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Integrated Electronics for Chip-Scale Trapped-Ion Quantum Control JULES STUART, Massachusetts Institute of Technology, RICH PANOCK, COLIN BRUZEWICZ, JONATHON SEDLACEK, ROBERT MCCONNELL, JEREMY SAGE, JOHN CHIAVERINI, MIT Lincoln Laboratory — Trapped-ion quantum information-processors offer many advantages for achieving high-fidelity operations, but current experiments are typically composed of large components that do not scale well with increasing numbers of ions. In order to achieve Moores-law-like growth, control systems must be integrated into a single device, using technologies that can be scaled. We demonstrate the operation of a new ion-trap design that incorporates on-chip, high-voltage CMOS electronics ($\pm$8V full swing) to generate the surface-electrode control potentials without the need for external analog voltage sources. Instead, a single digital bus programs all of the digital-to-analog converters (DACs) that control the segmented electrodes. We have used the electronics to change the applied voltages and repeatedly shuttle ions distances of 50 μm without significantly affecting the ion lifetime. Additionally, we have augmented the integrated CMOS amplifier circuit to include analog switches for reducing amplifier noise without compromising electrode voltage update speed. Integration of control circuits into a space smaller than the extent of an electrode will enable future ion trap designs in which the number of electrodes makes external sources, feedthroughs, and wire bonds impractical.

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