# OPERATION OF AN INDIVIDUAL RADIO RECEIVER FOR SATELLITE TELEVISION

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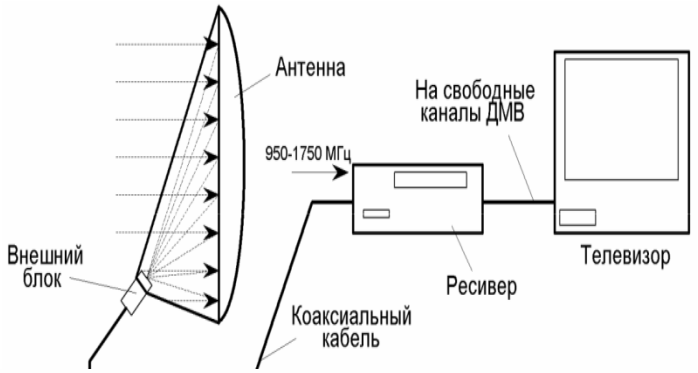
***Annotation:*** ***This article analyzes the functions of satellite television radios, antenna-feeder devices, satellite radio converter, satellite radio converter.***
***Key word:*** ***receivers, detector antennas, repeater satellites, polarizer, converter.***

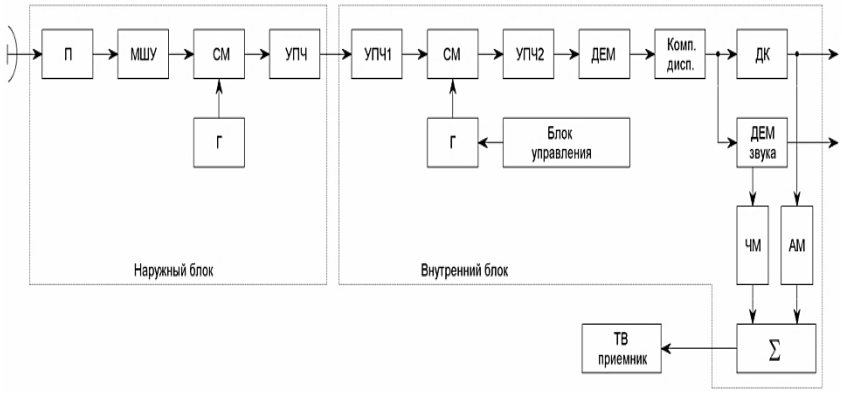
All radio receivers (RPR) of satellite television are built according to the superheterodyne scheme. An individual radio receiver consists of two parts: an outdoor unit, which is located directly on the antenna, and an indoor unit-satellite television receiver (receiver) installed near the TV. In Fig.1. the block diagram of the RPRU for receiving television broadcasting through repeater satellites is given.

Fig. 1. Structural diagram of a ground radio receiver.

The functional diagram of an individual receiver RVSS is shown in fig. 2.




Rice. 2. Functional diagram of an individual receiving device




Such a constructive and circuit design of satellite RPRs is due to the frequency range in which satellite systems operate. This is explained by the following considerations.

1. The frequency range 11.7 - 12.5 GHz corresponds to the wavelength range 2.5 - 2.56 cm. It is technically impossible to create detector antennas in this range. The most efficient antenna in this wavelength range is a reflector antenna (paraboloid), which has a large gain and a very narrow ("needle") radiation pattern (DN). The greater the ratio of the opening diameter of the paraboloid to the wavelength, the more sharply directed the pattern is formed and the greater the antenna gain. Reflector antennas are quite simple to manufacture and relatively cheap.

2. Only waveguides can be used as transmission lines for electromagnetic energy in this range. The use of other types of transmission lines, including a coaxial feeder, is impossible, since electromagnetic oscillations in the microwave range in coaxial feeders quickly decay. However,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waveguides are quite expensive to manufacture and their use in home satellite television systems is very difficult.

3. From the course "Radio Receivers" it is known that at the input of the receiver there is always a certain signal-to-noise ratio, determined by the ratio of the useful signal power to the noise power:

$$\gamma = (P_C / P_{Ш})_{ВХ}$$

This ratio does not remain constant from input to output of the receiver. When the useful signal propagates along the transmission line, the useful signal is attenuated due to natural power losses. At the same time, flotation and thermal noise from the transmission line are added to the input noise. As a result, at the output of the transmission line, i.e. already at the input of the receiver itself, the signal-to-noise ratio deteriorates. Moreover, this ratio worsens at the output of the linear part of the receiver. As a result, the noise figure increases and the sensitivity of the RPR decreases. Satellite receiver converter.

One way to reduce the noise figure, and therefore increase the sensitivity of the RPR, is to amplify the received signal immediately after the antenna. Devices that perform this function are called "antenna amplifiers". Structurally, antenna amplifiers are placed as close as possible to the antenna. In satellite RPRs, antenna amplifiers are located in the feed of a paraboloid and are called "low noise amplifiers" (LNA). The low-noise amplifier is structurally integrated with the polarizer and the first frequency converter. Such an amplifying-converting unit is called a “converter” (Fig. 2).

The converter solves the following tasks:

- carries out polarization selection of the signals received from the satellite-transmitter;
- protects the radio receiver via the mirror channel;
- produces power amplification of signals received at high frequency;
- performs the first frequency conversion of the received signals;
- produces a preliminary amplification of the converted signals at the first intermediate frequency.

The signal received from the satellite by the parabolic antenna is fed to the polarizer (P). The polarizer only passes a signal of a certain type of polarization to the input of the converter. The converter includes a low-noise amplifier (LNA), a mixer (SM) with a local oscillator (G) and an amplifier of the first intermediate frequency (IF). In a typical converter, the signal received by the antenna is amplified in a two- or three-stage transistor LNA, then its frequency is reduced in the first frequency converter to an intermediate frequency in the range of 950 - 1750 MHz.

RPRU for receiving TV broadcasting signals via repeater satellites is performed according to a superheterodyne scheme with double frequency conversion. This provides good selectivity for the adjacent satellite channel, almost complete suppression of the signals of the image channel and the signals of the return radiation of the local oscillator. The first frequency conversion, as already mentioned, is performed in an external unit (converter). The first intermediate frequency of the converted signals (more precisely, the frequency band) is chosen here high enough (950 ... 1750 MHz) so that the frequency of the first local oscillator and the frequencies of the mirror signals do not fall into the frequency band of the signals from the satellite. The first local oscillator is not tuned. It generates a signal of one fixed frequency, and the conversion is carried out in the frequency band $\Delta f$ = 800 MHz. For conversion to a wider ($\Delta f$ = 1200 MHz) frequency band, two local oscillators are used.

The first frequency conversion of the received signals can be carried out both with linear polarization (vertical or horizontal) and circular polarization. Electromagnetic waves of circular polarization are pre-converted into linear polarization waves. It is possible to simultaneously process signals of vertical and horizontal polarization if there are two converters in the external unit at the demodulator input (Fig. 3).



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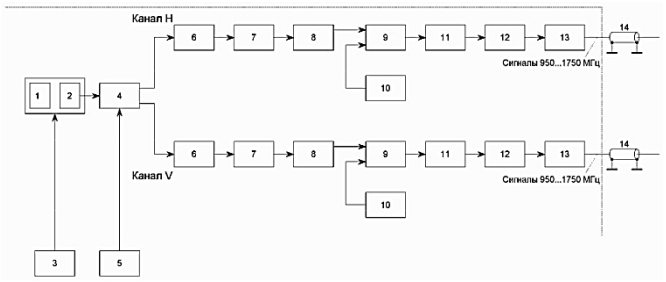


Fig.3. Structural diagram of the converter for simultaneous reception of signals of horizontal and vertical polarization 1-receiving antenna; 2-irradiator; 3-unit guidance to the satellite; 4-polarizer; 5-polarizer control unit; 6-band microwave filter; 7-waveguide-strip transition; 8-low-noise microwave signal amplifier; 9-first mixer; 10-first local oscillator; 11.12-amplifiers of signals of the first intermediate frequency (IF); 13-amplifier of the signals of the first IF in terms of power; 14-coaxial cable connecting the outdoor unit to the indoor unit.

Antenna. Microwave receiving antennas for satellite television broadcasting are mainly used in two types: phased antenna arrays (PAR) and parabolic antennas. The most widely used are parabolic antennas. The inner surface of the paraboloid of revolution is metal or metallized, designed to receive and reflect (reradiate) electromagnetic waves incident on it and direct them to the focus point where the irradiator is located.

The irradiator serves to receive electromagnetic waves reflected from the mirror, convert them into electrical signals and direct them to the waveguide. With satellite television broadcasting, the reception of electromagnetic waves having both linear and circular polarization. Therefore, a circular waveguide is attached to the irradiator, in which electromagnetic waves of any polarization can propagate.

Polarization is a physical characteristic of radiation that describes the direction of the vectors-moments of the electric field of a propagating electromagnetic wave.

The polarizer is used to select electromagnetic waves of only one (vertical or horizontal) polarization and direct them to the waveguide. The most important characteristic of the switch is the magnitude of the polarization attenuation, i.e. an indicator of the extent to which electromagnetic waves of unwanted polarization penetrate the output. The typical attenuation value is 30...50 dB. In the system of individual reception, the choice of electromagnetic waves of one or another polarization is carried out:

-mechanically - by turning the magnetic loop or electric probe by 90 °;

-in an electromagnetic way - by applying a certain voltage to the ferrite winding, along which an electromagnetic wave propagates.

This is controlled by an electronic circuit that is located in the receiver, and the choice of an electromagnetic wave of the appropriate polarization occurs simultaneously with the choice of a frequency channel (a television program).

The antenna-feeder system, in addition to these elements, may contain a remote guidance system for satellites, called a positioner.

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