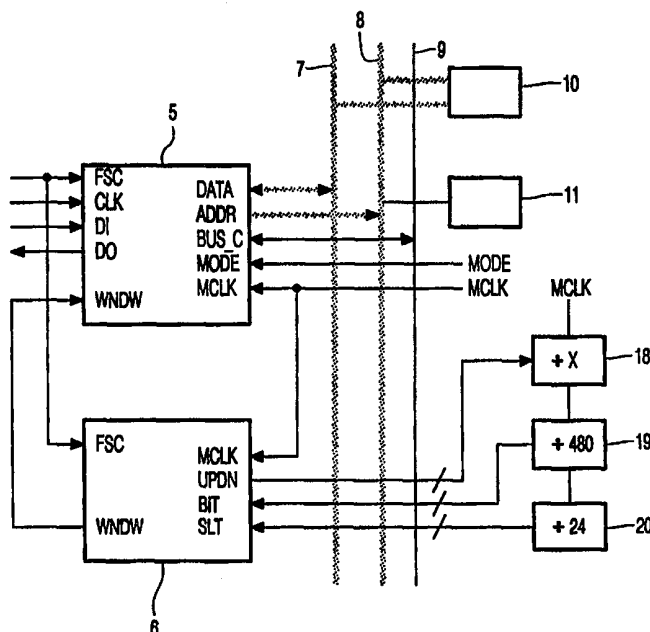




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(54) Title: A COMMUNICATION DEVICE WITH PHASE CONTINUOUS SYNCHRONISATION TO AN EXTERNAL NETWORK



(57) Abstract

A method of synchronising a local oscillator signal with a main oscillator signal in a network, wherein the local oscillator signal has a phase shift relative to and upon appearance of the main oscillator signal, which phase shift is being used as an at least initially fixed reference phase shift between the thus synchronised local oscillator signal and the main oscillator signal. Synchronisation accompanied by sudden phase jumps is thus avoided.

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"A communication device with phase continuous synchronisation to an external network".

The present invention relates to a method as defined in the preamble of claim 1.

The present invention also relates to a device as defined in the preamble of claim 5, and a communication device comprising such a device.

5 Such a method and device are known from European Patent Application EP-A-0613276. The known method and device perform synchronisation between a central unit and several base stations by means of transferring synchronisation information possibly including sync opportunity information and time delay information. This enables a base station receiving the synchronisation information to detect with which time delay after receipt
10 of the sync opportunity information synchronisation of its clock is actually to be carried out. A clock counter in each respective base station is preloaded to a respective value defined by the transmitted delay information. At zero count all base station clocks synchronize momentarily. Similar synchronization may take place with a given reference signal. It is a disadvantage of the known method and device that, if handsets coupled to respective base
15 stations are communicating with one another, synchronisation after a temporary disruption of information from the central unit and performed in a way as indicated above, will lead to a possible loss of synchronisation of mutually communicating handsets upon reappearance of the sync information. Such a situation can similarly arise in a DECT (Digital European Cordless Telephone) protocol system, where a connection to an ISDN network may be
20 subjected to a temporarily disappearing and/or reappearing reference signal given by the ISDN network. Neither case may, however, lead to an interruption, or disturbance of or a phase jump in ongoing communication between, for example, the handsets.

25 Therefore, it is an object of the present invention to provide a method and device presenting a solution to the general problem of resynchronising clocks in devices of a network.

To this end, the method and device according to the present invention has the features outlined in the characterizing parts of claims 1 and 5, respectively. It is an

advantage of the method and device according to the invention that the phase shift experienced after reappearance of the main oscillator signal is simply being used to base the synchronised local oscillator signal thereon, as a result of which no interruption or phase jumps will occur. Synchronisation now takes place in a way that an initially fixed phase shift is maintained between the main oscillator signal and the local oscillator signal. Thus after applying the method according to the invention, processing based on the synchronised local oscillator signal in the device has a fixed delay relative to processing based on the main oscillator signal. In a DECT environment this has the additional advantage that handsets communicating through the base station, where a further handset starts communication through the ISDN network which makes the main oscillator signal reappear, will now not be disturbed by the smooth synchronisation method according to the invention.

In an embodiment of the method according to the invention the initial phase shift is being determined upon reappearance of the main oscillator signal, whereafter the initial phase shift is substantially maintained for a period of time. Easy control is possible in a further embodiment according to the present invention, wherein the initial phase shift is being controlled step-by-step by influencing the dividing ratio of a reference counter.

In a further embodiment of the method according to the present invention, wherein the initially fixed reference phase shift is being diminished by gradually controlling the frequency of the local oscillator accordingly, timing margins can be recovered and gained in order to be capable of accommodating time delays or time shifts caused by data, cable or air delays.

At present the method and device according to the invention will be elucidated further together with their additional advantages while reference is made to the appended drawing, wherein like components are referred to by like reference numerals. In the drawing:

Fig. 1 shows a schematic view of a simplified communication device according to the invention having a base station and several handsets,

Fig. 2 shows an embodiment of an R-interface for application in the communication device shown in Fig. 1,

Fig. 3 shows an embodiment of a phase error circuit for application in the interface of Fig. 2,

Fig. 4 shows a timing diagram of signals used in the method according to

the invention, and

Fig. 5 shows graphs of signals used in the further improved method and device according to the invention.

The present invention will now be described, by way of example, with
5 reference to the accompanying drawings.

Fig. 1 shows a communication device 1 exemplified as a base station 2
coupled to a line, such as a telephone line 3 and two handsets 4-1, 4-2 shown generally
10 capable of communicating with each other by air through base station 2, but also capable of
communicating with other stations or networks (not shown) coupled to the line 3. Such a
network could be an ISDN network. The base station comprises several interfaces, the so
called R-interface to be described hereafter being indicated therein.

Fig. 2 shows a part relevant to the present description of the R-interface
15 at least containing synchronisation signals FSC and CLK. These synchronisation signals FSC
and CLK generated across the line 3 by the ISDN network disappear as soon as the base
station, which is a DECT base station, loses its logical signal connection with the ISDN
network. If during the loss of this connection two or more handsets are communicating with
each other while a further handset sets up a connection across the R-interface, said
20 synchronisation signals FSC and CLK reappear, whereafter the base station 2 will attempt to
synchronise itself to FSC. This may cause a disturbing phase jump and an accidental
disruption in the communication between the handsets 4-1, 4-2 if no precautionary measures
are taken.

In ISDN communication, FSC is a 8 KHz signal as shown in Figures 2-4.
25 Fig. 2 shows an implementation of the R-interface. It contains means for synchronization
embodied as a signal processing state machine circuit 5 and a phase error circuit 6 connected
to data, address and control buses 7, 8 and 9, respectively. A data memory 10 and a bus
control 11 are also connected to the buses 7, 8, 9. The phase error circuit 6 is elucidated
further in Fig. 3. FSINT shown therein is an internal 100 Hz signal used in the base station
30 2 providing a pulse every 10 msec. FSINT is an output signal of a window circuit 12
included in the phase error circuit 6. From a local clock MCLK having a frequency of, for
example, 13.824 MHz, pulse signals BIT and SLT respectively, are derived and used in the
window circuit 12. A reappearing FSC signal has a first FSC pulse, whose phase shift
REF_CNT is determined relative to the latest FSC pulse in reference counter 13 also

included in the phase error circuit 6. Furthermore, the circuit 6 contains a sync counter 14 and a comparator 15 coupled to phase shift outputs REF_CNT and SHIFT_CNT of both 11-bit counters 13 and 14 in order to compare these counted phase shifts for providing a control signal on its control output 16, if a phase difference is being detected between them. The control can be such that the initial phase shift REF_CNT is being maintained as a future reference for controlling SHIFT_CNT, such that the latter is being used as a basis for effecting synchronisation between the local oscillator signal FSINT and the network or main oscillator signal FSC. Control output 16 is connected to up/down count control circuit 17 for providing a control signal UPDN which influences the generally programmable dividing factor of counter 18. In the above case where, the MCLK frequency is 13.824 MHz, the dividing factor of bit counter 18 equals 12 and can be programmed to be, for example, 11, 12, or 13 depending on the control signal UPDN. Bit counter 18 thus provides an output signal having a frequency of 1.152 MHz, being the bit frequency. A slot counter 19, whose dividing factor is 480, provides the slot frequency of 2.4 KHz which further divided by counter 20 having a dividing factor equalling 24 provides the 100 Hz for FSINT as mentioned above. Processing of a possible call from said further handset in base station 2 is now to be based on FSINT which is synchronised phase shifted over SHIFT_CNT, so that the mutually communicating handsets 4-1 and 4-2 maintain contact and are not disturbed by the thus presented phase shifted synchronisation method. In the embodiment described the phase shift is actually measured once every 10 msec, whereby the measurement is carried out in a time window that is 125 μ sec wide. The window could extend from 62.5 μ sec before the signal Bit_Cnt=0 and Slot_Cnt=0 to 62.5 μ sec thereafter. If a phase difference is measured in the window, this can be eliminated by influencing the dividing factor of bit counter 18 accordingly during one or more periods of time.

Each frame of 10 msec comprises 24 slots. Each slot lasts approximately 416.6 μ sec (slot frequency is 2.4 KHz). Each slot contains 480 bits and comprises separate slot synchronisation information, maintenance information, 80 speech samples of approximately 277.7 μ sec in the so called B-field, and free shift time for accommodating time delays. The 80 speech samples are taken from 10 msec of speech, whereby the samples are read into a ring buffer (not shown) relatively slowly and read out in a so called Burst Mode by Burst Mode logic to fit into the 277.7 μ sec.

Although it will be clear from the above that manipulation of the dividing factor of bit counter 18 takes place for making SHIFT_CNT equal to REF_CNT in Fig. 4, Fig. 5 shows in a graph the step-by-step way wherein the count REF_CNT in reference

counter 13 is forced to move slowly in the direction of the value REF_OPT, which moving will thus be followed by SHIFT_CNT. Finally, SHIFT_CNT will be around zero which offers the additional advantage that there is more free shift time in each slot available to accommodate possible shifts in the B-field timing because of possible cable delays or air delays. Changing of REF_CNT can be done either under the control of a hardware state machine or under the control of a software state machine. A practical example of this improved method will be given. Suppose that the maximum initial phase shift of $+62.5 \mu\text{sec}$ or 72 bit times is measured. Assume that in order not to lose connection with handsets, REF_CNT should not change faster than one bit time per 10 msec. In that case, REF_CNT is moved from REF_MAX to REF_OPT in 720 msec. Depending on the severity of the initial timing violation, that violation will be audible only for a fraction of 720 msec.

In view of the foregoing it will be evident to a person skilled in the art that various modifications may be made within the spirit and the scope of the present invention as hereinafter defined by the appended claims and that the present invention is thus not limited to the examples provided.

CLAIMS:

1. A method of synchronising an oscillator signal, such as a local oscillator signal FSINT, with another oscillator signal FSC, such as a main oscillator signal in a network, the local oscillator signal having a phase shift REF_CNT relative to and upon appearance of the main oscillator signal, characterized in that the phase shift is being used as
5 an at least initially fixed reference phase shift SHIFT_CNT between the thus synchronised local oscillator signal and the main oscillator signal.
2. The method according to claim 1, characterized in that the initial phase shift is being determined upon reappearance of the main oscillator signal, whereafter the initial phase shift is substantially maintained for a period of time.
- 10 3. The method according to claim 1 or 2, characterized in that the initial phase shift is being controlled step-by-step by influencing the dividing ratio of a reference counter.
4. The method according to one of the claims 1-3, characterized in that the initially fixed reference phase shift is being diminished by gradually controlling the frequency
15 of the local oscillator accordingly.
5. A device for performing the method according to one of the claims 1-4, the device comprising a local oscillator for providing a local oscillator signal FSINT and means for synchronising the local oscillator signal with a main oscillator signal FSC, the former having a phase difference REF_CNT relative to the main oscillator signal upon its
20 appearance, characterized in that the synchronising means comprise means for fixing the phase shift and synchronising the future oscillator signal based on said fixed phase shift.
6. The device according to claim 5, characterised in that the synchronising means comprise counter means for counting the initial phase shift REF_CNT and following phase shifts SHIFT_CNT and comparator means coupled to the counter means for comparing
25 both phase shifts and providing a control signal in dependence on the determined phase shift differences.
7. The device according to claim 5 or 6, characterised in that the synchronising means comprise a counter whose dividing ratio is programmable by applying the control signal on a dividing ratio control input of the counter.

8. The device according to one of the claims 5-7, characterised in that the synchronising means comprise a hardware or software implemented state machine coupled to the REF_CNT counter means for influencing the division ratio thereof step by step.

9. A communication device comprising a device according to one of the

5 claims 5-8, the device comprising a local oscillator for providing a local oscillator signal and means for synchronising the local oscillator signal with a main oscillator signal, the former having a phase difference relative to the latter oscillator signal, characterised in that the synchronising means comprise means for fixing the phase shift and synchronising the future oscillator signal based on said fixed phase shift.

10 10. The communication device according to claim 9, wherein the communication device comprises a base station or a station in a telephone network or network, such as a local area network, a wide area network, an ISDN network or the like.

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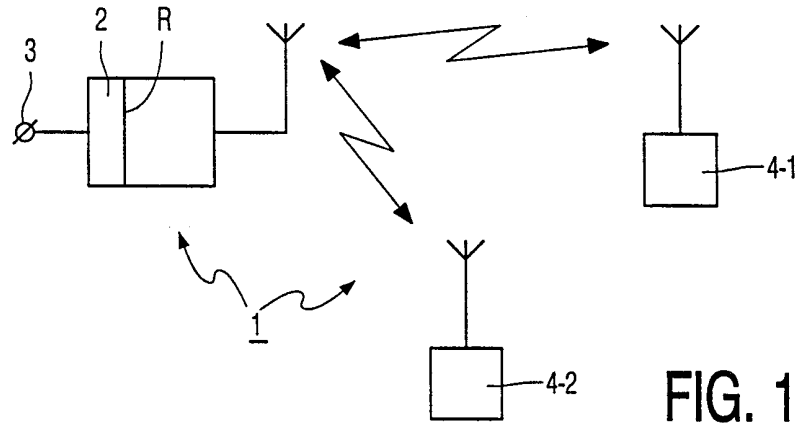


FIG. 1

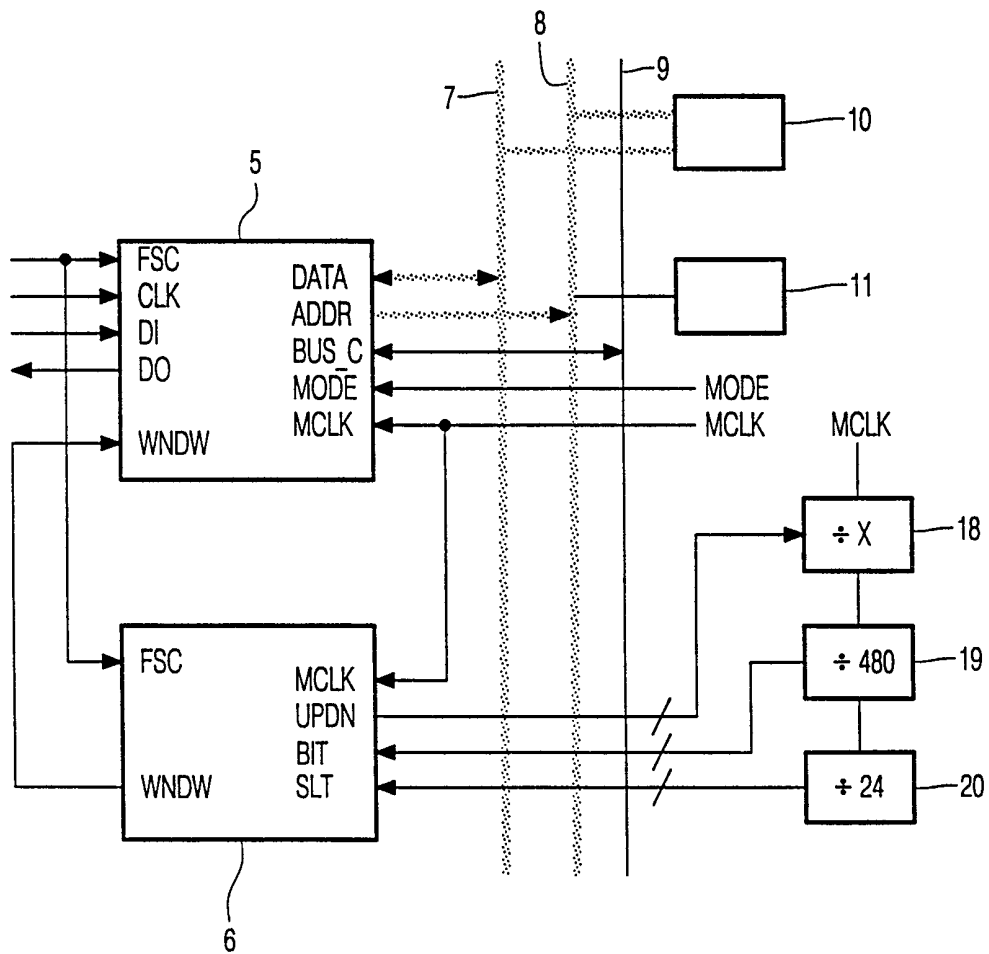


FIG. 2

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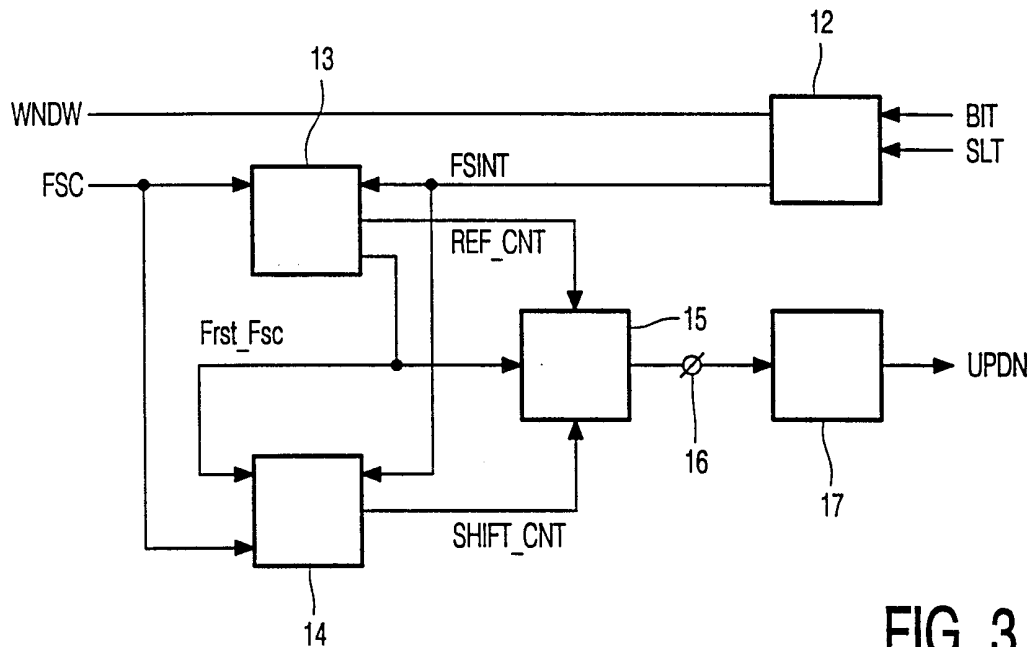


FIG. 3

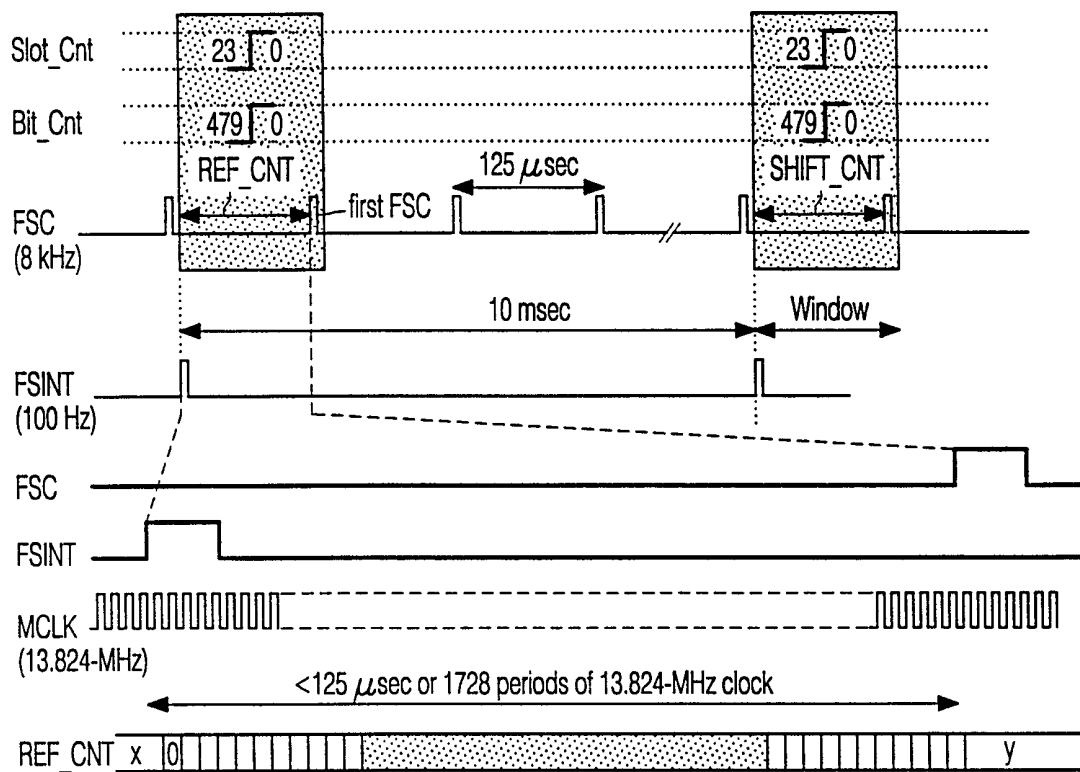


FIG. 4

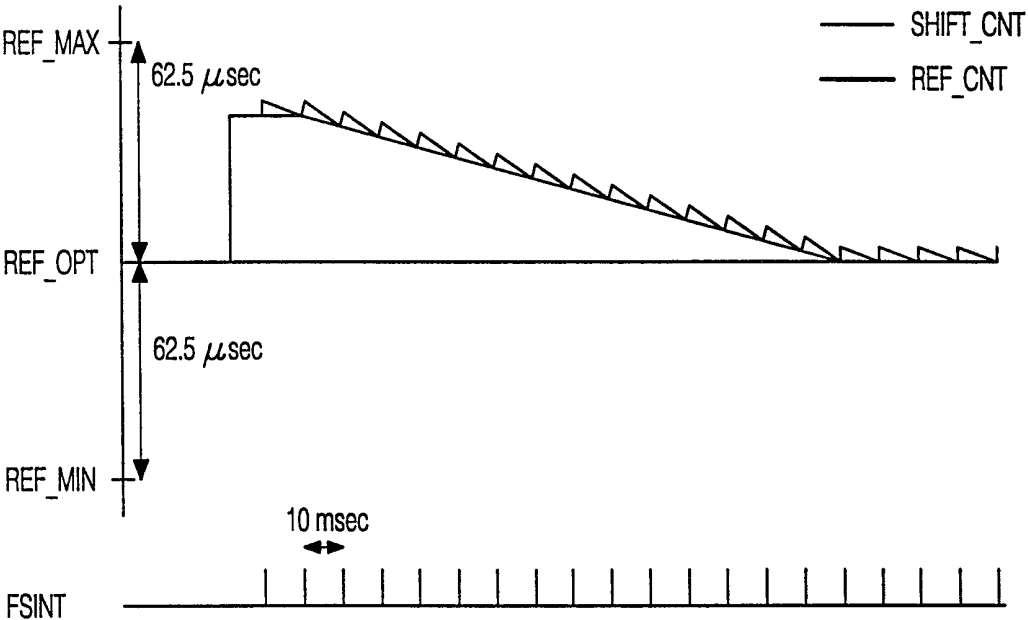


FIG. 5