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Symmetric subspace randomized benchmarking CHARLES BALDWIN, JOHN GAEBLER, BRYCE BYORK, DANIEL STACK, Honeywell Quantum Solutions — Randomized benchmarking is the standard tool for accurately characterizing error rates of quantum hardware. However, multi-qubit benchmarking requires individual addressing of each qubit, which is a difficult in certain trapped-ion testbeds. We present a new two-qubit randomized benchmarking procedure that operates only in the symmetric subspace of a pair of qubits. By performing benchmarking only in the symmetric subspace, we drastically reduce the number of gates required, and simplify the experimental implementation. We demonstrate the protocol in a trapped-ion experiment using arbitrary global single-qubit rotations and the Molmer-Sorenson interaction. Most expected errors in a Molmer-Sorenson gate keep population in the symmetric subspace but even errors that mix symmetric and anti-symmetric subspaces can be diagnosed. These errors appear as leakage and their rate can by characterized by combining our protocol with recently proposed leakage benchmarking.

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