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METHODS FOR OBTAINING A GIVEN TRANSMITTER POWER

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ABSTRACT:

Modern broadcasting and a number of special radio transmitters have an output power of the order of tens and hundreds of kilowatts. Any improvement aimed at increasing the efficiency can provide significant economic benefits. The task of improving the energy efficiency in modern transmitters should be solved taking into account the requirements of the standards for the value of nonlinear distortion and for the level of out-of-band emissions. The issue of device reliability is also important. Until recently, PWM transmitters have had the best efficiency. Pulse width modulation is used in almost all medium wave transmitters. The disadvantages of this method of generating the output signal include the need to use powerful vacuum devices in the output stage of such transmitters. This does not allow using the advantages of modern semiconductor element base. In transistor transmitters with an output power of more than several hundred watts, the amplifiers of the final stage are built according to the block-modular principle. In a typical design of such devices, the powers of individual transistor amplifier modules operating in class B are added together. In addition to the advantages due to the use of a semiconductor element base, such transmitters have better reliability compared to tube transmitters. Failure of one or part of the amplifier modules will lead to deterioration in the characteristics of the transmitter, but will not lead to a complete loss of performance.

KEYWORDS: modulation, transmitter, transmitter power, receiver.

INTRODUCTION:

At present, the advantages of the above principles of construction are most fully combined in transmitters with digital shaping of the signal envelope. The essence of this method lies in the formation of the output signal by adding the powers of highly efficient key amplifiers. In this case, the number of amplifiers delivering power to the load is divided by the amplitude of the modulating signal at each moment of time. Despite a number of advantages, the method of digital signal envelope shaping has found application only in broadcast transmitters of the ultra-high range with amplitude modulation. The question of the possibility of using digital modulation in 2 - transmitters of the short wave range with amplitude modulation and when generating a signal with one sideband remains open.

METHODS AND CALCULATION:

The specified useful (nominal) power provides the output (final) stage of the transmitter. The choice of an active element, especially transistors, to obtain a given transmitter power is a difficult task, since transistors have a small permissible power (Table 1.1) and their parameters are highly dependent on frequency. The maximum power of one transistor in the range of long, medium and short waves reaches 250 W, meter 100 ... 125 W, decimeter - tens of watts; as the wavelength decreases further, the power decreases rapidly [1]. Consequently, it is possible to obtain a given transmitter power with the help of transistors by the same techniques as with the use of radio tubes, only at low powers. It is pertinent to note here that due to the large scatter of parameters, the transistors, when they are connected in parallel or in series in one stage, provide a noticeably less useful power than the sum of the rated powers of the used transistors.

Table 1.1

Wave range, m	Transmitter power, kW			
	0,1…0,3	0,3…1	1…5	5…20
100…10000	0,65…0,7	0,7…0,75	0,75…0,8	0,8…0,85
10…100	0,6…0,65	0,65…0,7	0,7…0,75	0,75…0,8
1…10	0,55…0,6	0,6…0,65	0,75…0,8	0,8…0,85

It is possible to connect only two transistors in parallel or four in a push-pull circuit, two in the "shoulder", but at the same time it is often necessary to introduce special resistors into the emitter circuit of each transistor to equalize their modes, which leads to a decrease in the power amplification factor of the stage. Significant output power of transmitters (for example, more than 300 ... 500 W in the short-wave range) is obtained using bridge circuits for adding the power of several identical stages ("modules") [2]. The construction of a transmitter using this method somewhat increases its reliability, since the failure of one module, for example, the output stage, leads only to a slight decrease in power, but not to a complete loss of the transmitter's performance [3]. Between the output terminal of the transmitter (the input of the antenna-feeder system) and the transistors of the output stage, there are always matching circuits, filtering, etc. [4]. Despite the fact that they are usually performed on reactive elements (capacitors, inductors, transformers), some of the energy is always lost in them. At the initial design stage, nothing is known about these filtering and matching circuits, therefore, it is necessary to take into account their properties roughly, based on the generalized parameters of the available transmitters [5]. Losses in the output filtering (oscillatory) system of the transmitter in the first approximation can be taken into account by taking the approximate values of the efficiency of the output filtering system (ηOF) from [2] table. 1.1. Smaller values of the efficiency refer to the output filtering system, consisting of 1 ... 2 circuits, large - from 3 ... 4 circuits. The increase in the efficiency of the output filtering system as the number of circuits increases is due to the ability to strengthen the connection between them without fear that the filtration will be lower than required; strengthening of the connection leads to an increase in the insertion resistance R_{ex}, and, consequently, the efficiency of the output filtering system:

$$\eta_{OF} = \frac{R_{ex}}{(r_k + R_{OF})},$$

where r_k - is the loop loss resistance. When constructing amplification stages based on broadband transformers, the efficiency of the output transformer of the output stage should be taken into account ηTP≈0.85 ... 0.95.

Devices for adding and distributing power have an efficiency of ηsl ≈ 0.8 ... 0.9. Thus, the required (nominal) power of the transistors of the output stage of the transmitter is greater than the specified output power: $P_{NOM} \geq \frac{P_a}{(\eta_{OF} \cdot \eta_{T.Л} \cdot \eta_{sl})}$. It is pertinent to recall here that with amplitude and single-sideband modulation, the selection of transistors is carried out at maximum power. Comparison of the required power of the output stage with the unit power of transistors in a given frequency range makes it possible to decide whether it is possible to obtain the required power from one (output) stage with no more than four transistors, or whether it is necessary to use a system for adding the power of several modules. When constructing a transmitter, to simplify its tuning, the modules are built as broadband amplifiers [6]. In order to increase the efficiency, a transistor mode with a cut-off current, as well as a key mode, is used. When operating with current cutoff, a push-pull circuit and cutoff angle are used to provide an approximately harmonic voltage waveform at the output of the broadband module θ = 90° [7].

CONCLUSION:

The number of modules in the output stage of the transmitter depends on the given transmitter power and the power of one module, which, in turn, is determined by the power of the transistors and their number in the module (usually 2 or 4).

When choosing transistors for the output stage (or module), it is necessary to compare several types of transistors that provide a given power. To do this, you can use table 1.2, from which you finally choose the type of transistor that best meets all the requirements for the transmitter [8].

Table 1.2

Type	$P_{1max.}$,W	$E_{\kappa\ max}$, V	K_{3f}, dB	k_p	η, %	m, pieces
KT912	70	28	-30	10	50	>4
KT956	80	28	-40	20	45	4
KT957	150	28	-33	17	50	2
KT967	70	12,6	-40	20	60	>4
KT980	250	50	50	25	-	2

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