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Engineering anisotropic exchange interactions between quantum dot spin qubits YUN-PIL SHIM, MARK FRIESEN, Department of Physics, Unviersity of Wisconsin-Madison, Madison WI 53706 — We present a method for engineering anisotropic exchange interactions between quantum dot spin qubits using a Heisenberg antiferromagnetic spin chain as a spin bus. An external magnetic field is applied to create XXZ interactions between spin qubits that are weakly connected to a spin bus whose ground state is non-degenerate. We analyze the dependence of the anisotropy of the effective interaction on the external field and on the length of the spin bus. We show that the tunable XXZ interaction mediated by the spin bus can be used to generate multi-qubit entanglement and to efficiently implement universal gates based on encoded qubits. We also show that the operation of the spin bus is qualitatively different when the spin bus is near one of its magnetic field-induced quantum phase transitions. In this case, the qubits interact with a bus pseudo-spin and the resulting entanglement between pairs of qubits is enhanced.

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