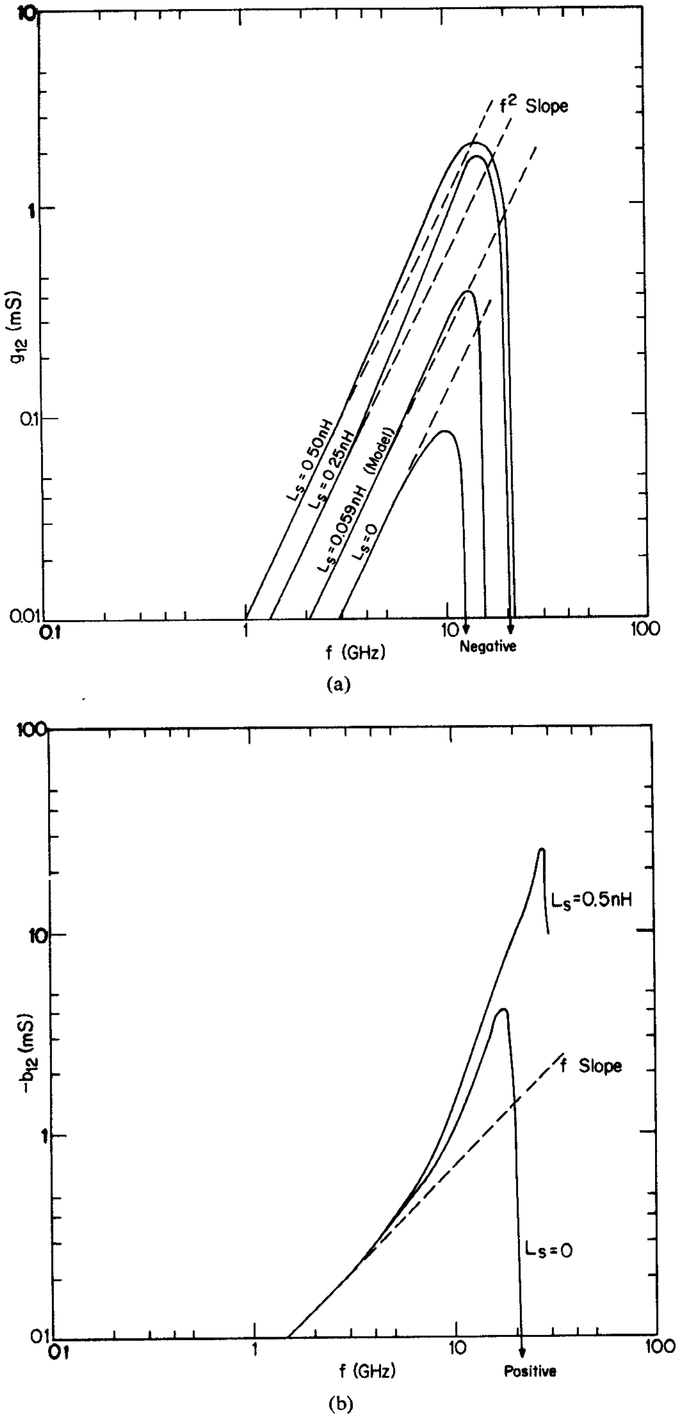

Fig. 3. y_{12} versus frequency with variable common-lead inductance. (a) g_{12} versus frequency. (b) b_{12} versus frequency.

indicate that g_{12} turns negative in *Ku* band. The effect of common-lead inductance on y_{12} can be seen clearly in Fig. 3, which gives the model data for the Fairchild chip as a function of common-lead inductance. By comparing Figs. 2 and 3, the L_s term is needed to fit the measured g_{12}.

The effect of device geometry has also been computed from experimental data. Increasing either gate length or gate width increases the g_{12}, but b_{12} appears to be essentially independent of geometry.

The data reported by Liechti [7] for both single- and dual-gate MESFET's at 10 GHz have also been converted to y parameters with the following feedback result:

	Single Gate	Dual Gate
g_{12}	0.382 mS	0.204 mS
b_{12}	−0.694 mS	−0.151 mS

The feedback is considerably reduced for the dual-gate device.

A positive g_{12} has been clearly demonstrated for GaAs MESFET's up to *Ku* band. This result is unique for FET's since microwave bipolar transistors normally have a negative g_{12}. From computer studies of the present GaAs MESFET model, the feedback inductance can be shown to increase stability (k) below about 8 GHz but decrease stability above 8 GHz. In addition, the maximum available gain or maximum stable gain is reduced by all of the feedback elements. Since the gain is usually reduced, it is confusing to refer to the feedback inductance or resistance as "regenerative" [3]. These results depend upon the particular model parameters of the GaAs MESFET. In addition, packaged MESFET's will behave quite differently due to additional feedback elements. In general, all feedback elements should be avoided since they normally lead to a reduction in gain over a broad frequency range regardless of the effect on g_{12}.

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The GaAs MESFET as a Pulse Regenerator in the Gigabit per Second Range

H. BENEKING AND W. FILENSKY

***Abstract*—Regeneration and amplification of fast pulses in the 50-ps range have been established using GaAs MESFET's under switching conditions. Sharpening factors, $t_{r_{in}}/t_{r_{out}}$, of 3 and voltage amplification factors of 2 at 50 Ω have been achieved for output pulses up to 100 mA. The sharpening effect is caused mainly by the voltage-dependent gate capacitance which varies with the input pulse amplitude.**

Using a GaAs MESFET under pinch-off conditions, any input pulse high enough may drive the FET into the active region. The turn-on time of the drain current is dependent on 1) the input time constant, 2) the voltage-dependent transconductance, and 3) the slope of the input pulse.

Because of the voltage-dependent gate capacitance the input time constant varies with the input signal. The simplified

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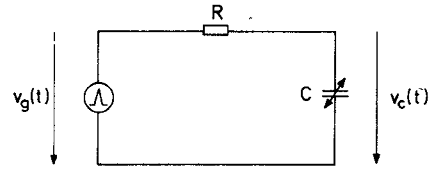

Fig. 1. Equivalent circuit of the entrance port.

equivalent circuit is shown in Fig. 1, where R represents the internal gate resistance in series with the generator impedance and C the gate capacitance. For mathematical evaluation, the voltage-dependent capacitance is assumed to show a junction diode behavior with relatively small diffusion potential. The capacitance then is given by

$$C = \frac{C_0}{\left[1 + \frac{V_B}{\phi} - \frac{v_c}{\phi}\right]^{1/n}}$$

where

- C_0 zero bias capacitance;
- V_B negative bias voltage;
- ϕ diffusion potential.

The differential equation, which governs the dependence of the intrinsic voltage $v_c(t)$ on the generator voltage in the case of a ramp function is

$$v_g(t) = \frac{V_g}{t_0} t = V_B + v_c + \left[\frac{RC_0}{n\phi} \frac{v_c}{\left[1 + \frac{V_B}{\phi} - \frac{v_c}{\phi}\right]^{1+1/n}} + \frac{RC_0}{\left[1 + \frac{V_B}{\phi} - \frac{v_c}{\phi}\right]^{1/n}}\right] \frac{dv_c}{dt}$$

$$\frac{V_g}{t_0} = \text{slope of the ramp.}$$

Consequently, the parametric pulse sharpening effect, as demonstrated in Fig. 2 for different input amplitudes, can be deduced; it can also be observed in commercially available junction FET's. Further evidence pointing to the presence of this effect are the input characteristics of the device: the reflected input pulse also shows a smaller rise time than the input pulse itself. Fig. 3 shows the regeneration and amplification of a 1-Gbit/s pulse train. It can be concluded that the GaAs MESFET's used are capable of sharpening pulses at rates up to 3 Gbit/s (see also [1]).

Besides transit-time effects, the delay time t_d is also dependent

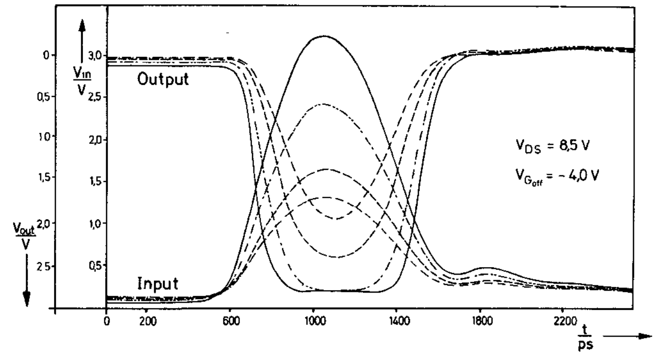

Fig. 2. Large signal behavior. MESFET driven by an avalanche generator. Load 50 Ω.

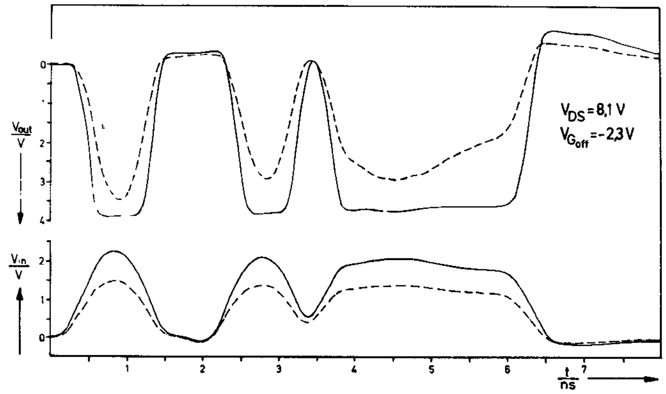

Fig. 3. Pulse sharpening and amplification. Load 50 Ω, switched power 0.3 W, MESFET driven by an avalanche word generator.

on the input voltage amplitude. As can be seen from Fig. 2, t_d measured at 50-percent peak voltage may be negative due to the sharpening effect.

The FET's are four-gate structures to minimize resistive effects with a gate width of 800 μm and a gate length of 1 μm. The technology has been reported earlier [2].

Acknowledgment

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