INTERFERENCE CANCELLATION APPARATUS AND METHOD

TECHNICAL FIELD

Embodiments of the present invention relate to the field of communications technologies, and in particular, to an interference cancellation apparatus and method.

BACKGROUND

In a wireless communications system such as a mobile cellular communications system, a wireless local area network (WLAN, Wireless Local Area Network), or a fixed wireless access (FWA, Fixed Wireless Access) system, communications nodes such as a base station (BS, Base Station) or an access point (AP, Access Point), a relay station (RS, Relay Station), and user equipment (UE, User Equipment) are generally capable of transmitting their own signals and receiving signals from other communications nodes. Because a radio signal is attenuated greatly in a radio channel, in comparison with a transmit signal of a local end, a signal coming from a communications peer becomes very weak when the signal arrives at a receive end. For example, a difference between transmit power and receive power of a communications node in the mobile cellular communications system may be up to 80 dB to 140 dB or even greater. Therefore, to avoid self-interference caused by a transmit signal of a transceiver to a receive signal of the transceiver, radio signal transmission and reception are generally differentiated by using different frequency bands or different time periods. For example, in a Frequency Division Duplex (FDD, Frequency Division Duplex) system, for transmission and reception, communication is performed by using different frequency bands separated by a certain guard band; in a Time Division Duplex (TDD, Time Division Duplex) system, for transmission and reception, communication is performed by using different time periods separated by a certain guard time interval, where the guard band in the ~~FDD~~ TDD system and the guard time interval in the FDD system are both used to ensure that reception and transmission are

fully isolated and to avoid interference caused by transmission to reception.

Different from the conventional FDD or TDD technology, a wireless full duplex technology may implement operations of reception and transmission simultaneously on a same radio channel. In this way, spectral efficiency of the wireless full duplex technology is twice that of the FDD or TDD technology. Apparently, a precondition for implementing wireless full duplex lies in that strong interference (referred to as self-interference, Self-interference) caused by a transmit signal of a transceiver to a receive signal of the transceiver is avoided, reduced, or canceled as much as possible, so that no adverse impact is caused to proper reception of a wanted signal.

In a full duplex system, self-interference entering a receiver mainly includes two types of self-interference components.

A first-type self-interference component is a main-path self-interference component, and its power is relatively high. The main-path self-interference component mainly includes a self-interference signal that is leaked from a transmit end to a receive end due to leakage of a circulator, and a self-interference signal that enters the receive end due to antenna echo reflection. Conventional passive radio frequency self-interference cancellation is mainly used to cancel the first-type self-interference component. A path delay, power, and phase of this type of component depend on hardware itself such as an intermediate radio frequency unit and an antenna and a feeder of a specific transceiver. The path delay, power, and phase are basically fixed or change slowly, and it is unnecessary to perform fast tracing on each interference path of the first-type self-interference component.

A second-type self-interference component is mainly a self-interference component that is formed after a transmit signal is transmitted by a transmit antenna and encounters multi-path reflection at a scatterer or a reflection plane or the like in a spatial propagation process. When the full duplex technology is applied to scenarios such as a base station and a relay station in a cellular system, and a WiFi access point (AP) disposed outdoors, because antennas of the devices are generally mounted relatively high, and there are few scatterers or reflection planes within a range of several meters to tens of meters around the devices, multi-path delays of multi-path reflected self-interference components that undergo spatial propagation, in the signals received by the devices, are relatively great and widely distributed, and with an

increase in delays, power of corresponding multi-path signals (signals reflected from scatterers or reflection planes or the like that are far away) tends to decrease.

In the prior art, generally, an apparatus having a structure shown in FIG. 1 is used to cancel the second-type self-interference component in a manner of active analog self-interference cancellation or digital baseband self-interference cancellation. Specifically, a baseband digital self-interference signal reconstructed in a digital domain is reconverted to an analog domain by using a digital to analog converter (Digital to Analog Converter, DAC), and then undergoes analog baseband processing (not shown in the figure) in the analog domain or is up-converted to an intermediate radio frequency, and is used to cancel a self-interference signal included in an analog receive signal; digital baseband self-interference cancellation in the digital domain is to use a reconstructed baseband digital self-interference signal to directly cancel a self-interference signal included in a digital receive signal in the ~~baseband~~ digital domain. However, self-interference cancellation performance of the apparatus is finally limited by a dynamic range of an ADC (Analog-to-Digital Converter, analog to digital converter)/DAC (Digital-to-Analog Converter, digital to analog converter). Generally, the dynamic range of the ADC/DAC is about 60 dB. Therefore, when power of the second-type self-interference component is 60 dB higher than that of a wanted signal, the second-type self-interference component cannot be effectively canceled in the conventional method.

SUMMARY

Embodiments of the present invention provide an interference cancellation apparatus and method, which can avoid being limited by a dynamic range of an ADC/DAC and can cancel a second-type self-interference component effectively.

According to a first aspect, an interference cancellation apparatus is provided, including:

a main receive antenna (110), configured to receive a radio frequency receive signal, and transmit the radio frequency receive signal to a first-type interference canceller (130);

a divider (120), configured to acquire a radio frequency reference signal generated according to a transmit signal, and transmit the radio frequency reference signal to the first-type interference canceller (130) and a second-type interference

reconstructor (150);

the first-type interference canceller (130), configured to receive the radio frequency reference signal transmitted by the divider (120) and the radio frequency receive signal transmitted by the main receive antenna (110), and cancel a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal to acquire a first processed signal, where the first-type self-interference component includes a main-path self-interference component;

the second-type interference reconstructor (150), configured to acquire the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal transmitted by the divider (120);

a coupler (140), configured to receive the first processed signal and the reconstructed self-interference signal transmitted by the second-type interference reconstructor (150), and cancel a second-type self-interference ~~signal~~ component in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal;

a down converter (160), configured to perform down-conversion processing on the second processed signal to generate a third processed signal; and

an analog to digital converter ADC (170), configured to perform analog to digital conversion on the third processed signal to generate a digital signal; where

the second-type interference reconstructor (150) is further configured to acquire a digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC (170) and the radio frequency reference signal transmitted by the divider (120), and perform self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

With reference to the first aspect, in a first possible implementation manner, the second-type interference reconstructor (150) includes:

a self-interference estimation module (1501), configured to acquire the digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC (170), and perform self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter; and

a self-interference signal reconstruction module (1502), configured to

receive the radio frequency reference signal transmitted by the divider (120) and the self-interference channel parameter acquired by the self-interference estimation module (1501), and acquire the reconstructed self-interference signal according to the self-interference channel parameter and the radio frequency reference signal.

With reference to the first aspect, in a second possible implementation manner, the apparatus further includes a first amplifier, where the first amplifier is configured to amplify the second processed signal.

With reference to the first aspect, in a third possible implementation manner, the apparatus further includes a second amplifier and a third amplifier, where:

the second amplifier is configured to amplify the first processed signal; and

the third amplifier is configured to amplify the radio frequency reference signal received by the second-type interference reconstructor.

With reference to the first possible implementation manner of the first aspect, in a fourth possible implementation manner, the self-interference signal reconstruction module (1502) includes:

a first delayer group, a first amplitude and phase adjuster group, and a first combiner, where:

the first delayer group includes at least one delayer, where the at least one delayer is connected in series, and the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the at least one delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

the first amplitude and phase adjuster group includes at least one amplitude and phase adjuster, where each amplitude and phase adjuster is configured to perform amplitude and phase adjustment on a delay signal of one radio frequency reference signal according to the self-interference channel parameter; and

the first combiner is configured to perform combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

With reference to the fourth possible implementation manner of the first aspect, in a fifth possible implementation manner, the self-interference signal reconstruction module (1502) further includes:

a first radio frequency selection switch, configured to receive the delay signal of the at least one radio frequency reference signal, select, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency reference signal according to the self-interference channel parameter, and transmit the selected delay signal of the at least one radio frequency reference signal to the first amplitude and phase adjuster group.

With reference to the first possible implementation manner of the first aspect, in a sixth possible implementation manner, the self-interference signal reconstruction module (1502) includes:

a second delayer group, a second amplitude and phase adjuster group, and a second combiner, where:

the second delayer group includes at least one circulator and at least one delayer, where the at least one circulator is connected in series by using a first port and a third port, and one end of the delayer is connected to a second port of the circulator; the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the at least one delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

the second amplitude and phase adjuster group includes at least one amplitude and phase adjuster, where each amplitude and phase adjuster is configured to perform amplitude and phase adjustment on a delay signal of one radio frequency reference signal according to the self-interference channel parameter; and

the second combiner is configured to perform combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

With reference to the sixth possible implementation manner of the first aspect, in a seventh possible implementation manner, the self-interference signal reconstruction module (1502) further includes:

a second radio frequency selection switch, configured to receive the delay signal of the at least one radio frequency reference signal, select, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency reference signal according to the self-interference channel parameter, and transmit the selected delay signal of the at least one radio frequency reference signal to the second

amplitude and phase adjuster group.

With reference to any one of the fourth to seventh possible implementation manners of the first aspect, in an eighth possible implementation manner, the amplitude and phase adjuster ~~group~~ includes an attenuator and a phase shifter, where:

the attenuator is configured to perform, according to the self-interference channel ~~first amplitude and phase parameter and the second amplitude and phase~~ parameter, amplitude adjustment processing on the received delay signal that is of the radio frequency reference signal and that is transmitted by the radio frequency selection switch; and

the phase shifter is configured to perform, according to self-interference channel~~the first amplitude and phase parameter and the second amplitude and phase parameter~~, phase shift processing on a delay signal that is of the radio frequency reference signal and that is obtained after amplitude adjustment processing is performed by the attenuator.

With reference to the first aspect or any one of the first to eighth possible implementation manners of the first aspect, in a ninth possible implementation manner, the first-type interference canceller (130) is specifically configured to perform, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive signal; or

perform, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a difference between a phase of the radio frequency reference signal and a phase of the first-type self-interference component in the radio frequency receive signal is 180 degrees or approximately 180 degrees.

With reference to the first aspect or any one of the first to ninth possible implementation manners of the first aspect, in a tenth possible implementation manner, the transmit signal includes a self-interference channel estimation timeslot

and a data transmission timeslot that are disposed at an interval.

According to a second aspect, an interference cancellation method is provided, including:

acquiring a radio frequency reference signal generated according to a transmit signal;

receiving a radio frequency receive signal by using a main receive antenna;

canceling a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal, to generate a first processed signal, where the first-type self-interference component includes a main-path self-interference component;

acquiring the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal;

canceling a second-type self-interference ~~signal~~ component in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal;

performing down-conversion processing on the second processed signal to generate a third processed signal;

performing analog to digital conversion on the third processed signal to generate a digital signal; and

acquiring a digital baseband reference signal, and performing self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

With reference to the second aspect, in a first possible implementation manner, the method further includes: amplifying the second processed signal.

With reference to the second aspect, in a second possible implementation manner, the method further includes:

amplifying the first processed signal; and

before the acquiring the reconstructed self-interference signal according to the self-interference channel parameter and the radio frequency reference signal, the method includes: amplifying the radio frequency reference signal.

With reference to the second aspect, in a third possible implementation manner, the acquiring the reconstructed self-interference signal according to a

manner of the second aspect, in a sixth possible implementation manner, the cancelling first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal includes:

performing, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive signal; or

performing, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a difference between a phase of the radio frequency reference signal and a phase of the first-type self-interference component in the radio frequency receive signal is 180 degrees or approximately 180 degrees.

With reference to the second aspect or any one possible implementation manner of the second aspect, in a seventh possible implementation manner, the transmit signal includes a self-interference channel estimation timeslot and a data transmission timeslot that are disposed at an interval.

In the interference cancellation apparatus and method according to the embodiments of the present invention, for a radio frequency receive signal acquired by a main receive antenna, interference cancellation processing is performed according to a radio frequency reference signal to cancel a first-type self-interference component in the radio frequency receive signal and acquire a first processed signal; and further, a reconstructed self-interference signal is acquired through self-interference channel estimation to cancel a second-type self-interference component in the first processed signal. Because the reconstructed self-interference signal is used directly in an analog domain to cancel the second-type self-interference component, a limitation by a dynamic range of an ADC/DAC can be avoided, and the

details are provided to facilitate comprehensive understanding of one or more embodiments. However, apparently, the embodiments may also not be implemented by using these specific details. In other examples, a well-known structure and device are shown in a form of block diagrams, to conveniently describe one or more embodiments.

Terminologies such as "part", "module", and "system" used in this specification are used to indicate computer-related entities, hardware, firmware, combinations of hardware and software, software, or software being executed. For example, a part may be, but is not limited to, a process that runs on a processor, a processor, an object, an executable file, a thread of execution, a program, and/or a computer. As shown in figures, both a computing device and an application that runs on a computing device may be parts. One or more parts may reside within a process and/or a thread of execution, and a part may be located on one computer and/or distributed between two or more computers. In addition, these parts may be executed from various computer-readable media that store various data structures. For example, the parts may communicate by using a local and/or remote process and according to, for example, a signal having one or more data packets (for example, data from two parts interacting with another part in a local system, a distributed system, and/or across a network such as the Internet interacting with other systems by using the signal).

An interference cancellation apparatus according to an embodiment of the present invention may be disposed in an access terminal that uses a wireless full duplex technology. An access terminal may also be referred to as a system, a subscriber unit, a subscriber station, a mobile station, ~~a mobile station,~~ a remote station, a remote terminal, a mobile device, a user terminal, a terminal, a wireless communications device, user agent, a user apparatus, or user equipment (UE, User Equipment). The access terminal may be a cellular phone, a cordless phone, a SIP (Session Initiation Protocol, Session Initiation Protocol) phone, a WLL (Wireless Local Loop, wireless local loop) station, a PDA (Personal Digital Assistant, personal digital assistant), a handheld device having a wireless communication function, an in-vehicle device, a wearable device, a computing device, or another processing device connected to a wireless modem.

In addition, the interference cancellation apparatus according to the

embodiment of the present invention may also be disposed in a base station that uses the wireless full duplex technology. The base station may be configured to communicate with a mobile device. The base station may be an AP (Access Point, wireless access point) of a WiFi system, or a BTS (Base Transceiver Station, base transceiver station) in a GSM (Global System ~~of~~ for Mobile communication, Global System for Mobile Communication) system or a CDMA (Code Division Multiple Access, Code Division Multiple Access) system, or may be an NB (NodeB, NodeB) in a WCDMA (Wideband Code Division Multiple Access, Wideband Code Division Multiple Access) system, or may be an eNB or an eNodeB (~~Evolutional~~ Evolved Node B, evolved NodeB) in a LTE (Long Term Evolution, Long Term Evolution) system, or a relay station or an access point, or a base station device in a future 5G network, or the like.

In addition, aspects or features of the present invention may be implemented as an apparatus or a product that uses standard programming and/or engineering technologies. The term "product" used in this application covers a computer program that can be accessed from any computer-readable part, carrier or medium. For example, the computer-readable medium may include but is not limited to: a magnetic storage part (for example, a hard disk, a floppy disk or a magnetic tape), an optical disc (for example, a CD (Compact Disk, compact disk), a DVD (Digital Versatile Disk, digital versatile disk), a smart card and a flash memory part (for example, EPROM (Erasable Programmable Read-Only Memory, erasable programmable read-only memory), a card, a stick, or a key drive). In addition, various storage media described in this specification may indicate one or more devices and/or other machine-readable media that is used to store information. The term "machine-readable media" may include but is not limited to a radio channel, and various other media that can store, include and/or carry an instruction and/or data.

It should be noted that in the embodiments of the present invention, interference cancellation may be canceling all interference components in a signal (including a first-type self-interference component and a second-type self-interference component), or may be canceling some interference components in a signal (including a part of a first-type self-interference component and a part of a second-type self-interference component).

FIG. 2 is a schematic structural diagram of an interference cancellation apparatus according to an embodiment of the present invention. As shown in FIG. 2,

radio frequency reference signal to acquire a first processed signal, where the first-type self-interference component includes a main-path self-interference component.

The second-type interference reconstructor 150 is configured to acquire the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal transmitted by the divider 120.

The coupler 140 is configured to receive the first processed signal and the reconstructed self-interference signal transmitted by the second-type interference reconstructor 150, and cancel a second-type self-interference ~~signal~~ component in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal.

The down converter 160 is configured to perform down-conversion processing on the second processed signal to generate a third processed signal.

The analog to digital converter ADC 170 is configured to perform analog to digital conversion on the third processed signal to generate a digital signal.

The second-type interference reconstructor 150 is further configured to acquire a digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC 170 and the radio frequency reference signal transmitted by the divider 120, and perform self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

FIG. 2 further shows that the divider 180 is configured to use the digital signal converted from the third processed signal as an output signal and as an input signal of the second-type interference reconstructor 150 separately.

Connection relationships, structures, and functions of parts in the embodiment shown in FIG. 2 are described in detail as follows:

(1) Main receive antenna 110

The main receive antenna 110 is configured to receive a radio signal, and input the received radio signal as a radio frequency receive signal to the first input end 131 of the first-type interference canceller 130, where the process of receiving a radio signal by the main receive antenna 110 may be similar to the process of receiving a radio signal by an antenna in the prior art, and is not further described herein for avoiding repetition.

combiner a, and a combiner b, where at least one transmission path constituted by at least one of a delayer, a phase adjuster, and an amplitude adjuster connected in series is included between the divider a and the combiner a, where an output end of the combiner a is connected to an input end of the combiner b. In the embodiment of the present invention, the first-type interference canceller 130 has two input ends. The divider a may be a power divider, and the combiner a and the combiner b may be couplers.

The first input end 131 (namely, an input port of the combiner b) of the first-type interference canceller 130 is connected to the output end of the main receive antenna 110, and is configured to receive a signal (namely, a radio frequency receive signal) from the output end of the main receive antenna 110; the second input end 132 (namely, an input port of the divider a) of the first-type interference canceller 130 is connected to the first output end 122 of the ~~combiner~~ divider 120, and is configured to receive one radio frequency reference signal from the ~~combiner~~ divider 120.

Optionally, the first-type interference canceller 130 is specifically configured to perform, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive signal; or

perform, based on the radio frequency~~first~~ receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the ~~first~~ radio frequency receive signal, and that a difference between a phase of the reference signal and a phase of the first-type self-interference component in the ~~first~~ radio frequency receive signal is 180 degrees or approximately 180 degrees; and

combine radio frequency reference signals obtained after delay processing, amplitude adjustment processing, and phase adjustment processing with the radio frequency receive signal.

Specifically, the second input end 132 of the first-type interference canceller 130 is connected to the first output end 122 of the divider 120, and a signal (namely, a radio frequency reference signal) output from the first output end 122 of the divider 120 is input through the second input end 132 of the first-type interference canceller 130 to the divider a, where the divider a may be a power divider. The divider a divides the radio frequency reference signal into several radio frequency reference signals (power of the several radio frequency reference signals may be the same or different). Using one of the several radio frequency reference signals as an example for description, an output end of the divider a outputs one radio frequency reference signal to an adjustment circuit constituted by a delayer, a phase adjuster, and an amplitude adjuster that are connected in series, where the adjustment circuit is configured to adjust a delay, an amplitude, and a phase of a signal by means of delaying, attenuation, phase shifting, and the like. For example, through attenuation, the amplitude of the radio frequency reference signal may approach the amplitude of the first-type self-interference component (including a main-path self-interference ~~signal~~ component) in the radio frequency receive signal. Certainly, a best effect is that the amplitudes are the same. However, because an error exists in an actual application, the amplitudes may be adjusted to approximately the same. In addition, through delaying and/or through phase shifting, the difference between the phase of the radio frequency reference signal and the phase of the radio frequency receive signal (specifically, the first-type self-interference component in the radio frequency receive signal) may be adjusted to 180 degrees or approximately 180 degrees.

Alternatively, through attenuation, the amplitude of the radio frequency reference signal may be in a direction opposite to the amplitude of the first-type self-interference component in the radio frequency receive signal. Certainly, a best effect is that directions of the amplitudes are opposite. However, because an error exists in an actual application, the amplitudes may be adjusted to be approximately opposite. In addition, through delaying and/or through phase shifting, the phase of the radio frequency reference signal may be adjusted to be the same or approximately the same as the phase of the radio frequency receive signal (specifically, the first-type self-interference component in the radio frequency receive signal).

The foregoing just takes one radio frequency reference signal output by the divider as example for description. Certainly, because the divider divides the radio

frequency reference signal into multiple signals, and finally the signals are combined by the combiner a, the delay processing, amplitude adjustment processing, and phase adjustment processing may also be functions that occur on each tributary output by the divider, and finally, after combination, objectives of the delay processing, amplitude adjustment processing, and phase adjustment processing of the radio frequency reference signal input at the input end of the divider are achieved, that is, each tributary output by the divider may include at least one of a delayer, a phase adjuster, and an amplitude adjuster.

Certainly, the amplitude adjustment may be expressed as attenuation or gain, and only attenuation is used as an example for description in the foregoing embodiment. In addition, in the embodiment of the present invention, "approximately" may indicate that a similarity between two is within a preset range, where the preset range may be determined at random according to actual use and requirements, and is not particularly limited by the present invention. For avoiding repetition, the following omits descriptions of similarities unless otherwise specified.

Afterward, radio frequency reference signals of all tributaries output by the divider a are combined by the combiner a after the amplitude and phase adjustment, and the radio frequency receive signal is input to another input port of the combiner b. Therefore, the combiner b may combine the radio frequency receive signal with the radio frequency reference signal obtained after the amplitude and phase adjustment and combination (for example, add the radio frequency reference signal to the radio frequency receive signal or subtract the radio frequency reference signal from the radio frequency receive signal), to cancel the first-type self-interference component in the radio frequency receive signal, thereby implementing first-type self-interference component cancellation processing for the radio frequency receive signal.

For illustration instead of limitation, in the embodiment of the present invention, the amplitude adjuster may be, for example, an attenuator. The phase adjuster may be, for example, a phase shifter. The delayer may be, for example, a delay line.

Therefore, the first processed signal output from the output end 133 (specifically, the output end of the combiner b) of the first-type interference canceller 130 is a signal generated by canceling the first-type self-interference component in the radio frequency receive signal.

It should be noted that in the embodiment of the present invention, the

delayer, phase adjuster, and amplitude adjuster may be adjusted in a manner of minimizing strength of the first processed signal output by the combiner b, based on the output of the combiner b. In addition, the present invention is not limited to the foregoing implementation manner, as long as strength of the radio frequency receive signal can be reduced according to the radio frequency reference signal (or strength of the first processed signal is less than strength of the radio frequency receive signal), an interference cancellation effect can be achieved.

(4) Second-type interference reconstructor 150

Specifically, as shown in FIG. 4, in the embodiment of the present invention, the second-type interference reconstructor 150 may include a self-interference estimation module 1501 and a self-interference signal reconstruction module 1502.

The self-interference estimation module 1501 is configured to acquire the digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC 170, and perform self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

Optionally, the self-interference estimation module 1501 includes any one of a field-programmable gate array FPGA (Field-Programmable Gate Array), a central processing unit CPU (Central Processing Unit), and ~~another~~ an application-specific integrated circuit ASIC (Application Specific Integrated Circuit). To perform self-interference channel estimation according to the digital baseband reference signal and the digital signal, a pilot-based channel estimation method or an adaptive filtering method such as an LMS (Least mean square, least mean squares) algorithm or an RLS (Recursive least ~~mean~~ squares, recursive least ~~mean~~ squares) algorithm may be used, which pertains to the prior art and is not further described.

In addition, optionally, the transmit signal includes a self-interference channel estimation timeslot and a data transmission timeslot that are disposed at an interval. In the data transmission timeslot, full duplex data communication may be performed. In the self-interference channel estimation timeslot, a communications peer does not transmit data, and a signal received by a local receiver includes only a self-interference signal. Because there is no signal from the communications peer, the local end uses the self-interference channel estimation timeslot to perform

self-interference channel estimation to acquire a self-interference channel parameter. Specifically, in the self-interference channel estimation timeslot, the radio frequency receive signal includes only a second-type self-interference component. In the self-interference channel estimation timeslot, by referring to the digital baseband reference signal, self-interference channel estimation is performed on the digital signal that is acquired by processing the radio frequency receive signal. Therefore, in the self-interference channel estimation timeslot, the communications peer does not transmit a signal, and a signal received by the receiver includes only a self-interference signal. Because there is no signal from the communications peer, the receiver may perform self-interference channel estimation in the self-interference channel estimation timeslot to acquire a self-interference channel parameter, where the self-interference channel parameter may include parameters indicating a transmission path delay, a phase, and an amplitude of a second-type self-interference component. In the data transmission timeslot, a signal received by the receiver includes a self-interference signal and a data signal, and the receiver may generate a reconstructed self-interference signal in the data transmission timeslot according to the radio frequency reference signal and the self-interference channel parameter, and use the reconstructed self-interference signal to cancel the second-type self-interference component.

The self-interference signal reconstruction module 1502 is configured to receive the radio frequency reference signal transmitted by the divider 120 and the self-interference channel parameter acquired by the self-interference estimation module 1501, and acquire the reconstructed self-interference signal according to the self-interference channel parameter and the radio frequency reference signal.

Further, referring to FIG. 5, the self-interference signal reconstruction module 1502 includes:

a first delayer group, a first amplitude and phase adjuster group, and a first combiner, where:

the first delayer group includes at least one delayer, where the at least one delayer is connected in series, and the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the at least one delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

self-interference channel parameter and output.

Alternatively, optionally, referring to FIG. 7,

the self-interference signal reconstruction module 1502 includes:

a second delayer group, a second amplitude and phase adjuster group, and a second combiner, where:

the second delayer group includes at least one circulator and at least one delayer, where the at least one circulator is connected in series by using a first port and a third port, and one end of the delayer is connected to a second port of the circulator; the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the at least one delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

the second amplitude and phase adjuster group includes at least one amplitude and phase adjuster, where each amplitude and phase adjuster is configured to perform amplitude and phase adjustment on a delay signal of one radio frequency reference signal according to the self-interference channel parameter; and

the second combiner is configured to perform combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

In addition, with reference to FIG. 7 and in combination with the foregoing description, it may be understood that the circulators in the first delayer group are connected by couplers. As shown in FIG. 7, a circulator includes three ports 1, 2, and 3. The first port 1 is configured to receive one radio frequency reference signal. The second port 2 of the circulator is configured to transmit the radio frequency reference signal received by the first port 1 to a delayer. The delayer performs delay processing on the radio frequency reference signal and then returns it to the second port 2. The circulator transmits the radio frequency reference signal obtained after delay processing to a next circulator through the third port 3. Delay lines may be used as delayers. Herein, the circulator receives the delay signal formed by the delayer, and transmits, through a coupler, a delay signal of the radio frequency reference signal, formed in each delay. That is, a third port 3 of a previous circulator is connected to an input end of a coupler, an output end of the coupler is connected to an amplitude and phase adjuster in the first amplitude and phase adjuster group, and another output end

of the coupler is connected to a first port 1 of a next circulator (the previous and next are only intended for clearly describing a sequence of transferring the radio frequency reference signal in the first delayer group, and not for limiting the implementation manner of the present invention). The first delayer group may include M delayers configured to delay the radio frequency reference signal for M times and form delay signals of M radio frequency reference signals. A quantity of delay taps that may be formed by the M delayers included in the first delayer group is M. In comparison with the embodiment corresponding to FIG. 6, when a delay line is used as a delayer, a single end of the delay line is connected to a second port 2 of a circulator, that is, a delay signal is formed by transmitting the radio frequency reference signal in the delay line forward and then backward, and therefore, a half of a length of the delay line may be saved in comparison with the embodiment corresponding to FIG. 6.

Further, referring to FIG. 8, the self-interference signal reconstruction module further includes:

a second radio frequency selection switch, configured to receive the delay signal of the at least one radio frequency reference signal, select, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency reference signal according to the self-interference channel parameter, and transmit the selected delay signal of the at least one radio frequency reference signal to the second amplitude and phase adjuster group.

The first radio frequency selection switch may be an M×K radio frequency selection switch. That is, in delay signals of the received M radio frequency reference signals, delay signals of K radio frequency reference signals may be selected from the delay signals of the M radio frequency reference signals according to the self-interference channel parameter and output.

Further, the amplitude and phase adjuster may be implemented in the following manners.

~~————~~Referring to FIG. ~~10~~9, in the first manner, the amplitude and phase adjuster includes:

~~The amplitude and phase adjuster group includes~~ an attenuator and a phase shifter, where:

the attenuator is configured to perform, according to the self-interference channel parameter, amplitude adjustment processing on the received delay signal that

is of the radio frequency reference signal and that is transmitted by the radio frequency selection switch; and

the phase shifter is configured to perform, according to the self-interference channel parameter, phase shift processing on a delay signal that is of the radio frequency reference signal and that is obtained after amplitude adjustment processing is performed by the attenuator.

In the embodiments corresponding to FIG. 6, FIG. 7, FIG. 8, and FIG. 9, if a smallest multi-path delay difference of a self-interference channel that can be resolved by the self-interference signal reconstruction module 1502 is T, a delay generated by each delay tap may be set to T, that is, each delayer may form a delay T for one radio frequency reference signal. The smallest multi-path delay difference is determined according to a bandwidth W of a baseband transmit signal of a peer end, that is, $T=\frac{1}{\alpha}\cdot\frac{1}{W}$, where $\alpha \geq 1$, and when $\alpha > 1$, a super-resolution algorithm needs to be used for implementation. For example, a transmit signal bandwidth is $W=40MHz$, and $T=\frac{1}{W}=25ns$ may be used. If the quantity of delay taps is $M=16$, a reconstructed self-interference signal with a maximum delay of $MT=400ns$ may be reconstructed. This is equivalent to a signal reflected by a reflector that is 60 meters away from an emitter.

(5) Coupler 140

The coupler 140 is configured to receive the first processed signal generated by the first-type interference canceller 130 and the reconstructed self-interference signal transmitted by the second-type interference reconstructor 150, and cancel the second-type self-interference ~~signal~~ component in the first processed signal according to the reconstructed self-interference signal to generate the second processed signal.

(6) Down converter 160

The down converter 160 is configured to perform down-conversion processing on the second processed signal transmitted by the coupler 140 to generate the third processed signal. Because the radio frequency receive signal is transmitted as a high frequency signal in a wireless transmission process, the down-conversion processing herein is to convert a high frequency signal component into a low frequency signal component, to avoid adverse impact of the high frequency signal component on self-interference channel estimation performed by the second-type

105. Cancel a second-type self-interference ~~signal~~ component in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal.

106. Perform down-conversion processing on the second processed signal to generate a third processed signal.

107. Perform analog to digital conversion on the third processed signal to generate a digital signal.

108. Acquire a digital baseband reference signal, and perform self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

Specifically, in step 101, a transmit signal after baseband processing (for example, processing such as digital to analog conversion, up conversion, and power amplification) may be used as a radio frequency reference signal, and input to, for example, a coupler or a power divider. Therefore, the radio frequency reference signal can be divided into two signals by the coupler or power divider, where one signal is used to generate a first processed signal and the other signal is used to generate a reconstructed self-interference signal.

Optionally, in step 108, the acquiring a digital baseband reference signal may specifically include: acquiring the digital baseband reference signal by performing digital sampling on the radio frequency reference signal.

In addition, the coupler or power divider is used to divide the radio frequency reference signal into two signals in such a manner that waveforms of the two signals can be consistent with that of the transmit signal, which is good for subsequent interference cancellation (including cancellation of the first-type self-interference component and cancellation of the second-type self-interference component) based on the radio frequency reference signal, where waveform consistency includes that the waveforms are the same as the waveform of the transmit signal or that a waveform similarity is within a preset range.

Optionally, after step 105, the method further includes: amplifying the second processed signal.

Alternatively, optionally, after step 103, the method further includes: amplifying the first processed signal; and

before the acquiring the reconstructed self-interference signal according

to the self-interference channel parameter and the radio frequency reference signal in step 104, the method further includes: amplifying the radio frequency reference signal.

The foregoing amplification of various signals is amplification performed by using a low noise amplifier (LNA). Directly amplifying the second processed signal may reduce a requirement of a transmitter side on power of a radio frequency transmit signal. Alternatively, separately amplifying the first processed signal and amplifying the radio frequency reference signal that enters the self-interference signal reconstruction module may also reduce a requirement on power of the radio frequency reference signal, and further reduce the requirement of the transmitter side on the power of the radio frequency transmit signal.

Optionally, the canceling a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal, to generate a first processed signal in step 103 includes:

performing, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive signal; or

performing, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a difference between a phase of the radio frequency reference signal and a phase of the first-type self-interference component in the radio frequency receive signal is 180 degrees or approximately 180 degrees.

In the embodiment of the present invention, for example, an adjustment circuit constituted by a delayer, a phase adjuster, and an amplitude adjuster that are connected in series may be used for implementation. Therefore, in step 103, the

CLAIMS

1. An interference cancellation apparatus, comprising:

a main receive antenna (110), configured to receive a radio frequency receive signal, and transmit the radio frequency receive signal to a first-type interference canceller (130);

a divider (120), configured to acquire a radio frequency reference signal generated according to a transmit signal, and transmit the radio frequency reference signal to the first-type interference canceller (130) and a second-type interference reconstructor (150);

the first-type interference canceller (130), configured to receive the radio frequency reference signal transmitted by the divider (120) and the radio frequency receive signal transmitted by the main receive antenna (110), and cancel a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal to acquire a first processed signal, wherein the first-type self-interference component comprises a main-path self-interference component;

the second-type interference reconstructor (150), configured to acquire the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal transmitted by the divider (120);

a coupler (140), configured to receive the first processed signal and the reconstructed self-interference signal transmitted by the second-type interference reconstructor (150), and cancel a second-type self-interference signal in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal;

a down converter (160), configured to perform down-conversion processing on the second processed signal to generate a third processed signal; and

an analog to digital converter ADC (170), configured to perform analog to digital conversion on the third processed signal to generate a digital signal; wherein

the second-type interference reconstructor (150) is further configured to acquire a digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC (170) and the radio frequency reference signal transmitted by the divider (120), and perform self-interference channel estimation according to

the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

2. The apparatus according to claim 1, wherein the second-type interference reconstructor (150) comprises:

a self-interference estimation module (1501), configured to acquire the digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC (170), and perform self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter; and

a self-interference signal reconstruction module (1502), configured to receive the radio frequency reference signal transmitted by the divider (120) and the self-interference channel parameter acquired by the self-interference estimation module (1501), and acquire the reconstructed self-interference signal according to the self-interference channel parameter and the radio frequency reference signal.

3. The apparatus according to claim 1, further comprising a first amplifier, wherein the first amplifier is configured to amplify the second processed signal.

4. The apparatus according to claim 1, further comprising a second amplifier and a third amplifier, wherein:

the second amplifier is configured to amplify the first processed signal; and

the third amplifier is configured to amplify the radio frequency reference signal received by the second-type interference reconstructor.

5. The apparatus according to claim 2, wherein the self-interference signal reconstruction module (1502) comprises:

a first delayer group, a first amplitude and phase adjuster group, and a first combiner, wherein:

the first delayer group comprises at least one delayer, wherein the delayer is connected in series, and the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

the first amplitude and phase adjuster group comprises at least one amplitude and phase adjuster, wherein each amplitude and phase adjuster is configured to perform amplitude and phase adjustment on a delay signal of one radio frequency reference signal according to the self-interference channel parameter; and

the first combiner is configured to perform combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

6. The apparatus according to claim 5, wherein the self-interference signal reconstruction module (1502) further comprises:

a first radio frequency selection switch, configured to receive the delay signal of the at least one radio frequency reference signal, select, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency reference signal according to the self-interference channel parameter, and transmit the selected delay signal of the at least one radio frequency reference signal to the first amplitude and phase adjuster group.

7. The apparatus according to claim 2, wherein the self-interference signal reconstruction module (1502) comprises:

a second delayer group, a second amplitude and phase adjuster group, and a second combiner, wherein:

the second delayer group comprises at least one circulator and at least one delayer, wherein the at least one circulator is connected in series by using a first port and a third port, and one end of the delayer is connected to a second port of the circulator; the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

the second amplitude and phase adjuster group comprises at least one amplitude and phase adjuster, wherein each amplitude and phase adjuster is configured to perform amplitude and phase adjustment on a delay signal of one radio frequency reference signal according to the self-interference channel parameter; and

the second combiner is configured to perform combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

8. The apparatus according to claim 7, wherein the self-interference signal reconstruction module (1502) further comprises:

a second radio frequency selection switch, configured to receive the delay signal of the at least one radio frequency reference signal, select, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency

reference signal according to the self-interference channel parameter, and transmit the selected delay signal of the at least one radio frequency reference signal to the second amplitude and phase adjuster group.

9. The apparatus according to any one of claims 5 to 8, wherein the amplitude and phase adjuster group comprises an attenuator and a phase shifter, wherein:

the attenuator is configured to perform, according to the first amplitude and phase parameter and the second amplitude and phase parameter, amplitude adjustment processing on the received delay signal that is of the radio frequency reference signal and that is transmitted by the radio frequency selection switch; and

the phase shifter is configured to perform, according to the first amplitude and phase parameter and the second amplitude and phase parameter, phase shift processing on a delay signal that is of the radio frequency reference signal and that is obtained after amplitude adjustment processing is performed by the attenuator.

10. The apparatus according to any one of claims 1 to 9, wherein:

the first-type interference canceller (130) is specifically configured to perform, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive signal; or

perform, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a difference between a phase of the reference signal and a phase of the first-type self-interference component in the radio frequency receive signal is 180 degrees or approximately 180 degrees.

11. The apparatus according to any one of claims 1 to 10, wherein the transmit signal comprises a self-interference channel estimation timeslot and a data transmission timeslot that are disposed at an interval.

12. The apparatus according to claim 2, wherein the self-interference estimation

module (1501) comprises a field programmable gate array FPGA, a central processing unit CPU, or another application-specific integrated circuit ASIC.

13. An interference cancellation method, comprising:

acquiring a radio frequency reference signal generated according to a transmit signal;

receiving a radio frequency receive signal by using a main receive antenna;

canceling a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal, to generate a first processed signal, wherein the first-type self-interference component comprises a main-path self-interference component;

acquiring the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal;

canceling a second-type self-interference signal in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal;

performing down-conversion processing on the second processed signal to generate a third processed signal;

performing analog to digital conversion on the third processed signal to generate a digital signal; and

acquiring a digital baseband reference signal, and performing self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

14. The method according to claim 13, wherein the method further comprises: amplifying the second processed signal.

15. The method according to claim 13, wherein the method further comprises:

amplifying the first processed signal; and

before the acquiring the reconstructed self-interference signal according to the self-interference channel parameter and the radio frequency reference signal, the method comprises: amplifying the radio frequency reference signal.

16. The method according to claim 13, wherein the acquiring the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal comprises:

performing delay processing on the radio frequency reference signal for at least one time, to form a delay signal of at least one radio frequency reference signal;

performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter; and

performing combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

17. The method according to claim 16, wherein before the performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter, the method further comprises:

selecting, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency reference signal according to the self-interference channel parameter; and

the performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter is specifically: performing amplitude and phase adjustment on the delay signal of each radio frequency reference signal in the selected delay signal of the at least one radio frequency reference signal.

18. The method according to claim 16, wherein the performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter comprises:

performing amplitude adjustment processing on the delay signal of the radio frequency reference signal according to the self-interference channel parameter; and

performing, according to the self-interference channel parameter, phase shift processing on a delay signal that is of the radio frequency reference signal and that is obtained after amplitude adjustment processing is performed.

19. The method according to any one of claims 13 to 18, wherein the cancelling interference in the radio frequency receive signal according to the radio frequency reference signal comprises:

performing, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive

signal; or

performing, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a difference between a phase of the reference signal and a phase of the first-type self-interference component in the radio frequency receive signal is 180 degrees or approximately 180 degrees.

20. The method according to any one of claims 13 to 19, wherein the transmit signal comprises a self-interference channel estimation timeslot and a data transmission timeslot that are disposed at an interval.

CLAIMS

1. An interference cancellation apparatus, comprising:

a main receive antenna (110), configured to receive a radio frequency receive signal, and transmit the radio frequency receive signal to a first-type interference canceller (130);

a divider (120), configured to acquire a radio frequency reference signal generated according to a transmit signal, and transmit the radio frequency reference signal to the first-type interference canceller (130) and a second-type interference reconstructor (150);

the first-type interference canceller (130), configured to receive the radio frequency reference signal transmitted by the divider (120) and the radio frequency receive signal transmitted by the main receive antenna (110), and cancel a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal to acquire a first processed signal, wherein the first-type self-interference component comprises a main-path self-interference component;

the second-type interference reconstructor (150), configured to acquire a reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal transmitted by the divider (120);

a coupler (140), configured to receive the first processed signal and the reconstructed self-interference signal transmitted by the second-type interference reconstructor (150), and cancel a second-type self-interference component in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal;

a down converter (160), configured to perform down-conversion processing on the second processed signal to generate a third processed signal; and

an analog to digital converter ADC (170), configured to perform analog to digital conversion on the third processed signal to generate a digital signal; wherein

the second-type interference reconstructor (150) is further configured to acquire a digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC (170) and the radio frequency reference signal transmitted by the divider (120), and perform self-interference channel estimation according to

the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

2. The apparatus according to claim 1, wherein the second-type interference reconstructor (150) comprises:

a self-interference estimation module (1501), configured to acquire the digital baseband reference signal, receive the digital signal generated by the analog to digital converter ADC (170), and perform self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter; and

a self-interference signal reconstruction module (1502), configured to receive the radio frequency reference signal transmitted by the divider (120) and the self-interference channel parameter acquired by the self-interference estimation module (1501), and acquire the reconstructed self-interference signal according to the self-interference channel parameter and the radio frequency reference signal.

3. The apparatus according to claim 1, further comprising a first amplifier, wherein the first amplifier is configured to amplify the second processed signal.

4. The apparatus according to claim 1, further comprising a second amplifier and a third amplifier, wherein:

the second amplifier is configured to amplify the first processed signal; and

the third amplifier is configured to amplify the radio frequency reference signal received by the second-type interference reconstructor.

5. The apparatus according to claim 2, wherein the self-interference signal reconstruction module (1502) comprises:

a first delayer group, a first amplitude and phase adjuster group, and a first combiner, wherein:

the first delayer group comprises at least one delayer, wherein the at least one delayer is connected in series, and the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the at least one delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

the first amplitude and phase adjuster group comprises at least one amplitude and phase adjuster, wherein each amplitude and phase adjuster is configured to perform amplitude and phase adjustment on a delay signal of one radio frequency reference signal according to the self-interference channel parameter; and

the first combiner is configured to perform combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

6. The apparatus according to claim 5, wherein the self-interference signal reconstruction module (1502) further comprises:

a first radio frequency selection switch, configured to receive the delay signal of the at least one radio frequency reference signal, select, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency reference signal according to the self-interference channel parameter, and transmit the selected delay signal of the at least one radio frequency reference signal to the first amplitude and phase adjuster group.

7. The apparatus according to claim 2, wherein the self-interference signal reconstruction module (1502) comprises:

a second delayer group, a second amplitude and phase adjuster group, and a second combiner, wherein:

the second delayer group comprises at least one circulator and at least one delayer, wherein the at least one circulator is connected in series by using a first port and a third port, and one end of the delayer is connected to a second port of the circulator; the first delayer group is configured to receive the radio frequency reference signal, and perform delay processing on the radio frequency reference signal by using the at least one delayer sequentially, to form a delay signal of at least one radio frequency reference signal;

the second amplitude and phase adjuster group comprises at least one amplitude and phase adjuster, wherein each amplitude and phase adjuster is configured to perform amplitude and phase adjustment on a delay signal of one radio frequency reference signal according to the self-interference channel parameter; and

the second combiner is configured to perform combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

8. The apparatus according to claim 7, wherein the self-interference signal reconstruction module (1502) further comprises:

a second radio frequency selection switch, configured to receive the delay signal of the at least one radio frequency reference signal, select, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency

reference signal according to the self-interference channel parameter, and transmit the selected delay signal of the at least one radio frequency reference signal to the second amplitude and phase adjuster group.

9. The apparatus according to any one of claims 5 to 8, wherein the amplitude and phase adjuster comprises an attenuator and a phase shifter, wherein:

the attenuator is configured to perform, according to the self-interference channel parameter, amplitude adjustment processing on the received delay signal that is of the radio frequency reference signal and that is transmitted by the radio frequency selection switch; and

the phase shifter is configured to perform, according to the self-interference channel parameter, phase shift processing on a delay signal that is of the radio frequency reference signal and that is obtained after amplitude adjustment processing is performed by the attenuator.

10. The apparatus according to any one of claims 1 to 9, wherein:

the first-type interference canceller (130) is specifically configured to perform, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive signal; or

perform, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a difference between a phase of the radio frequency reference signal and a phase of the first-type self-interference component in the radio frequency receive signal is 180 degrees or approximately 180 degrees.

11. The apparatus according to claim 2, wherein the self-interference estimation module (1501) comprises a field programmable gate array FPGA, a central processing unit CPU, or an application-specific integrated circuit ASIC.

12. An interference cancellation method, comprising:

acquiring a radio frequency reference signal generated according to a transmit signal;

receiving a radio frequency receive signal by using a main receive antenna;

canceling a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal, to generate a first processed signal, wherein the first-type self-interference component comprises a main-path self-interference component;

acquiring the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal;

canceling a second-type self-interference component in the first processed signal according to the reconstructed self-interference signal to generate a second processed signal;

performing down-conversion processing on the second processed signal to generate a third processed signal;

performing analog to digital conversion on the third processed signal to generate a digital signal; and

acquiring a digital baseband reference signal, and performing self-interference channel estimation according to the digital baseband reference signal and the digital signal to acquire the self-interference channel parameter.

13. The method according to claim 12, wherein the method further comprises: amplifying the second processed signal.

14. The method according to claim 12, wherein the method further comprises:

amplifying the first processed signal; and

before the acquiring the reconstructed self-interference signal according to the self-interference channel parameter and the radio frequency reference signal, the method comprises: amplifying the radio frequency reference signal.

15. The method according to claim 12, wherein the acquiring the reconstructed self-interference signal according to a self-interference channel parameter and the radio frequency reference signal comprises:

performing delay processing on the radio frequency reference signal for at least one time, to form a delay signal of at least one radio frequency reference signal;

performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter; and

performing combination processing on delay signals that are of radio frequency reference signals and obtained after amplitude and phase adjustment, to generate the reconstructed self-interference signal.

16. The method according to claim 15, wherein before the performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter, the method further comprises:

selecting, from delay signals of all radio frequency reference signals, a delay signal of at least one radio frequency reference signal according to the self-interference channel parameter; and

the performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter is specifically: performing amplitude and phase adjustment on the delay signal of each radio frequency reference signal in the selected delay signal of the at least one radio frequency reference signal.

17. The method according to claim 15, wherein the performing amplitude and phase adjustment on a delay signal of each radio frequency reference signal according to the self-interference channel parameter comprises:

performing amplitude adjustment processing on the delay signal of the radio frequency reference signal according to the self-interference channel parameter; and

performing, according to the self-interference channel parameter, phase shift processing on a delay signal that is of the radio frequency reference signal and that is obtained after amplitude adjustment processing is performed.

18. The method according to any one of claims 12 to 17, wherein the cancelling a first-type self-interference component in the radio frequency receive signal according to the radio frequency reference signal comprises:

performing, based on the radio frequency receive signal, delay processing, amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is in a direction opposite or approximately opposite to an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a phase of the radio frequency reference signal is the same or approximately the same as a phase of the first-type self-interference component in the radio frequency receive signal; or

performing, based on the radio frequency receive signal, delay processing,

amplitude adjustment processing, and phase adjustment processing on the radio frequency reference signal, so that an amplitude of the radio frequency reference signal is the same or approximately the same as an amplitude of the first-type self-interference component in the radio frequency receive signal, and that a difference between a phase of the radio frequency reference signal and a phase of the first-type self-interference component in the radio frequency receive signal is 180 degrees or approximately 180 degrees.