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DESIGN OF A SPECIAL SYSTEM (TRANSMITTER-ANTENNA) FOR ANTENNA MEASUREMENTS USING A UAV

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Abstract

In civilian and military radars and communication systems, antennas of various purposes are used, in particular, in the meter range of waves. Meter-band antennas are large pieces of equipment, often covering areas of 30 meters or more.

In the article, there are reasons for the need to measure antennas, their features and requirements for the equipment. The structure of the developed transmitter, circuit solutions, obtained parameters and their comparative analysis are presented. Conclusions are drawn regarding the use of the created facilities.

Keywords: transmitter, antenna measurements, frequency synthesizer, filter.

Introduction

Today, measurements of radio-technical equipment are of great importance, which make it possible to assess their condition and/or quality of preparation. During measurements, the frequency range is important, depending on which the size of the measurement object changes, which in turn affects the principles and methods of measurement. The only economically effective way for measure such systems is to carry them out using aircraft.. helicopters and UAV [1].

As a rule, specially ordered planes or helicopters are used, on which measuring and transmitting equipment are installed. Flights ordered by the latter are quite expensive and not all countries have such funds. Since the size and weight requirements on the equipment in use until now were quite mild, due to the use of high-powered aircraft, there was no problem with their renewal and downsizing. Today, the development of unmanned aerial vehicles has created an opportunity to look at the above questions in a different way, because it allows to reduce the cost of measurements in an orderly manner [2,4,9]. The above imposes its requirements on the equipment to be used. The equipment is divided into two groups: ground and airborne. Ground equipment is a measuring device-spectrum analyzer controlled by computers. The equipment installed on the flaying object (FO) is a transmitter whose radiation frequency depends on the operating range of the antenna to be measured and must be able to be changed by the control system. The fact that the equipment is installed on FO already imposes certain restrictions and requirements on the latter. Of course, the restrictions are bilateral [1,8]. Limitation on FO, resulting from the necessary flight time, weight of the lifting equipment, as well as limitation on dimensions, mass, power circuit, radiation range of the lifting equipment. The stated requirements cause serious problems in their resolution[1].

Conflict Setting

Present the proposed equipment to be installed on the flying device, which by its size and weight meets the requirements for the use of small UAVs and enables changing the radiation frequency. Present the research results.

Research results

A transmitter device based on a synthesizer that converts the metric wavelength range $\lambda = (8,57...1.5)$ m and the corresponding frequency range into the $f = (35...200)$ MHz range has been developed and investigated. Fig. 1 shows a block diagram of the transmitter.

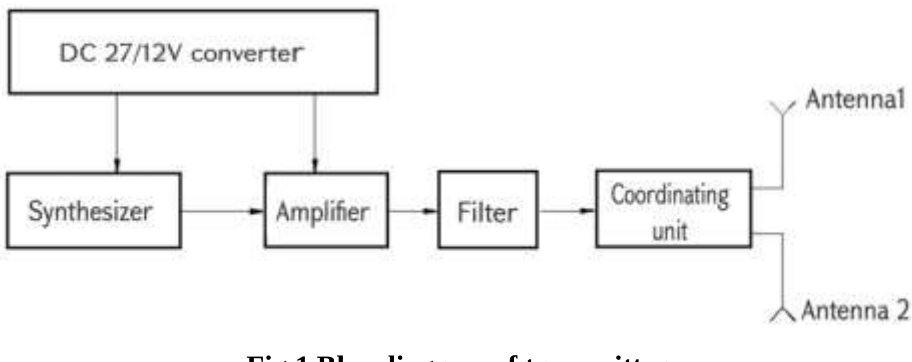

Fig.1 Bloc diagram of transmitter

The ADF4351 microcircuit was chosen as the base of the synthesizer. It is a unit with wide-band phase automatic tuning. The circuit diagram of the synthesizer is given in Fig. 2.

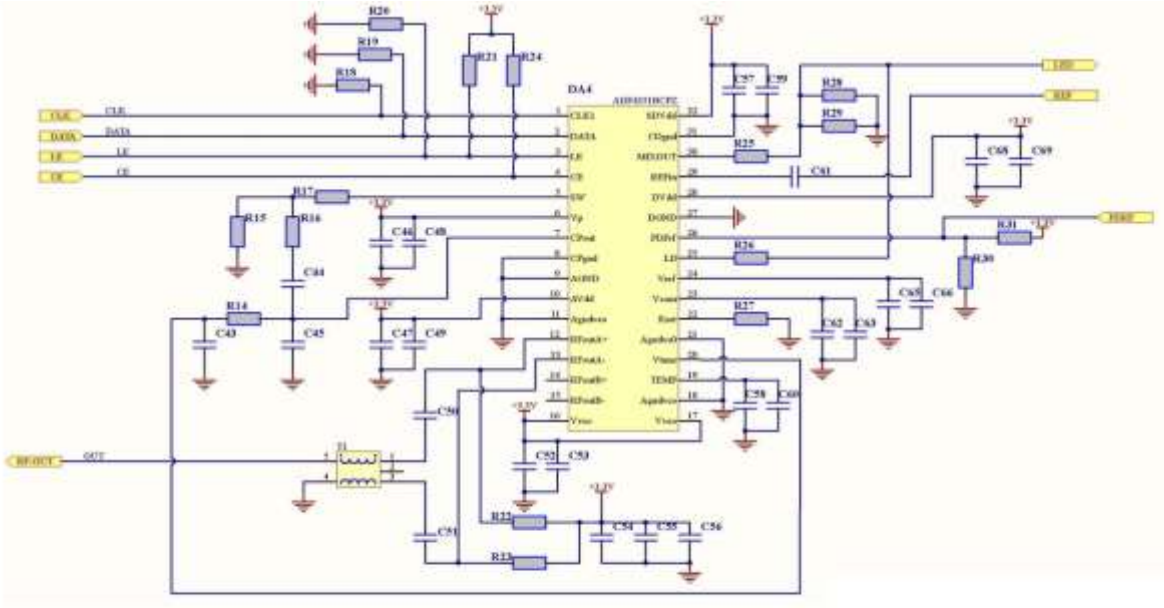

Fig.2 The circuit diagram of the synthesizer

A GK-163 quartz generator with a frequency of 200MHz and low phase noises was chosen to generate the reference signal of the synthesizer. The electrical schematic diagram of the control and amplification is given in Fig. 3.

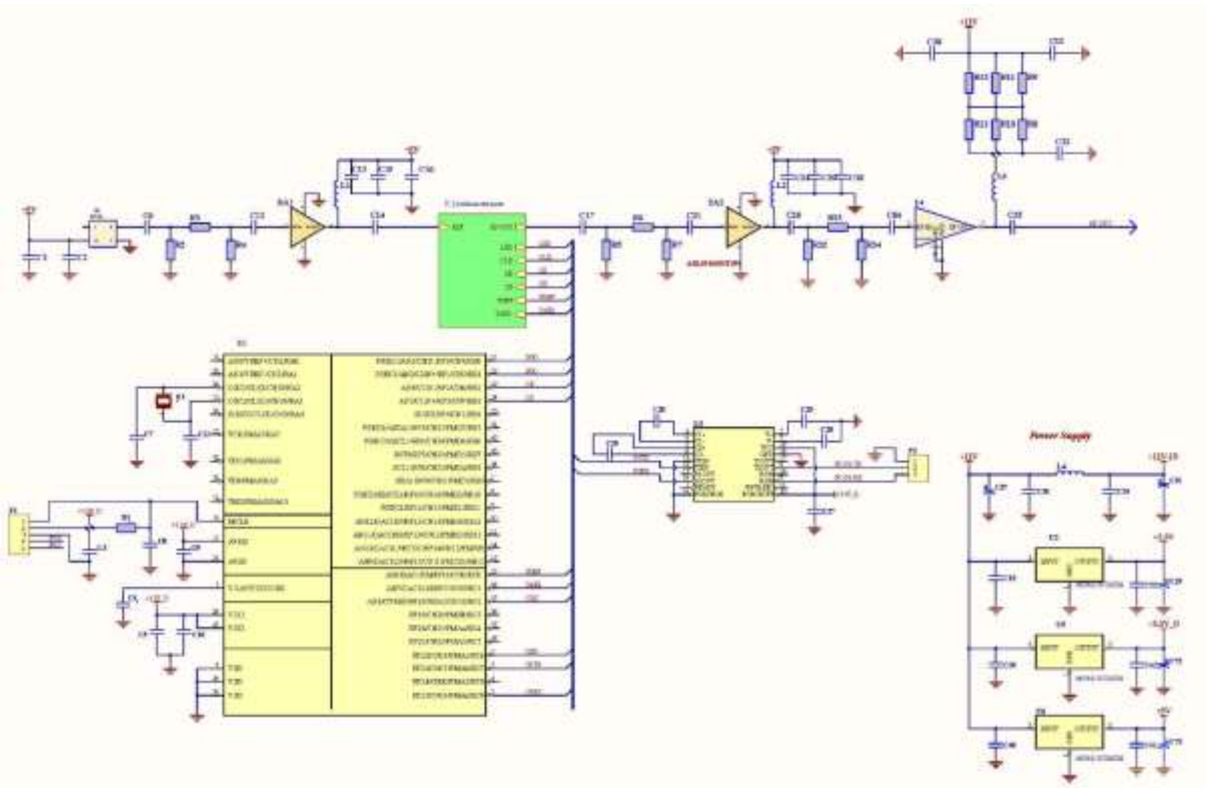

Fig.3 The electrical principle diagram of the control and amplification loop

The signal from the output of the generator is fed to the frequency synthesizer through the DA1 amplifier. The ADL5536 microcircuit was selected as an amplifier. Its necessity is determined by the fact that the level of the output signal of the quartz G1 generator is not sufficient for the input of the synthesizer. The output signal of the synthesizer is fed to the DA2 preamplifier. ADL5536 microcircuit was selected as a pre-amplifier. The amplified signal is then fed to the output amplifier U4. The PHA-202+ microcircuit was chosen as the output amplifier, which provides 1 W output power. The synthesizer is controlled by the U1 microcontroller, which receives commands from the computer through the COM interface. The U3 microcircuit acts as a COM converter. The electrical principle diagram of the control and amplification loop is given in Fig. 3.

A low-frequency filter is designed to suppress high harmonics at the output of the amplifier, the cut-off frequency of which is 250 MHz. The need for such a filter lies in the fact that drones have controlling, communication, and GPS systems on them, and an additional transmitter on drones can interfere with their normal operation. The electrical scheme of the filter ensuring electromagnetic compatibility is given in Fig. 4.

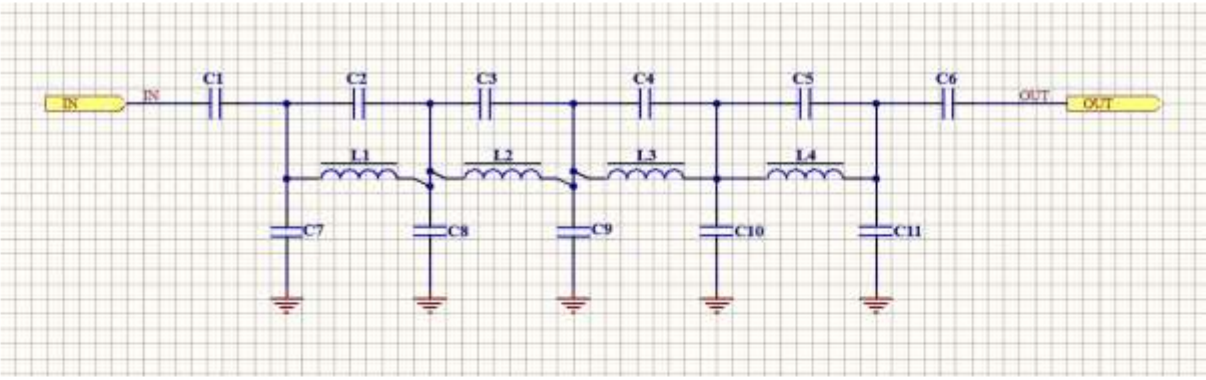

Fig. 4 The electrical scheme of the filter ensuring electromagnetic compatibility

A half-wave dipole antenna was selected as the radiating antenna in the developed system, which, due to its dimensions and weight, is a suitable option for placement on unmanned aerial vehicles. The corresponding matching circuit is used to match the output signal of the filter with the generator. The electrical scheme of the matching node is shown in Fig. 5.

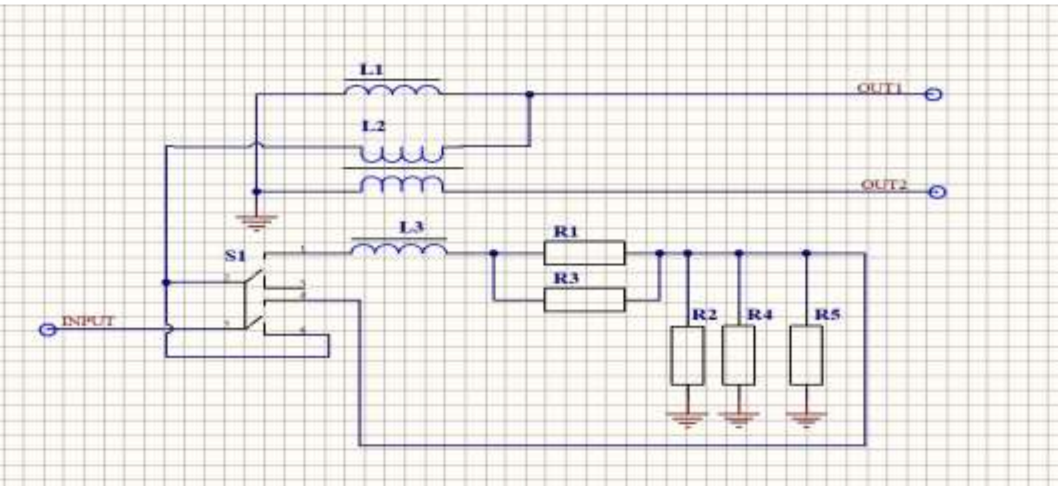

Fig.5 The electrical scheme of the matching node

A DC converter built on the basis of the LM2576 microcircuit was chosen to feed the transmitter. It converts the 27V voltage of the drone's battery to the 12V required by the transmitter.

The basic electrical circuit of the converter is shown in Fig. 6.

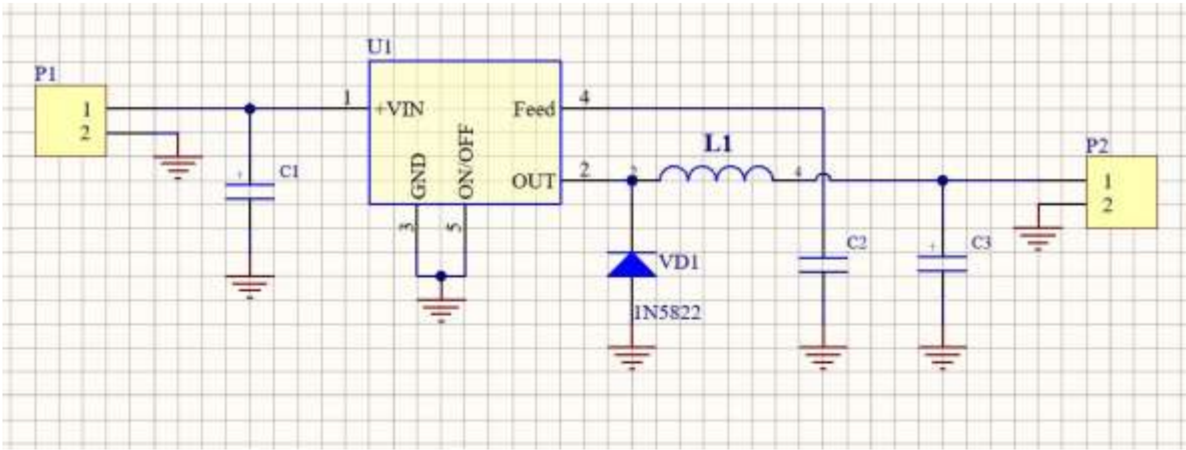

Fig. 6 The basic electrical circuit of the converter

On Fig. 7 shows a view of the conductor assembled in a caprolon case.

Fig.7 A transmitter assembled in a Karoline case

The wings of a half-wave generator are attached to the frame, and a DC converter is assembled on the frame, the image of which is shown in Fig. 8.

The spatial dimensions of the transmitter housing are $(90 \times 65 \times 40)$ mm2, and the weight of the transmitter and half-wave vibrator assembly does not exceed 0.5 kg.

Fig. 8. A DC converter is assembled on the cover and a half-wave coil attached to it

On Fig. Figure 9 shows the transmitter and half-wave vibrator assembly attached to the drone, which is mounted on a measuring tripod.

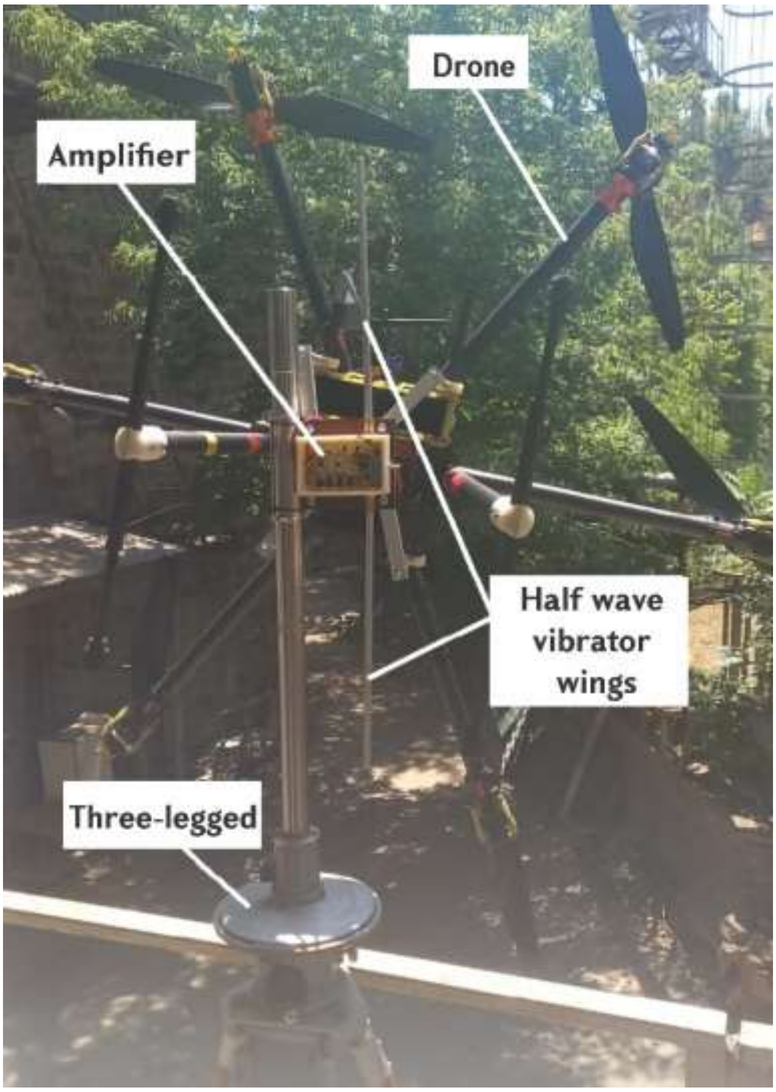

Fig. 9. The drone placed on the measuring tripod with the assembly attached to it

The results of measuring the Direction Diagram (DD) of the mentioned system in two dimensions are presented in Fig. 10 and 11.

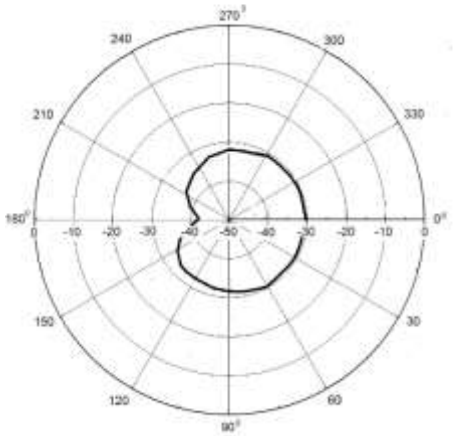

Fig. 10 DD of the System "Drone + transmitter + auxiliary half-wave vibrator + navigator" in the H-plane of the half-wave vibrator at a frequency of 200 MHz

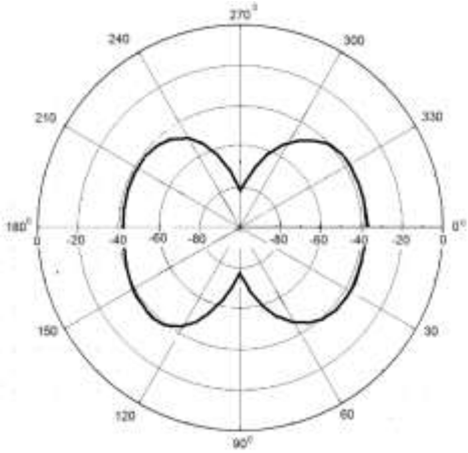

Fig. 11 DD of the System "Drone + transmitter + auxiliary half-wave vibrator + navigator" in the E-plane of the half-wave vibrator at a frequency of 200 MHz

From Fig. 10 it follows that the DD of the "drone + transmitter + auxiliary half-wave vibrator + navigator" system has an insufficient change compared to the DD of the half-wave vibrator at the corner site. It should be noted that when measuring the antenna system under test, it receives the radiation power of the transmitter located on the drone in those angles in which, according to Fig. 10, the radiating system "drone + transmitter + auxiliary half-wave vibrator + navigator" has a fairly even pattern.

Conclusion

Thus, a small-sized, fairly light-weight, frequency-regulated, reliable and necessary power transmitter was developed and built on a modern element basis, which, when installed on a drone, creates an opportunity to perform the parameters of large-sized antenna systems of ultra-short wave radars, in particular, the directivity diagram (DD), with the help of a round flying near object.

The necessary measuring stand was assembled, with the help of which, based on the developed method for measuring weakly directional antennas, the deviation of the DD of the assembled system "drone + transmitter + auxiliary half-wave vibrator + navigator" from the DD of a single half-wave vibrator in free space was studied.

The results obtained confirm, as expected, that the placement of the half-wave emitter on the drone does not lead to a significant change in the emitter pattern in the indicated angles. This fact is important from the electrodynamic point of view, therefore, if the change in the pattern is significant, it is necessary to take into account the distortion of the pattern when measuring the antenna system under test, when it is necessary to determine the parameters of the test object with high accuracy.

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ԴՐՈՆՆԵՐԻ ԿԻՐԱՌՄԱՄԲ ԱՆՏԵՆԱՆԵՐԻ ՉԱՓՈՒՄՆԵՐԻ ՀԱՄԱՐ ՆԱԽԱԳԾՎԱԾ ՅՈՒՐԱՀԱՏՈՒԿ ՀԱՄԱԿԱՐԳ (ՀԱՂՈՐԴԱԿ-ԱՆՏԵՆԱ)

Մարկոսյան Մ.Վ., Ավետիսյան Վ.Հ., Մարտիրոսյան Հ.Գ.
Երևանի Կապի Միջոցների Գիտահետազոտական Ինստիտուտ ՓԲԸ

Տարբեր նշանակության անտենաները, մասնավորապես մետրային ալիքների տիրույթում օգտագործվողները, կիրառվում են քաղաքացիական և ռազմական նշանակության ռադարներում, ինչպես նաև կապի համակարգերում: Հոդվածում բերվում են անտենաների չափումների անհրաժեշտության հիմնավորումները, դրանց յուրահատկությունները և սարքավորման նկատմամբ դրվող պահանջները:

Նկարագրվում է մշակված հաղորդիչի կառուցվածքը, սխեմատիկ լուծումները, ստացված պարամետրերը և դրանց համեմատական վերլուծությունը: Բերված արդյունքները հաստատում են, որ կեսալիքային տատանակի տեղակայումը դրոնի վրա չի բերում տատանակի (ուղղորդվածության դիագրամի) զգալի փոփոխությանը $0^0...90^0$ անկյունների հատվածում:

Բանալի բառեր. հաղորդակ, անտենային չափումներ, հաճախականությունների սինտեզատոր, զտիչ:

РАЗРАБОТКА СПЕЦИАЛЬНОЙ СИСТЕМЫ (ПЕРЕДАТЧИК-АНТЕННА), ПРЕДНАЗНАЧЕННОЙ ДЛЯ АНТЕННЫХ ИЗМЕРЕНИЙ С ПОМОЩЬЮ БПЛА

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В гражданских и военных РЛС и системах связи применяются антенны различного назначения, в частности, в метровом диапазоне волн.

В статье приведены обоснования необходимости измерения антенн, их особенности и требования, предъявляемые к оборудованию.

Представлены структура разработанного передатчика, схемные решения, полученные параметры и их сравнительный анализ. Сделаны выводы относительно использования созданных средств.

***Ключевые слова*:** Передатчик, антенные измерения, синтезатор частот, фильтр.

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