

JLH-69 amplifier option in inverting connection

The idea from [1] was used as a prototype of the amplifier. To eliminate the charge of the output capacitor at the moment of power-up, it was decided to use a source with an artificial midpoint, fig. 1.

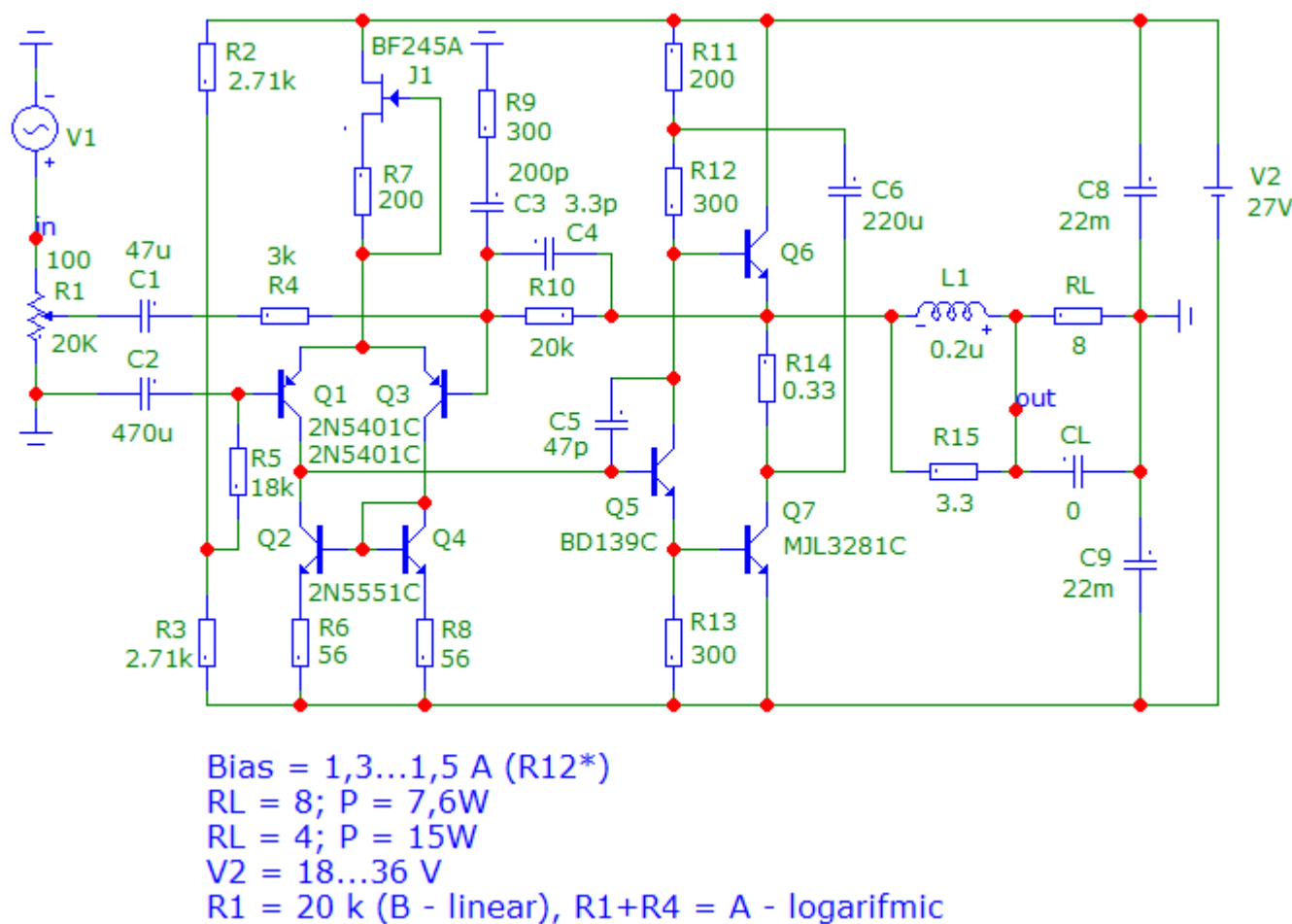


Fig. 1

The use of a differential stage with a load in the form of a current mirror makes it possible to more effectively close the transistor Q5 and thereby improve the opening of the transistor Q6.

In order to improve the SRPP (+) parameter, the current-setting resistor of the differential stage is replaced by a current source (generator) based on a JFET- transistor. The current is set by resistor R7 within 6 ... 7 mA. Capacitor C1 must be non-polar, or composed of two back-to-back polar capacitors. In parallel, it is desirable to include a film capacitor with a capacity of 1 ... 3 microfarads. The quiescent current (bias) in the range of 1.3 ... 1.5 A is set with a resistor R12.

The Bode diagram is shown in fig. 2.

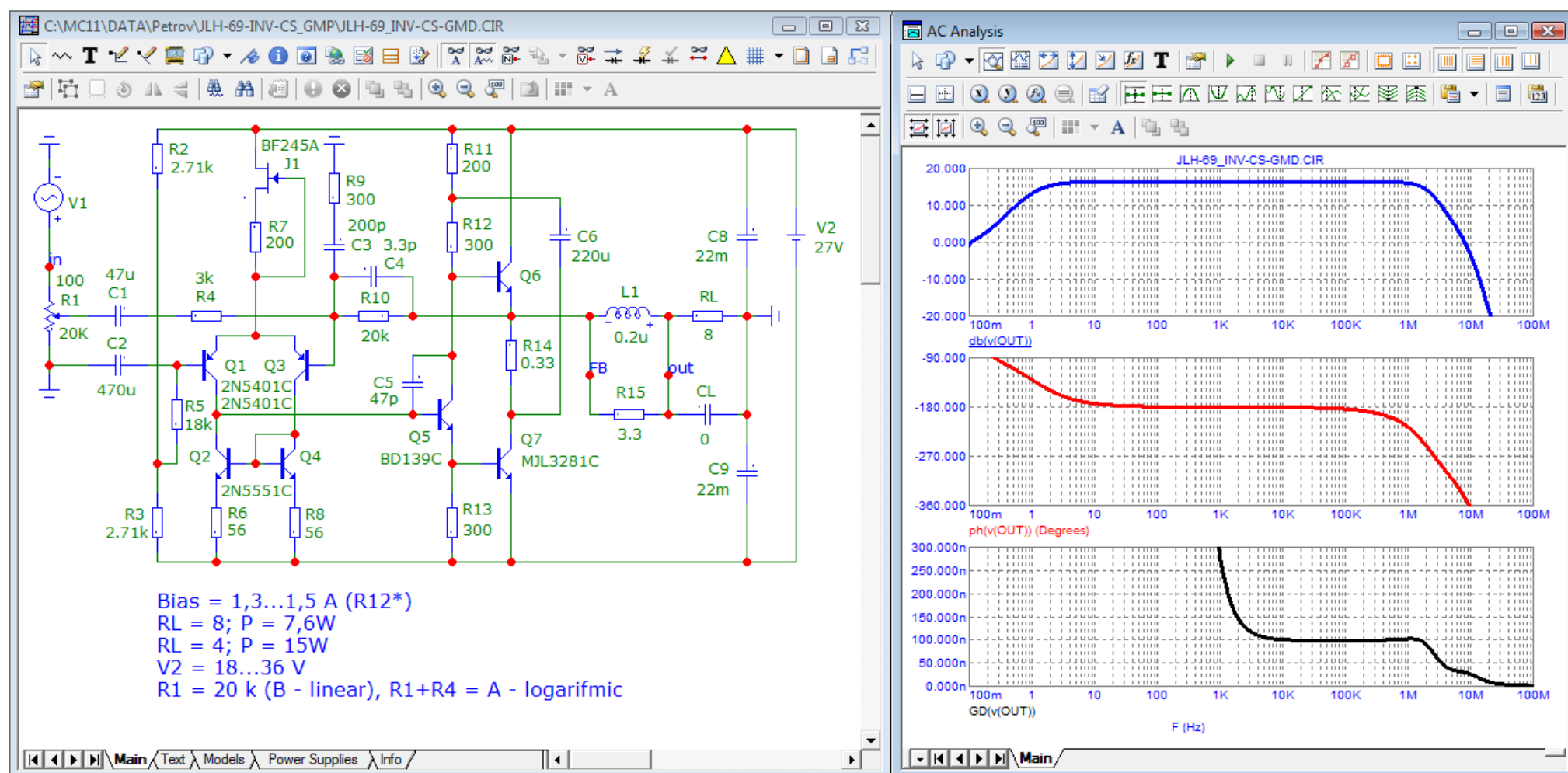


Fig. 2

It can be seen from the Bode diagram that the signal propagation delay time (time Propagation Delay) or in another group delay in the RF region is 100 ns and is almost constant up to almost 2 MHz. Then comes a gradual decline. Let's take a graph of the loop gain, fig. 3.

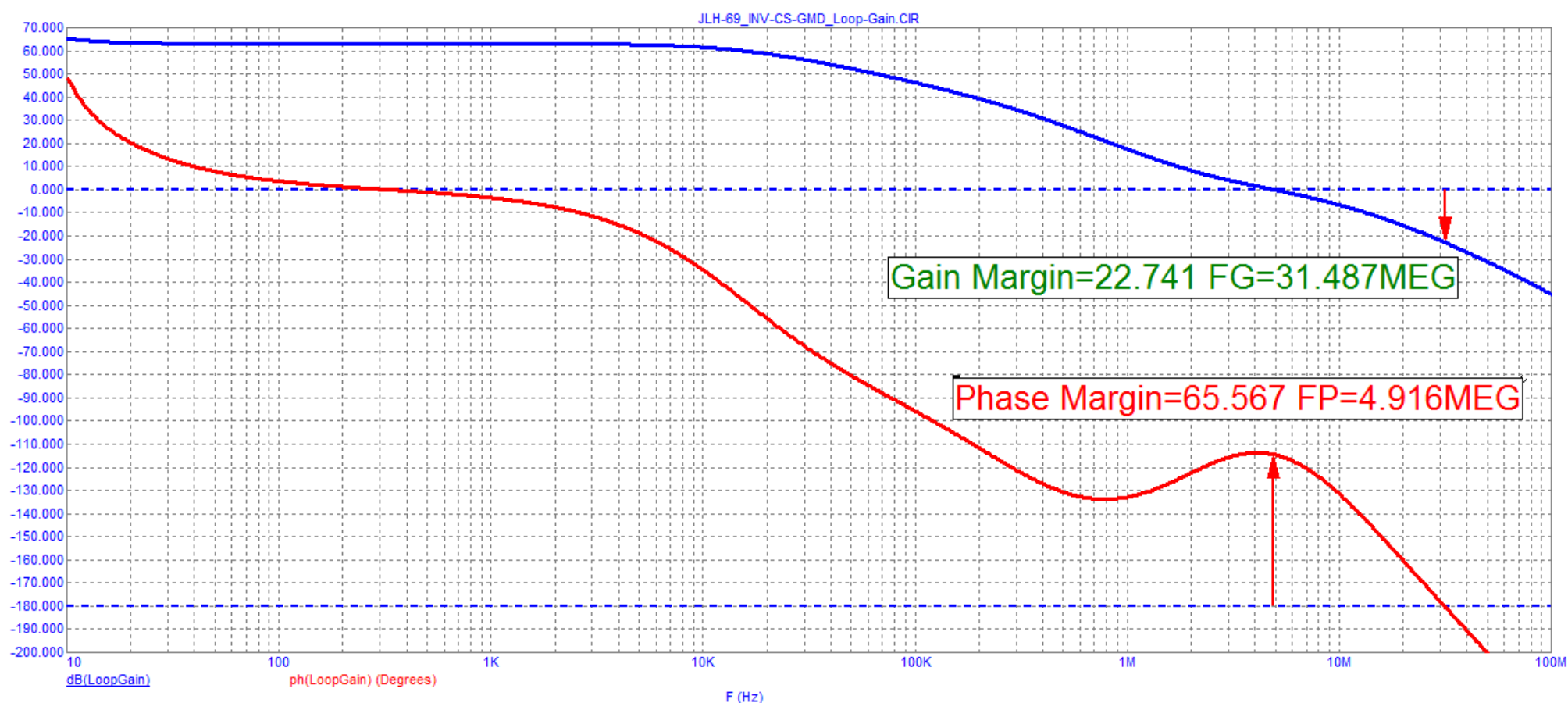


Fig. 3

Loop gain over the entire audio range of at least 60 dB. Thanks to the differential stage, the loop gain is increased by more than 30 dB (30 times). The phase margin is 65 degrees, and the gain margin is more than 22 dB. The constancy of the loop gain also guarantees the constancy of the output impedance.

Let us measure the distortion spectrum at a frequency of 20 kHz, fig. 4

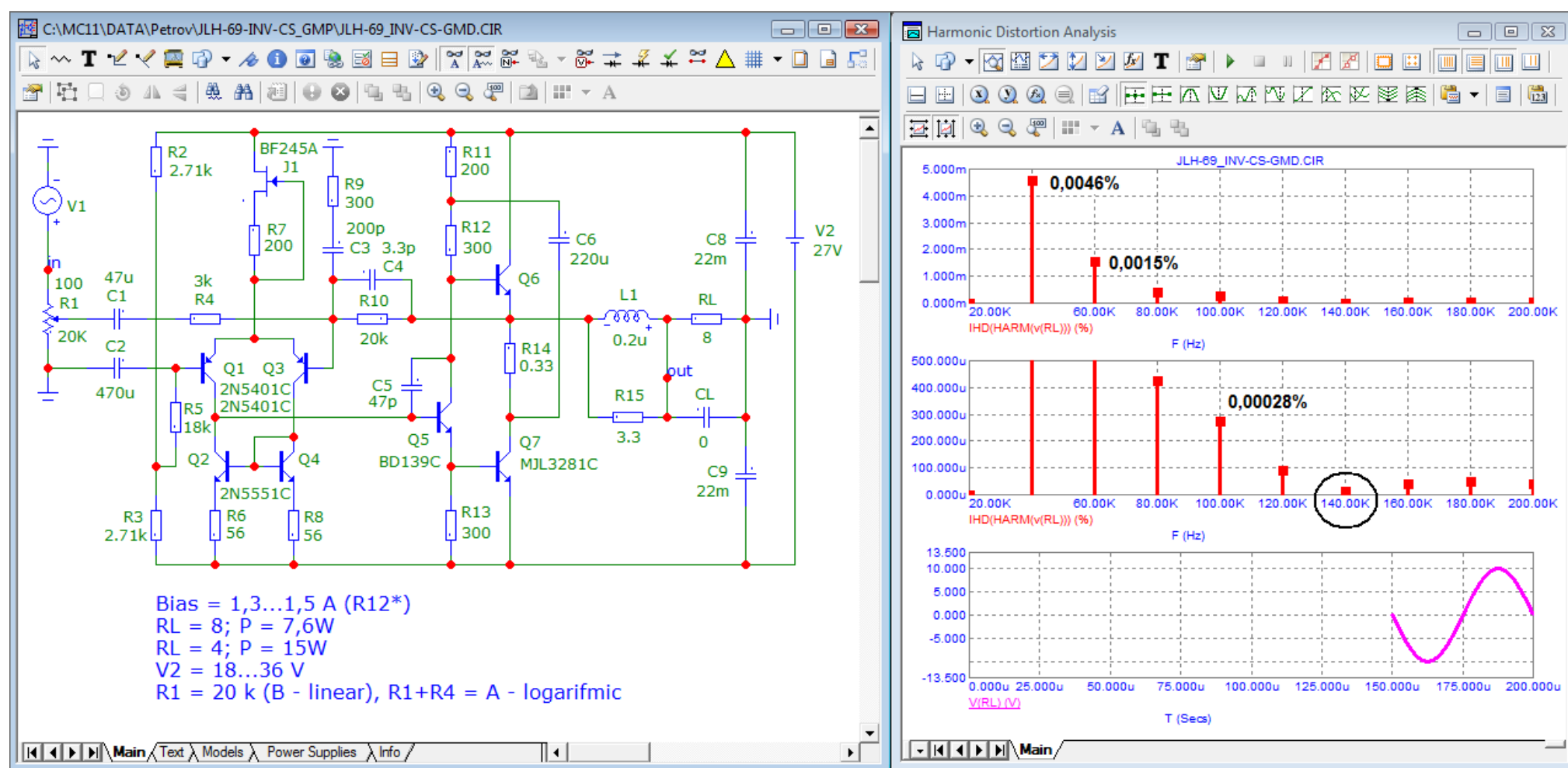


Fig. 4

It can be seen from the test that the spectrum is short, falling, in the spectrum there is mainly one 2nd harmonic. The fifth harmonic has a level of less than 0.0003%, and the 7th and 9th harmonics are negligible.

Let us measure the distortion spectrum at an output power of 1 watt, fig. 5

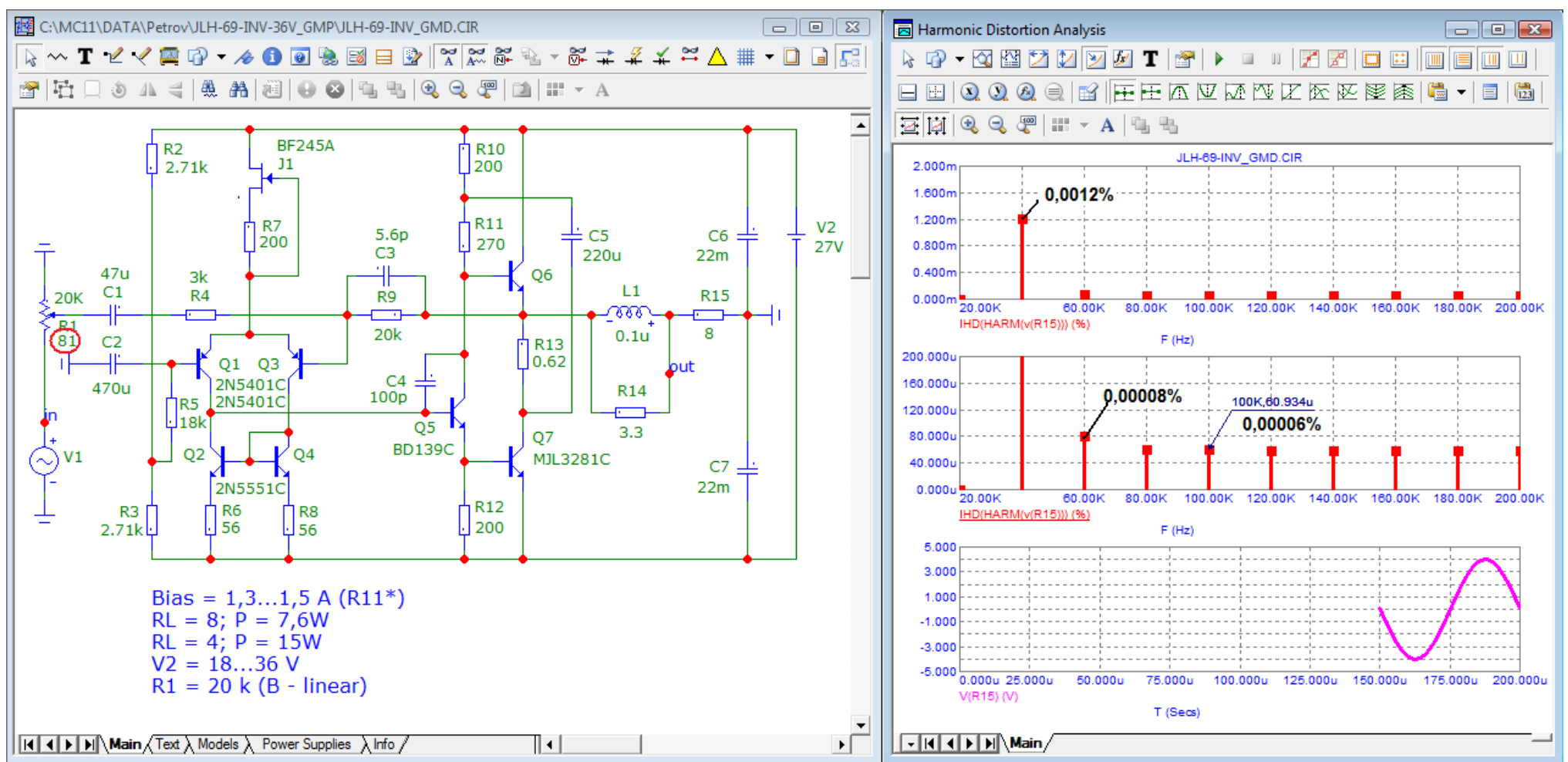


Fig. 5

The decrease in distortion at low volume is facilitated by an increase in the depth of the NFB due to an increase in the resistance of the signal source.

Let us measure the distortion at a frequency of 10 kHz using a notch filter, fig. 6

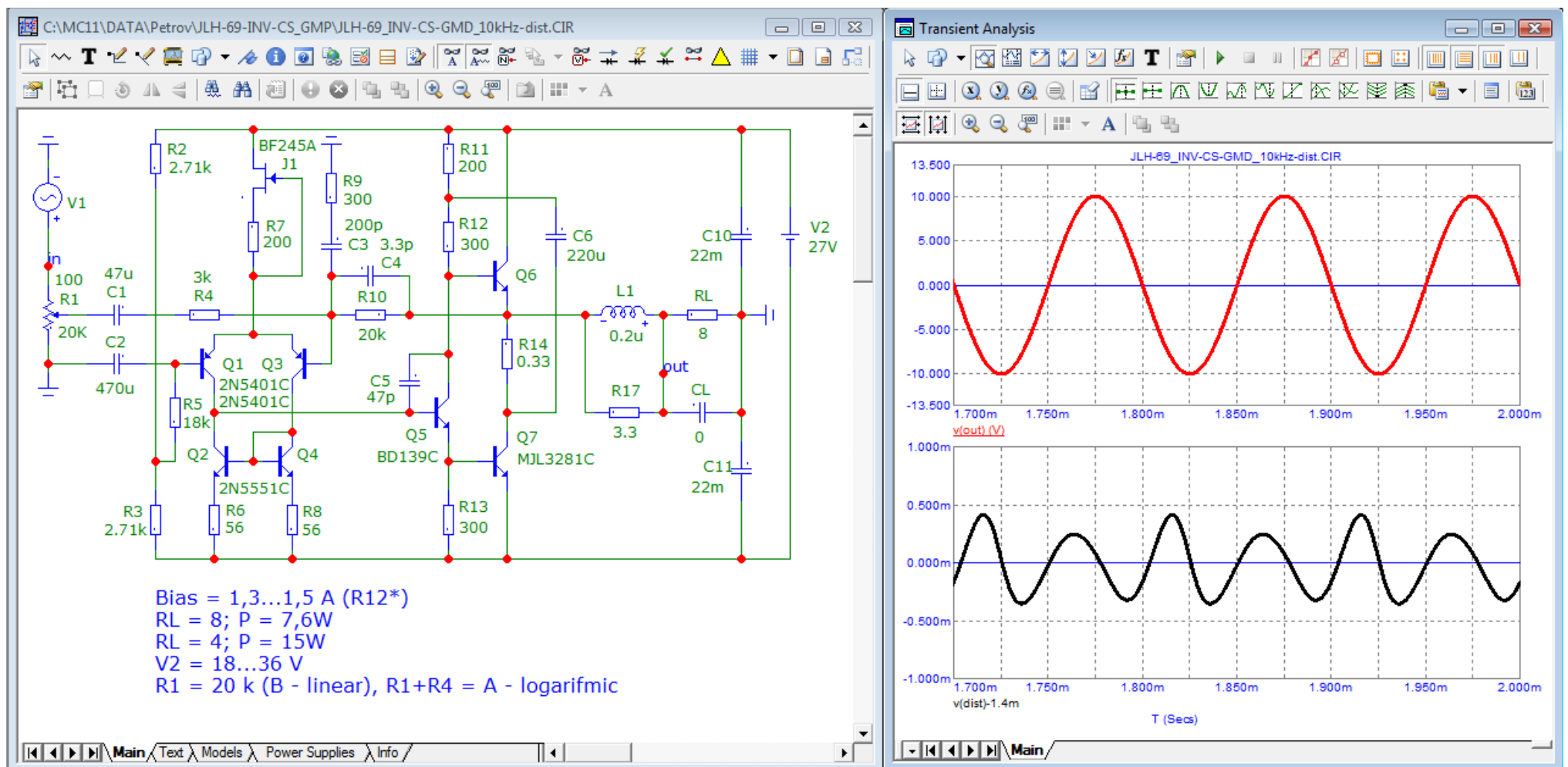


Fig. 6

The selection of distortion products using a notch filter also confirms that there is mainly one 2nd harmonic in the spectrum with a level of about 0.3 mV, which is 0.00003% of the level of 10 V. The 1.4 mV offset that occurs at the output is taken into account by subtracting this constant component from the distortion products.

We will measure vector errors, as well as all types of distortions using the compensation method, fig. 7

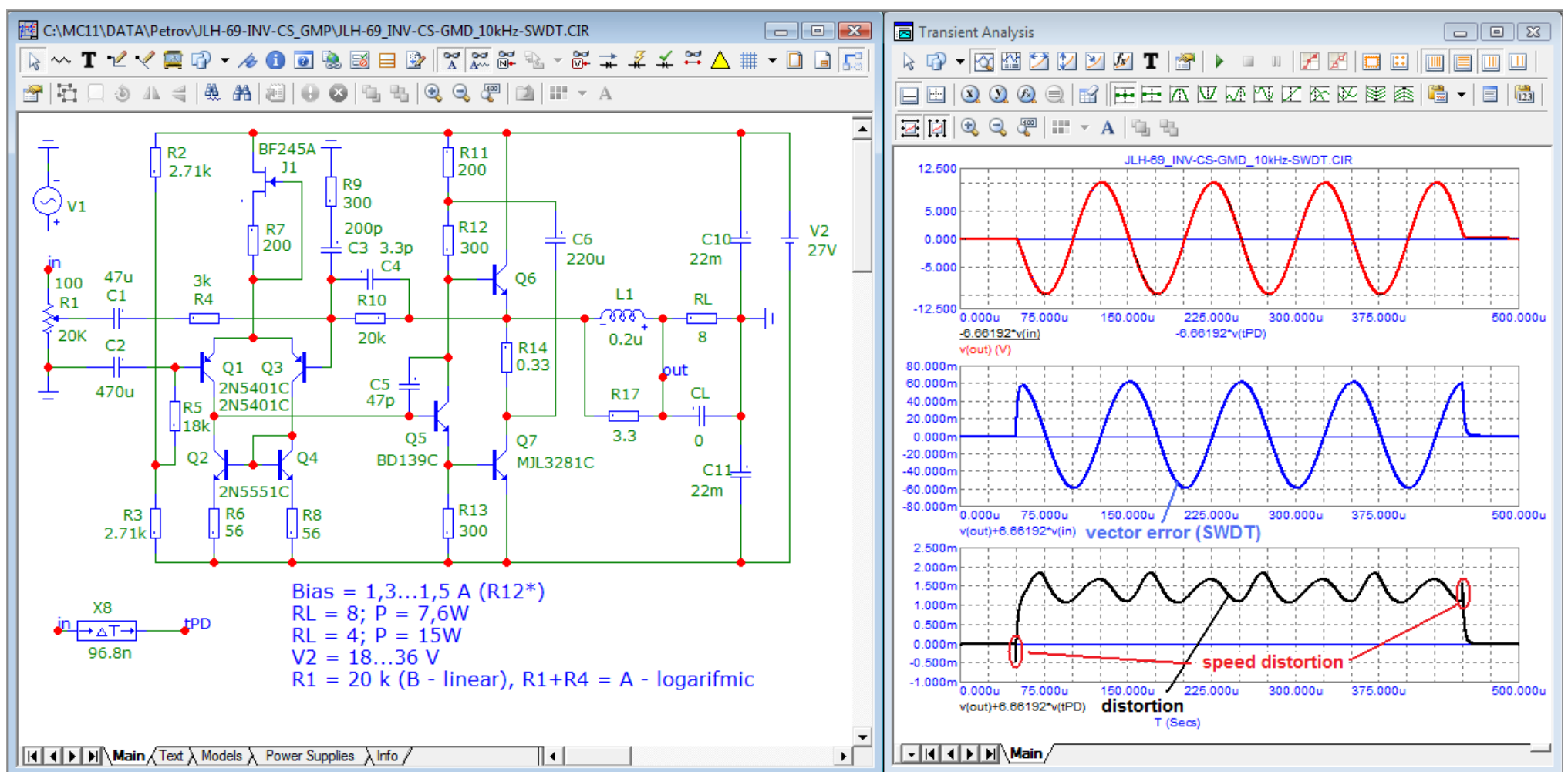


Fig. 7

Measurement of distortions by the compensation method gives the same amplitude and shape of distortion products in the steady state as in measurements with a notch filter (Fig. 6). The distortion products also have an offset of approximately 1.4 mV.

Let's measure intermodulation distortions, fig. 8

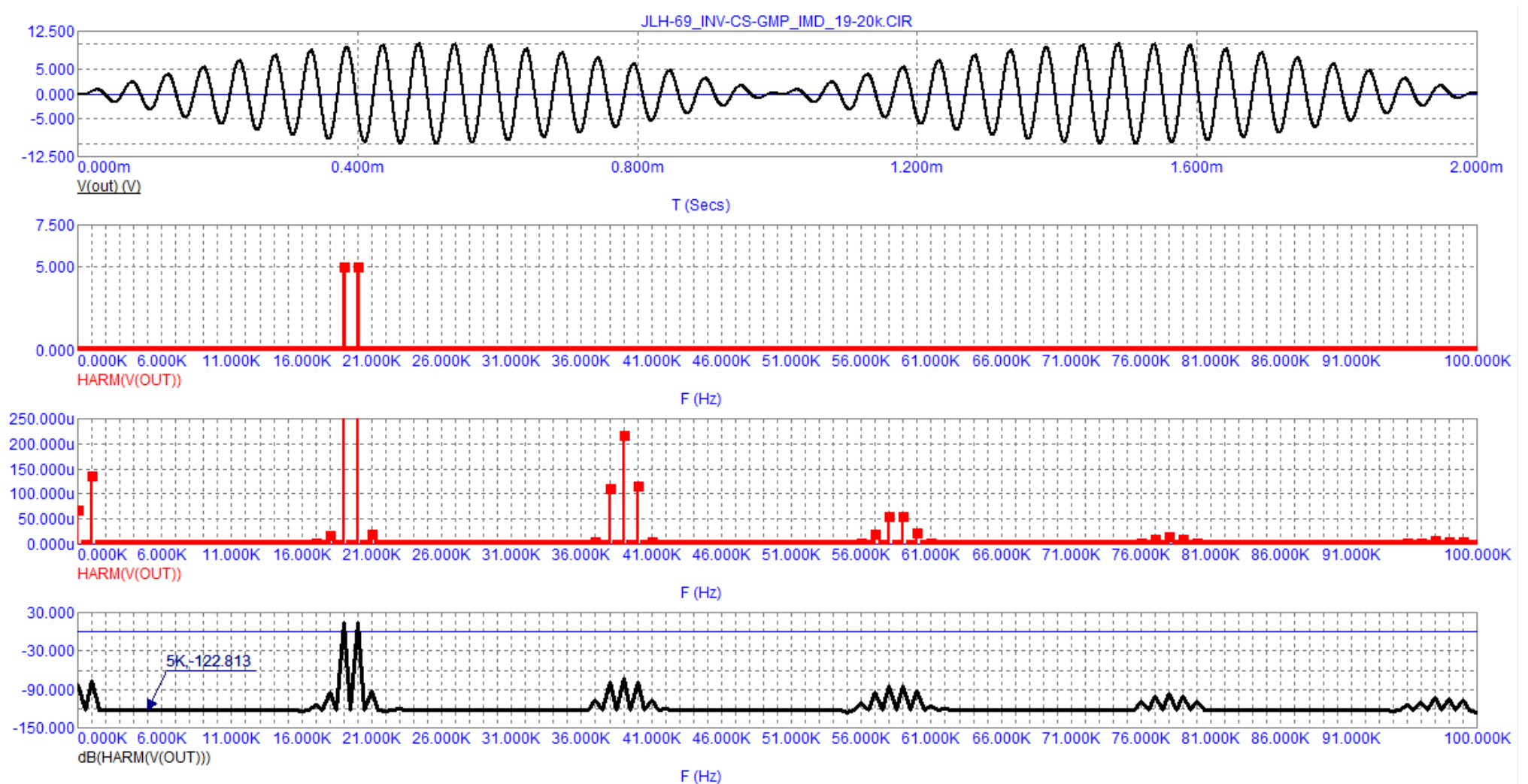


Fig. 8

The test shows that the level of the noise stand in the sound band is below -120 dB.

Let's check the performance of the amplifier at a frequency of 400 kHz, fig. 9

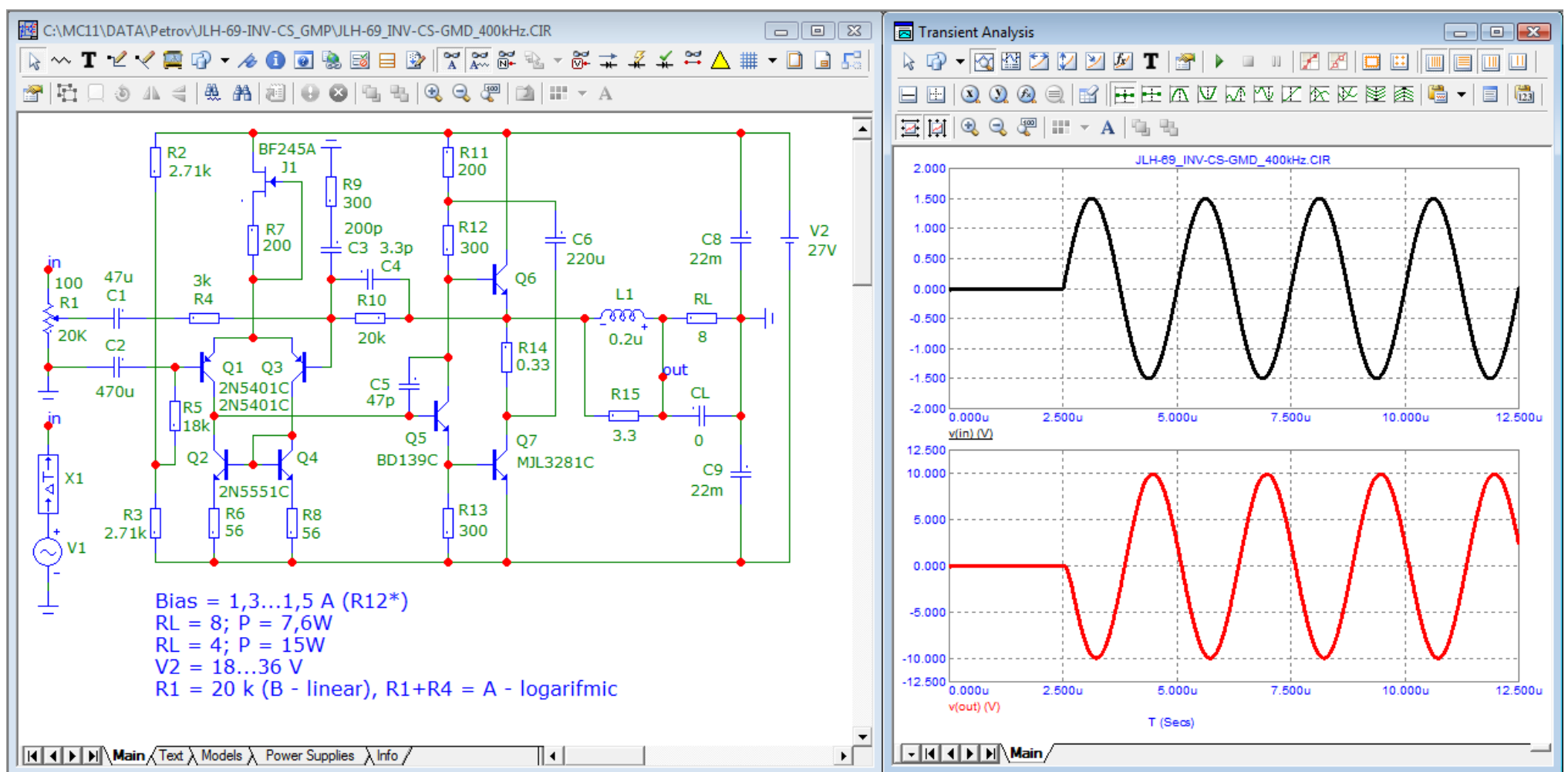


Fig. 9

As can be seen from the test, the amplifier copes well with a frequency of 400 kHz, there are no distortions visible to the naked eye, the voltage gain is the same as in the audio frequency region. There are only linear distortions in the form of a phase delay of the signal due to group delay = 100 ns.

Literature

1. <https://www.diyaudio.com/community/threads/jlh-1969-explanation.331158/post-6404128>

Completed prototype development and tests

Alexander Petrov.