CLAIMS

1. A matching circuit comprising:

a mismatch detection unit that is electrically connected to a transmitting circuit which is configured to generate a transmission signal and an antenna which is configured to wirelessly transmit the transmission signal;

a computation section that is electrically connected to the mismatch detection unit; and

a matching section that is electrically connected to the computation section and the transmitting circuit,

wherein the mismatch detection unit includes a first directional coupling section that is configured to generates a corresponding transmission signal which is a signal corresponding to the transmission signal from the transmitting circuit, a second directional coupling section that is configured to generate a corresponding reflection signal which is a signal corresponding to a reflection signal as an electrical signal to be reflected from the antenna to the transmitting circuit in response to the transmission signal, and a mismatch detection section that is configured to detect an amplitude ratio and a phase difference between the transmission signal and the reflection signal based on the corresponding transmission signal and the corresponding reflection signal,

the computation section is configured to transmit a matching section control signal to the matching section based on the amplitude ratio and the phase difference between the transmission signal and the reflection signal detected by the mismatch detection unit, and

the matching section is configured to perform, when the amplitude value of the reflection signal is equal to or less than a predetermined threshold, a matching process which is to change a signal value of the reflection signal by changing an impedance based on the matching section control signal, and to

judge, when the amplitude value of the reflection signal is larger than a predetermined threshold, a sub-reflection signal is detected and not to perform the matching process, the sub-reflection signal is a signal of which the an object around the antenna reflects the transmission signal.

2. The matching circuit according to claim 1, wherein

the computation section is configured to generate the matching section control signal based on a reflection coefficient which is calculated based on the amplitude ratio and the phase difference between the transmission signal and the reflection signal and represents a ratio between signal values of the transmission signal and the reflection signal.

3. The matching circuit according to claim 1 or 2, wherein

the matching section includes a variable inductance section capable of changing an inductance and a variable capacitance section capable of changing a capacitance, and changes the impedance by changing the inductance of the variable inductance section and the capacitance of the variable capacitance section.

4. The matching circuit according to claim 3, wherein

the variable inductance section is electrically connected between the transmitting circuit and the antenna,

the variable capacitance section is provided in plural including a first variable capacitance section and a second variable capacitance section,

the first variable capacitance section has one connection portion that is electrically connected between the variable inductance section and the transmission circuit and another connection portion that is grounded, and

the second variable capacitance section has one connection portion that is electrically connected between the

variable inductance section and the antenna and another connection portion that is grounded.

5. The matching circuit according to claim 3 or 4, wherein

the variable capacitance section successively changes the capacitance depending on a voltage to be applied thereto.

6. The matching circuit according to claim 3 or 4, wherein

the matching section includes a plurality of the first variable capacitance sections connected in parallel, a plurality of the second variable capacitance sections connected in parallel, and a capacitance switch section that is configured to switch each connection among the plurality of first variable capacitance sections and the plurality of second variable capacitance sections, and

the computation section controls the capacitance switch section to cause the plurality of first variable capacitance sections and the plurality of second variable capacitance sections to be grounded and change a total capacitance of the plurality of first variable capacitance sections and the plurality of second variable capacitance sections.

7. The matching circuit according to any one of claims 3 to 6, wherein

the matching section includes a plurality of the variable inductance sections and an inductance switch section that is configured to switch each connection between the plurality of variable inductance sections and the transmitting circuit, and the antenna, and causes the inductance switch section to switch the connection to change a total inductance of the plurality of variable inductance sections.

8. The matching circuit according to any one of claims 1 to 7, wherein

the mismatch detection unit includes:

a local oscillator that is configured to transmit a local oscillation signal having a predetermined frequency;

a first mixing section that is electrically connected to the first directional coupling section and the local oscillator and is configured to generate a mixed transmission signal by mixing signal values of the local oscillation signal and the corresponding transmission signal;

a second mixing section that is electrically connected to the second directional coupling section and the local oscillator and is configured to generate a mixed reflection signal by mixing signal values of the local oscillation signal and the corresponding reflection signal; and

an amplitude and phase detection section that is configured to detect the amplitude ratio and the phase difference between the transmission signal and the reflection signal by comparing the mixed transmission signal and the mixed reflection signal.

9. The matching circuit according to any one of claims 1 to 7, wherein

the mismatch detection unit includes:

a first mixing section that is electrically connected to the first directional coupling section and the second directional coupling section and is configured to generate a forward mixed signal by mixing signal values of the corresponding transmission signal and the corresponding reflection signal;

an amplitude detection section that is configured to detect amplitude of the corresponding transmission signal and amplitude of the corresponding reflection signal;

a second mixing section that is electrically connected to the first directional coupling section and the second directional coupling section and is configured to generate a

phase-shifted mixed signal by shifting any one phase of the corresponding transmission signal and the corresponding reflection signal and mixing the corresponding transmission signal and the corresponding reflection signal; and

an amplitude and phase detection section that is configured to detect an amplitude ratio between the transmission signal and the reflection signal based on the amplitude of the corresponding transmission signal and the amplitude of the corresponding reflection signal and is configured to detect phase difference between the transmission signal and the reflection signal by comparing the forward mixed signal and the phase-shifted mixed signal.

10. The matching circuit according to any one of claims 1 to 9, wherein

when amplitude of the reflection signal is equal to or larger than a predetermined threshold, the changing of the impedance performed by the matching section is stopped.

11. The matching circuit according to any one of claims 1 to 10, wherein

the matching circuit is electrically connected to a receiving circuit to which a reception signal received by the antenna is input and the reflection signal from the antenna is reflected.

12. The matching circuit according to any one of claims 1 to 11, wherein

the matching section is provided between the transmitting circuit and the antenna, and

the mismatch detection unit is provided between the matching section and the antenna and is connected to the transmitting circuit via the matching section.

13. The matching circuit according to any one of claims 1 to 11, wherein

the matching section is provided between the transmitting circuit and the antenna, and

the mismatch detection unit is provided between the transmitting circuit and the matching section and is connected to the antenna via the matching section.

14. The matching circuit according to any one of claims 1 to 11, wherein

the matching section is provided between the transmitting circuit and the antenna,

the mismatch detection unit is provided in plural including a first mismatch detection unit and a second mismatch detection unit,

the first mismatch detection unit is provided between the matching section and the antenna and is connected to the transmitting circuit via the matching section, and

the second mismatch detection unit is provided between the transmitting circuit and the matching section and is connected to the antenna via the matching section.

15. A wireless communication apparatus comprising:

the matching circuit according to any one of claims 1 to 14;

a transmitting circuit that is electrically connected to the matching circuit and generates the transmission signal; and

an antenna that is electrically connected to the matching circuit and wirelessly transmits the transmission signal.

16. The matching circuit according to any one of claims 1 to 14, wherein

the matching section is configured to perform the

matching process when the amplitude value of the reflection signal is larger than the predetermined threshold and the amplitude value of the reflection signal is constant for a predetermined time.