

**A FULL-DUPLEX ANALOG INTERCOM SYSTEM** ✓

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FIELD OF THE INVENTION

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The present invention relates to the field of duplex communication, and particularly to an analog intercom system for facilitating full duplex communication between cordless telephone handsets.

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BACKGROUND OF THE INVENTION

There currently exists at least one analog phone system having a base and multiple cordless, portable handsets. However, currently, an intercom facility is not implemented because the handsets cannot communicate with each other in a full duplex manner. Although a full duplex intercom system has been implemented in a number of digital systems, it is generally not found in analog systems, and especially in an analog phone system. This is because cordless phones are generally implemented by using frequency division duplex, i.e., the handsets all transmit at a single frequency and the base transmits at another different frequency. Because this type of cordless systems does not allow multiple handsets to simultaneously transmit at the same frequency, a full duplex handset-to-handset communication via the base is not possible.

Given that analog phone systems can generally be made more cheaply, there is a price and, thus commercial, advantage to having an analog phone system which is capable of facilitating full duplex

communication between the handsets. But as of this date, no such systems are known to exist. Given this background, it can be easily seen why an analog phone system which is capable of full duplex communication between the handsets is highly desirable.

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### OBJECT OF THE INVENTION

Therefore, it is an object of the present invention to provide a simple and cost effective way of facilitating a full duplex handset-to-handset intercom system preferably incorporated into a multiple-cordless-handset analog phone system.

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### SUMMARY OF THE INVENTION

The present invention facilitates full duplex handset-to-handset communication by recovering audio from multiple independent sources, e.g., the cordless handsets, by demodulating the modulated RF frequencies generated from the handsets where the demodulated signals are subsequently retransmitted by a single carrier frequency back to the handsets.

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The phone system incorporating the present handset-to-handset intercom system includes a base station, and a plurality of cordless handsets. The phone system generally works in a manner similar to other phone systems having a base station and a cordless handset. Here, the base station is connected to a regular phone line. When a call comes in, a receiving party picks up one of the handsets, the first handset, for instance.

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The voice signals from the caller is transmitted by the base to the handset at a carrier frequency  $f_b$ ; the voice signals from the receiving party is transmitted by the handset to the base station at another carrier frequency  $f_1$ . If the receiving party picks up the second handset, the second handset  
5 transmits the voice signals to the base station at another carrier frequency  $f_2$ .

The base has a circuitry for receiving and processing the two frequencies  $f_1$  and  $f_2$ , and transmitting a signal at  $f_b$ . The frequencies used are 49 Mhz for  $f_1$ , 49.2 Mhz for  $f_2$ , and 46 Mhz for  $f_b$ , though clearly other  
10 frequencies are possible. The circuitry in the base includes a receptor which receives and transmits the signals at the frequencies mentioned above. The receptor is coupled to a duplexer for discriminating between the transmitting signal  $f_b$  and the receiving signals  $f_1$  and  $f_2$ . When the signals  $f_1$  and  $f_2$  are received by the receptor, the duplexer routes the  
15 signals to an RF amplifier for the signals to be amplified. The amplified signals are then sent to a mixer, where the signals are mixed using a 38.3 Mhz local oscillator to yield signals of 10.7 Mhz and 10.9 Mhz. A bandpass filter is used to filter the signals.

The two frequencies 10.7 Mhz and 10.9 Mhz are separated using a  
20 audio recovery circuit. In the first path of the circuit, the signals are mixed using a mixer with a 10.245 Mhz local oscillator to yield frequencies 655 Khz and 455 Khz. In the second path, the 10.7 Mhz and 10.9 Mhz signals are again mixed using another mixer with a 10.445 Mhz local oscillator to yield frequencies 455 Khz and 255 Khz. In the first path, a 455 Khz  
25 bandpass filter is used to filter out the 655 Khz frequency. The 455 Khz signal is then demodulated by the demodulator to recover the audio signal

for  $f_1$  (the modulated audio signal transmitted by the handset at 49 Mhz). In the second path, the 455 Khz bandpass filter is again used to filter out the 255 Khz frequency. The 455 Khz signal is then demodulated by the demodulator to recover the audio signal for  $f_2$  (the modulated audio signal transmitted by the handset at 49.2 Mhz).

The recovered audio signals are then expanded using a expander. The audio signals are subsequently amplified using an audio amplifier, and then compressed using a compandor. The audio signals are then modulated to a transmitting frequency of 46 Mhz using a voltage controlled oscillator. The RF signal is then amplified using a RF amplifier. The duplexer allows only the 46 Mhz signal to be transmitted. The 46 Mhz signal which is carrying the two audio signals is received by both handsets, which demodulate and recover the audio from the 46 Mhz signal. The duplex communication is now accomplished.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating the analog intercom system of the present invention.

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FIG. 2 is a block diagram of the circuitry in the base station for receiving and processing the signals emanating from the handsets.

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### DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates a phone system 1 with multiple handsets  
5 incorporating the analog intercom feature of the present invention. Although the preferred embodiment of the present intercom system is incorporated into an analog phone system as shown in FIG. 1, it can be a separate, dedicated intercom system provided the essential components as described below are supplied. The phone system 1 incorporating the  
10 handset-to-handset intercom system includes a base station 10, and a plurality of cordless handsets, here, the first handset 20 and second handset 30. Although only two are shown here for illustration purposes, additional handsets can be added to the system.

The phone system 1 generally works in a manner similar to other  
15 phone systems having a base station and a cordless handset. Here, the base station 10 is connected to a regular phone line. When a call comes in, a receiving party picks up one of the handsets, the first handset 20, for instance. The voice signals from the caller is transmitted by the base to the handset at a carrier frequency  $f_b$ ; the voice signals from the receiving party  
20 is transmitted by the handset 20 to the base station 10 at another carrier frequency  $f_1$ . If the receiving party picks up the second handset 30, the second handset 30 transmits the voice signals to the base station 10 at another carrier frequency  $f_2$ .

In a prior art analog phone system having a similar configuration,  
25 both of the handsets transmitted the voice signals at the same frequency. Because the two signals interfered with each other, it was not possible for

both of the handsets to be used simultaneously for intercom purposes. Moreover, the base station had no means for processing the two signals in a full duplex manner. Hence, a full duplex intercom communication between the handsets was not possible.

5       The present systems rectifies this problem by having a circuitry, shown in FIG. 2, for receiving and processing the two frequencies  $f_1$  and  $f_2$ , and transmitting a signal at  $f_b$ . The frequencies used are 49 Mhz for  $f_1$ , 49.2 Mhz for  $f_2$ , and 46 Mhz for  $f_b$ . However, it should be appreciated that the choice of frequency is not critical for the invention (though may be relevant  
10 to other considerations such as FCC regulation), and other combinations of values are certainly possible.

In referring to FIG. 2, the structure and the operation of the circuitry  
12 shall be described. To properly illustrate the circuitry's ability to handle full duplex communication, it shall be assumed that the modulated voice  
15 signals  $f_1$  and  $f_2$  are being transmitted by the handsets and are being processed by the circuitry 12 simultaneously.

The circuitry 12 includes a receptor 40 which receives and transmits the signals at the frequencies mentioned above. The receptor 40 is coupled to a duplexer 42 for discriminating between the transmitting signal  
20  $f_b$  and the receiving signals  $f_1$  and  $f_2$ . When the signals  $f_1$  and  $f_2$  are received by the receptor, the duplexer 42 routes the signals to an RF amplifier 44 for the signals to be amplified. The amplified signals are then sent to a mixer 46, where the signals are mixed using a 38.3 Mhz local oscillator to yield signals of 10.7 Mhz and 10.9 Mhz. A bandpass filter 50 is  
25 used to filter the signals. One skilled in the art would appreciate that one may design a circuit performing the same function as the circuitry 12

without the use of a duplexer. However, a use of the duplexer 12 is highly preferred as it simplifies the circuitry.

The audio portion of the two frequencies 10.7 Mhz and 10.9 Mhz are recovered using a audio recovery circuit 51. In the first path of the circuit 51, the signals are mixed using a mixer 52 with a 10.245 Mhz local oscillator to yield frequencies 655 Khz and 455 Khz. In the second path, the 10.7 Mhz and 10.9 Mhz signals are again mixed using a mixer 56 with a 10.445 Mhz local oscillator to yield frequencies 455 Khz and 255 Khz. In the first path, a 455 Khz bandpass filter 60 is used to filter out the 655 Khz frequency. The 455 Khz signal is then demodulated by the demodulator 64 to recover the audio signal for  $f_1$  (the modulated audio signal transmitted by the handset at 49 Mhz). In the second path, the 455 Khz bandpass filter 62 is again used to filter out the 255 Khz frequency. The 455 Khz signal is then demodulated by the demodulator 66 to recover the audio signal for  $f_2$  (the modulated audio signal transmitted by the handset at 49.2 Mhz).

The recovered audio signals are then expanded using a expander 68. However, the use of the expander is optional. The audio signals are subsequently amplified using an audio amplifier 70, and then compressed using a compandor 72. The audio signals are then modulated to a transmitting frequency of 46 Mhz using a voltage controlled oscillator 74. The RF signal is then amplified using a RF amplifier 76. The duplexer 42 allows only the 46 Mhz signal to be transmitted. The 46 Mhz signal which is carrying the two audio signals is received by both handsets 20 and 30, which demodulate and recover the audio from the 46 Mhz signal. The duplex communication is now accomplished.

The present invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. For instance, although here, the intercom system was incorporated into a phone system, it may be a dedicated stand-alone system. For the stand-alone intercom system, the components and their functionalities are  
5 basically the same as one described above except that the base need not be connected to a phone line. The presently disclosed embodiments are, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims and all  
10 changes which come within the meaning and range of equivalency of the claims are, therefore, to be embraced therein.

**CLAIMS**

We Claim:

- 1 1. A full-duplex analog intercom system comprising:  
2 a plurality of cordless handsets, said handsets adapted for  
3 receiving, transmitting, and processing a signal;  
4 a base adapted for receiving, transmitting, and processing a signal;  
5 and  
6 a circuit located inside said base, said circuit having a means for  
7 demodulating modulated signals, a means for recovering audio from  
8 demodulated signals, and a means for transmitting multiple audio signals  
9 on a single carrier frequency,  
10 whereby each of said handsets transmits an audio signal modulated  
11 on a unique carrier frequency to said base, and wherein said base  
12 receives said modulated signals from said handsets, recovers the audio  
13 from said modulated signals, and simultaneously transmits all of the  
14 recovered audio back to said handsets modulated on a single carrier  
15 frequency which is different than the carrier frequencies used by the  
16 handsets.
- 1 2. The analog system as recited in Claim 1 wherein said circuit further  
2 includes a duplexer for discriminating between different signals.
- 1 3. The analog system as recited in Claim 1 wherein said means for  
2 recovering audio includes a local oscillator, bandpass filter, and a  
3 demodulator.



- 1 4. The analog system as recited in Claim 1 wherein said circuit further  
2 includes an expander, a compandor, and an audio amplifier.
- 1 5. The analog system as recited in Claim 1 wherein said handsets are  
2 cordless telephone handsets.
- 1 6. The analog system as recited in Claim 5 wherein said base is a  
2 telephone base.
- 1 7. The analog system as recited in Claim 1 further comprising a  
2 plurality of RF amplifiers.
- 1 8. The analog system as recited in Claim 2 wherein said means for  
2 recovering audio includes a local oscillator, bandpass filter, and a  
3 demodulator.
- 1 9. The analog system as recited in Claim 2 wherein said circuit further  
2 includes an expander, a compandor, and an audio amplifier.
- 1 10. The analog system as recited in Claim 8 wherein said circuit further  
2 includes an expander, a compandor, and an audio amplifier.
- 1 11. An analog method of facilitating an full-duplex communication  
2 between handsets comprising:  
3 transmitting an audio signal from a first handset modulated at  
4 frequency  $f_1$ ;  
5 transmitting an audio signal from a second handset modulated at  
6 frequency  $f_2$ ;  
7 demodulating said  $f_1$  signal and  $f_2$  signal;  
8 recovering the audio signal from said  $f_1$  signal and  $f_2$  signal;  
9 modulating the recovered audio signal from said  $f_1$  signal and  $f_2$   
10 signal on a single carrier frequency  $f_c$ ;



11 transmitting said  $f_0$  signal to said first and second handsets; and  
12 demodulating said  $f_0$  signal and recovering the audio signal from  
13 said  $f_0$  signal in said handsets.

1 12. The analog method as recited in Claim 11 wherein said  $f_1$  signal  
2 operates at 49 Mhz.

1 13. The analog method as recited in Claim 12 wherein said  $f_2$  signal  
2 operates at 49.2 Mhz.

1 14. The analog method as recited in Claim 13 wherein said  $f_0$  signal  
2 operates at 46 Mhz.

