NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VIRGINIA

CTRONICS DIVISION INTERNAL REPORT NO. 203

TESTS OF COOLED 5-GHz PARAMETRIC AND GASFET AMPLIFIERS

SANDER WEINREB

APRIL 1980

NUMBER OF COPIES: 150

TESTS OF COOLED 5 GHZ PARAMETRIC AND GASFET AMPLIFIERS

S. Weinreb

I. INTRODUCTION

The Observatory utilizes many low-noise 4.5 - 5 GHz amplifiers at the VLA, at Green Bank, and for IF amplifiers at the 36' telescope. These amplifiers are of 3 types: Comtech paramp P/N 91196, AIL paramp P/N 558569-1, and NRAO GASFET amplifiers described in EDIR #202. In order to make an accurate comparison of the performance of these amplifiers, one each of the paramps, both having, coincidently, serial number 109, were borrowed from Tucson and tested in the automated noise and gain measurement set described in EDIR #202. A secondary goal was the measurements of the sensitivity of the paramps to pump power, pump frequency, and bias voltage.

II. RESULTS

The results are summarized in Table I which presents for all three amplifiers in the 4.5 to 5.0 GHz range, the frequency-average noise temperature T_{av}, the minimum noise temperature T_{low}, the maximum gain G_{max}, and the gain variation with frequency ΔG. Different rows in the tables represent different tunings (bias-voltage, pump power and frequency) for the paramps and two different amplifiers for the GASFET's.

More detailed information concerning gain and noise temperature vs. frequency is given in Figures 1 and 2. At the top of each set of curves

a legend shows the line type (i.e., solid, dashed, dotted, etc.) and the tuning parameters for the gain and noise temperature curves with that line type.

III. CONCLUSIONS

The Comtech and AIL paramps give identical performance to within 2°K of noise temperature. When either is tuned for less than 3dB gain variation from 4.5 to 5 GHz the noise temperature varies from 15°K to 25°K over the band,with an average of 19°K. Noise temperatures as low as 12°K at a single frequency could be achieved on both paramps but this required tuning for a narrow-band, high-gain frequency response.

The paramps were difficult to tune because of the fairly critical effects of bias voltage, pump power, and pump frequency. The pump frequency can be set at the manufacturer's specified value but it is not known whether this frequency will remain optimum over the life of the paramp with many temperature cycles. If only the gain of a paramp is monitored, it is possible to mistune a paramp for flat-gain but high average noise temperature as shown in Figure 1D. This was corrected by tuning the pump frequency 100 MHz higher as in Figure 1A.

The NRAO 2-stage GASFET amplifier utilizing Mitsubishi MGF 1412 transistors had an average noise temperature 1°K or 2°K higher than the value for flat-gain tuning of the paramps. It was insensitive to DC bias, was flat with frequency, and would be expected to be stable over a period of many years. At the time of this writing attempts to duplicate this amplifier have resulted in units with average noise temperature 5 to 7°K higher as shown in the bottom row of Table II. This is probably due to some variability in the transistors and is being investigated.

TABLE I - SUMMARY OF RESULTS

COMTECH PARAMP

Figure	T_{av} °K	T_{low} °K	G_{MAX} DB	ΔG DB	Comments
1A	18.3	15.2	13.8	2.1	Flat response 31.85 GHz, 54mW -.19v, -0.6μA
1B	17.2	13.9	19.3	6.7	Narrow band 31.90 GHz, 60mW -.20v, -0.8μA
1C	21.8	12.2	22.4	14.2	Very narrow band 31.85 GHz, 55mW -.13v, 0μA
1D	24.8	21.9	11.5	10.6	Flat, high T_{av} 31.75 GHz, 75mW -.30v, -1.1μA

AIL PARAMP

2A	19.9	17.0	14.9	2.6	Flat response 26.28 GHz, 39.5mW +.914v, 0μA
2B	16.4	12.2	19.6	8.0	Lowest noise 26.20 GHz, 59mW +.90v, 0μA

NRAO GASFETS

2D	20.1	20.0	30.7	1.0	2-stage, 2-isolator #23 into #25 MGF 1412 #9239259
-	25.5	24.0	14.9	0.9	Single stage #26 MGF 1412 #9239290 5v, 16mA, -1.09v

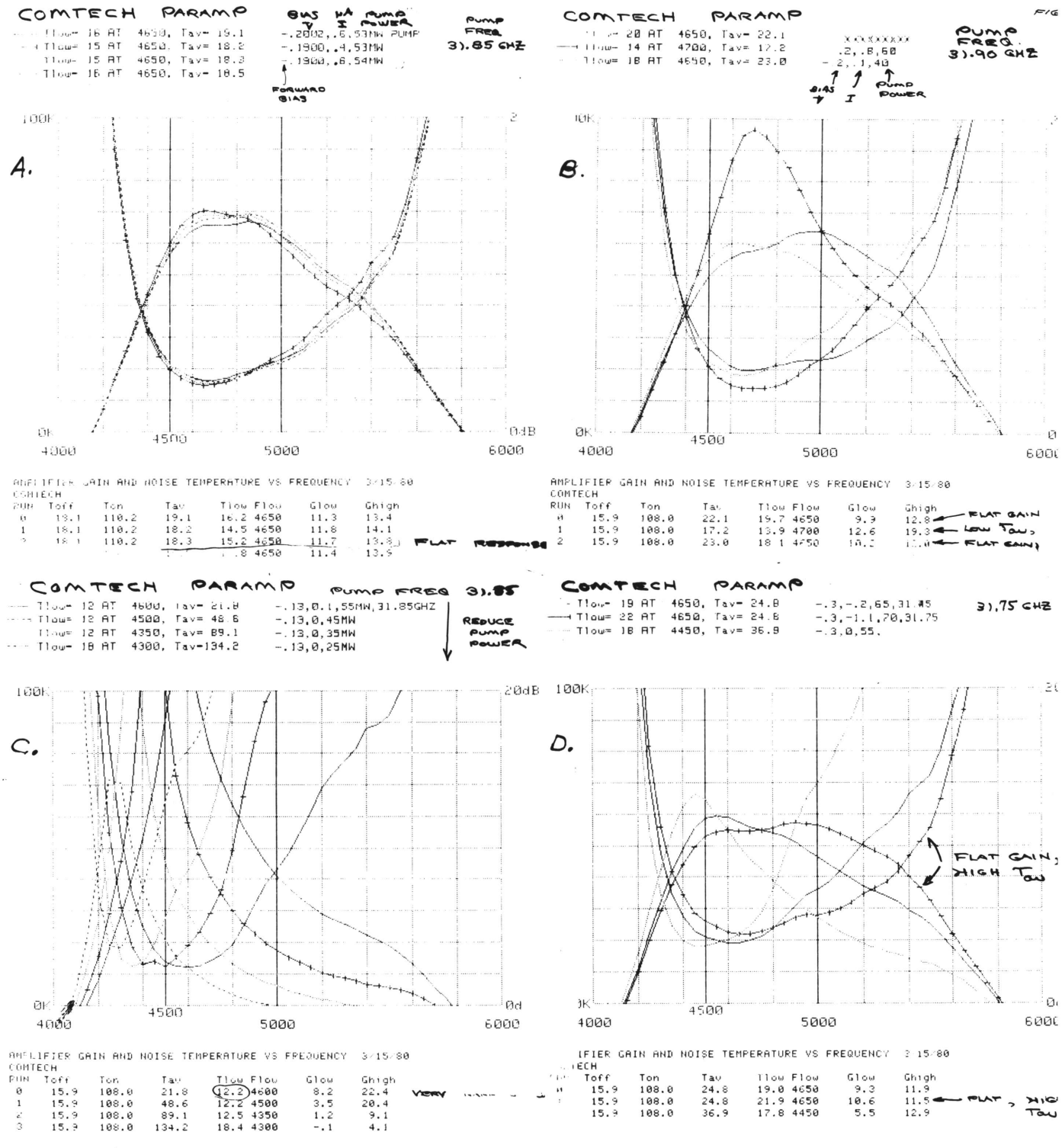

Figure 1 - Gain and noise temperature performance of Comtech paramp as a function of frequency, 4 to 6 GHz, bias voltage, pump power, and pump frequency.

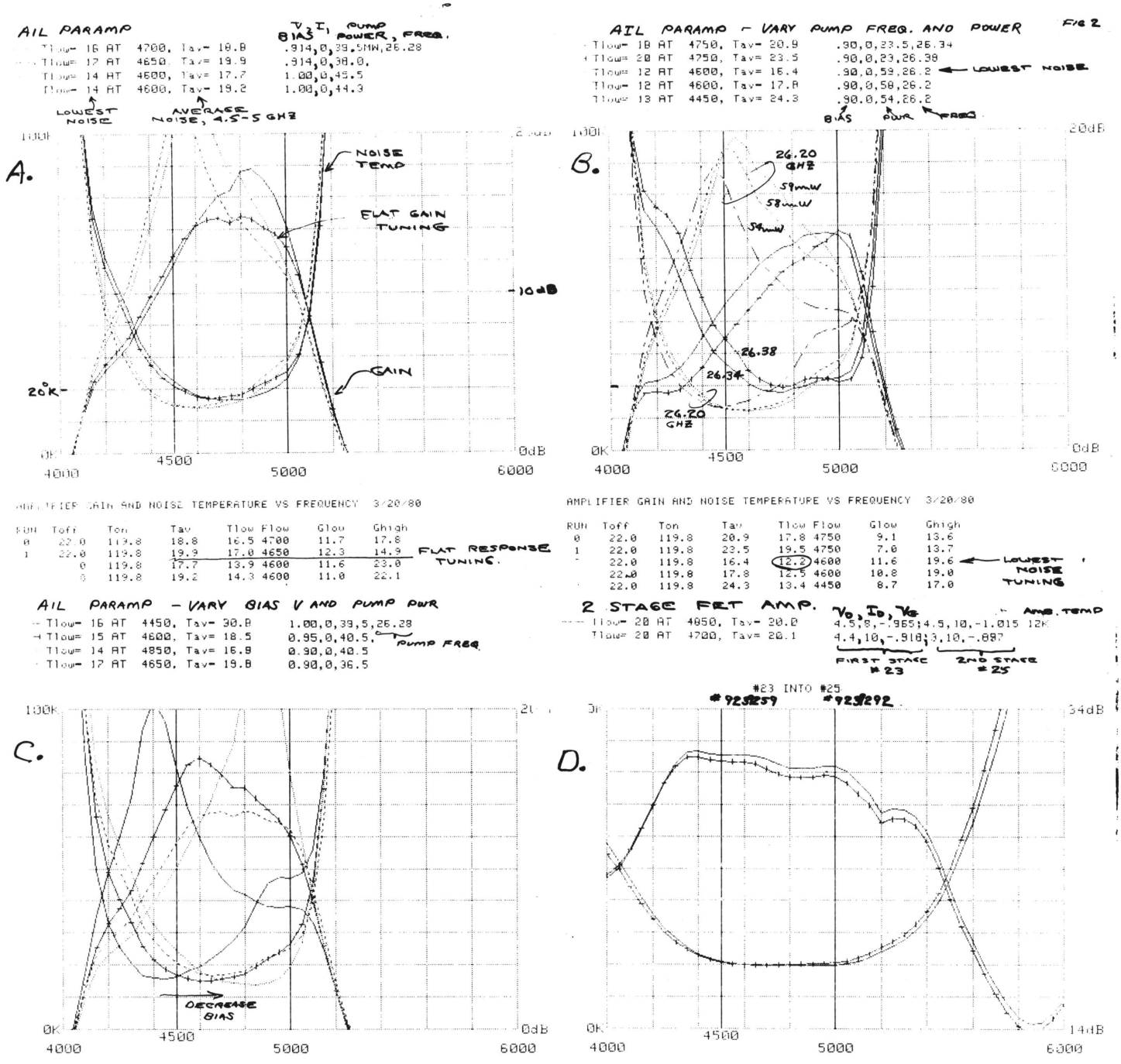

Figure 2 - Gain and noise performance of AIL paramp and NRAO 2-stage GASFET amplifier.