

TRANSMITTING AND RECEIVING CIRCUIT AND MODULATION CIRCUIT

CLAIM OF PRIORITY

This application claims benefit of the Japanese Patent
5 Application No. 2006-317456 filed on November 24, 2006, which
is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

10 The present invention relates to a transmitting and
receiving circuit including a modulation circuit which
performs phase modulation and reflective transmission of
received radio waves in accordance with transmitted data, and
to a modulation circuit.

15 2. Description of the Related Art

Conventionally, a transmitting and receiving circuit has
been proposed which receives received radio waves with a
transmitting and receiving antenna to detect and introduce
the received radio waves into a demodulation circuit in radio
20 wave reception and to perform phase modulation and reflective
transmission of the received radio waves in radio wave
transmission (see Japanese Unexamined Patent Application
Publication No. 2003-318774, for example).

Fig. 3 is a block diagram illustrating a schematic
25 configuration of a transmitting and receiving circuit
disclosed in the publication. Fig. 4 is a diagram
illustrating a detailed circuit configuration of the
transmitting and receiving circuit illustrated in Fig. 3. In

Figs. 3 and 4, a modulation circuit 100 has a circuit configuration for performing phase modulation and reflective transmission of received radio waves from an antenna 102 in accordance with transmitted data from a control circuit 101
5 input to a transmitted data input terminal Pin. A demodulation circuit 103 detects the received radio waves from the antenna 102, extracts signal waves from the received radio waves, and inputs the extracted signal waves to the control circuit 101 via a signal output terminal Pout. A
10 switching circuit 104 inserted between the modulation circuit 100 and the demodulation circuit 103 performs ON-OFF control of signal conduction between the modulation circuit 100 and the demodulation circuit 103 on the basis of a control signal from the control circuit 101 input via a switching control
15 signal input terminal Pcon.

As illustrated in Fig. 4, the switching circuit 104 includes a FET (Field-Effect Transistor) 1041 as a switching device. In accordance with the control signal from the control circuit 101, the switching circuit 104 performs a
20 switching operation to turn on the switch in the radio wave reception and to turn off the switch in the radio wave transmission. Due to the switching operation by the switching circuit 104, the received radio waves from the antenna 102 are input to the demodulation circuit 103 in the
25 radio wave reception, and the demodulation circuit 103 is cut off from the modulation circuit 100 in the radio wave transmission to prevent the demodulation circuit 103 from adversely affecting the modulation circuit 100.

The control circuit 101 supplies the transmitted data to the gate of a FET 1001 of the modulation circuit 100 via the transmitted data input terminal Pin. In accordance with the transmitted data, the FET 1001 of the modulation circuit 100
5 is turned on or off to modulate the phase of the received radio waves from the antenna 102 and transmit the modulated waves from the antenna 102. In this case, the received radio waves from the antenna 102 are totally reflected both in the OFF state of the FET 1001 (Fig. 5A) and the ON state of the
10 FET 1001 (Fig. 5B). In the configuration of the transmitting and receiving circuit, the phase modulation (BPSK: Binary Phase Shift Keying) is performed such that the phase of a reflected signal in the ON state and the phase of a reflected signal in the OFF state are different from each other by 180
15 degrees due to the phase adjusting action by a stub electrode.

In the above-described conventional transmitting and receiving circuit, however, the switching circuit 104 is inserted between the modulation circuit 100 and the demodulation circuit 103 to perform the switching between the
20 reception and the transmission of a signal. Due to the ON resistance of the FET 1041, therefore, a loss occurs in the signal input to the demodulation circuit 103 in the radio wave reception.

25 SUMMARY OF THE INVENTION

The present invention has been made in view of the above circumstance. The present invention provides a transmitting and receiving circuit and a modulation circuit capable of

preventing a loss of a signal input to a demodulation circuit in radio wave reception, and capable of suppressing a loss of a modulated signal.

According to an aspect of the present invention, a
5 transmitting and receiving circuit includes an input and output terminal, a stripline, a demodulation circuit, a first switching element, and a second switching element. The input and output terminal is connected to an antenna. The stripline has one end connected to the input and output
10 terminal. The demodulation circuit is connected to the other end of the stripline to detect received radio waves and extract signal waves from the received radio waves. The first switching element is provided between the one end of the stripline and the ground. The second switching element
15 is provided between the other end of the stripline and the ground. In the transmitting and receiving circuit, phase modulation is performed through an ON-OFF operation of the first and second switching elements. Further, the switching between the transmission and the reception is performed
20 through an ON-OFF operation of the second switching element.

According to the above configuration, a switching element for switching between the transmission and the reception or a switching element for performing the phase modulation is not present on the path from the antenna to the
25 demodulation circuit. It is therefore possible to prevent the loss of the signal input to the demodulation circuit in the radio wave reception, and to suppress the loss of the modulated signal.

Further, in the transmitting and receiving circuit according to the above aspect of the present invention, in radio wave reception, the received radio waves may be input to the demodulation circuit, with both of the first and
5 second switching elements turned off. Further, in radio wave transmission, reflected waves subjected to the phase modulation may be transmitted, with the one end of the stripline used as a reflecting surface in a state in which the first switching element is turned on, or with the other
10 end of the stripline used as a reflecting surface in a state in which the first switching element is turned off and the second switching element is turned on.

According to the above configuration, at least one of the first and second switching elements is turned off in the
15 phase modulation in the radio wave transmission. It is therefore possible to cut off the demodulation circuit from the modulation circuit.

According to another aspect of the present invention, a modulation circuit includes an input and output terminal, a
20 stripline, a first switching element, and a second switching element. The input and output terminal is connected to an antenna. The stripline has one end connected to the input and output terminal, and the other end connected to an input terminal of a demodulation circuit which detects received
25 radio waves and extracts signal waves from the received radio waves. The first switching element is provided between the one end of the stripline and the ground. The second switching element is provided between the other end of the

stripline and the ground. In the modulation circuit, phase modulation is performed, with a reflecting surface for the received radio waves switched between the one end and the other end of the stripline through an ON-OFF operation of the first and second switching elements. Further, at least one of the first and second switching elements is turned off in the phase modulation to cut off the demodulation circuit.

According to the above aspects of the present invention, it is possible to prevent the loss of the signal input to the demodulation circuit in the radio wave reception, and to suppress the loss of the modulated signal.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram illustrating a schematic configuration of a transmitting and receiving circuit according to an embodiment of the present invention;

Fig. 2 is a circuit configuration diagram of the transmitting and receiving circuit according to the embodiment of the present invention;

Fig. 3 is a block diagram illustrating a schematic configuration of a conventional transmitting and receiving circuit;

Fig. 4 is a detailed circuit configuration diagram of the modulation circuit, the demodulation circuit, and the switching circuit illustrated in Fig. 3; and

Figs. 5A and 5B are explanatory diagrams of operations of the modulation circuit of Fig. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of the present invention will be described in detail below with reference to the accompanying drawings.

Fig. 1 is a block diagram illustrating a schematic

5 configuration of a transmitting and receiving circuit 1 according to an embodiment of the present invention. As illustrated in the drawing, the transmitting and receiving circuit 1 according to the present embodiment includes, as main constituent components thereof, a transmitting and
10 receiving antenna 10, an input and output terminal 1a connected to the antenna 10, a modulation circuit 11 for performing phase modulation, a demodulation circuit 12 for demodulating a signal input thereto via the modulation circuit 11 in radio wave reception, and a control circuit 13
15 for switching transmission and reception timing and controlling the phase modulation by the modulation circuit 11.

The antenna 10 receives radio waves transmitted from a communication device with which the transmitting and receiving circuit 1 communicates, and transmits reflected
20 radio waves subjected to the phase modulation by the modulation circuit 11. In the radio wave reception, the modulation circuit 11 inputs the received radio waves from the antenna 10 directly to the demodulation circuit 12. In the radio wave transmission, the modulation circuit 11
25 performs the phase modulation and the transmission (reflective transmission) of the received radio waves from the antenna 10 in accordance with transmitted data from the control circuit 13. The demodulation circuit 12 detects the

received radio waves from the antenna 10, and extracts signal waves from the received radio waves. The control circuit 13 receives the signal waves from the demodulation circuit 12 in the radio wave reception, and inputs modulation data to the modulation circuit 11 in the radio wave transmission. The control circuit 13 receives a signal from the demodulation circuit 12 via a signal output terminal Pout.

Fig. 2 is a detailed circuit configuration diagram of the modulation circuit 11 and the demodulation circuit 12.

10 The modulation circuit 11 includes two diodes, i.e., a first diode 111 (a first switching element) and a second diode 112 (a second switching element), and a stripline 113 of a length equal to a quarter wavelength of the received radio waves. One end of the stripline 113 is connected to the input and output terminal 1a connected to the antenna 10, while the other end of the stripline 113 is connected to an input terminal of the demodulation circuit 12. Further, in the present configuration, the first diode 111 is connected between the one end of the stripline 113 and the ground, and

20 the second diode 112 is connected between the other end of the stripline 113 and the ground. In the connection of the first and second diodes 111 and 112, the cathodes of the diodes are on the ground side. A connected portion of the first diode 111 and the one end of the stripline 113 is

25 connected to a transmitted data input terminal Pin, while a connected portion of the second diode 112 and the other end of the stripline 113 is connected to a switching control signal input terminal Pcon.

The transmitted data is not input to the modulation circuit 11 except in the radio wave transmission, and thus the first and second diodes 111 and 112 are both in an OFF state. In the radio wave reception, therefore, the received
5 radio waves from the antenna 10 are input to the demodulation circuit 12 through the stripline 113. In this case, a switching element is not interposed between the antenna 10 and the demodulation circuit 12. Thus, the received radio waves are input to the demodulation circuit 12 without being
10 attenuated. In the radio wave transmission, the transmitted data is input to the transmitted data input terminal Pin, and the ON-OFF control of the first and second diodes 111 and 112 is performed on the basis of the value ("1" or "0") of the signal of the data.

15 In the radio wave transmission (modulated transmission), one of the first and second diodes 111 and 112 is always in the ON state. When the first diode 111 is turned on, the received radio waves are totally reflected at the one end (the side near the first diode 111) of the stripline 113.
20 When the first diode 111 is turned off and the second diode 112 is turned on, the received radio waves are totally reflected at the other end (the side near the second diode 112) of the stripline 113. In this case, the received radio waves totally reflected at the second diode 112 travel back
25 and forth in the stripline 113 having the length of the quarter wavelength. Thus, there arises a phase difference of a half wavelength from the received radio waves totally reflected at the one end (the side near the first diode 111)

of the stripline 113. In the above-described manner, the received radio waves from the antenna 10 are totally reflected both in the ON state of the first diode 111 and the ON state of the second diode 112. Further, the phase modulation (BPSK) is performed such that the phase of a reflected signal in the ON state of the first diode 111 and the phase of a reflected signal in the ON state of the second diode 112 are different from each other by 180 degrees.

Further, in the radio wave transmission, one of the first and second diodes 111 and 112 is always in the ON state, and thus the demodulation circuit 12 is cut off from the modulation circuit 11. With the modulation circuit 11 and the demodulation circuit 12 thus cut off from each other in the radio wave transmission, there is no need for a special switching circuit for cutting off the modulation circuit 11 and the demodulation circuit 12 from each other. Accordingly, the transmitting and receiving circuit 1 can be configured with a smaller number of components. As a result, a reduction in cost is achieved.

The demodulation circuit 12 includes a diode 121, a capacitor 122, and a resistor 123. The demodulation circuit 12 is configured such that the anode of the diode 121 is connected to the other end of the stripline 113 of the modulation circuit 11 via an output terminal (illustration omitted), of the modulation circuit 11, that the cathode of the diode 121 is connected to the signal output terminal Pout, and that the capacitor 122 and the resistor 123 are connected in parallel between the cathode of the diode 121 and the

ground. Using the diode 121, the demodulation circuit 12 detects the received radio waves from the antenna 10 passing through the modulation circuit 11 in the radio wave reception.

As described above, according to the transmitting and
5 receiving circuit 1 of the present embodiment, if the first and second diodes 111 and 112 are both brought into the OFF state, the received radio waves from the antenna 10 can be directly input to the demodulation circuit 12 via the stripline 113. An element causing a signal loss is not
10 present on the line through which the received radio waves are input from the antenna 10 to the demodulation circuit 12 via the stripline 113. Therefore, the received radio waves can be input to the demodulation circuit 12 without being attenuated. Accordingly, the signal loss occurring in the
15 conventional modulation circuit 100 (see Fig. 3) in the radio wave reception can be solved.

Further, with the first diode 111 brought into the ON state, the received radio waves can be totally reflected at the one end of the stripline 113, i.e., the side of the
20 stripline 113 near the first diode 111. Similarly, with only the second diode 112 brought into the ON state, the received radio waves can be totally reflected at the other end of the stripline 113, i.e., the side of the stripline 113 near the second diode 112. Further, if the received radio waves are
25 totally reflected at the other end of the stripline 113, the received radio waves travel back and forth in the stripline 113 having the length equal to the quarter wavelength of the received radio waves. Thus, the received radio waves have a

phase difference of 180 degrees from the received radio waves totally reflected at the one end of the stripline 113.

Therefore, through the ON-OFF operation of the first and second diodes 111 and 112 in accordance with the transmitted
5 data, the phase modulation and the reflective transmission of the received radio waves can be performed.

Furthermore, due to the phase modulation, one of the first and second diodes 111 and 112 is always in the ON state. Thus, the modulation circuit 11 can be cut off from the
10 demodulation circuit 12 in the radio wave transmission. It is therefore possible to provide the modulation circuit 11 with a switching function for cutting off the demodulation circuit 12 from the modulation circuit 11. Accordingly, the components of the transmitting and receiving circuit 1 can be
15 reduced in number. As a result, a reduction in the cost of the transmitting and receiving circuit 1 is achieved.

In the present embodiment, the diodes are used as the first and second switching elements. However, the switching elements are not limited the diodes, and thus can be
20 configured by transistors (bipolar or unipolar transistors), for example.

The present invention can be applied to a transmitting and receiving circuit which performs phase modulation and reflective transmission of received radio waves in accordance
25 with transmitted data.

WHAT IS CLAIMED IS:

1. A transmitting and receiving circuit comprising:
 - an input and output terminal connected to an antenna;
 - 5 a stripline having one end connected to the input and output terminal;
 - a demodulation circuit connected to the other end of the stripline to detect received radio waves and extract signal waves from the received radio waves;
 - 10 a first switching element provided between the one end of the stripline and the ground; and
 - a second switching element provided between the other end of the stripline and the ground,
 - wherein phase modulation is performed through an ON-OFF
 - 15 operation of the first and second switching elements, and
 - wherein the switching between the transmission and the reception is performed through an ON-OFF operation of the second switching element.
- 20 2. The transmitting and receiving circuit according to Claim 1,
 - wherein, in radio wave reception, the received radio waves are input to the demodulation circuit, with both of the first and second switching elements turned off, and
 - 25 wherein, in radio wave transmission, reflected waves subjected to the phase modulation are transmitted, with the one end of the stripline used as a reflecting surface in a state in which the first switching element is turned on, or

with the other end of the stripline used as a reflecting surface in a state in which the first switching element is turned off and the second switching element is turned on.

5 3. A modulation circuit comprising:

an input and output terminal connected to an antenna;

a stripline having one end connected to the input and output terminal, and the other end connected to an input terminal of a demodulation circuit which detects received

10 radio waves and extracts signal waves from the received radio waves;

a first switching element provided between the one end of the stripline and the ground; and

a second switching element provided between the other
15 end of the stripline and the ground,

wherein phase modulation is performed, with a reflecting surface for the received radio waves switched between the one end and the other end of the stripline through an ON-OFF operation of the first and second switching elements, and

20 wherein at least one of the first and second switching elements is turned off in the phase modulation to cut off the demodulation circuit.