THE WIDE-BAND AMPLIFIERS μPG100B/μPG101B

1. GENERAL

μPG100B/101B is the GaAs MMIC (GaAs Microwave Monolithic Integrated Circuit) developed as the low noise wide band amplifier/medium power wide band amplifier.

μPG100B features NF of 3 dB or less and power gain of 15 dB from 50 MHz to 3 GHz, and μPG101B features $P_{O(1\ dB)}$ (output power at 1 dB gain compression point) of about 17 dBm and power gain of 13 dB in the same frequency band.

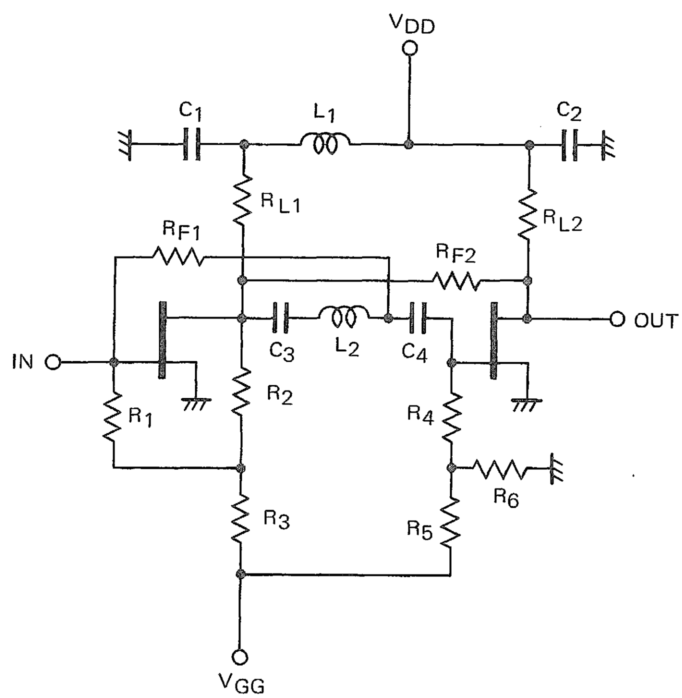
These ICs are suitable for IF stages of microwave communication system and the measurement equipment which require low noise and the medium power characteristics respectively.

This data sheet introduces the characteristics and applications of these ICs.

2. INTERNAL EQUIVALENT CIRCUIT

Fig. 1 shows the internal equivalent circuit of μPG100B/101B.

Fig. 1 μPG100B/101B Equivalent Circuit Diagram



As the circuit configuration, the single end type which consists of two stages of GaAs FET with a gate length of 0.8 μm and a gate width of 1 mm is utilized. To realize the wide band characteristic, both the first and second stage FETs are provided with negative feedback by feedback resistors R_{F1} (for the first stage) and R_{F2} (for the second stage), respectively. (Only the second stage FET for μPG100B has the gate width of 500 μm).

The operating currents for the first and second stage FETs are set as shown in Table 1. The second FET stage of μPG101B is biased by a relatively large bias current of 55 mA to get high output power.

Because of the large bias current it is required to put choke coil in parallel with load resistor R_{L2} to prevent V_{DS} from getting down.

Table 1 Internal FET Operating Current Values

(Unit: mA)

	First Stage	Second Stage
μPG100B	25	20
μPG101B	40	55

3. DEVICE CHARACTERISTICS

Fig. 2 and 3 show the Gain and NF versus frequency characteristics for μPG100B and μPG101B, respectively.

Both devices have extremely good temperature characteristics of the gain variation, which is approximately about 0.5 dB (0.005 dB/°C) within the ambient temperature range from –25 to +75 °C.

μPG100B features NF of 3 dB or less from 50 to 3 000 MHz and μPG101B features NF of 6.5 dB or less within the same band. μPG100B is especially suitable for a low noise, wide band amplifier.

Fig. 2 μPG100B Gain and NF vs. Frequency

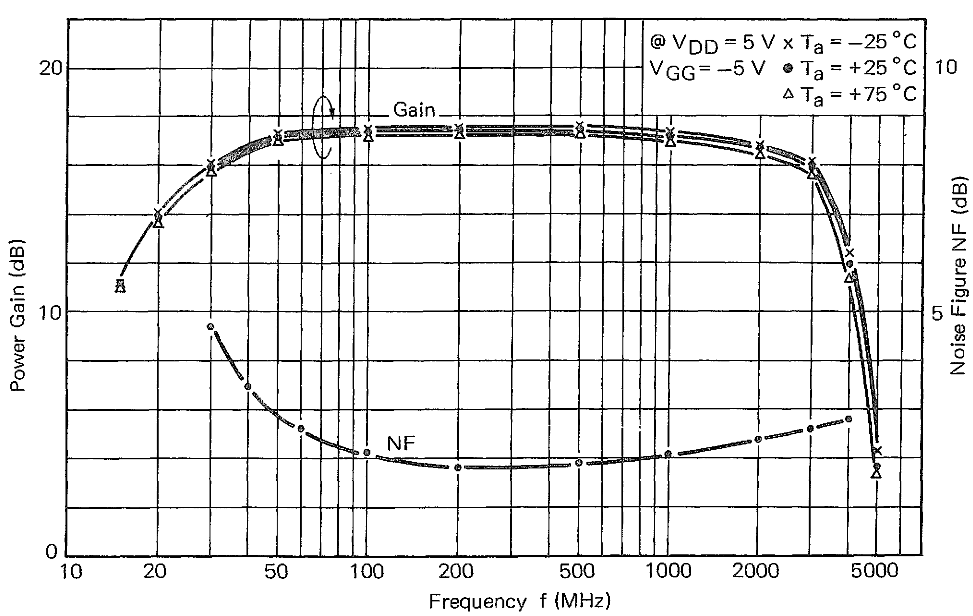


Fig. 3 μPG101B Gain and NF vs. Frequency

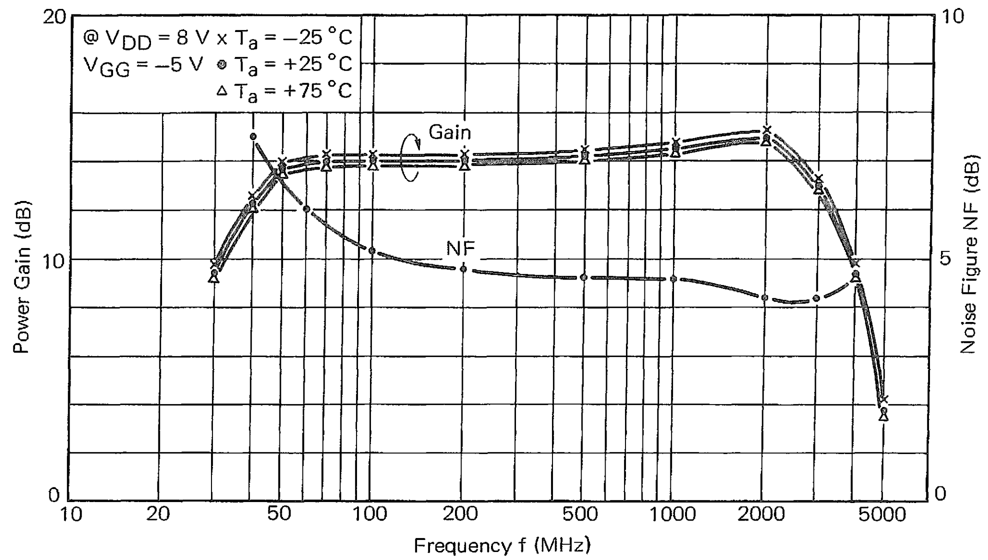


Fig. 4 and 5 show input/output return loss versus frequency characteristics as a function of temperature for μPG100B and μPG101B, respectively.

Fig. 4 μPG100B Return Loss vs. Frequency

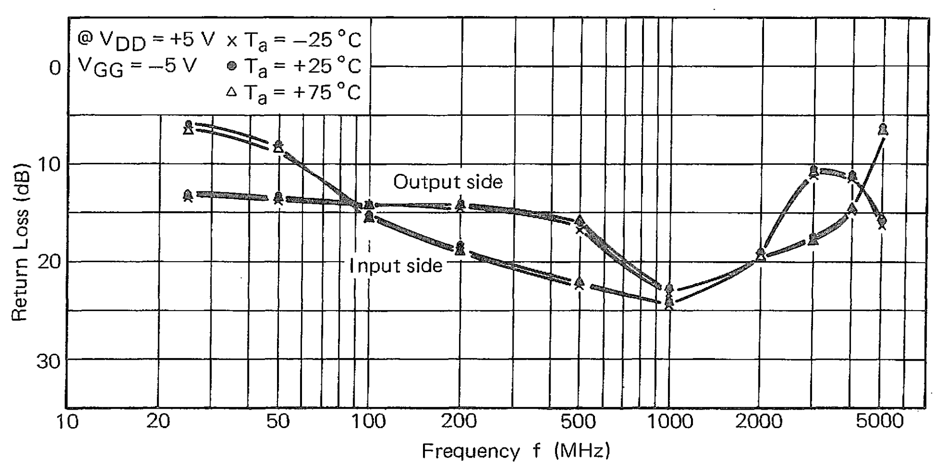


Fig. 5 μPG101B Return Loss vs. Frequency

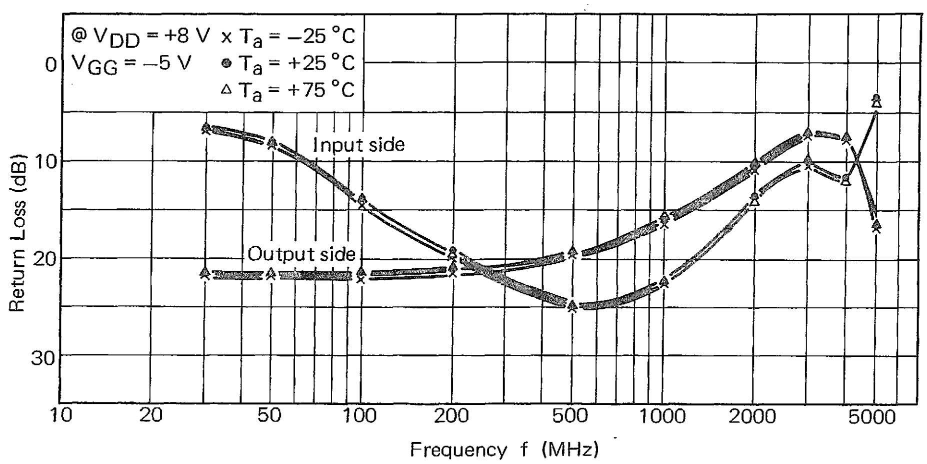


Fig. 6 through 11 show the temperature and the supply voltage dependency of P_{in}–P_{out} for μPG100B and μPG101B.

The output power at 1 dB gain compression point, $P_{O(1\ dB)}$, is +7 dBm for μPG100B and +17 dBm for μPG101B (@. f = 2 GHz). μPG101B is suitable for a medium output power, wide band amplifier. As for the temperature characteristics of both μPG100B and μPG101B, $P_{O(1\ dB)}$ varies about 0.5 dB (0.005 dB/°C), which is almost the same as gain variation.

As for the supply voltage dependency of $P_{O(1\ dB)}$, μPG100B has 2 dB/V on the V_{DD} side and 1 dB/V on the V_{GG} side; μPG101B has 1 dB/V on the V_{DD} side and 0.8 dB/V on the V_{GG} side.

For practical use, the 3-pin regulator is recommended to be used for stabilizing the supply voltage to prevent the characteristic from changing caused by supply voltage variation.

Fig. 6 μPG100B P_{out}–P_{in} Characteristic

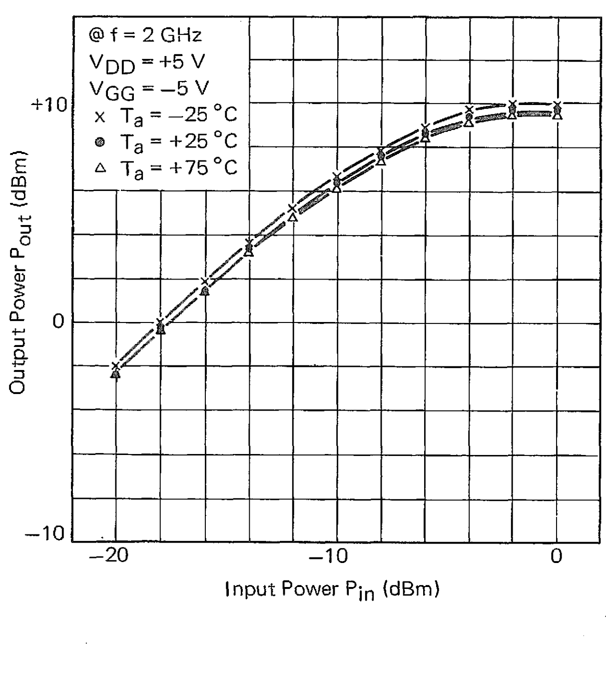


Fig. 7 μPG101B P_{out}–P_{in} Characteristic

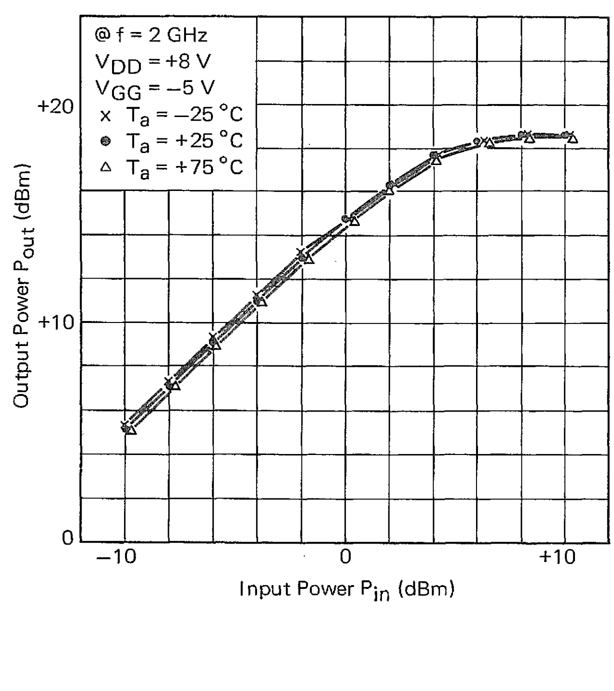


Fig. 8 μPG100B P_{out}–P_{in} Characteristic

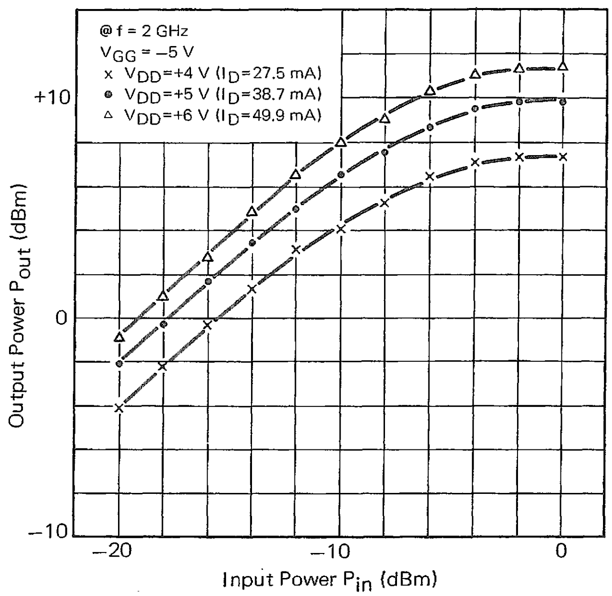


Fig. 9 μPG101B P_{out}–P_{in} Characteristic

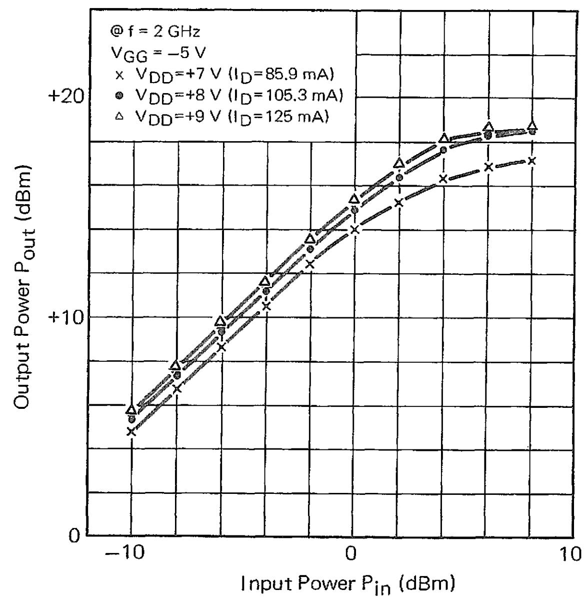


Fig. 10 μPG100B P_{out}–P_{in} Characteristic

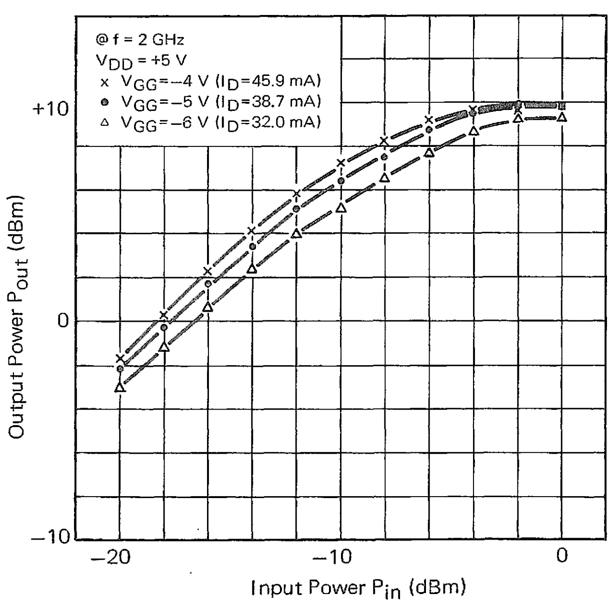
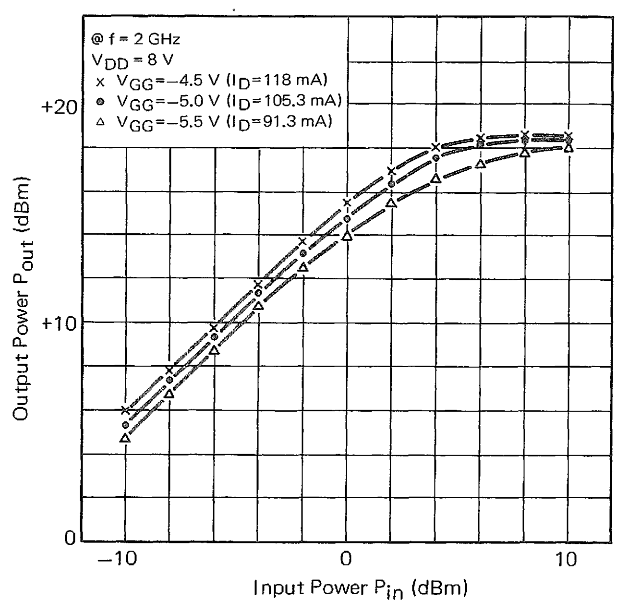


Fig. 11 μPG101B P_{out}–P_{in} Characteristic

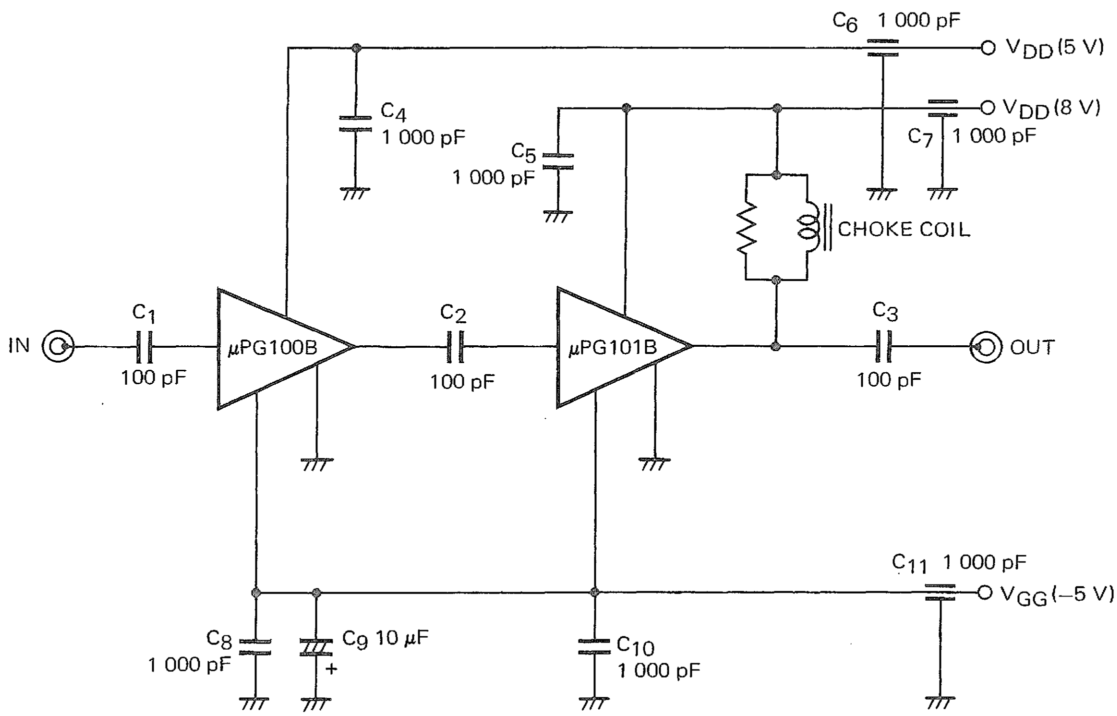


4. APPLICATIONS

When these ICs are practically used, generally these are cascaded and used as multi-stage amplifiers. In this case, the first stage requires the low noise characteristic, and the second stage requires linearity. Here, the amplifier using μPG100B for the first stage and μPG101B for the second stage is introduced.

Fig. 12 and 13 show the circuit diagram for this amplifier and the bias circuit example, respectively.

Fig. 12 Circuit Diagram of μPG100B/μPG101B Cascade Connection Amplifier



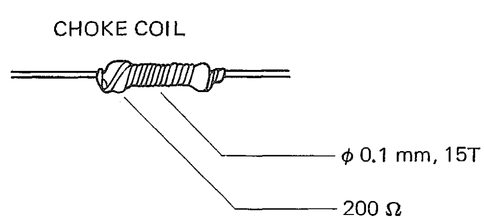
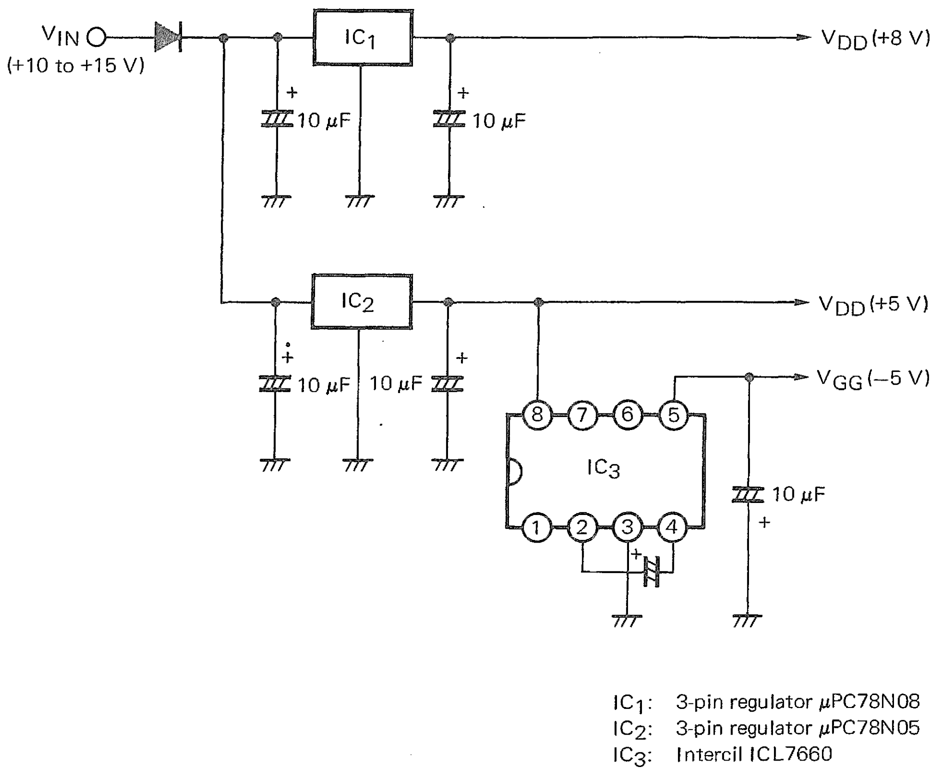


Fig. 13 Bias Circuit Example



μPG100B requires V_{DD} +5 V and V_{GG} −5 V as the supply voltage; μPG101B requires V_{DD} +8 V and V_{GG} −5 V. (V_{GG} can be used in common for both μPG100B and μPG101B.)

V_{DD} is applied to μPG101B using the external choke coil. The DC block capacitors are inserted into input/output of μPG100B and μPG101B, and these ICs are connected with the 50 Ω microstripline.

To compose this circuit, take special care to the following points:

(1) If the air-core coil is used as the choke coil for μPG101B, coil Q becomes too high and may resonate with the stray capacity, causing a dip in the band. To avoid this, coil Q should be dumped by the resistor of about 200 Ω in advance.

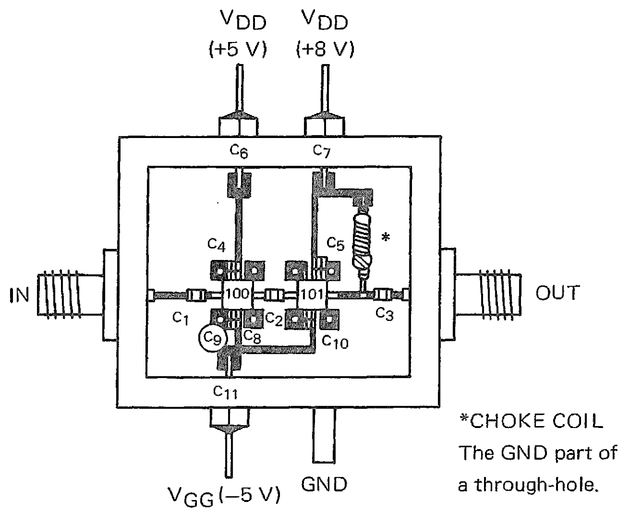
The circuit diagram shown in Fig. 12 is recommended to be used.

(2) As the multi-stage amplifier gives high gain, if ripple of power supply is present on the V_{GG} side, it is amplified and causes the output waveform to be amplitude-modulated. An electrolytic capacitor should be used to remove this ripple.

As shown in Fig. 13, the bias circuit can be easily composed by using the 5 V and 8 V 3-pin regulator for V_{DD} and converting +5 V into −5 V with the DC-DC converter for V_{GG}.

Fig. 14 shows the printed pattern example and the assembly method. In this figure, the teflon board of 0.635 mm thickness is soldered to the chassis with conductive epoxy (silver paste), all the parts are mounted on the board surface, and the GND part of each IC is grounded with a through-hole.

Fig. 14 Assembly Method



*CHOKE COIL
The GND part of each IC is grounded with a through-hole.

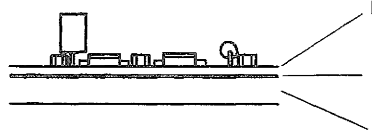


Fig. 15 through 18 show the characteristics of the amplifier composed as described above.
Summary of test result is shown as follows:

- Gain: 32 dB or more (@ 50 to 3 000 MHz)
- NF: 2.8 dB or less (@ 50 to 3 000 MHz)
- Input return loss: 10 dB or more (@ 50 to 3 000 MHz)
- Output return loss: 5 dB or more (@ 50 to 3 000 MHz)
- $P_{O(1\ dB)}$: +18 dBm or more (@ 50 to 3 000 MHz)
- IM_3: 37 dBc @ f_1 = 2 GHz, f_2 = 2.01 GHz, Output level of +10 dBm for each wave
- 3-dB frequency band width: 34 to 3 100 MHz

Fig. 15 μPG100B/101B Gain and NF vs. Frequency

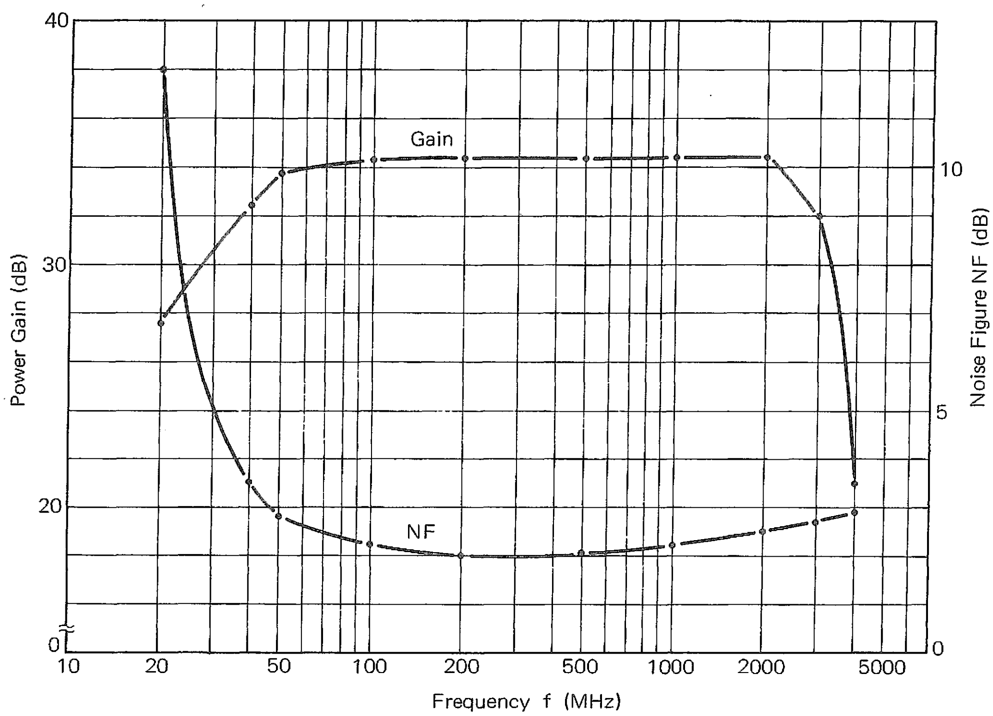


Fig. 16 μPG100B/101B Return Loss vs. Frequency Characteristics

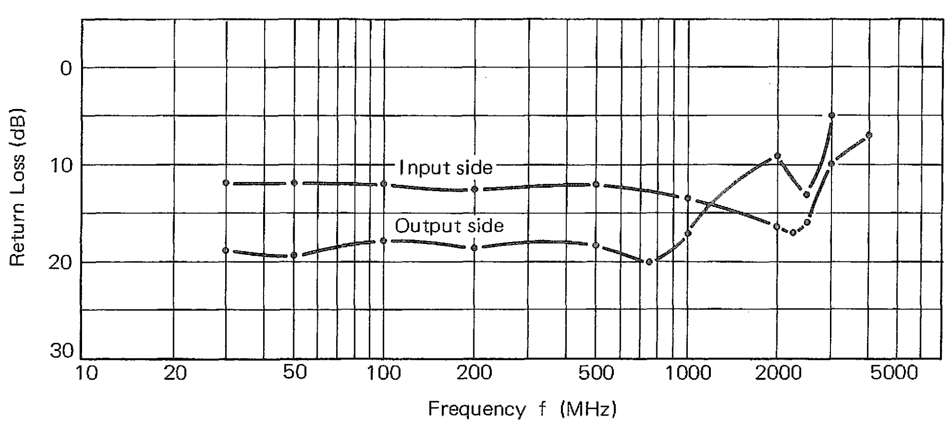


Fig. 17 μPG100B/101B P_{out}–P_{in} Characteristics

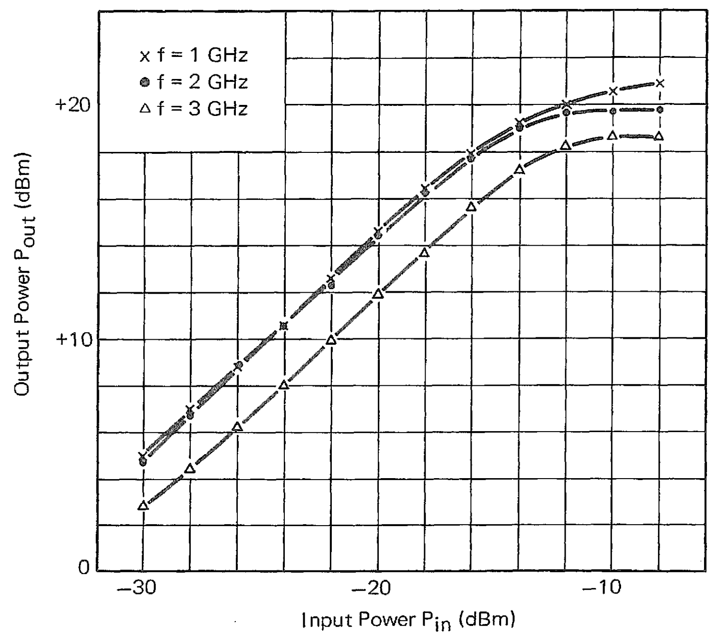
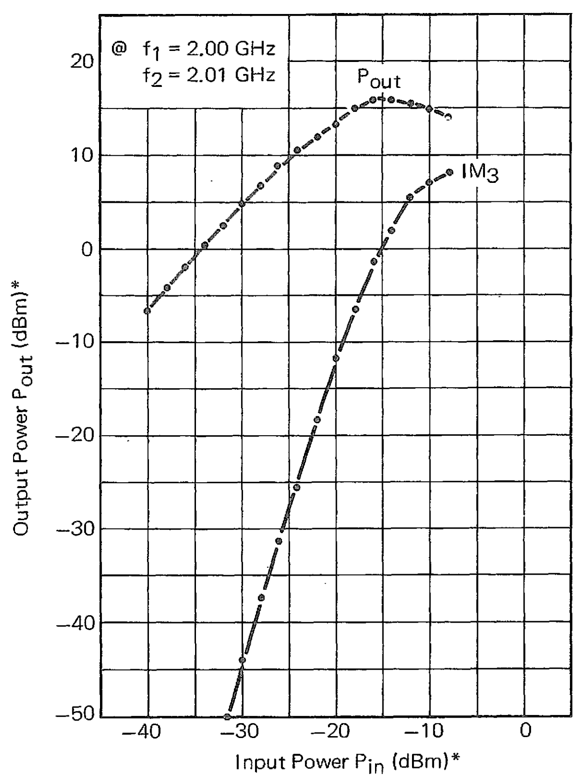


Fig. 18 μPG100B/101B P_{out}–P_{in} Characteristics



*The value of the input/output level for each signal.

5. CAUTIONS FOR USE

(1) Take great care to protect against static electricity because the GaAs MES FET is used as a basic cell in the IC. Be sure to ground the work bench, your body and soldering iron, and use a metal tray for storing the products.

(2) The package cap is adhered with AuSn. Therefore, be sure to perform soldering at temperatures under 260 °C for 10 seconds or less.

Be careful that the lead wires are shortcircuited via the AuSn part when solder is put into contact with the AuSn part.

IEP–1079
September 1987M
Printed in Japan