High input impedance wideband rf preamplifier for SQUIDs[a)]

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We describe a wideband rf preamplifier with high input impedance designed for operation of superconducting quantum interference devices (SQUIDs).

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RF-biased SQUIDs (Superconducting Quantum Interference Devices) are becoming widely used instruments for sensitive measurements of very small voltages, currents, and magnetic fields.[1] Since typical signals to be measured in SQUID systems are small, the ultimate resolution of the detecting system depends critically on the noise levels in the preamplifier. For this reason, a tuned preamplifier of medium bandwidth at a selected frequency is preferred for normal operation of an rf-biased SQUID. However, in many cases, operation over a wide frequency range is desirable (for instance for device modeling and characterization). In this note we describe the circuit of a wideband, high input impedance preamplifier which was developed for the study of fast transient effects in rf-biased SQUIDs. The use of this preamplifier enables measurement of high frequency signal components. The high input impedance is required to avoid external loading of the resonant circuit that couples to the SQUID.

The complete circuit of the preamplifier is shown in Fig. 1. The circuit consists of two stages of cascode amplifiers, which are followed by two stages of direct coupled emitter followers to provide a low impedance drive for the two output amplifiers. The use of cascode circuits is advantageous for wide frequency range and low noise performance, where the load on a common-source FET is furnished by a common-gate FET. In this configuration the feedback capacitance due to the Miller effect (which lowers the high frequency gain) can be significantly reduced and thus provide a better frequency response. With the drain-source voltage set in the pinch-off region, the common-source connected FET is self-biased by a small source resistor such that the drain current is slightly below saturation. This reduces the noise level in the transistor. As is common practice, large resistance is used to link the gate to ground, so that the reactance of the input capacitance is relatively small making the input noise contributed by this resistor insignificant. The upper FET is also reverse biased, and it should be noted that its drain current is limited by the lower FET where smaller I_{DSS} is selected. Voltage gain in the cascode stage is determined by the lower FET and by the compensated load connected to the drain of the upper FET. All the FET's used in the circuit are N-channel depletion mode silicon junction type. For the front-end FET chosen the input capacitance is about 6 pF in common-source configuration. At 30 MHz, the mid-band frequency, the input admittance is $Y_{in} = (10 + j1000) \times 10^{-6}$ mho when the output is short circuited.

Two low noise wideband hybrid amplifiers with standard 50-Ω input and output impedance (Aydin

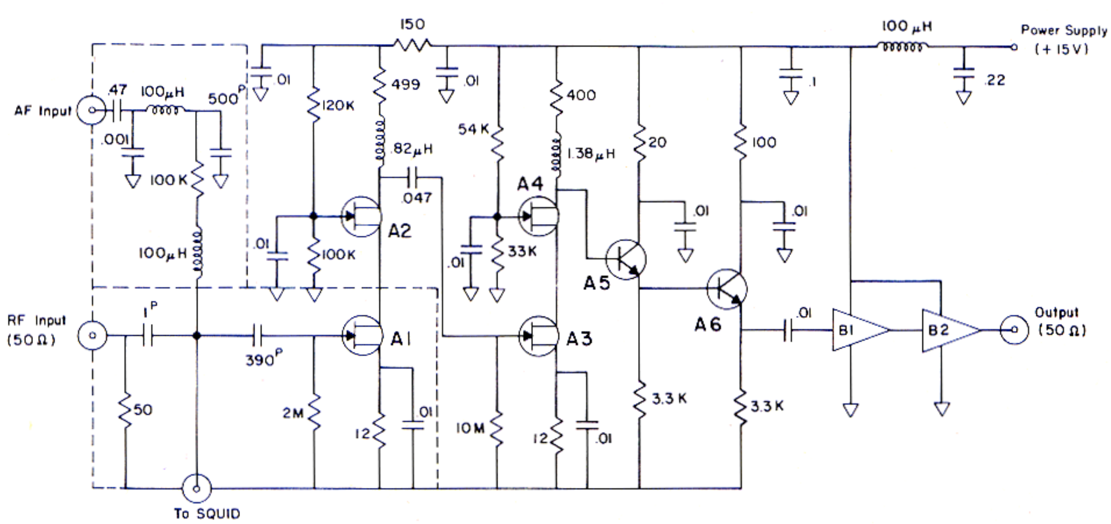

FIG. 1. Circuit diagram of the preamplifier. Dashed lines indicate shielding compartments in the circuit housing. Component models: A1, A2, A4: 2N3823; A3: SK3116; A5, A6: SK3018; B1, B2: MHT-250, Aydin Vector.

