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 `qx2` and `qx4`.

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_c.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 folders labeled `qx2` and `qx4` respectively. 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. If the output permutation is different than the input permutation, it is appended to the name. For example, the circuit `Full_Adder_c_0132_0123.qc` takes the input in the permutation (23), however, the output qubits are not permuted. A summary is given below.

Name	lines	G - x2	Dep	G - x4	Dep
01_01234.qc	5	149	89	157	92
01_01342.qc	5	**77**	**38**		
01_10342.qc	5			**77**	40
1_01234.qc	5	28	15	24	13
1_02134.qc	5	**24**	**12**		
1_01234.qc	5			**24**	13
3_17_b_01234.qc	5	49	29	55	33
3_17_b_02134.qc	5	43	26		
3_17_b_12034.qc	5			43	24
3_17_c_01234.qc	5	49	30	53	34
3_17_c_02134.qc	5	43	27		
3_17_c_20134.qc	5			43	27
3_17_d_01234.qc	5	49	26	53	29
3_17_d_02134.qc	5	45	25		
3_17_d_20134.qc	5			45	25
3_17_e_01234.qc	5	47	26	49	26
3_17_e_02134.qc	5	**41**	**23**		
3_17_e_20134.qc	5			**41**	**23**
17_01234.qc	5	141	92	153	97
17_20341.qc	5	**101**	**67**		
17_10324.qc	5			109	68
a2x_c_01234.qc	5	85	58	75	45
a2x_c_02341.qc	5	59	41	59	38
a2x_e_01234.qc	5	70	44	60	36
a2x_e_02341.qc	5	52	30		
a2x_e_31204.qc	5			**39**	**23**
a3x_c_01234.qc	5	176	127	144	103
a3x_c_10324.qc	5	86	54	52	39
a3x_d_01234.qc	5	156	110	134	90
a3x_d_01324.qc	5	66	38		
a3x_d_01324.qc	5			**54**	**37**
Full_Adder_c_01234.qc	5	60	48	60	40
Full_Adder_c_01324.qc	5	28	22		
Full_Adder_c_32104.qc	5			30	25
Full_Adder_c_0132_0123.qc	4	**24**	**17**		
Full_Adder_d_01234.qc	5	74	50	64	38

Full_Adder_d_01324.qc	5	42	25		
Full_Adder_d_10324.qc	5			32	19
Full_Adder_e_01234.qc	5	53	32	65	36
Full_Adder_e_01324.qc	5	37	23		
Full_Adder_d_10324.qc	5			31	17
Toffoli_c_01234.qc	5	**17**	**14**	31	23
Toffoli_c_21034.qc	5			**17**	**14**
Toffoli_d_01234.qc	5	25	16	33	19
Toffoli_d_02134.qc	5			25	15
Toffoli_e_01234.qc	5	27	14	29	15
Toffoli_e_12034.qc	5	23	14		
Toffoli_e_10234.qc	5			23	14

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.