



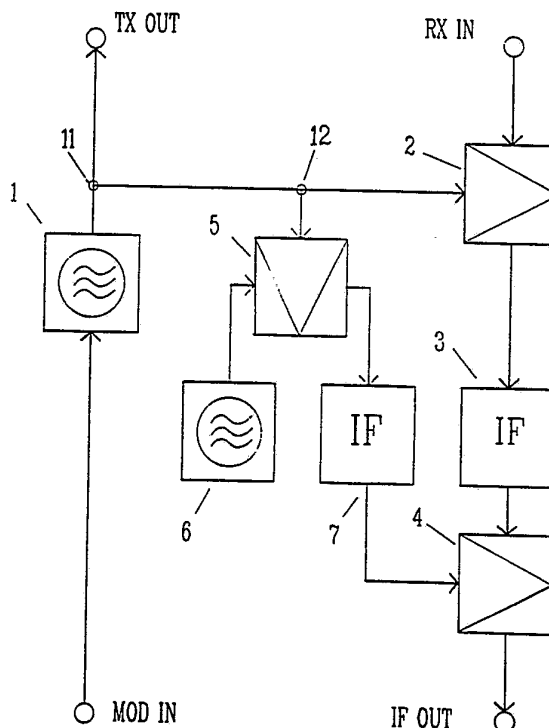
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: PCT/FI92/00228 (22) International Filing Date: 19 August 1992 (19.08.92) (30) Priority data: 914085 29 August 1991 (29.08.91) FI (71) Applicant (for all designated States except US): NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, SF-02600 Espoo (FI). (72) Inventor; and (75) Inventor/Applicant (for US only) : MÄKINEN, Jarmo [FI/FI]; Vahverotie 5D, SF-02730 Espoo (FI). (74) Agent: OY KOLSTER AB; Stora Robertsgatan 23, SF-00120 Helsinki (FI).		(81) Designated States: AU, DE, GB, JP, SE, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, SE). Published With international search report.

(54) Title: FREQUENCY-MODULATED TRANSCEIVER

(57) Abstract

The invention relates to a frequency-modulated transceiver wherein the transmitter comprises a frequency-modulated high frequency oscillator (1) and the receiver comprises, coupled to a cascade, a high frequency mixer (2) whose local oscillator signal is a modulated output signal from the high frequency oscillator (1), and an intermediate frequency mixer (4) having an intermediate frequency local oscillator signal containing transmission modulation. In accordance with the invention the transceiver further comprises a third mixer (5) for providing said intermediate frequency local oscillator signal from a modulated output signal of the high frequency oscillator.



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Frequency-modulated transceiver

The Field of the Invention

The invention relates to a frequency-modulated transceiver wherein the transmitter comprises a frequency-modulated high frequency oscillator, and the receiver comprises, coupled to a cascade, a high frequency mixer whose local oscillator signal is a modulated output signal from the high frequency oscillator, and an intermediate frequency mixer having an intermediate frequency local oscillator signal containing transmission modulation.

Background of the Invention

In particular in radio devices operating in the microwave regions (> 1 GHz), such as radio links, it is advantageous to minimise the number of high frequency and microwave components, since they are the most expensive and often the most critical components in the system. For instance, in a full-duplex radio operating on a high frequency (microwaves, millimetric waves) it is very costly to manufacture separate local oscillators for the transmitter and the receiver. On the other hand, the use of the same high frequency oscillator both for the transmitter and the down-conversion section of the receiver causes certain problems. The most preferred way to generate the transmission signal is frequency modulation of said common high frequency oscillator, but in such a case the transmission modulation will be summed to the received signal as well, and it has to be somehow cancelled.

One known method for cancelling the transmission modulation from a received signal is to sum a baseband signal corresponding to the transmission modulation in an appropriate delay and phase relation to a baseband signal of the receiver, whereby the

transmission modulation in the receipt signal is cancelled.

5 In Finnish Patent 80,549 the residual modulation is eliminated by using in the receiver a second intermediate frequency mixing stage in which local oscillator is also modulated with a transmission signal so that the transmission modulation in the received signal is cancelled in the second mixing.

10 There are certain drawbacks in the above-mentioned methods. In the first solution the detector of the receiver has to handle the modulations in both the receiving and transmitting directions, wherefore the required bandwidth increases and thus the selectivity of the receiver diminishes.

15 Furthermore, both methods have the problem of matching of the linearity of modulation and countermodulation, which makes it difficult to completely eliminate the transmission modulation from the received signal. The matter is further complicated
20 by the fact that the properties of oscillators vary according to the ambient conditions. This problem can be mitigated to some degree by an automatic control of the compensation during operation, but this increases the complexity of the apparatus.

25 Disclosure of the Invention

The above problems are avoided with a frequency-modulated transceiver as disclosed in the introductory paragraph. Said transceiver is
30 characterised according to the invention in that it comprises a third mixer for generating said intermediate frequency local oscillator signal from a modulated output signal of the high frequency oscillator.

In the transceiver according to the invention the receiving portion comprises at least two mixing
35 stages. In the first mixing stage the local oscillator

signal is a transmission signal, and in the second intermediate frequency mixing stage eliminating the transmission modulation from the received signal, the local oscillator signal is produced by mixing from the transmission signal.

With the solution according to the invention the compensation of the transmission modulation from the received signal is more efficient than in the prior art methods, because in the invention the local oscillator signal in the second mixing stage, i.e. the compensation signal, is derived from the signal to be compensated, and therefore the properties of the signals correspond well one to another. For instance, the nonlinearity of the modulation will not affect the resulting compensation.

Brief description of the drawings

In the following the invention will be described in more detail by means of illustrative embodiments with reference to the attached drawing wherein Figures 1 and 2 provide block diagrams of two transceivers embodying the present invention.

Detailed description of the invention

In the transceivers of Figures 1 and 2 the modulation signal of the transmitter is applied to the modulation input of a high frequency oscillator 1. From the output of the high frequency oscillator 1 the transmitting-frequency frequency-modulated signal is applied through branching device 11 either directly or through a possible high frequency amplifier (not shown) to an antenna. The modulation signal is preferably a digital signal. In this context high frequency refers in particular but not exclusively to microwave frequencies (>1 GHz).

The receiver comprises, cascade connected in the following order, a high frequency mixer 2, an

intermediate frequency section 3 (typically comprising filters and amplifiers) and an intermediate frequency mixer 4. After these, there is usually a second intermediate frequency section and a detector, which are not shown in the figures. The received signal is applied from the antenna to the mixer 2. A frequency-modulated output signal of said oscillator 1 is applied, via the branching devices 11 and 12 to the local oscillator input of the mixer 2. The mixer 2 converts the received signal into the first intermediate frequency while introducing into it the modulation content of the output signal of the oscillator 1. The intermediate frequency output signal of the mixer 2 is preferably passband filtered and amplified by the first intermediate frequency section 3 and applied to the intermediate frequency mixer 4.

The branching device 12 branches the output signal of the oscillator 1 also to the input of a mixer 5. The output of an oscillator 6 is coupled to the local oscillator input of the mixer 5. The mixer 5 provides from the inputted modulated transmission signal an intermediate frequency signal, which is applied through an intermediate frequency filter 7 to the local oscillator input of the mixer 4. As a result, the local oscillator signal of the mixer 4 contains, with an equal phase, a modulation equal to that of the particular transmitter in the input signal of the mixer 4. The filtering functions of the intermediate frequency sections 3 and 7 and the directions of the mixings of the mixers 2 and 5 are selected so that the modulation caused by the particular transmitter in the received signal is compensated when the mixer 4 converts the received signal to the second intermediate frequency. Therefore, no residual modulation of the particular

transmitter should occur in the output signal of the mixer 4.

5 The only feature that makes the compensation non-ideal is the linear distortion and the different delays in the intermediate frequency sections 3 and 7. Since the intermediate frequency sections 3 and 7 can however be fairly wideband and nearly identical with each other, no significant errors can occur impeding the compensation.

10 The solution according to the invention is advantageous also in that in general the mixing required for providing the compensation signal, i.e. the local oscillator signal of the mixer 4, and the oscillator signal required already exist in the transmitter in the
15 phase locking circuit of the high frequency oscillator 1. Figure 2 illustrates application of the invention in such a transceiver comprising a phase-locked loop. The phase-locked loop comprises a phase comparator 8, which compares the phase of the output signal of a
20 reference oscillator 9 and the intermediate frequency filter 7, and provides an output signal representing the phase difference. In a summing device 10 a modulation signal MOD IN of the transmitter is summed to the output signal of the phase comparator 8. With the resultant
25 summation signal, the frequency of the oscillator 1 is modulated. This embodiment of the invention has the drawback that the frequency of the signal applied from the intermediate frequency filter 7 to the phase locking circuits 8, 9 and 10 is fixed to the frequency
30 difference between the transmitter and the receiver. The channel changeover may however be carried out by modulating the frequency of the oscillator 6.

 In an alternative embodiment of the invention the input- and local oscillator gates of the mixer 5 of

Figure 1 may be interchanged. The mixer 5 is preferably a subharmonic mixer.

5 The oscillator 6 can consist e.g. of a quartz oscillator and a chain of multipliers. This is an advantageous realisation, for the required signal level at the local oscillator input of the mixer 5 is fairly low. Another way to realise the oscillator 6 is to use various phase-locked loops.

10 The attached figures and the associated description are intended merely to illustrate the present invention. In its details a transceiver according to the invention may vary within the scope of the attached claims.

Claims:

1. A frequency-modulated transceiver wherein the transmitter comprises a frequency-modulated high frequency oscillator (1), and the receiver comprises, coupled to a cascade, a high frequency mixer (2) whose local oscillator signal is a modulated output signal from the high frequency oscillator (1), and an intermediate frequency mixer (4) having an intermediate frequency local oscillator signal containing transmission modulation, c h a r a c t e r - i s e d by comprising a third mixer (5) for providing said intermediate frequency local oscillator signal from a modulated output signal of the high frequency oscillator.

2. A transceiver according to claim 1, c h a r a c - t e r i s e d in that an intermediate frequency filter and/or -amplifier is coupled between the high frequency mixer (2) and the intermediate frequency mixer (4).

3. A transceiver according to claims 1 or 2, c h a r a c t e r i s e d in that a second intermediate frequency filter and/or -amplifier (3) is coupled between the third mixer (5) and the intermediate frequency mixer (4).

4. A transceiver according to claims 1, 2 or 3, c h a r a c t e r i s e d in that the third mixer (5) is a subharmonic mixer.

5. A transceiver according to claims 1, 2, 3 or 4, c h a r a c t e r i s e d in that the frequency of the oscillator signal to the third mixer (5) is adjustable.

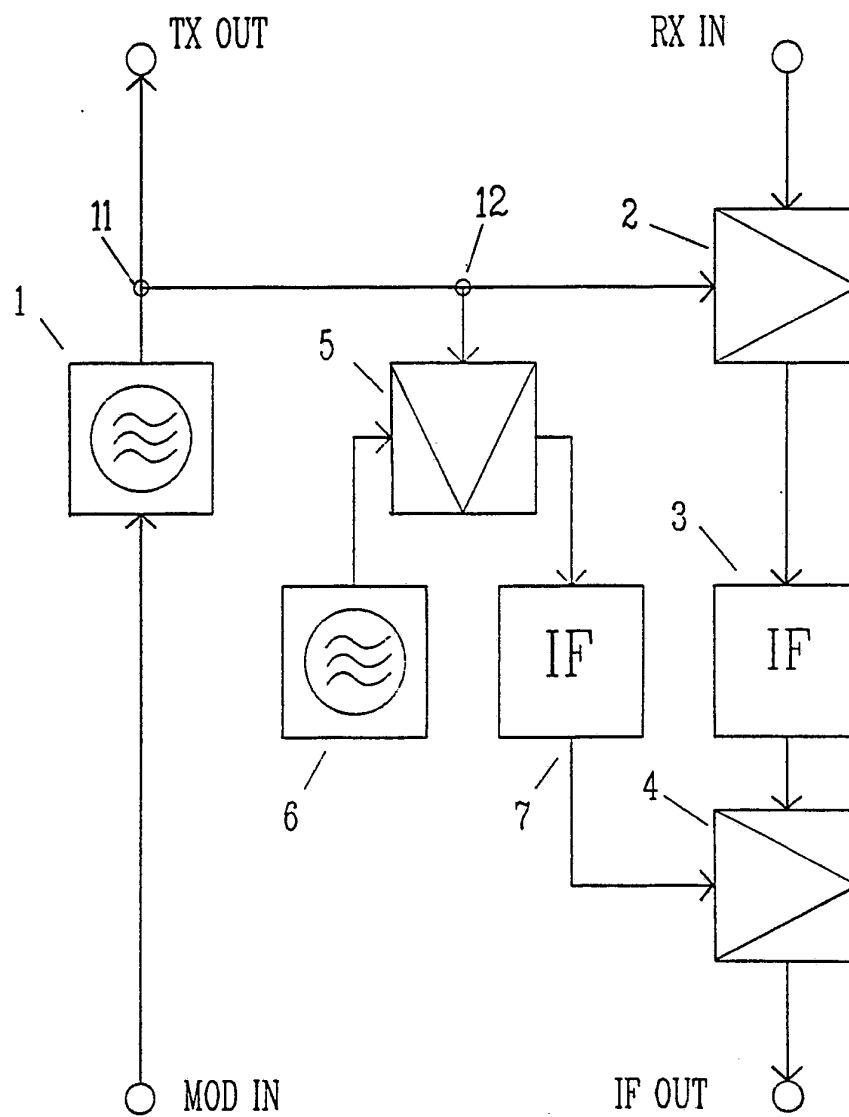


Fig. 1.

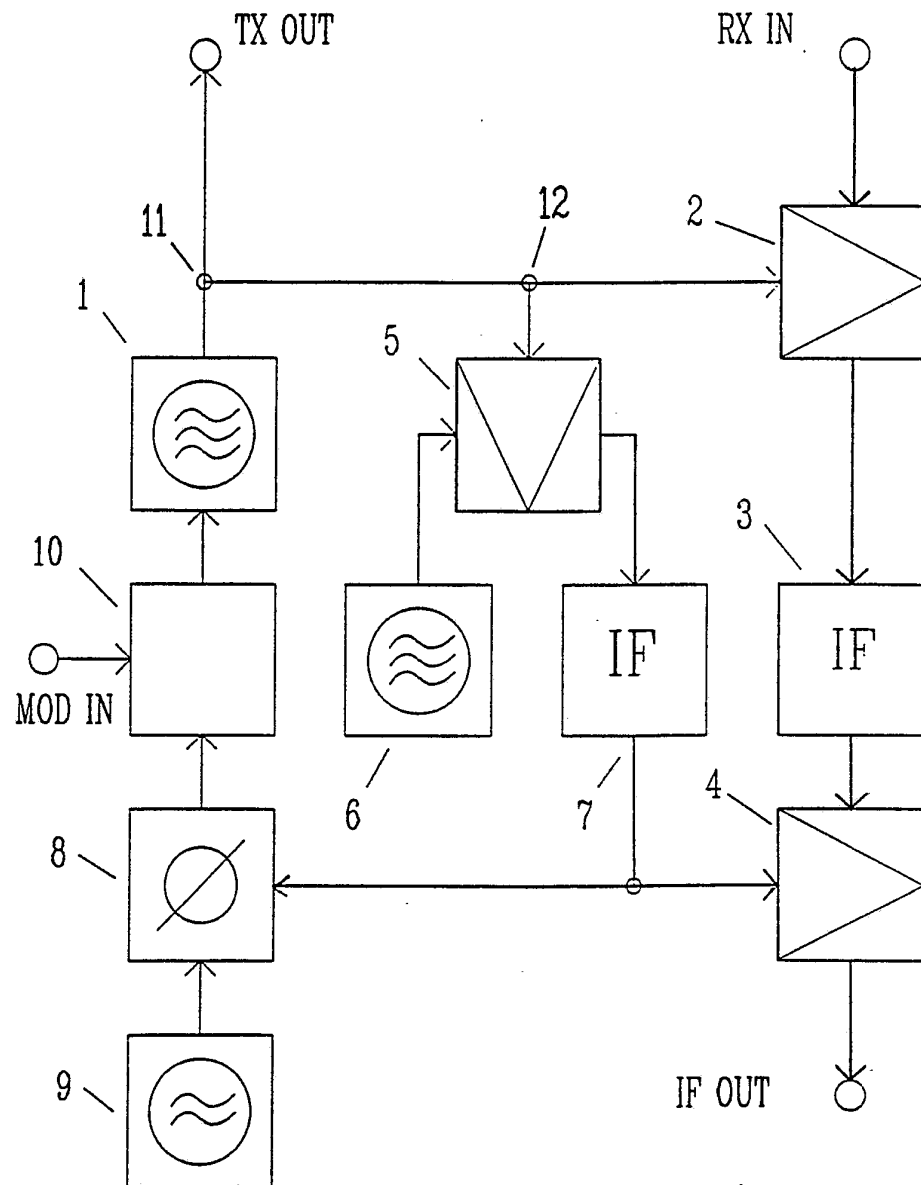


Fig. 2.

INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 92/00228

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶ According to International Patent Classification (IPC) or to both National Classification and IPC IPC5: H 04 B 1/40											
II. FIELDS SEARCHED Minimum Documentation Searched⁷ <table style="width: 100%; border-collapse: collapse;"> <tr> <th style="width: 25%; border: 1px solid black; text-align: left;">Classification System</th> <th style="border: 1px solid black; text-align: left;">Classification Symbols</th> </tr> <tr> <td style="border: 1px solid black; height: 40px; vertical-align: bottom;">IPC5</td> <td style="border: 1px solid black; vertical-align: bottom;">H 04 B</td> </tr> </table> Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched⁸ SE,DK,FI,NO classes as above			Classification System	Classification Symbols	IPC5	H 04 B					
Classification System	Classification Symbols										
IPC5	H 04 B										
III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹ <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%; text-align: left;">Category *</th> <th style="width: 60%; text-align: left;">Citation of Document,¹¹ with indication, where appropriate, of the relevant passages¹²</th> <th style="width: 30%; text-align: left;">Relevant to Claim No.¹³</th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top;">Y</td> <td style="vertical-align: top;">GB, A, 2122456 (RONALD R. WHITE ET AL) 11 January 1984, see page 2, line 112 - line 115 -- </td> <td style="vertical-align: top;">1-5</td> </tr> <tr> <td style="vertical-align: top;">Y</td> <td style="vertical-align: top;">US, A, 4491969 (RAVI DATTA) 1 January 1985, see column 5, line 18 - line 30 -- ----- </td> <td style="vertical-align: top;">1-5</td> </tr> </tbody> </table>			Category *	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³	Y	GB, A, 2122456 (RONALD R. WHITE ET AL) 11 January 1984, see page 2, line 112 - line 115 --	1-5	Y	US, A, 4491969 (RAVI DATTA) 1 January 1985, see column 5, line 18 - line 30 -- -----	1-5
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Y	US, A, 4491969 (RAVI DATTA) 1 January 1985, see column 5, line 18 - line 30 -- -----	1-5									
* Special categories of cited documents:¹⁰ "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 "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											
IV. CERTIFICATION <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of the Actual Completion of the International Search 7th December 1992 </td> <td style="width: 50%; border: 1px solid black; padding: 5px;"> Date of Mailing of this International Search Report 10 -12- 1992 </td> </tr> <tr> <td style="border: 1px solid black; padding: 5px;"> International Searching Authority SWEDISH PATENT OFFICE </td> <td style="border: 1px solid black; padding: 5px;"> Signature of Authorized Officer BERTIL LJUNGDAHL </td> </tr> </table>			Date of the Actual Completion of the International Search 7th December 1992	Date of Mailing of this International Search Report 10 -12- 1992	International Searching Authority SWEDISH PATENT OFFICE	Signature of Authorized Officer BERTIL LJUNGDAHL					
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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 92/00228

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 2122456	84-01-11	JP-A- 58210729	83-12-08
		US-A- 4685099	87-08-04
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