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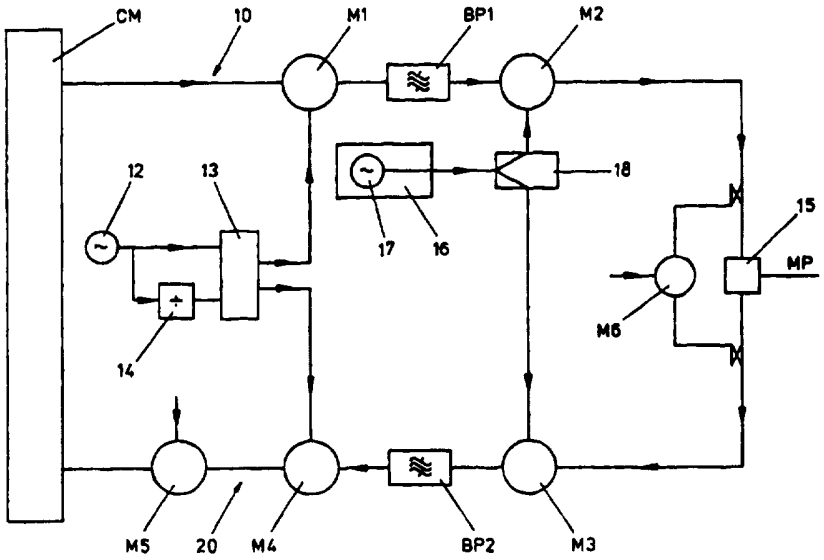

(57) Abstract

A transmitter/receiver circuit for one station of a microwave radio system comprising one signal path (10) for upconverting a signal for transmission from an antenna and a second signal path (20) for downconverting a signal received on the antenna. A single local oscillator (12) runs at twice the duplex frequency and is used to provide the signals for the upconversion and the downconversion: the oscillator signal is used directly for upconversion, and is divided by two for downconversion. A local oscillator synthesiser (17) effects the final upconversion stage of the transmitted signal and the initial downconversion stage of the received signal. Thus, the arrangement is of simple construction and requires fewer local oscillators than prior art devices. Also, the local oscillator synthesisers for two communicating radio stations can be of exactly the same, relatively simple design.

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MICROWAVE RADIO SYSTEM

This invention relates to a microwave radio system.

Microwave radio systems are known in which each station uses a common antenna for transmitting and receiving signals. At each station, a transmitter/receiver circuit serves to "upconvert" the signal to be transmitted from a low carrier frequency to an appropriate microwave carrier frequency, and serves to "downconvert" the received signal to an appropriate low carrier frequency. Licensed frequency bands are generally split between upper and lower half bands: in an intercommunicating pair of stations, one station transmits in the upper half band and receives in the lower half band; correspondingly, because the transmit frequency of each station is the receive frequency of the other, the second station of the pair receives in the upper half band and transmits in the lower half band. Always the transmit and receive frequencies are offset by a constant amount, known as the duplex frequency.

It is known for each station of a microwave radio system to use a common microwave local oscillator synthesiser for the final upconversion stage of the transmitted signal and the initial downconversion stage of the received signal. The synthesisers in the two stations run at significantly different frequencies and are of different designs, arranged so that the intermediate frequencies in the respective transmit and receive signal paths remain constant. Known circuits are further complicated in requiring as many as five local oscillators in each station to provide the necessary upconversion and downconversion of the signals being transmitted and received: often a sixth local oscillator is required in order to provide a built-in loop test function.

In accordance with the present invention, there is provided a transmitter/receiver circuit for a microwave radio station, the circuit comprising a signal path for upconverting a signal for transmission from an antenna and a signal path for downconverting a signal received on said antenna, and a local oscillator circuit providing a first IF local oscillator signal equal to the duplex frequency and a second IF local oscillator

signal equal to twice the duplex frequency, the two IF oscillator signals being applied to respective mixers in the upconverting and downconverting signal paths or vice versa.

Thus, in a microwave radio system providing duplex communication between two stations, one station uses the IF local oscillator signal of twice duplex frequency in the upconverting (transmitting) signal path, and the IF local oscillator frequency equal to the duplex frequency in the downconverting (receiving) signal path. However, the other station uses the duplex frequency as IF local oscillator signal in the upconverting path and the twice-duplex frequency as IF local oscillator signal in the downconverting path.

In an embodiment of the invention which will be described, a common microwave local oscillator synthesiser is used for the final upconversion stage of the transmitted signal and the initial downconversion stage of the received signal. The local oscillator synthesiser runs at the same frequency in both stations and is preferably of the same design. The synthesiser frequency tuning bandwidth needs to be only half that of the licensed band in order to cover the full band.

The IF local oscillator signals are generated from a single oscillator, for example from an oscillator running at twice the duplex spacing, a divide-by-two circuit providing the duplex frequency signal. This duplex frequency signal may also be used for a loop-test circuit of the station, where such a loop-test function is required. Further, one of the IF local oscillator signals may be used as a microwave reference for the SHF synthesiser.

A final downconversion stage may use a separate local oscillator, or a signal divided from the above-described IF local oscillator. Alternatively, the local oscillator frequency may be that required for the final downconversion stage, with a multiplier providing the IF local oscillator signals.

The transmitter/receiver circuit of this invention requires fewer local oscillators than hitherto known arrangements. It is a further advantage that the SHF synthesiser is the same in both stations and can be of relatively simple design.

An embodiment of this invention will now be described by way of example only and with reference to the accompanying drawing, the single figure of which is a schematic block diagram of the transmitter/receiver circuit of a microwave r.f. head in a microwave radio system.

Referring to the drawing there is shown, in schematic form, the signal transmitter/receiver circuit of one station of a microwave radio system: it will be appreciated that the radio system comprises an identical pair of such stations. In one particular application, the circuit which is shown is housed in an outdoor or antenna unit and has a microwave port MP coupled to a transmit/receive microwave antenna: in the example which is shown, the circuit includes a multiplexer CM which is connected over a coaxial cable to an indoor unit (not shown) which provides the customer or user interface. The indoor unit passes signals to be transmitted to the multiplexer CM and these signals are upconverted, in a signal path 10, for application to the common transmit/receive antenna via a diplexer 15. Signals received by this antenna are downconverted, in a signal path 20, and passed via multiplexer CM and the coaxial cable, to the indoor unit.

Each of the signal paths 10,20 includes various amplifier stages, filters and gain control arrangements, which have been omitted from the drawing for the sake of simplicity. Further, transmit signal path 10 includes mixers M1 and M2 for the frequency upconversion, and receive signal path 20 includes mixers M3, M4 and M5 for the frequency downconversion. For purposes which will be described, the intermediate frequency circuits are broadband, but are made frequency selective by bandpass filters BP1 and BP2 in the transmit and receive signal paths.

The transmit/receive circuit further comprises a local oscillator 12 having a divide-by-two divider circuit 14 connected to its output. The output frequency of local oscillator 12 is twice the duplex spacing (i.e. the difference between the frequencies of the radio signals transmitted from and received at the port MP), and the frequency of the output from divider circuit 14 is therefore equal to the duplex spacing. A change-over switch 13 (or cable cross patching)

applies either the output of oscillator 12 to mixer M1 and the output of divider circuit 14 to mixer M4, or the output of divider circuit 14 to mixer M1 and the output of oscillator 12 to mixer M4, as will be described.

The transmit/receive circuit further comprises a microwave local oscillator synthesiser 16, based on a voltage controlled oscillator 17, providing a super high frequency (SHF) signal of selected frequency, for example within the range of 35.5915 to 36.7045 GHz: this super high frequency signal is applied via a splitter 18 to mixers M2 and M3.

It will be appreciated that the transmit/receive circuits of the two intercommunicating stations of the radio system are identical. The transmit signal frequency of one station is the receive signal frequency of the other station, and vice-versa: one station transmits in the upper half band and receives in the lower half band, whilst the other station receives in the upper half band and transmits in the lower half band. There is always a constant difference (duplex spacing) between the transmit and receive frequencies, and the frequency of local oscillator 12 corresponds to twice this duplex spacing.

Suppose for example that the station which is shown transmits in the upper half band and receives in the lower half band, with a duplex spacing of 1260 MHz (the oscillator 12 running at 2520 MHz). In the example shown, a signal to be transmitted is passed from the indoor unit to the outdoor unit on a carrier frequency of 210 MHz, then upconverted at mixer M1 (fed with 2520 MHz from oscillator 12) to an intermediate frequency IF_t of 2730 MHz. The signal is further upconverted at mixer M2: suppose that the synthesiser 16 is running at a selected frequency of 35.87 GHz, then the microwave transmit frequency will be 38.60 GHz. With a duplex spacing of 1260 MHz, the received signal frequency will be 37.34 GHz: this is downconverted at mixer M3, also fed with the SHF signal of 35.87 GHz from synthesiser 16, to an intermediate frequency IF_r of 1470 MHz; mixer M4 is fed with an 1260 MHz from divider circuit 14, to downconvert the signal to a carrier frequency of 210 MHz. Finally, in the example shown, the received signal is downconverted to 70 MHz by a mixer M5 which is fed with a

280 MHz local oscillator signal provided by a separate local oscillator. Bandpass filter BP1 is centred at the transmit IF frequency of 2730 MHz and filter BP2 is tuned to the receive IF frequency of 1470 MHz.

In the other station of the radio system, the synthesiser runs at the same selected frequency, but the change-over switch 13 is used in its alternative state (i.e. the local oscillator frequency of 2520 MHz is used for the received signal downconversion and the divided local oscillator frequency of 1260 MHz is used for the transmitted signal upconversion). The bandpass filters BP1 and BP2 are exchanged so that the transmit IF filter is at 1470 MHz and the receive filter is at 2730 MHz

The output from the IF local oscillator 12 (or from the divider circuit 14) may be used as a reference for the synthesiser 16. Further, the duplex frequency may be used (from the divider circuit 14) as local oscillator signal for a mixer M6 in a loop-test circuit.

Claims

1) A transmitter/receiver circuit for a microwave radio station, the circuit comprising a signal path for upconverting a signal for transmission from an antenna and a signal path for downconverting a signal received on said antenna, and a local oscillator circuit providing a first IF local oscillator signal equal to the duplex frequency and a second IF local oscillator signal equal to twice the duplex frequency, the two IF oscillator signals being applied to respective mixers in the upconverting and downconverting signal paths or vice versa.

2) A transmitter/receiver circuit as claimed in claim 1, comprising a common microwave local oscillator synthesiser which is used for the final upconversion stage of the transmitted signal and for the initial downconversion stage of the received signal.

3) A transmitter/receiver circuit as claimed in claim 2, wherein the local oscillator synthesiser runs at the same frequency in two communicating radio stations.

4) A transmitter/receiver circuit as claimed in claim 2 or 3, wherein the local oscillator synthesiser is of the same design in two communicating radio stations.

5) A transmitter/receiver circuit as claimed in any preceding claim, wherein the IF local oscillator signals are generated from a single oscillator.

6) A transmitter/receiver circuit as claimed in claim 5, wherein the IF local oscillator signals are generated from an oscillator running at twice the duplex spacing, a divide-by-two circuit providing the duplex frequency signal.

7) A transmitter/receiver circuit as claimed in claim 6, arranged to use the duplex frequency signal for a loop-test circuit of the radio station.

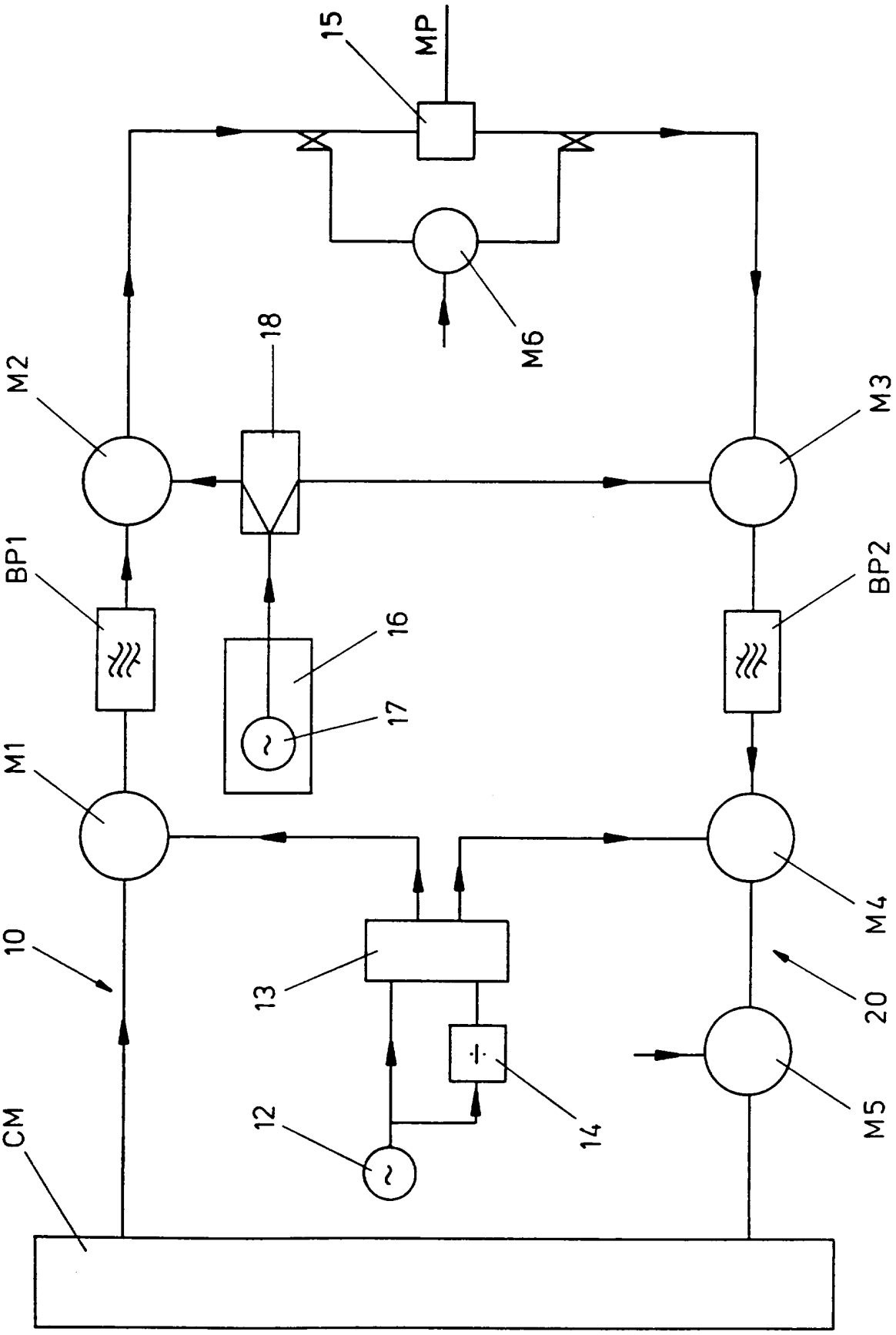
8) A transmitter/receiver circuit as claimed in any of claims 2 to 7, wherein one of the local oscillator signals is used as a microwave reference for the local oscillator synthesiser.

9) A transmitter/receiver circuit as claimed in any preceding claim, wherein a separate local oscillator provides a final downconversion stage.

10) A transmitter/receiver circuit as claimed in any of claims 1 to 8, wherein a final downconversion stage is provided by dividing a signal generated from the IF local oscillator.

11) A transmitter/receiver circuit as claimed in any of claims 1 to 8, wherein the local oscillator frequency is required for the final downconversion stage, a multiplier providing the IF local oscillator signals.

12) A transmitter/ receiver circuit for a microwave radio station, the circuit being substantially as herein described with reference to the accompanying drawings.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INTERNATIONAL SEARCH REPORT

Int ional Application No
PCT/GB 95/01959

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B1/50 H03D7/16

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 6 H04B H03D

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.
A	US,A,5 239 689 (FUKUDA KUNIO) 24 August 1993 see column 1, line 34 - column 6, line 32; figures 1A,1B	1
A	US,A,4 231 116 (SEKIGUCHI NOBUO ET AL) 28 October 1980 see column 2, line 56 - column 4, line 22; figures 1,3	1
A	US,A,4 489 413 (RICHMOND ROBERT L ET AL) 18 December 1984 see column 3, line 12 - column 4, line 48; figure 1	1

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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
20 December 1995	04. 01. 96

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 246 658 (NIPPON ELECTRIC CO) 25 November 1987 see column 1, line 1 - column 4, line 53; figures 1,2	1

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

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