December 28, 2005

# Report on the LeCroy 9354AL Oscilloscope, and the ENI A-300 Amplifier

## 1. LeCroy 9354AL Oscilloscope

Display problem at the last LOI experiments was solved by changing the cpu board of the oscilloscope.

## 2. Temperature Distributions of the ENI A-300 Amplifier Chassis

We have measured the temperature distributions on the ENI chassis with no RF input. The A-300 was placed on a cart in the open, not inside an enclosed equipment rack as in the present LOI system. The thermometer is of the radiation type, but is calibrated with a thermolabel. The top (ceiling) panel showed the highest temperatures. The results are listed in Table 1.

Table 1 Temperature distributions at the top panel [degree C]

left to right looking at the front panel →

| | | | |
|---|---|---|---|
| rear ↑ | 45.9 | 39.3 | 39.5 |
| | 47.9 | 40.9 | 43.1 |
| | 51.1 | 42.5 | 49.0 |
| | 52.1 | 43.0 | 51.2 |
| | 52.2 | 43.5 | 52.3 |
| | 52.0 | 42.9 | 52.7 |
| | 51.0 | 42.3 | 53.0 |
| | 49.4 | 40.2 | 52.6 |
| | 43.3 | 38.1 | 46.1 |
| front ↓ | 38.0 | | 37.3 |

The temperatures at the center of the top panel almost agreed with those measured by M Middendorf using their A-300 in November 2005. In order to see the tendency easily, temperature mapping is shown in fig.1. Dotted lines at the top panel shows the location of the screws which fix the cooling fins inside. The cooling fan is attached at the rear panel which blows the air out.

The highest temperature, 53 ºC, is hot to touch, but not too hot as we had at the last experiment. It is then supposed that the 'too hot state' may come from the insufficient ventilation around the ENI enclosure. However, as seen in the figure, the high temperatures can be lowered if the air inlet at the side panel extends more to the front side. Such improvements will be performed before shipping to ISIS in early 2006.

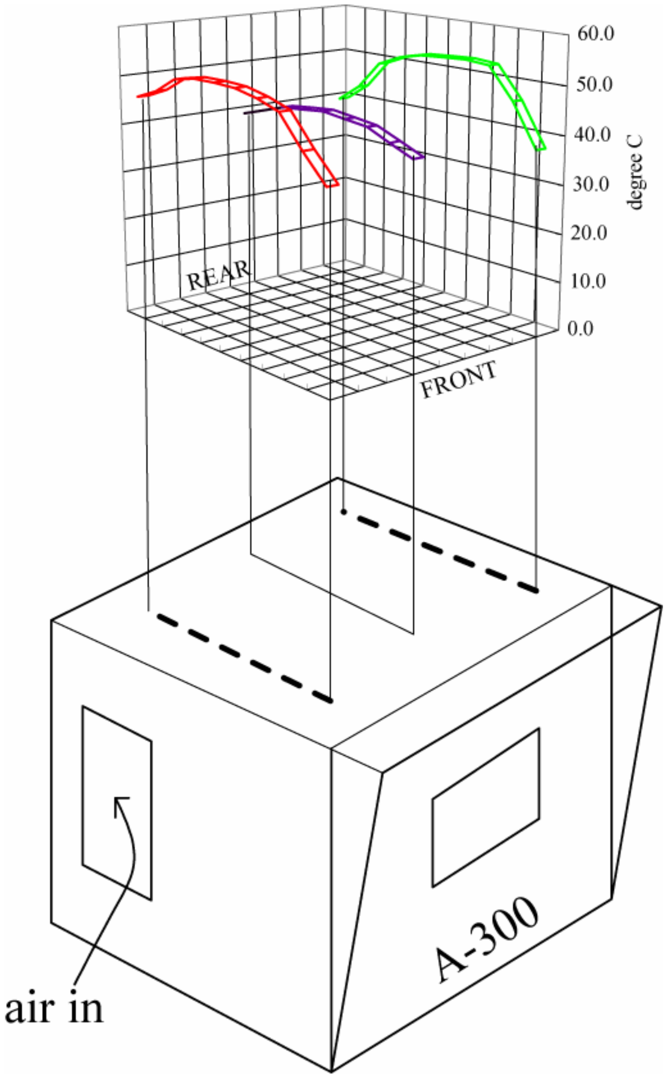


Fig.1 Temperature mapping at the top panel of the ENI A-300 amplifier. Cooling fan is attached at the rear panel, blowing the air out.

## 3. Power Test of the ENI A-300 Amplifier

The FFT spectrum of the ENI output signal was carefully investigated whether subharmonic components are included, which appeared at the driver stage and cavity gap voltages, and the cavity input current in the last LOI experiments. In the experiments, the average output power of the ENI A-300 amplifier was ~26Vrms with 54% duty factor. By considering the voltage variations during the RF ON period, the present test covered the output power level from 5 watts to 306 watts into 50Ω load, and the frequency from 1.3 MHz to 6.0 MHz. However, no subharmonics were observed. The power gain of the ENI amplifier was also derived, resulting in 56 ~ 52dB: the specification is 55dB by the manual.

### 3.1 Experimental setup

December 28, 2005

In fig. 2, schematic of the experimental setup is shown. The function generator, Kikusui FG4500A produces RF signals at fixed frequency and amplitude with cw mode. The voltage across the 50Ω load is fed into the LeCroy 9354AL oscilloscope where the FFT analysis is performed: frequency resolution is less than 100KHz, and the Nyquist frequency higher than 250MHz.

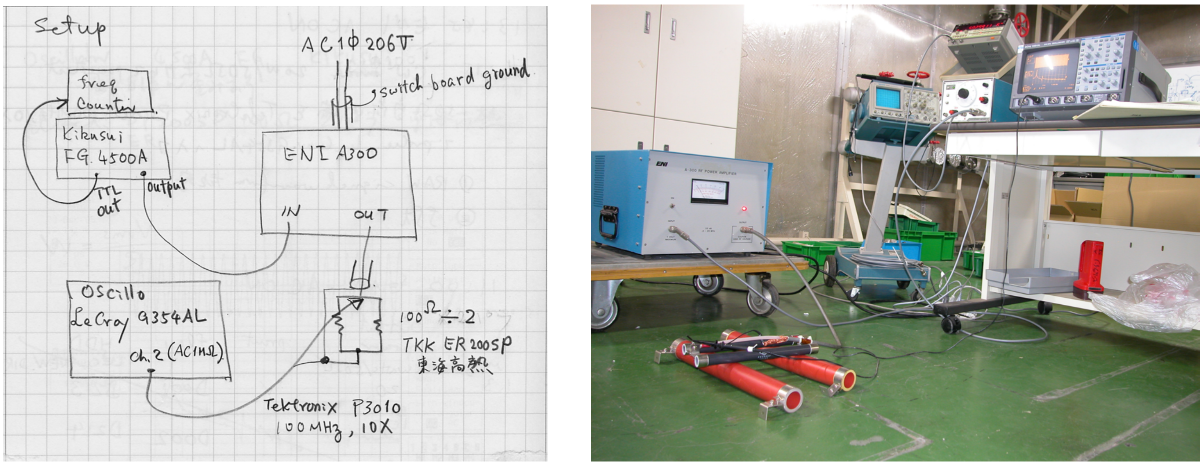


Fig. 2 Setup

3.2 Power test

The results of FFT analysis are given in fig. 3. No subharmonic components are seen at each frequency and power level. Higher harmonic components, however, can be seen. As shown in section 3.3 these come from the input signal, not from the ENI non-linear response.

3.3 Power gain

By measuring the input and output power spectrum of the fundamental frequency, power gain of the ENI amplifier was derived. As for input power measurements, the output of the Kikusui FG4500A was directly fed into the 50Ω load. The spectra are shown in Fig. 4, and the power gain is listed in Table 2. It is seen that the higher harmonics in the ENI output come from the function generator.

Table 2 Power gain of the ENI A-300 at 4MHz.

| ENI output power [watts/50Ω] | input power [dBm] | output power [dBm] | power gain [dB] |
|---|---|---|---|
| 5 | -17.6 | 38.5 | 56.1 |
| 25 | -11.8 | 43.8 | 55.6 |
| 50 | -9.0 | 46.4 | 55.4 |
| 100 | -6.1 | 49.1 | 55.2 |
| 306 | -1.4 | 50.9 | 52.2 |

(*Y Irie*)

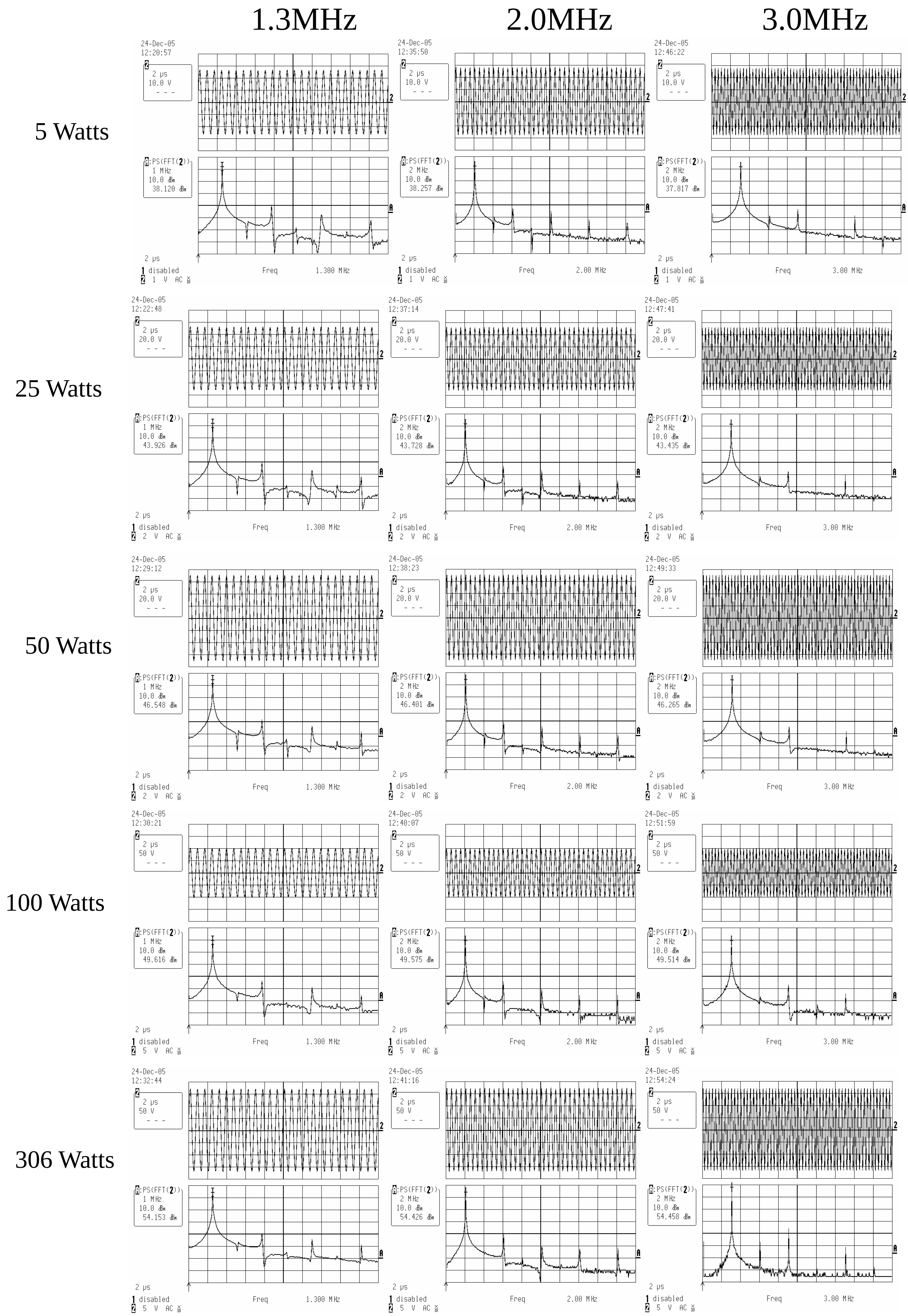


Fig. 3 Power spectra of the ENI A300 amplifier output

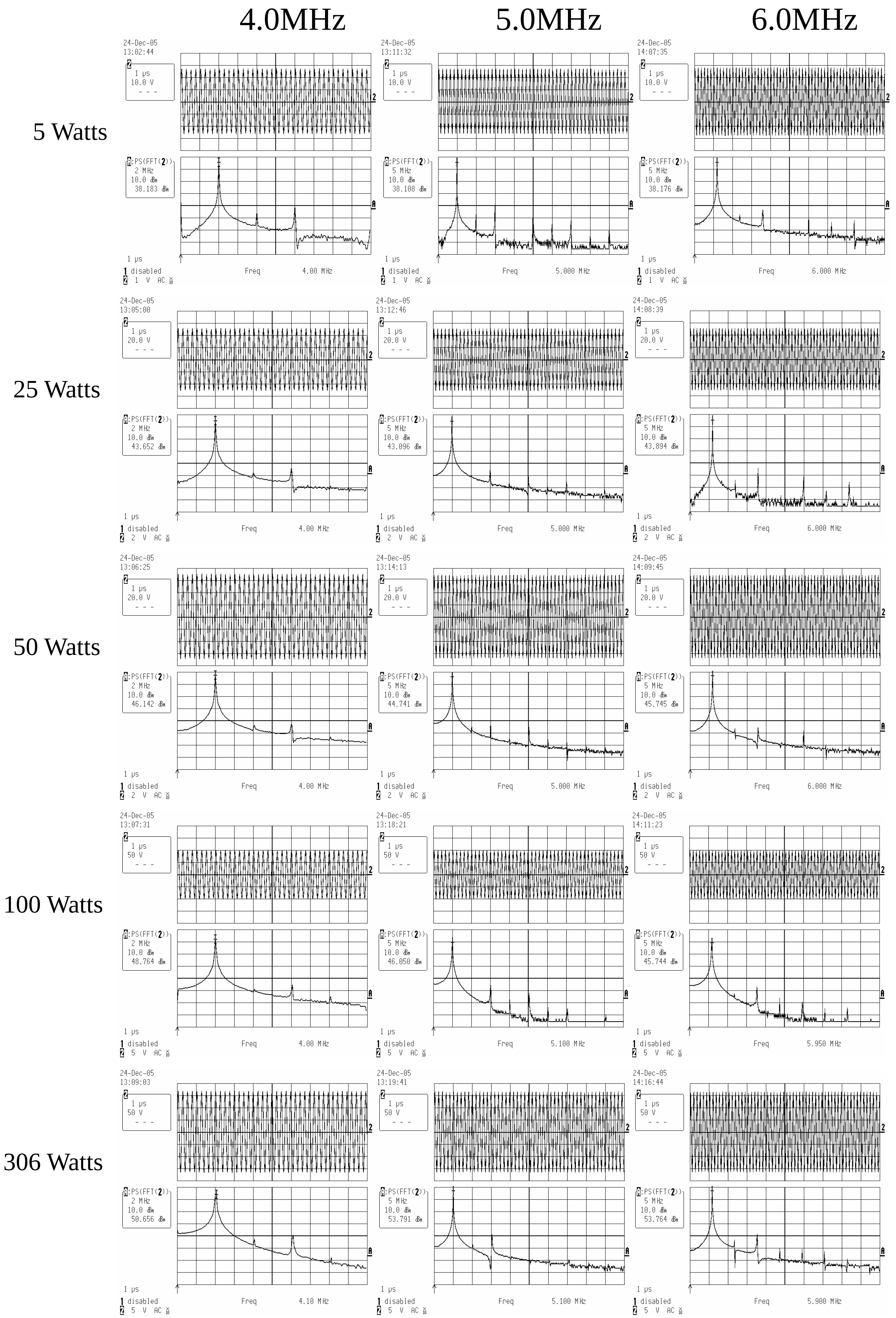


Fig. 3    Power spectra of the ENI A300 amplifier output

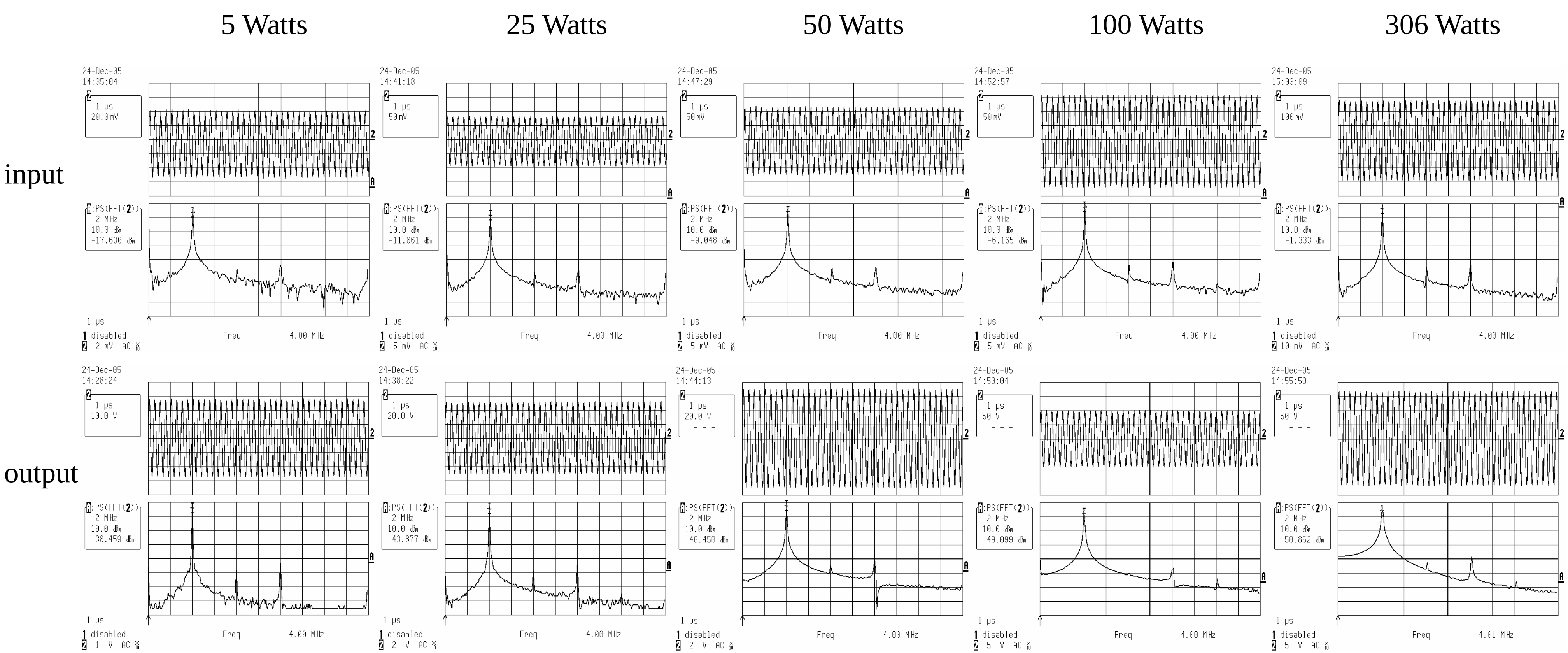


Fig.4 Comparison of ENI input/output signal at 4.0MHz