NATIONAL RADIO ASTRONOMY OBSERVATORY
CHARLOTTESVILLE, VIRGINIA

ELECTRONICS DIVISION INTERNAL REPORT NO. 261

TEMPERATURE COEFFICIENTS OF GAIN AND PHASE FOR VARIOUS MICROWAVE COMPONENTS

S. WEINREB AND R. HARRIS

JUNE 1986

NUMBER OF COPIES: 150

TEMPERATURE COEFFICIENTS OF GAIN AND PHASE FOR VARIOUS MICROWAVE COMPONENTS

S. Weinreb and R. Harris

The gain and phase vs. frequency curves at temperatures of approximately 25C and 55C were measured for two filters, four isolators, and five amplifiers at center frequencies of 1.5 to 23.5 GHz. A Hewlett-Packard 8510 network analyzer was used for the measurements. The devices were heated using a small temperature-controlled hot plate clamped to an aluminum plate and the device under test. A linear variation of gain and phase is assumed for the measurement temperature range. The resulting temperature coefficients are summarized in Table I and full results are presented in Figures 1-5.

It is informative to compare the phase coefficients expressed in ps (10^{-12} seconds) per °C in the last column of Table I with other coefficients and specifications. The magnitudes of the measured coefficients are of the order of .05 ps/°C and four such components in a typical front-end would give a coefficient of 0.2 ps/°C. A five-meter length of transmission line having effective length change of 20 x 10^{-6}/°C (i.e., a "phase stable" cable) would give 0.5 ps/°C. Thus, cables rather than RF components are critical to the phase-stability specification.

The Very Large Array phase stability goal was 1°/GHz over a 1,000 second period (i.e., between calibrator observations); this is 2.8 ps change in 1,000 seconds. RF component temperature control of ± 2C over 1,000 seconds (very easy) would give only ± 0.4 ps change.

The frequency standard for the Very Long Baseline array has a time stability specification of 2 ps in 1,000 seconds and 20 ps in 10,000 seconds. Thus, RF component temperature variations of ± 2C in 1,000 seconds or ± 20C in 10,000 seconds give peak phase variations only 20% of the rms phase fluctuation due to the frequency standard.

TABLE I. Summary of Results

COMPONENT	FREQ. GHZ	$\Delta G/\Delta T$ dB/°C	$\Delta\phi/\Delta T$ °/°C	$\Delta\tau/\Delta T$ ps/°C
Filter, six-pole, 570 MHz BW	1.5	< .003	+ .06	+ .11
Amplifier, 18 dB gain, Miteq	1.5	- .020	+ .03	+ .05
Filter, six-pole, 700 MHz BW	4.7	- .003	- .20	- .12
Isolator, C-band	4.7	- .001	- .06	- .04
Amplifier, 20 dB gain	4.7	- .020	- .13	- .07
Isolator, X-band	8.4	- .001	- .08	- .03
Amplifier, 17 dB, Miteq	8.4	- .016	- .16	- .05
Isolator, KU-band	14.9	< .001	- .30	- .06
Amplifier, 16 dB, Miteq	14.9	- .016	- .25	- .04
Isolator, K-band	23.5	- .003	- .15	- .02
Amplifier, 19 dB, NRAO	23.5	- .014	- .43	- .05

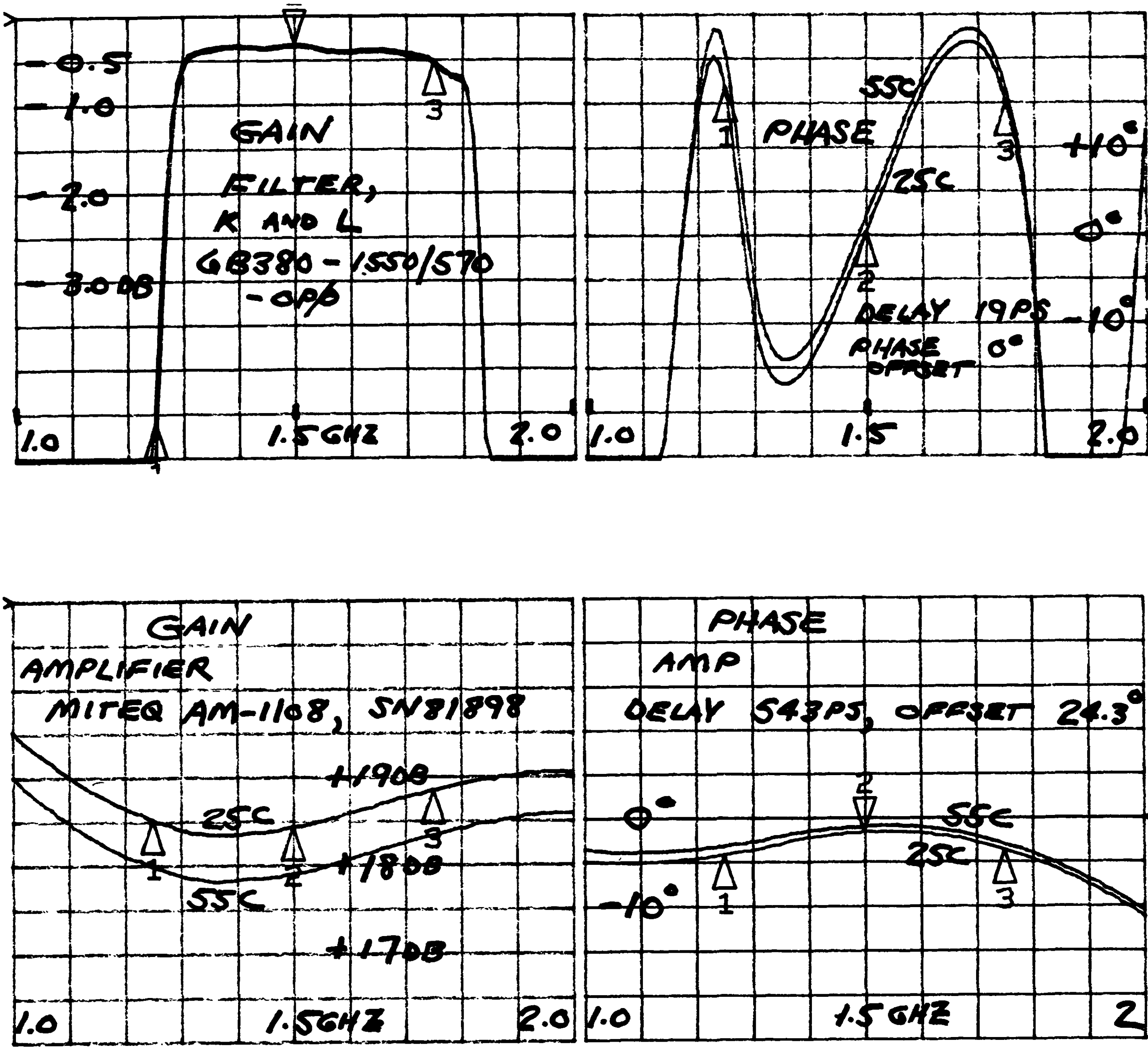

Fig. 1. Test results for L-band filter and amplifier.

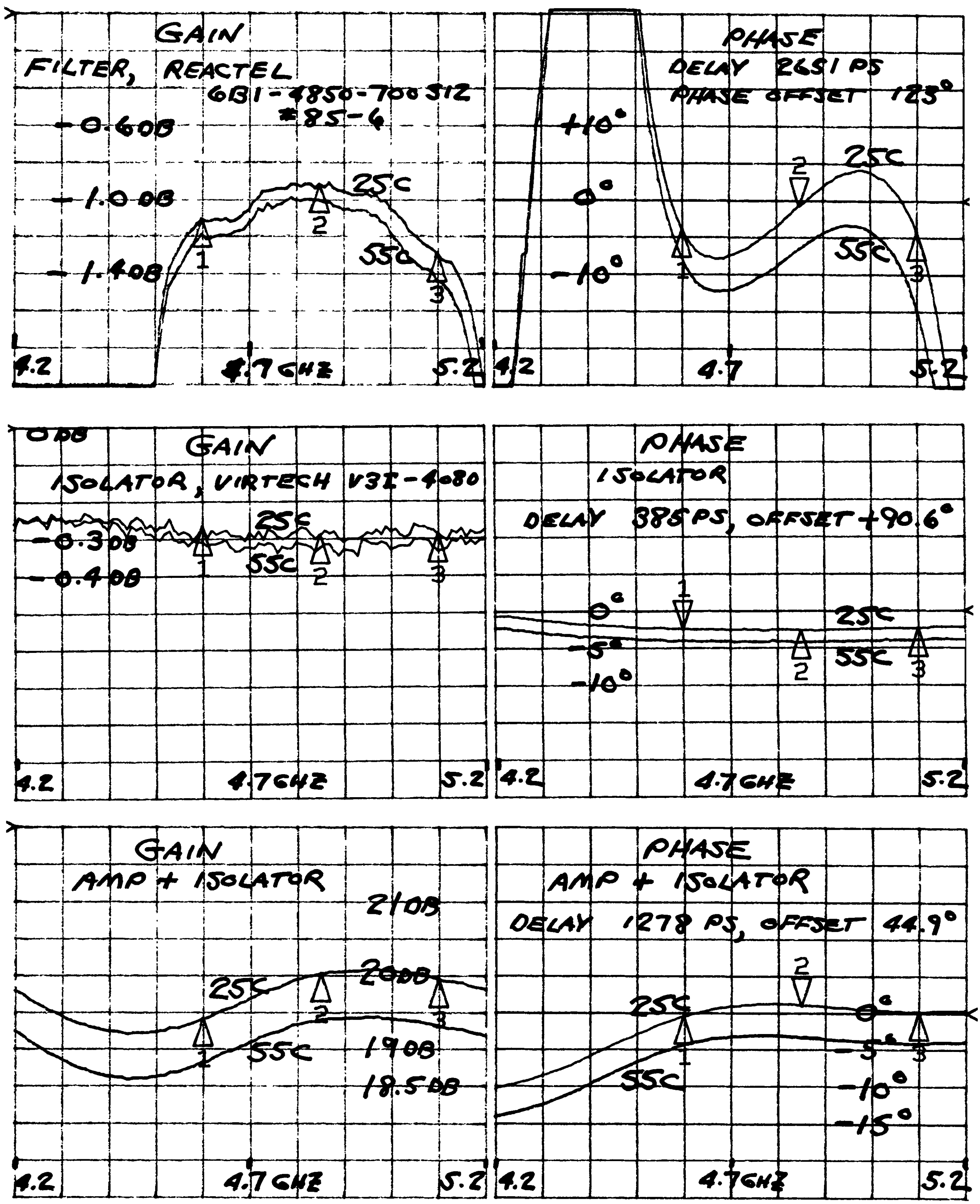

Fig. 2. Test results for C-band filter, isolator, and amplifier.

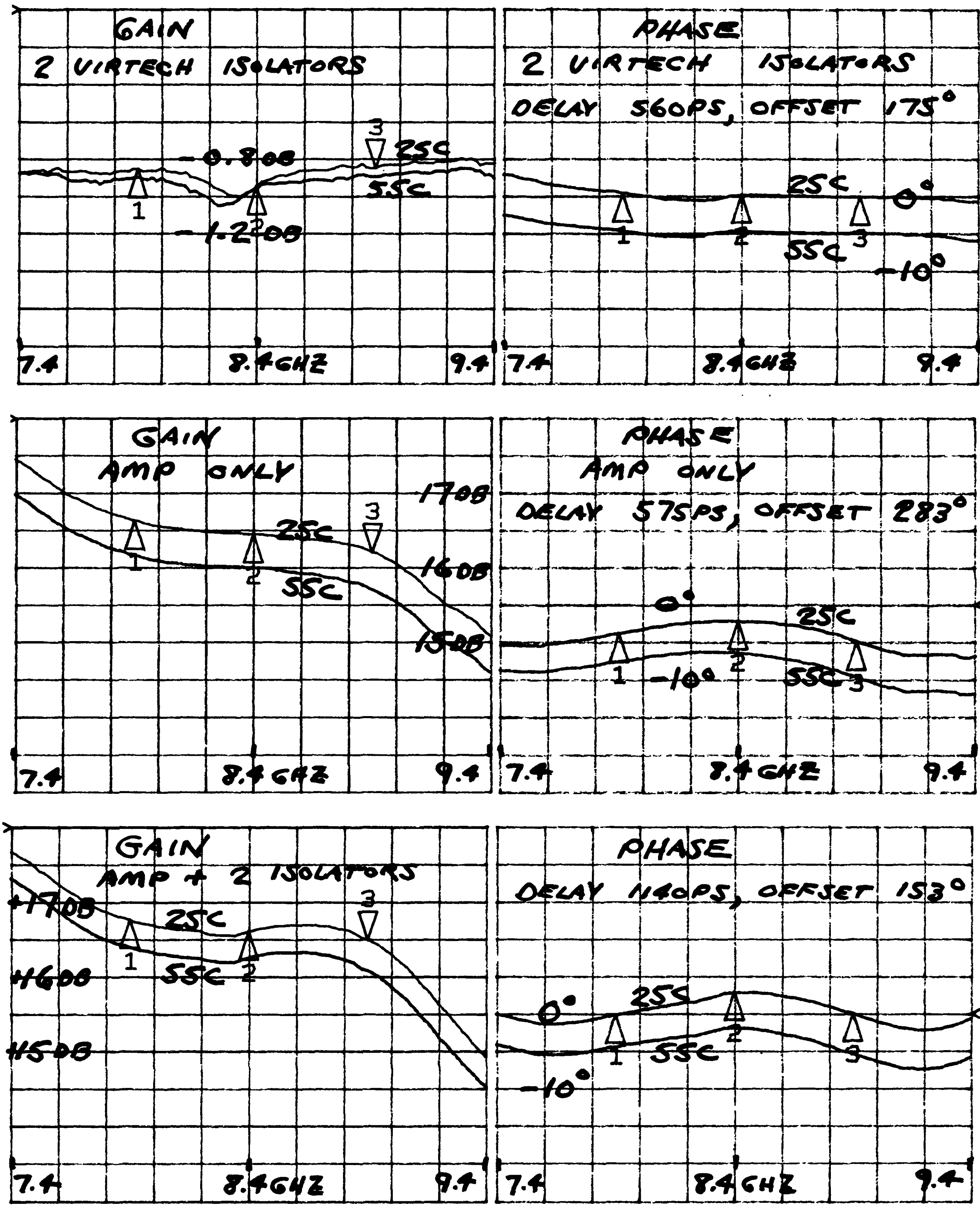

Fig. 3. Test results for X-band isolators and amplifier.

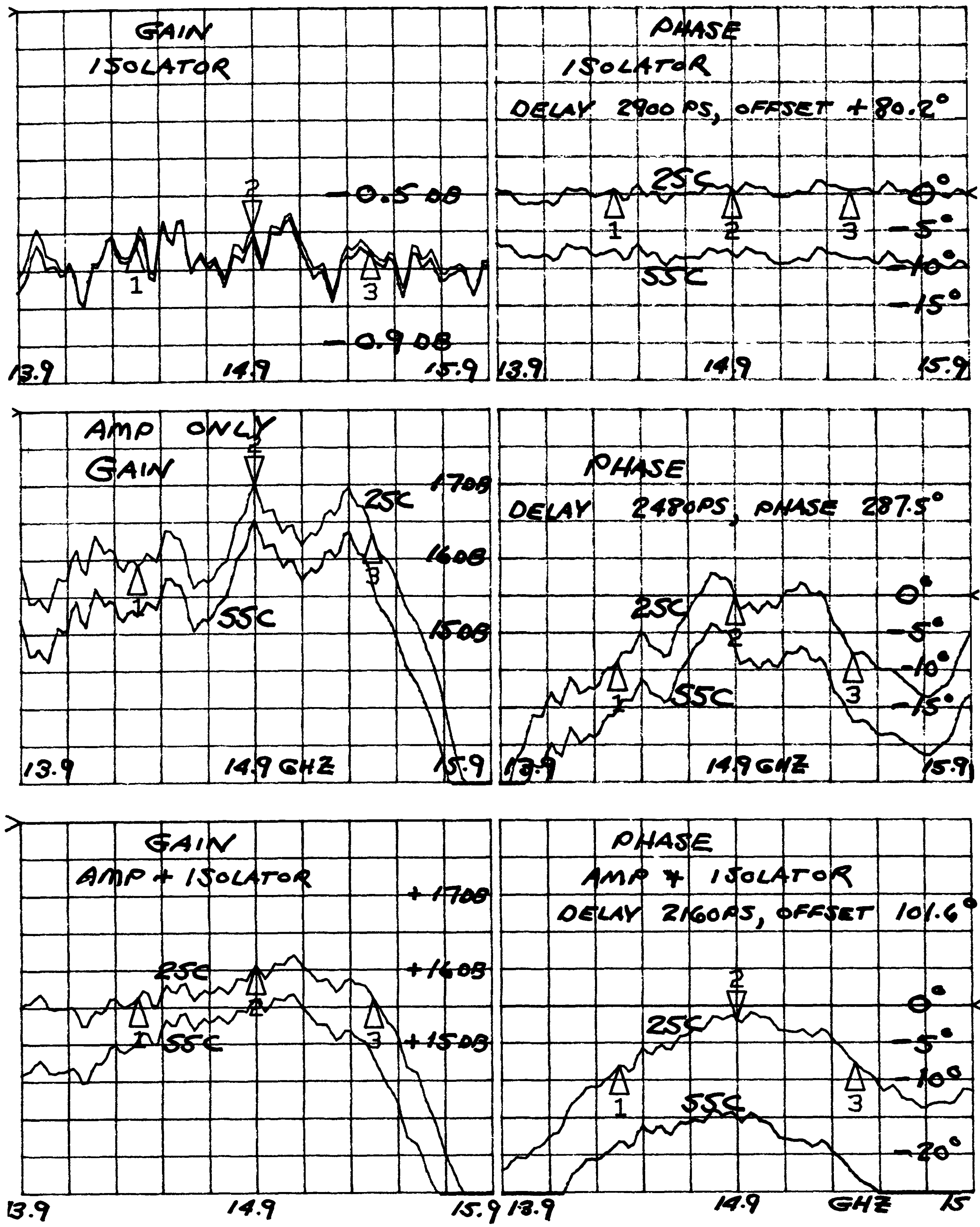

Fig. 4. Test results for KU-band isolator and amplifier.

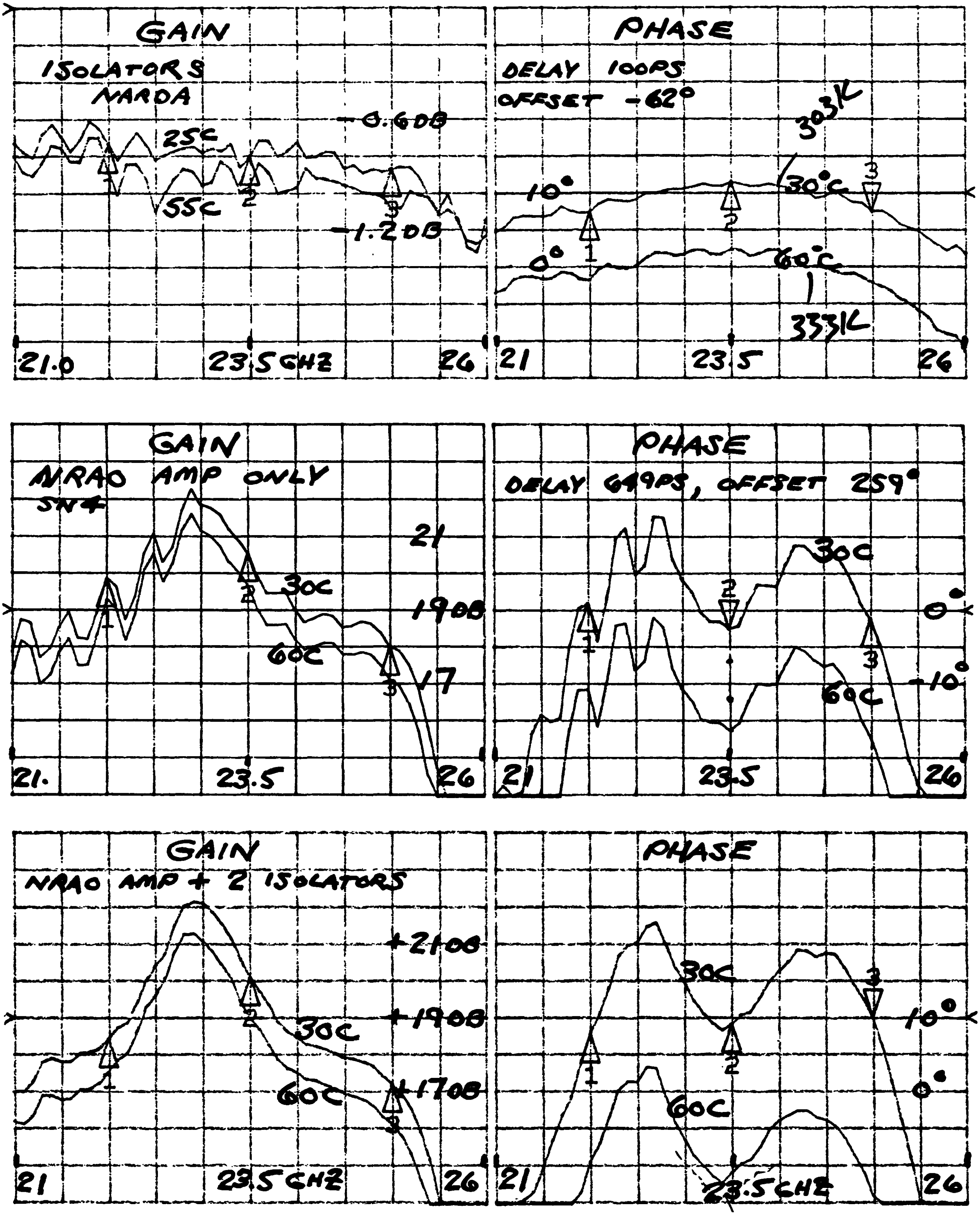

Fig. 5. Test results for K-band isolators and amplifier.