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Quantum electrodynamics with a single nuclear spin in silicon GUILHERME TOSI, FAHD MOHIYADDIN, STEFANIE TENBERG, ARNE LAUCHT, VIVIEN SCHMITT, UNSW Australia, RAJIB RAHMAN, GERHARD KLIMECK, Purdue University, ANDREA MORELLO, UNSW Australia — The nuclear spin state of a phosphorus donor in isotopically enriched silicon-28 is an excellent system to store quantum information in the solid state. The nearly noise-free magnetic environment and the spins insensitivity to electric fields yield a solid-state qubit with record coherence times. However, these very features also render coupling to other quantum systems very challenging. Here we propose a novel method that uses electric fields to interface phosphorus nuclear spins with other quantum mechanical degrees of freedom. It consists of a Raman process where a microwave magnetic drive is supplemented by an electrically-driven time-dependent modulation of the hyperfine coupling to a surrounding electron. Applications of this method include the coupling of a single nuclear spin to a microwave resonator, and the long distance coupling of two nuclear spins via electric dipole-dipole interactions. Most importantly, despite being strongly coupled to other degrees of freedom via electric fields, the nuclear qubit remains highly immune to electric noise due to a new stabilization mechanism in which the magnetic drive AC-Stark shifts the qubit precession frequency to create a second-order clock transition.

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