APPARATUS AND METHODS FOR MULTI-BAND RADIO FREQUENCY SIGNAL ROUTING

BACKGROUND

Field

[0001] Embodiments of the invention relate to electronic systems, and in particular, to radio frequency (RF) electronics.

Description of the Related Technology

[0002] An RF system can include antennas for receiving and/or transmitting RF signals. However, there can be several components in an RF system that may need to access to the antennas. For example, an RF system can include different transmit or receive paths associated with different frequency bands, different communication standards, and/or different power modes, and each path may need access to a particular antenna at certain instances of time.

[0003] An antenna switch module can be used to electrically connect a particular antenna to a particular transmit or receive path of the RF system, thereby allowing multiple components to share antennas. In certain configurations, an antenna switch module is in communication with a diversity module, which processes signals that are received and/or transmitted using one or more diversity antennas.

SUMMARY

[0004] In certain examples, the present disclosure relates to a mobile device. The mobile device includes at least one diversity antenna, a diversity module electrically coupled to the at least one diversity antenna, and an antenna switch module. The diversity module is electrically coupled to the at least one diversity antenna, and is configured to generate a high band (HB) signal, a mid band (MB) signal, and a low band (LB) signal based on processing one or more diversity signals received from the at least one diversity antenna. The HB signal has a frequency content that is greater than a frequency content of the MB signal and the MB signal has a frequency content that is greater than a frequency content of the LB signal. The diversity module is further configured to generate a combined LB/HB

signal based on combining the LB signal and the HB signal. The antenna switch module is configured to receive the MB signal and the combined LB/HB signal from the diversity module.

[0004a] In a first aspect, the present disclosure refers to a diversity module for a mobile device, the diversity module comprising, a first antenna-side multi-throw switch; a second antenna-side multi-throw switch; a first transceiver-side multi-throw switch; a second transceiver-side multi-throw switch electrically connected to a bidirectional terminal; a low band processing circuit configured to generate a low band signal, the low band processing circuit electrically coupled in a first signal path between the first antenna-side multi-throw switch and the first transceiver-side multi-throw switch; a mid band processing circuit configured to generate a mid band signal having a frequency content that is greater than a frequency content of the low band signal, the mid band processing circuit electrically coupled in a second signal path between the second antenna-side multi-throw switch and the second transceiver-side multi-throw switch, the second transceiver-side multi-throw switch configured to provide the mid band signal to the bidirectional terminal in a first mode and to provide a transmit signal from the bidirectional terminal to a first bypass path in a second mode; and a high band processing circuit configured to generate a high band signal at an output, the high band signal having a frequency content that is greater than the frequency content of the mid band signal, the high band processing circuit electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch so as to inhibit transmit leakage from the bidirectional terminal through the second transceiver-side multi-throw switch from reaching the output of the high band processing circuit.

[0005] In a number of examples, the frequency content of the LB signal is less than 1 GHz, the frequency content of the MB signal is between 1 GHz and 2.3 GHz, and the frequency content of the HB signal is greater than 2.3 GHz.

[0006] In various examples, the mobile device further includes a transceiver and one or more primary antennas, and the transceiver is electrically coupled to the one or more primary antennas via the antenna switch module.

[0007] In some examples, the diversity module includes a diplexer configured to generate the combined LB/HB signal based on the LB signal and the HB signal.

[0008] Accordingly to certain examples, the diversity module includes a LB processing circuit configured to generate the LB signal, a MB processing circuit configured to generate the MB signal, and a HB processing circuit configured to generate the HB signal.

[0009] In some examples, the LB processing circuit includes a first filter and a first LNA arranged in a cascade, the MB processing circuit includes a second filter and a second LNA arranged in a cascade, and the HB processing circuit includes a third filter and a third LNA arranged in a cascade.

[0010] In various examples, the mobile device further includes a diversity antenna terminal configured to receive a combined MB/HB diversity signal, and a band selection switch including an input electrically coupled to the diversity antenna terminal, a first output electrically coupled to an input of the MB processing circuit, and a second output electrically coupled to an input of the HB processing circuit.

[0011] In certain examples, the present disclosure relates to a method of front end signal processing in a mobile device. The method includes receiving one or more diversity signals from at least one diversity antenna and generating a HB signal, a MB signal, and a LB signal based on processing the one or more diversity signals using a diversity module. The HB signal has a frequency content that is greater than a frequency content of the MB signal, and the MB signal has a frequency content that is greater than a frequency content of the LB signal. The method further includes generating a combined LB/HB signal based on combining the LB signal and the HB signal using the diversity module, providing

the MB signal to an antenna switch module over a first signal route, and providing the combined LB/HB signal to the antenna switch module over a second signal route.

[0012] According to a number of examples, the frequency content of the LB signal is less than 1 GHz, the frequency content of the MB signal is between 1 GHz and 2.3 GHz, and the frequency content of the HB signal is greater than 2.3 GHz.

[0013] In various examples, the method further includes receiving one or more primary signals from at least one primary antenna, and providing the one or more primary signals to the antenna switch module.

[0014] In some examples generating the combined LB/HB signal includes combining the LB signal and the HB signal using a diplexer.

[0015] In certain examples, the present disclosure relates to a diversity module for a mobile device. The diversity module includes a LB processing circuit configured to generate a LB signal based on processing one or more diversity signals, a MB processing circuit configured to generate a MB signal based on processing the one or more diversity signals, and a HB processing circuit configured to generate a HB signal based on processing the one or more diversity signals. The MB signal has a frequency content that is greater than a frequency content of the LB signal, and the HB signal has a frequency content that is greater than a frequency content of the MB signal. The diversity module further includes a MB terminal configured to receive the MB signal, a shared LB/HB terminal, and a multi-throw switch electrically coupled to the shared LB/HB terminal. The multi-throw switch is configured to provide the LB signal to the shared LB/HB terminal in a first state and to provide the HB signal to the shared LB/HB terminal in a second state.

[0016] According to various examples, the frequency content of the LB signal is less than 1 GHz, the frequency content of the MB signal is between 1 GHz and 2.3 GHz, and the frequency content of the HB signal is greater than 2.3 GHz.

[0017] In some examples, the diversity module further includes a diplexer configured to combine the LB signal and the HB signal to generate a combined LB/HB signal, and the multi-throw switch is configured to provide the combined LB/HB signal to the shared LB/HB terminal in a third state. In certain examples, the diversity module further includes a first switch electrically coupled between an output of the HB processing circuit and a first input of the diplexer, and a second switch electrically coupled between an

output of the LB processing circuit and a second input of the diplexer. In various examples, the first and second switches are configured to close when the multi-throw switch operates in the third state and to open when the multi-throw switch operates in the first or second states.

[0018] In a number of examples, the LB processing circuit includes a first filter and a first LNA arranged in a cascade, the MB processing circuit includes a second filter and a second LNA arranged in a cascade, and the HB processing circuit includes a third filter and a third LNA arranged in a cascade.

[0019] In various examples, the diversity module further includes a first diversity antenna terminal configured to receive a LB diversity signal, and the first diversity antenna terminal is electrically coupled to an input of the LB processing circuit. In some examples, the diversity module further includes a second diversity antenna terminal configured to receive a combined MB/HB diversity signal, and a band selection switch including an input electrically coupled to the second diversity antenna terminal, a first output electrically coupled to an input of the MB processing circuit, and a second output electrically coupled to an input of the HB processing circuit.

[0020] According to some examples, the LB processing circuit includes a plurality of low band filters having different frequency ranges, the MB processing circuit includes a plurality of mid band filters having different frequency ranges, and the HB processing circuit includes a plurality of high band filters having different frequency ranges.

[0021] In certain examples, the present disclosure relates to a diversity module. The diversity module includes a first antenna-side multi-throw switch, a second antenna-side multi-throw switch, a first transceiver-side multi-throw switch, a second transceiver-side multi-throw switch, a LB processing circuit configured to generate a LB signal, a MB processing circuit configured to generate a MB signal having a frequency content that is greater than a frequency content of the LB signal, and a HB processing circuit configured to generate a HB signal having a frequency content that is greater than the frequency content of the MB signal. The LB processing circuit is electrically coupled in a first signal path between the first antenna-side multi-throw switch and the first transceiver-side multi-throw switch, the MB processing circuit electrically coupled in a second signal path between the second antenna-side multi-throw switch and the second transceiver-side

multi-throw switch, and the HB processing circuit is electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch.

[0022] In a number of examples, the frequency content of the LB signal is less than 1 GHz, the frequency content of the MB signal is between 1 GHz and 2.3 GHz, and the frequency content of the HB signal is greater than 2.3 GHz.

[0023] In various examples, the diversity module further includes a first transmit bypass path between the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch, and a second transmit bypass path between the second transceiver-side multi-throw switch and the second antenna-side multi-throw switch.

[0024] According to certain examples, the diversity module is operable in a plurality of modes including a normal operating mode and a swap mode. Additionally, the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch are configured to select the first transmit bypass path in the swap mode, and the second transceiver-side multi-throw switch and the second antenna-side multi-throw switch are configured to select the second transmit bypass path in the swap mode.

[0025] In some examples, the diversity module further includes a first diversity antenna terminal electrically coupled to the first antenna-side multi-throw switch, a second diversity antenna terminal electrically coupled to the second antenna-side multi-throw switch, a first bidirectional terminal electrically coupled to the first transceiver-side multi-throw switch, and a second bidirectional terminal electrically coupled to the second transceiver-side multi-throw switch.

[0026] In various examples, the diversity module is operable in a plurality of modes including a normal operating mode and a swap mode, and the first transceiver-side multi-throw switch is configured to provide one of the LB signal or the HB signal to the first bidirectional terminal in the normal operating mode, and the second transceiver-side multi-throw switch is configured to provide MB signal to the second bidirectional terminal in the normal operating mode.

[0027] In some examples, the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch are configured to electrically couple the first bidirectional terminal to the first diversity antenna terminal via the first transmit bypass path

in the swap mode, and the second transceiver-side multi-throw switch and the second antenna-side multi-throw switch are configured to electrically couple the second bidirectional terminal to the second diversity antenna terminal via the second transmit bypass path in the swap mode.

[0028] According to a number of examples, the LB processing circuit includes a first filter and a first LNA arranged in a cascade, the MB processing circuit includes a second filter and a second LNA arranged in a cascade, and the HB processing circuit includes a third filter and a third LNA arranged in a cascade.

[0029] In certain examples, the present disclosure relates to a mobile device. The mobile device includes a transceiver, an antenna switch module, at least one diversity antenna, and a diversity module that includes a transceiver-side and an antenna-side. The diversity module is electrically coupled to the transceiver via the antenna switch module on the transceiver-side and is electrically coupled to the at least one diversity antenna on the antenna-side. The diversity module includes a first antenna-side multi-throw switch, a second antenna-side multi-throw switch, a first transceiver-side multi-throw switch, a second transceiver-side multi-throw switch, a LB processing circuit, a MB processing circuit, and a HB processing circuit. The LB processing circuit is electrically coupled in a first signal path between the first antenna-side multi-throw switch and the first transceiver-side multi-throw switch, the MB processing circuit is electrically coupled in a second signal path between the second antenna-side multi-throw switch and the second transceiver-side multi-throw switch, and the HB processing circuit is electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch.

[0029a] In a second aspect, the present disclosure refers to a mobile device comprising, a transceiver; an antenna switch module; at least one diversity antenna; and a diversity module including a transceiver-side and an antenna-side, the diversity module electrically coupled to the transceiver via the antenna switch module on the transceiver-side and electrically coupled to the at least one diversity antenna on the antenna-side, the diversity module including a first antenna-side multi-throw switch, a second antenna-side multi-throw switch, a first transceiver-side multi-throw switch, a second transceiver-side multi-throw switch electrically connected to the antenna switch module via a bidirectional terminal, a low band processing circuit, a mid band processing circuit, and a high band processing circuit, the

second transceiver-side multi-throw switch configured to couple an output of the mid band processing circuit to the bidirectional terminal in a first mode and to provide a transmit signal from the bidirectional terminal to a first bypass path in a second mode, the low band processing circuit electrically coupled in a first signal path between the first antenna-side multi-throw switch and the first transceiver-side multi-throw switch, the mid band processing circuit electrically coupled in a second signal path between the second antenna-side multi-throw switch and the second transceiver-side multi-throw switch, and the high band processing circuit electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch so as to inhibit transmit leakage from the bidirectional terminal through the second transceiver-side multi-throw switch from reaching an output of the high band processing circuit.

[0030] In various examples, the LB processing circuit is configured to generate a LB signal based on processing one or more diversity signals received from the at least one diversity antenna, the MB processing circuit is configured to generate a MB signal having a frequency content that is greater than a frequency content of the LB signal based on processing the one or more diversity signals, and the HB processing circuit is configured to generate a HB signal having a frequency content that is greater than the frequency content of the MB signal based on processing the one or more diversity signals.

[0031] In certain examples, the frequency content of the LB signal is less than 1 GHz, the frequency content of the MB signal is between 1 GHz and 2.3 GHz, and the frequency content of the HB signal is greater than 2.3 GHz.

[0032] According to some examples, the diversity module further includes a first transmit bypass path between the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch, and a second transmit bypass path between the second transceiver-side multi-throw switch and the second antenna-side multi-throw switch.

[0033] In various examples, the diversity module is operable in a plurality of modes including a normal operating mode and a swap mode, the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch configured to select the first transmit bypass path in the swap mode, and the second transceiver-side multi-throw switch and the second antenna-side multi-throw switch configured to select the second transmit bypass path in the swap mode.

[0034] In certain examples, the first transceiver-side multi-throw switch is configured to select an output of the HB processing circuit or an output of the LB processing circuit in the normal operating mode, and the second transceiver-side multi-throw switch is configured to select an output of the MB processing circuit in the normal operating mode.

[0035] In various examples, the LB processing circuit includes a first filter and a first LNA arranged in a cascade, the MB processing circuit includes a second filter and a second LNA arranged in a cascade, and the HB processing circuit includes a third filter and a third LNA arranged in a cascade.

[0036] According to certain examples, the mobile device further includes one or more primary antennas, and the transceiver is electrically coupled to the one or more primary antennas via the antenna switch module.

[0037] In certain examples, the present disclosure relates to a method of signal processing in a diversity module. The method includes receiving one or more diversity signals using at least one diversity antenna, and generating a LB signal based on processing the one or more diversity signals using a LB processing circuit that is electrically coupled in a first signal path between a first antenna-side multi-throw switch and a first transceiver-side multi-throw switch. The method further includes generating a MB signal based on processing the one or more diversity signals using a MB processing circuit that is

electrically coupled in a second signal path between a second antenna-side multi-throw switch and a second transceiver-side multi-throw switch, the MB signal having a frequency content that is greater than a frequency content of the LB signal. The method further includes generating a HB signal based on processing the one or more diversity signals using a HB processing circuit that is electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch, the HB signal having a frequency content that is greater than the frequency content of the MB signal.

[0037a] In a third aspect, the present disclosure refers to a method of signal processing in a diversity module, the method comprising, receiving one or more diversity signals using at least one diversity antenna; generating a low band signal based on processing the one or more diversity signals using a low band processing circuit, the low band processing circuit electrically coupled in a first signal path between a first antenna-side multi-throw switch and a first transceiver-side multi-throw switch; generating a mid band mid band signal based on processing the one or more diversity signals using a mid band processing circuit, the mid band processing circuit electrically coupled in a second signal path between a second antenna-side multi-throw switch and a second transceiver-side multi-throw switch, the mid band signal having a frequency content that is greater than a frequency content of the low band signal; using the second transceiver-side multi-throw switch to provide the mid band signal to a bidirectional terminal in a first mode and to provide a transmit signal from the bidirectional terminal to a first bypass path in a second mode; and generating a high band signal at an output of a high band processing circuit based on processing the one or more diversity signals using the high band processing circuit, the high band processing circuit electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch so as to inhibit transmit leakage from the bidirectional terminal through the second transceiver-side multi-throw switch from reaching the output of the high band processing circuit, the high band signal having a frequency content that is greater than the frequency content of the mid band signal.

[0038] In various examples, the method further includes operating the diversity module in one of a plurality of operating modes including a normal operating mode and a bypass mode, selecting the LB signal or the HB signal using the first transceiver-

side multi-throw switch when the diversity module is in the normal operating mode, and selecting the MB signal using the second transceiver-side multi-throw switch when the diversity module is in the normal operating mode.

[0039] According to some examples, the method further includes selecting the first transmit bypass path using the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch when the diversity module is in the swap mode, and selecting the second transmit bypass path using the second transceiver-side multi-throw switch and the second antenna-side multi-throw switch when the diversity module is in the swap mode.

[0040] In a number of examples, the frequency content of the LB signal is less than 1 GHz, the frequency content of the MB signal is between 1 GHz and 2.3 GHz, and the frequency content of the HB signal is greater than 2.3 GHz.

BRIEF DESCRIPTION OF THE DRAWINGS

[0041] Figure 1 is a schematic block diagram of one example of a wireless device.

[0042] Figure 2 is a schematic block diagram of a radio frequency (RF) system according to one embodiment.

[0043] Figure 3 is a schematic block diagram of an RF system according to another embodiment.

CLAIMS

1. A diversity module for a mobile device, the diversity module comprising:

a first antenna-side multi-throw switch;

a second antenna-side multi-throw switch;

a first transceiver-side multi-throw switch;

a second transceiver-side multi-throw switch electrically connected to a bidirectional terminal;

a low band processing circuit configured to generate a low band signal, the low band processing circuit electrically coupled in a first signal path between the first antenna-side multi-throw switch and the first transceiver-side multi-throw switch;

a mid band processing circuit configured to generate a mid band signal having a frequency content that is greater than a frequency content of the low band signal, the mid band processing circuit electrically coupled in a second signal path between the second antenna-side multi-throw switch and the second transceiver-side multi-throw switch, the second transceiver-side multi-throw switch configured to provide the mid band signal to the bidirectional terminal in a first mode and to provide a transmit signal from the bidirectional terminal to a first bypass path in a second mode; and

a high band processing circuit configured to generate a high band signal at an output, the high band signal having a frequency content that is greater than the frequency content of the mid band signal, the high band processing circuit electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch so as to inhibit transmit leakage from the bidirectional terminal through the second transceiver-side multi-throw switch from reaching the output of the high band processing circuit.

2. The diversity module of claim 1 wherein the frequency content of the low band signal is less than 1 GHz, the frequency content of the mid band signal is between 1 GHz and 2.3 GHz, and the frequency content of the high band signal is greater than 2.3 GHz.

3. The diversity module of claim 1 wherein the diversity module further includes a second bypass path between the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch.

4. The diversity module of claim 3 wherein the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch select the second bypass path in the second mode.

5. The diversity module of claim 1 further comprising a first diversity antenna terminal electrically coupled to the first antenna-side multi-throw switch, and a second diversity antenna terminal electrically coupled to the second antenna-side multi-throw switch.

6. The diversity module of claim 5 wherein the first transceiver-side multi-throw switch is configured to select one of the low band signal or the high band signal in the first mode.

7. The diversity module of claim 6 wherein the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch are configured to select a second bypass path in the second mode.

8. The diversity module of claim 1 wherein the low band processing circuit includes a first filter and a first low noise amplifier arranged in a cascade, the mid band processing circuit includes a second filter and a second low noise amplifier arranged in a cascade, and the high band processing circuit includes a third filter and a third low noise amplifier arranged in a cascade.

9. A mobile device comprising:

a transceiver;

an antenna switch module;

at least one diversity antenna; and

a diversity module including a transceiver-side and an antenna-side, the diversity module electrically coupled to the transceiver via the antenna switch module on the transceiver-side and electrically coupled to the at least one diversity antenna on the antenna-side, the diversity module including a first antenna-side multi-throw switch, a second antenna-side multi-throw switch, a first transceiver-side multi-throw switch, a second transceiver-side multi-throw switch electrically connected to the antenna switch module via a bidirectional terminal, a low band processing circuit, a mid band processing circuit, and a high band processing circuit, the second transceiver-side multi-throw switch configured to couple an output of the mid band processing circuit to the bidirectional terminal in a first mode and to provide a transmit signal from the bidirectional terminal to a first bypass path in

a second mode, the low band processing circuit electrically coupled in a first signal path between the first antenna-side multi-throw switch and the first transceiver-side multi-throw switch, the mid band processing circuit electrically coupled in a second signal path between the second antenna-side multi-throw switch and the second transceiver-side multi-throw switch, and the high band processing circuit electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch so as to inhibit transmit leakage from the bidirectional terminal through the second transceiver-side multi-throw switch from reaching an output of the high band processing circuit.

10. The mobile device of claim 9 wherein the low band processing circuit is configured to generate a low band signal based on processing one or more diversity signals received from the at least one diversity antenna, the mid band processing circuit is configured to generate a mid band signal having a frequency content that is greater than a frequency content of the low band signal based on processing the one or more diversity signals, and the high band processing circuit is configured to generate a high band signal having a frequency content that is greater than the frequency content of the mid band signal based on processing the one or more diversity signals.

11. The mobile device of claim 10 wherein the frequency content of the low band signal is less than 1 GHz, the frequency content of the mid band signal is between 1 GHz and 2.3 GHz, and the frequency content of the high band signal is greater than 2.3 GHz.

12. The mobile device of claim 9 wherein the diversity module further includes a second bypass path between the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch.

13. The mobile device of claim 12 wherein the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch select the second bypass path in the second mode.

14. The mobile device of claim 13 wherein the first transceiver-side multi-throw switch is configured to select an output of the high band processing circuit or an output of the low band processing circuit in the first mode.

15. The mobile device of claim 13 wherein the low band processing circuit includes a first filter and a first low noise amplifier arranged in a cascade, the mid band processing circuit includes a second filter and a second low noise amplifier arranged in a cascade, and the high band processing circuit includes a third filter and a third low noise amplifier arranged in a cascade.

16. The mobile device of claim 9 further comprising one or more primary antennas, the transceiver electrically coupled to the one or more primary antennas via the antenna switch module.

17. A method of signal processing in a diversity module, the method comprising:

receiving one or more diversity signals using at least one diversity antenna;

generating a low band signal based on processing the one or more diversity signals using a low band processing circuit, the low band processing circuit electrically coupled in a first signal path between a first antenna-side multi-throw switch and a first transceiver-side multi-throw switch;

generating a mid band mid band signal based on processing the one or more diversity signals using a mid band processing circuit, the mid band processing circuit electrically coupled in a second signal path between a second antenna-side multi-throw switch and a second transceiver-side multi-throw switch, the mid band signal having a frequency content that is greater than a frequency content of the low band signal;

using the second transceiver-side multi-throw switch to provide the mid band signal to a bidirectional terminal in a first mode and to provide a transmit signal from the bidirectional terminal to a first bypass path in a second mode; and

generating a high band signal at an output of a high band processing circuit based on processing the one or more diversity signals using the high band processing circuit, the high band processing circuit electrically coupled in a third signal path between the second antenna-side multi-throw switch and the first transceiver-side multi-throw switch so as to inhibit transmit leakage from the bidirectional terminal through the second transceiver-side multi-throw switch from reaching the output of the high band processing circuit, the high band signal having a frequency content that is greater than the frequency content of the mid band signal.

18. The method of claim 17 further comprising selecting the low band signal or the high band signal using the first transceiver-side multi-throw switch in the first mode.

19. The method of claim 18 further comprising selecting a second bypass path using the first transceiver-side multi-throw switch and the first antenna-side multi-throw switch in the second mode.

20. The method of claim 17 wherein the frequency content of the low band signal is less than 1 GHz, the frequency content of the mid band signal is between 1 GHz and 2.3 GHz, and the frequency content of the high band signal is greater than 2.3 GHz.