

CLAIMS

1. A device, comprising:
a control qubit;
a first target qubit coupled to the control qubit by a first mode-selective coupler that facilitates A-mode coupling; and
a second target qubit coupled to the control qubit by a second mode-selective coupler that facilitates B-mode coupling.
2. The device according to the preceding claim, wherein the control qubit, the first target qubit, and the second target qubit are two-junction transmon qubits.
3. The device according to the preceding claim, wherein the first mode-selective coupler comprises a capacitor that capacitively couples a middle capacitor pad of the control qubit to a middle capacitor pad of the first target qubit.
4. The device according to the preceding claim, wherein the capacitor has a capacitance that is less than shunting capacitance values of the control qubit and less than shunting capacitance values of the first target qubit.
5. The device according to any of the preceding claims and with features of claim 2, wherein the second mode-selective coupler comprises a first capacitor that capacitively couples an end capacitor pad of the control qubit to an end capacitor pad of the second target qubit and comprises a second capacitor that capacitively couples the end capacitor pad of the control qubit to a middle capacitor pad of the second target qubit.
6. The device according to the preceding claim, wherein the first capacitor has a first capacitance that is less than shunting capacitance values of the control qubit and less than shunting capacitance values of the second target qubit, and wherein the second capacitor has a second capacitance that is half the first capacitance.
7. The device according to any of the preceding claims, wherein the first target qubit and the second target qubit are degenerate targets.

8. The device according to the preceding claim, wherein the first target qubit entangles with the control qubit when the control qubit is driven by a first microwave tone corresponding to an A-mode excitation frequency of the degenerate targets, and wherein the second target qubit entangles with the control qubit when the control qubit is driven by a second microwave tone corresponding to a B-mode excitation frequency of the degenerate targets.
9. A method, comprising:
providing a control qubit;
coupling the control qubit to a first target qubit by a first mode-selective coupler that facilitates A-mode coupling; and
coupling the control qubit to a second target qubit by a second mode-selective coupler that facilitates B-mode coupling.
10. The method according to the preceding claim, wherein the control qubit, the first target qubit, and the second target qubit are two-junction transmon qubits.
11. The method according to the preceding claim, wherein the first mode-selective coupler comprises a capacitor that capacitively couples a middle capacitor pad of the control qubit to a middle capacitor pad of the first target qubit.
12. The method according to the preceding claim, wherein the capacitor has a capacitance that is less than shunting capacitance values of the control qubit and less than shunting capacitance values of the first target qubit.
13. The method according to any of the preceding claims and with features of claim 10, wherein the second mode-selective coupler comprises a first capacitor that capacitively couples an end capacitor pad of the control qubit to an end capacitor pad of the second target qubit and comprises a second capacitor that capacitively couples the end capacitor pad of the control qubit to a middle capacitor pad of the second target qubit.
14. The method according to the preceding claim, wherein the first capacitor has a first capacitance that is less than shunting capacitance values of the control qubit and less than shunting capacitance values of the second target qubit, and wherein the second capacitor has a second capacitance that is half the first capacitance.

15. The method according to any of the preceding claims 9 to 14, wherein the first target qubit and the second target qubit are degenerate targets.
16. The method according to the preceding claim, further comprising:
driving the control qubit with a first microwave tone corresponding to an A-mode excitation frequency of the degenerate targets, thereby entangling the first target qubit with the control qubit; and
driving the control qubit with a second microwave tone corresponding to a B-mode excitation frequency of the degenerate targets, thereby entangling the second target qubit with the control qubit.
17. An apparatus, comprising:
a first mode-selective coupler that facilitates A-mode coupling between a control qubit and a first target qubit; and
a second mode-selective coupler that facilitates B-mode coupling between the control qubit and a second target qubit.
18. The apparatus according to the preceding claim, wherein the first mode-selective coupler comprises a capacitor that couples a middle capacitor pad of the control qubit to a middle capacitor pad of the first target qubit, wherein a capacitance of the capacitor is less than shunting capacitance values of the control qubit and less than shunting capacitance values of the second target qubit.
19. The apparatus according to any of the preceding claims 17 to 18, wherein the second mode-selective coupler comprises a first capacitor that couples an end capacitor pad of the control qubit to an end capacitor pad of the second target qubit and comprises a second capacitor that couples the end capacitor pad of the control qubit to a middle capacitor pad of the second target qubit, wherein a first capacitance of the first capacitor is less than shunting capacitance values of the control qubit and less than shunting capacitance values of the second target qubit, and wherein a second capacitance of the second capacitor is half the first capacitance.
20. The apparatus according to any of the preceding claims 17 to 19, wherein the first target

qubit and the second target qubit are degenerate targets, wherein the first target qubit entangles with the control qubit when the control qubit is driven by a first microwave tone corresponding to an A-mode excitation frequency of the degenerate targets, and wherein the second target qubit entangles with the control qubit when the control qubit is driven by a second microwave tone corresponding to a B-mode excitation frequency of the degenerate targets.