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Author : H Mollee.
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Department : P.G. Transistors & Diodes Development

Preamplifier for pager applications.

Abstract:

In this report a description is given of a preamplifier for pager applications based upon the BFC505 transistor. This transistor consists of two BFR505 crystals connected in cascade. This preamplifier or cascode features a high gain at a low supply voltage and low supply current. A detailed circuit description, lay-out and a (typical) specification are given.

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1 Introduction.

In this report the design of a preamplifier (cascode) for pager applications is described. This preamplifier consists of two BFR505 crystals in a SOT353 encapsulation. This preamplifier has the following features:

- low supply voltage (2 V).
- low power consumption (≤ 0.5 mA).
- high gain.
- small size.

In this design we use a BFC505 because this, together with the use of 0402-components, enables us to use a minimum of space on the PCB.

The amplifier has the following (typical) specification:

Gain.	G_p	15	dB.
Bandwidth	B	25	MHz.
return loss at input	s_{11}	-12	dB.
return loss at output	s_{22}	-12	dB.
3^{rd} -order intercept point[1]	IP_3	-14	dBm.
1 dB compression point[1]	P_{L1}	-24	dBm.
Noise figure	NF	3.0	dB.

[1] reffered to output.

2 Designing the circuit.

Due to the low supply voltage of 2 V it is very difficult to achieve thermal stability. In general, thermal stability is achieved by an emitter-resistor. If the temperature rises, the collector current will increase. As the base-voltage is constant, this means that the base-emitter voltage drops, which means that the collector current drops and stability is achieved. In our case thermal stability is also achieved by an emitter-resistor, but the voltage drop may not be too large because of the low supply voltage. In our case this voltage drop is about 0.3 V. Both in- and output are matched to 50 Ω by means of passive components. Under normal conditions the input will not necessarily be matched to 50 Ω but to optimized for a loop antenna. However, for evaluation purposes this is unpractical. With the bias-circuit the collector current is set to ≈0.3 mA. This is done by a ladder-network of three resistors with each node connected to the base of a transistor and a resistor in the emitter. This emitter-resistor is decoupled for AC. The input is matched to 50 Ω by an inductor of 15 nH and a capacitor of 3.9 pF. To achieve sufficient gain we transform the 50 Ω load to a higher impedance. This is done by the two capacitors of 9.1 pF and 1.5 pF. Together with an inductor of ≈ 20 nH (2.5 turns, Ø 0.5 mm, d = 2 mm) these capacitors form a resonant circuit tuned to 900 MHz. Tuning the circuit to exactly 900 MHz must be done by bending the inductor. The 30 Ω resistor is used to ensure unconditional AC-stability.
The schematic diagram of the cascode can be seen in figure 1. For this circuit a lay-out has been designed which can be found in figure 2 and 3.

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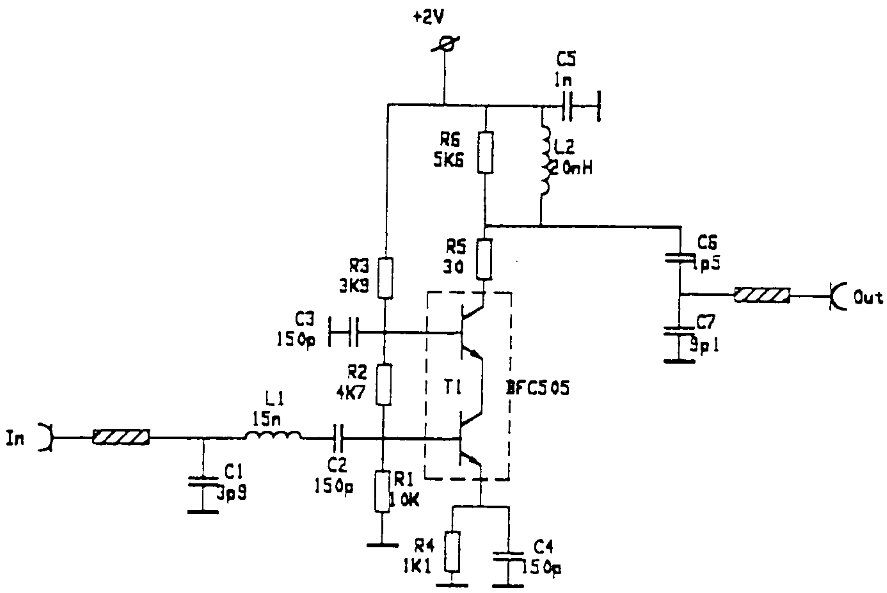

fig. 1: Schematic diagram of cascode circuit.

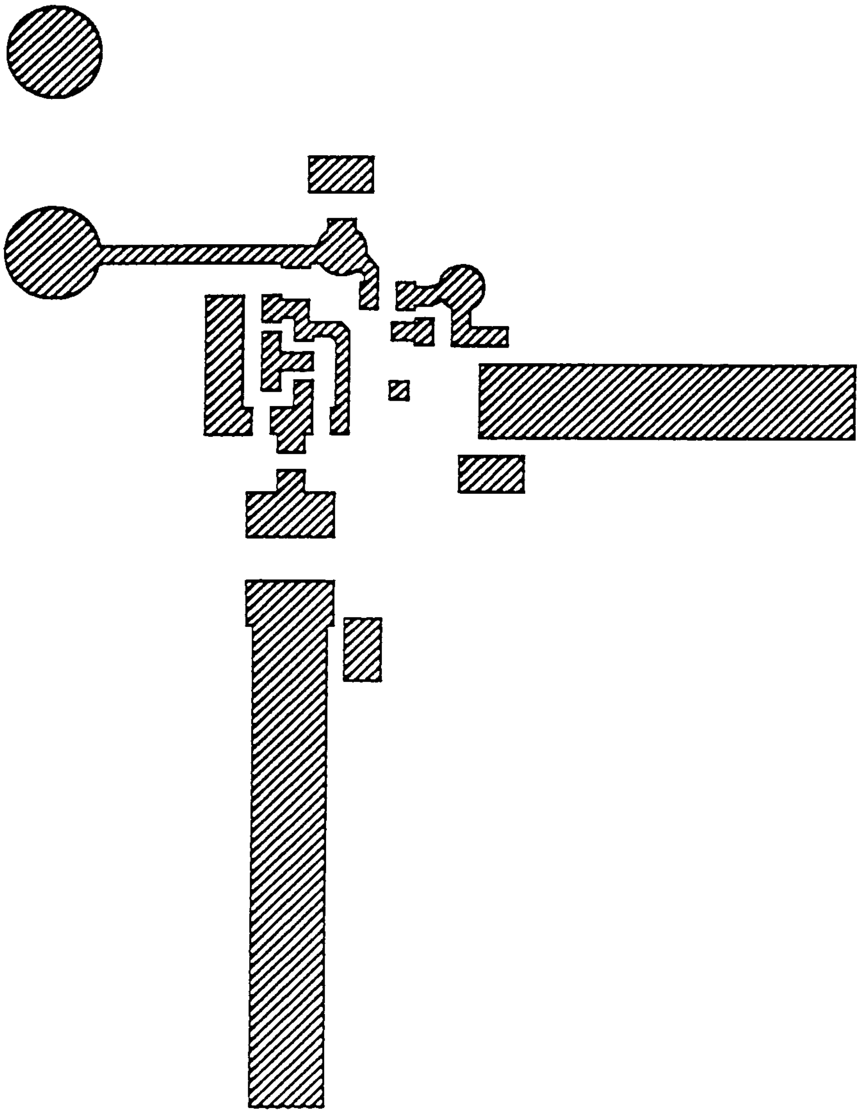

fig. 2: Lay-out of cascode circuit.

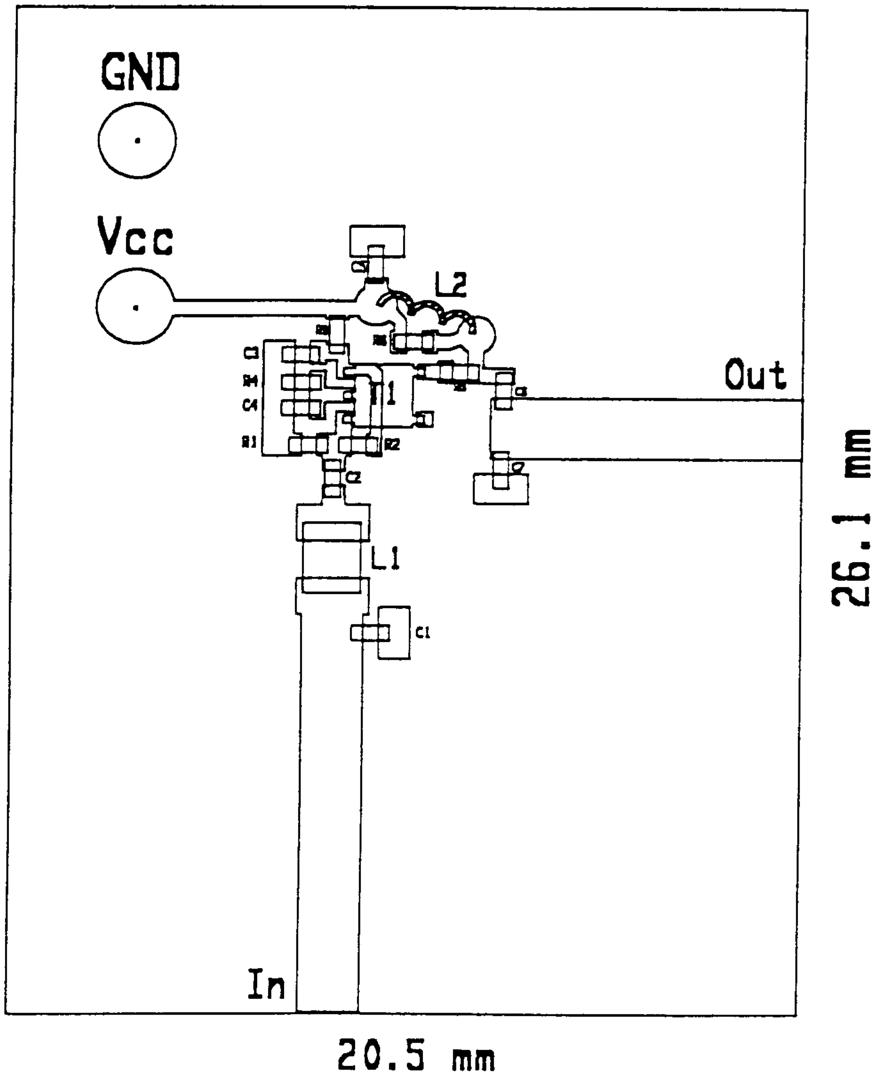

fig. 3: Component lay-out cascode.