CLAIMS

1. A duplexer comprising:

a transmit filter that is connected between an antenna terminal and a transmit terminal and has a plurality of acoustic wave resonators;

a receive filter that is connected between the antenna terminal and a receive terminal and has a plurality of acoustic wave resonators; and

a cancel circuit that is connected in parallel with at least one of the plurality of acoustic wave resonators of the transmit filter and the plurality of acoustic wave resonators of the receive filter,

wherein the cancel circuit includes an acoustic wave resonator, and further includes a first acoustic wave resonator or a first electrostatic capacitor on at least one of an input side and an output side of said acoustic wave resonator in the cancel circuit, said first acoustic wave resonator or first electrostatic capacitor being connected in series with the said acoustic wave resonator in the cancel circuit,

wherein at least a part of a transmit signal leaking to the receive terminal or a receive signal leaking to the transmit terminal is cancelled by a signal passing through the cancel circuit,

wherein one of the transmit filter and the receive filter having a pass band frequency lower than that of the other is a ladder type filter, and

wherein an anti-resonance frequency of the first acoustic wave resonator is in a pass band of one of the transmit filter and the receive filter having a pass band frequency higher than that of the other.

2. The duplexer as claimed in claim 1, wherein the cancel circuit further comprises a second acoustic wave resonator or a second electrostatic capacitor on at least one of the input side and the output side of the acoustic wave resonator, said second acoustic wave resonator or second electrostatic capacitor being connected in parallel with the acoustic wave resonator in the cancel circuit.

3. The duplexer as claimed in claim 1, wherein the cancel circuit is connected between the transmit terminal and the receive terminal in parallel with the transmit filter and the receive filter.

4. The duplexer as claimed in claim 1, wherein the cancel circuit is connected between the transmit terminal and the antenna terminal in parallel with the transmit filter.

5. The duplexer as claimed in claim 1, wherein the cancel circuit is connected between the receive terminal and the antenna terminal in parallel with the receive filter.

6. The duplexer as claimed in claim 1, wherein a plurality of cancel circuits are provided.

7. The duplexer as claimed in claim 1, wherein the first electrostatic capacitors connected in series are structured by an IDT without a reflector.

8. The duplexer as claimed in claim 2, wherein the second electrostatic capacitor is connected in parallel with the acoustic wave resonator in the cancel circuit and is structured by an IDT (Interdigital Transducer) without a reflector.

9. The duplexer as claimed in claim 2, wherein at least one of the acoustic wave resonator in the cancel circuit, the first acoustic wave resonators or the first electrostatic capacitors connected in series, and the second acoustic wave resonator or the second electrostatic capacitor connected in parallel is provided on a transmit filter chip or on a receive filter chip.

10. The duplexer as claimed in claim 1, wherein:

the first acoustic wave resonator or the first electrostatic capacitor that is provided on the side of the transmit terminal is provided on a transmit filter chip;

the first acoustic wave resonators or the first electrostatic capacitor that is provided on the side of the receive terminal is provided on a receive filter chip; and

the acoustic wave resonator in the cancel circuit with which the first acoustic wave resonators or the first electrostatic capacitors are connected in series on the input and output sides thereof, respectively, is provided on the transmit filter chip or the receive filter chip.

11. The duplexer as claimed in claim 1, wherein: the transmit filter and the receive filter are each a filter including a series resonator; and

a relation "$\lambda_{IDT} > 1.138 \text{ X } \lambda_{cap}$" is obtained when a pitch of electrode fingers of a series resonator having the largest pitch of electrode fingers in the series resonators connected in parallel with the cancel circuit included in one of the transmit filter and the receive filter having a pass band frequency higher than that of the other is "λ_{IDT}", and a pitch of electrode fingers of the first acoustic wave resonator in series is "λ_{cap}".

12. A filter comprising:

a plurality of acoustic wave resonators connected between an input terminal and an output terminal; and

a cancel circuit that is connected in parallel with at least one of the plurality of acoustic wave resonators via two nodes, said two nodes being respectively provided on an input side and an output side of the at least one of the plurality of acoustic wave resonators,

wherein the cancel circuit includes an acoustic wave resonator, and further includes a first acoustic wave resonator or a first electrostatic capacitor that is provided on at least one of an input side and an output side of said acoustic wave resonator in the cancel circuit, said first acoustic wave resonator or first electrostatic capacitor being connected in series with the acoustic wave resonator in the cancel circuit,

wherein the plurality of acoustic wave resonators connected between the input terminal and the output terminal structure a ladder type filter, and

wherein an anti-resonance frequency of the first acoustic wave resonator is in a suppressed band on a higher frequency side of the ladder type filter.

13. A filter comprising:

a plurality of acoustic wave resonators connected between an input terminal and an output terminal; and

a cancel circuit that is connected in parallel with at least one of the plurality of acoustic wave resonators via two nodes, said two nodes being respectively provided on an input side and an output side of the at least one of the plurality of acoustic wave resonators,

wherein the cancel circuit includes an acoustic wave resonator, and further includes a first acoustic wave resonator or a first electrostatic capacitor that is provided on at least one of an input side and an output side of said acoustic wave resonator in the cancel circuit, said first acoustic wave resonator or first electrostatic capacitor being connected in series with the acoustic wave resonator in the cancel circuit,

wherein the cancel circuit further includes a second acoustic wave resonator or a second electrostatic capacitor on at least one of the input side and the output side of the acoustic wave resonator in the cancel circuit, the second acoustic wave resonator or second electrostatic capacitor being connected in parallel with the acoustic wave resonator in the cancel circuit.

14. A communication module comprising:

the duplexer as claimed in claim 1.

15. A duplexer comprising:

a transmit filter that is connected between an antenna terminal and a transmit terminal and has a plurality of acoustic wave resonators;

a receive filter that is connected between the antenna terminal and a receive terminal and has a plurality of acoustic wave resonators; and

a cancel circuit that is connected in parallel with at least one of the plurality of acoustic wave resonators of the transmit filter and the plurality of acoustic wave resonators of the receive filter,

wherein the cancel circuit includes an acoustic wave resonator, and further includes a first acoustic wave resonator or a first electrostatic capacitor on at least one of an input side and an output side of said acoustic wave resonator in the cancel circuit, said first acoustic wave resonator or first electrostatic capacitor being connected in series with the said acoustic wave resonator in the cancel circuit,

wherein the cancel circuit further comprises a second acoustic wave resonator or a second electrostatic capacitor on at least one of the input side and output side of the acoustic wave resonator, said second acoustic wave resonator or second electrostatic capacitor being connected in parallel with the acoustic wave resonator in the cancel circuit,

wherein at least a part of a transmit signal leaking to the receive terminal or a receive signal leaking to the transmit terminal is cancelled by a signal passing through the cancel circuit,

wherein one of the transmit filter and the receive filter having a pass band frequency higher than that of the other is ladder type filter; and

wherein a resonance frequency of the second acoustic wave resonator is in a pass band of one of the transmit filter and the receive filter having a pass band frequency lower than that of the other.

16. The filter as claimed in claim 13 wherein:

the plurality of acoustic wave resonators connected between the input terminal and the output terminal structure a ladder type filter; and

a resonance frequency of the second acoustic wave resonator is in a suppressed band on a lower frequency side of the ladder type filter.

17. The duplexer as claimed in claim 1, wherein the acoustic wave resonator in the cancel circuit is a longitudinal coupling type resonator.

18. The duplexer as claimed in claim 1, wherein the cancel circuit is connected in parallel with at least one of the plurality of acoustic wave resonators of the transmit filter and the plurality of acoustic wave resonators of the receive filter via two nodes, said two nodes being respectively provided on an input side and an output side of the at least one of the plurality of acoustic wave resonators of the transmit filter and the plurality of acoustic wave resonators of the receive filter.

19. The filter as claimed in claim 12, wherein the acoustic wave resonator in the cancel circuit is a longitudinal coupling type resonator.

CLAIMS

What is claimed is:

1. A duplexer comprising:

a transmit filter that is connected between an antenna terminal and a transmit terminal and has a plurality of acoustic wave resonators;

a receive filter that is connected between the antenna terminal and a receive terminal and has a plurality of acoustic wave resonators; and

a delay line or a longitudinal coupling type resonator that is connected in parallel with at least one of the plurality of acoustic wave resonators of the transmit filter and the plurality of acoustic wave resonators of the receive filter and has at least two IDTs (Interdigital Transducers).

2. The duplexer as claimed in claim 1 further comprising a first acoustic wave resonator that is provided at least one of on an input side and on an output side of the delay line or the longitudinal coupling type resonator and is connected in series with the delay line or the longitudinal coupling type acoustic wave resonator,

wherein:

one of the transmit filter and the receive filter having a pass band frequency lower than that of the other is a ladder type filter; and

an anti-resonance frequency of the first acoustic wave resonator is in a pass band of one of the transmit filter and the receive filter having a pass band frequency higher than that of the other.

3. The duplexer as claimed in claim 1or 2 further comprising a second acoustic wave

resonator that is provided at least one of on an input side and on an output side of the delay line or the longitudinal coupling type resonator and is connected in parallel with the delay line or the longitudinal coupling type acoustic wave resonator,

wherein:

one of the transmit filter and the receive filter having a pass band frequency higher than that of the other is a ladder type filter; and

a resonance frequency of the second acoustic wave resonator is in a pass band of one of the transmit filter and the receive filter having a pass band frequency lower than that of the other.

4. The duplexer as claimed in any of claims 1 to 3 further comprising an acoustic wave resonator or an electrostatic capacitor that is provided at least one of on an input side and on an output side of the delay line or the longitudinal coupling type resonator and is connected in series with the delay line or the longitudinal coupling type resonator.

5. The duplexer as claimed in claim 4 wherein the acoustic wave resonator or the electrostatic capacitor is provided both of on the input side and on the output side of the delay line or the longitudinal coupling type resonator and is connected in series with the delay line or the longitudinal coupling type resonator.

6. The duplexer as claimed in claim 4 or 5 further comprising an acoustic wave resonator or an electrostatic capacitor connected in parallel with the delay line or the longitudinal coupling type resonator between a node between the delay line or the longitudinal coupling type resonator and the acoustic wave resonator or the electrostatic capacitor connected in series and a ground.

7. The duplexer as claimed in any of claims 1 to 6, wherein the longitudinal coupling type resonator has three IDTs.

8. The duplexer as claimed in any of claims 1 to 7, wherein the delay line or the longitudinal coupling type resonator is connected between the transmit terminal and the receive terminal in parallel with the transmit filter and the receive filter.

9. The duplexer as claimed in any of claims 1 to 7, wherein the delay line or the longitudinal coupling type resonator is connected between the transmit terminal and the antenna terminal in parallel with the transmit filter.

10. The duplexer as claimed in any of claims 1 to 7, wherein the delay line or the longitudinal coupling type resonator is connected between the receive terminal and the antenna terminal in parallel with the receive filter.

11. The duplexer as claimed in any of claims 1 to 10, wherein a plurality of the delay lines or the longitudinal coupling type resonators are provided.

12. The duplexer as claimed in claim 4 or 5, wherein the electrostatic capacitor connected in series is structured by an IDT without a reflector.

13. The duplexer as claimed in claim 6, wherein the electrostatic capacitor connected

in parallel is structured by an IDT without a reflector.

14. The duplexer as claimed in claim 6, wherein at least one of or all of either the delay line or the longitudinal coupling type resonator, either the acoustic wave resonator or the electrostatic capacitor connected in series, and either the acoustic wave resonator or the electrostatic capacitor connected in parallel is provided on a transmit filter chip and a receive filter chip.

15. The duplexer as claimed in claim 5, wherein:

an acoustic wave resonator or an electrostatic capacitor of the acoustic wave resonators or the electrostatic capacitors connected in series provided on the side of the transmit terminal is provided on a transmit filter chip;

an acoustic wave resonator or an electrostatic capacitor of the acoustic wave resonators or the electrostatic capacitors connected in series provided on the side of the receive terminal is provided on a receive filter chip; and

the delay line or the longitudinal coupling type resonator is provided on the transmit filter chip or the receive filter chip.

16. The duplexer as claimed in claim 4 or 5, wherein:

the transmit filter and the receive filter are a filter including a series resonator; and

a relation "$\lambda_{IDT} > 1.138 \text{ X } \lambda_{cap}$" is obtained when a pitch of electrode fingers of a series resonator having the largest pitch of electrode fingers in the series resonators connected in parallel with the delay line or the longitudinal coupling type resonator included in one of the

transmit filter and the receive filter having a pass band frequency higher than that of the other is "λ_{IDT}", and a pitch of electrode fingers of the acoustic wave resonator connected in series is "λ_{cap}".

17. A filter comprising:

a plurality of acoustic wave resonators connected between an input terminal and an output terminal; and

a delay line or a longitudinal coupling type resonator that is connected in parallel with at least one of the plurality of acoustic wave resonators and has at least two IDTs (Interdigital Transducers).

18. The filter as claimed in claim 17 further comprising a first acoustic wave resonator that is provided at least one of on an input side and on an output side of the delay line or the longitudinal coupling type resonator and is connected in series with the delay line or the longitudinal coupling type resonator,

wherein:

the plurality of acoustic wave resonators connected between the input terminal and the output terminal structure a ladder type filter; and

an anti-resonance frequency of the first acoustic wave resonator is in a suppressed band on a higher frequency side of the ladder type filter.

19. The filter as claimed in claim 17 further comprising a second acoustic wave resonator that is provided at least one of on an input side and on an output side of the delay line or the longitudinal coupling type resonator and is connected in parallel with the delay line or the

longitudinal coupling type resonator,

wherein:

the plurality of acoustic wave resonators connected between the input terminal and the output terminal structure a ladder type filter; and

a resonance frequency of the second acoustic wave resonator is in a suppressed band on a lower frequency side of the ladder type filter.

20. The filter as claimed in any of claims 17 to 19 further comprising an acoustic wave resonator or an electrostatic capacitor that is provided at least one of on an input side and on an output side of the delay line or the longitudinal coupling type resonator and is connected in series with the delay line or the longitudinal coupling type resonator.

21. The filter as claimed in claim 20 further comprising an acoustic wave resonator or an electrostatic capacitor connected in parallel with the delay line or the longitudinal coupling type resonator between a node between the delay line or the longitudinal coupling type resonator and the acoustic wave resonator or the electrostatic capacitor connected in series and a ground.

22. A communication module comprising:

the duplexer as claimed in any of claims 1 to 16 or the filter as claimed in any of claims 17 to 21.