

Description

This invention relates to apparatus for receiving and transmitting RF signals.

Data transceivers of the type used for remote access to vehicles must be reliable, be small in size and have low power consumption. A remote access system generally comprises a base unit in a vehicle and a remote unit to be carried by the driver. The base and remote units are coupled by a UHF radio link for a bi-directional exchange of data when activated to verify that the remote unit is authorized to provide vehicle access. It is generally desirable that the remote unit be small enough to be carried on a key ring and have a battery sufficient for several years of operation. It should also have high temperature stability.

US-A-4 786 903 discloses a transponder which includes an oscillator block for receiving RF signals when in the receiver mode and for transmitting modulated RF signals when in the transmit mode. The circuit includes an oscillator block which is shared in the receive and transmit mode.

The paper entitled "A low cost super-regenerative SAW stabilised receiver" by Ash, published at the IEEE International Conference on Consumer Electronics, Session XII on 2-5 June 1987 and in the accompanying Digest of Technical Papers p152-153 discloses the use of a SAW device as an oscillator feedback in a receiver circuit.

The present invention seeks to provide improved apparatus for receiving and transmitting such signals.

Accordingly, an aspect of the present invention provides apparatus for receiving and transmitting signals as specified in claim 1.

An embodiment uses a surface acoustic wave (SAW) device of the type described in U.S. Patent No. 4,749,964, which discloses a receiver having a simple circuit and including a surface acoustic wave (SAW) device in the feedback circuit of the RF oscillator. The circuit includes a quenching oscillator coupled to the RF oscillator to turn the RF oscillator on and off at a given frequency and duty cycle, and an input RF signal is superimposed on the RF oscillator to modulate the oscillation by increasing the duty cycle. The modulation is recovered by low pass filtering the output of the oscillator.

It will be apparent that the invention may provide a transceiver having a small size, low power consumption, and high temperature stability.

In a practical embodiment, there is provided a low power transmitter/receiver having a receiving mode and a transmitting mode and which comprises an RF oscillator having an input and an output and a feedback circuit containing a surface acoustic wave device coupling the input and the output to cause RF oscillations, control means for switching between transmitting and receiving modes, transmission means

coupled to the output and effective during transmitting mode for transmitting the RF oscillations, and input means effective during receiving mode for coupling a modulated RF signal to the oscillator input, and low pass filter means coupled to the oscillator output to recover the modulation.

An embodiment of the present invention is described below, by way of illustration only, with reference to the accompanying drawings, in which:-

Figures 1 and 2 are schematic diagrams of first and second embodiments of transceiver;

Figure 3 is a schematic diagram of the circuit of Figure 2 showing in solid lines the portion of the circuit used during the receive mode;

Figure 4, parts a-d, are waveforms occurring in various parts of the circuit of Figure 3;

Figure 5 is a schematic diagram of the circuit of Figure 2 showing in solid lines the portion of the circuit used during the transmit mode; and

Figure 6, parts a and b, are waveforms occurring in various parts of the circuit of Figure 5.

The embodiment of transceiver described below was specifically designed for use with a remote vehicle access system using a short range radio link operating at a carrier frequency of 300MHz. The embodiment is not limited to that particular application, however. Other short range radio link applications include toll booth billing, fleet management, and service information data transfer, for example.

Figure 1 shows the transceiver 10 connected to an antenna 12 and having a controller 14 for switching between receiving and transmitting modes. The antenna is directly coupled to the input of an RF amplifier 16 which has an output coupled through a very small capacitor 18 to the input of an RF super-regenerator oscillator circuit 20. The oscillator 20 comprises an inverting amplifier 22 having an input and an output, and a feedback loop comprising a SAW delay line 24 connected between the output and the input of the amplifier 22. The SAW delay line 24 is selected to produce an oscillator frequency, of the order of 300 MHz, which is the same as the carrier frequency of the received signal.

The inverting amplifier 22 is selectively coupled to a quench oscillator 26 and a data source 28 by a switch 30 controlled by the controller 12 to turn the RF oscillator 20 on and off. The quench oscillator operates at a quench frequency, of the order of 50kHz, which turns the RF oscillator 20 on and off at the same frequency when the switch 30 connects the quench oscillator to the amplifier 22. The output of the RF oscillator 20 is connected to a detector 32 adapted to detect the RF envelope and to a low pass filter 34 adapted to strip the RF and the quench frequency from the signal to yield an output at a terminal 36. The output of the oscillator 20 is also coupled through a very small capacitor 38 to a transmit buffer 40 which has an output connected to the antenna 12. The data

source 28, when connected to the inverting amplifier 22 by the switch 30, produces pulse width modulated voltage pulses corresponding to data to be transmitted and thus turns the oscillator 20 on and off on the basis of the voltage pulses to generate bursts of RF oscillation. In this mode of operation, the switch 30 can be thought of as a modulator. The controller 14 is connected to the transmit buffer 40 to turn the buffer on only during the transmission mode.

The transceiver, by reason of its simplicity is inexpensive and has low power consumption. The RF oscillator 20 is shared by the receiving and transmitting modes. The RF amplifier 16, the inverting amplifier 22 and the transmit buffer 40 each require only one transistor. The SAW device (e.g., an RF Monolithics SL1012 SAW delay line) is a single phase delay line which provides the oscillator with a high temperature stability and a narrow bandwidth (typically a ± 250 kHz 3dB bandwidth). The delay line oscillator's centre frequency and matching characteristics are very sensitive to loading effects from peripheral circuitry. This is due to the high impedance nature of the super-regenerative circuit - a high impedance looking into the oscillator is desirable for high sensitivity to signals from the RF amplifier 16. Therefore coupling signals in and out of the oscillator during transmit and receive modes would be difficult if mode switching or signal gating is done at the oscillator itself. Minute changes in impedance around the oscillator can swing the centre frequency many tens of kilohertz. The present circuit overcomes this problem by maintaining a constant impedance load to the oscillator by coupling lightly in and out of this stage and keeping the voltage biases of the RF amplifier 16 and the transmit buffer 40 constant for both transmit and receive modes. The coupling capacitors 18 and 38 are very small, on the order of 1pf or less to assure minimal load changes on the oscillator.

A variant of the circuit of Figure 1 is shown in Figure 2. Instead of switching the transmit buffer 40 on and off, a PIN switch 42 controlled by the controller 14 is used to couple selectively the transmit buffer 40 and the RF amplifier 16 to the antenna 12. In other respects the circuit is the same as that of Figure 1. The advantage of the PIN switch 42 is that it reduces the risk of any transmission due to leakage of the transmit buffer 40 and is isolated from the RF oscillator 20 by the RF amplifier 16 and the transmit buffer 40 to prevent load changes on the oscillator due to switching. The disadvantage of the PIN switch is that it takes more current to operate than the circuit of Figure 1. Thus it is better suited for a base unit housed in a vehicle, for example, while the circuit without the PIN switch is preferred for a miniature remote unit operated by a battery. The circuits described below show the PIN switch, although as described above, this can be omitted.

Figure 3 illustrates in solid lines the portion of the

circuit of Figure 2 which is active during the receive mode. Figure 4, parts a to d, illustrates signal waveforms developed in certain parts of the receiver circuit. In the receive mode, the system is a conventional super-regenerative configuration. Signals from the antenna 12 are fed to the RF amplifier 16, which provides approximately 10 dB of gain and 20 dB of isolation (to suppress spurious radiation) to yield the signals of Figure 4, part a. The inverting amplifier 22 and SAW delay line 24 form a regenerative oscillator at the frequency of the RF carrier. The oscillator is activated with a high-frequency periodic quench signal (nominally 50kHz), shown at Figure 4, part b, providing a constant duty cycle oscillator envelope, shown in region 50 of Figure 4, part c. The quench signals have a ramped leading edge to turn on the RF oscillator 20 when a certain bias voltage is reached. Any RF signals coupled into the oscillator section from the RF amplifier 16 will increase the duty cycle of the envelope, shown in regions 52 of Figure 4 part c, since RF energy at the oscillator frequency will cause the oscillator to turn on at a lower bias point (equivalent to a point earlier on the quench waveform). The changes in the oscillator envelope are detected and filtered by elements 32 and 34 to recover the modulation, providing a representation of the original transmitted signal as shown in part d of Figure 4.

Figure 5 shows in solid lines the active portion of the circuit of Figure 2 during transmit mode. The data source 28 generates a data signal for transmission, shown in Figure 6, part a, which turns the RF oscillator 20 on and off to generate an RF signal comprising pulse width modulated RF bursts as shown in part b of Figure 6. A small amount of the RF energy is coupled through the small capacitor 38 into the transmit buffer 40, which provides gain and matching to the antenna. The output level is also a function of the transmit buffer, and can be adjusted within the operating range of its transistor.

Claims

1. A combined receiver and transmitter device switchable between a receiving mode for receiving RF signals and a transmitting mode for transmitting RF signals, the device comprising a combined RF oscillator (20) which includes a feedback circuit (22,24) comprising a surface acoustic wave device (24) coupled between an input and an output of the RF oscillator and adapted in use to produce RF oscillations; input means (12,16,18) adapted to couple a received modulated RF signal to the input of the RF oscillator during the receiving mode; a low pass filter (34) coupled to the output of the RF oscillator and adapted to filter the received modulated RF signal; a transmitter (38,40,12) adapted to be coupled to

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the output of the RF oscillator during the transmitting mode so as to transmit the RF oscillations produced by the RF oscillator; and a controller (14) adapted to switch the device between the transmitting and receiving modes.

2. A device according to claim 1, comprising modulating means (30) operable during the transmitting mode to couple a data signal to the RF oscillator so as to modulate the output of the RF oscillator.
3. A device according to claim 1 or 2, comprising a quench oscillator (26) adapted to be coupled to the RF oscillator during the receiving mode to switch the RF oscillator between an oscillating and a non-oscillating condition.
4. A device according to claim 1, 2 or 3, comprising an RF amplifier (22) connected between the input and the output of the RF oscillator.
5. A device according to any preceding claim, comprising an antenna (12), and wherein the controller (14) includes a switch (42) adapted to connect the antenna to the transmitter or the input means.
6. A device according to any preceding claim, comprising a high impedance capacitive coupling (38) between the output of the RF oscillator and the transmitter.
7. A device according to any preceding claim, comprising a high impedance capacitive coupling (18) between the input of the RF oscillator and the input means.

Patentansprüche

1. Eine kombinierte Empfangs- und Sendevorrichtung, die zwischen einem Empfangsmodus für den Empfang von HF-Signalen und einem Sendemodus für das Senden von HF-Signalen umschaltbar ist, wobei die Vorrichtung umfaßt einen kombinierten HF-Oszillator (20), der einen Rückkoppelschaltkreis (22, 24) mit einer Oberflächen-Akustik-Wellenvorrichtung (24) einschließt, die zwischen einem Eingang und einem Ausgang des HF-Oszillators gekoppelt ist und im Gebrauch angepaßt ist, um HF-Oszillationen zu erzeugen; Eingangsmittel (12, 16, 18), die angepaßt sind, um ein empfangenes modulierte HF-Signal an den Eingang des HF-Oszillators während des Empfangsmodus zu koppeln; einen Tiefpaßfilter (34), der an den Ausgang des HF-Oszillators gekoppelt ist und der angepaßt ist, um das empfangene modulierte HF-Signal zu filtern; ei-

nen Sender (38, 40, 12), der angepaßt ist, um an den Ausgang des HF-Oszillators während des Sendemodus gekoppelt zu sein, um die HF-Oszillationen zu senden, die durch den HF-Oszillator erzeugt werden; und einem Steuergerät (14), das angepaßt ist, um das Gerät zwischen den Sende- und Empfangsmodi zu schalten.

2. Eine Vorrichtung nach Anspruch 1 mit Modulationsmitteln (30), die während des Sendemodus wirksam sind, um ein Datensignal an den HF-Oszillator zu koppeln, um den Ausgang des HF-Oszillators zu modulieren.
3. Eine Vorrichtung nach Anspruch 1 oder 2 mit einem Löschoszillator (26), der angepaßt ist, um an den HF-Oszillator während des Empfangsmodus gekoppelt zu sein, um den HF-Oszillator zwischen einem oszillierenden und einem nichtoszillierenden Zustand zu schalten.
4. Eine Vorrichtung nach Anspruch 1, 2 oder 3 mit einem HF-Verstärker (22), der zwischen dem Eingang und dem Ausgang des HF-Oszillators geschaltet ist.
5. Eine Vorrichtung nach einem der vorhergehenden Ansprüche mit einer Antenne (12), und worin das Steuergerät (14) einen Schalter (42) umfaßt, der angepaßt ist, um die Antenne mit dem Sender oder den Eingangsmitteln zu verbinden.
6. Eine Vorrichtung nach einem der vorhergehenden Ansprüche mit einer kapazitiven Kopplung hoher Impedanz (38) zwischen dem Ausgang des HF-Oszillators und dem Sender.
7. Eine Vorrichtung nach einem der vorhergehenden Ansprüche mit einer kapazitiven Kopplung hoher Impedanz (18) zwischen dem Eingang des HF-Oszillators und den Eingangsmitteln.

Revendications

1. Dispositif émetteur récepteur combiné susceptible d'être commuté entre un mode de réception pour recevoir des signaux RF et un mode d'émission pour émettre des signaux RF, le dispositif comprenant un oscillateur RF combiné (20) qui comprend un circuit de rétroaction (22, 24) comportant un dispositif à onde acoustique de surface (24) couplé entre une entrée et une sortie de l'oscillateur RF et susceptible d'être utilisé pour produire des oscillations RF, des moyens d'entrée (12, 16, 18) susceptibles de coupler un signal RF modulé reçu à l'entrée de l'oscillateur RF en mode de réception, un filtre passe-bas



(34) couplé à la sortie de l'oscillateur et susceptible de filtrer le signal RF modulé reçu, un émetteur (38, 40, 12) susceptible d'être couplé à la sortie de l'oscillateur RF en mode d'émission de manière à transmettre les oscillations RF produites par l'oscillateur RF, et un contrôleur (14) susceptible de commuter le dispositif entre les modes d'émission et de réception.

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2. Dispositif selon la revendication 1, comprenant des moyens de modulation (30) susceptibles de fonctionner en mode d'émission pour coupler un signal de données à l'oscillateur RF de manière à moduler la sortie de l'oscillateur RF.

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3. Dispositif selon la revendication 1 ou 2, comprenant un oscillateur de découpage (26) susceptible d'être couplé à l'oscillateur RF en mode de réception pour commuter l'oscillateur RF entre un état oscillant et un état non oscillant.

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4. Dispositif selon la revendication 1, 2 ou 3, comprenant un amplificateur RF (22) connecté entre l'entrée et la sortie de l'oscillateur RF.

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5. Dispositif selon l'une quelconque des revendications précédentes, comprenant une antenne (12) et dans lequel le contrôleur (14) comprend un commutateur (42) susceptible de connecter l'antenne à l'émetteur ou aux moyens d'entrée.

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6. Dispositif selon l'une quelconque des revendications précédentes, comprenant un couplage capacitif de haute impédance (38) entre la sortie de l'oscillateur RF et l'émetteur.

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7. Dispositif selon l'une quelconque des revendications précédentes, comprenant un couplage capacitif de haute impédance (18) entre l'entrée de l'oscillateur RF et les moyens d'entrée.

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