OPERATING MODES OF PULSE SIGNAL AMPLIFIERS

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named after Muhammad al-Khwarizmi

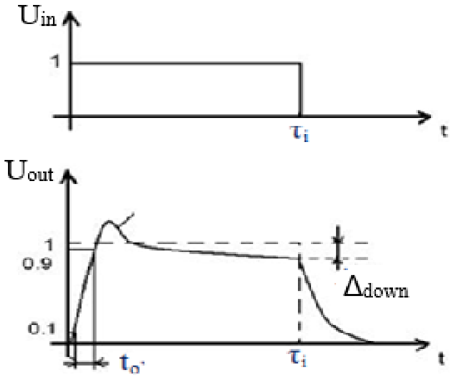
Abstract the article examines the characteristics of pulse signal amplifiers, areas of use, transition characteristics, useful operation coefficient, and the specific characteristics of the use of D mode.

Key words: amplifier, pulsed, signal, characteristic, self-generation, useful work coefficient.

Class D amplifiers have been widely used in recent years. They are again called pulse amplifiers. In such an amplifier, the sound signal is changed into a sequence of pulses of different widths as a result of wide pulse modulation. The repetition frequency of pulses is usually taken in the limits of 300-500 kHz, which is optimal for the entire audio range. If the amplifier is a subwoofer amplifier and only needs to amplify the range of 100-200 Hz, then the feedback frequency can be reduced to 50-100 kHz. In the past, pulse amplifiers were of interest only because of their high efficiency (typically above 90%) and were used only for driving high-power electric motors. This was directly related to the lack of high-frequency power reconnection elements capable of operating at high frequencies, as a result of which high nonlinear distortions could not be avoided. But now many electronic component companies are producing specialized elements for building class D amplifiers that can operate at frequencies of 1 MHz and higher.

Pulse amplifiers are designed to amplify pulse signals. Pulse signals are divided into radio pulses used in radar stations and video pulses used in video equipment. The main characteristic of pulsed amplifiers is the transition characteristic shown in fig 1. The transient characteristic is the response of a pulsed amplifier when a unit pulse is applied to its input. Impulse amplifiers have strict requirements regarding distortion of the amplified signal.

In pulsed amplifiers, the distortion of the amplified signal is determined by the quantitative indicators t_{int} of the transition characteristic, namely the grid settling time and the drop in flat height Δ_{down}.



Picture 1. Transient characteristics of pulsed amplifiers

The higher the high-few cut-off frequency, the less distortion of the grid front. The smaller the lower cut-off frequency fp, the smaller the distortion of the amplified signal in the field of flat height of the pulse dtush. Therefore, in order to amplify signals without distortion, pulse amplifiers must have a wide bandwidth from one hz to tens of mhz. Broadband amplifiers use resistor cascades with additional correction circuits built on special high-frequency transistors with a large amplification area.

Naturally, the amplification factor of the pulse amplifiers is not too large. Therefore, pulse amplifiers consist of several cascades.

In turn, self-generating type amplifiers are divided into two subgroups, in which the feedback is organized before and after the output filter. In circuits where the feedback is carried up to the output filter, it only corrects the nonlinearity of the power comparator, leaving the output filter out of control. Such amplifiers do not have a flat achx, and their output impedance increases sharply with increasing frequency.

Amplifiers with feedback only from the output filter are free of all these disadvantages, in which negative feedback is provided after the filter and all nonlinearities can be corrected, and the oscillation process begins due to the fact that the phase shift at a certain frequency is 180 degrees, that is, at this frequency, the feedback is positive remains and the amplifier acts as a generator.

The phase is shifted due to the signal delay occurring in the comparator itself, the output filter and the special phase-shifting rc circuit.

There are several modes of operation of the reinforcement elements, which differ from each other in their properties, so they have different fields of application. The gain is derived from the output static volt-ampere characteristic of the gain element, so that in order to obtain a given initial operating point (quiet point) that determines the operating mode of the gain element, it is necessary to ensure a certain mode of supply of the gain element with constant current.

We will consider the specific features of the use of mode d in amplifiers.

D mode or switch mode refers to the mode in which the amplifying element is in only two states during operation - closed (the current flowing through it is zero) or open (the voltage drop between the output electrodes is close to zero). In this case, the energy loss in the amplification element is very small, and fik is close to one.

Switch mode is used only to amplify rectangular pulses of arbitrary length and size. In this case, the voltage of the amplified pulses in the output circuit is taken almost equal to the voltage of the supply source and does not depend on the amplitude of the pulses at the input of the amplifier.

Such amplification of right-angle pulses with maximum limitation is used in electronic computing machines, rectifiers and control devices, where the switch mode is considered the most useful. The amplification element cannot amplify cascade harmonic signals operating in switch mode. It is necessary to change them into rectangular pulses with constant amplitude, but with lengths proportional to the instantaneous value of the harmonic signal voltage.

In this case, the frequency of arrival of pulses should be constant and greater than the maximum frequency of the harmonic signal. This conversion process is called pulse-width modulation.

Thus, the harmonic signals are modulated before being fed to the input of the class d amplification cascade. After amplitude modulated pulses are amplified, they are reversed (demodulated) to the original harmonic signal.

Class d amplifiers are used in two operating modes - ad (fig. 2.a) and bd (fig. 2.b).

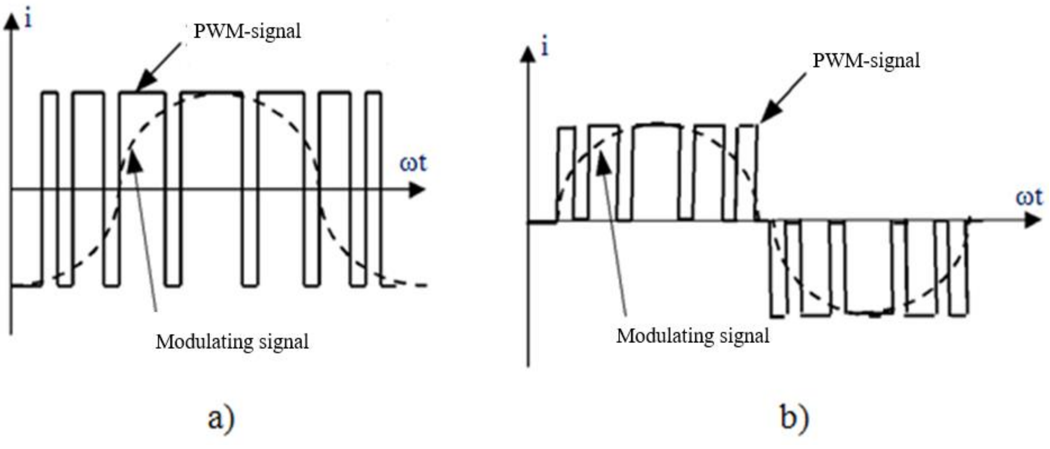


Figure 2. Operating modes of class d amplifiers
(PWM-pulse-width modulation)

If the ad mode implementation uses relatively simple circuitry as for the a mode, then the bd mode amplification element is implemented using complex two-stroke circuits that are dual-controlled.

Mode a makes it possible to obtain a high efficiency (over 90%) in the final power amplifier cascade when the signal to be amplified, like mode d, varies over wide ranges. Such a high useful efficiency can be provided in mode e only by means of two-stroke circuits in which the amplification elements work at the cut-off angle of the current (mode b) or at a slightly larger (mode ab) cut-off angle. Thus, high efficiency modes can be be or abe modes.

The meaning of the be or abe modes is that the operating point of the amplification element is not recorded, but due to the change in the voltage at the output of the supply source, which is specially adjusted in such a way that the voltage drop in the amplification element for the active mode is obtained as a minimum. Changes depending on the level of the amplified signal.

As a result, the minimum voltage loss in the amplification element takes place, which makes it possible to obtain almost the same voltage utilization coefficient, which does not depend on the level of the signal, and, therefore, a high useful operation coefficient.

References

1. Д.А.Давронбеков, А.Х.Абдукадиров. Мобил алоқа тизимларининг 4G авлоди / Ўқув қўлланма. Т.: “O‘quv-ta’lim metodika”, 2015. - 328 b.

2. Д.Денисов. Тенденции развития 5G сетей. Новые частоты E-диапазона и технология OAM – 3 с. // Elektron manba URL: https://nag.ru/material/30112 (murojaat sanasi 27.11.2023)

3. А.Н. Степутин, А.Д. Николаев. Мобильная связь на пути 6G. В 2 томах (комплект из 2 книг). Инфра-Инженерия, 2017 г.- 796 с.

4. В.А.Хан. Формирование оптических каналов в телекоммуникационных и измерительно-информационных системах // диссертация доктора технических наук: 05.12.13 / Новосибирск: 2006.-362 с.

5. A.A.Xalikov, D.A.Davronbekov, J.F.Kurbanov. Raqamli mobil aloqa vositalari / Darslik. T.: “O´zbekiston faylasuflari milliy jamiyati” nashriyoti, 2018. – 556 b.

6. Е.Богданова. Транспортная сеть 5G/IMT-2020 / Первая миля 7/2019. -с.40-47

7. R.Ibraimov, D.Davronbekov, M.O.Sultonova. Features of building fronthaul networks in 4G/5G on the basis of wireless optical communication channels / An Interdisciplinary Journal of Neuroscience and Quantum Physics "NeuroQuantology". 2022; Volume 20, Issue 11. -P.1555-1564. DOI: 10.14704/nq.2022.20.11.NQ66147

8. M.O.Sultonova. Transport telecommunication networks of mobile communication for shared use / I International Conference on "Advance Research in Humanities Sciences and Education". 2022. -p.261-266.