CONVENTION

AUSTRALIA **681647**

Patents Act 1990

REQUEST FOR A STANDARD PATENT

AND NOTICE OF ENTITLEMENT

The Applicant identified below requests the grant of a patent to the nominated person identified below for an invention described in the accompanying standard complete patent specification.

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[54]Invention Title:

DUAL MODE PORTABLE DIGITAL SIGNAL TRANSCEIVER

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[31,33,32]

Details of basic application(s):-

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Applicant states the following:

1. The nominated person is the assignee of the actual inventor~~(s)~~

2. The nominated person is
   - the applicant
   - ~~the assignee of the applicant~~
   - ~~authorised to make this application by the applicant~~

   of the basic application.

3. The basic application~~(s)~~ was/~~were~~ the first made in a convention country in respect of the invention.

The nominated person is not an opponent or eligible person described in Section 33-36 of the Act.

22 June 1994

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Our Ref : 372574

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DUAL MODE PORTABLE DIGITAL SIGNAL TRANSCEIVER

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(56) Prior Art Documents
US 4479256

(57) Claim

1. Dual mode portable digital signal transceiver providing communication, in a first transmission mode, via a terrestrial network using a transmit first frequency band and a receive second frequency band and, in a second transmission mode, via a satellite network using a transmit third frequency band and a receive fourth frequency band, said first frequency band and said third frequency band being substantially adjoining and said second frequency band and said fourth frequency band being far apart, said transceiver including ~~comprising~~ means for synthesizing a modulation first frequency for modulation of signals transmitted in said first frequency band and said third frequency band and a conversion second frequency for demodulation of signals received in said second frequency band and said fourth frequency band, and means for dividing said conversion second frequency, supplying a conversion third frequency for demodulation of signals received in said fourth frequency band and said second frequency band.

AUSTRALIA

Patents Act

COMPLETE SPECIFICATION
(ORIGINAL)

Class Int. Class

Application Number:
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Accepted:
Published:

Priority

Related Art:

Name of Applicant:

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Invention Title:

DUAL MODE PORTABLE DIGITAL SIGNAL TRANSCEIVER

Our Ref : 372574
POF Code: 1501/230687

The following statement is a full description of this invention, including the best method of performing it known to applicant(s):

DUAL MODE PORTABLE DIGITAL SIGNAL TRANSCEIVER

BACKGROUND OF THE INVENTION

The field of the invention is that of digital radio.

To be more precise, the invention concerns a dual mode portable transceiver, i.e. a transceiver able to operate in either of two transmission systems, firstly a terrestrial radio network, for example a cellular network, and secondly a satellite radio network. One specific field of application of the invention is to GSM (Global System for Mobile communications) DCS 1800 terrestrial radio and Globalstar/Inmarsat satellite radio.

These two radio networks naturally have to use different frequency bands. The GSM DCS 1800 terrestrial system uses transmit frequencies in the 1 710 MHz to 1 785 MHz band and receive frequencies in the 1 805 MHz to 1 880 MHz band. The Globalstar satellite system uses the 1 610 MHz to 1 625.5 MHz transmit frequency band and the 2 483.5 MHz to 2 500 MHz band.

These different frequency bands require the presence in a dual mode transceiver of transmit and receive means specific to each mode of operation (terrestrial or satellite). This increases the cost, the overall size, the weight and the power consumption of the receiver. These features are crucial to the design of a portable device, and a constant preoccupation is to reduce them.

If the frequency bands in question are close together it may be possible to use the same transmit and/or receive means subject to some adaptation. This applies to the transmit frequency bands of the GSM and Globalstar systems, for example. On the other hand, if the frequency bands are relatively far apart (as in the case with the receive frequency bands of these systems), it is essential to use duplicate transmit and/or receive means, and in particular duplicate modulator and/or demodulator means, leading to problems with weight, power consumption, etc.

An object of the present invention is to alleviate the drawbacks of the prior art.

According to one aspect of the present invention there is provided a dual mode portable digital signal transceiver providing communication, in a first transmission mode, via a terrestrial network using a transmit first frequency band and a receive second frequency band and, in a second transmission mode, via a satellite network using a transmit third frequency band and a receiver fourth frequency band, said first frequency band and said third frequency band being substantially adjoining and said second frequency and said fourth frequency band being far apart, the transceiver including means for synthesizing a modulation first frequency for modulation of signals transmitted in said first frequency band and said third frequency band and a conversion second frequency for demodulation of signals received in said second frequency band and said fourth frequency band, and means for dividing said conversion second frequency, supplying a conversion third frequency for demodulation of signals received in said fourth frequency band and said second frequency band.

Thus, in accordance with one ~~essential~~ feature of the invention, two demodulation frequencies are available but only one frequency synthesizer is required, the second frequency being obtained by dividing down the first, which is generated by the synthesizer. This produces a saving in weight, in overall size and in power consumption which is essential in the case of a portable transceiver. Demodulation of one of the bands requires the use of the conversion second and third frequencies while demodulation of the other band uses only the second frequency (in one specific embodiment a fourth frequency may be needed).

The device may advantageously ~~comprises~~ include:

- modulation means on two paths in phase quadrature controlled by said first frequency carrying out direct conversion modulation of signals transmitted in said first frequency band and said third frequency band;

- first conversion means on two paths in phase quadrature controlled by said second frequency carrying out direct conversion demodulation of signals received in said second frequency band and said fourth frequency band;

- second intermediate frequency conversion means controlled by said third frequency supplying the product of signals received in said fourth frequency band and said second frequency band by said third frequency and supplying an intermediate frequency signal to be demodulated by said first conversion means.

Thus in a first mode demodulation ~~uses~~ may use direct conversion and in the second mode an intermediate frequency. The quadrature conversion means ~~are~~ may be used in both modes. Again this produces a saving in overall size and power consumption.

In another specific embodiment of the invention said second frequency ~~controls~~ may control intermediate frequency conversion means, said transceiver then comprising means for generating a fixed fourth frequency controlling the direct conversion quadrature conversion and modulation means.

Said frequency divider means preferably divide by N where N is an integer substantially equal to ± $f_{r1}/(f_{r2}-f_{r1})$, f_{r1} corresponding to said fourth or said second frequency band and f_{r2} corresponding to said second frequency band or said fourth frequency band.

This second frequency can thus provide adequate direct intermediate frequency conversion for subsequent use of the quadrature conversion means.

~~The~~ According to a further aspect of the present invention ~~also concerns~~ there is provided a dual mode portable digital signal transceiver providing communications, in a first transmission mode, via a terrestrial network using a transmit first frequency band and a receive second frequency band and, in a second transmission mode, via a satellite network using a transmit third frequency band and a receive fourth frequency band, said second and fourth frequency bands being substantially adjoining and said first and third frequency bands being far apart, ~~comprising~~ said transceiver including means for synthesizing a conversion first frequency for demodulation of signals received in said second and fourth frequency bands and a modulation second frequency for modulation of signals transmitted in said first and third frequency bands, and

means for dividing said modulation second frequency supplying a modulation third frequency for modulation of signals transmitted in said third frequency band and said first frequency band.

In this case it is the transmit frequency bands which are treated separately, as they are not close together.

The digital signals transmitted in said first mode are advantageously coded by means of a first type of coding and the digital signals transmitted in said second mode are coded by means of a second type of coding and said first modulation means or said first conversion means are selectively connected to first or second coding and decoding means according to the transmission mode in use.

In one specific embodiment of the invention, the device ~~comprises~~ may comprise second means for dividing said second frequency supplying a fourth frequency for converting at least one signal being processed to the intermediate frequency.

It is thus possible to carry out a second conversion to the intermediate frequency.

The device of the invention preferably comprises a first transmit/receive antenna for receiving at least one of said receive frequency bands and transmitting at least one of said transmit frequency bands, said frequency bands being substantially adjoining, and a second receive antenna and a second transmit antenna, said first antenna being directly associated with said first conversion means or said first modulation means and said second antenna being associated with said second conversion means or said second modulation means.

Accordingly, reception and transmission in the four frequency bands require only two antennas.

In this case, the device advantageously comprises means for selecting one of said antennas according to the transmission mode in use.

In another advantageous embodiment of the invention the transceiver comprises a signal dual resonance antenna tuned to transmit and receive all said frequency bands.

The invention applies to the GSM and Globalstar systems, among others, in which:

- said first band of transmit frequencies is between 1 710 MHz and 1 785 MHz;
- said first receive band is between 1 805 MHz and 1 880 MHz;
- said second band of transmit frequencies is between 1 610 MHz and 1 625.5 MHz; and
- said second band of receive frequencies is between 2 483.5 MHz and 2 500 MHz.

In this case, said divider means advantageously divide by three.

A preferred embodiment of the present invention will now be described with reference to the accompanying drawings wherein:

Figure 1 shows the distribution of the transmit and receive frequency bands in the embodiment corresponding to GSM terrestrial transmission and Globalstar satellite transmission.

Figure 2 is a block diagram of a transceiver in accordance with the invention using the figure 1 frequency bands.

Figure 3 shows one embodiment of the analog demodulator from figure 2.

Figure 4 shows one embodiment of the transceiver from figure 2 using a single dual-band antenna.

The present invention provides a dual mode radio transceiver for communications via a terrestrial network and via a satellite network.

The preferred embodiment of the invention described below concerns a transceiver of this kind for GSM DCS 1800 cellular radio and Globalstar satellite radio. Figure 1 shows the frequency bands used by these two systems.

These radio systems and the respective frequency bands are naturally only examples. The device of the invention can clearly be implemented in other frequency bands and for other systems.

Figure 1 shows on the frequency axis 11 the frequency bands used by the Globalstar system, namely:

- transmit (TX) frequency band 12:
1 610 MHz - 1 625.5 MHz;
- receive (RX) frequency band 13:
2 483.5 MHz - 2 500 MHz;

and the frequency bands of the GSM system:

- transmit (TX) frequency band 14:
1 710 MHz - 1 785 MHz;
- receive (RX) frequency band 15:
1 805 MHz - 1 880 MHz.

This figure clearly shows that the GSM system frequency bands 14 and 15 are close together. They can therefore be transmitted and received using a bidirectional antenna. On the other hand, the Globalstar system frequency bands 12 and 13 are far apart, and two antennas are needed.

The receive bands 13 and 15 are also far apart. It is therefore not possible to receive them using the same receive means (antenna, baseband converters, etc).

Figure 2 is a block diagram of the dual mode transceiver of the invention for the figure 1 frequency bands.

The transmit subsystem is described first. The transceiver comprises a microphone 21 which feeds sound signals to a speech coder module 22. The encoded speech signal 23 is passed to a digital signal processor (DSP)

24 which carries out the channel coding of the signal.

The DSP 24 is conventionally connected to a random access memory (RAM) 247. It is controlled by a microprocessor 248 connected to the keypad 249.

The DSP 24 feeds a signal 25 to a digital modulator subsystem 26 comprising a GSMK modulator module 27 producing two paths 28_I and 28_Q in phase quadrature. The two paths 28_I and 28_Q are filtered by respective low-pass filters 29_I and 2_{9Q} and then passed to an analog modulator subsystem 210.

The subsystem 210 comprises two mixers 211_I and 211_Q which respectively produce the following products:

- mixer 211_I: product of the signal 212_I output by the filter 29_I with a pure carrier 213_I supplied by the transmit voltage-controlled oscillator (VCO) 214 of a frequency synthesizer module 215;

- mixer 211_Q: product of the signal 212_Q output by the filter 29_Q with a pure carrier 213_Q corresponding to the carrier 213_I phase-shifted 90° by the phase-shifter 216.

The two modulated paths are combined and amplified by a first amplifier 217 supplying a signal 218 to a power amplifier 219 and then to an optional circulator 220. The circulator 220 is connected to a bidirectional antenna 221 tuned to 1.7 GHz by a duplexer 222 the function of which is explained below.

The transmit means of the analog modulator subsystem 210 and the amplifier 219 are broadband means. They are chosen so that they can amplify the signal:

- in the frequency band 1 610 MHz - 1 625.5 MHz for the satellite mode;

- in the frequency band 1 710 MHz - 1 785 MHz for the terrestrial mode.

Thus the same means transmit in both modes, with no duplication of components. It suffices to adjust the modulation frequency supplied by the oscillator 214 to the specific frequency of the transmission mode in use.

In the case of reception, however, the same means cannot be used because the two receive bands 13 and 15 are far apart (see figure 1). The invention nevertheless offers a new solution, enabling the number of components duplicated to be reduced, and in particular enabling the use of only one analog modulator subsystem.

A low-noise receive amplifier 223 receives, depending on the receive mode selected, either the signal 224 received by the antenna 221 (terrestrial mode) or the signal 225 received by a second antenna 226 and then modified (satellite mode). Downstream of the amplifier 223 the signal is processed identically, regardless of the transmission mode.

The signal 227 output by the amplifier 223 feeds the subsystem 210 which carries out the baseband conversion. Two mixers 228_I and 228_Q receiving the baseband conversion frequency 229 generated by a receive oscillator 230 of the synthesizer module 215 effect the baseband conversion. A phase-shifter 231 provides the 90° phase-shift required for conversion of the quadrature path.

The baseband signals 232_I and 232_Q are passed to the digital demodulator subsystem 26 which comprises, for each of the I and Q paths, a low-pass filter 233_I, 233_Q, an amplifier 234_I, 234_Q and an analog/digital converter 235_I, 235_Q.

The digitized signals 236 are fed to the signal processor module 24 whose functions include demodulation and channel decoding. The sound signal is reconstituted by the speech coder 24 and fed to a loudspeaker 237.

The different processing of the receive signals, according to the transmission mode, is described next.

The amplifier 223 is preceded by a switch 238 with two positions corresponding to respective transmission modes.

This can be a mechanical switch or a low-loss electrical switch such as an AsGa diode switch.

In a first position (terrestrial transmission) the switch 238 connects the amplifier 223 to the duplexer 222 and therefore to the antenna 221. The broadband antenna 221 can transmit both transmit bands 12 and 14 and receive the receive band 15. This triple use reduces the overall size and weight of the portable receiver. The duplexer 222 separates the transmitted and received signals.

In the second position (satellite transmission), the switch 238 makes the connection to the antenna 226 via a processor subsystem. The antenna 226 is tuned to 2.5 GHz, corresponding to the satellite receive band 15, and connected to an optional circulator 239 and thence to a low-noise amplifier 240.

The frequency band 13 (2.5 GHz) cannot be converted directly by the analog modulator subsystem 210. Thus, in accordance with the invention, the processing subsystem comprises a mixer 241 adapted to convert the received signal 242 to an intermediate frequency compatible with the conversion means. The mixer 241 is followed by a bandpass filter 243 supplying a signal 225 free of mixing spuriae.

The frequency f_t for conversion to the intermediate frequency 244 is chosen such that:

$$f_t \approx f_{r1} \pm f_{r2}$$

where: f_t is the conversion frequency 244;

f_{r1} is the modulation frequency of the signal received by the antenna 226 (approximately 2.5 GHz);

f_{r2} is the modulation frequency of the signal received by the antenna 221 (approximately 1.8 GHz), i.e. the frequency at which the analog demodulator subsystem

210 operates.

In accordance with one essential feature of the invention, the conversion frequency f_t is not synthesized in the conventional way by a VCO type frequency synthesizer. Instead, it is obtained from the conversion frequency 229 by a frequency divider 245. A single frequency synthesizer is therefore sufficient for conversion to the intermediate frequency 241 and for demodulation 288_i, 288_Q in satellite mode. This represents a further saving in weight, overall size and power consumption.

Accordingly, demodulation of the signal 224 is by direct conversion by the subsystem 26 whereas demodulation of the signal 225 is at intermediate frequency under the control of a single local oscillator 230.

In the embodiment of the invention corresponding to the figure 1 frequency bands, the frequency divider 245 divides by three:

- satellite receive frequency: f_{r2} = 2 480 MHz;
- terrestrial receive frequency (equal to the conversion frequency 229): f_{r1} = 1 850 MHz.

It is a simple matter to show that by subtracting f_t = 1 850/3 MHz ≈ 620 MHz from f_{r2} the result is 2 480 MHz - 620 MHz = 1 860 MHz, i.e. substantially f_{r1}. The signal 225 at the frequency 1 860 MHz can be demodulated directly by the analog subsystem 26.

More generally, the frequency divider 245 divides by N and N is chosen such that:

$$f_{r2} \pm f_{r1}/N \approx f_{r1}$$

i.e. $N \approx \pm f_{r1}/(f_{r2}-f_{r1})$

The embodiment described above has numerous variants.

In particular, the modulation of all the signals and the demodulation of the signals in terrestrial mode is described above for direct conversion. This technique is advantageous for many reasons and in particular for its economy of resources (no conversion to the intermediate frequency), and therefore of cost, overall size and power consumption, not to mention the reduced risk of interference.

However, the analog modulator subsystem 26 can comprise intermediate frequency conversion means. The various modulation and conversion frequencies can then advantageously be obtained from a single synthesizer frequency which is divided down to obtain the required frequencies. Figure 3 shows this principle applied to demodulation (only the components different from those in figure 2 are described).

The voltage-controlled oscillator 230 generates a frequency 229 which controls a mixer 31 for converting the received signals 32 to the intermediate frequency, regardless of the transmission mode. To eliminate mixing spuriae the signal 33 output by the mixer 31 is filtered by a bandpass filter 34 before it is fed to the two mixers 228_I and 228_Q.

The two mixers 228_I and 228_Q are controlled by a pure carrier 35 generated by a fixed frequency oscillator 36.

The mixer 224 is controlled by the frequency 244 obtained by dividing the frequency 229 by N (245).

The description of figure 2 presupposes that the digital processing carried out by the modules 24 and 26 is exactly the same in both transmission modes, so that these modules could be shared by the two modes. This assumes, for example, that satellite transmission and GSM transmission both use time-division multiple access (TDMA).

Other multiple access techniques can be used, however, such as frequency-division multiple access

(FDMA) or code-division multiple access (CDMA).

In this case, the digital modules 24 and 26 can be partially duplicated, as shown in dashed line in figure 2.

If the received signal is from a satellite, the switches 246_i and 246_Q direct the I and Q paths 232_I and 232_Q to a demodulator subsystem 26 which carries out demodulation appropriate to the modulation employed and then a signal processor 24′ which outputs a signal 23 to the speech coder module 22.

The second processor 24′ advantageously shares the random access memory 247 and the control microprocessor 248 with the first.

Although not shown in figure 2, it is clear that the same distinction between the processing applied must be made on transmission.

To simplify the switching arrangements and to reduce interference the switches 246_I and 246_Q can be switched simultaneously with the switch 238 previously described.

Finally, the use of two separate antennas (221 and 226) is not mandatory. The device of the invention can equally well be provided with a single dual-band antenna, as shown in figure 4. This further reduces the overall size and weight.

In this case the transceiver comprises a single dual resonance antenna 41 (resonant frequencies 1.8 GHz and 2.5 GHz).

The antenna is connected to a triplexer 42 feeding:

- the signals 43 to be transmitted to the antenna 41;

- the signals 44 received at the frequency f_{r2} = 1.8 GHz to the amplifier 223;

- the signals 45 received at the frequency f_{r1} = 2.5 GHz to the optional circulator 239 and the amplifier 240.

Other embodiments are feasible without departing from the scope of the invention. In particular, the separate processing of the signals described for reception can be applied for transmission when the transmit frequency bands are far apart.

The claims defining the invention are as follows:
~~THERE IS CLAIMED:~~

1. Dual mode portable digital signal transceiver providing communication, in a first transmission mode, via a terrestrial network using a transmit first frequency band and a receive second frequency band and, in a second transmission mode, via a satellite network using a transmit third frequency band and a receive fourth frequency band, said first frequency band and said third frequency band being substantially adjoining and said second frequency band and said fourth frequency band being far apart, said transceiver ~~comprising~~ including means for synthesizing a modulation first frequency for modulation of signals transmitted in said first frequency band and said third frequency band and a conversion second frequency for demodulation of signals received in said second frequency band and said fourth frequency band, and means for dividing said conversion second frequency, supplying a conversion third frequency for demodulation of signals received in said fourth frequency band and said second frequency band.

2. Transceiver according to claim 1 further comprising:

- modulation means on two paths in phase quadrature controlled by said first frequency carrying out direct conversion modulation of signals transmitted in said first frequency band and said third frequency band;
- first conversion means on two paths in phase quadrature controlled by said second frequency carrying out direct conversion demodulation of signals received in said second frequency band and said fourth frequency band;
- second intermediate frequency conversion means controlled by said third frequency supplying the product of signals received in said fourth frequency band and said second frequency band by said third frequency and

supplying an intermediate frequency signal to be demodulated by said first conversion means.

3. Transceiver according to claim 1 wherein said frequency divider means divide by N where N is an integer substantially equal to ± $f_{r1}/(f_{r2}-f_{r1})$, f_{r1} corresponding to said fourth ~~and~~ or said second frequency bands and f_{r2} corresponding to said second ~~and~~ or fourth frequency bands.

4. Dual mode portable digital signal transceiver providing communications, in a first transmission mode, via a terrestrial network using a transmit first frequency band and a receive second frequency band and, in a second transmission mode, via a satellite network using a transmit third frequency band and a receive fourth frequency band, said second and said fourth frequency bands being substantially adjoining and said first and said third frequency bands being far apart, said transceiver ~~comprising~~ including means for synthesizing a conversion first frequency for demodulation of signals received in said second and fourth frequency bands and a modulation second frequency for modulation of signals transmitted in said first and third frequency bands, and means for dividing said modulation second frequency supplying a modulation third frequency for modulation of signals transmitted in said third frequency band and said first frequency band.

5. Transceiver according to claim 4 further comprising:

- conversion means on two paths in phase quadrature controlled by said first frequency and carrying out direct conversion demodulation of signals received in said second and fourth frequency bands;
- first modulation means on two paths in phase quadrature controlled by said second frequency carrying out direct conversion modulation of signals to be transmitted in said first and third frequency bands;

- second intermediate frequency modulation means controlled by said third frequency and supplying the product of intermediate signals modulated by said first modulation means by said third frequency and supplying signals to be transmitted in said third and first frequency bands.

6. ~~Device~~ Transceiver according to claim 4 wherein said frequency division means divide by N where N is an integer substantially equal to $\pm f_{r1}/(f_{r2}-f_{r1})$, where f_{r1} corresponds to said third or first frequency bands and f_{r2} corresponds to said first or third frequency bands.

7. ~~Device~~ Transceiver according to claim 2 wherein the digital signals transmitted in said first mode are coded by means of a first type of coding and the digital signals transmitted in said second mode are coded by means of a second type of coding, and said first modulation means or said first conversion means are selectively connected to first or second coding and decoding means according to the transmission mode in use.

8. ~~Device~~ Transceiver according to claim 1 further comprising a first transmit/receive antenna for receiving at least one of said receive frequency bands and transmitting at least one of said transmit frequency bands, said frequency bands being substantially adjoining.

9. ~~Device~~ Transceiver according to claim 8 further comprising a second receive or transmit antenna, said first antenna being directly associated with said first conversion means or said first modulation means and said second antenna being associated with said second conversion means or said second modulation means.

10. ~~Device~~ Transceiver according to claim 9 further comprising means for selecting one of said antennas according to the transmission mode in use.

11. ~~Device~~ Transceiver according to claim 1 further comprising a single dual resonance antenna tuned to transmit and

receive all of said frequency bands.

12. Transceiver according to claim 1 wherein said second frequency controls third intermediate frequency conversion means and said device comprises means for generating a fixed fourth frequency controlling conversion and direct conversion quadrature modulation means.

13. Transceiver according to claim 1 wherein:

- said first band of transmit frequencies is between 1 710 MHz and 1 785 MHz;

- said first receive band is between 1 805 MHz and 1 880 MHz;

- said second band of transmit frequencies is between 1 610 MHz and 1 625.5 MHz; and

- said second band of receive frequencies is between 2 483.5 MHz and 2 500 MHz.

14. Transceiver according to claim 13 wherein said divider means divide by three.

15. Dual mode portable digital signal transceiver substantially as herein described with reference to the drawings.

DATED: 30 June, 1997

PHILLIPS ORMONDE & FITZPATRICK
Attorneys for:
SOCIETE ANONYME DITE: ALCATEL MOBILE COMMUNICATION FRANCE

ABSTRACT OF THE DISCLOSURE

A dual mode portable digital radio transceiver for communicating via a terrestrial network (first mode) and via a satellite network (second mode) synthesizes a modulation first frequency for modulation of signals transmitted in both modes and a conversion second frequency for demodulation of signals received in the two modes. It divides the conversion second frequency supplying a conversion third frequency for demodulation of signals received in one of the modes using a signal receive frequency band far away from the other frequency bands used. It is therefore possible, using a single synthesized pure carrier, to carry out direct conversion in a first mode and intermediate frequency conversion followed by the same direct conversion in the second mode.

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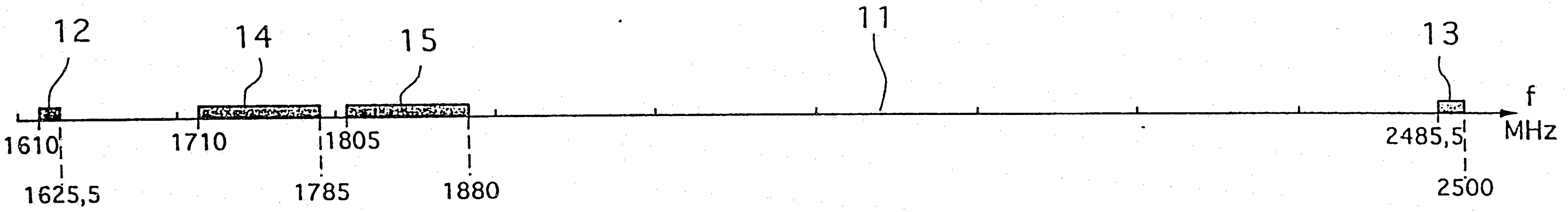

Fig. 1

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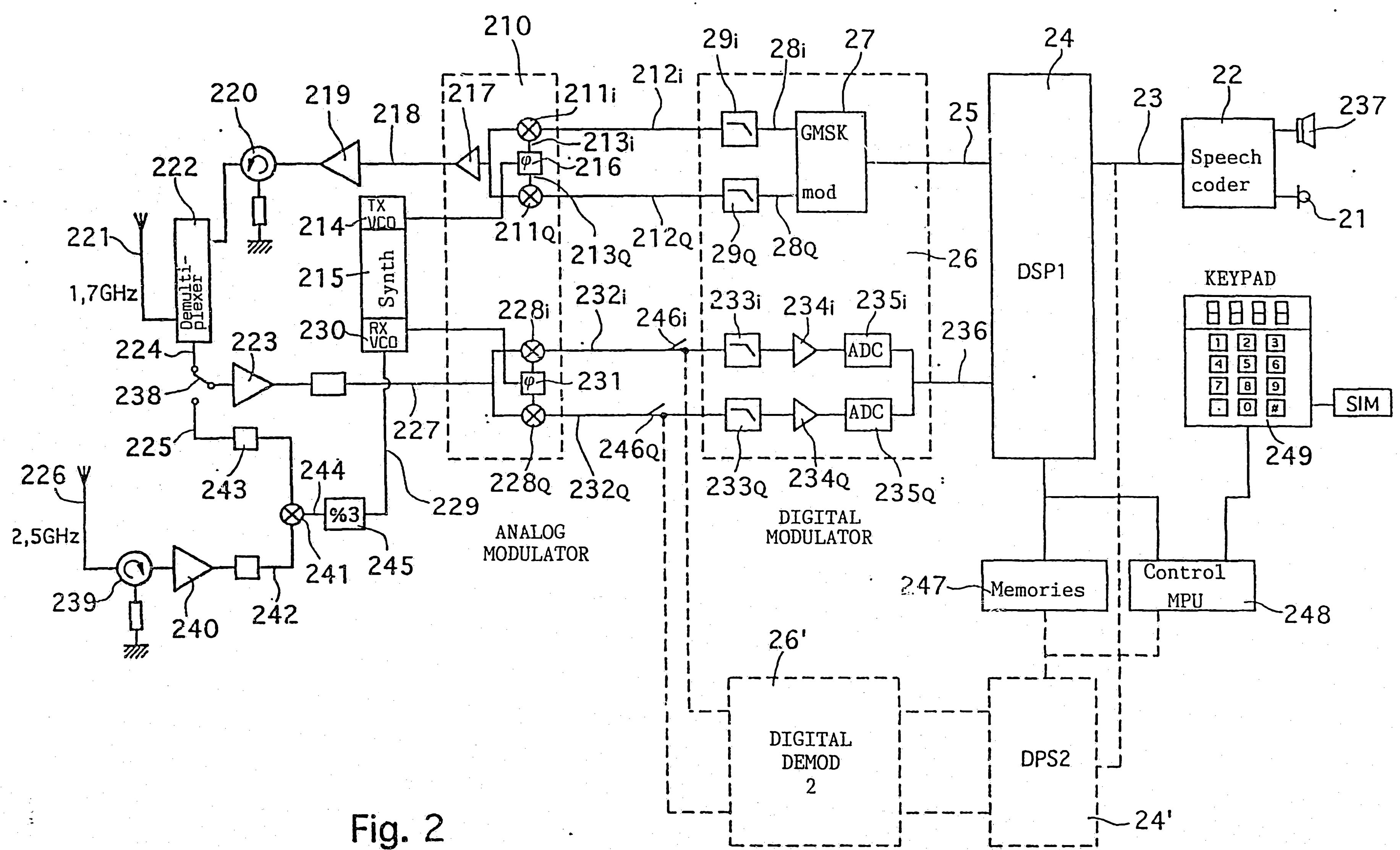

Fig. 2

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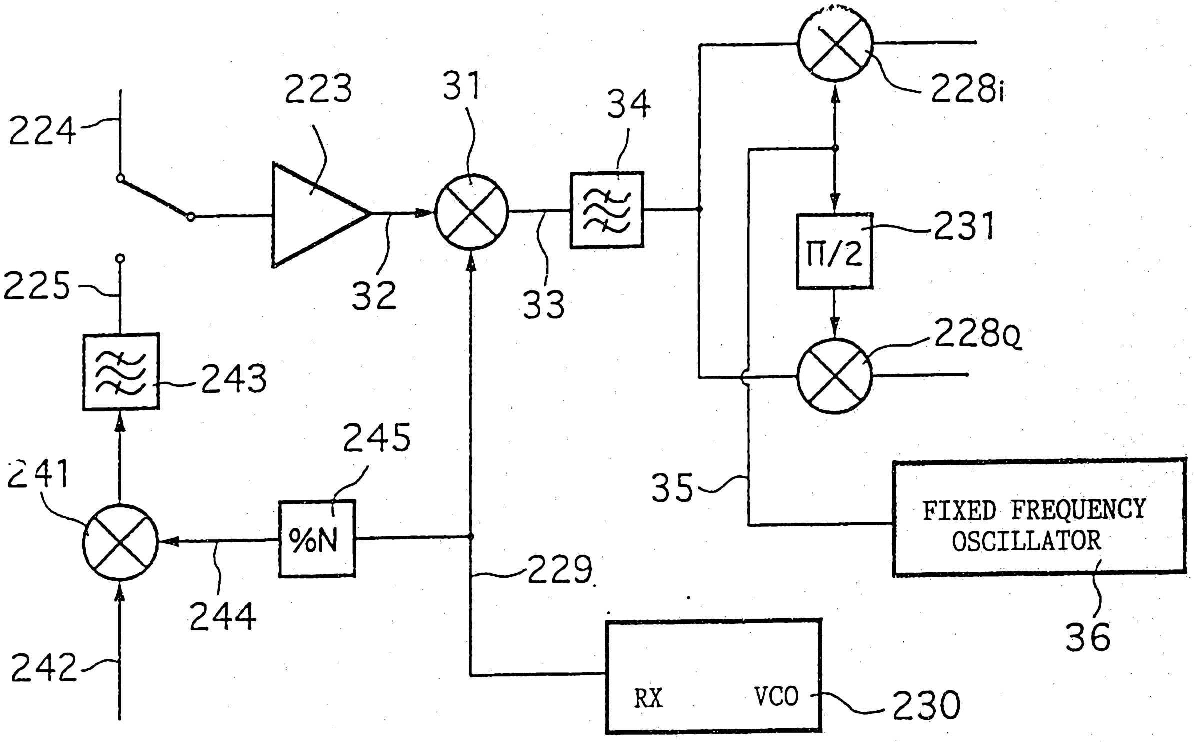
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Fig. 3

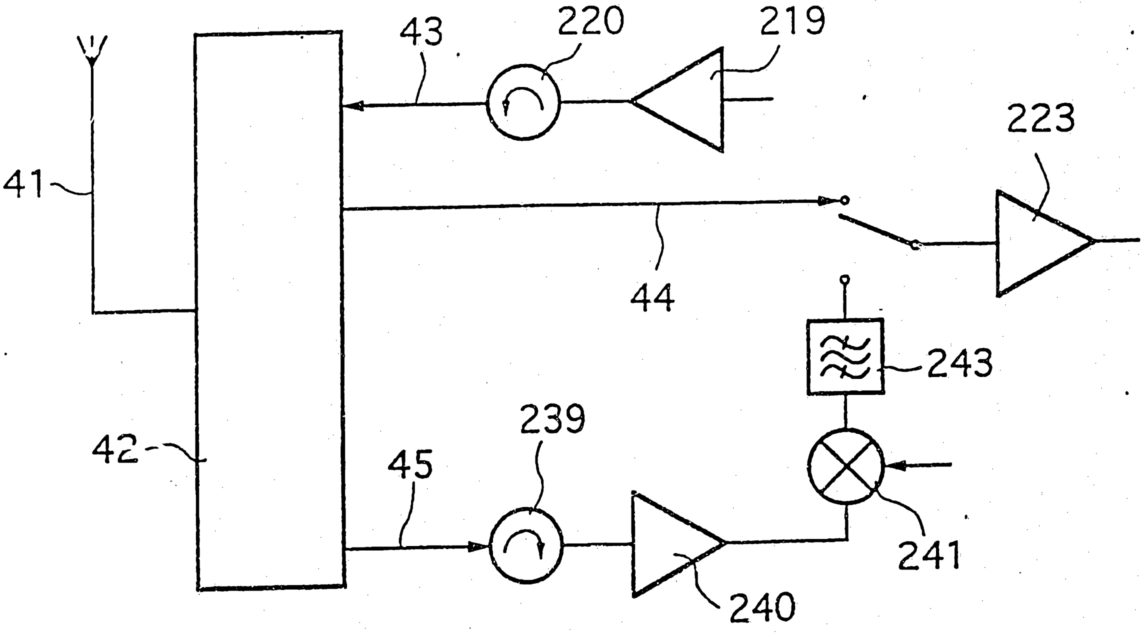
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Fig. 4