

The tikz-quantumgates Package: Drawing quantum circuits with TikZ

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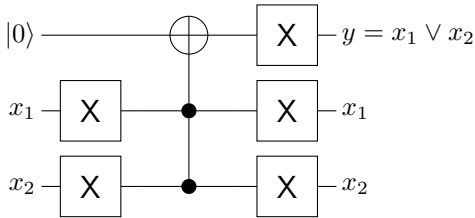
BTU Cottbus-Senftenberg

May 30, 2019

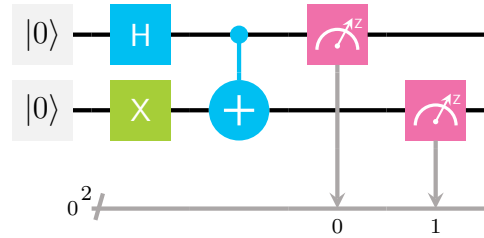
See <https://github.com/matthias-wolff/tikz-quantumgates/blob/master/tikz-quantumgates.pdf> for the latest version of this document.

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=west] at (-0.6,2) {$|0\rangle$};
7 \node[anchor=west] at (-0.6,1) {$x_1$};
8 \node[anchor=west] at (-0.6,0) {$x_2$};
9 \qwire{0}{2}\qgateX{0}{1}\qgateX{0}{0}
10 \qgateCNC{b}{1}{2}\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}
```








































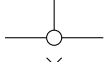



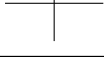
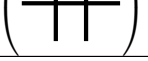


```
1 \documentclass{standalone}
2 \usepackage{tikz-quantumgates}
3 \begin{document}
4 \centering
5 \begin{tikzpicture}
6 \node[anchor=west] at (0.6,-0.3) {\footnotesize 0};
7 \qzero{0}{2}\qzero{0}{1}
8 \qgateH{0}{2}\qgateX{0}{1}\qgateCNC{b}{1}{2}\qgateCNC{t}{1}{0}
9 \qgateCNC{b}{1}{2}\qgateCNC{t}{1}{0}\qgateCNC{b}{1}{2}\qgateCNC{t}{1}{0}
10 \qgateCNC{b}{1}{2}\qgateCNC{t}{1}{0}\qgateCNC{b}{1}{2}\qgateCNC{t}{1}{0}
11 \qgateCNC{b}{1}{2}\qgateCNC{t}{1}{0}\qgateCNC{b}{1}{2}\qgateCNC{t}{1}{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>
$ 0\rangle$		<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>\qgateUa*[option]{x}{y}{sublabel}</code>
		<code>\qgateUb*[option]{x}{y}{sublabel}</code>
		<code>\qgateUc*[option]{x}{y}{sublabel}</code>
		<code>\qgateCNX[option]{cwires}{x}{y}</code>
		<code>\qgateCNR[option]{x}{y}</code>
		<code>\qgateCNC[option]{cwires}{x}{y}</code>
		<code>\qgateCNC*[option]{cwires}{x}{y}</code>
		<code>\qgateSWt[option]{x}{y}</code> (not an “official” IBM QX symbol)
		<code>\qgateSWR[option]{x}{y}</code> (not an “official” IBM QX symbol)

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Standard	Option ibmqx	Command
		<code>\qgateSWb[option]{x}{y}</code> (not an “official” IBM QX symbol)
		<code>\qmeasM[option]{x}{y}</code>
		<code>\qmeasM*[option]{x}{y}{axis}{wires}</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> (not an “official” IBM QX symbol)
		<code>\qgateUu[option]{x}{y}{label}</code> (not an “official” IBM QX symbol)
		<code>\qgateUuu[option]{x}{y}{label}</code> (not an “official” IBM QX symbol)

Any gate can be equipped with control wires, e.g.

		<code>\qgateUc[option]{x}{y}\qgateControl[option]{cwires}{x}{y}</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

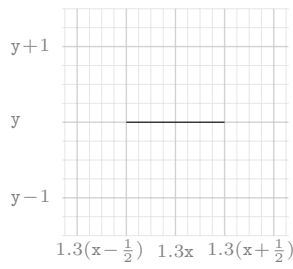
`\qwire[option]{x}{y}`

Draws a wire.

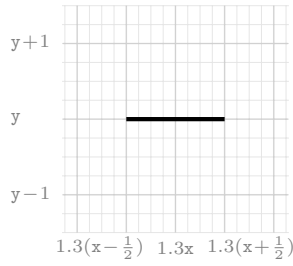
Parameters

- `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 `(\qgateSx*x,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}
```

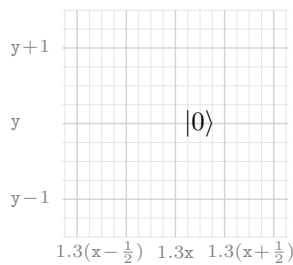
`\qzero[option]{x}{y}`

Draws the zero-state preparator.

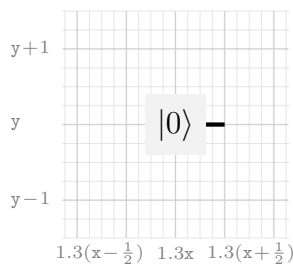
Parameters

- `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 `(\qgateSx*x,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:

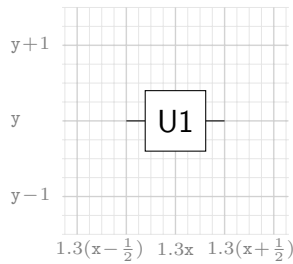
A **B** **C** **D** **E** **F** **G** **H**

If `ibmqx` is passed, `ibmqxG` will be used.

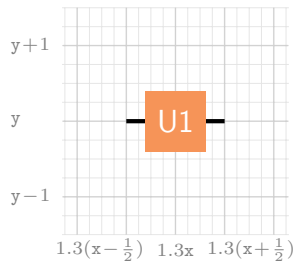
x, y Position of symbol in schematic. The actual TikZ coordinates are $(\backslash\text{qgateSx}*x, y)$.

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}`

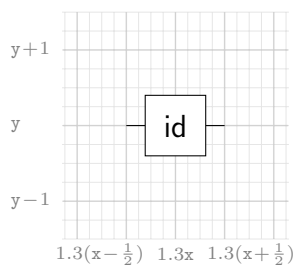
Draws the identity gate.

Parameters

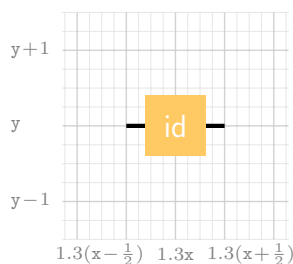
option Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.

x, y Position of symbol in schematic. The actual TikZ coordinates are $(\backslash\text{qgateSx}*x, y)$.

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

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

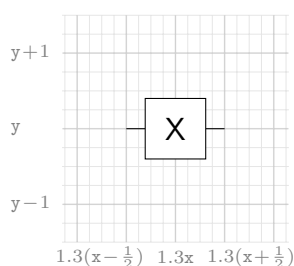
`\qgateX[option]{x}{y}`

Pauli-X gate.

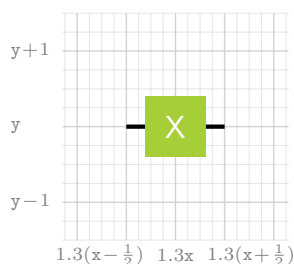
Parameters

- `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 (`\qgateSx*x,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

$$X \doteq \left(\begin{array}{c|cc} & \langle 0| & \langle 1| \\ \hline |0\rangle & 0 & 1 \\ |1\rangle & 1 & 0 \end{array} \right) \quad \text{1} \quad \text{\texttt{\$}\displaystyle X\doteq\qgateOX \$}$$

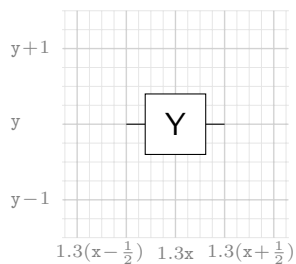
`\qgateY[option]{x}{y}`

Pauli-Y gate.

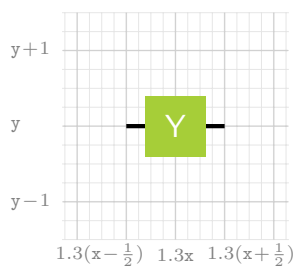
Parameters

- `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 (`\qgateSx*x,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

$$Y \doteq \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & 0 & -i \\ |1\rangle & i & 0 \end{pmatrix}$$

1 `\displaystyle Y\dot{=} \qgateY{0}{0}`

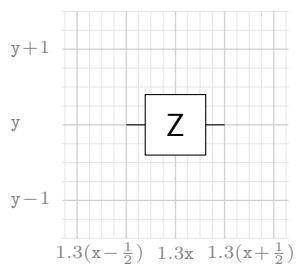
`\qgateZ[option]{x}{y}`

Pauli-Z gate.

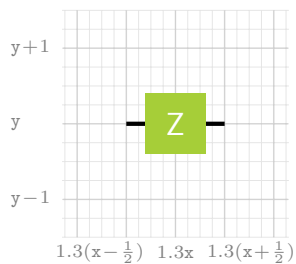
Parameters

- 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 (`\qgateSx*x, 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

$$Z \doteq \begin{pmatrix} & \begin{matrix} \langle 0| & \langle 1| \end{matrix} \\ \begin{matrix} |0\rangle \\ |1\rangle \end{matrix} & \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \end{pmatrix} \quad 1 \quad \text{\textcolor{violet}{\$}\displaystyle Z\textcolor{violet}{\doteq}\textcolor{violet}{\qgateOZ} \$}$$

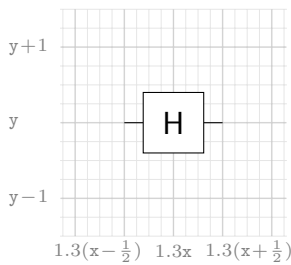
`\qgateH[option]{x}{y}`

Hadamard gate.

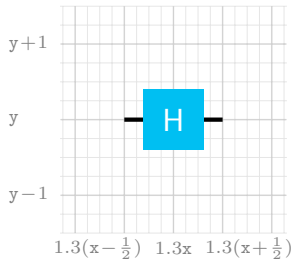
Parameters

- 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 (`\qgateSx*x,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

$$H \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} & \begin{matrix} \langle 0| & \langle 1| \end{matrix} \\ \begin{matrix} |0\rangle \\ |1\rangle \end{matrix} & \begin{pmatrix} 1 & 1 \\ 1 & -1 \end{pmatrix} \end{pmatrix} \quad 1 \quad \text{\textcolor{violet}{\$}\displaystyle H\textcolor{violet}{\doteq}\textcolor{violet}{\qgateOH} \$}$$

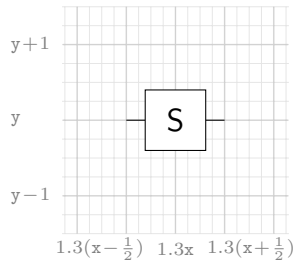
`\qgateS[option]{x}{y}`

S phase gate.

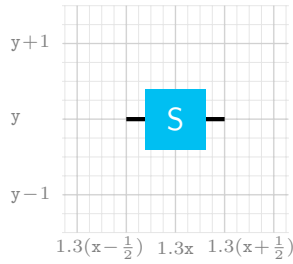
Parameters

- 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 (`\qgateSx*x,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 $\displaystyle S=\sqrt{Z}\doteq\qgateOS$
```

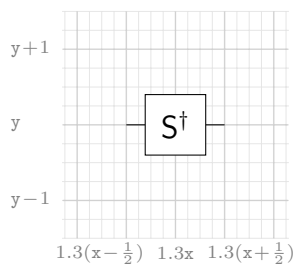
`\qgateSi[option]{x}{y}`

Inverse S phase gate.

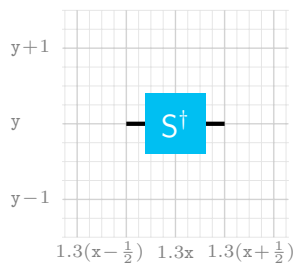
Parameters

- 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 (`\qgateSx*x,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 $\displaystyle S^\dagger \doteq \frac{1}{\sqrt{2}} \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & 1 & 0 \\ |1\rangle & 0 & -i \end{pmatrix}$

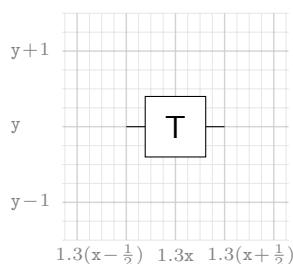
`\qgateT[option]{x}{y}`

T phase gate.

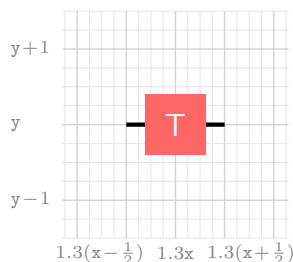
Parameters

- `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 `(\qgateSx*x,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

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

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

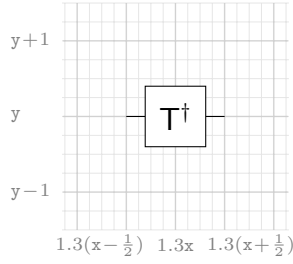
`\qgateTi[option]{x}{y}`

Inverse T phase gate.

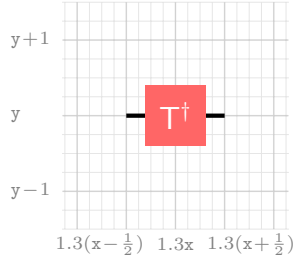
Parameters

- `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 `(\qgateSx*x,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

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

```
1 $\displaystyle T^\dagger \doteq \qgate0Ti $
```

2.3 Single-Qubit Physical Gate of IBM Q Experience

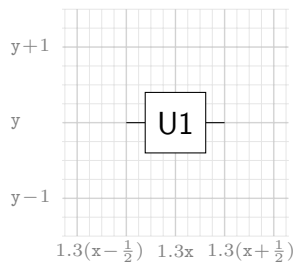
```
\qgateUa[option]{x}{y}
\qgateUa*[option]{x}{y}{sublabel}
```

U1 gate of IBM Q Experience.

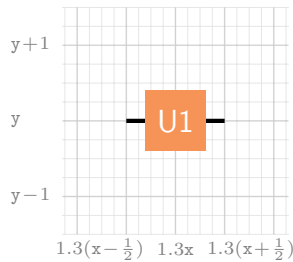
Parameters

- 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 `(\qgateSx*x,y)`.
- sublabel** Sub-label, e.g. for gate parameters (starred version only)

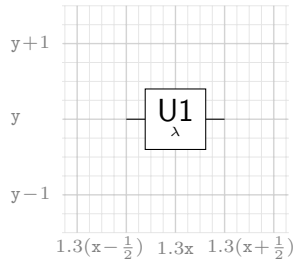
Examples



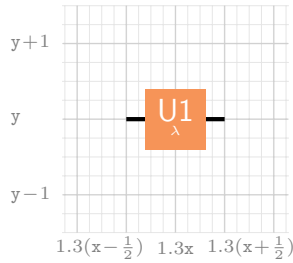
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUa{0}{0}
4 \end{tikzpicture}
```



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



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



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

Gate Operator

$$U1_{\lambda} \doteq \left(\begin{array}{c|cc} & \langle 0| & \langle 1| \\ \hline |0\rangle & 1 & 0 \\ |1\rangle & 0 & e^{i\lambda} \end{array} \right)$$

```
1 $\displaystyle U1_{\lambda}\doteq\qgateOUa$
```

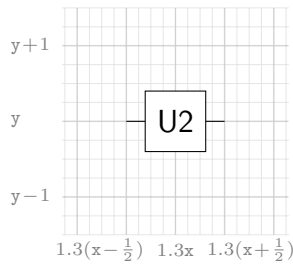
```
\qgateUb[option]{x}{y}
\qgateUb*[option]{x}{y}{sublabel}
```

U2 gate of IBM Q Experience.

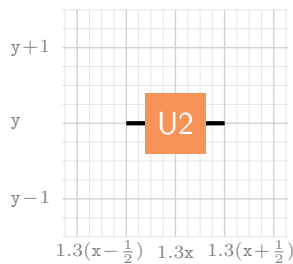
Parameters

- 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 `(\qgateSx*x,y)`.
- sublabel** Sub-label, e. g. for gate parameters (starred version only)

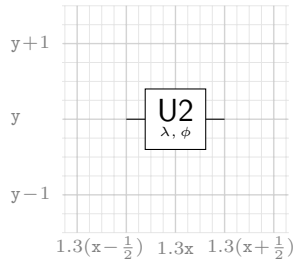
Examples



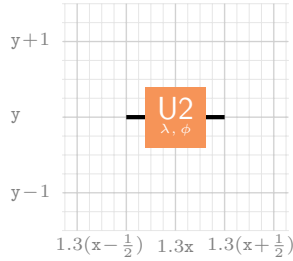
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUb{0}{0}
4 \end{tikzpicture}
```



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



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUb*{0}{0}{\lambda,\phi}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUb*[ibmqx]{0}{0}{\lambda,\phi}
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 $\displaystyle U_{2,\lambda,\phi} \doteq \qgateUb{\lambda,\phi}$

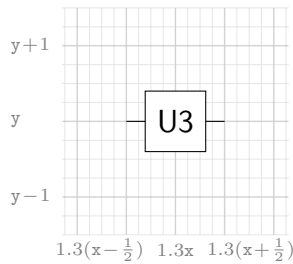
```
\qgateUc[option]{x}{y}
\qgateUc*[option]{x}{y}{sublabel}
```

U3 gate of IBM Q Experience.

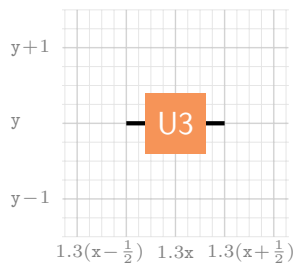
Parameters

- 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 `(\qgateSx*x,y)`.
- sublabel** Sub-label, e.g. for gate parameters (starred version only)

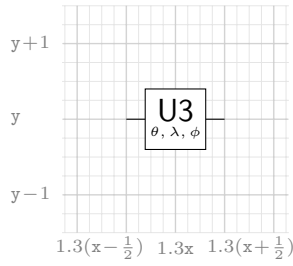
Examples



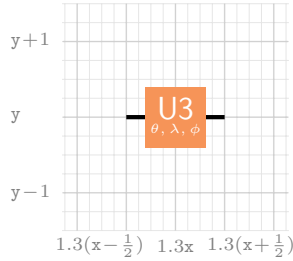
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUc{0}{0}
4 \end{tikzpicture}
```



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



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUc*{0}{0}{\theta,\lambda,\phi}
4 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUc*[ibmqx]{0}{0}{\theta,\lambda,\phi}
4 \end{tikzpicture}
```

Gate Operator

$$U_{3\lambda,\phi,\theta} \doteq \begin{pmatrix} & \langle 0| & \langle 1| \\ |0\rangle & \cos(\frac{\theta}{2}) & -\sin(\frac{\theta}{2})e^{\lambda i} \\ |1\rangle & \sin(\frac{\theta}{2})e^{\phi i} & \cos(\frac{\theta}{2})e^{(\lambda+\phi)i} \end{pmatrix} \quad \text{\texttt{\$}\displaystyle U3_{\lambda,\phi,\theta}\doteq\qgateUc\text{\texttt{\$}}}$$

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:

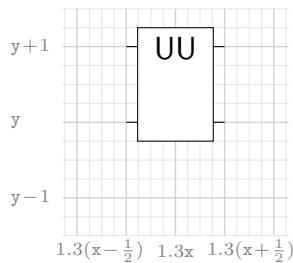
A B C D E F G H

If `ibmqx` is passed, `ibmqxG` will be used.

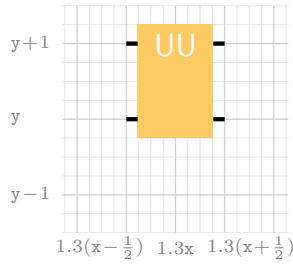
x, y Position of symbol in schematic. The actual TikZ coordinates are `(\qgateSx*x,y)`.

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:

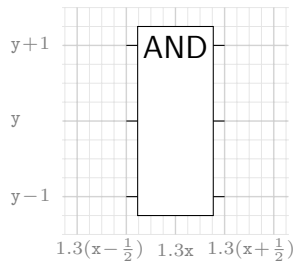
A B C D E F G H

If `ibmqx` is passed, `ibmqxG` will be used.

x, y Position of symbol in schematic. The actual TikZ coordinates are `(\qgateSx*x,y)`.

label Gate label.

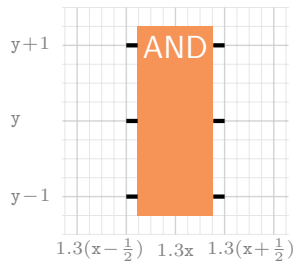
Examples



```

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

```



```

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

```

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

XOR symbol of controlled-NOT gate.

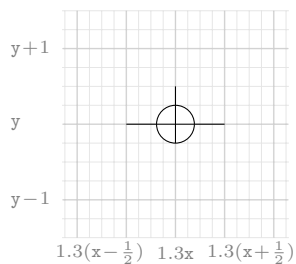
Parameters

option Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.

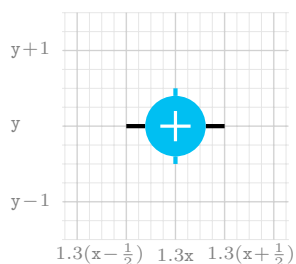
cwires Control wires, `t` for top, `b` for bottom, and `tb` for both sides.

x, y Position of symbol in schematic. The actual TikZ coordinates are `(\qgateSx*x,y)`.

Examples



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



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

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

Control qubit symbol of a controlled gate. Starred version draws inverse control.

Parameters

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

A B C D E F G H

If `ibmqx` is passed, `ibmqxD` will be used.

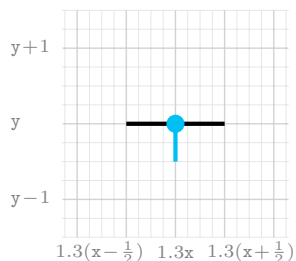
cwires Control wires, `t` for top, `b` for bottom, and `tb` for both sides.

x, y Position of symbol in schematic. The actual TikZ coordinates are $(\backslash\text{qgateSx}*x, y)$.

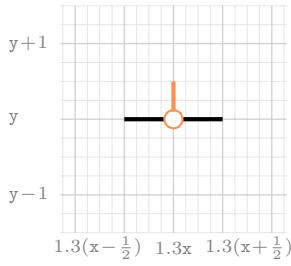
Examples



```
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}
```



```

1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNC*[ibmqxA]{t}{0}{0}
4 \end{tikzpicture}

```

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

Run-through qubit symbol of a controlled gate.

Parameters

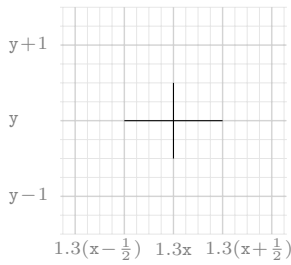
option Omit for standard circuit styling or `ibmqxA`, ..., `ibmqxH` for IBM Q Experience circuit styling. The last letter of `ibmqx*` defines the color control wire:

A B C D E F G H

If `ibmqx` is passed, `ibmqxD` will be used.

x, y Position of symbol in schematic. The actual TikZ coordinates are `(\qgateSx*x,y)`.

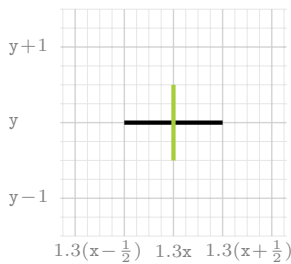
Examples



```

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

```



```

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

```

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

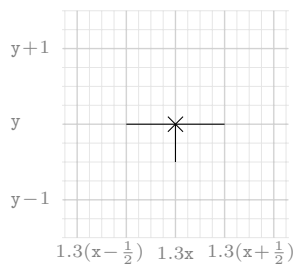
Top qubit of a SWAP gate.

Parameters

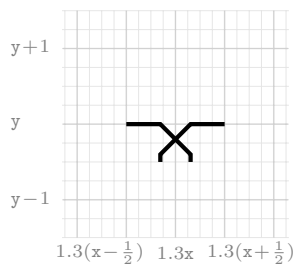
option Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.

x, y Position of symbol in schematic. The actual TikZ coordinates are `(\qgateSx*x,y)`.

Examples



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



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

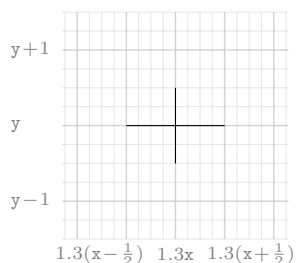
`\qgateSWR[option]{x}{y}`

Run-through qubit of a SWAP gate.

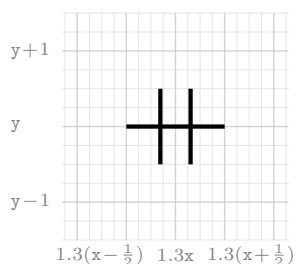
Parameters

- `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 `(\qgateSx*x,y)`.

Examples



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



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

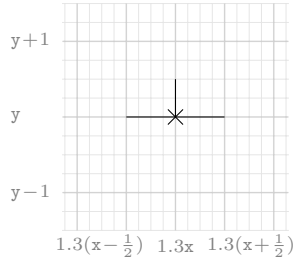
`\qgateSWb[option]{x}{y}`

Bottom qubit of a SWAP gate.

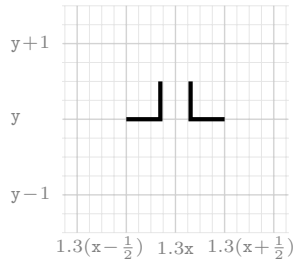
Parameters

- 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 $(\backslash\text{qgateSx}*x, y)$.

Examples



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



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

2.5 Measurement Symbols

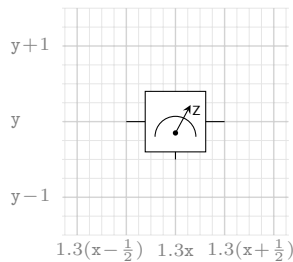
```
\qmeasM[option]{x}{y}
\qmeasM*[option]{x}{y}{axis}{wires}
```

Measurement symbol.

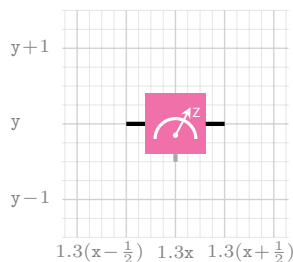
Parameters

- 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 $(\backslash\text{qgateSx}*x, y)$.
- axis** Axis of measurement: X, Y, or Z (starred version only).
- wires** Wires, b for bottom, r for right, and br for both (starred version only).

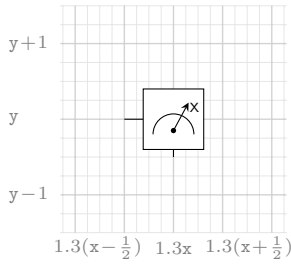
Examples



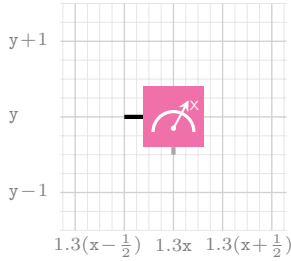
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasM{0}{0}
4 \end{tikzpicture}
```



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



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



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

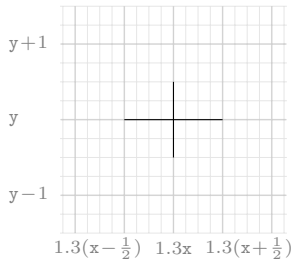
`\qmeasR[option]{x}{y}`

Measurement run-through qubit symbol.

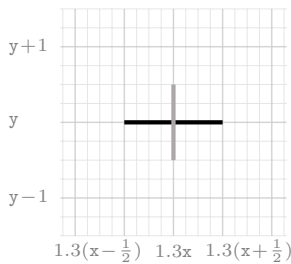
Parameters

- 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 `(\qgateSx*x,y)`.

Examples



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



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

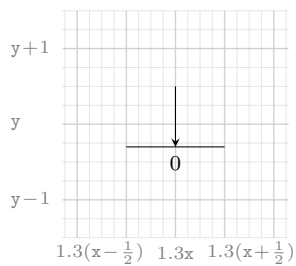
`\qmeasMB[option]{b}{x}{y}`

Measurement-joins-bus symbol.

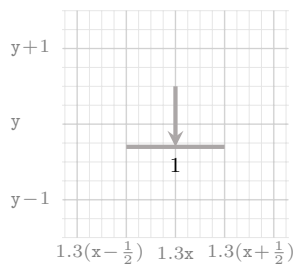
Parameters

- 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 `(\qgateSx*x,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}
```

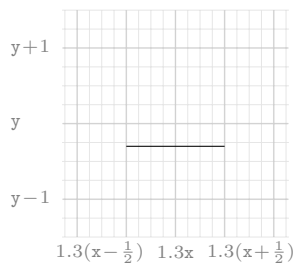
`\qmeaB[option]{x}{y}`

Measurement bus symbol.

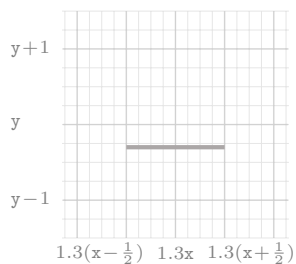
Parameters

- `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 `(\qgateSx*x,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}
```

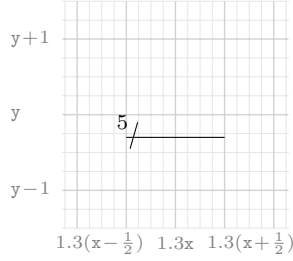
`\qmeaBh[option]{b}{x}{y}`

Measurement bus header symbol.

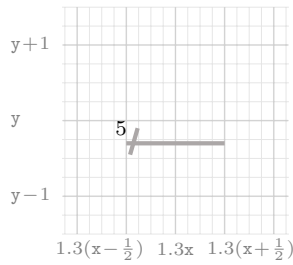
Parameters

- 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 $(\backslash\text{qgateSx}*x, y)$.

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

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

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

Toffoli (CCNOT) Gate Operator

$$CCNOT \doteq \left(\begin{array}{c|cccccccc} & \langle 000 | & \langle 001 | & \langle 010 | & \langle 011 | & \langle 100 | & \langle 101 | & \langle 110 | & \langle 111 | \\ \hline |000\rangle & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ |001\rangle & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ |010\rangle & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ |101\rangle & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ |100\rangle & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ |101\rangle & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ |110\rangle & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ |111\rangle & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \end{array} \right)$$

```
1 $\displaystyle CCNOT\dotseq\qgateOCCNOT$
```

2.7 Auxiliary Commands

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

Adds control wire(s) to any gate (except CNOT and measurement).

Parameters

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

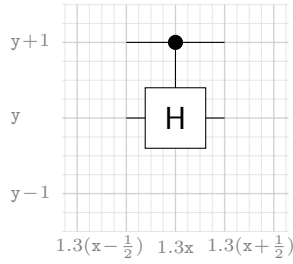
A B C D E F G H

If `ibmqx` is passed, `ibmqxD` will be used.

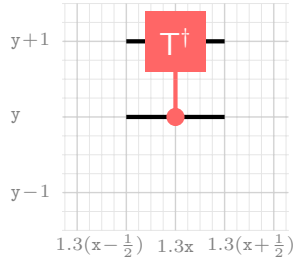
cwires Control wires, `t` for top, `b` for bottom, and `tb` for both sides.

x, y Position of symbol in schematic. The actual TikZ coordinates are $(\backslash\text{qgateSx}*x, y)$.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNC{b}{0}{1}
4   \qgateH{0}{0}\qgateControl{t}{0}{0}
5 \end{tikzpicture}
```



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateTi[ibmqx]{0}{1}\qgateControl[ibmqxE]{b}{0}{1}
4   \qgateCNC[ibmqxE]{t}{0}{0}
5 \end{tikzpicture}
```

```
\qnode[style]{x}{y}{label}
```

TikZ node in schematics coordinates.

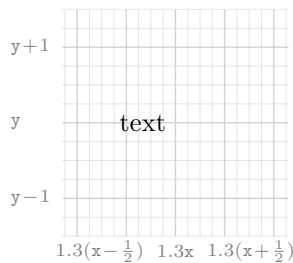
Parameters

style TikZ node style.

x, y Position of symbol in schematic. The actual TikZ coordinates are $(\backslash\text{qgateSx}*x, y)$.

label Node label.

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qnode[anchor=east]{0}{0}{text}
4 \end{tikzpicture}
```

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 %% TODO:
13 %% - Barrier symbols: \qbarrX
14
15 %% == REQUIRED PACKAGES =====
16
17 \RequirePackage{xifthen}
18 \RequirePackage{tikz}
19
20 %% == DEFINITIONS AND COLORS =====
21 \def\qgateSx{1.3}
22
23 \definecolor{ibmqxA}{HTML}{F69458} % IBM QX Ux gate
24 \definecolor{ibmqxB}{HTML}{FFCA64} % IBM QX id gate
25 \definecolor{ibmqxC}{HTML}{A6CE38} % IBM QX Pauli gates
26 \definecolor{ibmqxD}{HTML}{00BFF2} % IBM QX H, S, S' und CNOT gates
27 \definecolor{ibmqxE}{HTML}{FF6666} % IBM QX T und T' gates
28 \definecolor{ibmqxF}{HTML}{F070AA} % IBM QX measurement and if
29 \definecolor{ibmqxG}{HTML}{ADC1C6} % IBM QX barrier
30 \definecolor{ibmqxH}{HTML}{F2F2F2} % IBM QX |0> state
31 \definecolor{ibmqxI}{HTML}{ABA7A7} % IBM QX measurement wire
32
33 %% == COMMANDS =====
34
35 % Wire
36 \newcommand{\qwire}[3][]{\{
37   \pgfmathsetmacro\x{\qgateSx*(#2)}
38   \pgfmathsetmacro\y{(#3)}
39   \ifthenelse{\isin{ibmqx}{#1}}{\{
40     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
41   }\{
42     \tikzset{lstyle/.style={}}
43   }\{
44     \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
45   }}
46
47 % Zero state preparator
48 \newcommand{\qzero}[3][]{\{
49   \pgfmathsetmacro\x{\qgateSx*(#2)}
50   \pgfmathsetmacro\y{(#3)}
51   \ifthenelse{\isin{ibmqx}{#1}}{\{
52     \draw[ultra thick,line cap=butt] (\x+0.4,\y) -- (\x+\qgateSx/2,\y);
53     \draw[draw=none,fill=ibmqxH] (\x-0.4,\y-0.4) rectangle (\x+0.4,\y+0.4);
54     \node at (\x,\y){\large $\lvert 0 \rangle$};
55   }\{
56     \node[anchor=east] at (\x+\qgateSx/2,\y){$\lvert 0 \rangle$};
57   }\{
58   }}
59
60 % General single-qubit gate
61 \newcommand\qgateU[4][]{\{
62   \pgfmathsetmacro\x{\qgateSx*(#2)}
63   \pgfmathsetmacro\y{(#3)}
64   \ifthenelse{\isin{ibmqx}{#1}}{\{
65     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
66     \ifthenelse{\equal{ibmqx}{#1}}{\{
67       \tikzset{rstyle/.style={draw=none,fill=ibmqxG}}
68     }\{
69       \tikzset{rstyle/.style={draw=none,fill=#1}}
70     }\{
71       \tikzset{tstyle/.style={white}}
72     }\{

```

```

73 \tikzset{lstyle/.style={}}
74 \tikzset{rstyle/.style={fill=white}}
75 \tikzset{tstyle/.style={}}
76 }%
77 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x-0.4 ,\y);
78 \draw[lstyle] (\x+0.4 ,\y) -- (\x+\qgateSx/2,\y);
79 \draw[rstyle] (\x-0.4 ,\y-0.4) rectangle (\x+0.4,\y+0.4);
80 \node[tstyle,anchor=center] at (\x,\y) {\sf\large #4};
81 }}
82
83 % Identity gate
84 \newcommand\qgateID[3][]{\%
85 \ifthenelse{\isin{ibmqx}{#1}}{\%
86 \qgateU[ibmqxB]{#2}{#3}{id}
87 }{\%
88 \qgateU{#2}{#3}{id}
89 }%
90 }
91 \newcommand\qgateOID{\%
92 \def\ket##1{\scriptstyle|##1\rangle}
93 \def\bra##1{\scriptstyle\langle ##1|}
94 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
95 & \bra{0} & \bra{1} \\ \hline
96 \ket{0} & 1 & 0 \\
97 \ket{1} & 0 & 1
98 \end{array}\!\!\right)
99 }}
100
101 % Pauli-X gate
102 \newcommand\qgateX[3][]{\%
103 \ifthenelse{\isin{ibmqx}{#1}}{\%
104 \qgateU[ibmqxC]{#2}{#3}{X}
105 }{\%
106 \qgateU{#2}{#3}{X}
107 }%
108 }
109 \newcommand\qgateOX{\%
110 \def\ket##1{\scriptstyle|##1\rangle}
111 \def\bra##1{\scriptstyle\langle ##1|}
112 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
113 & \bra{0} & \bra{1} \\ \hline
114 \ket{0} & 0 & 1 \\
115 \ket{1} & 1 & 0
116 \end{array}\!\!\right)
117 }}
118
119 % Pauli-Y gate
120 \newcommand\qgateY[3][]{\%
121 \ifthenelse{\isin{ibmqx}{#1}}{\%
122 \qgateU[ibmqxC]{#2}{#3}{Y}
123 }{\%
124 \qgateU{#2}{#3}{Y}
125 }%
126 }
127 \newcommand\qgateOY{\%
128 \def\ket##1{\scriptstyle|##1\rangle}
129 \def\bra##1{\scriptstyle\langle ##1|}
130 \def\j{\mathrm{i}}
131 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
132 & \bra{0} & \bra{1} \\ \hline
133 \ket{0} & 0 & -\j \\
134 \ket{1} & \j & 0
135 \end{array}\!\!\right)
136 }}
137
138 % Pauli-Z gate
139 \newcommand\qgateZ[3][]{\%
140 \ifthenelse{\isin{ibmqx}{#1}}{\%
141 \qgateU[ibmqxC]{#2}{#3}{Z}
142 }{\%
143 \qgateU{#2}{#3}{Z}
144 }%

```

```

145 }
146 \newcommand\qgateOZ{%
147   \def\ket##1{\scriptstyle|##1\rangle}
148   \def\bra##1{\scriptstyle\langle ##1|}
149   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
150     & \bra{0} & \bra{1} \\ \hline
151     \ket{0} & 1 & 0 \\
152     \ket{1} & 0 & -1
153   \end{array}\!\!\right)
154 }}
155
156 % Hadamard gate
157 \newcommand\qgateH[3][]{%
158   \ifthenelse{\isin{ibmqx}{#1}}{%
159     \qgateU[ibmqxD]{#2}{#3}{H}
160   }{%
161     \qgateU{#2}{#3}{H}
162   }%
163 }
164 \newcommand\qgateOH{%
165   \def\ket##1{\scriptstyle|##1\rangle}
166   \def\bra##1{\scriptstyle\langle ##1|}
167   \dfrac{1}{\sqrt{2}}\!
168   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
169     & \bra{0} & \bra{1} \\ \hline
170     \ket{0} & 1 & 1 \\
171     \ket{1} & 1 & -1
172   \end{array}\!\!\right)
173 }}
174
175 % S phase gate
176 \newcommand\qgateS[3][]{%
177   \ifthenelse{\isin{ibmqx}{#1}}{%
178     \qgateU[ibmqxD]{#2}{#3}{S}
179   }{%
180     \qgateU{#2}{#3}{S}
181   }%
182 }
183 \newcommand\qgateOS{%
184   \def\ket##1{\scriptstyle|##1\rangle}
185   \def\bra##1{\scriptstyle\langle ##1|}
186   \def\j{\mathrm{i}}
187   \dfrac{1}{\sqrt{2}}\!
188   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
189     & \bra{0} & \bra{1} \\ \hline
190     \ket{0} & 1 & 0 \\
191     \ket{1} & 0 & \j
192   \end{array}\!\!\right)
193 }}
194
195 % Inverse S phase gate
196 \newcommand\qgateSi[3][]{%
197   \ifthenelse{\isin{ibmqx}{#1}}{%
198     \qgateU[ibmqxD]{#2}{#3}{S$^\dagger$}
199   }{%
200     \qgateU{#2}{#3}{S$^\dagger$}
201   }%
202 }
203 \newcommand\qgateOSi{%
204   \def\ket##1{\scriptstyle|##1\rangle}
205   \def\bra##1{\scriptstyle\langle ##1|}
206   \def\j{\mathrm{i}}
207   \dfrac{1}{\sqrt{2}}\!
208   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
209     & \bra{0} & \bra{1} \\ \hline
210     \ket{0} & 1 & 0 \\
211     \ket{1} & 0 & -\j
212   \end{array}\!\!\right)
213 }}
214
215 % T phase gate
216 \newcommand\qgateT[3][]{%

```

```

217 \ifthenelse{\isin{ibmqx}{#1}}{%
218   \qgateU[ibmqxE]{#2}{#3}{T}
219 }{%
220   \qgateU{#2}{#3}{T}
221 }%
222 }
223 \newcommand\qgateOT{%
224   \def\ket##1{\scriptstyle|##1\rangle}
225   \def\bra##1{\scriptstyle\langle ##1|}
226   \def\j{\mathrm{i}}
227   \dfrac{1}{\sqrt{2}}\!
228   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
229     & \bra{0} & \bra{1} \\ \hline
230     \ket{0} & 1 & 0 \\
231     \ket{1} & 0 & \frac{1}{\sqrt{2}}(1\!+\!\j)
232   \end{array}\!\right)
233 }}
234
235 % Inverse T phase gate
236 \newcommand\qgateTi[3][]{%
237   \ifthenelse{\isin{ibmqx}{#1}}{%
238     \qgateU[ibmqxE]{#2}{#3}{T$\dagger$}
239   }{%
240     \qgateU{#2}{#3}{T$\dagger$}
241   }%
242 }
243 \newcommand\qgateOTi{%
244   \def\ket##1{\scriptstyle|##1\rangle}
245   \def\bra##1{\scriptstyle\langle ##1|}
246   \def\j{\mathrm{i}}
247   \dfrac{1}{\sqrt{2}}\!
248   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
249     & \bra{0} & \bra{1} \\ \hline
250     \ket{0} & 1 & 0 \\
251     \ket{1} & 0 & \frac{1}{\sqrt{2}}(1\!-\!\j)
252   \end{array}\!\right)
253 }}
254
255 % U1 gate of IBM Q Experience
256 \makeatletter
257 \newcommand\qgateUa{\@ifstar\qgateUaS\qgateUaN}
258 \makeatother
259 \newcommand\qgateUaN[3][]{% unstarred version
260   \ifthenelse{\isin{ibmqx}{#1}}{%
261     \qgateU[ibmqxA]{#2}{#3}{U1}
262   }{%
263     \qgateU{#2}{#3}{U1}
264   }%
265 }
266 \newcommand\qgateUaS[4][]{% starred version
267   \ifthenelse{\isin{ibmqx}{#1}}{%
268     \qgateU[ibmqxA]{#2}{#3}{\qgateSublabel{U1}{#4}}
269   }{%
270     \qgateU{#2}{#3}{\qgateSublabel{U1}{#4}}
271   }%
272 }
273 \newcommand\qgateOUa{%
274   \def\ket##1{\scriptstyle|##1\rangle}
275   \def\bra##1{\scriptstyle\langle ##1|}
276   \def\ee{\mathrm{e}}
277   \def\j{\mathrm{i}}
278   \left(\hspace*{-0.4ex}\begin{array}{c|cc}
279     & \bra{0} & \bra{1} \\ \hline
280     \ket{0} & 1 & 0 \\
281     \ket{1} & 0 & \ee^{-\lambda\j}
282   \end{array}\!\right)
283 }}
284
285 % U2 gate of IBM Q Experience
286 \makeatletter
287 \newcommand\qgateUb{\@ifstar\qgateUbS\qgateUbN}
288 \makeatother

```

```

289 \newcommand\qgateUbN[3] [] {% unstarred version
290 \ifthenelse{\isin{ibmqx}{#1}}{%
291 \qgateU[ibmqxA]{#2}{#3}{U2}
292 }{%
293 \qgateU{#2}{#3}{U2}
294 }%
295 }
296 \newcommand\qgateUbS[4] [] {% starred version
297 \ifthenelse{\isin{ibmqx}{#1}}{%
298 \qgateU[ibmqxA]{#2}{#3}{\qgateSublabel{U2}{#4}}
299 }{%
300 \qgateU{#2}{#3}{\qgateSublabel{U2}{#4}}
301 }%
302 }
303 \newcommand\qgateOUb{%
304 \def\ket##1{\scriptstyle|##1\rangle}
305 \def\bra##1{\scriptstyle\langle ##1|}
306 \def\mathrm{e}{}
307 \def\mathrm{j}{}
308 \renewcommand\arraystretch{1.4}
309 \dfrac{1}{\sqrt{2}}\!
310 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
311 & \bra{0} & \bra{1} \\ \hline
312 \ket{0} & 1 & -\mathrm{e}^{\mathrm{i}\lambda j} \\
313 \ket{1} & \mathrm{e}^{\mathrm{i}\phi j} & \mathrm{e}^{\mathrm{i}(\lambda+\phi)j} \\
314 \end{array}\!\right)
315 }}
316
317 % U3 gate of IBM Q Experience
318 \makeatletter
319 \newcommand\qgateUc{\@ifstar\qgateUcS\qgateUcN}
320 \makeatother
321 \newcommand\qgateUcN[3] [] {%
322 \ifthenelse{\isin{ibmqx}{#1}}{% unstarred version
323 \qgateU[ibmqxA]{#2}{#3}{U3}
324 }{%
325 \qgateU{#2}{#3}{U3}
326 }%
327 }
328 \newcommand\qgateUcS[4] [] {% starred version
329 \ifthenelse{\isin{ibmqx}{#1}}{% unstarred version
330 \qgateU[ibmqxA]{#2}{#3}{\qgateSublabel{U3}{#4}}
331 }{%
332 \qgateU{#2}{#3}{\qgateSublabel{U3}{#4}}
333 }%
334 }
335 \newcommand\qgateOUc{%
336 \def\ket##1{\scriptstyle|##1\rangle}
337 \def\bra##1{\scriptstyle\langle ##1|}
338 \def\mathrm{e}{}
339 \def\mathrm{j}{}
340 \renewcommand\arraystretch{1.4}
341 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
342 & \bra{0} & \bra{1} \\ \hline
343 \ket{0} & \cos(\frac{\theta}{2}) & -\sin(\frac{\theta}{2})\mathrm{e}^{\mathrm{i}\lambda j} \\
344 \ket{1} & \sin(\frac{\theta}{2})\mathrm{e}^{\mathrm{i}\phi j} & \cos(\frac{\theta}{2})\mathrm{e}^{\mathrm{i}(\lambda+\phi)j} \\
345 \end{array}\!\right)
346 }}
347
348 % General two-qubit gate
349 \newcommand\qgateUu[4] [] {%
350 \pgfmathsetmacro\x{\qgateSx*{#2}}
351 \pgfmathsetmacro\y{#3}
352 \ifthenelse{\isin{ibmqx}{#1}}{%
353 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
354 \ifthenelse{\equal{ibmqx}{#1}}{%
355 \tikzset{rstyle/.style={draw=none,fill=ibmqxG}}
356 }{%
357 \tikzset{rstyle/.style={draw=none,fill=#1}}
358 }
359 \tikzset{tstyle/.style={white}}
360 }{%

```

```

361 \tikzset{lstyle/.style={}}
362 \tikzset{rstyle/.style={fill=white}}
363 \tikzset{tstyle/.style={}}
364 }%
365 \draw[rstyle] (\x-0.5 ,\y-0.25) rectangle (\x+0.5,\y+1.25);
366 \draw[lstyle] (\x-\qgateSx/2,\y+1) -- (\x-0.5 ,\y+1);
367 \draw[lstyle] (\x+0.5 ,\y+1) -- (\x+\qgateSx/2,\y+1);
368 \draw[lstyle] (\x-\qgateSx/2,\y ) -- (\x-0.5 ,\y );
369 \draw[lstyle] (\x+0.5 ,\y ) -- (\x+\qgateSx/2,\y );
370 \node[anchor=north,tstyle] at (\x,\y+1.25){\sf\large #4};
371 }}
372
373 % General three-qubit gate
374 \newcommand{\qgateUuu}[4][]{\{
375 \pgfmathsetmacro\x{\qgateSx*(#2)}
376 \pgfmathsetmacro\y{(#3)}
377 \ifthenelse{\isin{ibmqx}{#1}}{%
378 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
379 \ifthenelse{\equal{ibmqx}{#1}}{%
380 \tikzset{rstyle/.style={draw=none,fill=ibmqxG}}
381 }{%
382 \tikzset{rstyle/.style={draw=none,fill=#1}}
383 }
384 \tikzset{tstyle/.style={white}}
385 }{%
386 \tikzset{lstyle/.style={}}
387 \tikzset{rstyle/.style={fill=white}}
388 \tikzset{tstyle/.style={}}
389 }%
390 \draw[rstyle] (\x-0.5 ,\y-1.25) rectangle (\x+0.5,\y+1.25);%
391 \draw[lstyle] (\x-\qgateSx/2,\y+1) -- (\x-0.5 ,\y+1);%
392 \draw[lstyle] (\x+0.5 ,\y+1) -- (\x+\qgateSx/2,\y+1);%
393 \draw[lstyle] (\x-\qgateSx/2,\y ) -- (\x-0.5 ,\y );%
394 \draw[lstyle] (\x+0.5 ,\y ) -- (\x+\qgateSx/2,\y );%
395 \draw[lstyle] (\x-\qgateSx/2,\y-1) -- (\x-0.5 ,\y-1);%
396 \draw[lstyle] (\x+0.5 ,\y-1) -- (\x+\qgateSx/2,\y-1);%
397 \node[anchor=north,tstyle] at (\x,\y+1.25){\sf\large #4};%
398 }}
399
400 % CNOT gate XOR symbol
401 \newcommand{\qgateCNX}[4][]{\{
402 \pgfmathsetmacro\x{\qgateSx*(#3)}
403 \pgfmathsetmacro\y{(#4)}
404 \ifthenelse{\isin{ibmqx}{#1}}{%
405 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
406 \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
407 \tikzset{rstyle/.style={draw=none,fill=ibmqxD}}
408 \tikzset{tstyle/.style={very thick,white}}
409 \def\R{0.4}
410 }{%
411 \tikzset{lstyle/.style={}}
412 \tikzset{cstyle/.style={}}
413 \tikzset{rstyle/.style={fill=white}}
414 \tikzset{tstyle/.style={}}
415 \def\R{0.25}
416 }%
417 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x-\R ,\y);
418 \draw[lstyle] (\x+\R ,\y) -- (\x+\qgateSx/2,\y);
419 \draw[rstyle] (\x ,\y) circle (\R);
420 \ifthenelse{\isin{ibmqx}{#1}}{%
421 \draw[tstyle] (\x-0.2,\y) -- (\x+0.2,\y);
422 \draw[tstyle] (\x,\y-0.2) -- (\x,\y+0.2);
423 }{%
424 \draw[lstyle] (\x-\R,\y) -- (\x+\R,\y);
425 \draw[lstyle] (\x,\y-\R) -- (\x,\y+\R);
426 }
427 \ifthenelse{\isin{t}{#2}}{%
428 \draw[cstyle] (\x,\y+\R) -- (\x,\y+0.5);
429 }{}
430 \ifthenelse{\isin{b}{#2}}{%
431 \draw[cstyle] (\x,\y-\R) -- (\x,\y-0.5);
432 }{}

```

```

433 }}
434
435 % CNOT gate control qubit symbol
436 \makeatletter
437 \newcommand\qgateCNC{\@ifstar\qgateCNCS\qgateCNCN}
438 \makeatother
439 \newcommand\qgateCNCS[4]{}{\qgateCNCint{#1}{#2}{#3}{#4}{inv}}%starred version
440 \newcommand\qgateCNCN[4]{}{\qgateCNCint{#1}{#2}{#3}{#4}{}} %unstarred version
441 \newcommand\qgateCNCint[5]{%
442   \pgfmathsetmacro\x{\qgateSx*(#3)}
443   \pgfmathsetmacro\y{(#4)}
444   \ifthenelse{\isin{ibmqx}{#1}}{%
445     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
446     \ifthenelse{\equal{ibmqx}{#1}}{%
447       \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
448       \ifthenelse{\equal{inv}{#5}}{%
449         \tikzset{rstyle/.style={draw=ibmqxD,thick,fill=white}}
450       }{%
451         \tikzset{rstyle/.style={draw=none,fill=ibmqxD}}
452       }
453     }{%
454       \tikzset{cstyle/.style={#1,ultra thick,line cap=butt}}
455       \ifthenelse{\equal{inv}{#5}}{%
456         \tikzset{rstyle/.style={draw=#1,thick,fill=white}}
457       }{%
458         \tikzset{rstyle/.style={draw=none,fill=#1}}
459       }
460     }
461     \tikzset{tstyle/.style={white}}
462     \def\r{0.12}
463   }{%
464     \tikzset{lstyle/.style={}}
465     \tikzset{cstyle/.style={}}
466     \ifthenelse{\equal{inv}{#5}}{%
467       \tikzset{rstyle/.style={draw=black,fill=white}}
468     }{%
469       \tikzset{rstyle/.style={draw=none,fill=black}}
470     }
471     \tikzset{tstyle/.style={}}
472     \def\r{0.1}
473   }%
474   \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
475   \draw[rstyle] (\x, \y) circle (\r);
476   \ifthenelse{\isin{t}{#2}}{%
477     \draw[cstyle] (\x,\y+0.1) -- (\x,\y+0.5);
478   }{}
479   \ifthenelse{\isin{b}{#2}}{%
480     \draw[cstyle] (\x,\y-0.1) -- (\x,\y-0.5);
481   }{}
482 }}
483
484
485 % \newcommand\qgateCNC[4]{}{%
486 %   \pgfmathsetmacro\x{\qgateSx*(#3)}
487 %   \pgfmathsetmacro\y{(#4)}
488 %   \ifthenelse{\isin{ibmqx}{#1}}{%
489 %     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
490 %     \ifthenelse{\equal{ibmqx}{#1}}{%
491 %       \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
492 %       \tikzset{rstyle/.style={draw=none,fill=ibmqxD}}
493 %     }{%
494 %       \tikzset{cstyle/.style={#1,ultra thick,line cap=butt}}
495 %       \tikzset{rstyle/.style={draw=none,fill=#1}}
496 %     }
497 %     \tikzset{tstyle/.style={white}}
498 %     \def\r{0.12}
499 %   }{%
500 %     \tikzset{lstyle/.style={}}
501 %     \tikzset{cstyle/.style={}}
502 %     \tikzset{rstyle/.style={draw=none,fill=black}}
503 %     \tikzset{tstyle/.style={}}
504 %     \def\r{0.1}

```

```

505 % }%
506 % \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
507 % \draw[rstyle] (\x, \y) circle (\r);
508 % \ifthenelse{\isin{t}{#2}}{%
509 %   \draw[cstyle] (\x,\y+0.1) -- (\x,\y+0.5);
510 % }{}
511 % \ifthenelse{\isin{b}{#2}}{%
512 %   \draw[cstyle] (\x,\y-0.1) -- (\x,\y-0.5);
513 % }{}
514 % }}
515
516 % CNOT gate run-through qubit symbol
517 \newcommand\qgateCNR[3][]{\%
518 \pgfmathsetmacro\x{\qgateSx*(#2)}
519 \pgfmathsetmacro\y{(#3)}
520 \ifthenelse{\isin{ibmqx}{#1}}{%
521 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
522 \ifthenelse{\equal{ibmqx}{#1}}{%
523 \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
524 }{%
525 \tikzset{cstyle/.style={#1,ultra thick,line cap=butt}}
526 }
527 }{%
528 \tikzset{lstyle/.style={}}
529 \tikzset{cstyle/.style={}}
530 }%
531 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
532 \draw[cstyle] (\x, \y-0.5) -- (\x, \y+0.5);
533 }}
534
535 % Swap gate top qubit symbol
536 \newcommand\qgateSWt[3][]{\%
537 \pgfmathsetmacro\x{\qgateSx*(#2)}
538 \pgfmathsetmacro\y{(#3)}
539 \ifthenelse{\isin{ibmqx}{#1}}{%
540 \draw[ultra thick,line cap=butt]
541 (\x-\qgateSx/2,\y) -- (\x-0.2,\y) -- (\x+0.2,\y-0.4) -- (\x+0.2,\y-0.5);
542 \draw[ultra thick,line cap=butt]
543 (\x+\qgateSx/2,\y) -- (\x+0.2,\y) -- (\x-0.2,\y-0.4) -- (\x-0.2,\y-0.5);
544 }{%
545 \pgfmathsetmacro\w{0.1}
546 \draw(\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
547 \draw(\x-\w, \y-\w) -- (\x+\w, \y+\w);
548 \draw(\x-\w, \y+\w) -- (\x+\w, \y-\w);
549 \draw(\x, \y) -- (\x, \y-0.5);
550 }%
551 }}
552
553 % Swap gate run-through qubit symbol
554 \newcommand\qgateSWr[3][]{\%
555 \pgfmathsetmacro\x{\qgateSx*(#2)}
556 \pgfmathsetmacro\y{(#3)}
557 \ifthenelse{\isin{ibmqx}{#1}}{%
558 \draw[ultra thick,line cap=butt] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
559 \draw[ultra thick,line cap=butt] (\x-0.2, \y+0.5) -- (\x-0.2, \y-0.5);
560 \draw[ultra thick,line cap=butt] (\x+0.2, \y+0.5) -- (\x+0.2, \y-0.5);
561 }{%
562 \draw(\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
563 \draw(\x, \y-0.5) -- (\x, \y+0.5);
564 }%
565 }}
566
567 % Swap gate bottom qubit symbol
568 \newcommand\qgateSWb[3][]{\%
569 \pgfmathsetmacro\x{\qgateSx*(#2)}
570 \pgfmathsetmacro\y{(#3)}
571 \ifthenelse{\isin{ibmqx}{#1}}{%
572 \draw[ultra thick,line cap=butt]
573 (\x-\qgateSx/2,\y) -- (\x-0.2,\y) -- (\x-0.2,\y+0.5);
574 \draw[ultra thick,line cap=butt]
575 (\x+\qgateSx/2,\y) -- (\x+0.2,\y) -- (\x+0.2,\y+0.5);
576 }{%

```



```

577 \pgfmathsetmacro\w{0.1}
578 \draw(\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
579 \draw(\x-\w,\y-\w) -- (\x+\w,\y+\w);
580 \draw(\x-\w,\y+\w) -- (\x+\w,\y-\w);
581 \draw(\x,\y) -- (\x,\y+0.5);
582 }%
583 }}
584
585 % Measurement symbol
586 \makeatletter
587 \newcommand\qmeasM{\ifstar\qmeasMS\qmeasMN}
588 \makeatother
589 \newcommand\qmeasMN[3][]{
590 \qmeasMS[#1]{#2}{#3}{Z}{br}
591 }
592 \newcommand\qmeasMS[5][]{%
593 \pgfmathsetmacro\x{\qgateSx*(#2)}
594 \pgfmathsetmacro\y{(#3)}
595 \ifthenelse{\isin{ibmqx}{#1}}{%
596 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
597 \tikzset{rstyle/.style={draw=none,fill=ibmqxF}}
598 \tikzset{tstyle/.style={white,very thick,line cap=butt}}
599 \tikzset{pstyle/.style={->,stealth,white,thick,line cap=butt}}
600 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
601 }{%
602 \tikzset{lstyle/.style={}}
603 \tikzset{rstyle/.style={fill=white}}
604 \tikzset{tstyle/.style={}}
605 \tikzset{pstyle/.style={->,stealth,line cap=butt}}
606 \tikzset{cstyle/.style={}}
607 }%
608 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x-0.4,\y);
609 \draw[rstyle] (\x-0.4,\y-0.4) rectangle (\x+0.4,\y+0.4);
610 \draw[tstyle] (\x+0.27,\y-0.2) arc (0:180:0.27);
611 \draw[pstyle] (\x,\y-0.15) -- (\x+0.2,\y+0.22);
612 \node[pstyle] at (\x+0.28,\y+0.15) {\tiny\sffamily #4};
613 \fill[pstyle] (\x,\y-0.15) circle (0.035);
614 \ifthenelse{\isin{r}{#5}}{%
615 \draw[lstyle] (\x+0.4,\y) -- (\x+\qgateSx/2,\y);%
616 }{}
617 \ifthenelse{\isin{b}{#5}}{%
618 \draw[cstyle] (\x,\y-0.4) -- (\x,\y-0.5);%
619 }{}
620 }}
621
622 % Measurement run-through qubit symbol
623 \newcommand\qmeasR[3][]{%
624 \pgfmathsetmacro\x{\qgateSx*(#2)}
625 \pgfmathsetmacro\y{(#3)}
626 \ifthenelse{\isin{ibmqx}{#1}}{%
627 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
628 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
629 }{%
630 \tikzset{lstyle/.style={}}
631 \tikzset{cstyle/.style={}}
632 }%
633 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
634 \draw[cstyle] (\x,\y-0.5) -- (\x,\y+0.5);
635 }}
636
637 % Measurement-joins-bus symbol
638 \newcommand\qmeasMB[4][]{%
639 \pgfmathsetmacro\x{\qgateSx*(#3)}
640 \pgfmathsetmacro\y{(#4)}
641 \ifthenelse{\isin{ibmqx}{#1}}{%
642 \tikzset{cstyle/.style={->,stealth,ibmqxI,ultra thick,line cap=butt}}
643 }{%
644 \tikzset{cstyle/.style={->,stealth}}
645 }%
646 \draw[cstyle] (\x-\qgateSx/2,\y-0.3) -- (\x+\qgateSx/2,\y-0.3);
647 \draw[cstyle,->] (\x,\y+0.5) -- (\x,\y-0.3)
648 \node[anchor=north,black] {\footnotesize #2};

```

```

649 }}
650
651 % Measurement bus symbol
652 \newcommand\qmeasB[3][]{\%
653 \pgfmathsetmacro\x{\qgateSx*(#2)}
654 \pgfmathsetmacro\y{(#3)}
655 \ifthenelse{\isin{ibmqx}{#1}}{\%
656 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
657 }{\%
658 \tikzset{cstyle/.style={}}}
659 }%
660 \draw[cstyle](\x-\qgateSx/2,\y-0.3) -- (\x+\qgateSx/2,\y-0.3);
661 }}
662
663 % Measurement bus head symbol
664 \newcommand\qmeasBh[4][]{\%
665 \pgfmathsetmacro\x{\qgateSx*(#3)}
666 \pgfmathsetmacro\y{(#4)}
667 \ifthenelse{\isin{ibmqx}{#1}}{\%
668 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
669 }{\%
670 \tikzset{cstyle/.style={}}}
671 }%
672 \draw[cstyle](\x-\qgateSx/2,\y-0.3) -- (\x+\qgateSx/2,\y-0.3);
673 \draw[cstyle](\x-\qgateSx/2+0.05,\y-0.45) -- (\x-\qgateSx/2+0.15,\y-0.1)
674 node[anchor=east,black]{\footnotesize #2};
675 }}
676
677 %% == OTHER GATE OPERATORS =====
678
679 \newcommand\qgateOCNOT{\%
680 \def\ket##1{\scriptstyle|##1\rangle}
681 \def\bra##1{\rotatebox{90}{\scriptstyle\langle ##1|}}
682 \left(\hspace*{-0.4ex}\begin{array}{c|cccc}
683 & \bra{00} & \bra{01} & \bra{10} & \bra{11} \\ \hline
684 \ket{00} & 1 & 0 & 0 & 0 \\
685 \ket{01} & 0 & 1 & 0 & 0 \\
686 \ket{10} & 0 & 0 & 0 & 1 \\
687 \ket{11} & 0 & 0 & 1 & 0
688 \end{array}\!\!\right)
689 }}
690
691 \newcommand\qgateOCCNOT{\%
692 \def\ket##1{\scriptstyle|##1\rangle}
693 \def\bra##1{\rotatebox{90}{\scriptstyle\langle ##1|}}
694 \left(\hspace*{-0.4ex}\begin{array}{c|cccccccc}
695 & \bra{000} & \bra{001} & \bra{010} & \bra{011} & \bra{100} & \bra{101} & \bra{110} & \bra{111} \\ \hline
696 \ket{000} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
697 \ket{001} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
698 \ket{010} & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
699 \ket{011} & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
700 \ket{100} & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
701 \ket{101} & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
702 \ket{110} & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
703 \ket{111} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
704 \end{array}\!\!\right)
705 }}
706
707 %% == AUXILIARY COMMANDS =====
708
709 % Control wires for gates
710 \newcommand\qgateControl[4][]{\%
711 \pgfmathsetmacro\x{\qgateSx*(#3)}
712 \pgfmathsetmacro\y{(#4)}
713 \ifthenelse{\isin{ibmqx}{#1}}{\%
714 \ifthenelse{\equal{ibmqx}{#1}}{\%
715 \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
716 }{\%
717 \tikzset{cstyle/.style={#1,ultra thick,line cap=butt}}
718 }
719 }{\%
720 \tikzset{cstyle/.style={}}}

```

```

721 }%
722 \ifthenelse{\isin{t}{#2}}{%
723   \draw[cstyle] (\x,\y+0.4) -- (\x,\y+0.5);
724 }%
725 \ifthenelse{\isin{b}{#2}}{%
726   \draw[cstyle] (\x,\y-0.4) -- (\x,\y-0.5);
727 }%
728 }}
729
730 % TikZ node in circuit coordinate system
731 \newcommand\qnode[4][]{\%
732   \pgfmathsetmacro\x{\qgateSx*(#2)}
733   \pgfmathsetmacro\y{(#3)}
734   \node[anchor=center,#1] at (\x,\y) {#4};
735 }
736
737 %% == PACKAGE-INTERNAL COMMANDS =====
738
739 % Draw scale paper for documentations
740 \newcommand{\qScalePaper}{\%
741   \draw[help lines,xstep=\qgateSx/8,ystep=0.25,opacity=0.2] (-1.5,-1.5) grid (1.5,1.5);
742   \draw[help lines,line width=.6pt,xstep=\qgateSx/2,ystep=1,opacity=0.2] (-1.49,-1.5) grid (1.49,1.5);
743   \node[anchor=west,color=gray] at (-1,-1.7) {\scriptsize $\qgateSx(\texttt{x})!\!-\!\!\frac{1}{2}$};
744   \node[anchor=west,color=gray] at (0,-1.7) {\scriptsize $\qgateSx(\texttt{x})$};
745   \node[anchor=west,color=gray] at (1,-1.7) {\scriptsize $\qgateSx(\texttt{x})!\!+\!\!\frac{1}{2}$};
746   \node[anchor=west,color=gray] at (-2.3,-1) {\scriptsize $\texttt{y}!\!-\!\!1$};
747   \node[anchor=west,color=gray] at (-2.3,0) {\scriptsize $\texttt{y}$};
748   \node[anchor=west,color=gray] at (-2.3,1) {\scriptsize $\texttt{y}!\!+\!\!1$};
749 }
750
751 % Draw gate label with sub-label
752 \newcommand\qgateSublabel[2]{\%
753   {\renewcommand{\arraystretch}{0.4}%
754     \begin{tabular}{c}#1\\\tiny #2\end{tabular}}}%
755 }
756
757 %% == 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.