

CLAIMS

What is claimed is:

- 1 1. A method for wireless communication, comprising:
2 identifying a first carrier and a second carrier that are scheduled for a
3 transmission in a transmission time interval (TTI), the first carrier using a dedicated radio
4 frequency spectrum band and the second carrier using a shared radio frequency spectrum
5 band;
6 performing a listen before talk (LBT) procedure to determine availability of
7 the second carrier for transmissions during the TTI; and
8 allocating a total transmission power for the TTI across the first carrier and the
9 second carrier based at least in part on a type of control channel for transmission of control
10 information during the TTI, an outcome of the LBT procedure, a timing of the LBT
11 procedure relative to the TTI, one or more other transmissions to be transmitted during the
12 TTI, or any combination thereof.
- 1 2. The method of claim 1, further comprising:
2 prioritizing the first carrier and second carrier for power allocation based at
3 least in part on a payload of the control information.
- 1 3. The method of claim 1, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmissions in a first subframe and a second
3 subframe that is after the first subframe, and the first carrier is scheduled for transmission in
4 the second subframe, and wherein the allocating further comprises:
5 prioritizing the second carrier to provide a first portion of the total
6 transmission power to the second carrier irrespective of the scheduled transmission on the
7 first carrier; and
8 allocating a difference between the total transmission power and the first
9 portion of the total transmission power to the first carrier.
- 1 4. The method of claim 1, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmissions in each of the plurality of
3 subframes, and the first carrier is scheduled for transmission in a second subframe that is after
4 a first subframe, and wherein the allocating further comprises:

5 determining a first portion of the total transmission power to be allocated to
6 the second carrier irrespective of the scheduled transmission of the first carrier;
7 reducing the first portion of the total transmission power based at least in part
8 on a parameter associated with a transmission using the second carrier;
9 allocating the reduced first portion of the total transmission power to the
10 second carrier for each of the plurality of subframes; and
11 allocating a difference between the total transmission power and the reduced
12 first portion of the total transmission power to the first carrier.

1 5. The method of claim 4, wherein the parameter associated with the
2 transmission using the second carrier comprises a modulation and coding scheme (MCS), a
3 redundancy version identification (RV ID), a power loss (PL) measurement, or any
4 combination thereof.

1 6. The method of claim 1, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmissions in a first subframe and a second
3 subframe that is after the first subframe, and the first carrier is scheduled for transmission in
4 the second subframe, and wherein the allocating further comprises:
5 determining whether the second carrier is scheduled for transmission in a third
6 subframe of the plurality of subframes after the second subframe;
7 dropping the first carrier in the second subframe; and
8 allocating the total transmission power to the second carrier.

1 7. The method of claim 1, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmissions in each of the plurality of
3 subframes, and the first carrier is scheduled for transmission in a second subframe that is after
4 a first subframe, and wherein the allocating further comprises:
5 determining that control information and shared channel information is
6 scheduled to be transmitted on the first carrier during the second subframe;
7 diverting a portion of the total transmission power to the first carrier;
8 transmitting the control information using the first carrier; and
9 dropping the shared channel information scheduled to be transmitted on the
10 first carrier.

1 8. The method of claim 1, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmissions in each of the plurality of
3 subframes, and the first carrier is scheduled for transmission in a second subframe that is after
4 a first subframe, and wherein the allocating further comprises:

5 determining that control information and shared channel information is
6 scheduled to be transmitted on the first carrier during the second subframe and that only
7 shared channel information is scheduled to be transmitted on the second carrier during the
8 second subframe;

9 diverting a first portion of the total transmission power to the first carrier;

10 allocating a difference between the total transmission power and the first
11 portion of the total transmission power to the second carrier;

12 transmitting the control information and shared channel information using the
13 first carrier; and

14 transmitting shared channel information scheduled to be transmitted on the
15 second carrier.

1 9. The method of claim 8, wherein a ratio of the total transmission power
2 to divert is based at least in part on whether channel state information (CSI) is to be
3 transmitted using the second carrier.

1 10. The method of claim 1, wherein the TTI comprises a plurality of
2 subframes and each of the first carrier and the second carrier are scheduled for transmissions
3 in a first subframe immediately following completion of the LBT procedure, and wherein the
4 allocating further comprises:

5 pre-allocating, prior to performing the LBT procedure, a first portion of the
6 total transmission power to the first carrier and a difference between the total transmission
7 power and the first portion of the total transmission power to the second carrier.

1 11. The method of claim 10, wherein a ratio between the first portion and
2 the total transmission power is determined based at least in part on whether control channel
3 information scheduled on one or more of the first carrier or second carrier, or whether
4 channel state information (CSI) is to be transmitted using a physical uplink shared channel
5 (PUSCH).

1 12. The method of claim 10, further comprising:

2 transmitting a first portion of a first subframe following the LBT procedure
3 using the pre-allocated transmission powers;
4 reallocating the total transmission power for the TTI across the first carrier and
5 the second carrier based at least in part on the outcome of the LBT procedure; and
6 transmitting a remaining portion of the first subframe using the reallocated
7 transmission powers.

1 13. The method of claim 1, wherein the TTI comprises a plurality of
2 subframes and each of the first carrier and the second carrier are scheduled for transmissions
3 in a first subframe and the LBT procedure is completed during the first subframe, and
4 wherein the allocating further comprises:
5 pre-allocating, prior to performing the LBT procedure, a first portion of the
6 total transmission power to the first carrier and a difference between the total transmission
7 power and the first portion of the total transmission power to the second carrier; and
8 transmitting on the first carrier during an entirety of the first subframe using
9 the first portion of the total transmission power regardless of the outcome of the LBT
10 procedure.

1 14. The method of claim 1, wherein allocating the total transmission power
2 for the TTI across the first carrier and the second carrier is further based on whether the first
3 carrier is associated with a primary cell or a primary secondary cell.

1 15. A method for wireless communication, comprising:
2 identifying a user equipment (UE) capable of transmitting using both a first
3 carrier and a second carrier, the first carrier using a dedicated radio frequency spectrum band
4 and the second carrier using a shared radio frequency spectrum band;
5 allocating wireless resources of the first carrier and the second carrier to the
6 UE for uplink transmissions during a transmission time interval (TTI);
7 configuring the UE to allocate a total transmission power for uplink
8 transmissions during the TTI across the first carrier and the second carrier based at least in
9 part on a type of control channel for transmission of control information during the TTI, an
10 outcome of the LBT procedure, a timing of the LBT procedure relative to the TTI, one or
11 more other transmissions to be transmitted during the TTI, or any combination thereof; and
12 receiving the uplink transmissions from the UE on at least one of first carrier
13 and the second carrier.

1 16. An apparatus for wireless communication, comprising:
2 means for identifying a first carrier and a second carrier that are scheduled for
3 a transmission in a transmission time interval (TTI), the first carrier using a dedicated radio
4 frequency spectrum band and the second carrier using a shared radio frequency spectrum
5 band;
6 means for performing a listen before talk (LBT) procedure to determine
7 availability of the second carrier for transmissions during the TTI; and
8 means for allocating a total transmission power for the TTI across the first
9 carrier and the second carrier based at least in part on a type of control channel for
10 transmission of control information during the TTI, an outcome of the LBT procedure, a
11 timing of the LBT procedure relative to the TTI, one or more other transmissions to be
12 transmitted during the TTI, or any combination thereof.

1 17. The apparatus of claim 16, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmissions in each of the plurality of
3 subframes, and the first carrier is scheduled for transmission in a second subframe that is after
4 a first subframe, and
5 wherein the means for allocating a total transmission power for the TTI across
6 the first carrier and the second carrier comprises:
7 means for prioritizing the second carrier to provide a first portion of
8 the total transmission power to the second carrier irrespective of the scheduled transmission
9 on the first carrier, when; and
10 means for allocating a difference between the total transmission power
11 and the first portion of the total transmission power to the first carrier.

1 18. The apparatus of claim 16, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmissions in each of the plurality of
3 subframes, and the first carrier is scheduled for transmission in a second subframe that is after
4 a first subframe, and
5 wherein the means for allocating a total transmission power for the TTI across
6 the first carrier and the second carrier comprises:
7 means for determining whether the second carrier is scheduled for
8 transmission in a third subframe of the plurality of subframes after the second subframe;
9 means for dropping the first carrier in the second subframe; and

10 means for allocating the total transmission power to the second carrier.

1 19. The apparatus of claim 16, wherein the TTI comprises a plurality of
2 subframes and each of the first carrier and the second carrier are scheduled for transmissions
3 in a first subframe immediately following completion of the LBT procedure, and
4 wherein the means for allocating a total transmission power for the TTI across
5 the first carrier and the second carrier comprises means for pre-allocating, prior to performing
6 the LBT procedure, a first portion of the total transmission power to the first carrier and a
7 difference between the total transmission power and the first portion of the total transmission
8 power to the second carrier.

1 20. The apparatus of claim 16, wherein allocating the total transmission
2 power for the TTI across the first carrier and the second carrier is further based on whether
3 the first carrier is associated with a primary cell or a primary secondary cell.

1 21. An apparatus for wireless communication, comprising:
2 means for identifying a user equipment (UE) capable of transmitting using
3 both a first carrier and a second carrier, the first carrier using a dedicated radio frequency
4 spectrum band and the second carrier using a shared radio frequency spectrum band;
5 means for allocating wireless resources of the first carrier and the second
6 carrier to the UE for uplink transmissions during a transmission time interval (TTI);
7 means for configuring the UE to allocate a total transmission power for uplink
8 transmissions during the TTI across the first carrier and the second carrier based at least in
9 part on a type of control channel for transmission of control information during the TTI, an
10 outcome of the LBT procedure, a timing of the LBT procedure relative to the TTI, one or
11 more other transmissions to be transmitted during the TTI, or any combination thereof; and
12 means for receiving the uplink transmissions from the UE on at least one of
13 first carrier and the second carrier.

1 22. An apparatus for wireless communication, in a system comprising:
2 a processor;
3 memory in electronic communication with the processor; and
4 instructions stored in the memory and operable, when executed by the
5 processor, to cause the apparatus to:

6 identify a first carrier and a second carrier that are scheduled for a
7 transmission in a transmission time interval (TTI), the first carrier using a dedicated radio
8 frequency spectrum band and the second carrier using a shared radio frequency spectrum
9 band;
10 perform a listen before talk (LBT) procedure to determine availability of the
11 second carrier for transmissions during the TTI; and
12 allocate a total transmission power for the TTI across the first carrier and the
13 second carrier based at least in part on a type of control channel for transmission of control
14 information during the TTI, an outcome of the LBT procedure, a timing of the LBT
15 procedure relative to the TTI, one or more other transmissions to be transmitted during the
16 TTI, or any combination thereof.

1 23. The apparatus of claim 22, wherein the instructions further comprise
2 instructions executable by the processor to cause the apparatus to prioritize the first carrier
3 and the second carrier for power allocation based at least in part on a payload of the control
4 information.

1 24. The apparatus of claim 22, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmission in a first subframe and a second
3 subframe that is after the first subframe, and the first carrier is scheduled for transmission in
4 the second subframe, and

5 wherein the instructions executable by the processor to allocate a total
6 transmission power for the TTI across the first carrier and the second carrier comprise
7 instructions executable by the processor to:

8 prioritize the second carrier to provide a first portion of the total
9 transmission power to the second carrier irrespective of the scheduled transmission on the
10 first carrier; and

11 allocate a difference between the total transmission power and the first
12 portion of the total transmission power to the first carrier.

1 25. The apparatus of claim 22, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmission in a first subframe and a second
3 subframe that is after the first subframe, and the first carrier is scheduled for transmission in
4 the second subframe, and

5 wherein the instructions executable by the processor to allocate a total
6 transmission power for the TTI across the first carrier and the second carrier comprise
7 instructions executable by the processor to:
8 determine a first portion of the total transmission power to be allocated
9 to the second carrier irrespective of the scheduled transmission of the first carrier;
10 reduce the first portion of the total transmission power based at least in
11 part on a parameter associated with a transmission using the second carrier;
12 allocate the reduced first portion of the total transmission power to the
13 second carrier for each of the plurality of subframes; and
14 allocate a difference between the total transmission power and the reduced
15 first portion of the total transmission power to the first carrier.

1 26. The apparatus of claim 22, wherein the parameter associated with the
2 transmission using the second carrier comprises a modulation and coding scheme (MCS), a
3 redundancy version identification (RV ID), a power loss (PL) measurement, or any
4 combination thereof.

1 27. The apparatus of claim 22, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmission in a first subframe and a second
3 subframe that is after the first subframe, and the first carrier is scheduled for transmission in
4 the second subframe, and

5 wherein the instructions executable by the processor to allocate a total
6 transmission power for the TTI across the first carrier and the second carrier comprise
7 instructions executable by the processor to:
8 determine whether the second carrier is scheduled for transmission in a
9 third subframe of the plurality of subframes after the second subframe;
10 drop the first carrier in the second subframe; and
11 allocate the total transmission power to the second carrier.

1 28. The apparatus of claim 22, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmission in a first subframe and a second
3 subframe that is after the first subframe, and the first carrier is scheduled for transmission in
4 the second subframe, and

5 wherein the instructions executable by the processor to allocate a total
6 transmission power for the TTI across the first carrier and the second carrier comprise
7 instructions executable by the processor to:
8 determine that control information and shared channel information is
9 scheduled to be transmitted on the first carrier during the second subframe;
10 divert a portion of the total transmission power to the first carrier;
11 transmit the control information using the first carrier; and
12 drop the shared channel information scheduled to be transmitted on the
13 first carrier.

1 29. The apparatus of claim 22, wherein the TTI comprises a plurality of
2 subframes, the second carrier is scheduled for transmission in a first subframe and a second
3 subframe that is after the first subframe, and the first carrier is scheduled for transmission in
4 the second subframe, and

5 wherein the instructions executable by the processor to allocate a total
6 transmission power for the TTI across the first carrier and the second carrier comprise
7 instructions executable by the processor to:
8 determine that control information and shared channel information is
9 scheduled to be transmitted on the first carrier during the second subframe and that only
10 shared channel information is scheduled to be transmitted on the second carrier during the
11 second subframe;
12 divert a first portion of the total transmission power to the first carrier;
13 allocate a difference between the total transmission power and the first
14 portion of the total transmission power to the second carrier;
15 transmit the control information and shared channel information using
16 the first carrier; and
17 transmit shared channel information scheduled to be transmitted on the
18 second carrier.

1 30. The apparatus of claim 29, wherein a ratio of the total transmission
2 power to divert is based at least in part on whether channel state information (CSI) is to be
3 transmitted using the second carrier.

1 31. The apparatus of claim 22, wherein the TTI comprises a plurality of
2 subframes and each of the first carrier and the second carrier are scheduled for transmission
3 in a first subframe immediately following completion of the LBT procedure, and
4 wherein the instructions further comprise instructions executable by the
5 processor to pre-allocate, prior to performing the LBT procedure, a first portion of the total
6 transmission power to the first carrier and a difference between the total transmission power
7 and the first portion of the total transmission power to the second carrier.

1 32. The apparatus of claim 31, wherein a ratio between the first portion
2 and the total transmission power is determined based at least in part on whether control
3 channel information is scheduled for transmission on one or more of the first carrier or
4 second carrier, or whether channel state information (CSI) is to be transmitted using a
5 physical uplink shared channel (PUSCH).

1 33. The apparatus of claim 31, wherein the instructions comprise
2 instructions executable by the processor to to:
3 transmit a first portion of a first subframe following the LBT procedure using
4 the pre-allocated transmission powers;
5 reallocate the total transmission power for the TTI across the first carrier and
6 the second carrier based at least in part on the outcome of the LBT procedure; and
7 transmit a remaining portion of the first subframe using the reallocated
8 transmission powers.

1 34. The apparatus of claim 22, wherein the TTI comprises a plurality of
2 subframes and each of the first carrier and the second carrier are scheduled for transmissions
3 in a first subframe and the LBT procedure is completed during the first subframe, and
4 wherein the instructions are operable, when executed by the processor, to
5 cause the apparatus to:
6 pre-allocate, prior to performing the LBT procedure, a first portion of
7 the total transmission power to the first carrier and a difference between the total transmission
8 power and the first portion of the total transmission power to the second carrier; and
9 transmitting on the first carrier during an entirety of the first subframe
10 using the first portion of the total transmission power regardless of the outcome of the LBT
11 procedure.

1 35. The apparatus of claim 22, wherein allocating the total transmission
2 power for the TTI across the first carrier and the second carrier is further based on whether
3 the first carrier is associated with a primary cell or a primary secondary cell.

1 36. An apparatus for wireless communication, in a system comprising:
2 a processor;
3 memory in electronic communication with the processor; and
4 instructions stored in the memory and operable, when executed by the
5 processor, to cause the apparatus to:
6 identify a user equipment (UE) capable of transmitting using both a first
7 carrier and a second carrier, the first carrier using a dedicated radio frequency spectrum band
8 and the second carrier using a shared radio frequency spectrum band;
9 allocate wireless resources of the first carrier and the second carrier to the UE
10 for uplink transmissions during a transmission time interval (TTI);
11 configure the UE to allocate a total transmission power for uplink
12 transmissions during the TTI across the first carrier and the second carrier based at least in
13 part on a timing for transmission of the control information, an outcome of the LBT
14 procedure, a timing of the LBT procedure relative to the TTI, one or more other
15 transmissions to be transmitted during the TTI, or any combination thereof; and
16 receive the uplink transmissions from the UE on at least one of first carrier and
17 the second carrier.

1 37. A non-transitory computer readable medium storing code for wireless
2 communication, the code comprising instructions executable by a processor to:
3 identify a first carrier and a second carrier that are scheduled for a
4 transmission in a transmission time interval (TTI), the first carrier using a dedicated radio
5 frequency spectrum band and the second carrier using a shared radio frequency spectrum
6 band;
7 perform a listen before talk (LBT) procedure to determine availability of the
8 second carrier for transmissions during the TTI; and
9 allocate a total transmission power for the TTI across the first carrier and the
10 second carrier based at least in part on a type of control channel for transmission of control
11 information during the TTI, an outcome of the LBT procedure, a timing of the LBT

12 procedure relative to the TTI, one or more other transmissions to be transmitted during the
13 TTI, or any combination thereof.

1 38. The non-transitory computer readable medium of claim 37, wherein
2 the TTI comprises a plurality of subframes, the second carrier is scheduled for transmission
3 in a first subframe and a second subframe that is after the first subframe, and the first carrier
4 is scheduled for transmission in the second subframe, and
5 wherein the code further comprises instructions executable by a processor to:
6 prioritize the second carrier to provide a first portion of the total
7 transmission power to the second carrier irrespective of the scheduled transmission on the
8 first carrier; and
9 allocate a difference between the total transmission power and the first
10 portion of the total transmission power to the first carrier.

1 39. The non-transitory computer readable medium of claim 37, wherein
2 the TTI comprises a plurality of subframes, the second carrier is scheduled for transmission
3 in a first subframe and a second subframe that is after the first subframe, and the first carrier
4 is scheduled for transmission in the second subframe, and
5 wherein the code further comprises instructions executable by a processor to:
6 determine whether the second carrier is scheduled for transmission in a
7 third subframe of the plurality of subframes after the second subframe;
8 drop the first carrier in the second subframe; and
9 allocate the total transmission power to the second carrier.

1 40. The non-transitory computer readable medium of claim 37, wherein
2 the TTI comprises a plurality of subframes and each of the first carrier and the second carrier
3 are scheduled for transmissions in a first subframe immediately following completion of the
4 LBT procedure, and
5 wherein the code further comprises instructions executable by a processor to
6 pre-allocate, prior to performing the LBT procedure, a first portion of the total transmission
7 power to the first carrier and a difference between the total transmission power and the first
8 portion of the total transmission power to the second carrier.

1 41. The non-transitory computer readable medium of claim 37, wherein
2 allocating the total transmission power for the TTI across the first carrier and the second

3 carrier is further based on whether the first carrier is associated with a primary cell or a
4 primary secondary cell.

1 42. A non-transitory computer readable medium storing code for wireless
2 communication, the code comprising instructions executable by a processor to:
3 identify a user equipment (UE) capable of transmitting using both a first
4 carrier and a second carrier, the first carrier using a dedicated radio frequency spectrum band
5 and the second carrier using a shared radio frequency spectrum band;
6 allocate wireless resources of the first carrier and the second carrier to the UE
7 for uplink transmissions during a transmission time interval (TTI);
8 configure the UE to allocate a total transmission power for uplink
9 transmissions during the TTI across the first carrier and the second carrier based at least in
10 part on a type of control channel for transmission of control information during the TTI, an
11 outcome of the LBT procedure, a timing of the LBT procedure relative to the TTI, one or
12 more other transmissions to be transmitted during the TTI, or any combination thereof; and
13 receive the uplink transmissions from the UE on at least one of first carrier and
14 the second carrier.