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QuIDE – Quantum IDE

USER MANUAL

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1 About QuIDE

QuIDE is a software tool, which allows to simulate quantum computations – it can be classified as a quantum computer simulator or a quantum circuit simulator.

QuIDE enables users to build quantum circuits graphically or using the source code in C# programming language. At any time it is possible to generate the graphical quantum circuit from the source code, and vice versa.

2 System and hardware requirements

2.1 Operating system

QuIDE can be run on the following Microsoft Windows systems (or higher):

- Windows Vista SP2
- Windows 7 SP1 (or higher)
- Windows 8
- Windows 8.1

Both 32-bit and 64-bit systems are supported.

2.2 .NET Framework

QuIDE requires the runtime environment of the Microsoft .NET Framework 4.5.1 or higher installed.

Windows 8.1 includes the .NET Framework 4.5.1, so there is no need to install it separately.

In case of the other, older systems, it is necessary to download and install the Microsoft .NET Framework runtime from the Microsoft website.

2.3 Hardware requirements

Minimal hardware requirements for the .NET Framework 4.5.1 are:

- Processor: **1 GHz**
- RAM: **512 MB**
- Disk space (minimum):
 - 32-bit: **850 MB**
 - 64-bit: **2 GB**

3 Installation

QuIDE is available on the official project website: <http://www.quide.eu/>.

QuIDE can be downloaded as a zipped file. After unzipping the file, we have to run the **setup.exe**. QuIDE will be then automatically installed. After that, it will be available in the Start menu.

4 Getting started

4.1 User interface

The graphical user interface is in the form of the Integrated Development Environment (IDE). In a one window, the following sub-windows are available:

- The Source Code Editor
- The Interactive Circuit Designer
- The Console Output Tab
- The Run-Time Preview of the internal quantum state
- The Properties Panel

Each of these sub-windows can be hidden, moved or resized.

These all elements are presented in Figure 1.

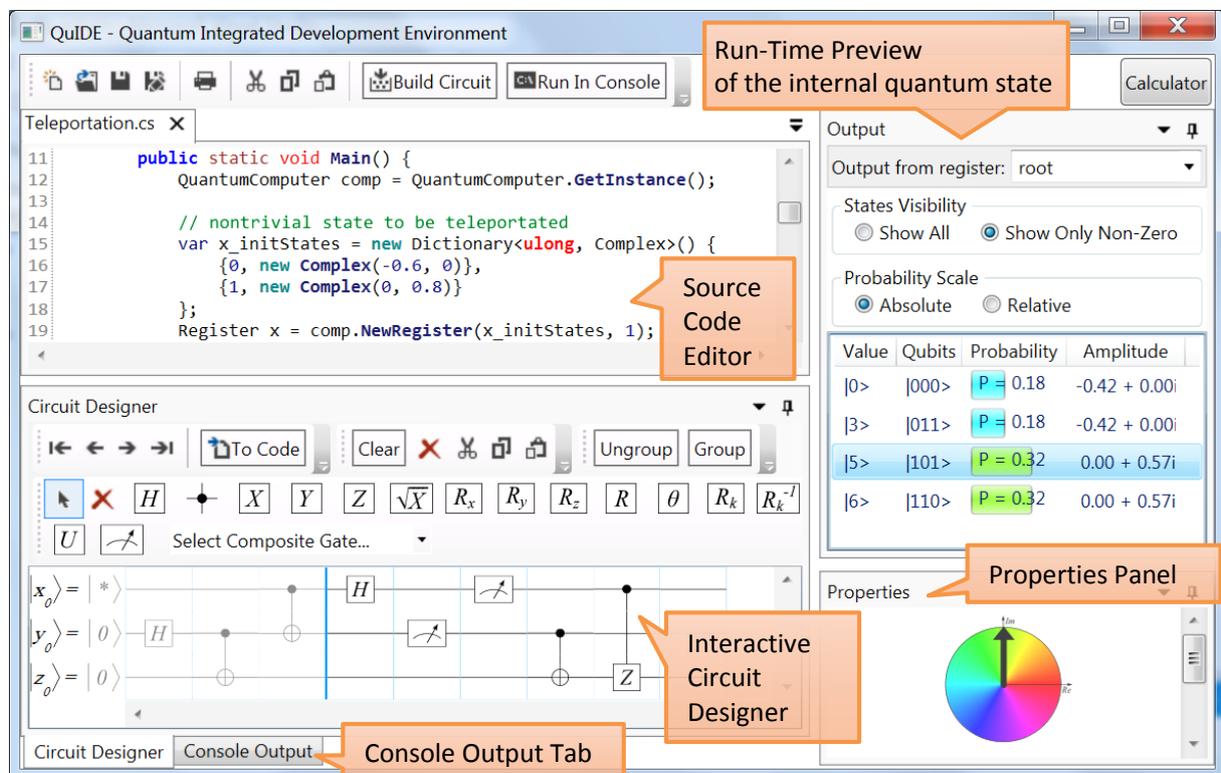
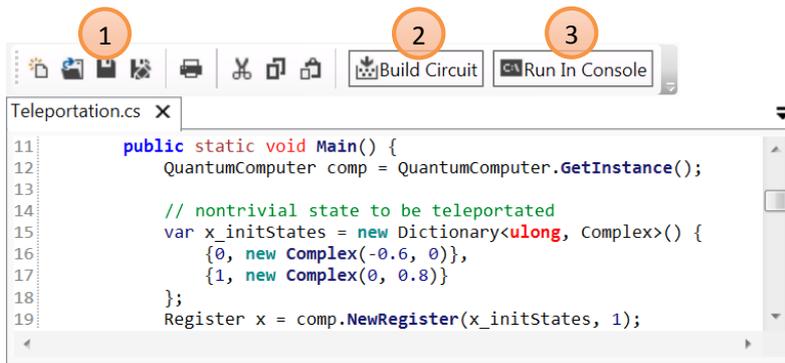


Figure 1. QuIDE graphical user interface

4.1.1 Source Code Editor

It is a standard editor, supporting the syntax highlighting for the C# programming language. It allows to work with many files at the same time, by opening them in separate tabs.



After clicking the button [Build Circuit] **(2)**, the graphical circuit is generated from the source code (from the active tab in the editor). The generated circuit is shown in the *Interactive Circuit Designer* and is available for editing.

The source code from the active tab in the editor can be also run directly in the console, by clicking the button [Run In Console] **(3)**. The standard output of the executed program is printed in the *Console Output Tab*.

The editor supports many useful keyboard shortcuts such as Ctrl+C (copy), Ctrl+V (paste), Ctrl+Z (undo), Ctrl+Y (redo), Ctrl+N (new file), Ctrl+O (open), Ctrl+S (save) etc..

4.1.2 Interactive Circuit Designer

In this graphical editor we can build the quantum circuits, which consist of quantum gates applied to quantum bits (qubits).

The example quantum circuit build in QuIDE is presented in Figure 2.

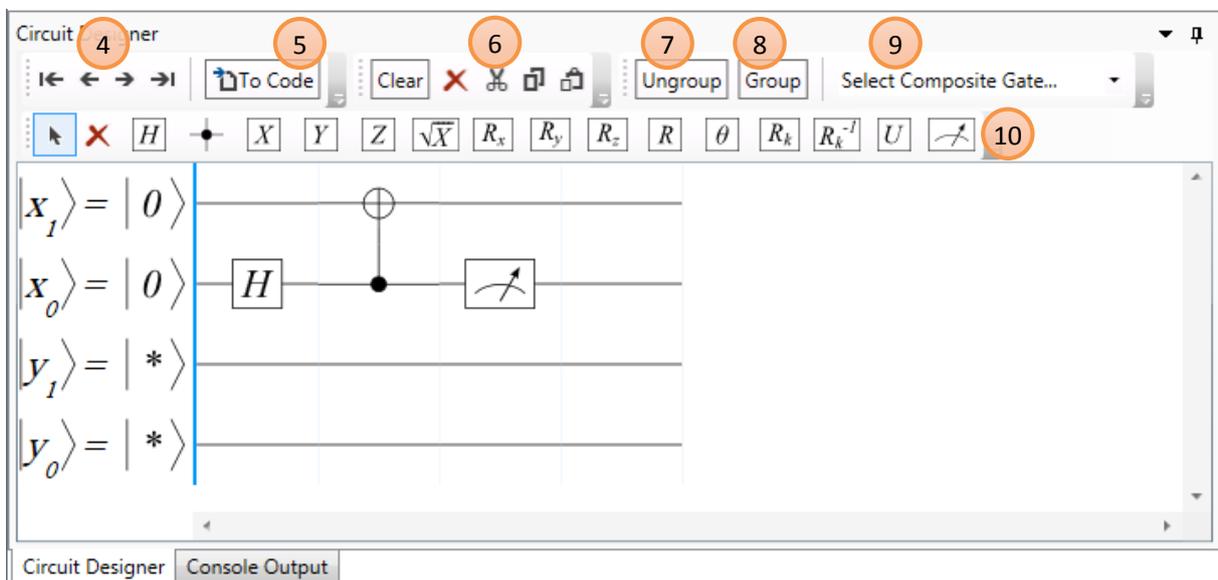


Figure 2. Example quantum circuit in QuIDE

4.1.2.1 Quantum Registers

The circuit in Figure 2 consists of two quantum registers: $|x\rangle$ and $|y\rangle$. Each of them consists of two qubits: $|x_0\rangle$ and $|x_1\rangle$, as well as $|y_0\rangle$ and $|y_1\rangle$. Always, the qubit with the index 0 is the Least Significant Bit of the register. Having many registers, the Least Significant Bit is the qubit at the bottom of the circuit.

The qubits of the $|x\rangle$ register are initialized to the pure basis states – in this case, to 0. The qubits of the $|y\rangle$ register are in the so-called mixed state – it is impossible to determine their values. In order to view or edit the state of this register, we need to right-click it and choose the *Edit...* option from the context menu.

Every register and qubit can be modified by right-clicking it and choosing one of the options:

- Edit...
- Insert Qubit Above
- Insert Qubit Below
- Insert Register Above
- Insert Register Below
- Delete Qubit
- Delete Register

4.1.2.2 Quantum Gates

The quantum gates represent the operations which can be applied to quantum bits. The typical quantum gates are available in the toolbar above the *Interactive Circuit Designer* **(10)**.

The circuit in Figure 2 starts with the application of the Hadamard gate (noted as H) to the qubit $|x_0\rangle$. Then, there is the C-Not gate, for which the control qubit is $|x_0\rangle$, and the target qubit is $|x_1\rangle$. In the next step, the qubit $|x_0\rangle$ is measured.

The quantum gates are executed from the left to right. The gates in the same column are executed simultaneously – they form a single step of a simulation.

In order to add a quantum gate, we have to choose a gate from the toolbar **(10)**, and then click on the empty place of the circuit. If the gate requires specifying some additional arguments (e.g. angle value for a rotation gate), the dialog window is shown. After typing the correct values, the gate is inserted.

Each gate can be a controlled gate – we can add to it a control qubit. For example, the Not gate (X), after adding a control qubit becomes a C-Not gate (a controlled Not gate). In order to add a control qubit, we

need to choose the option “Add control bit” () from the toolbar **(10)**. Then, we have to left-click in the circuit, in the place of the planned control qubit. With the left mouse button clicked, we drag and drop to the gate to which we are adding a control qubit. After releasing the mouse button, the control qubit is added. The control qubit and the controlled gate are required to be in the same column. The quantum gates X , R_k and R_k^{-1} can have more than one control qubit.

The gates can be selected – by using the selection tool () from the toolbar **(10)** or by holding the [Shift] key – and by dragging the mouse over the circuit with the left button pressed. The selected gates can be cut, copied, pasted or deleted by using the buttons from toolbar **(6)** or via common keyboard shortcuts.