VLBA ACQUISITION MEMO #185

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To: VLBA Data Acquisition Group

From: Alan E.E. Rogers

Subject: Tests of emitter follower head pre-amplifier

Introduction

At present, both the MKIIIA and VLBA recorders use a 2N3906 transistor pre-amplifier configured as an emitter follower. The emitter follower stage is followed by another 2N3906 as a common emitter amplifier with about 30 dB voltage gain. In the MKIIIA the common emitter stage is in on the read board a few inches from the headblock assembly. The interconnection loads the emitter follower with about 10-20 pf stray capacitance which in some cases will make the emitter follower act as a Colpitt's oscillator at the head resonance. Another problem with the emitter follower in both the MKIIIA and VLBA recorders is that it results in less than optimum noise performance.

Damping the head resonance

Richard P. Ingalls devised a damping circuit to prevent the emitter follower pre-amps from oscillating - at least with the MKIII reproduce board. Recently, the damping action of this circuit had to be increased to suppress oscillations when the MKIIIA headblock assembly is connected to the K-3A reproduce electronics (K-3A is the Japanese implementation of the MKIIIA) which presents more capacitance to the emitter followers. The following results were obtained on the head resonance:

Test Condition	Height of Resonant Peak (≈11 MHz)
Normal Damping	+15 dB
With 12 pf added load	+19 dB
With ferrite bead removed	+20 dB
With 100 Ω + 470 pf damping	+ 5 dB

Figure 1 shows the emitter follower and common emitter follower circuit.

Signal to noise ratio

With the emitter follower pre-amplifier we are largely electronic noise dominated and only at frequencies above 2 MHz is any tape noise (increase in noise level when a degaussed tape is played) evident. At low frequencies the emitter follower adds 3 dB to the noise floor since at input impedances less than 300 Ω the 2N3906 puts out a constant noise voltage and both stages see a low impedance. In order to access the potential for improvement in SNR a special test was made in which the SNR was measured for one head on a particular tape, then the effective head impedance was raised by adding a 1000 pf capacitor across the head coil and the SNR again measured. The result was that at 1.3 MHz the SNR (signal to blank tape noise) increased from 35 dB to 40 dB

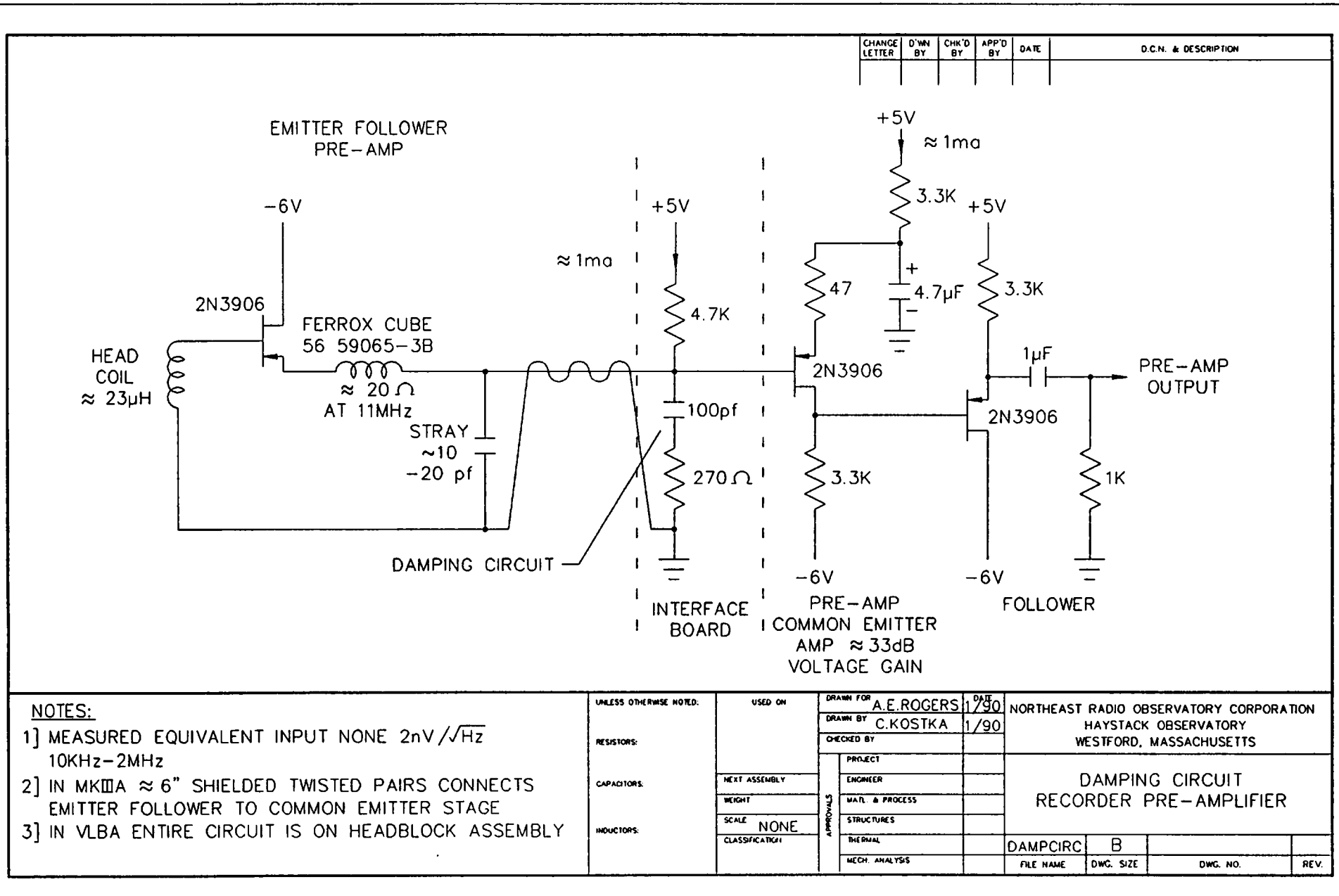
and at 1.3 MHz (the new head resonance frequency with 1000 pf) the noise level is now clearly tape noise limited since the noise floor increased by 6 dB when the blank tape was running. Figure 2 shows the signal and noise spectra with and without the 1000 pf capacitor.

Conclusion

Replacing the 2N3906 emitter follower with a 2N3906 gain stage would improve the SNR at all frequencies by at least 3 dB. A new pre-amp design perhaps including the head resonance in the bandpass (as is done in the VCR) has the potential of improving the overall SNR of the MKIIA and VLBA recorders by 5 dB - an added margin we would dearly like to achieve.

Attachment (2)
Figure 1. Damping Circuit
Figure 2. Tape Info.

Figure 1.



NOTES:

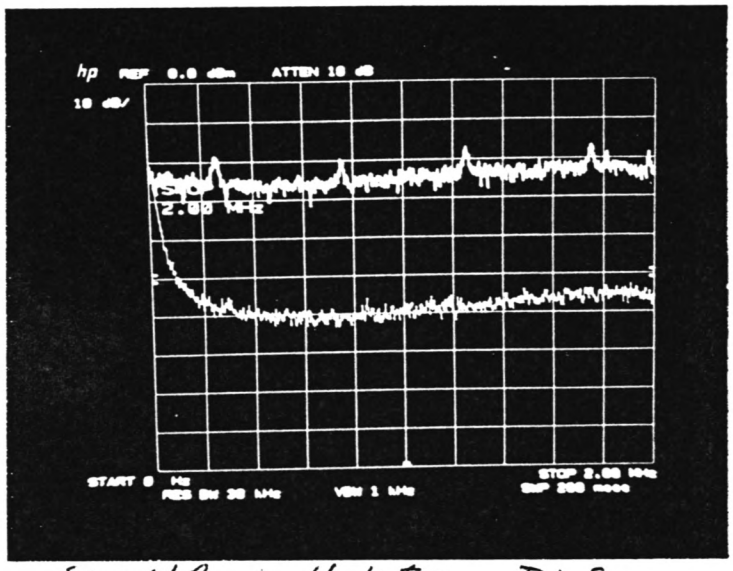
1] MEASURED EQUIVALENT INPUT NONE $2nV/\sqrt{Hz}$ 10KHz-2MHz

2] IN MKIIIA ≈ 6" SHIELDED TWISTED PAIRS CONNECTS EMITTER FOLLOWER TO COMMON EMITTER STAGE

3] IN VLBA ENTIRE CIRCUIT IS ON HEADBLOCK ASSEMBLY

UNLESS OTHERWISE NOTED:	USED ON	DRAWN FOR A.E.ROGERS	DATE 1/90	NORTHEAST RADIO OBSERVATORY CORPORATION HAYSTACK OBSERVATORY WESTFORD, MASSACHUSETTS
RESISTORS:		DRAWN BY C.KOSTKA	1/90	
CAPACITORS:	NEXT ASSEMBLY	CHECKED BY		DAMPING CIRCUIT RECORDER PRE-AMPLIFIER
INDUCTORS:	WEIGHT	APPROVALS: PROJECT, ENGINEER, MATL. & PROCESS, STRUCTURES, THERMAL, MECH. ANALYSIS		
	SCALE NONE			
	CLASSIFICATION			

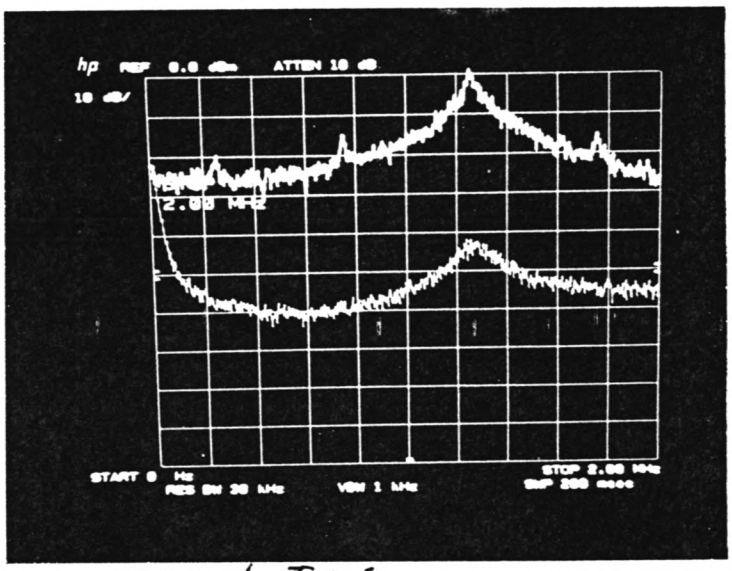
FILE NAME	DWG. SIZE	DWG. NO.	REV.
DAMPCIRC	B		



Signal / Running blank tape Tek 9 -

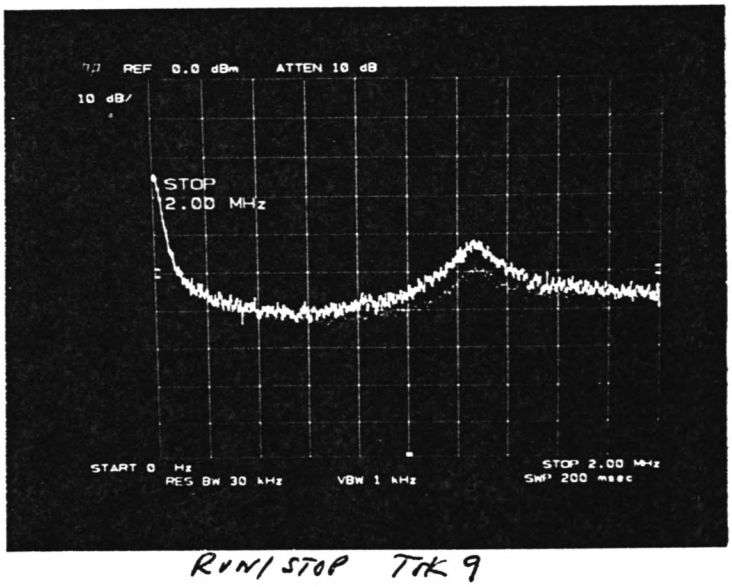
UPPER TRACE
135 IPS MKIIIA
PLAYBACK MKIII FORMAT

LOWER TRACE
135 IPS ON BLANK TAPE



1000pf Tek 9

1000 pf ADDED
ACROSS HEAD



RUN/STOP Tek 9

UPPER TRACE
135 IPS ON BLANK TAPE

LOWER TAPE STOPPED

Figure 2.