CLAIMS

1. A device, comprising:

a first qubit having a first coupling capacitor and a second coupling capacitor;

a second qubit having a first coupling capacitor and a second coupling capacitor; and

a multi-resonant architecture comprising a first resonator that capacitively couples the first qubit to the second qubit through the first coupling capacitor of each of the first qubit and the second qubit, and a second resonator that capacitively couples the first qubit to the second qubit through the second coupling capacitor of each of the first qubit and the second qubit,

wherein the first qubit has a first operational frequency, wherein the second qubit has a second operational frequency, wherein the first resonator has a first resonant frequency that is less than the first operational frequency and the second operational frequency, and wherein the second resonator has a second resonant frequency that is greater than the first operational frequency and the second operational frequency.

2. The device of claim 1, wherein the first resonator and the second resonator are λ/2 resonators, and wherein the first resonator and the second resonator are in parallel.

3. The device of claim 2, wherein the first resonant frequency is about 3 gigahertz, wherein the second resonant frequency is about 6 gigahertz, and wherein the first operational frequency and the second operational frequency are between 4.5 gigahertz and 5.5 gigahertz.

4. The device of claim 1, wherein the first resonant frequency, the second resonant frequency, the first operational frequency, and the second operational frequency are fixed.

5. A device, comprising:

a first qubit;

a second qubit; and

a multi-resonant architecture comprising a resonator, wherein a first end of the resonator is capacitively coupled to the first qubit and to the second qubit, and wherein a second end of the resonator is coupled to ground, wherein the first qubit has a first operational frequency, wherein the second qubit has a second operational frequency, wherein the resonator has a first harmonic frequency that is less than the first operational frequency and the second

operational frequency, and wherein the resonator has a second harmonic frequency that is greater than the first operational frequency and the second operational frequency.

6. The device of claim 5, wherein the resonator is a λ/4 resonator.

7. The device of claim 6, wherein the first harmonic frequency is about 2 gigahertz, wherein the second harmonic frequency is about 6 gigahertz, and wherein the first operational frequency and the second operational frequency are between 4.5 gigahertz and 5.5 gigahertz.

8. The device of claim 5, wherein the first harmonic frequency, the second harmonic frequency, the first operational frequency, and the second operational frequency are fixed.

9. A device, comprising:

a first qubit;

a second qubit; and

a multi-resonant architecture comprising a resonator that capacitively couples the first qubit to the second qubit and a differential direct coupler that capacitively couples the first qubit to the second qubit, wherein the differential direct coupler capacitively couples opposite pads of the first qubit and the second qubit.

10. The device of claim 9, wherein the first qubit has a first operational frequency, wherein the second qubit has a second operational frequency, and wherein the resonator has a resonant frequency that is greater than the first operational frequency and the second operational frequency.

11. The device of claim 10, wherein the resonator is a λ/2 resonator, and wherein the resonator and the differential direct coupler are in parallel.

12. The device of claim 11, wherein the resonant frequency is about 6 gigahertz, and wherein the first operational frequency and the second operational frequency are between 4.5 gigahertz and 5.5 gigahertz.

13. The device of claim 10, wherein the resonant frequency, the first operational frequency, and the second operational frequency are fixed.

14. A device, comprising:

a first qubit having a first coupling capacitor and a second coupling capacitor;

a second qubit having a first coupling capacitor and a second coupling capacitor; and

a multi-resonant architecture comprising a resonator and a direct coupler, wherein a first end of the resonator is capacitively coupled to the first qubit and to the second qubit through the first coupling capacitor of each of the first qubit and the second qubit, wherein a second end of the resonator is coupled to ground, wherein the direct coupler capacitively couples the first qubit to the second qubit through the second coupling capacitor of each of the first qubit and the second qubit, and wherein the direct coupler capacitively couples common pads of the first qubit and the second qubit, wherein the direct coupler is a short section of transmission line having a resonance frequency greater than about 30 GHz, such that the direct coupler provides substantially frequency-independent coupling at transmon qubit frequencies of around 5 GHz, wherein the first qubit has a first operational frequency, wherein the second qubit has a second operational frequency, and wherein the resonator has a resonant frequency that is greater than the first operational frequency and the second operational frequency.

15. The device of claim 14, wherein the resonator is a λ/4 resonator.

16. The device of claim 15, wherein the resonant frequency is about 6 gigahertz, and wherein the first operational frequency and the second operational frequency are between 4.5 gigahertz and 5.5 gigahertz.

17. The device of claim 14, wherein the resonant frequency, the first operational frequency, and the second operational frequency are fixed.

18. An apparatus, comprising:

a first transmon qubit having a first operational frequency;

a second transmon qubit having a second operational frequency; and

a multi-resonant architecture comprising a λ/4 resonator, wherein a first end of the λ/4 resonator is coupled between coupling capacitors of the first transmon qubit and the second transmon qubit, wherein a second end of the λ/4 resonator is shorted to ground, wherein a first harmonic of the λ/4 resonator is a first resonant frequency less than the first operational

frequency and the second operational frequency, and wherein a second harmonic of the λ/4 resonator is a second resonant frequency greater than the first operational frequency and the second operational frequency.

19. The apparatus of claim 18, wherein the first harmonic is about 2 gigahertz, and wherein the second harmonic is about 6 gigahertz.