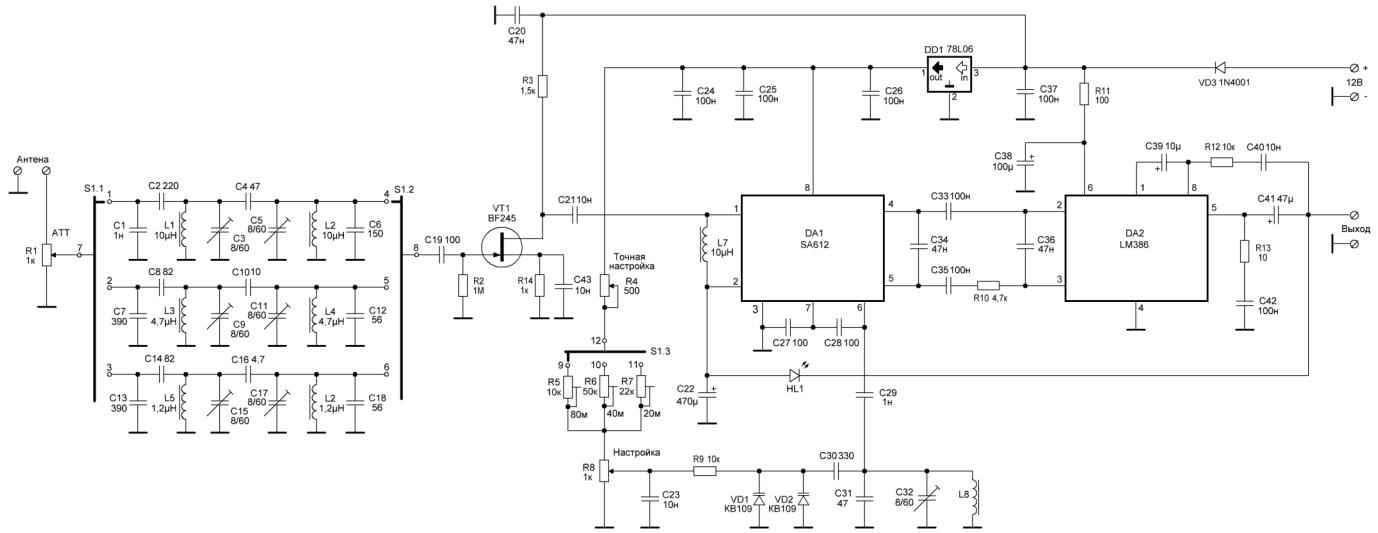
HF Receiver “MARIA”
(20, 40, 80 meters)

One of the prototypes of the proposed receiver was published in a magazine back in 1999. Despite the past years since the publication, the ease of Assembly of the receiver, high repeatability, availability of inexpensive components allows this design to remain very popular among beginners and experienced radio Amateurs. Indeed, the ability to listen to three Amateur radio bands looks very attractive. In addition, by adding automatic gain control (AGC) to the receiver, there is a tangible comfort when listening to radio stations. And finally, the size of the PCB allows you to make the receiver light and compact (dimensions 101x49mm).



Operation

Direct frequency conversion receiver. The principle of this system is very simple: the heart of the receiver is the NE612 chip, a high – frequency mixer-generator, followed by the integrated circuit of the lm386 low-frequency amplifier. Since the frequency of the local oscillator (or its harmonics) is relatively close to the reception frequency, the difference is only in the low-frequency spectrum. The sum (since any good mixer subtracts and adds at the same time) is in the high-frequency spectrum and, as a result, is completely suppressed by the low-pass filter. There is no intermediate frequency in the receiver, which greatly simplifies this type of receiver, and the quality remains extremely good. The clarity of the signals, especially in the CW, is striking.

Of course, there are drawbacks associated with the principle of direct conversion reception itself, but in this implementation, they were mostly eliminated. Since the NE612 has a conversion factor of at least 15 dB, there is no microphone effect due to too much gain of the input bandpass filter. Indeed, this phenomenon is particularly characteristic of this type of Assembly when using a diode mixer whose conversion factor is -6 dB, and where it is necessary to compensate for a very large low-frequency gain. Thus, in our case, the amplifying circuit should amplify about 21 dB (6 + 15) less. The hum that is present when the receiver is powered from the mains has completely disappeared due to the fact that the gain of the bandpass filter is reduced by using a voltage regulator.

At certain times, simultaneous reception of one or more very powerful broadcast stations (receiver saturation) may be a concern, but the adjustable bandpass filter attenuator solves this problem well. The main drawback of direct conversion reception is that we hear two side bands of the signal, that is, the audible station is heard from both sides (unlike conventional SSB receivers, where one of the side bands is removed). This can be annoying on busy days, but the human ear is able to make an excellent choice of signals. At the very least, this avoids switching the sideband; we can hear stations in both the upper and lower sidebands.

Let's take a closer look at how the receiver works. The high-frequency signal from the antenna is fed to the variable resistor R1, which serves for global gain control of the receiver. This is a high-frequency attenuator, which also has the feature of significantly reducing the receiver saturation caused by signals from broadcast transmitters (especially in the evening).

The bandpass switch S1 selects a bandpass filter according to the selected range. This very selective two-element bandpass filter is necessary because the frequency of the heterodyne is not switched according to the selected range, but the harmonics of the same oscillator are used.

Really! The generator built into DA1 (SA612, NE612), like any good generator, generates harmonics. What is usually a disadvantage in this scheme makes it easier for us. Since the main Amateur radio bands are harmonic, it is sufficient to set the main frequency of the generator at the lowest reception band. In our case – 3.5 MHz for the 80-meter band. The second harmonic will give us 7 MHz (40 meters), and the fourth harmonic will be at 14 MHz (20 meters).

Serious filtering of the RF signal at the input avoids simultaneous reception of all bands, which causes the presence of two-element low-pass filters. So we have a simple but powerful 3-band receiver. Trying to get other ranges, such as 15 and 10 m, in the same way, leads to instability of the receiver. Therefore, we will limit ourselves to the ranges of 80, 40 and 20 m, which is already good. The signal from the bandpass filter is amplified by the transistor VT1 before being fed to the mixer chip DA1.

The R3 resistor determines the amplifier's gain, which can be reduced so as not to create instability at high frequencies. The DA1 chip is powered by a voltage regulator DD1 (78L06).

The frequency of the heterodyne is determined by L8, C30, C31, C32, VD1 and VD2. VD1 and VD2 are varicaps, meaning their capacitance varies depending on the voltage. We will change this voltage using an alternating resistor R8. In this scheme, R8 is used as a "coarse" setting. The variable resistor R4 is used for "fine" tuning, which allows you to more accurately configure the station. This solution was chosen in order to avoid buying a multi-turn resistor, certainly much more pleasant to use, but also much more expensive, especially for novice radio Amateurs.

The L8 coil is wound on toroid:

- T50-2 (red), contains 45 turns wire 0,35 mm;

Tuning resistors R5, R6 and R7 are used to adjust the limits of each of the ranges.

Let's go back to our signal, which was converted to low-frequency in DA1 on pins 4 and 5. Next, the signal goes to the low-pass filter (C34, R10 and C36), whose role is to remove frequencies above 3 kHz. C33 and C35 are isolation capacitors for DC voltages. The line between the DA1 chip and the DA2 amplifier chip (LM386) is symmetrical, which has the advantage of reducing unwanted broadcast signals and increasing the gain of useful signals.

The gain of the DA2 chip is set to a maximum (46 dB) using the C39 capacitor. This is necessary for this type of receiver if you want to enjoy a comfortable speaker system. The R12 and C40 have the function of reducing the white noise generated by the large gain of the DA2 chip. R13 and C42 prevent the DA2 chip from being excited if the resistance of the speaker used is too low. R11 and C38 also prevent DA2 excitations depending on the type of battery used, especially if the latter has a very low internal resistance.

The signal is powerful enough to power the speaker 8 Ohms, but it is better to use a headset or connect a set of speakers with an active amplifier.

A simplified automatic gain control (AGC) circuit has been added to the receiver circuit, so that strong signals do not saturate the receiver, making listening much more enjoyable. This is a very simple system, but requires some description. The DC voltage usually present on pins 1 and 2 of the DA2 chip is approximately 1.4 volts. If we reduce it, the gain of the chip is also reduced. Connect the led, the cathode of which is connected to the ground through the speaker winding. It becomes conductive for the voltage at its pins of 1.7 volts. If there are weak signals on the speaker, nothing happens. On the other hand, if the signal exceeds 0.6 volts from peak to peak, the diode becomes conductive on negative half-waves, which leads to a decrease in the voltage at pins 1 and 2 and thus to a decrease in gain. C22 determines the AGC time constant, and at the same time removes residual interference present at the constant voltage. The L7 choke serves to equalize the DC voltages on pins 1 and 2 of the DA1 chip, while preventing RF loss to ground via C22.

The VD3 diode protects the device from unintentional polarity changes when the power supply is connected.

Alignment

First of all, it is important to double check the integrity of all elements and soldering. The SA612 (NE612) and LM386 chips are recommended to be placed last, paying close attention to their direction. If the Assembly was done correctly, the receiver should work immediately after power is turned on. You will need either an RF generator or a control receiver to set it up. If you don't have one, you must have an Amateur ham radio or, better yet, a radio club in your area. You will always find someone to help you.

The simplest setting will be made using the control receiver. Connect the corresponding antenna connectors together with a small coaxial cable. This will allow us to hear the local oscillator in the control receiver. Pre-set the following: R1 completely counterclockwise (minimum gain), R8 completely counterclockwise, same for R5, R6 and R7. R4 in the middle.

- Turn on both receivers. Switch S1 to a range of 80 meters. Set the control receiver to 3.500 MHz. By adjusting the tuning capacitor C32, we achieve the audibility of the generator signal in the control receiver.
- Then the R8 is turned completely clockwise, the control receiver is rebuilt to 3.800 MHz. Set up R5 to hear the signal in the control receiver.
- Switch S1 to 40 meters. Set the control receiver to 3.600 MHz (7200: 2nd harmonic). R8 leave completely clockwise. Set up R6 to hear the signal in the control receiver.
- Switch S1 to 20m. Set the control receiver to 3.587.5 MHz (14.350: 4th harmonic). R8 completely clockwise. Setting Up R7.

So we've set up a realignment within the 20, 40, and 80 meter ranges: 3.500-3.800 MHz for 80 meters; 7.000-7.200 MHz for 40 meters; and 14.000-14.350 MHz for 20 meters. it's Possible that during the previous settings, you might be a little out of range, but it's more important that they are completely covered by the realignment.

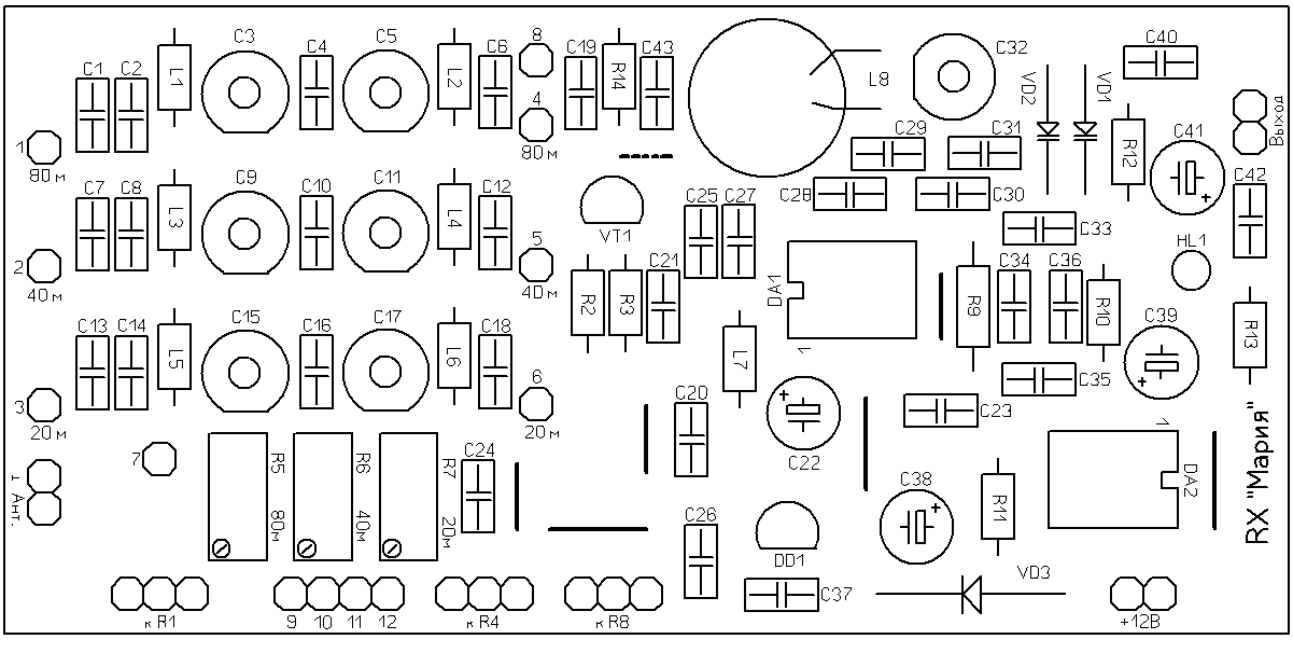
Now we will configure the input bandpass filters. The control receiver is no longer needed, we can disable it. Connect the antenna to the receiver input. If you don't have an antenna, a ten-meter-long wire antenna will do just fine.

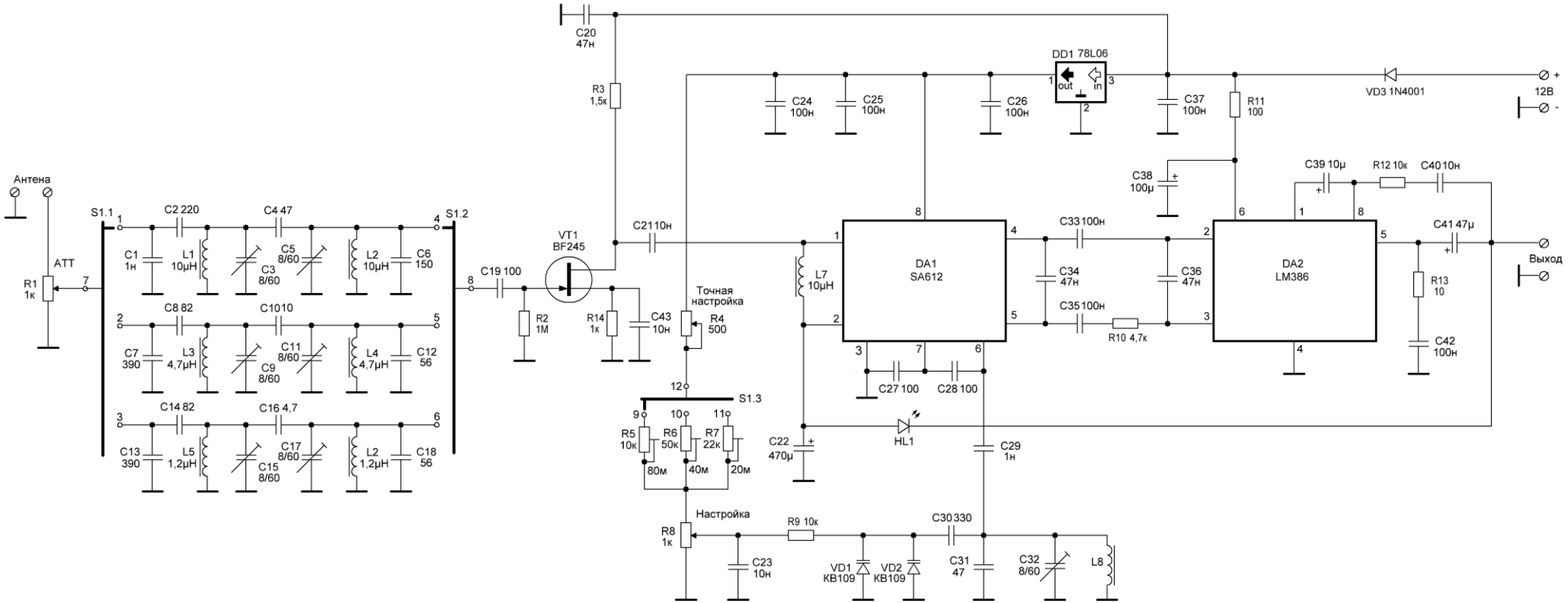
- Set R1 completely clockwise (maximum gain).
- S1 at 80 m, with a variable resistor R8, tune to a loud station (preferably in the middle of the range). Adjust C3 and C5 to the maximum signal level.
- S1 at 40m, same with C9 and C11 adjustment.
- S1 at 20m, same with C15 and C17 adjustment.

Repeat the settings for each range group several times for best results.

There are no additional comments for tweaking using the RF generator, because if you have a generator, you know how to use it… ☺

Now your receiver is set up, and we can only wish you long and pleasant hours when listening to Amateur radio frequencies.




Антена
ATT
R1 1к
S1.1
S1.2
C1 1н
L1 10μH
C2 220
C3 8/60
C4 47
C5 8/60
L2 10μH
C6 150
C7 390
L3 4,7μH
C8 82
C9 8/60
C10 10
C11 8/60
L4 4,7μH
C12 56
C13 390
L5 1,2μH
C14 82
C15 8/60
C16 4,7
C17 8/60
L2 1,2μH
C18 56
C19 100
R2 1M
VT1 BF245
C20 47н
R3 1,5к
C21 10н
R14 1к
C43 10н
Точная настройка
R4 500
S1.3
R5 10к
R6 50к
R7 22к
80м
40м
20м
Настройка
R8 1к
C23 10н
C22 470μ
L7 10μH
DA1 SA612
C24 100н
C25 100н
C26 100н
DD1 78L06
out
in
C37 100н
R11 100
VD3 1N4001
+ 12В -
C38 100μ
C33 100н
C34 47н
C35 100н
R10 4,7к
C36 47н
DA2 LM386
C39 10μ
R12 10к
C40 10н
C41 47μ
R13 10
C42 100н
Выход
C27 100
C28 100
HL1
C29 1н
R9 10к
C30 330
C31 47
VD1 КВ109
VD2 КВ109
C32 8/60
L8