

The tikz-quantumgates Package: Drawing quantum circuits with TikZ

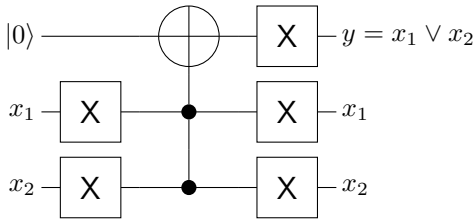
Matthias Wolff^[0000-0002-3895-7313]

BTU Cottbus-Senftenberg

August 20, 2018

Abstract

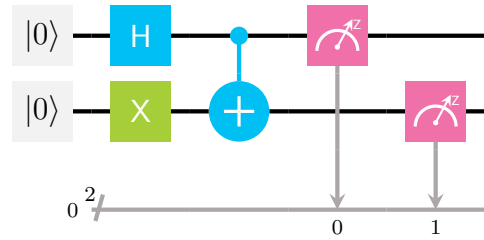
This package provides macros for drawing quantum gates and circuits with TikZ [1].



```

1 \documentclass{standalone}
2 \usepackage{tikz-quantumgates}
3 \begin{document}
4   \centering
5   \begin{tikzpicture}
6     \node[anchor=east] at (-0.6,2) {\$|0\rangle\$};
7     \node[anchor=east] at (-0.6,1) {\$x_1\$};
8     \node[anchor=east] at (-0.6,0) {\$x_2\$};
9     \qwire{0}{2}\qgateX{0}{1}\qgateX{0}{0}
10    \qgateCNC{b}{1}{2}\qgateCNC{bt}{1}{1}\qgateCNC{t}{1}{0}
11    \qgateX{2}{2}\qgateX{2}{1}\qgateX{2}{0}
12    \node[anchor=west] at (3.2,2) {\$y=x_1\vee x_2\$};
13    \node[anchor=west] at (3.2,1) {\$x_1\$};
14    \node[anchor=west] at (3.2,0) {\$x_2\$};
15  \end{tikzpicture}
16 \end{document}

```



```

1 \documentclass{standalone}
2 \usepackage{tikz-quantumgates}
3 \begin{document}
4   \centering
5   \begin{tikzpicture}
6     \node[anchor=east] at (0.6,-0.3) {\footnotesize 0};
7     \qzero[ibmqx]{0}{2}\qzero[ibmqx]{0}{1}
8     \qgateH[ibmqx]{1}{2}\qgateX[ibmqx]{1}{1}\qmeasBh[ibmqx]{2}{1}{0}
9     \qgateCNC[ibmqx]{b}{2}{2}\qgateCNC[ibmqx]{t}{2}{1}\qmeasB[ibmqx]{2}{0}
10    \qmeasM[ibmqx]{3}{2}\qmeasR[ibmqx]{3}{1}\qmeasMB[ibmqx]{0}{3}{0}
11    \qwire[ibmqx]{4}{2}\qmeasM[ibmqx]{4}{1}\qmeasMB[ibmqx]{1}{4}{0}
12  \end{tikzpicture}
13 \end{document}



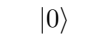

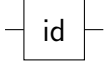

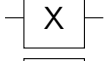



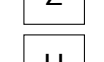

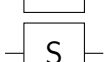

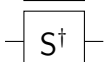

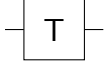

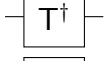

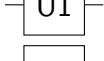

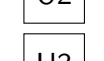





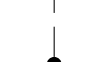

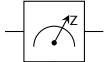





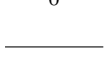
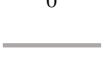


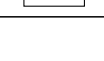





```

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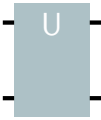
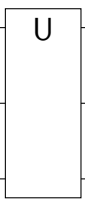

1 Overview

1.1 List of Circuit Symbols

Standard	Option ibmqx	Command
		<code>\qwire[option]{x}{y}</code>
		<code>\qzero[option]{x}{y}</code>
		<code>\qgateID[option]{x}{y}</code>
		<code>\qgateX[option]{x}{y}</code>
		<code>\qgateY[option]{x}{y}</code>
		<code>\qgateZ[option]{x}{y}</code>
		<code>\qgateH[option]{x}{y}</code>
		<code>\qgateS[option]{x}{y}</code>
		<code>\qgateSi[option]{x}{y}</code>
		<code>\qgateT[option]{x}{y}</code>
		<code>\qgateTi[option]{x}{y}</code>
		<code>\qgateUa[option]{x}{y}</code>
		<code>\qgateUb[option]{x}{y}</code>
		<code>\qgateUc[option]{x}{y}</code>
		<code>\qgateCNX[option]{cwires}{x}{y}</code>
		<code>\qgateCNR[option]{x}{y}</code>
		<code>\qgateCNC[option]{cwires}{x}{y}</code>
		<code>\qmeasM[option]{x}{y}</code>
		<code>\qmeasR[option]{x}{y}</code>
		<code>\qmeasMB[option]{b}{x}{y}</code>
		<code>\qmeasB[option]{x}{y}</code>
		<code>\qmeasBh[option]{b}{x}{y}</code>
		<code>\qgateU[option]{x}{y}{label}</code>

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Standard	Option ibmqx	Command
		<code>\qgateUu[option]{x}{y}{label}</code>
		<code>\qgateUuu[option]{x}{y}{label}</code>

1.2 Installation

Download `tikz-quantumgates.sty` from [2] file into your project folder and include the package with `\usepackage{tikz-quantumgates}`.

2 Documentation of Commands

2.1 Wire and State Preparation Symbols

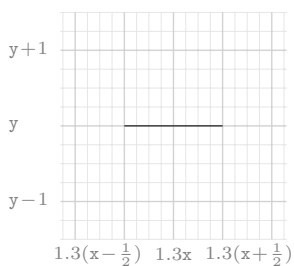
`\qwire[option]{x}{y}`

Draws a wire.

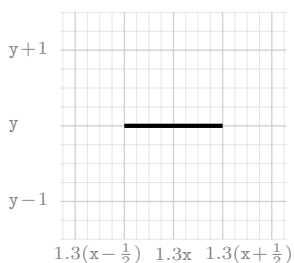
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x, y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qwire{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qwire[ibmqx]{0}{0}
4 \end{tikzpicture}
```

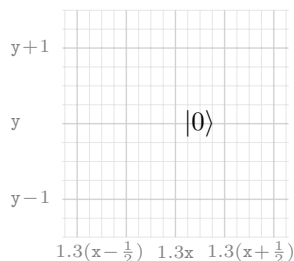
`\qzero[option]{x}{y}`

Draws the zero-state preparator.

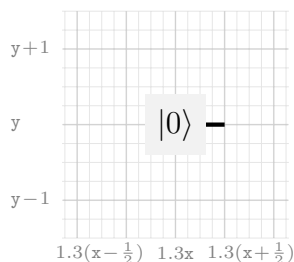
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qzero{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qzero[ibmqx]{0}{0}
4 \end{tikzpicture}
```

2.2 Single-Qubit Gate Symbols

`\qgateU[option]{x}{y}{label}`

Draws a general single-qubit quantum gate.

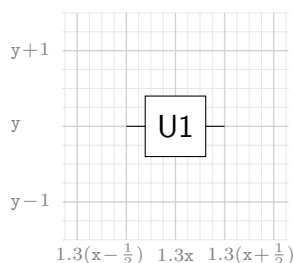
Parameters

- option** Omit for standard circuit styling or `ibmqxA`, ..., `ibmqxH` for IBM Q Experience circuit styling. The last letter of `ibmqx*` defines the color of the gate symbol:

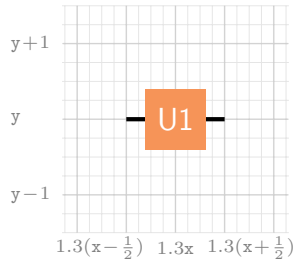
A B C D E F G H

- x, y** Coordinates of anchor point
- label** Gate label.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateU{0}{0}{U1}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateU[ibmqxA]{0}{0}{U1}
4 \end{tikzpicture}
```

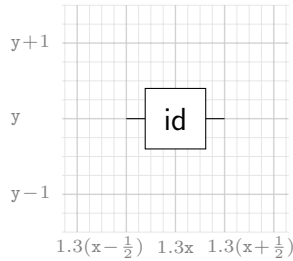
`\qgateID[option]{x}{y}`

Draws the identity gate.

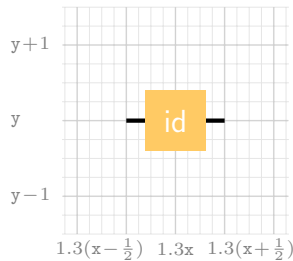
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x, y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateID{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateID[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$I \doteq \left(\begin{array}{c|cc} & \langle 0| & \langle 1| \\ \hline |0\rangle & 1 & 0 \\ |1\rangle & 0 & 1 \end{array} \right)$$

`\displaystyle I\dotseq\qgateOID`

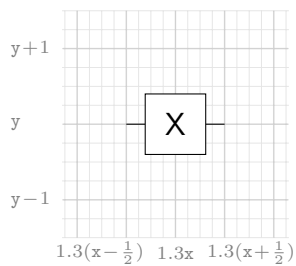
`\qgateX[option]{x}{y}`

Pauli-X gate.

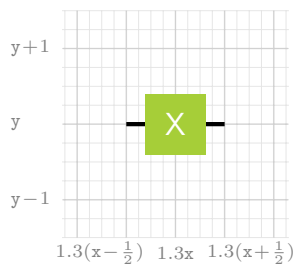
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x, y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateX{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateX[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$X \doteq \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & 0 & 1 \\ |1\rangle & 1 & 0 \end{pmatrix}$$

1 $\displaystyle X \doteq \qgate{0}{0}$

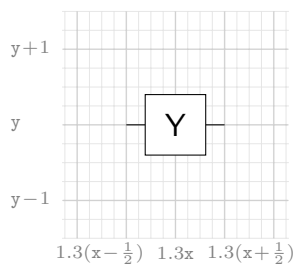
`\qgateY[option]{x}{y}`

Pauli-Y gate.

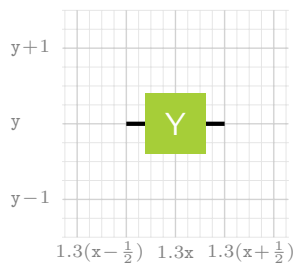
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x`, `y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateY{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateY[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$Y \doteq \begin{pmatrix} & | & \langle 0| & \langle 1| \\ \hline |0\rangle & 0 & -i \\ |1\rangle & i & 0 \end{pmatrix} \quad \text{1} \quad \text{\texttt{\$}\displaystyle Y\doteq\qgate0Y \$}$$

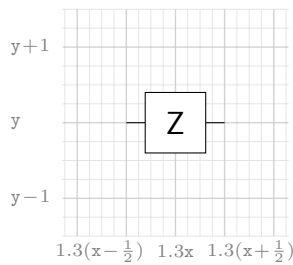
`\qgateZ[option]{x}{y}`

Pauli-Z gate.

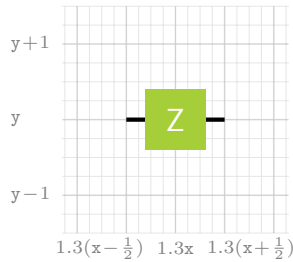
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x, y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateZ{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateZ[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$Z \doteq \begin{pmatrix} & | & \langle 0| & \langle 1| \\ \hline |0\rangle & 1 & 0 \\ |1\rangle & 0 & -1 \end{pmatrix} \quad \text{1} \quad \text{\texttt{\$}\displaystyle Z\doteq\qgate0Z \$}$$

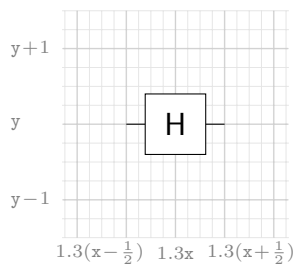
`\qgateH[option]{x}{y}`

Hadamard gate.

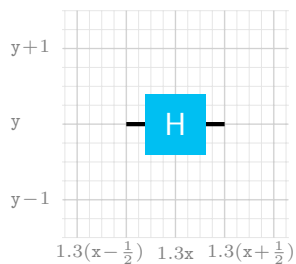
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x, y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateH{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateH[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$H \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & 1 & 1 \\ |1\rangle & 1 & -1 \end{pmatrix}$$

```
1 $\displaystyle H\dotseq\qgateOH$
```

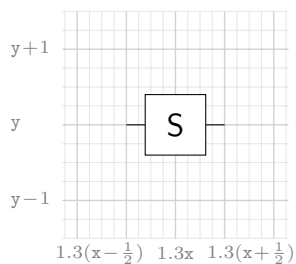
`\qgateS[option]{x}{y}`

S phase gate.

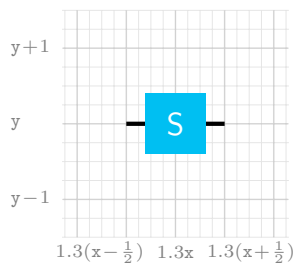
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateS{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateS[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$S = \sqrt{Z} \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} | & \langle 0| & \langle 1| \\ |0\rangle & 1 & 0 \\ |1\rangle & 0 & i \end{pmatrix}$$

```
1  $\displaystyle S=\sqrt{Z}\doteq\qgate{0}{0}$ 
```

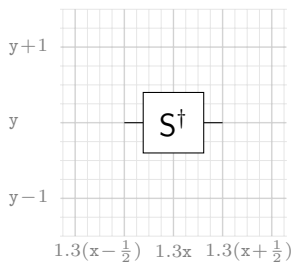
`\qgateSi[option]{x}{y}`

Inverse S phase gate.

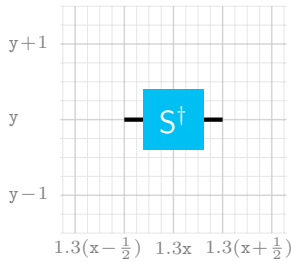
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x, y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateSi{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateSi[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$S^\dagger \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} | & \langle 0| & \langle 1| \\ |0\rangle & 1 & 0 \\ |1\rangle & 0 & -i \end{pmatrix}$$

```
1  $\displaystyle S^\dagger\doteq\qgate{0}{Si}$ 
```

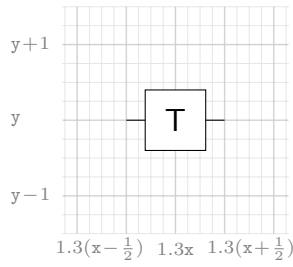
`\qgateT[option]{x}{y}`

T phase gate.

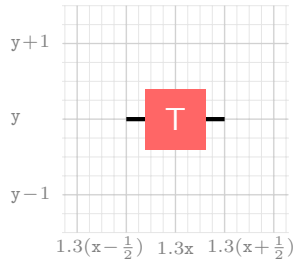
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x, y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateT{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateT[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$T = \sqrt{S} \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} | & \langle 0| & \langle 1| \\ \hline |0\rangle & 1 & 0 \\ |1\rangle & 0 & \frac{1}{\sqrt{2}}(1+i) \end{pmatrix}$$

```
1 $\displaystyle T=\sqrt{S}\doteq\qgateOT$
```

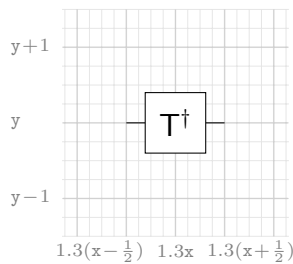
`\qgateTi[option]{x}{y}`

Inverse T phase gate.

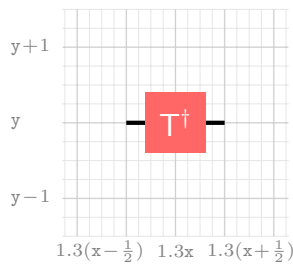
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateTi{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateTi[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$T^\dagger \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & 1 & 0 \\ |1\rangle & 0 & \frac{1}{\sqrt{2}}(1-i) \end{pmatrix} \quad \text{\textcolor{violet}{\code{\displaystyle T^\dagger\doteq\gate{0Ti}}}}$$

2.3 Single-Qubit Physical Gate of IBM Q Experience

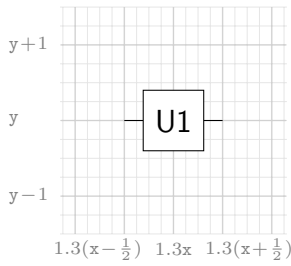
`\qgateUa[option]{x}{y}`

U1 gate of IBM Q Experience.

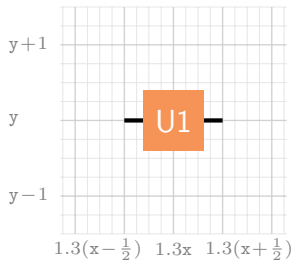
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
x, y Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUa{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUa[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$U1_\lambda \doteq \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & 1 & 0 \\ |1\rangle & 0 & e^{i\lambda} \end{pmatrix} \quad \text{\textcolor{violet}{\code{\displaystyle U1_{\lambda}\doteq\gate{0Ua}}}}$$

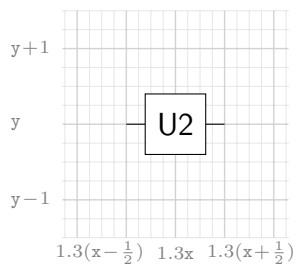
`\qgateUb[option]{x}{y}`

U2 gate of IBM Q Experience.

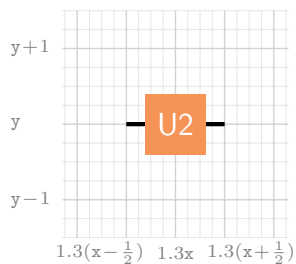
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
x, y Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUb{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUb[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$U_{2,\lambda,\phi} \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & 1 & e^{\lambda i} \\ |1\rangle & e^{\phi i} & e^{(\lambda+\phi)i} \end{pmatrix}$$

```
1 $\displaystyle U_{2,\{\lambda,\phi\}}\doteq\qgateUb $
```

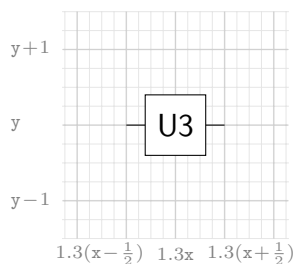
`\qgateUc[option]{x}{y}`

U3 gate of IBM Q Experience.

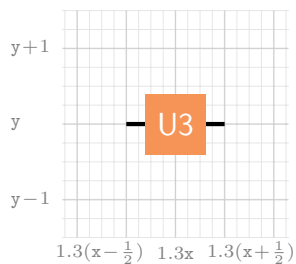
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUc{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUc[ibmqx]{0}{0}
4 \end{tikzpicture}
```

Gate Operator

$$U_{3,\lambda,\phi,\theta} \doteq \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & \cos(\frac{\theta}{2}) & \sin(\frac{\theta}{2})e^{i\lambda} \\ |1\rangle & \sin(\frac{\theta}{2})e^{i\phi} & \cos(\frac{\theta}{2})e^{i(\lambda+\phi)} \end{pmatrix} \quad \text{\texttt{\textbackslash doteq\qgateUuc}}$$

2.4 Multiple-Qubit Gate Symbols

`\qgateUu[option]{x}{y}{label}`

General three-qubit gate.

Parameters

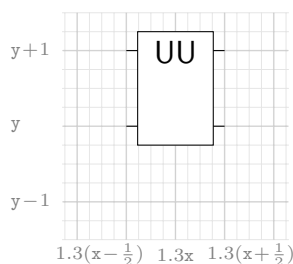
option Omit for standard circuit styling or `ibmqxA`, ..., `ibmqxH` for IBM Q Experience circuit styling. The last letter of `ibmqx*` defines the color of the gate symbol:

A B C D E F G H

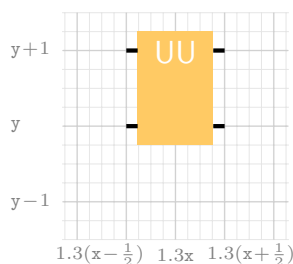
x, y Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

label Gate label.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUu{0}{0}{UU}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUu[ibmqxB]{0}{0}{UU}
4 \end{tikzpicture}
```

`\qgateUuu[option]{x}{y}{label}`

General three-qubit gate.

Parameters

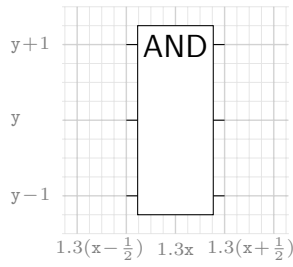
option Omit for standard circuit styling or `ibmqxA`, ..., `ibmqxH` for IBM Q Experience circuit styling. The last letter of `ibmqx*` defines the color of the gate symbol:

A B C D E F G H

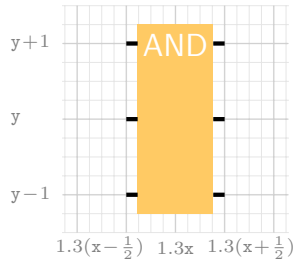
x, y Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

label Gate label.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUuu{0}{0}{AND}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUuu[ibmqxB]{0}{0}{AND}
4 \end{tikzpicture}
```

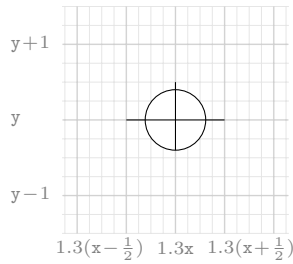
`\qgateCNX[option]{cwires}{x}{y}`

XOR symbol of controlled-NOT gate.

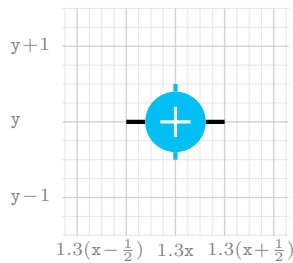
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- cwires** Control wires, `t` for top, `b` for bottom, and `tb` for both sides.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNX{t}{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNX[ibmqx]{tb}{0}{0}
4 \end{tikzpicture}
```

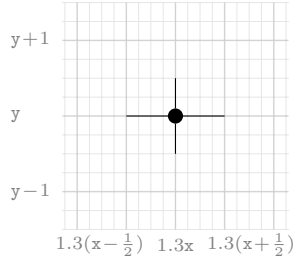
`\qgateCNC[option]{cwires}{x}{y}`

Control qubit symbol of controlled-NOT gate.

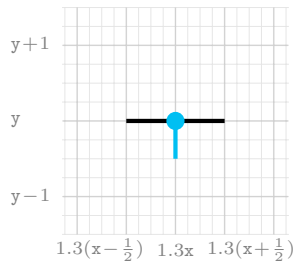
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- cwires** Control wires, `t` for top, `b` for bottom, and `tb` for both sides.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNC{bt}{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNC[ibmqx]{b}{0}{0}
4 \end{tikzpicture}
```

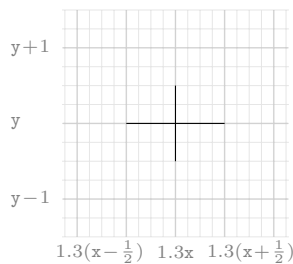
`\qgateCNR[option]{x}{y}`

Run-through qubit symbol of controlled-NOT gate.

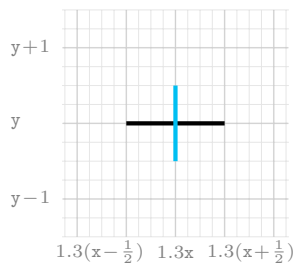
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNR{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNR[ibmqx]{0}{0}
4 \end{tikzpicture}
```


2.5 Measurement Symbols

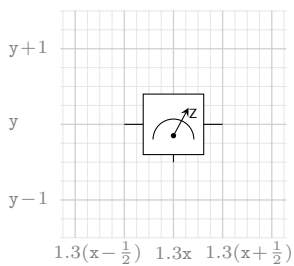
`\qmeasM[option]{x}{y}`

Measurement symbol.

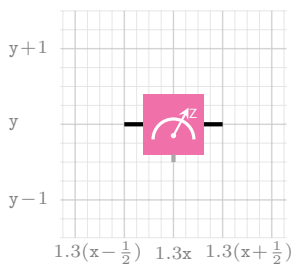
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasM{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasM[ibmqx]{0}{0}
4 \end{tikzpicture}
```

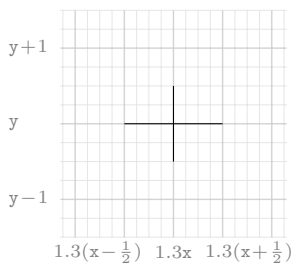
`\qmeaR[option]{x}{y}`

Measurement run-through qubit symbol.

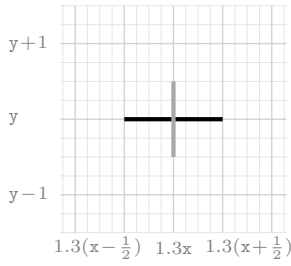
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeaR{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasR[ibmqx]{0}{0}
4 \end{tikzpicture}
```

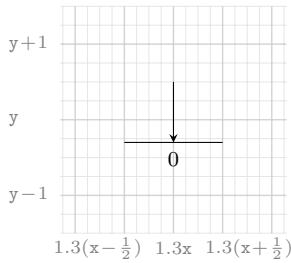
`\qmeasMB[option]{b}{x}{y}`

Measurement-joins-bus symbol.

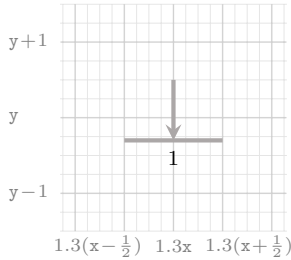
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- b** Bit identifier on conventional bits bus.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasMB{0}{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasMB[ibmqx]{1}{0}{0}
4 \end{tikzpicture}
```

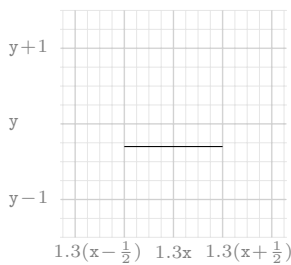
`\qmeaB[option]{x}{y}`

Measurement bus symbol.

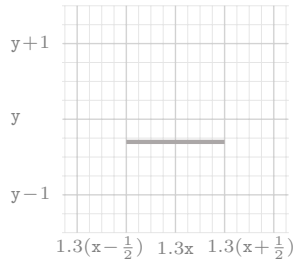
Parameters

- option** Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- x, y** Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasB{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasB[ibmqx]{0}{0}
4 \end{tikzpicture}
```

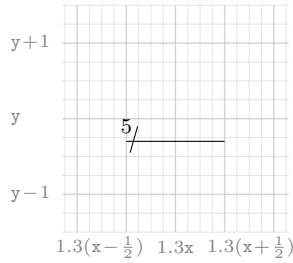
`\qmeaBh[option]{b}{x}{y}`

Measurement bus header symbol.

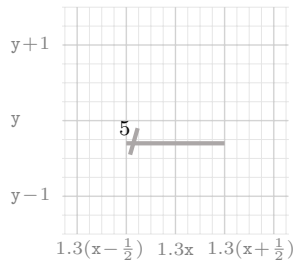
Parameters

- `option` Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.
- `x`, `y` Position of symbol in schematic. The actual TikZ coordinates are $(1.3x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasBh{5}{0}{0}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasBh[ibmqx]{5}{0}{0}
4 \end{tikzpicture}
```

2.6 Further Gate Operators

CNOT Gate Operator

$$CNOT \doteq \left(\begin{array}{c|cccc} & \overline{00} & \overline{01} & \overline{10} & \overline{11} \\ \hline |00\rangle & 1 & 0 & 0 & 0 \\ |01\rangle & 0 & 1 & 0 & 0 \\ |10\rangle & 0 & 0 & 0 & 1 \\ |11\rangle & 0 & 0 & 1 & 0 \end{array} \right)$$

```
1 $\displaystyle CNOT\dotseq\qgateOCNOT$
```

Toffoli (CCNOT) Gate Operator

$$CCNOT \doteq \begin{pmatrix} & |000\rangle & |001\rangle & |010\rangle & |011\rangle & |100\rangle & |101\rangle & |110\rangle & |111\rangle \\ \hline |000\rangle & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ |001\rangle & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ |010\rangle & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ |101\rangle & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ |100\rangle & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ |101\rangle & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ |110\rangle & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ |111\rangle & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{pmatrix} \quad \text{\texttt{\textcolor{blue}{\displaystyle CCNOT\dotseq\qgateOCCNOT}}}$$

3 The Package Source Code

```

1%% == LaTeX PACKAGE tikz-quantumgates =====
2%%   Drawing quantum circuits with TikZ
3%%
4%% Matthias Wolff, BTU Cottbus-Sentenberg
5%% August 20, 2018
6%%
7%% References:
8%% [1] T. Tantau. TikZ & PGF - Manual for Version 3.0.1a. 2015.
9%%   http://mirror.ctan.org/graphics/pgf/base/doc/pgfmanual.pdf Retrieved
10%%   July 22, 2018.
11%%
12
13%% == REQUIRED PACKAGES =====
14
15\RequirePackage{xifthen}
16\RequirePackage{tikz}
17
18%% == TikZ STYLES AND COLORS =====
19
20% \tikzset{
21%   tdplotCsFront/.style={solid},
22%   tdplotCsBack/.style={dashed},
23%   tdplotCsFill/.style={opacity=0},
24%   tdplotPtFront/.style={},
25%   tdplotPtBack/.style={},
26%   tdplotCsDrawAux/.style={}
27% }
28
29\def\sx{1.3}
30
31\definecolor{ibmqxA}{HTML}{F69458}
32\definecolor{ibmqxB}{HTML}{FFCA64}
33\definecolor{ibmqxC}{HTML}{A6CE38}
34\definecolor{ibmqxD}{HTML}{00BFF2}
35\definecolor{ibmqxE}{HTML}{FF6666}
36\definecolor{ibmqxF}{HTML}{F070AA}
37\definecolor{ibmqxG}{HTML}{ADC1C6}
38\definecolor{ibmqxH}{HTML}{F2F2F2}
39\definecolor{ibmqxI}{HTML}{ABA7A7}
40
41%% == COMMANDS =====
42
43% Wire
44\newcommand{\qwire}[3][]{\%
45  \pgfmathsetmacro\x{\sx*(#2)}
46  \pgfmathsetmacro\y{(#3)}
47  \ifthenelse{\isin{ibmqx}{#1}}{\%
48    \tikzset{lstyle/.style={ultra thick,line cap=butt}}
49  }{\%
50    \tikzset{lstyle/.style={}}
51  }%
52  \draw[lstyle] (\x-\sx/2,\y) -- (\x+\sx/2,\y);
53}
54
55% Zero state preparator

```

```

56 \newcommand{\qzero}[3] [] {%
57   \pgfmathsetmacro\x{\sx*(#2)}
58   \pgfmathsetmacro\y{(#3)}
59   \ifthenelse{\isin{ibmqx}{#1}}{%
60     \draw[ultra thick,line cap=butt] (\x+0.4,\y) -- (\x+\sx/2,\y);
61     \draw[draw=none,fill=ibmqxH] (\x-0.4,\y-0.4) rectangle (\x+0.4,\y+0.4);
62     \node at (\x,\y){\large $\lvert 0 \rangle$};
63   }{%
64     \node[anchor=east] at (\x+\sx/2,\y){$\lvert 0 \rangle$};
65   }%
66 }
67
68 % General single-qubit gate
69 \newcommand\qgateU[4] [] {%
70   \pgfmathsetmacro\x{\sx*(#2)}
71   \pgfmathsetmacro\y{(#3)}
72   \ifthenelse{\isin{ibmqx}{#1}}{%
73     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
74     \tikzset{rstyle/.style={draw=none,fill=#1}}
75     \tikzset{tstyle/.style={white}}
76   }{%
77     \tikzset{lstyle/.style={}}
78     \tikzset{rstyle/.style={fill=white}}
79     \tikzset{tstyle/.style={}}
80   }%
81   \draw[lstyle] (\x-\sx/2,\y) -- (\x-0.4,\y);
82   \draw[lstyle] (\x+0.4,\y) -- (\x+\sx/2,\y);
83   \draw[rstyle] (\x-0.4,\y-0.4) rectangle (\x+0.4,\y+0.4);
84   \node[tstyle] at (\x,\y) {\sf\large #4};
85 }
86
87 % Identity gate
88 \newcommand\qgateID[3] [] {%
89   \ifthenelse{\isin{ibmqx}{#1}}{%
90     \qgateU[ibmqxB]{#2}{#3}{id}
91   }{%
92     \qgateU{#2}{#3}{id}
93   }%
94 }
95 \newcommand\qgateOID{%
96   \def\ket##1{\scriptstyle|##1\rangle}
97   \def\bra##1{\scriptstyle\langle ##1|}
98   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
99     & \bra{0} & \bra{1} \\ \hline
100    \ket{0} & 1 & 0 \\
101    \ket{1} & 0 & 1
102   \end{array}\!\!\right)
103 }}
104
105 % Pauli-X gate
106 \newcommand\qgateX[3] [] {%
107   \ifthenelse{\isin{ibmqx}{#1}}{%
108     \qgateU[ibmqxC]{#2}{#3}{X}
109   }{%
110     \qgateU{#2}{#3}{X}
111   }%
112 }
113 \newcommand\qgateOX{%
114   \def\ket##1{\scriptstyle|##1\rangle}
115   \def\bra##1{\scriptstyle\langle ##1|}
116   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
117     & \bra{0} & \bra{1} \\ \hline
118    \ket{0} & 0 & 1 \\
119    \ket{1} & 1 & 0
120   \end{array}\!\!\right)
121 }}
122
123 % Pauli-Y gate
124 \newcommand\qgateY[3] [] {%
125   \ifthenelse{\isin{ibmqx}{#1}}{%
126     \qgateU[ibmqxC]{#2}{#3}{Y}
127   }{%

```

```

128 \qgateU{#2}{#3}{Y}
129 }%
130 }
131 \newcommand\qgateOY{%
132 \def\ket##1{\scriptstyle|##1\rangle}
133 \def\bra##1{\scriptstyle\langle ##1|}
134 \def\j{\mathrm{i}}
135 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
136 & \bra{0} & \bra{1} \\ \hline
137 \ket{0} & 0 & -\j \\
138 \ket{1} & \j & 0
139 \end{array}\!\!\right)
140 }}
141
142 % Pauli-Z gate
143 \newcommand\qgateZ[3][]{%
144 \ifthenelse{\isin{ibmqx}{#1}}{%
145 \qgateU[ibmqxC]{#2}{#3}{Z}
146 }{%
147 \qgateU{#2}{#3}{Z}
148 }%
149 }
150 \newcommand\qgateOZ{%
151 \def\ket##1{\scriptstyle|##1\rangle}
152 \def\bra##1{\scriptstyle\langle ##1|}
153 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
154 & \bra{0} & \bra{1} \\ \hline
155 \ket{0} & 1 & 0 \\
156 \ket{1} & 0 & -1
157 \end{array}\!\!\right)
158 }}
159
160 % Hadamard gate
161 \newcommand\qgateH[3][]{%
162 \ifthenelse{\isin{ibmqx}{#1}}{%
163 \qgateU[ibmqxD]{#2}{#3}{H}
164 }{%
165 \qgateU{#2}{#3}{H}
166 }%
167 }
168 \newcommand\qgateOH{%
169 \def\ket##1{\scriptstyle|##1\rangle}
170 \def\bra##1{\scriptstyle\langle ##1|}
171 \dfrac{1}{\sqrt{2}}\!\!
172 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
173 & \bra{0} & \bra{1} \\ \hline
174 \ket{0} & 1 & 1 \\
175 \ket{1} & 1 & -1
176 \end{array}\!\!\right)
177 }}
178
179 % S phase gate
180 \newcommand\qgateS[3][]{%
181 \ifthenelse{\isin{ibmqx}{#1}}{%
182 \qgateU[ibmqxD]{#2}{#3}{S}
183 }{%
184 \qgateU{#2}{#3}{S}
185 }%
186 }
187 \newcommand\qgateOS{%
188 \def\ket##1{\scriptstyle|##1\rangle}
189 \def\bra##1{\scriptstyle\langle ##1|}
190 \def\j{\mathrm{i}}
191 \dfrac{1}{\sqrt{2}}\!\!
192 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
193 & \bra{0} & \bra{1} \\ \hline
194 \ket{0} & 1 & 0 \\
195 \ket{1} & 0 & \j
196 \end{array}\!\!\right)
197 }}
198
199 % Inverse S phase gate

```

```

200 \newcommand\qgateSi[3][]{\%
201 \ifthenelse{\isin{ibmqx}{#1}}{\%
202 \qgateU[ibmqxD]{#2}{#3}{S$^\dagger$}
203 }{\%
204 \qgateU{#2}{#3}{S$^\dagger$}
205 }%
206 }
207 \newcommand\qgateOSi{\%
208 \def\ket##1{\scriptstyle|##1\rangle}
209 \def\bra##1{\scriptstyle\langle ##1|}
210 \def\j{\mathrm{i}}
211 \dfrac{1}{\sqrt{2}}\!
212 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
213 & \bra{0} & \bra{1} \\ \hline
214 \ket{0} & 1 & 0 \\
215 \ket{1} & 0 & -\j
216 \end{array}\!\right)
217 }}
218
219 % T phase gate
220 \newcommand\qgateT[3][]{\%
221 \ifthenelse{\isin{ibmqx}{#1}}{\%
222 \qgateU[ibmqxE]{#2}{#3}{T}
223 }{\%
224 \qgateU{#2}{#3}{T}
225 }%
226 }
227 \newcommand\qgateOT{\%
228 \def\ket##1{\scriptstyle|##1\rangle}
229 \def\bra##1{\scriptstyle\langle ##1|}
230 \def\j{\mathrm{i}}
231 \dfrac{1}{\sqrt{2}}\!
232 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
233 & \bra{0} & \bra{1} \\ \hline
234 \ket{0} & 1 & 0 \\
235 \ket{1} & 0 & \frac{1}{\sqrt{2}}(1\!+\!\j)
236 \end{array}\!\right)
237 }}
238
239 % Inverse T phase gate
240 \newcommand\qgateTi[3][]{\%
241 \ifthenelse{\isin{ibmqx}{#1}}{\%
242 \qgateU[ibmqxE]{#2}{#3}{T$^\dagger$}
243 }{\%
244 \qgateU{#2}{#3}{T$^\dagger$}
245 }%
246 }
247 \newcommand\qgateOTi{\%
248 \def\ket##1{\scriptstyle|##1\rangle}
249 \def\bra##1{\scriptstyle\langle ##1|}
250 \def\j{\mathrm{i}}
251 \dfrac{1}{\sqrt{2}}\!
252 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
253 & \bra{0} & \bra{1} \\ \hline
254 \ket{0} & 1 & 0 \\
255 \ket{1} & 0 & \frac{1}{\sqrt{2}}(1\!-\!\j)
256 \end{array}\!\right)
257 }}
258
259 % U1 gate of IBM Q Experience
260 \newcommand\qgateUa[3][]{\%
261 \ifthenelse{\isin{ibmqx}{#1}}{\%
262 \qgateU[ibmqxA]{#2}{#3}{U1}
263 }{\%
264 \qgateU{#2}{#3}{U1}
265 }%
266 }
267 \newcommand\qgateOUa{\%
268 \def\ket##1{\scriptstyle|##1\rangle}
269 \def\bra##1{\scriptstyle\langle ##1|}
270 \def\j{\mathrm{e}}
271 \def\j{\mathrm{i}}

```

```

272 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
273 & \bra{0} & \bra{1} \\ \hline
274 \ket{0} & 1 & 0 \\
275 \ket{1} & 0 & e^{-\lambda j} \\
276 \end{array}\!\!\right)
277 }}
278
279 % U2 gate of IBM Q Experience
280 \newcommand\qgateUb[3][]{%
281 \ifthenelse{\isin{ibmqx}{#1}}{%
282 \qgateU[ibmqxA]{#2}{#3}{U2}
283 }{%
284 \qgateU{#2}{#3}{U2}
285 }%
286 }
287 \newcommand\qgateOUb{%
288 \def\ket##1{\scriptstyle|##1\rangle}
289 \def\bra##1{\scriptstyle\langle ##1|}
290 \def\j{\mathrm{e}}
291 \def\j{\mathrm{i}}
292 \renewcommand\arraystretch{1.4}
293 \dfrac{1}{\sqrt{2}}\!
294 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
295 & \bra{0} & \bra{1} \\ \hline
296 \ket{0} & 1 & e^{-\lambda j} \\
297 \ket{1} & e^{-\phi j} & e^{-(\lambda+\phi)j} \\
298 \end{array}\!\!\right)
299 }}
300
301 % U3 gate of IBM Q Experience
302 \newcommand\qgateUc[3][]{%
303 \ifthenelse{\isin{ibmqx}{#1}}{%
304 \qgateU[ibmqxA]{#2}{#3}{U3}
305 }{%
306 \qgateU{#2}{#3}{U3}
307 }%
308 }
309 \newcommand\qgateOUc{%
310 \def\ket##1{\scriptstyle|##1\rangle}
311 \def\bra##1{\scriptstyle\langle ##1|}
312 \def\j{\mathrm{e}}
313 \def\j{\mathrm{i}}
314 \renewcommand\arraystretch{1.4}
315 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
316 & \bra{0} & \bra{1} \\ \hline
317 \ket{0} & \cos(\frac{\theta}{2}) & \sin(\frac{\theta}{2})e^{-\lambda j} \\
318 \ket{1} & \sin(\frac{\theta}{2})e^{-\phi j} & \cos(\frac{\theta}{2})e^{-(\lambda+\phi)j} \\
319 \end{array}\!\!\right)
320 }}
321
322 % General two-qubit gate
323 \newcommand\qgateUu[4][]{%
324 \pgfmathsetmacro\x{\sx*(#2)}
325 \pgfmathsetmacro\y{(#3)}
326 \ifthenelse{\isin{ibmqx}{#1}}{%
327 \tikzset{style/.style={ultra thick,line cap=butt}}
328 \tikzset{rstyle/.style={draw=none,fill=#1}}
329 \tikzset{tstyle/.style={white}}
330 }{%
331 \tikzset{style/.style={}}
332 \tikzset{rstyle/.style={fill=white}}
333 \tikzset{tstyle/.style={}}
334 }%
335 \draw[rstyle] (\x-0.5 ,\y-0.25) rectangle (\x+0.5,\y+1.25);
336 \draw[lstyle] (\x-\sx/2,\y+1 ) -- (\x-0.5 ,\y+1);
337 \draw[lstyle] (\x+0.5 ,\y+1 ) -- (\x+\sx/2,\y+1);
338 \draw[lstyle] (\x-\sx/2,\y ) -- (\x-0.5 ,\y );
339 \draw[lstyle] (\x+0.5 ,\y ) -- (\x+\sx/2,\y );
340 \node[anchor=north,tstyle] at (\x,\y+1.25){\sf\large #4};
341 }
342
343 % General three-qubit gate

```



```

344 \newcommand{\qgateUuu}[4] [] {%
345   \pgfmathsetmacro\x{\sx*(#2)}
346   \pgfmathsetmacro\y{(#3)}
347   \ifthenelse{\isin{ibmqx}{#1}}{%
348     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
349     \tikzset{rstyle/.style={draw=none,fill=#1}}
350     \tikzset{tstyle/.style={white}}
351   }{%
352     \tikzset{lstyle/.style={}}
353     \tikzset{rstyle/.style={fill=white}}
354     \tikzset{tstyle/.style={}}
355   }%
356   \draw[rstyle] (\x-0.5 ,\y-1.25) rectangle (\x+0.5,\y+1.25);%
357   \draw[lstyle] (\x-\sx/2,\y+1 ) -- (\x-0.5 ,\y+1);%
358   \draw[lstyle] (\x+0.5 ,\y+1 ) -- (\x+\sx/2,\y+1);%
359   \draw[lstyle] (\x-\sx/2,\y ) -- (\x-0.5 ,\y );%
360   \draw[lstyle] (\x+0.5 ,\y ) -- (\x+\sx/2,\y );%
361   \draw[lstyle] (\x-\sx/2,\y-1 ) -- (\x-0.5 ,\y-1);%
362   \draw[lstyle] (\x+0.5 ,\y-1 ) -- (\x+\sx/2,\y-1);%
363   \node[anchor=north,tstyle] at (\x,\y+1.25){\sf\large #4};%
364 }
365
366 % CNOT gate XOR symbol
367 \newcommand{\qgateCNX}[4] [] {%
368   \pgfmathsetmacro\x{\sx*(#3)}
369   \pgfmathsetmacro\y{(#4)}
370   \ifthenelse{\isin{ibmqx}{#1}}{%
371     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
372     \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
373     \tikzset{rstyle/.style={draw=none,fill=ibmqxD}}
374     \tikzset{tstyle/.style={very thick,white}}
375   }{%
376     \tikzset{lstyle/.style={}}
377     \tikzset{cstyle/.style={}}
378     \tikzset{rstyle/.style={fill=white}}
379     \tikzset{tstyle/.style={}}
380   }%
381   \draw[lstyle] (\x-\sx/2,\y) -- (\x-0.4 ,\y);
382   \draw[lstyle] (\x+0.4 ,\y) -- (\x+\sx/2,\y);
383   \draw[rstyle] (\x ,\y) circle (0.4);
384   \ifthenelse{\isin{ibmqx}{#1}}{%
385     \draw[tstyle] (\x-0.2,\y) -- (\x+0.2,\y);
386     \draw[tstyle] (\x,\y-0.2) -- (\x,\y+0.2);
387   }{%
388     \draw[lstyle] (\x-0.4,\y) -- (\x+0.4,\y);
389     \draw[lstyle] (\x,\y-0.4) -- (\x,\y+0.4);
390   }
391   \ifthenelse{\isin{t}{#2}}{%
392     \draw[cstyle] (\x,\y+0.4) -- (\x,\y+0.5);
393   }{}
394   \ifthenelse{\isin{b}{#2}}{%
395     \draw[cstyle] (\x,\y-0.4) -- (\x,\y-0.5);
396   }{}
397 }
398
399 % CNOT gate control qubit symbol
400 \newcommand{\qgateCNC}[4] [] {%
401   \pgfmathsetmacro\x{\sx*(#3)}
402   \pgfmathsetmacro\y{(#4)}
403   \ifthenelse{\isin{ibmqx}{#1}}{%
404     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
405     \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
406     \tikzset{rstyle/.style={draw=none,fill=ibmqxD}}
407     \tikzset{tstyle/.style={white}}
408     \def\r{0.12}
409   }{%
410     \tikzset{lstyle/.style={}}
411     \tikzset{cstyle/.style={}}
412     \tikzset{rstyle/.style={draw=none,fill=black}}
413     \tikzset{tstyle/.style={}}
414     \def\r{0.1}
415   }%

```

```

416 \draw[lstyle] (\x-\sx/2,\y) -- (\x+\sx/2,\y);
417 \draw[rstyle] (\x ,\y) circle (\r);
418 \ifthenelse{\isin{t}{#2}}{%
419 \draw[cstyle] (\x,\y+0.1) -- (\x,\y+0.5);
420 }{}
421 \ifthenelse{\isin{b}{#2}}{%
422 \draw[cstyle] (\x,\y-0.1) -- (\x,\y-0.5);
423 }{}
424 }
425
426 % CNOT gate run-through qubit symbol
427 \newcommand\qgateCNR[3][]{%
428 \pgfmathsetmacro\x{\sx*(#2)}
429 \pgfmathsetmacro\y{(#3)}
430 \ifthenelse{\isin{ibmqx}{#1}}{%
431 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
432 \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
433 }{%
434 \tikzset{lstyle/.style={}}
435 \tikzset{cstyle/.style={}}
436 }%
437 \draw[lstyle] (\x-\sx/2,\y ) -- (\x+\sx/2,\y );
438 \draw[cstyle] (\x ,\y-0.5) -- (\x ,\y+0.5);
439 }
440
441 % Measurement symbol
442 \newcommand\qmeasM[3][]{%
443 \pgfmathsetmacro\x{\sx*(#2)}
444 \pgfmathsetmacro\y{(#3)}
445 \ifthenelse{\isin{ibmqx}{#1}}{%
446 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
447 \tikzset{rstyle/.style={draw=none,fill=ibmqxF}}
448 \tikzset{tstyle/.style={white,very thick,line cap=butt}}
449 \tikzset{pstyle/.style={->,>stealth,white,thick,line cap=butt}}
450 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
451 }{%
452 \tikzset{lstyle/.style={}}
453 \tikzset{rstyle/.style={fill=white}}
454 \tikzset{tstyle/.style={}}
455 \tikzset{pstyle/.style={->,>stealth,line cap=butt}}
456 \tikzset{cstyle/.style={}}
457 }%
458 \draw[lstyle] (\x-\sx/2 ,\y ) -- (\x-0.4 ,\y);
459 \draw[lstyle] (\x+0.4 ,\y ) -- (\x+\sx/2,\y);
460 \draw[rstyle] (\x-0.4 ,\y-0.4 ) rectangle (\x+0.4,\y+0.4);
461 \draw[tstyle] (\x+0.27 ,\y-0.2 ) arc (0:180:0.27);
462 \draw[pstyle] (\x ,\y-0.15) -- (\x+0.2,\y+0.22);
463 \node[pstyle] at (\x+0.26,\y+0.15) {\tiny\sf Z};
464 \fill[pstyle] (\x ,\y-0.15) circle (0.035);
465 \draw[cstyle] (\x ,\y-0.4 ) -- (\x,\y-0.5);
466 }
467
468 % Measurement run-through qubit symbol
469 \newcommand\qmeasR[3][]{%
470 \pgfmathsetmacro\x{\sx*(#2)}
471 \pgfmathsetmacro\y{(#3)}
472 \ifthenelse{\isin{ibmqx}{#1}}{%
473 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
474 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
475 }{%
476 \tikzset{lstyle/.style={}}
477 \tikzset{cstyle/.style={}}
478 }%
479 \draw[lstyle] (\x-\sx/2,\y ) -- (\x+\sx/2,\y );
480 \draw[cstyle] (\x ,\y-0.5) -- (\x ,\y+0.5);
481 }
482
483 % Measurement-joins-bus symbol
484 \newcommand\qmeasMB[4][]{%
485 \pgfmathsetmacro\x{\sx*(#3)}
486 \pgfmathsetmacro\y{(#4)}
487 \ifthenelse{\isin{ibmqx}{#1}}{%

```

```

488 \tikzset{cstyle/.style={>=stealth,ibmqxI,ultra thick,line cap=butt}}
489 }{%
490 \tikzset{cstyle/.style={>=stealth}}
491 }%
492 \draw[cstyle](\x-\sx/2,\y-0.3) -- (\x+\sx/2,\y-0.3);
493 \draw[cstyle,->](\x,\y+0.5) -- (\x,\y-0.3)
494 node[anchor=north,black]{\footnotesize #2};
495 }
496
497 % Measurement bus symbol
498 \newcommand\qmeasB[3][]{\%
499 \pgfmathsetmacro\x{\sx*(#2)}
500 \pgfmathsetmacro\y{(#3)}
501 \ifthenelse{\isin{ibmqx}{#1}}{%
502 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
503 }{%
504 \tikzset{cstyle/.style={}}
505 }%
506 \draw[cstyle](\x-\sx/2,\y-0.3) -- (\x+\sx/2,\y-0.3);
507 }
508
509 % Measurement bus head symbol
510 \newcommand\qmeasBh[4][]{\%
511 \pgfmathsetmacro\x{\sx*(#3)}
512 \pgfmathsetmacro\y{(#4)}
513 \ifthenelse{\isin{ibmqx}{#1}}{%
514 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
515 }{%
516 \tikzset{cstyle/.style={}}
517 }%
518 \draw[cstyle](\x-\sx/2,\y-0.3) -- (\x+\sx/2,\y-0.3);
519 \draw[cstyle](\x-\sx/2+0.05,\y-0.45) -- (\x-\sx/2+0.15,\y-0.1)
520 node[anchor=east,black]{\footnotesize #2!};
521 }
522
523 %% == OTHER GATE OPERATORS =====
524
525 \newcommand\qgateOCNOT{\%
526 \def\ket##1{\scriptstyle|##1\rangle}
527 \def\bra##1{\rotatebox{90}{\scriptstyle\langle ##1|}}
528 \left(\hspace*{-0.4ex}\begin{array}{c|cccc}
529 & \ket{00} & \ket{01} & \ket{10} & \ket{11} \\ \hline
530 \ket{00} & 1 & 0 & 0 & 0 \\
531 \ket{01} & 0 & 1 & 0 & 0 \\
532 \ket{10} & 0 & 0 & 0 & 1 \\
533 \ket{11} & 0 & 0 & 1 & 0
534 \end{array}\!\!\right)
535 }
536
537 \newcommand\qgateOCCNOT{\%
538 \def\ket##1{\scriptstyle|##1\rangle}
539 \def\bra##1{\rotatebox{90}{\scriptstyle\langle ##1|}}
540 \left(\hspace*{-0.4ex}\begin{array}{c|cccccccc}
541 & \ket{000} & \ket{001} & \ket{010} & \ket{011} & \ket{100} & \ket{101} & \ket{110} & \ket{111} \\ \hline
542 \ket{000} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
543 \ket{001} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
544 \ket{010} & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
545 \ket{011} & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
546 \ket{100} & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
547 \ket{101} & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
548 \ket{110} & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
549 \ket{111} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
550 \end{array}\!\!\right)
551 }
552
553 %% == AUXILIARY COMMANDS =====
554
555 \newcommand{\qScalePaper}{\%
556 \draw[help lines,xstep=\sx/8,ystep=0.25,opacity=0.2] (-1.5,-1.5) grid (1.5,1.5);
557 \draw[help lines,line width=.6pt,xstep=\sx/2,ystep=1,opacity=0.2] (-1.49,-1.5) grid (1.49,1.5);
558 \node[anchor=gray] at (-1,-1.7) {\scriptsize $\sx\texttt{x}\texttt{!}\texttt{!}\frac{1}{2}$};
559 \node[anchor=gray] at (0,-1.7) {\scriptsize $\sx\texttt{x}\texttt{x}\texttt{x}$};

```

```

560 \node[anchor=west,color=gray] at (1,-1.7) {\scriptsize $\texttt{x}\!\!+\!\!\frac{1}{2}$};
561 \node[anchor=west,color=gray] at (-2.3,-1) {\scriptsize $\texttt{y}\!\!-\!\!1$};
562 \node[anchor=west,color=gray] at (-2.3,0) {\scriptsize $\texttt{y}$};
563 \node[anchor=west,color=gray] at (-2.3,1) {\scriptsize $\texttt{y}\!\!+\!\!1$};
564 }
565
566 %% == EOF ==

```

References

- [1] Till Tantau. Tikz & pgf - manual for version 3.0.1a. <http://mirror.ctan.org/graphics/pgf/base/doc/pgfmanual.pdf>, 2015. Retrieved: July 27, 2018.
- [2] Matthias Wolff. The `tikz-quantumgates` package: Drawing quantum circuits with TikZ. <https://github.com/matthias-wolff/tikz-quantumgates>, 2018. Retrieved: August 20, 2018.