653850

SPRUSON & FERGUSON

AUSTRALIA

PATENTS ACT 1990

PATENT REQUEST: STANDARD PATENT

I/We, the Applicant(s)/Nominated Person(s) specified below, request I/We be granted a patent for the invention disclosed in the accompanying standard complete specification.

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[54] Invention Title:

~~Apparatus For Controlling Consumption Power For GaAs FET~~

APPARATUS FOR CONTROLLING POWER DISSIPATION BY AN AMPLIFIER USING A GaAs FET

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Details of Basic Application(s):

[31] Appl'n No(s):	[33] Country:	[32] Application Date:
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NEC Corporation

By: J. Yamaura

Registered Patent Attorney

IRN: 219465

INSTR CODE: 57995

5845/5

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Australia

Patents Act 1990

NOTICE OF ENTITLEMENT

I, Fraser Patison Old, of Spruson & Ferguson, 31 Market Street, Sydney, New South Wales, 2000, Australia, being the patent attorney for the Applicant(s)/Nominated Person(s) in respect of an application entitled:

APPARATUS FOR CONTROLLING ~~CONSUMPTION POWER FOR GaAs FET~~ POWER DISSIPATION BY AN AMPLIFIER USING A GaAs FET

state the following:-

The Applicant(s)/Nominated Person(s) has/have entitlement from the actual inventor(s) as follows:-

> The Applicant(s)/Nominated Person(s), by virtue of a Contract of Employment between the actual inventor(s) as employee(s) and the Applicant(s)/Nominated Person(s) as employer(s), is a person entitled to have the patent assigned to it if a patent were granted on an application made by the actual inventor(s).

The Applicant(s)/Nominated Person(s) is/are the applicant(s) of the basic application(s) listed on the Patent Request.

The basic application(s) listed on the Patent Request is/are the application(s) first made in a Convention Country in respect of the invention.

DATED this 24th day of November 19 92

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F P Old

IRN: 219465 INSTR CODE: 57995

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APPARATUS FOR CONTROLLING POWER DISSIPATION BY AN AMPLIFIER USING A GAAS FET

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(56) Prior Art Documents
AU 499114 86384/75 H03F 3/16
AU 456522 26663/71 H03F 3/16
US 4166962

(57) Claim

1. An apparatus for controlling power dissipated by an amplifier using a GaAs FET comprising:

first power source means for supplying a positive direct-current voltage to a drain region of said FET;

second power source means for supplying a negative direct-current voltage to a gate region of said FET;

voltage controlling means connected to an output terminal of said second power source means for controlling an output voltage from said second power source means;

resistor means having a terminal connected to an output terminal of said first power source means and another terminal connected to said drain region of said FET;

variable resistor means having first and second fixed terminals and a movable terminal which slides on said variable resistor means to vary linearly resistance between the movable terminal and the second fixed terminal, the first fixed terminal connected to said output terminal of said first power source means, and the second fixed terminal connected to an output terminal of said voltage controlling means, said movable terminal being connected to said gate region of said FET; and

resistor control means for detecting a voltage developed across said resistor means for supplying a control signal to said voltage controlling means, thereby setting said voltage to be substantially equal to a preset reference value,

. . ./2

said voltage controlling means controlling, in response to said control signal from said resistor control means, said voltage supplied from said second power source means to said gate region of said FET, thereby keeping a drain current of said FET at a constant value.

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COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

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Invention Title: ~~Apparatus For Controlling Consumption Power For GaAs FET~~
APPARATUS FOR CONTROLLING POWER DISSIPATION BY AN AMPLIFIER USING A GaAs FET

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

AUSTRALIA PATENT OFFICE MS

5845/6

APPARATUS FOR CONTROLLING POWER DISSIPATION BY AN AMPLIFIER USING A GaAs FET

BACKGROUND OF THE INVENTION

The present invention relates to an apparatus for controlling electric power dissipated by an amplifier using a GaAs field effect transistor (FET), and in particular to an apparatus capable of minimising variation in gain, variation in phase, and the deviation of gain within a band for the amplifier.

DESCRIPTION OF THE RELATED ART

In a conventional apparatus for controlling electric power dissipated by an amplifier using a GaAs FET, a positive voltage having a fixed value is continuously supplied from a power supply circuit to a drain region of the GaAs FET and a negative voltage having a variable value is delivered from a power supply to a gate region of the GaAs FET. The negative voltage fed to the gate region is controlled according to a value not less than a pinch-off voltage of the GaAs FET to alter a source-to-drain or drain current (ID), thereby controlling the power dissipated by the GaAs FET.

However, in the conventional power controller of this type, the drain current is changed by varying the gate voltage of the GaAs FET to control the power dissipation, which leads to considerably large changes respectively in the gain, the phase, and the deviation of gain within a band. The changes in the gain and phase cause an alteration in the quantity of improvement of distortion; moreover, the variation in the deviation minimises a compensation bandwidth of the GaAs FET. This consequently leads to the drawback that, in a linear amplifier in which a component of intermodulation distortion appearing in an amplifier including a multi-stage connection is compensated for by

cancelling the distortion component with a component having an identical amplitude and an opposite phase with respect to those of the distortion component, the compensation cannot be easily achieved.

In order to improve the disadvantageous feature, fine and complex control is required in consideration of the gain and phase, which leads to a problem that the hardware configuration and software system are complicated and increased in number.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an apparatus for controlling an electric power dissipated by an amplifier including a GaAs FET capable of minimising variation in gain, variation in phase, and deviation of gain within a band developed when dissipated power is controlled, thereby solving or at least ameliorating the problem discussed above.

Therefore, the invention discloses an apparatus for controlling power dissipated by an amplifier using a GaAs FET comprising:

first power source means for supplying a positive direct-current voltage to a drain region of said FET;

second power source means for supplying a negative direct-current voltage to a gate region of said FET;

voltage controlling means connected to an output terminal of said second power source means for controlling an output voltage from said second power source means;

resistor means having a terminal connected to an output terminal of said first power source means and another terminal connected to said drain region of said FET;

variable resistor means having first and second fixed terminals and a movable terminal which slides on said variable resistor means to vary linearly resistance between the movable terminal and the second fixed terminal, the first fixed terminal connected to said output terminal of said first power source means, and the second fixed terminal connected to an output terminal of said voltage controlling means, said movable terminal being connected to said gate region of said FET; and

resistor control means for detecting a voltage developed across said resistor means for supplying a control signal to said voltage controlling means, thereby setting said voltage to be substantially equal to a preset reference value,

said voltage controlling means controlling, in response to said control signal from said resistor control means, said voltage supplied from said second power source means to said gate region of said FET, thereby keeping a drain current of said FET at a constant value.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention now will be described with reference to the accompanying drawings, in which:

Fig. 1 is a schematic block diagram showing the configuration of an example of the power dissipation controlling apparatus of the prior art;

Fig. 2 is a graph showing changes respectively in the gain, the phase, and the deviation of gain within a band developed when the dissipated power is controlled;

Fig. 3 is a block diagram schematically showing an embodiment of an apparatus for controlling electric power dissipated by an amplifier using a GaAs FET; and

Fig. 4 is a graph showing changes respectively in the gain, the phase, and the deviation of gain within a band developed when the dissipated power is controlled in the power controlling apparatus of Fig. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For better understanding of the present invention, description firstly will be given of an apparatus for controlling electric power dissipated by a conventional amplifier using a GaAs FET.

Fig. 1 shows an apparatus for controlling an electric power dissipated by a conventional GaAs FET amplifier, whereas Fig. 2 shows changes respectively in the gain, the phase, and the deviation of gain within a band developed when the dissipated power is controlled in the power controlling apparatus of Fig. 1.

Conventionally, an apparatus for controlling an electric power dissipated by a GaAs FET amplifier includes, as shown in Fig. 1, a power source circuit 1 for continuously supplying a positive voltage having a fixed value to a drain region of the GaAs FET 7, a power source circuit 2 for supplying a negative voltage, and a variable voltage circuit 4 for controlling the negative voltage produced from the power source circuit 2 to supply the controlled negative voltage to a gate region of the GaAs FET. The negative voltage fed from the variable voltage circuit 4 is controlled according to a value not less than a pinch-off voltage of the GaAs FET 7 to alter a drain current (ID), thereby controlling the electric power dissipated by the GaAs FET.

However, in such a conventional power controlling apparatus, the gate voltage of the GaAs FET is controlled by a control signal supplied from an input terminal 8 to vary the drain current, thereby supervising the dissipated power. Consequently, due to

the power control, there appear considerably large changes respectively in the gain, the phase, and the deviation of gain within a band as shown in Fig. 2.

Fig. 3 shows the structure of the power controlling apparatus in an embodiment of the present invention.

The apparatus of Fig. 3 includes a first power source circuit 1 for producing a positive direct-current voltage, a second power source circuit 2 for producing a negative direct-current voltage, a variable voltage circuit 4 having an input connected to an output from the power source circuit 2 for controlling an output voltage from the power source circuit 2 based on a control signal received from a control circuit 5, and a GaAs FET 7 having a source region connected to a common or shared potential.

Between an output terminal of the power source circuit 1 and a drain region of the GaAs FET 7, a resistor 3 is arranged. Between an output terminal of the power source circuit 1 and an output terminal of the variable voltage circuit 4, is disposed a variable resistor 6 having an adjusting member. The adjusting member is connected to a gate region of the GaAs FET 7. The

resistor 3 is connected between two input terminals of the control circuit 5. The control circuit 5 detects a voltage developed across the resistor 3 and then compares the voltage with a predetermined reference voltage. Depending on a result of comparison, to set the detected voltage to be substantially equal to the predetermined reference value, the control circuit 5 delivers a control signal to the variable voltage circuit 4.

Description will now be given of the operation of the dissapated ~~consumption~~ power controlling apparatus thus constructed. Fig. 4 shows changes respectively in the gain, the phase, and the deviation of gain within a band developed when the dissipated power is controlled. ~~consumption power is controlled in the consumption power controlling apparatus according to the present invention.~~

In the amplifier using ~~including~~ a GaAs FET to be operated with a source region thereof connected to a grounding potential as shown in Fig. 3, the drain current (ID) is generally controlled as follows. First, the variable voltage circuit 4 is set to the minimum voltage and is then powered from the power source circuit 2 so as to develop the negative voltage representing a lowest value.

Next, the adjustable member of the variable resistor 6 is moved toward the side of the variable voltage circuit 4 to supply the lowest voltage to the gate region of the GaAs FET 7; thereafter, the power source circuit 1 is turned on to supply a positive voltage thereto. Thereafter, the variable resistor 6 is adjusted so as to cause a predetermined drain current (ID) to flow. For a regular drain current (ID), there appears across the resistor 3 a voltage drop which is a product (R · ID) between the

resistance R of the resistor 3 and the drain current ID. Consequently, the control circuit 5 monitors the voltage drop through the resistor 3 to control the variable voltage circuit 4 so that the value of product (R · ID) is continuously kept retained at the predetermined reference value. That is, the control circuit 5 includes a comparator for comparing the value of voltage with the predetermined reference value. Depending on a result of comparison, the control circuit 5 sends a control signal to the variable voltage circuit 4, thereby controlling the quantity of voltage change in voltage to be developed by the variable voltage circuit 4.

Next, a detailed description will be given particularly of reduction of the power ~~consumption in the consumption power control according to the present invention.~~ dissipated.

As above, the apparatus is initiated to supply the gate region of the GaAs FET with the lowest voltage to prevent a large drain current from flowing therethrough. Thereafter, the adjusting member of the variable resistor 6 is moved to lower the voltage (Vcc) to be supplied from the power source circuit 1. When the voltage is decreased, the gate voltage of the FET is also lowered and hence the drain current (ID) is minimized. This means that the voltage monitored by the control circuit 5 is reduced. The control circuit 5 compares the predetermined reference voltage with the product between the resistance R of the resistor 3 and the drain current ID to continuously achieve the control operation until there is attained a matching condition as a result of comparison, thereby completing a cycle of control operation. Until the preset ~~consumption~~ dissipation power is developed,

the control circuit 5 conducts several cycles of control operation above.

In accordance with the present invention, there are disposed resistor means arranged between an output terminal of first power source means and a drain region of a GaAs FET and variable resistor means having an adjusting member and being arranged between output terminals respectively of the first power source means and variable voltage means, the adjusting member being connected to a gate region of the GaAs FET. Control means having two input terminals between which the resistor means is arranged supplies a control signal to the variable voltage means, thereby controlling a voltage developed across the resistor means to be substantially equal to a predetermined reference value.

In consequence, since the drain current flowing through the GaAs FET is set to be a fixed value, even when the ~~consumption~~ dissipated power is controlled, the changes respectively in the gain, the phase, and the deviation of gain within a band can be satisfactorily minimized.

In the embodiment, for simplification of drawing, a circuit for deleting a direct-current component from a high-frequency signal supplied to the amplifier is shown in quite a simplified form.

As above, in accordance with the present invention, there can be attained an advantageous effect that the changes respectively in the gain, the phase, and the deviation of gain within a band can be satisfactorily minimized even when the ~~consumption~~ dissipated power is controlled. Consequently, in a case where an amplifier to which the consumption power controlling apparatus is applied to

compensate for the distortion, there need not be accomplished the fine and complex control operation, thereby contributing to minimization of the circuit.

While the present invention has been described with reference to the particular illustrative embodiments, it is not to be restricted by those embodiments but only by the appended claims. It is to be appreciated that those skilled in the art can change or modify the embodiments without departing from the scope and spirit of the present invention.

The claims defining the invention are as follows:

1. An apparatus for controlling power dissipated by an amplifier using a GaAs FET comprising:

first power source means for supplying a positive direct-current voltage to a drain region of said FET;

second power source means for supplying a negative direct-current voltage to a gate region of said FET;

voltage controlling means connected to an output terminal of said second power source means for controlling an output voltage from said second power source means;

resistor means having a terminal connected to an output terminal of said first power source means and another terminal connected to said drain region of said FET;

variable resistor means having first and second fixed terminals and a movable terminal which slides on said variable resistor means to vary linearly resistance between the movable terminal and the second fixed terminal, the first fixed terminal connected to said output terminal of said first power source means, and the second fixed terminal connected to an output terminal of said voltage controlling means, said movable terminal being connected to said gate region of said FET; and

resistor control means for detecting a voltage developed across said resistor means for supplying a control signal to said voltage controlling means, thereby setting said voltage to be substantially equal to a preset reference value,

said voltage controlling means controlling, in response to said control signal from said resistor control means, said voltage supplied from said second power source means to said gate region of said FET, thereby keeping a drain current of said FET at a constant value.

2. The apparatus as claimed in claim 1, wherein said resistor control means includes comparing means for comparing the voltage developed across said resistor means with said preset reference value and supplying said control signal to said voltage controlling means when a result from said comparing means says the voltage across said resistor means is not equal to the preset reference value.

DATED this Ninth Day of August 1994
NEC Corporation

Patent Attorneys for the Applicant
SPRUSON & FERGUSON

APPARATUS FOR CONTROLLING POWER DISSIPATION BY AN AMPLIFIER USING A GaAs FET

~~Apparatus for Controlling Consumption Power for GaAs FET~~

Abstract

In a consumption power controlling apparatus for a GaAs FET amplifier, even when a consumption power is controlled, the changes respectively in the gain, the phase, and the deviation of gain within a band can be minimized in a satisfactory manner. There are disposed resistor means (3) arranged between first power source means (1) and a drain region of a GaAs FET (7) and variable resistor means (6) having an adjusting member and being arranged between output terminals respectively of the first power source means (1) and variable voltage means (4). The adjusting member (6) is connected to a gate region of the GaAs FET (7). There is also disposed control means (5) having two input terminals between which the resistor means (3) is connected to supply a control signal to the variable voltage means (4) so as to control a voltage developed across the resistor means (3) to be substantially equal to a predetermined reference value, thereby obtaining a fixed drain current of the FET (7).

Figure 3

FIG. 1

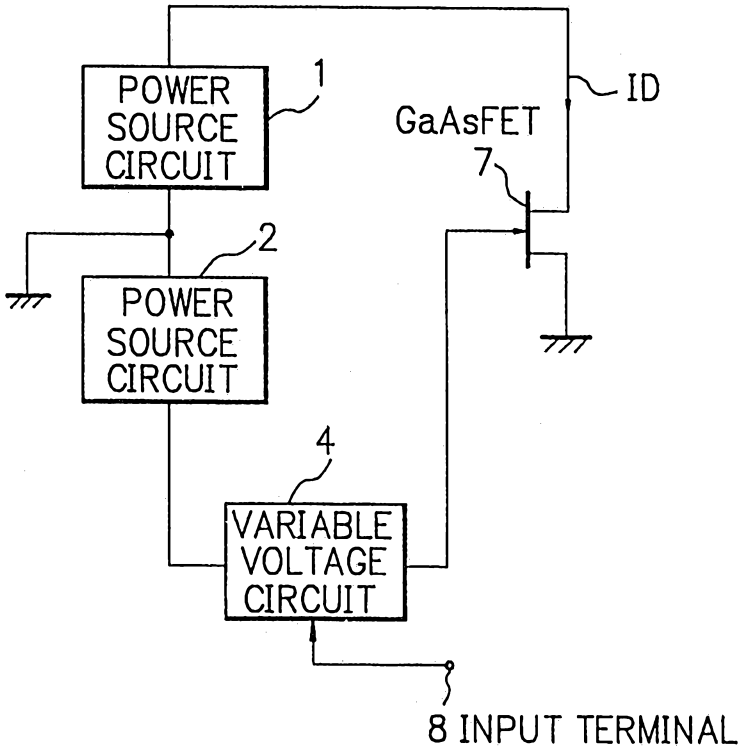
POWER SOURCE CIRCUIT
1
ID
GaAsFET
7
2
POWER SOURCE CIRCUIT
4
VARIABLE VOLTAGE CIRCUIT
8 INPUT TERMINAL

FIG. 2

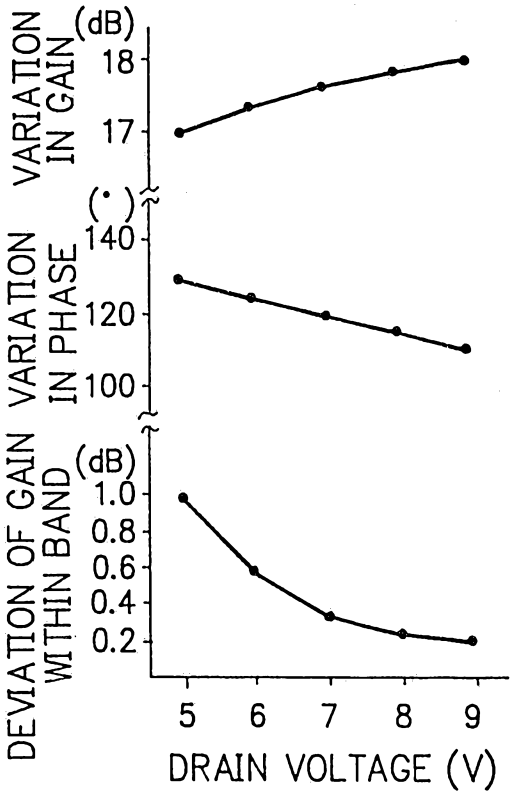
VARIATION IN GAIN
(dB)
18
17
VARIATION IN PHASE
(°)
140
120
100
DEVIATION OF GAIN WITHIN BAND
(dB)
1.0
0.8
0.6
0.4
0.2
5
6
7
8
9
DRAIN VOLTAGE (V)

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FIG. 3

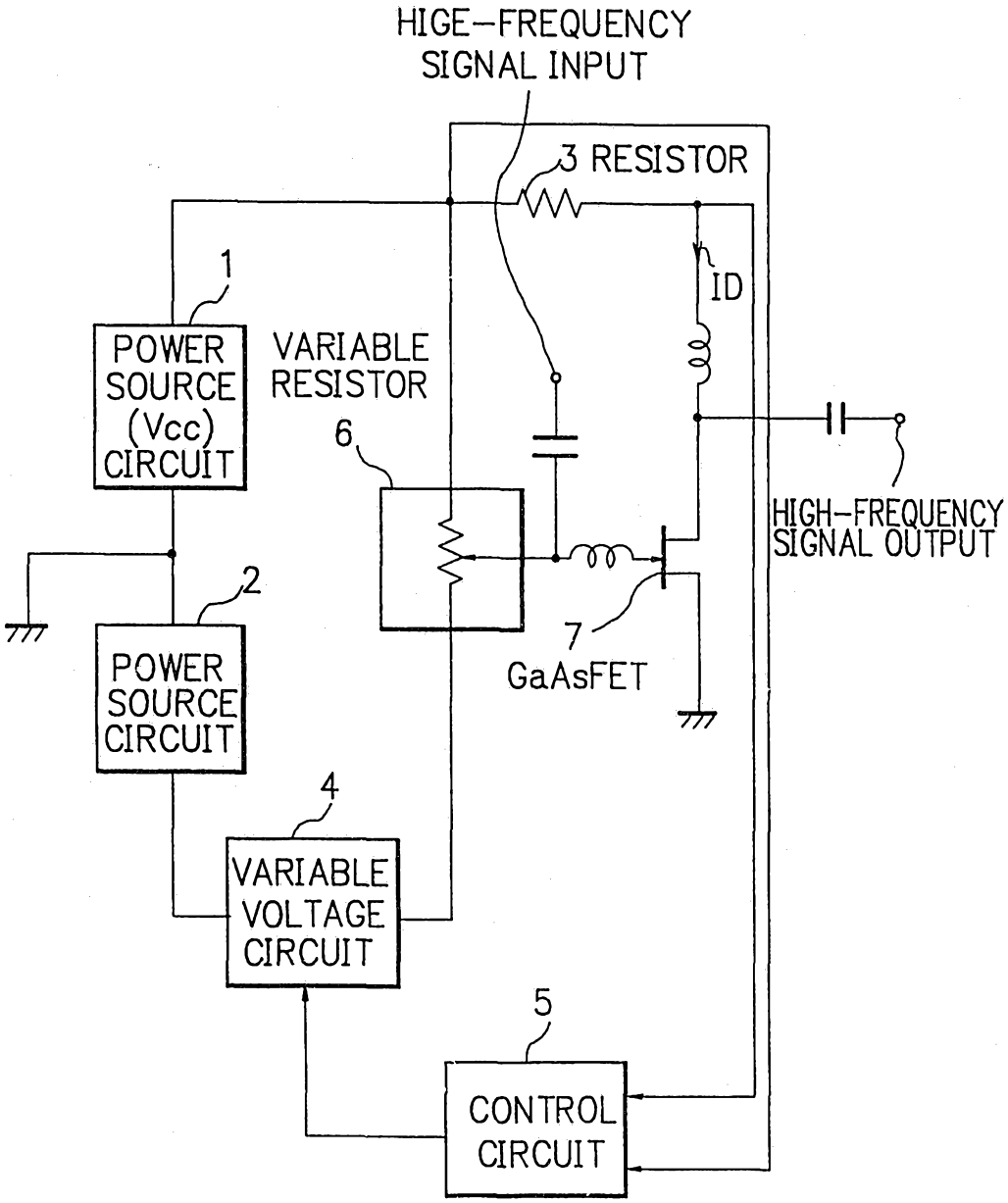
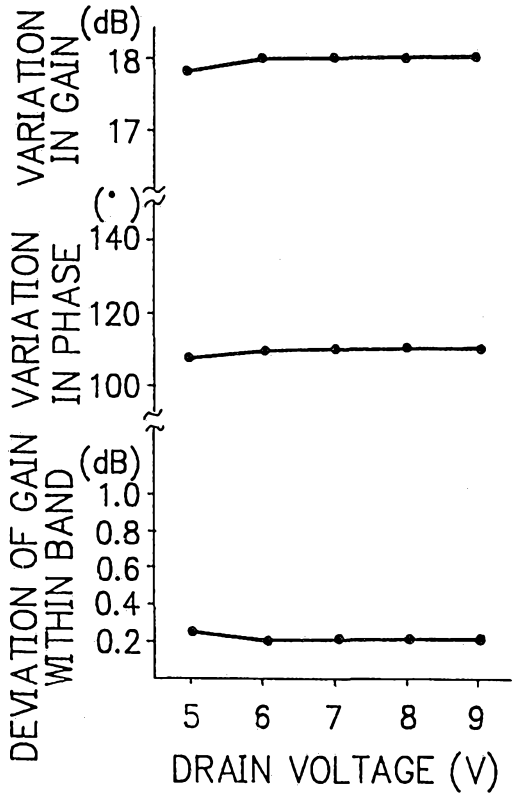


FIG. 4


VARIATION IN GAIN
(dB)
18
17
VARIATION IN PHASE
(°)
140
120
100
DEVIATION OF GAIN WITHIN BAND
(dB)
1.0
0.8
0.6
0.4
0.2
5
6
7
8
9
DRAIN VOLTAGE (V)