Weekly Report ('04 Winter) # 3
"RF-buffer as noise source"

Noriyasu NAKAGAWA

December 22, 2004

1 RF-buffer noise level

It is not clear how much a RF-buffer makes noise in the demodulator. In this week, I would like to begin analysis by comparing measurements and calculation.

At first, I measured them changing the RF-buffer gain 2, 4, 10, 20. From this measurement, we can know linearity of RF-buffer and the noise level. They are plotted on figure 1. The black line shows the noise level of the demodulator that is currently used for TAMA300.

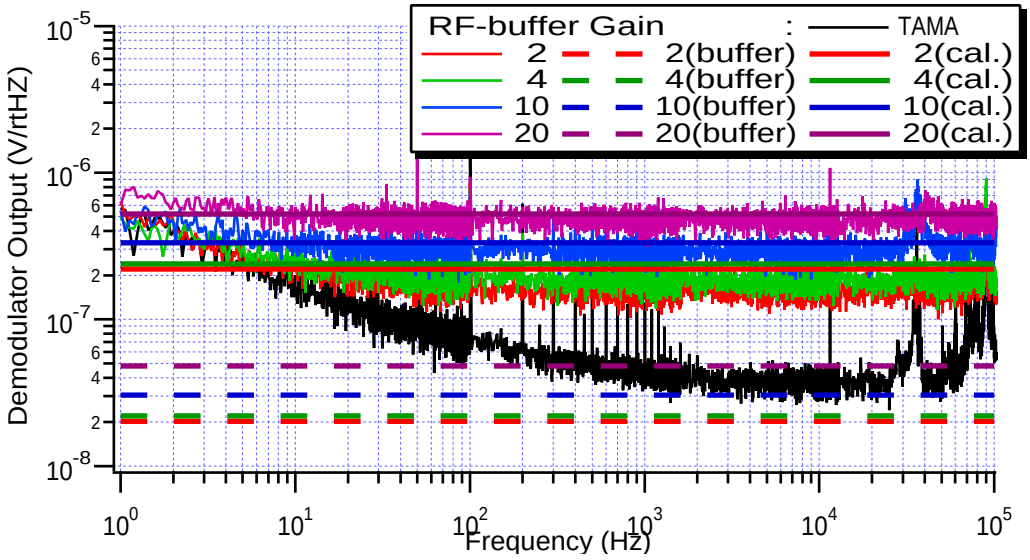

Figure 1: RF-buffer noise level

Next, I calculate them. It is necessary to know a conversion gain for the calculation. The way is like that. LO-input is a 15.235MHz sinusoidal wave, and RF-input is a 15.234MHz sinusoidal wave. I measure RF-input power and output power of the

demodulator 1kHz. The ratio as a conversion gain(C_g) is given from these powers. The calculation is like equation (1).

$$C_g = \frac{\mathrm{RF-input}}{\mathrm{Demodulator-out}} = \frac{-4.379[\mathrm{dBVrms}]}{-12.13[\mathrm{dBm}]} = \frac{0.6042[\mathrm{V}]}{0.05533[\mathrm{V}]} = 10.92 \quad (1)$$

An original buffer noise is also calculated by the equation (2). They are plotted on the figure 1 as "$\cdots$ (buffer) ".

$$e_{noise} = (1 + \frac{R_f}{R_g})\sqrt{e_n^2 + 2(i_n R_{seq}) + 4kT(2R_{seq})} \quad (2)$$

'R_f' is a feedback resistance, 'R_g' is a gain detemination resistance, 'e_n' is a input voltage noise (AD811 is 1.9nV/rtHz), and 'i_n' is a input current noise (AD811 in 20pA/rtHz) of the buffer. 'R_{seq}' is $R_f \parallel R_g$, 'k' is Boltzmann constant, and 'T' is a temperature. Output noise from a buffer of the demodulator (e_{buffer}) is given by equation (3). They are plotted on the figure 1 as "$\cdots$ (cal.) ".

$$e_{buffer} = C_g \times e_{noise} \quad (3)$$

The result of this experiment shows that the RF-buffer noise is large and this noise level agrees with calculation. Consequently, I have to replace AD811 with other buffer.

2 Demodulator using AD8099

An AD8099 is said an ultra low noise, but it manages lower power than AD811. RF power is low power so that it is enough for this demodulator. When the gain of AD8099 is 2, 'e_n' is 2.1nV/rtHz, and'i_n' is 2.6pA/rtHz. The noise level of AD8099 is about 4nV/rtHz. This noise level is 0.2 times of an AD811, and it is almost same as TAMA demodulator. I designed the demodulator with an AD8099, the circuit appears in Figure 2.

3 Next Week

- Measurement of the AD8099 demodulator.
- Measurement of the photodetector noise leve.
- (I gave updivide the ground plate.)

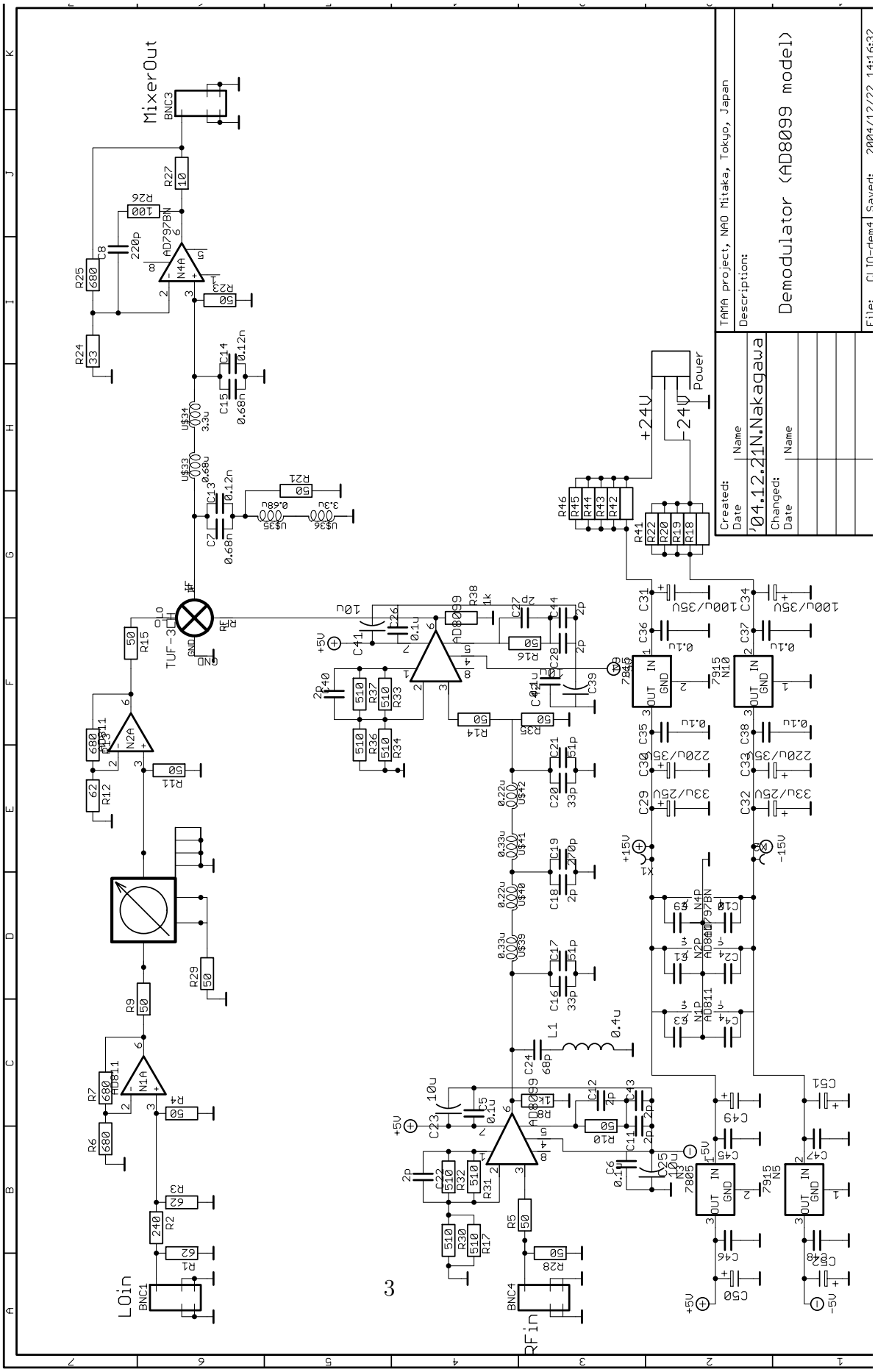

Figure 2: The circuit of the demodulator using AD8099