

The tikz-quantumgates Package: Drawing quantum circuits with TikZ

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

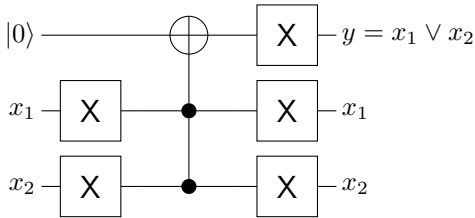
BTU Cottbus-Senftenberg

May 28, 2019

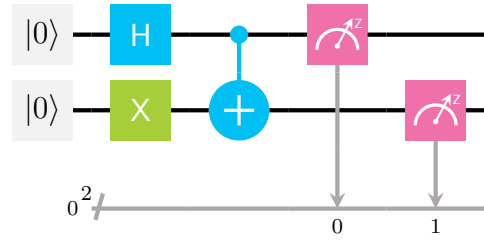
See <https://github.com/matthias-wolff/tikz-quantumgates/blob/master/tikz-quantumgates.pdf> for the latest version of this document.

Abstract

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



```
1 \documentclass{standalone}
2 \usepackage{tikz-quantumgates}
3 \begin{document}
4   \centering
5   \begin{tikzpicture}
6     \node[anchor=west] at (-0.6,2) {\textstyle|0\rangle};
7     \node[anchor=west] at (-0.6,1) {\textstyle x_1};
8     \node[anchor=west] at (-0.6,0) {\textstyle 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) {\textstyle y=x_1\vee x_2};
13    \node[anchor=west] at (3.2,1) {\textstyle x_1};
14    \node[anchor=west] at (3.2,0) {\textstyle x_2};
15  \end{tikzpicture}
16 \end{document}
```



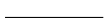

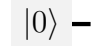


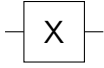



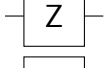



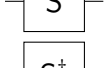

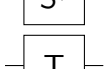

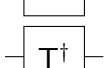

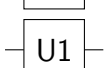



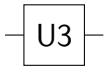

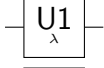

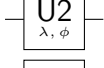

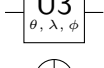

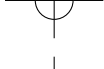



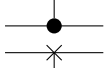




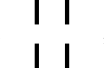
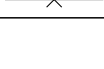
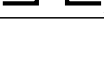


```
1 \documentclass{standalone}
2 \usepackage{tikz-quantumgates}
3 \begin{document}
4   \centering
5   \begin{tikzpicture}
6     \node[anchor=west] at (0.6,-0.3) {\footnotesize 0};
7     \qzero{ibmqx}{0}{2}\qzero{ibmqx}{0}{1}
8     \qgateH{ibmqx}{1}{2}\qgateX{ibmqx}{1}{1}\qmeasBh{ibmqx}{2}{1}{0}
9     \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}
```

Contents

1	Overview	3
1.1	List of Circuit Symbols	3
1.2	Installation	4
2	Documentation of Commands	4
2.1	Wire and State Preparation Symbols	4
	\qwire[option]{x}{y}	4
	\qzero[option]{x}{y}	5
2.2	Single-Qubit Gate Symbols	5
	\qgateU[option]{x}{y}{label}	5
	\qgateID[option]{x}{y}	6
	\qgateX[option]{x}{y}	7
	\qgateY[option]{x}{y}	7
	\qgateZ[option]{x}{y}	8
	\qgateH[option]{x}{y}	9
	\qgateS[option]{x}{y}	9
	\qgateSi[option]{x}{y}	10
	\qgateT[option]{x}{y}	11
	\qgateTi[option]{x}{y}	11
2.3	Single-Qubit Physical Gate of IBM Q Experience	12
	\qgateUa[option]{x}{y}	
	\qgateUa*[option]{x}{y}{sublabel}	12
	\qgateUb[option]{x}{y}	
	\qgateUb*[option]{x}{y}{sublabel}	13
	\qgateUc[option]{x}{y}	
	\qgateUc*[option]{x}{y}{sublabel}	14
2.4	Multiple-Qubit Gate Symbols	15
	\qgateUu[option]{x}{y}{label}	15
	\qgateUuu[option]{x}{y}{label}	16
	\qgateCNX[option]{cwires}{x}{y}	16
	\qgateCNC[option]{cwires}{x}{y}	17
	\qgateCNR[option]{x}{y}	17
	\qgateSWt[option]{x}{y}	18
	\qgateSWR[option]{x}{y}	19
	\qgateSWb[option]{x}{y}	19
2.5	Measurement Symbols	20
	\qmeasM[option]{x}{y}	
	\qmeasM*[option]{x}{y}{axis}{wires}	20
	\qmeaR[option]{x}{y}	20
	\qmeasMB[option]{b}{x}{y}	21
	\qmeaB[option]{x}{y}	21
	\qmeaBh[option]{b}{x}{y}	22
2.6	Further Gate Operators	23
2.7	Auxiliary Commands	23
	\qgateControl[option]{cwires}{x}{y}	23
	\qnode[style]{x}{y}{label}	24
3	The Package Source Code	24
	References	34

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>\qgateSWt[option]{x}{y}</code> (not an “official” IBM QX symbol)
		<code>\qgateSWR[option]{x}{y}</code> (not an “official” IBM QX symbol)
		<code>\qgateSWb[option]{x}{y}</code> (not an “official” IBM QX symbol)

Continued on next page

Continued from previous page

Standard	Option ibmqx	Command
		<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 [?] file into your project folder and include the package with `\usepackage{tikz-quantumgates}`.

2 Documentation of Commands

2.1 Wire and State Preparation Symbols

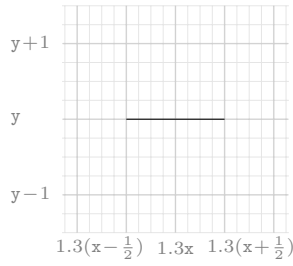
`\qwire[option]{x}{y}`

Draws a wire.

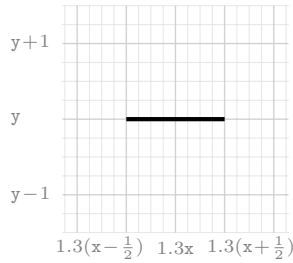
Parameters

- `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}
```

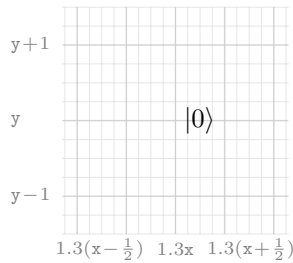
`\qzero[option]{x}{y}`

Draws the zero-state preparator.

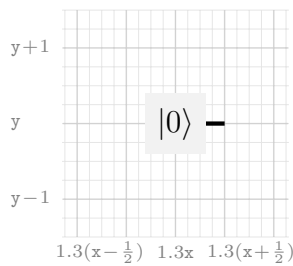
Parameters

- 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:

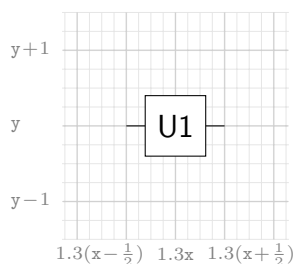
A **B** **C** **D** **E** **F** **G** **H**

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

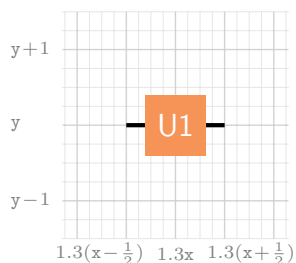
x, y Position of symbol in schematic. The actual TikZ coordinates are $(\backslash\text{qgateSx}*x, y)$.

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}`

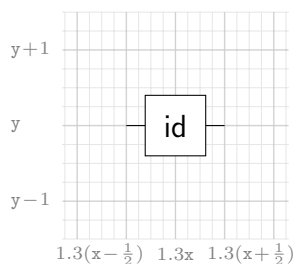
Draws the identity gate.

Parameters

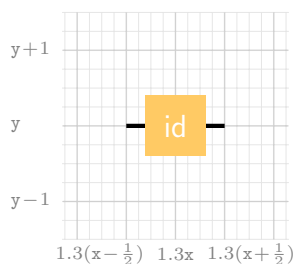
option Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.

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

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

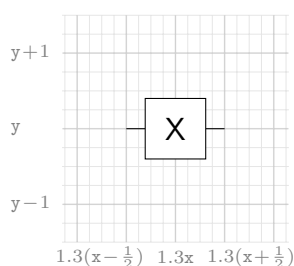
`\qgateX[option]{x}{y}`

Pauli-X gate.

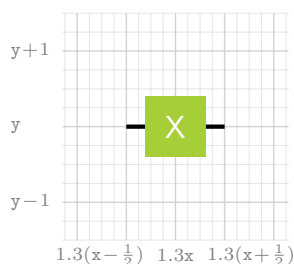
Parameters

- `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

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

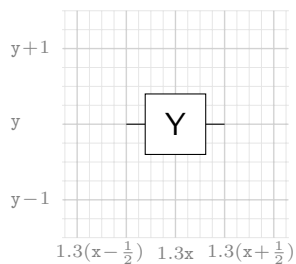
`\qgateY[option]{x}{y}`

Pauli-Y gate.

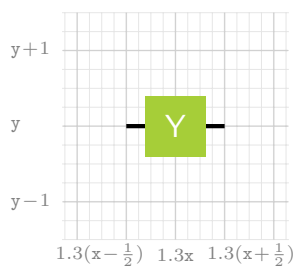
Parameters

- `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{}
```

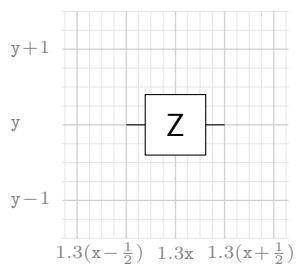
`\qgateZ[option]{x}{y}`

Pauli-Z gate.

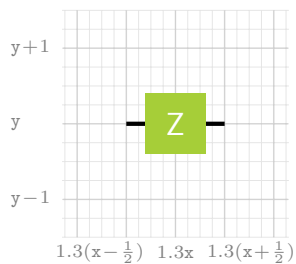
Parameters

- 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

$$Z \doteq \begin{pmatrix} & | & \langle 0| & \langle 1| \\ \langle 0| & 1 & 0 \\ \langle 1| & 0 & -1 \end{pmatrix}$$

1 `\displaystyle Z\doteq\qgateOZ`

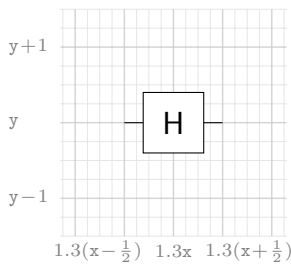
`\qgateH[option]{x}{y}`

Hadamard gate.

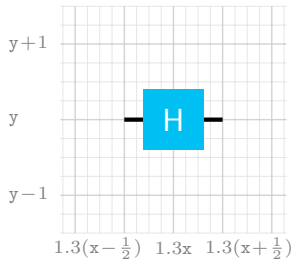
Parameters

- 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

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

1 `\displaystyle H\doteq\qgateOH`

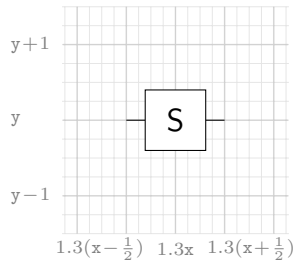
`\qgateS[option]{x}{y}`

S phase gate.

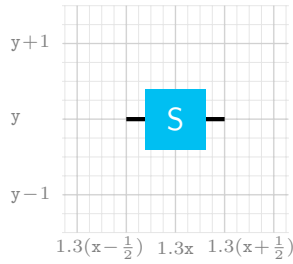
Parameters

- 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 $
```

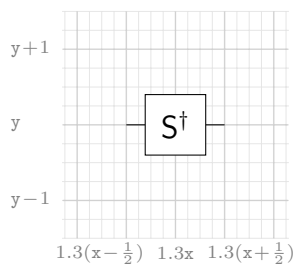
`\qgateSi[option]{x}{y}`

Inverse S phase gate.

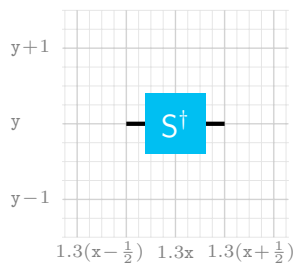
Parameters

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

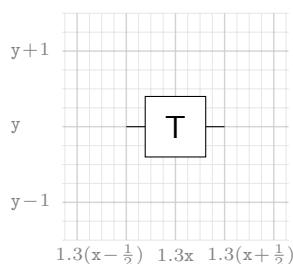
`\qgateT[option]{x}{y}`

T phase gate.

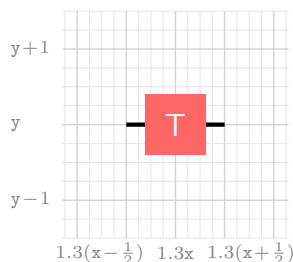
Parameters

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

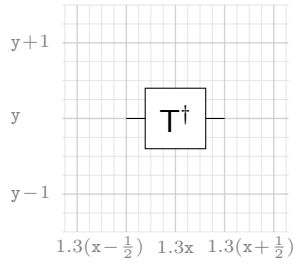
`\qgateTi[option]{x}{y}`

Inverse T phase gate.

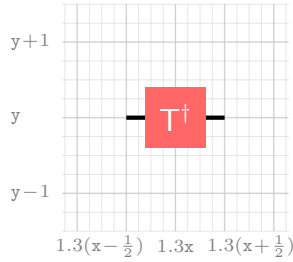
Parameters

- `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

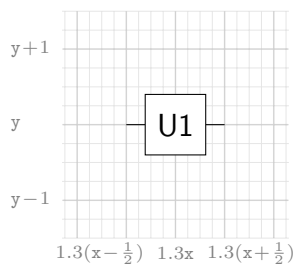
```
\qgateUa[option]{x}{y}
\qgateUa*[option]{x}{y}{sublabel}
```

U1 gate of IBM Q Experience.

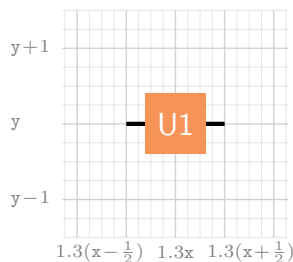
Parameters

- 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)

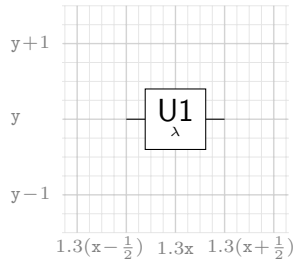
Examples



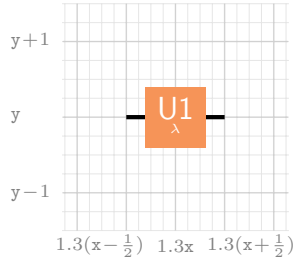
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUa{0}{0}
4 \end{tikzpicture}
```



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

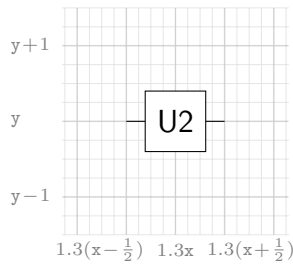
```
\qgateUb[option]{x}{y}
\qgateUb*[option]{x}{y}{sublabel}
```

U2 gate of IBM Q Experience.

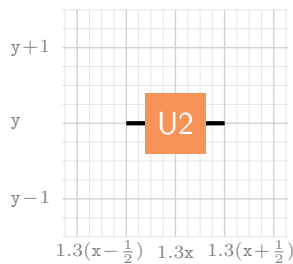
Parameters

- 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)

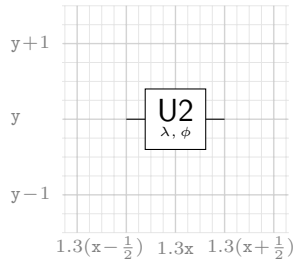
Examples



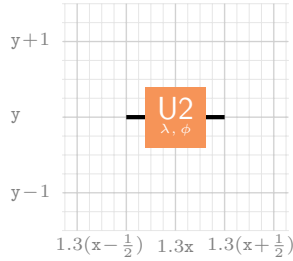
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUb{0}{0}
4 \end{tikzpicture}
```



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

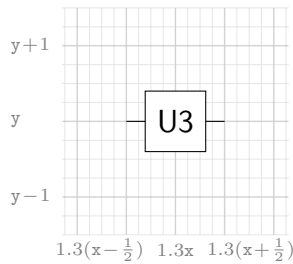
```
\qgateUc[option]{x}{y}
\qgateUc*[option]{x}{y}{sublabel}
```

U3 gate of IBM Q Experience.

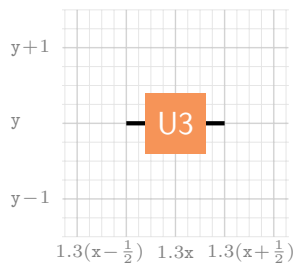
Parameters

- 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)

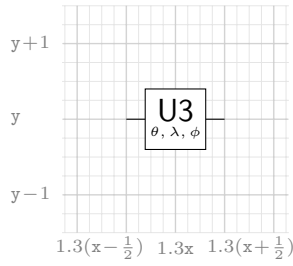
Examples



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



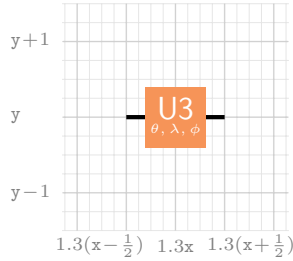
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateUc[ibmqx]{0}{0}
4 \end{tikzpicture}
```



```

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:

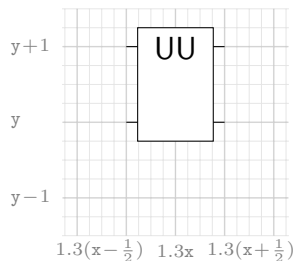
A B C D E F G H

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.

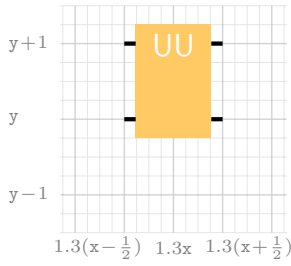
Examples



```

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:

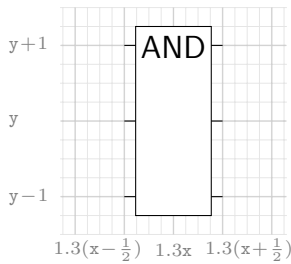
A B C D E F G H

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.

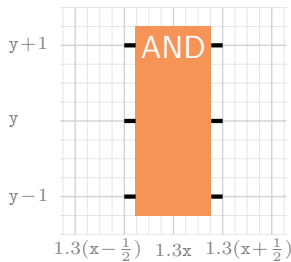
Examples



```

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.

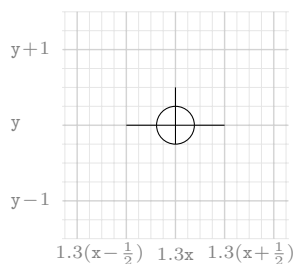
Parameters

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

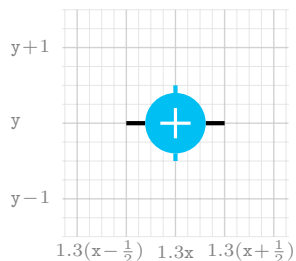
cwires Control wires, `t` for top, `b` for bottom, and `tb` for both sides.

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

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \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 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:

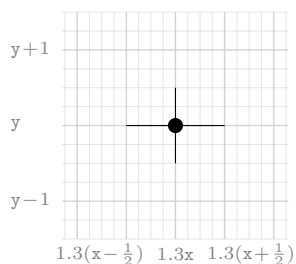
A B C D E F G H

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

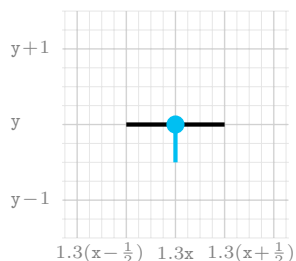
cwires Control wires, `t` for top, `b` for bottom, and `tb` for both sides.

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

Examples



```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qgateCNC{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 a controlled gate.

Parameters

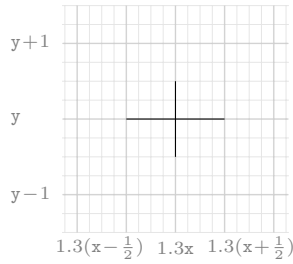
option Omit for standard circuit styling or `ibmqxA`, ..., `ibmqxH` for IBM Q Experience circuit styling. The last letter of `ibmqx*` defines the color control wire:

A B C D E F G H

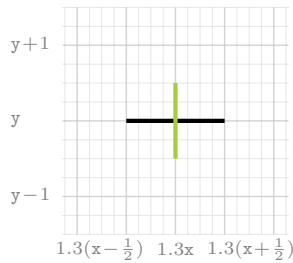
If `ibmqx` is passed, `ibmqxD` will be used.

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

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}`

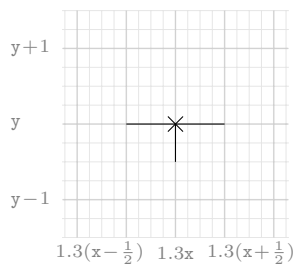
Top qubit of a SWAP gate.

Parameters

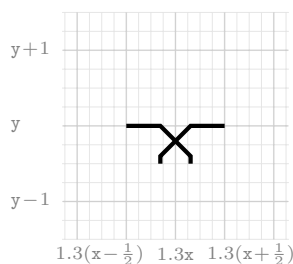
option Omit for standard circuit styling or `ibmqx` for IBM Q Experience circuit styling.

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

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}
```

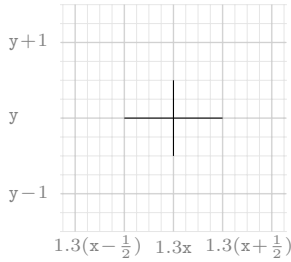
```
\qgateSWR[option]{x}{y}
```

Run-through qubit of a SWAP gate.

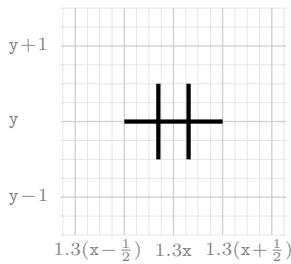
Parameters

- 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}
```

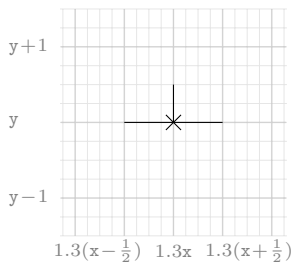
```
\qgateSWb[option]{x}{y}
```

Bottom qubit of a SWAP gate.

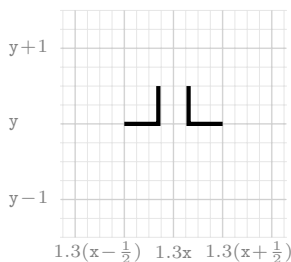
Parameters

- 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 `(\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

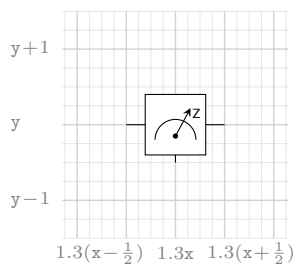
```
\qmeasM[option]{x}{y}
\qmeasM*[option]{x}{y}{axis}{wires}
```

Measurement symbol.

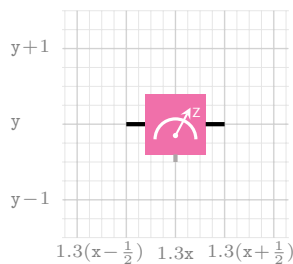
Parameters

- 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 `(\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).

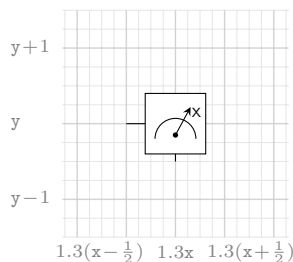
Examples



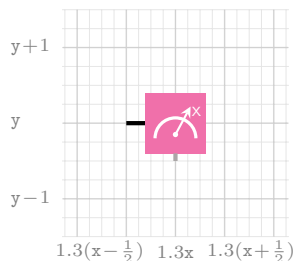
```
1 \begin{tikzpicture}
2   \qScalePaper
3   \qmeasM{0}{0}
4 \end{tikzpicture}
```



```
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}
```

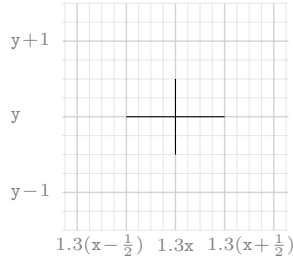
```
\qmeaR[option]{x}{y}
```

Measurement run-through qubit symbol.

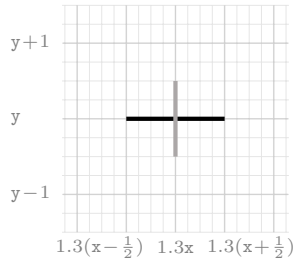
Parameters

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

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}
```

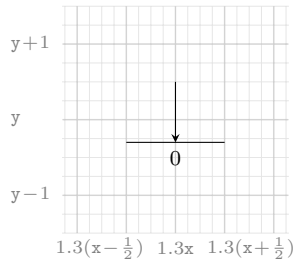
`\qmeasMB[option]{b}{x}{y}`

Measurement-joins-bus symbol.

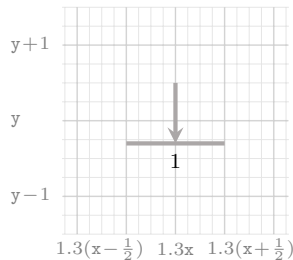
Parameters

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

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}
```

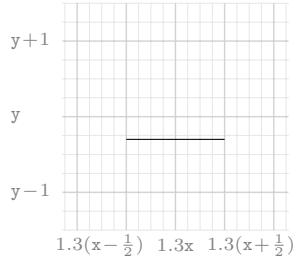
`\qmeaB[option]{x}{y}`

Measurement bus symbol.

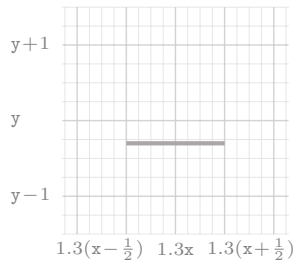
Parameters

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

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}
```

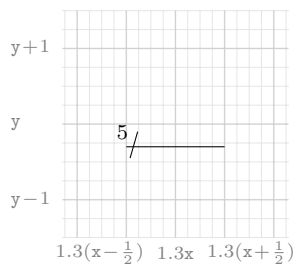
`\qmeasBh[option]{b}{x}{y}`

Measurement bus header symbol.

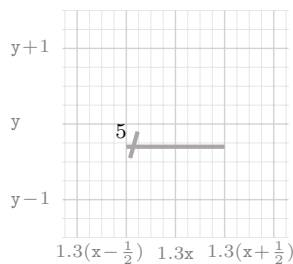
Parameters

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

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

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

Toffoli (CCNOT) Gate Operator

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

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:

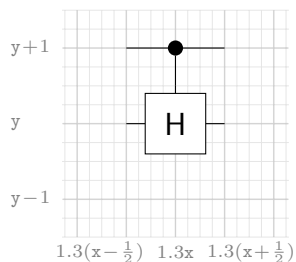
A B C D E F G H

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

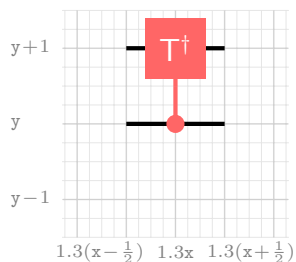
cwires Control wires, `t` for top, `b` for bottom, and `tb` for both sides.

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}
```

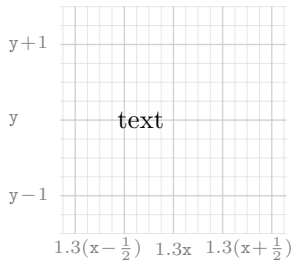
```
\qnode[style]{x}{y}{label}
```

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   \pgfmithsetmacro\x{\qgateSx*(#2)}
38   \pgfmithsetmacro\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] 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\lvert ##1 \rangle}
93 \def\bra##1{\scriptstyle\langle ##1 \rvert}
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\lvert ##1 \rangle}
111 \def\bra##1{\scriptstyle\langle ##1 \rvert}
112 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
113 & \bra{0} & \bra{1} \\ \hline
114 \ket{0} & 0 & 1 \\
\end{array}\!\!\right)

```

```

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\mathrm{e}{}
277 \def\mathrm{j}{}
278 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
279 & \bra{0} & \bra{1} \\ \hline
280 \ket{0} & 1 & 0 \\
281 \ket{1} & 0 & \mathrm{e}^{-\mathrm{j}\lambda}
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}}\left(
310 \left(\hspace*{-0.4ex}\begin{array}{c|cc}
311 & \bra{0} & \bra{1} \\ \hline
312 \ket{0} & 1 & -\mathrm{e}^{-\mathrm{j}\lambda} \\
313 \ket{1} & \mathrm{e}^{-\mathrm{j}\phi} & \mathrm{e}^{-\mathrm{j}(\lambda+\phi)}
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{1} \\ \hline
343     \ket{0} & \cos(\frac{\theta}{2}) & -\sin(\frac{\theta}{2})e^{i\lambda j} \\
344     \ket{1} & \sin(\frac{\theta}{2})e^{i\phi j} & \cos(\frac{\theta}{2})e^{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 \newcommand\qgateCNC[4][]{\{
437   \pgfmathsetmacro\x{\qgateSx*(#3)}
438   \pgfmathsetmacro\y{(#4)}
439   \ifthenelse{\isin{ibmqx}{#1}}{%
440     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
441     \ifthenelse{\equal{ibmqx}{#1}}{%
442       \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
443       \tikzset{rstyle/.style={draw=none,fill=ibmqxD}}
444     }{%
445       \tikzset{cstyle/.style={#1,ultra thick,line cap=butt}}
446       \tikzset{rstyle/.style={draw=none,fill=#1}}
447     }
448     \tikzset{tstyle/.style={white}}
449     \def\r{0.12}
450   }{%
451     \tikzset{lstyle/.style={}}
452     \tikzset{cstyle/.style={}}
453     \tikzset{rstyle/.style={draw=none,fill=black}}
454     \tikzset{tstyle/.style={}}
455     \def\r{0.1}
456   }%
457   \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
458   \draw[rstyle] (\x,\y) circle (\r);
459   \ifthenelse{\isin{t}{#2}}{%
460     \draw[cstyle] (\x,\y+0.1) -- (\x,\y+0.5);
461   }{}
462   \ifthenelse{\isin{b}{#2}}{%
463     \draw[cstyle] (\x,\y-0.1) -- (\x,\y-0.5);
464   }{}
465 }}
466
467 % CNOT gate run-through qubit symbol
468 \newcommand\qgateCNR[3][]{\{
469   \pgfmathsetmacro\x{\qgateSx*(#2)}
470   \pgfmathsetmacro\y{(#3)}
471   \ifthenelse{\isin{ibmqx}{#1}}{%
472     \tikzset{lstyle/.style={ultra thick,line cap=butt}}
473     \ifthenelse{\equal{ibmqx}{#1}}{%
474       \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}

```

```

475 }{%
476   \tikzset{cstyle/.style={#1,ultra thick,line cap=butt}}
477 }
478 }{%
479   \tikzset{lstyle/.style={}}
480   \tikzset{cstyle/.style={}}
481 }%
482 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
483 \draw[cstyle] (\x, \y-0.5) -- (\x, \y+0.5);
484 }}
485
486 % Swap gate top qubit symbol
487 \newcommand\qgateSWt[3][]{%
488   \pgfmathsetmacro\x{\qgateSx*(#2)}
489   \pgfmathsetmacro\y{(#3)}
490   \ifthenelse{\isin{ibmqx}{#1}}{%
491     \draw[ultra thick,line cap=butt]
492       (\x-\qgateSx/2,\y) -- (\x-0.2,\y) -- (\x+0.2,\y-0.4) -- (\x+0.2,\y-0.5);
493     \draw[ultra thick,line cap=butt]
494       (\x+\qgateSx/2,\y) -- (\x+0.2,\y) -- (\x-0.2,\y-0.4) -- (\x-0.2,\y-0.5);
495   }{%
496     \pgfmathsetmacro\w{0.1}
497     \draw(\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
498     \draw(\x-\w, \y-\w) -- (\x+\w, \y+\w);
499     \draw(\x-\w, \y+\w) -- (\x+\w, \y-\w);
500     \draw(\x, \y) -- (\x, \y-0.5);
501   }%
502 }}
503
504 % Swap gate run-through qubit symbol
505 \newcommand\qgateSWR[3][]{%
506   \pgfmathsetmacro\x{\qgateSx*(#2)}
507   \pgfmathsetmacro\y{(#3)}
508   \ifthenelse{\isin{ibmqx}{#1}}{%
509     \draw[ultra thick,line cap=butt] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
510     \draw[ultra thick,line cap=butt] (\x-0.2, \y+0.5) -- (\x-0.2, \y-0.5);
511     \draw[ultra thick,line cap=butt] (\x+0.2, \y+0.5) -- (\x+0.2, \y-0.5);
512   }{%
513     \draw(\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
514     \draw(\x, \y-0.5) -- (\x, \y+0.5);
515   }%
516 }}
517
518 % Swap gate bottom qubit symbol
519 \newcommand\qgateSWb[3][]{%
520   \pgfmathsetmacro\x{\qgateSx*(#2)}
521   \pgfmathsetmacro\y{(#3)}
522   \ifthenelse{\isin{ibmqx}{#1}}{%
523     \draw[ultra thick,line cap=butt]
524       (\x-\qgateSx/2,\y) -- (\x-0.2,\y) -- (\x-0.2,\y+0.5);
525     \draw[ultra thick,line cap=butt]
526       (\x+\qgateSx/2,\y) -- (\x+0.2,\y) -- (\x+0.2,\y+0.5);
527   }{%
528     \pgfmathsetmacro\w{0.1}
529     \draw(\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
530     \draw(\x-\w, \y-\w) -- (\x+\w, \y+\w);
531     \draw(\x-\w, \y+\w) -- (\x+\w, \y-\w);
532     \draw(\x, \y) -- (\x, \y+0.5);
533   }%
534 }}
535
536 % Measurement symbol
537 \makeatletter
538 \newcommand\qmeasM{\@ifstar\qmeasMS\qmeasMN}
539 \makeatother
540 \newcommand\qmeasMN[3][]{%
541   \qmeasMS[#1]{#2}{#3}{Z}{br}
542 }
543 \newcommand\qmeasMS[5][]{%
544   \pgfmathsetmacro\x{\qgateSx*(#2)}
545   \pgfmathsetmacro\y{(#3)}
546   \ifthenelse{\isin{ibmqx}{#1}}{%

```

```

547 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
548 \tikzset{rstyle/.style={draw=none,fill=ibmqxF}}
549 \tikzset{tstyle/.style={white,very thick,line cap=butt}}
550 \tikzset{pstyle/.style={->,>=stealth,white,thick,line cap=butt}}
551 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
552 }{%
553 \tikzset{lstyle/.style={}}
554 \tikzset{rstyle/.style={fill=white}}
555 \tikzset{tstyle/.style={}}
556 \tikzset{pstyle/.style={->,>=stealth,line cap=butt}}
557 \tikzset{cstyle/.style={}}
558 }%
559 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x-0.4,\y);
560 \draw[rstyle] (\x-0.4,\y-0.4) rectangle (\x+0.4,\y+0.4);
561 \draw[tstyle] (\x+0.27,\y-0.2) arc (0:180:0.27);
562 \draw[pstyle] (\x,\y-0.15) -- (\x+0.2,\y+0.22);
563 \node[pstyle] at (\x+0.28,\y+0.15) {\tiny\sffamily #4};
564 \fill[pstyle] (\x,\y-0.15) circle (0.035);
565 \ifthenelse{\isin{r}{#5}}{%
566 \draw[lstyle] (\x+0.4,\y) -- (\x+\qgateSx/2,\y);%
567 }{}
568 \ifthenelse{\isin{b}{#5}}{%
569 \draw[cstyle] (\x,\y-0.4) -- (\x,\y-0.5);%
570 }{}
571 }}
572
573 % Measurement run-through qubit symbol
574 \newcommand\qmeasR[3][]{\%
575 \pgfmathsetmacro\x{\qgateSx*(#2)}
576 \pgfmathsetmacro\y{(#3)}
577 \ifthenelse{\isin{ibmqx}{#1}}{%
578 \tikzset{lstyle/.style={ultra thick,line cap=butt}}
579 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
580 }{%
581 \tikzset{lstyle/.style={}}
582 \tikzset{cstyle/.style={}}
583 }%
584 \draw[lstyle] (\x-\qgateSx/2,\y) -- (\x+\qgateSx/2,\y);
585 \draw[cstyle] (\x,\y-0.5) -- (\x,\y+0.5);
586 }}
587
588 % Measurement-joins-bus symbol
589 \newcommand\qmeasMB[4][]{\%
590 \pgfmathsetmacro\x{\qgateSx*(#3)}
591 \pgfmathsetmacro\y{(#4)}
592 \ifthenelse{\isin{ibmqx}{#1}}{%
593 \tikzset{cstyle/.style={>=stealth,ibmqxI,ultra thick,line cap=butt}}
594 }{%
595 \tikzset{cstyle/.style={>=stealth}}
596 }%
597 \draw[cstyle] (\x-\qgateSx/2,\y-0.3) -- (\x+\qgateSx/2,\y-0.3);
598 \draw[cstyle,->] (\x,\y+0.5) -- (\x,\y-0.3)
599 node[anchor=north,black] {\footnotesize #2};
600 }}
601
602 % Measurement bus symbol
603 \newcommand\qmeasB[3][]{\%
604 \pgfmathsetmacro\x{\qgateSx*(#2)}
605 \pgfmathsetmacro\y{(#3)}
606 \ifthenelse{\isin{ibmqx}{#1}}{%
607 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
608 }{%
609 \tikzset{cstyle/.style={}}
610 }%
611 \draw[cstyle] (\x-\qgateSx/2,\y-0.3) -- (\x+\qgateSx/2,\y-0.3);
612 }}
613
614 % Measurement bus head symbol
615 \newcommand\qmeasBh[4][]{\%
616 \pgfmathsetmacro\x{\qgateSx*(#3)}
617 \pgfmathsetmacro\y{(#4)}
618 \ifthenelse{\isin{ibmqx}{#1}}{%

```



```

619 \tikzset{cstyle/.style={ibmqxI,ultra thick,line cap=butt}}
620 }{%
621 \tikzset{cstyle/.style={}}
622 }%
623 \draw[cstyle] (\x-\qgateSx/2,\y-0.3) -- (\x+\qgateSx/2,\y-0.3);
624 \draw[cstyle] (\x-\qgateSx/2+0.05,\y-0.45) -- (\x-\qgateSx/2+0.15,\y-0.1)
625 node[anchor=east,black] {\footnotesize #2};
626 }}
627
628 %% == OTHER GATE OPERATORS =====
629
630 \newcommand\qgateOCNOT{%
631 \def\ket##1{\scriptstyle|##1\rangle}
632 \def\bra##1{\rotatebox{90}{\scriptstyle\langle ##1|}}
633 \left(\hspace*{-0.4ex}\begin{array}{c|cccc}
634 & \bra{00} & \bra{01} & \bra{10} & \bra{11} \\ \hline
635 \ket{00} & 1 & 0 & 0 & 0 \\
636 \ket{01} & 0 & 1 & 0 & 0 \\
637 \ket{10} & 0 & 0 & 0 & 1 \\
638 \ket{11} & 0 & 0 & 1 & 0
639 \end{array}\!\!\right)
640 }}
641
642 \newcommand\qgateOCCNOT{%
643 \def\ket##1{\scriptstyle|##1\rangle}
644 \def\bra##1{\rotatebox{90}{\scriptstyle\langle ##1|}}
645 \left(\hspace*{-0.4ex}\begin{array}{c|cccccccc}
646 & \bra{000} & \bra{001} & \bra{010} & \bra{011} & \bra{100} & \bra{101} & \bra{110} & \bra{111} \\ \hline
647 \ket{000} & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
648 \ket{001} & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
649 \ket{010} & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
650 \ket{011} & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
651 \ket{100} & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
652 \ket{101} & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
653 \ket{110} & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
654 \ket{111} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1
655 \end{array}\!\!\right)
656 }}
657
658 %% == AUXILIARY COMMANDS =====
659
660 % Control wires for gates
661 \newcommand\qgateControl[4][]{%
662 \pgfmathsetmacro\x{\qgateSx*(#3)}
663 \pgfmathsetmacro\y{(#4)}
664 \ifthenelse{\isin{ibmqx}{#1}}{%
665 \ifthenelse{\equal{ibmqx}{#1}}{%
666 \tikzset{cstyle/.style={ibmqxD,ultra thick,line cap=butt}}
667 }{%
668 \tikzset{cstyle/.style={#1,ultra thick,line cap=butt}}
669 }
670 }{%
671 \tikzset{cstyle/.style={}}
672 }%
673 \ifthenelse{\isin{t}{#2}}{%
674 \draw[cstyle] (\x,\y+0.4) -- (\x,\y+0.5);
675 }{}
676 \ifthenelse{\isin{b}{#2}}{%
677 \draw[cstyle] (\x,\y-0.4) -- (\x,\y-0.5);
678 }{}
679 }}
680
681 % TikZ node in circuit coordinate system
682 \newcommand\qnode[4][]{%
683 \pgfmathsetmacro\x{\qgateSx*(#2)}
684 \pgfmathsetmacro\y{(#3)}
685 \node[#1] at (\x,\y) {#4};
686 }
687
688 %% == PACKAGE-INTERNAL COMMANDS =====
689
690 % Draw scale paper for documentations

```

```

691 \newcommand{\qScalePaper}{%
692   \draw[help lines,xstep=(\qgateSx/8),ystep=0.25,opacity=0.2] (-1.5,-1.5) grid (1.5,1.5);
693   \draw[help lines,line width=.6pt,xstep=(\qgateSx/2),ystep=1,opacity=0.2] (-1.49,-1.5) grid (1.49,1.5);
694   \node[anchor=west,color=gray] at (-1,-1.7) {\scriptsize $\qgateSx(\texttt{x})!-\!\frac{1}{2}$};
695   \node[anchor=west,color=gray] at (0,-1.7) {\scriptsize $\qgateSx(\texttt{x})$};
696   \node[anchor=west,color=gray] at (1,-1.7) {\scriptsize $\qgateSx(\texttt{x})!+\!\frac{1}{2}$};
697   \node[anchor=west,color=gray] at (-2.3,-1) {\scriptsize $\texttt{y}!-\!1$};
698   \node[anchor=west,color=gray] at (-2.3,0) {\scriptsize $\texttt{y}$};
699   \node[anchor=west,color=gray] at (-2.3,1) {\scriptsize $\texttt{y}!+\!1$};
700 }
701
702 % Draw gate label with sub-label
703 \newcommand\qgateSublabel[2]{%
704   {\renewcommand{\arraystretch}{0.4}%
705     \begin{tabular}{c}#1\\tiny #2\end{tabular}}%
706 }
707
708 %% == EOF =====

```