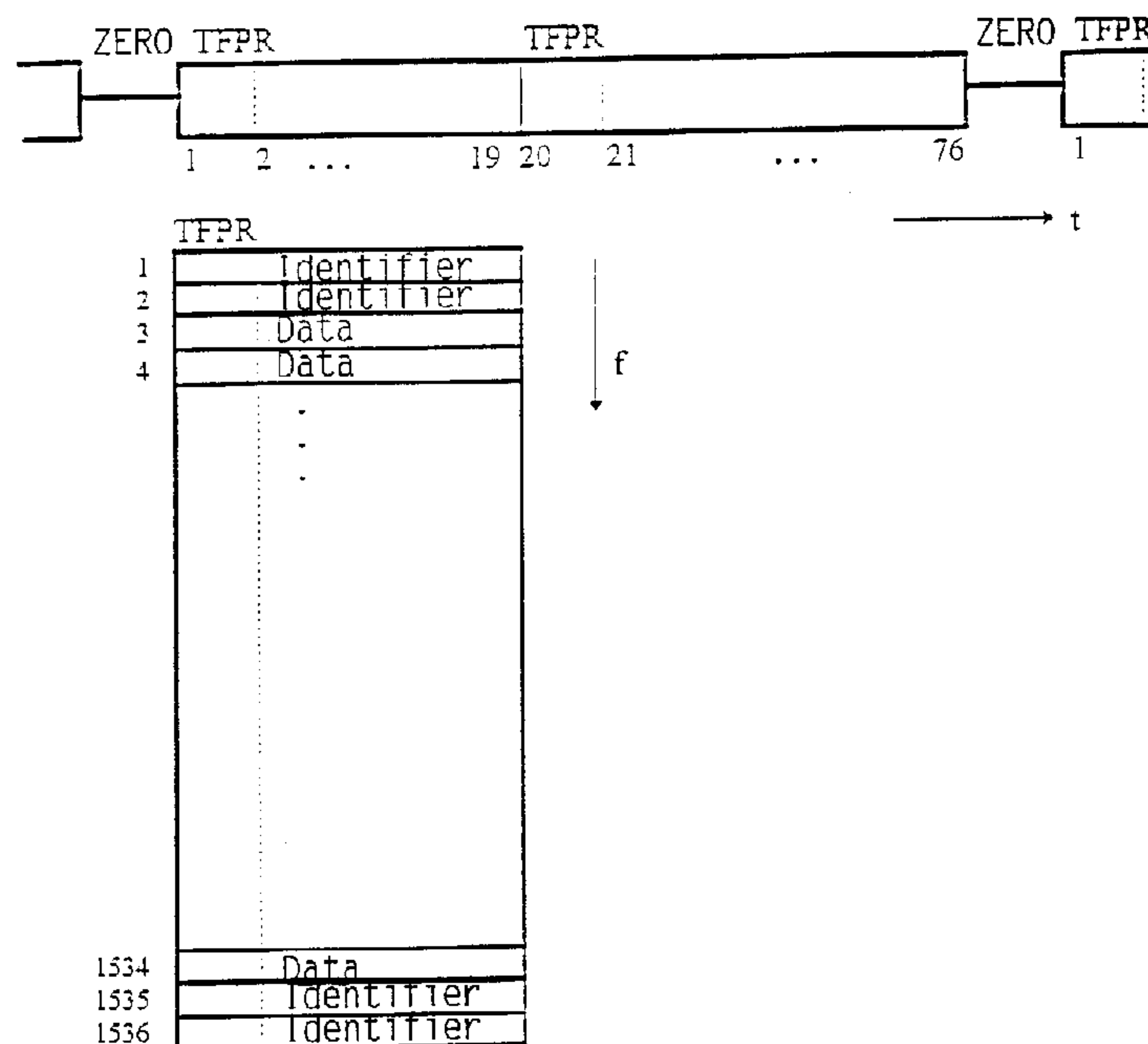




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(54) Titre : CIRCUITERIE ET PROCEDE PERMETTANT DE REALISER UNE VOIE DE RETOUR DE DONNEES D'UN RECEPTEUR A UN EMETTEUR DANS UN RESEAU A FREQUENCE COMMUNE
(54) Title: CIRCUIT ARRAY AND PROCESS FOR CREATING A DATA FEEDBACK CHANNEL FROM RECEIVER TO TRANSMITTER IN A COMMON FREQUENCY NETWORK



(57) Abrégé/Abstract:

The establishment of an interactive broadcasting network requires not only a transmission channel from transmitter to receiver but also a transmission channel from receiver to transmitter. A novel method of creating a data feedback channel from receiver to transmitter is implemented in a common frequency network and involves the use of a transmission procedure in conformity with the DAB standard. Each receiver or user is assigned an identifier which is transmitted in the data feedback channel at specially reserved frequencies to request transmission capacity. A computer then allocates transmission capacity to the receiver. The signals received in the forward channel are evaluated using the synchronization symbols they contain in order to synchronize the transmitter component in the receiver. The novel process can be used in all common frequency networks which use data transmission in conformity with the DAB standard and ensures a particularly economical synchronization in the receiver.



Abstract

The establishment of an interactive broadcasting network requires not only a transmission channel from transmitter to receiver but also a transmission channel from receiver to transmitter. A novel method of creating a data feedback channel from receiver to transmitter is implemented in a common frequency network and involves the use of a transmission procedure in conformity with the DAB standard. Each receiver or user is assigned an identifier which is transmitted in the data feedback channel at specially reserved frequencies to request transmission capacity. A computer then allocates transmission capacity to the receiver. The signals received in the forward channel are evaluated using the synchronization symbols they contain in order to synchronize the transmitter component in the receiver. The novel process can be used in all common frequency networks which use data transmission in conformity with the DAB standard and ensures a particularly economical synchronization in the receiver.

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**Circuit Array and Method
for Creating a Data Feedback Channel
from Receiver to Transmitter in a Common Frequency Network**

The invention concerns a method for the creation of a data feedback channel in a common frequency network having multi-channel transmission according to the preamble of claim 1 as well as a circuit array for carrying out the method in accordance with the preamble of claim 14.

There is a long-felt need for a data feedback channel for use in broadcasting to allow interactive selection of transmitted data from a large data supply or to be able to facilitate billing according to actual media consumption.

Known in the art from WO 94/01825 is a system for the calculation of fees for electronic services. The consumer has a device in which the charges due are compared to a credit amount and subtracted from same to facilitate use of the service. Towards this end, there is a connection between a central computer and the device at the user location.

This system has the disadvantage that two differing types of transmission are selected for bi-directional communication between the user and the central transmission location. In addition, it is not possible to effect interactive operation, since the system is only designed for fee calculation.

Known in the art from WO 92/10038 is a fee calculation system for cable TV with which, similar to WO 94/01825, a device is situated at the user location. This device has the following components: a receiver for a first transmission procedure, a decoder in order to decode the received data, a monitoring circuit to verify the access authorization of the user, a transmitter to transmit data to a central location using a second transmission procedure as well as a demultiplexer for separation of the forward and feedback channels.

This system has the disadvantage that the transmission requires cables and therefore cannot be utilized for mobile receivers. There is the additional disadvantage that two differing transmission procedures are utilized. No information is disclosed with regard to the transmission method itself.

A fee calculation system for a so-called "Value Added Service" is known in the art from EP 601 523 A1 with which an identifier which identifies the data type is added to each data set at a central location and transmitted to the user. The user has a device having individual identification codes and stores the transmitted identifiers. Transmission of a control code by the central location facilitates a request for desired information from the user to the central location which is transmitted along with the identification code.

Disadvantageously, this publication only discloses the fact that the identification code is to be transmitted to associate the transmitted data with a particular terminal. No information is given concerning the transmission protocol

used.

Known in the art from EP 595354 A1 is a fee calculation system for broadcasting. This system has a computer located on the transmitter side which stores different types of data, a receiver which receives these data and a transmission format which includes an identifier for each type of data. The receiver thereby comprises circuits for data processing of each data type and a memory for storing the identifiers. The computer transmits conversion data for the calculation of fees in irregular time intervals which are stored in the receiver and utilized together with the identifier for the calculation of fees. Data is transferred by the receiver via a telephone line back to the computer located on the sender side. The receiver requires access authorization previously granted by the computer.

The disclosed fee calculation system has the disadvantage that use requires an additional telephone line for the data feedback channel. Even in the event that such a line is available, additional costs result. In addition, a telephone line has a very small transmission bandwidth so that the transmission capacity is low.

Known in the art from EP 488289 A2 is a cable-related bi-directional video transmission system. A video signal in a base band is mixed to a particular frequency position in the radio frequency range and transmitted along a cable to the receiver. The frequency position of the video signal to be transmitted is determined by a control unit following request by the receiver. The control unit controls the mixer in the transmitter and receiver to effect transmission of the video and request signals within a frequency region

which is not in use.

This system has the disadvantage that transmission requires a cable so that it cannot be used by mobile receivers. In addition, there is no description of how to effect high precision synchronization of the mixer in an inexpensive and straightforward fashion.

The purpose of the present invention is to realize a data feedback channel between a mobile radio receiver and a most recently received transmitter, wherein the transmitter and the receiver operate in multi-channel transmission mode within a common frequency network.

This purpose is achieved in accordance with the invention through the features of claims 1 and 15.

As embodied and broadly described herein, the present invention provides a method for the creation of a data feedback channel for transmitting data from a receiver to a transmitter in a common frequency network. A forward channel exists between the transmitter and the receiver. The method comprises receiving, at the receiver, first data from the transmitter via the forward channel, the first data being modulated to a plurality of first carrier frequencies proximate each other in frequency space and transmitted in frames separated by first synchronization symbols. The method also comprises evaluating at least one of the first carrier frequencies and the first synchronization symbols. The method further comprises transmitting second data from the receiver to the transmitter via the data feedback channel, the second data being modulated to a plurality of second carrier frequencies proximate each other in frequency space and transmitted in frames separated by second

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synchronization symbols. The time and frequency synchronization of the second carrier frequencies of the second data is dependent on at least one of the first carrier frequencies and the first carrier synchronization symbols.

As further embodied and broadly described herein, the present invention provides a circuit configuration for the realization of a data feedback channel between a receiver and a transmitter in common frequency network operation. The receiver comprises radio frequency means for receiving an output signal for transmission from the receiver to the transmitter, and frequency synchronization means for receiving the output signal via the radio frequency means. The receiver also comprises time synchronization means for receiving the output signal via the radio frequency means and synchronization signal production means for receiving outputs of the frequency synchronization means and the time synchronization means. Finally, the receiver comprises data symbol production means for receiving outputs of the frequency synchronization means, wherein the data symbol production means includes an encoder, a generator for the production of COFDM symbols, and a modulator.

The method in accordance with the invention has the advantage that the synchronization of frequency and of the transmission time slot in the receiver, which is particularly difficult in a common frequency network, is substantially simplified through evaluation of the received signal. The signal frequency of the transmitter to which a data feedback channel is to be constructed, is utilized to synchronize components in the receiver for determining the transmission frequency of the data feedback channel. In

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addition, components for time synchronization of the signal transmitted by the receiver in the data feedback channel are controlled using the time sequence of the signal frames received from the transmitter to which a data feedback channel is to be connected.

Advantageous configurations are given in the dependent

claims.

The invention is further described and explained below in connection with the embodiment of the drawing.

Fig. 1 shows a plurality of transmission channels plotted against frequency, and

Fig. 2 shows a data feedback channel transmission frame as a function of time and frequency.

Fig. 1 shows a plurality of transmission channels for a COFDM transmission process having a transmission bandwidth of approximately 1.5 MHz per transmission channel as a function of frequency f . Transmission data is transmitted from the transmitter to the receiver via forward channels H1, H2 and H3, as is known in the art with conventional radio broadcasting. Data is transmitted from one or more receivers to the transmitter via data feedback channel R1 to effect interactive data transmission. The data feedback channel can, in particular, be used to request specific data on an individualized basis. Such data would include, e.g. stock market prices, local traffic reports and detour recommendations, or local weather forecasts. Frequency and time multiplexing is carried out to allow a plurality of receivers to share one data feedback channel R1. Towards this end, a central computer assigns carrier frequencies and time slots to each receiver in the form of data symbols.

In order to be able to associate the data received by the transmitter via the data feedback channel with a user, which is particularly important for transmissions requiring payment of fees, each user or each receiver is given an

individual identifier. The data transmitted to the receiver in the forward channel begins with the identifier so that the receiver can direct evaluation to the requested data. The identifier can be assigned by a collection location for fees associated with the Service Provider. The user could either program the identifier in the receiver himself or could allow this to be done by the collection location, the manufacturer or by customer service.

The transmission format utilized in the data feedback channel comprises a transmission frame having the same time duration as the transmitted frame received in the forward channel. In addition, the number of carrier frequencies utilized for transmission and their separations in frequency and thereby the bandwidth utilized for transmission are the same in the forward and feedback channels. In this manner, the same transmission mode is always selected for the forward and feedback transmission channels. In addition, the same type of modulation is utilized in the forward and feedback channels.

Although the forward and feedback transmission channels have different frequency ranges, it is nevertheless possible to generate the transmission frequency of the data feedback channel in the receiver in a simple fashion using frequency division and frequency multiplication based on the frequency received in the forward channel. Due to the high frequency precision which is required by a common frequency network, the determination of the transmission frequency in the data feedback channel using the frequencies in the forward channel avoids substantial difficulties in circuitry. The COFDM receiver signal for synchronization is directed from the radio frequency portion of the receiver to the

transmitter components of the receiver. Appropriate division and multiplication of the frequency is effected by the transmitter components to generate the transmission frequency. The generated signal having the desired frequency is subsequently used as a regulation signal for a frequency regulation loop. The frequency regulation loop defines carrier frequencies sent by the receiver.

In addition, time synchronization of the signals transmitted by the receiver can be completely controlled using the time sequence of the received signals. Towards this end, an envelope detector detects the zero symbols of the received signal and passes same to a threshold circuit. In the event that the signal amplitude lies below a threshold value, a zero symbol is detected. As soon as the threshold value is crossed, the signal shown in figure 2 is transmitted by the receiver.

The feedback channel transmission frame is bordered by two zero symbols and, in contrast to the forward channel, is subdivided into a plurality of subframes, e.g. four, at the beginning of which a synchronization symbol TFPR is transmitted. The remaining symbols transmitted in a subframe are data symbols.

Appropriate components are provided for the production of a TFPR symbol as is already known in the art with conventional transmitters for the synchronization and production of a reference for difference-phase-modulated signals. The received signal facilitates time synchronization of these components.

The data symbols are introduced in each subframe following

the TFPR symbol which, based on the zero symbol of the received signal, are time-delayed and introduced into the data stream of the transmitted signal.

A decoder, a generator for a COFDM signal and a modulator for COFDM signals are provided for production of these data symbols. Thereby, the generator for a COFDM signal is synchronized as described with respect to time and in frequency via the received signal or from a signal derived therefrom. The data entered by the user is encoded and modulated into a COFDM signal. Towards this end, one must note that, in contrast to conventional COFDM signal modulators, a certain number of carriers are reserved in the data feedback channel for identifier transmission and are therefore removed from modulation.

The data feedback channel has a small number of carrier frequencies which are solely reserved for transmission of the assigned receiver identifier to the transmitter. In the event that transmission capacity is requested, the identifier is transmitted by the receiver in a selected data symbol at only one of the reserved carrier frequencies. This means that a special modulator is provided for to modulate the identifier to a carrier frequency. The carrier frequency and data symbol utilized are thereby randomly chosen from the carrier frequencies reserved therefor. In the event that the transmitter can decode the request, transmission capacity is allocated.

In the event that at least two receivers have selected the same data symbol and the same carrier frequency for purposes of identifier transmission, the transmitter cannot decode the request due to interference problems and does not

allocate transmission capacity. This is detected by the receiver after a certain period of time and the identifier is once more sent at another carrier frequency in a differing data symbol. This process is repeated until transmission capacity is allocated to the receiver. The waiting time between two identifier transmissions can thereby be chosen in dependence on the number of unsuccessful identifier transmissions.

In the event that one reserves only four carrier frequencies for transmission of the identifier and in the event that a transmission frame of 96 ms duration is subdivided into four subframes, it is possible for 16 identifier transmissions to be transmitted in one transmission frame, which corresponds to approximately 167 per second. The identifier transmitted thereby can be up to 36 bits in length. In this manner, 137 billion receivers can have differing identifiers. Since a number of receivers of this magnitude is inconceivable in a single common frequency network, the identifier can also be encoded. This improves error protection and assists in recognition of improper use associated with the unauthorized reception of data by the receiver.

In order to allocate transmission capacity to the receiver, the transmitter transmits a data telegram over the non-reserved carrier frequencies which begins with the identifier of the receiver and which is transmitted in data symbols at carrier frequencies which are not in use. The receiver which, due to the transmission of its identifier, expects an allocation, monitors the forward channel to detect his identifier. In the event that he has recognized same within a certain period of time he considers the subsequently transmitted data to be transmission symbols and

carrier frequencies made available to him for the transmission process. Subsequent thereto, the receiver begins to transmit the data.

In this fashion the request and allocation of transmission capacity between the receiver and the transmitter is effected. In areas having only a small number of requests, the transmitter can allocate a plurality of carrier frequencies and a larger transmission time slot to one receiver. In this fashion, the transmission time is correspondingly shortened. In highly populated areas where a large number of receivers simultaneously request transmission capacity, it is advantageous for only a small number of carrier frequencies and narrow transmission time slots to be allocated to simultaneously serve a large number of receivers.

Due to the small transmission power of a mobile receiver, its transmission signal should only be received by the nearest transmitter. Since the transmitters in a common frequency network are, in any event, connected to each other by means of data cables, a central computer determines the signal strength of the received signal for a plurality of transmitters to associate a receiver with a transmitter. This can be done in a manner similar to that of roaming in radio networks for mobile telephones. In this fashion, the capacity of the data feedback channel of the common frequency network can be increased.

In addition thereto, this central computer can also be utilized, to store the transmission capacity allocated to each individual receiver together with time information and to carry out an associated calculation of fees. The service

utilized and the service provider can also be stored for use in fee calculation.

In addition, the central computer can be utilized to verify the access authorization based on the identifier transmitted. This can be done by comparison to stored identifiers or through utilization of an algorithm which must lead to a certain result for access authorization. Towards this end, one can differentiate among differing levels of access authorization. The first level can be utilized to check whether or not the received identifier is authorized at all. In the event that this is not the case, no transmission capacity is allocated. In a second level, one can check whether or not the received identifier has access authorization to the requested data. If this is not the case, an appropriate message is transmitted and the connection terminated. Alternative thereto, the second step could also require an additional identifier.

Claims

1. A method for the creation of a data feedback channel for transmitting data from a receiver to a transmitter in a common frequency network, a forward channel existing between the transmitter and the receiver, said method comprising:
 - receiving, at the receiver, first data from the transmitter via the forward channel, the first data being modulated to a plurality of first carrier frequencies proximate each other in frequency space and transmitted in frames separated by first synchronization symbols;
 - evaluating at least one of:
 - i) the first carrier frequencies;
 - ii) the first synchronization symbols;
 - transmitting second data from the receiver to the transmitter via the data feedback channel, the second data being modulated to a plurality of second carrier frequencies proximate each other in frequency space and transmitted in frames separated by second synchronization symbols, the time and frequency synchronization of the second carrier frequencies of the second data being dependent on said at least one of:
 - i) the first carrier frequencies;
 - ii) the first synchronization symbols.

2. Method according to claim 1, wherein the frame transmission duration and type of modulation in the data feedback channel are identical to the frame transmission duration and type of modulation in the forward channel.
3. Method according to either one of claims 1 and 2, wherein the transmission bandwidth and the frequency separation between two of said second carrier frequencies in the data feedback channel is identical to the frequency separation between two of said first carrier frequencies in the forward channel.
4. Method according to any one of claims 1 through 3, wherein a frame in the data feedback channel is subdivided into a plurality of subframes each beginning with a transmitted synchronization symbol.
5. Method according to any one of claims 1 through 4 wherein the data feedback channel has one or more carrier frequencies for the transmission of requests for transmission capacity from the receiver to the transmitter.
6. Method according to any one of claims 1 through 5 wherein the receiver has at least one of an apparatus identifier and an individual user-specific identifier which is transmitted by the receiver and transmitter for request and for allocation of transmission capacity.

7. Method according to claim 6, wherein the at least one of the apparatus identifier and the user-specific identifier is transmitted in an encoded fashion.
8. Method according to either one of claims 6 and 7, wherein the transmission capacity associated with each of the apparatus identifier and the user-specific identifier is stored together with time information and used for the calculation of fees.
9. Method according to any one of claims 6 through 8, wherein upon allocation of transmission capacity by the transmitter to the receiver, the receiver's at least one of the apparatus identifier and the user-specific identifier, as well as the carrier frequencies and time slots provided for transmission are transmitted.
10. Method according to any one of claims 1 through 9, wherein a second request for transmission capacity is transmitted at a differing carrier frequency in the event that no allocation of transmission capacity occurs following a certain amount of time subsequent to the request therefor.
11. Method according to any one of claims 1 through 9, wherein a second request for transmission capacity is transmitted in a differing time slot in the event that no allocation of transmission capacity occurs following a certain amount of time subsequent to the request therefor.

12. Method according to any one of claims 1 through 11, wherein, in the event of a second request for transmission capacity, the carrier frequency and/or the time slot used therefor are randomly determined and the duration between two requests is determined based on the urgency of the transmission.
13. Method according to any one of claims 1 through 12, wherein a plurality of receivers use a common data feedback channel (R1).
14. Method according to any one of claims 1 through 13, wherein one transmitter is chosen from the request signal of the receiver received by one or a plurality of transmitters in a common frequency network based on field strength information and the selected transmitter establishes a broadcasting connection with the receiver.
15. A circuit configuration for the realization of a data feedback channel between a receiver and a transmitter in common frequency network operation, the receiver comprising:
 - radio frequency means for receiving an output signal for transmission from the receiver to the transmitter;
 - frequency synchronization means for receiving the output signal via the radio frequency means;

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- time synchronization means for receiving the output signal via the radio frequency means;
- synchronization signal production means for receiving outputs of the frequency synchronization means and the time synchronization means;
- data symbol production means for receiving outputs of the frequency synchronization means, wherein the data symbol production means includes:
 - an encoder;
 - a generator for the production of COFDM symbols, and;
 - a modulator.

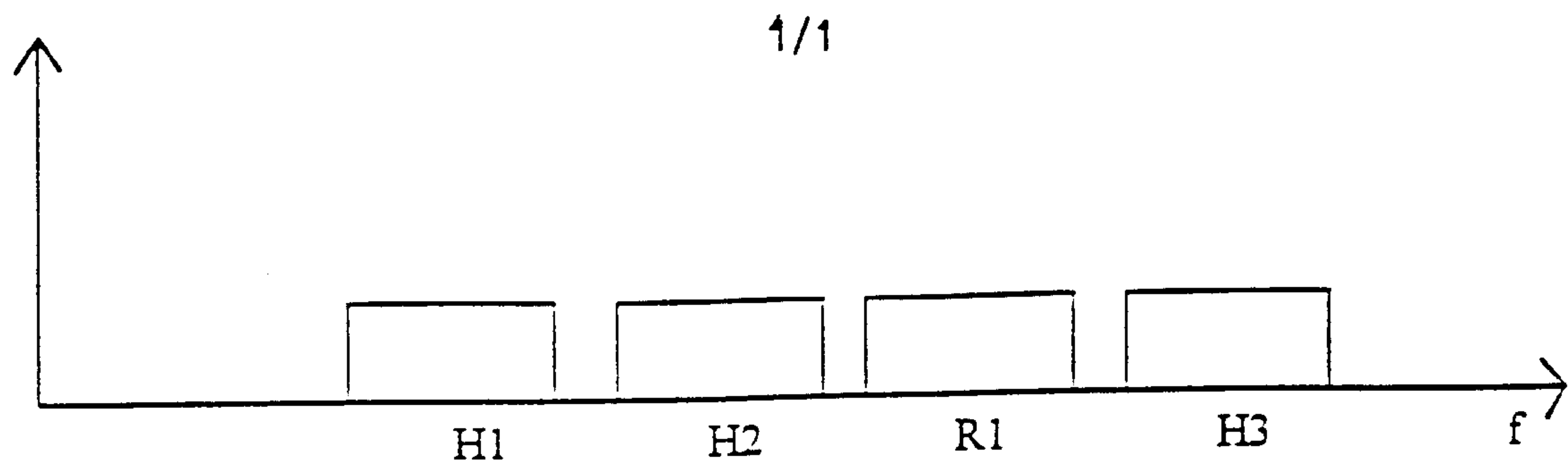


Fig. 1

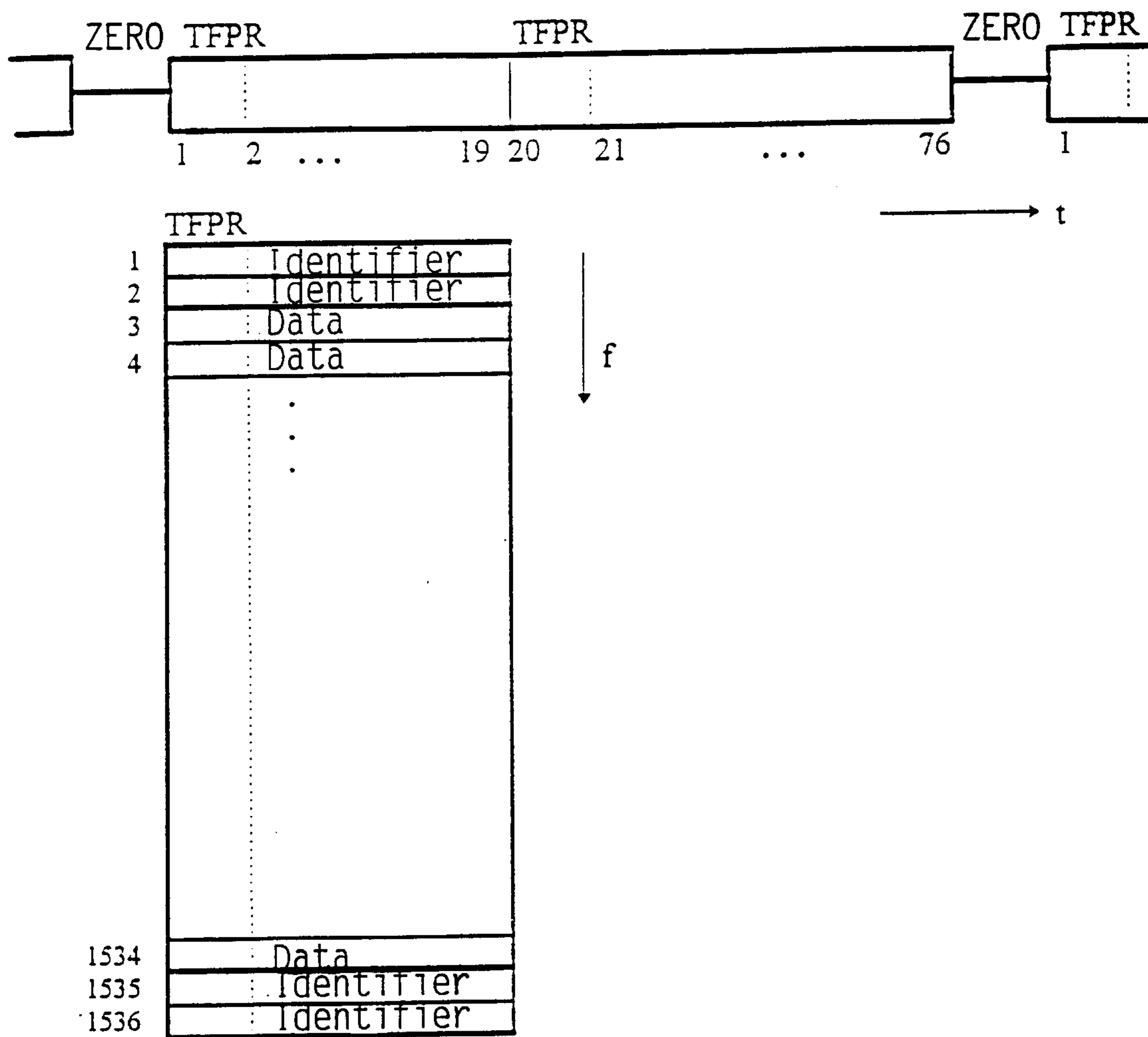
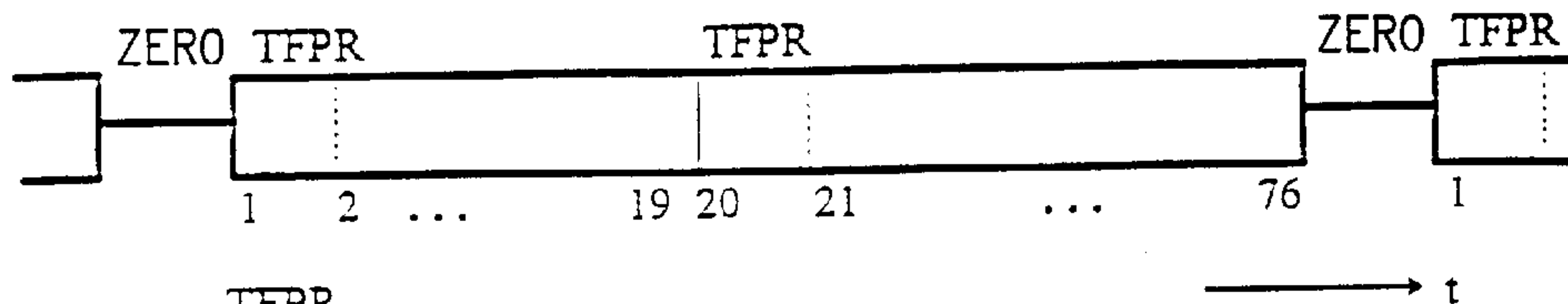


Fig. 2



TFPR

1	Identifier
2	Identifier
3	Data
4	Data
	.
	.
	.
1534	Data
1535	Identifier
1536	Identifier

f