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High-resolution Magnetic Field Imaging of Integrated Circuit Activity with a Quantum Diamond Microscope MATTHEW TURNER[1], NICHOLAS LANGELLIER, THOMAS BABINEC, Harvard University, PAULI KEHAYIAS, Sandia National Labs, MARKO LONCAR, Harvard University, RON WALSWORTH, University of Maryland, EDLYN LEVINE, The MITRE Corporation — We demonstrate imaging of DC magnetic field emanations from an integrated circuit (IC) in different active functional states using a Nitrogen-Vacancy (NV) Quantum Diamond Microscope (QDM). The QDM provides full-vector images with simultaneous wide-field-of-view and micron-scale resolution of IC magnetic fields that arise from DC currents in the IC correlated with local circuit activity, and pass largely unperturbed through standard IC materials, enabling a non-invasive detection modality. This simultaneous wide-field (˜4 mm), high spatial resolution (˜10 um), IC magnetic activity imaging capability is not achievable with other techniques. We study activity in both an intact and decapsulated field programmable gate array (FPGA) and find that QDM images can quantifiably determine the IC active state with high fidelity through direct observation of the data and machine-learning methods.

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