The information contained herein covers the practical application of the Adler tube since it was returned from Zenith in March where the following modifications were made.

The input and output connectors have a "c" clamp to keep the inner conductor from moving the coupling loop. Micrometers were added to give an indication of mechanical alignment of the input and output couplers. End bell clamping assembly was modified to allow more precise positioning of the R.F. capsule in the magnet. Both tubes were checked; tube 333 was erratic and had to be reconditioned. The DC block and pump balun were modified to operate above ground, and a change was made in the power supply unit here and this was noted on the schematic.

Noise temperatures measured higher than those specified by Zenith. However, their measurements were made with an automatic noise figure indicator while the ones measured here by the Y-factor method, using an Argon tube and hot-cold source.

Stability tests with tube 334-R -- noise temperature of 140 °K and 40 db gain -- show approximately .3 °K peak-to-peak noise with 15 second integration time. Changes in room temperature are quite evident on the output record. By the process of elimination, the quadrapole voltage and magnet seem quite sensitive to such changes. Pump frequency and output seem to be constant with temperature change but both are quite critical to the proper alignment for obtaining best noise temperature of the EBPA. The magnet supply uses two Kepco power supplies in series. This modification was made by D. Durand and has good stability once warm-up has been obtained.

**Variation of Adler Tube Noise Temperature With Operating Parameters**

The results of measurements made on the noise temperatures of two Adler tubes between June 21 and September 15, 1962 are shown on the accompanying graphs.

In addition, to the plotted parameters, the interception current was also monitored. It was found that lowest noise temperatures and best stability occurred
simultaneously with low interception current. The interception current is monitored at the cuccia couplers and is used as an indication of proper beam position. Any mismatch or improper voltages and currents change the beam position and therefore induces a current into the plates of the couplers. Therefore, in beginning measurements after installing the tube, the best procedure is to adjust the mechanical adjustments for minimum interception current and the electrical adjustments as per the manufacturer's specifications. This will bring the noise temperature within a range readable on the Automatic Noise Figure Indicator. Once this is achieved, the system can be adjusted for lowest noise temperature directly. It was found that it is possible to get very close to the proper mechanical adjustment, local oscillator frequency, and mixer current on the first try. Following this, lowest noise temperature is achieved by cyclic adjustment of the other electrical parameters with occasional modification of the above-mentioned three. Once a low noise temperature was achieved, it remained constant over long periods of time (days). In fact, the disturbing factors were usually external to the tube, such as equipment failures or changes in the measurement program.

As can be seen from the attached graphs, the noise temperature is extremely sensitive to changes in the tube voltages, currents, and frequencies, and the Quadrapole voltage being the most critical and Electrode B Voltage being the least critical. The critical parameters are usually adjusted very close to the brink of noise temperature degeneration. If they are set too close to the drop off point, slight instabilities, in power supply or room temperature for instance, will cause a degradation in noise temperature.

The gain vs. pump power and noise temperature vs. pump power measurements show that the Rhode and Swartz SLRD is not as stable as the FXR pump. However, one should consider the fact that during the two above-mentioned measurements the pump had to be turned off and on, and therefore the stability would not be as good.

The two tubes showed similar characteristics as far as sensitivity to parameter change, but tube 233-R gave a much lower noise temperature (100°) than did tube 234-R (140°).
Voltages and Currents for Adler Tube 234-R

These are the values which are held constant while one at a time is varied for the following curves. (Noise temperature is measured with Hot-Cold Noise Source.)

\[
\begin{align*}
A &= 25.1 \text{ V} \\
B &= 14.5 \text{ V} \\
CC &= 11.4 \text{ V} \\
Q &= 7.3 \text{ V} \\
\text{Mag} &= 1.25 \text{ A (on PS No. 1312)} \\
\text{Call} &= 29 \mu\text{A} \\
\text{Cath} &= 0+ (\text{inception current}) \\
\text{Mixer} &= 1 \text{ mA} \\
\text{L/O} &= 1451 \text{ Mc} \\
\text{Pump} &= 2832.5 \text{ Mc} \\
\text{Mag Volts} &= \text{PS 1312: 38 V} \\
\text{PS} &= 31 \text{ V} \\
\text{NT with above settings} &= 160^\circ\text{K} - 165^\circ\text{K}
\end{align*}
\]

Voltages and Currents for Adler Tube 233-R

\[
\begin{align*}
A &= 26.2 \text{ V} \\
B &= 18.0 \text{ V} \\
CC &= 8.7 \text{ V} \\
Q &= 6.4 \text{ V} \\
\text{Mag} &= 1.255 \\
\text{Call} &= 18.5 \mu\text{A} \\
\text{Cath} &= 12.6 \text{ mA} \\
\text{Inc} &= 0.5 \mu\text{A} \\
\text{Mixer} &= 1 \text{ mA} \\
\text{L/O} &= 1435 \text{ Mc} \\
\text{Pump} &= 2809.5 \text{ Mc} \\
\text{NT with above settings} &= 110^\circ\text{K} - 130^\circ\text{K}
\end{align*}
\]
The following block diagrams describe the systems used in making the various measurements. A description of components is attached.

I. **Noise Figure Measurements**

A. **Y-Factor Method (Argon)**

B. **Automatic Method**

C. **Hot-Cold, Y-Factor Method**
II. Gain Measurements

III. Coupler Alignment

A. Input coupler adjusted with voltages applied.
B. Output coupler adjusted without voltages applied.

IV. Gain Measurement as a Function of Pump Power
V. Noise Measurements as a Function of Pump Power

Components Used in Measurement

1. EBPA
2. Pump
3. Mixer-Preamplifier
4. L.O.
5. Noise Source (Argon)
6. Noise Source, Hot-Cold
7. Noise Source, Power Supply
8. Test Receiver
9. Automatic Noise Figure Indicator
10. Signal Generator
11. Isolator
12. Sweep Generator
13. Frequency Meter, Cavity
14. Scope
15. 50
16. 10 db Attenuator
17. Directional Coupler
18. Crystal Detector
19. Power Meter and Bolometer
20. Directional Coupler
21. Pump

FXR Model S772A
LEL Model LAC-3
GR Model 1218-A
AIL Model 7010
AIL Model 70
AIL Model 71
AIL Model 132
HP Model 340B
HP Model 614A
Melabs Model RL-1
HP Model 682C
FXR Model N410A
HP Model 431A
Rhode & Swartz SLR
Adler Tube #234R
Noise Temperature vs Local Oscillator Frequency
(MIXER CURRENT @ 1mA)
Adler Tube #234R
Noise Temperature
vs
Quadrupole Voltage

[Graph with quadrupole voltage on the x-axis and noise temperature on the y-axis, showing a linear relationship]
Adler Tube #234R
Noise Temperature vs Electrode B Voltage

Electrode B Voltage
Adler Tube #234 R
Noise Temperature vs Electrode A Voltage
Adler Tube #233R
Noise Temperature vs Magnet Current
(current readings taken on external B = 1 k. Farmer.)
Adler Tube #233R
Noise Temperature vs Magnet Current

(current readings taken on external O-1.5 Ammeter)