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Compact Superconducting Kinetic Inductance Traveling Wave Parametric Amplifiers with On-chip Bias Circuitry

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***Abstract*–Quantum computing systems and fundamental physics experiments using superconducting technologies frequently require signal amplification chains operating near the quantum limit of added noise. Both Josephson Parametric Amplifiers (JPAs) and Traveling Wave Parametric Amplifiers (TWPAs) have been used as first-stage amplifiers to enable readout chains operating within a few quanta or less of the quantum limit [1–4] – and are presently entering the commercial industry. However, nearly all demonstrations and existing products require bulky external microwave components for interconnection and application of requisite biases. These components – cabling interconnects, bias tees, directional couplers, and diplexers – dramatically increase the overall amplifier footprint, installation complexity, and reduce already limited available cryogenic volumes. Additionally, they introduce loss and reflections which impact the measurement efficiency and readout system noise performance; thus making it more difficult to operate near the quantum limit.**

Here we present the design and validation of microfabricated bias tees, directional couplers, and diplexers for operating three-wave mixing Kinetic Inductance TWPAs (KITs). Additionally we present the performance of KITs integrated with the microfabricated rf components. Using these devices we demonstrate reduction in the total amplifier footprint by a factor of nearly five, reduction in the number of lossy interconnections to the practical minimum. These results represent significant progress towards the miniaturization and simplification of parametric amplifier setups and should greatly aid in their more widespread applicability.

***Keywords (Index Terms)*–Traveling wave parametric amplifier, kinetic inductance, quantum-limit, compact, efficient, superconducting, quantum computing**

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