

Chapter 12

Electron Spin Qubit in Semiconductor-1-Qubit and 2-Qubit Gates

12.1 Introduction

In Chap.11, we showed how to implement a qubit using electron spin on a silicon substrate. We also demonstrated how to initialize and measure a qubit. In this chapter, we will study how to perform a universal 1-qubit gate and a 2-qubit entanglement gate to fulfill the last two DiVincenzo's criteria (Sect. 1.3). In Chap.10, we showed that by applying a vertical DC magnetic field and a rotating horizontal magnetic field and then *working in the rotating frame*, we would be able to rotate any state on Bloch sphere about any vector. This allows us to build a universal 1-qubit gate (Section 27.4 in [1]) However, in the literature, many silicon qubits are still implemented with the setup in Chap. 9 which means that the qubit is placed in a vertical DC magnetic field and a perturbing and linearly oscillating horizontal magnetic field. This is what we will use in this chapter. We will first summarize an experimental paper on how it implements 1-qubit gate. Then we will discuss the implementation of a 2-qubit entanglement gate with an example.

References

1. Hui-Yong, W. *Introduction to Quantum Computing Holes* (Springer, London, 2024).