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A-3-3 Gain Improvement by Self-Neutralization of Microwave SIT

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A very effective method for power gain improvement of microwave static induction transistors(SITs) has been proposed and examined.

The authors have found that, with common-gate configuration of SIT, magnitude of reverse transmission coefficient S_{12} becomes extremely small at a certain frequency. This phenomenon is self-neutralization that brings about a successful gain improvement.

This paper describes the principle of self-neutralization and its utility and simplicity in applications to microwave SITs.

Fig.1-a shows an equivalent circuit of three stray capacitances in a SIT chip in which a gate-grounding inductance is connected to gate electrode. This can be transformed to another equivalent circuit, shown in Fig.1-b, by Δ-Y transformation. An equivalent common capacitance C_G can be calculated with a following relation provided that three stray capacitances in Fig.1-a are known;

$$C_G = \frac{C_{sg}C_{dg} + C_{sg}C_{ds} + C_{dg}C_{ds}}{C_{ds}}$$

Since the common impedance vanishes at a frequency f_N, the resonance frequency C_G and L_G connected in series, input and output currents are separated at point G which one can consider a virtual ground point. This point G is interpreted as an equivalent point to the intrinsic gate called by Nishizawa et al.[1]. Thus the self-neutralization cancels out undesirable feedback stray components.

The SIT chips used in following applications were the same used in 1 GHz 100 W SIT reported last year[2]. One chip is divided into five electrically independent blocks. Typical performances in common-source amplifier were as follows; output power of 10 W and gain of 7 to 8 dB with one block and 100 W and 4 dB with twelve blocks(3 chips) were obtained. Three stray capacitances in one block were 5.3 pF, 2.5 pF and 2.5 pF for C_{sg}, C_{dg} and C_{ds} respectively, from which C_G become 13 pF.

1 GHz 10 W SIT: The gate grounding inductance was chosen to be 1.7 nH by only adjusting length and number of bonding wires for tuning f_N to 1 GHz. A very high gain of 12 dB was obtained with one block common-gate amplifier at 1 GHz as shown in Fig.2. Any critical phenomena which had been often encountered in neutralized active devices were not observed in its operation.

1 GHz 80 W SIT: In this application, internal matching networks for both input and output ports were provided to obtain power sharing in 12 blocks parallel

operation. An output power of 80 W and a gain of 8 dB were obtained as shown in Fig. 3, which was greatly improved compared with a linear gain of 5 dB in 100 W SIT[2].

2 GHz 5 W SIT: For 2 GHz application, the grounding inductance was 0.4 nH. A gain of 9 dB was obtained with one block SIT as shown in Fig.4, which was higher than non-neutralized SITs[3] by about 5 dB.

The self-neutralization, to conclude, is thus a successful and simple tool to improve power gain of microwave SITs involving no critical operations.

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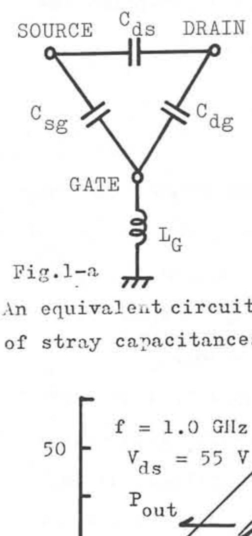

Fig.1-a
An equivalent circuit of stray capacitances.

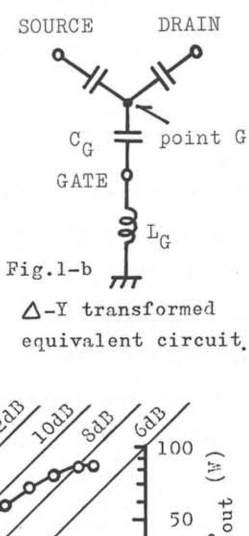

Fig.1-b
Δ-Y transformed equivalent circuit.

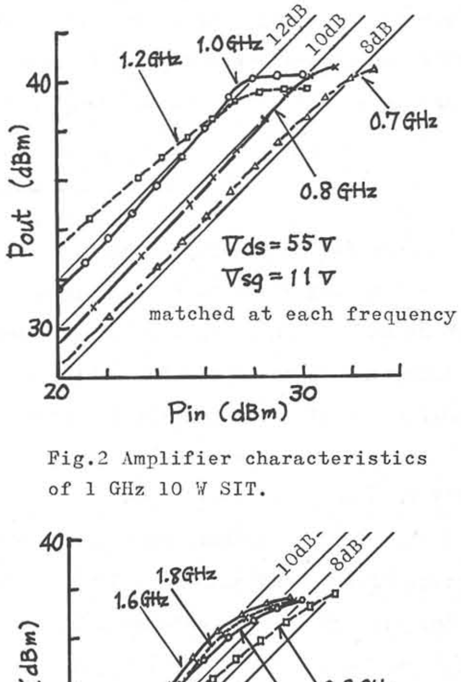

Fig.2 Amplifier characteristics of 1 GHz 10 W SIT.

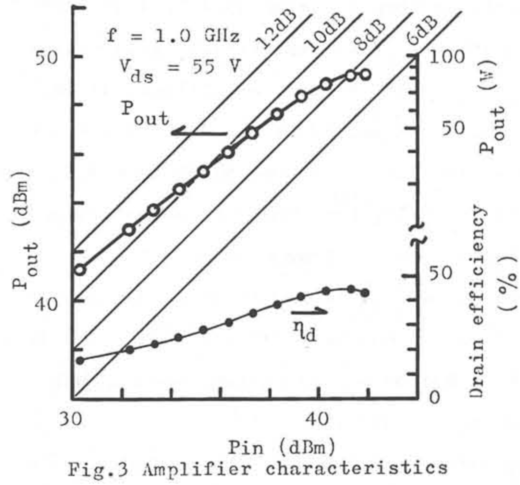

Fig.3 Amplifier characteristics of 1 GHz 80 W SIT.

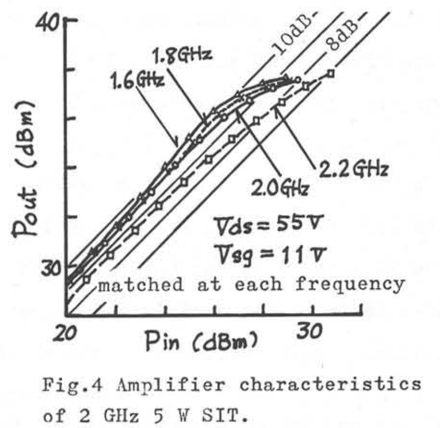

Fig.4 Amplifier characteristics of 2 GHz 5 W SIT.