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Gatemon Benchmarking and Two-Qubit Operation[1] LUCAS CASPARIS, THORVALD LARSEN, MICHAEL OLSEN, KARL PETERSSON, FERDINAND KUEMMETH, PETER KROGSTRUP, JESPER NYGARD, CHARLES MARCUS, Center for Quantum Devices and Station Q Copenhagen, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark — Recent experiments have demonstrated superconducting transmon qubits with semiconductor nanowire Josephson junctions [2] [3]. These hybrid gatemon qubits utilize field effect tunability singular to semiconductors to allow complete qubit control using gate voltages, potentially a technological advantage over conventional flux-controlled transmons. Here, we present experiments with a two-qubit gatemon circuit. We characterize qubit coherence and stability and use randomized benchmarking to demonstrate single-qubit gate errors of $\sim$0.5 % for all gates, including voltage-controlled Z rotations. We show coherent capacitive coupling between two gatemons and coherent SWAP operations. Finally, we perform a two-qubit controlled-phase gate with an estimated fidelity of $\sim$91 %, demonstrating the potential of gatemon qubits for building scalable quantum processors.

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[2]G. de Lange et al., Physical Review Letters **115**, 127002 (2015).
[3]T. W. Larsen, K. D. Petersson et al., Physical Review Letters **115**, 127001 (2015).

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