

# Benchmark Circuits for IBM's Quantum Computer

## 1 Introduction

IBM's 5 qubit quantum computer [1] supports gates from the Clifford+T gate library. This repository contains some Clifford+T circuits that have been transformed to be executed on IBM's Q5.

## 2 Benchmark Circuits

The following circuits are available in the folder labeled `original`.

Name	Qubits	Gates	Depth	T-depth	Source
01.qc	5	51	28	9	[3]
1.qc	3	17	11	6	[3]
3_17_b.qc	3	33	23	5	[2]
3_17_c.qc	3	35	26	6	[2]
3_17_d.qc	3	35	24	4	[2]
3_17_e.qc	3	33	21	4	[2]
17.qc	4	43	30	4	[3]
a2x_c.qc	4	31	22	5	[2]
a2x_e.qc	4	30	20	4	[2]
a3x_c.qc	5	48	37	9	[2]
a3x_e.qc	5	44	33	8	[2]
Full_Adder_c.qc	4	20	19	7	[2]
Full_Adder_d.qc	4	22	15	2	[2]
Full_Adder_e.qc	4	21	12	2	[2]
Toffoli_c.qc	3	17	16	6	[2]
Toffoli_d.qc	3	17	12	3	[2]
Toffoli_e.qc	3	17	12	3	[2]

The transformed circuits—to fit the Q5 architecture—are found in the folder labeled `IBM`. Different permutations, produce different results. Since the computer has 5 available qubits, circuits can be extended to 5 qubits at no cost. The

names of the circuits are obtained by taken the original name and appending the permutation to it. A summary is given below.

Name	Qubits	Gates	Depth	T-depth
01_01234.qc	5	149		
01_01342.qc	5	<b>77</b>		
1_01234.qc	5	29		
1_02134.qc	5	<b>25</b>		
3_17_b_01234.qc	5	49		
3_17_b_02134.qc	5	<b>43</b>		
3_17_c_01234.qc	5	49		
3_17_c_02134.qc	5	<b>43</b>		
3_17_d_01234.qc	5	51		
3_17_d_02134.qc	5	47		
3_17_e_01234.qc	5	49		
3_17_e_02134.qc	5	<b>43</b>		
17_01234.qc	5	141		
17_03421.qc	5	<b>119</b>		
a2x_c_01234.qc	5	87		
a2x_c_02341.qc	5	59		
a2x_e_01234.qc	5	70		
a2x_e_02341.qc	5	<b>52</b>		
a3x_c_01234.qc	5	176		
a3x_c_10324.qc	5	86		
a3x_d_01234.qc	5	156		
a3x_d_01324.qc	5	<b>66</b>		
Full_Adder_c_01234.qc	5	60		
Full_Adder_c_01324.qc	5	<b>28</b>		
Full_Adder_d_01234.qc	5	74		
Full_Adder_d_01324.qc	5	42		
Full_Adder_e_01234.qc	5	55		
Full_Adder_e_01324.qc	5	37		
Toffoli_c_01234.qc	5	<b>17</b>		
Toffoli_d_01234.qc	5	25		
Toffoli_e_01234.qc	5	27		
Toffoli_e_12034.qc	5	23		

The same circuits are available (in IBM format) in the folder labelled **qasm**.

## References

- [1] IBM Q. <https://www.research.ibm.com/ibm-q/>. Accessed: 2017-09-05.

- [2] D. Michael Miller, Mathias Soeken, and Rolf Drechsler. Mapping NCV circuits to optimized Clifford+T circuits. In *Reversible Computation - 6th International Conference, RC 2014, Kyoto, Japan, July 10-11, 2014. Proceedings*, pages 163–175, 2014.
- [3] Martin Roetteler, Mathias Soeken, and Nathan Wiebe. Reversible Logic Synthesis and Quantum Computing Benchmarks. <http://quantumfpl.stationq.com/>. Accessed: 2017-09-19.