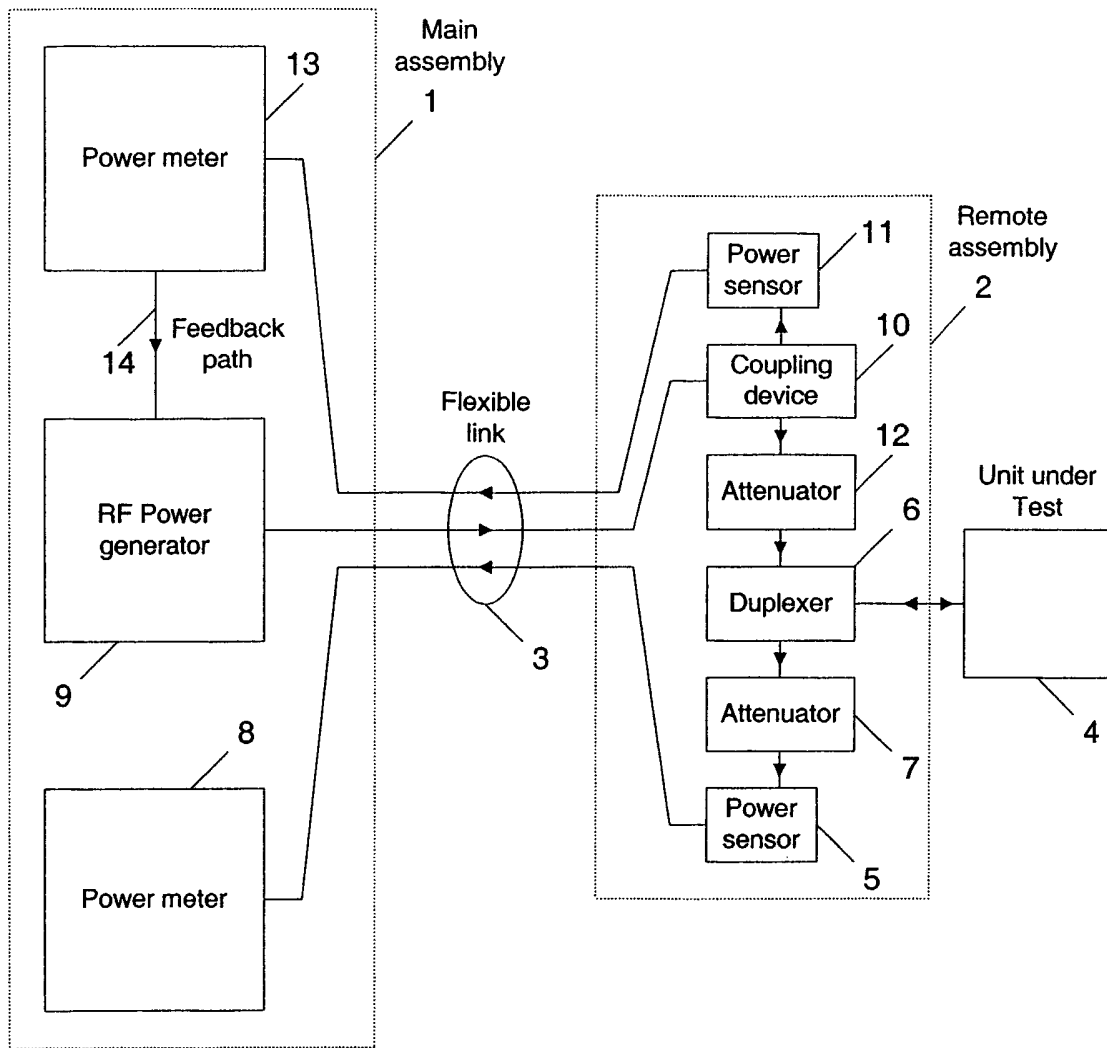


Figure 3

INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 03/00701

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> IPC 7 G01R31/28		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) IPC 7 G01R		
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) EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX, IBM-TDB		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 313 644 B1 (KIM BO JONG ET AL) 6 November 2001 (2001-11-06) abstract; claim 1 column 6, line 35 - line 58 column 7, line 7 - line 33 column 9, line 18 - line 36 -----	1-13
A	US 6 268 735 B1 (BEGG MATTHEW THOMAS ET AL) 31 July 2001 (2001-07-31) abstract; figure 2A column 1, line 49 - line 59 column 2, line 4 - line 10 column 2, line 64 - column 3, line 11 column 5, line 18 - line 44 -----	1-13
<input type="checkbox"/> Further documents are listed in the continuation of box C.		
<input checked="" type="checkbox"/> 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  26 May 2003		Date of mailing of the international search report  05/06/2003
Name and mailing address of the ISA 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		Authorized officer  Binger, B

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/GB 03/00701

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.: 14  
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:  
Contrary to the provisions of Rule 6.2(a) PCT, claim 14 refers to Figure 3.
  
3.  Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1.  As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No PCT/GB 03/00701
---

Patent document cited in search report	Publication date	Publication date	Patent family member(s)	Publication date
US 6313644	B1	06-11-2001	KR 218152 B1 CN 1211892 A	01-09-1999 24-03-1999
US 6268735	B1	31-07-2001	NONE	