A WAY OF CORRECTION OF DAA RECEIVING CHANNELS CHARACTERISTICS USING THE HETERODYNE SIGNAL

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Usually a problem of correction of a digital antenna array (DAA) channels characteristics is solved by applying an external pilot-signal or additional diversing of control signal with respect to radio frequency.

To minimize the hardware expenditures it is proposed to use unnominal heterodyne operational mode, which consists in changing the excitation conditions in a control period so to cause the generation of parasitic broadband or multimode signals. At the same time it is necessary to provide stable arising of intermediate frequency oscillation at mixer's output. In the event of a narrow pass band of intermediate frequency amplifiers such signal is quite suitable for equalization of complex transfer characteristics of receiving channels.

As a correction procedures it is proposed to use a method [1], according to which the correction process is consisted in weighing the digital voltages in receiving channels be complex weight coefficients which quadratic components have been calculated for a set of N readings

$$\alpha_{rq}^{c} = \frac{\sum_{i=1}^{N} V_{rq_i}^{c} a_i^{c} + \sum_{i=1}^{N} V_{rq_i}^{s} a_i^{s}}{RQ \sum_{i=1}^{N} \left(V_{rq_i}^{c^2} + V_{rq_i}^{s^2} \right)},$$

$$\alpha_{rq}^{s} = \frac{\sum_{i=1}^{N} V_{rq_i}^{c} a_i^{s} - \sum_{i=1}^{N} V_{rq_i}^{s} a_i^{c}}{RQ \sum_{i=1}^{N} \left(V_{rq_i}^{c^2} + V_{rq_i}^{s^2} \right)},$$

where α_{rq}^{c}, α_{rq}^{s} — quadratic components of correction coefficient of the rqth primary DAA channel situated in the rth row of qth column,

$$V_{rq_i}^{c} = U_{rq_i}^{c} \cos(x_r + x_q) + U_{rq_i}^{s} \sin(x_r + x_q)$$

$$V_{rq_i}^{s} = U_{rq_i}^{s} \cos(x_r + x_q) - U_{rq_i}^{c} \sin(x_r + x_q)$$

$$x_r = \frac{2\pi}{\lambda} d_r \left(r - \frac{R+1}{2} \right) \sin\beta \cdot \cos\varepsilon$$

$$x_q = \frac{2\pi}{\lambda} d_q \left(q - \frac{Q+1}{2} \right) \sin\beta \cdot \sin\varepsilon$$

$U_{rq_i}^{c}$, $U_{rq_i}^{s}$ — quadratic components of response of the rqth primary DAA channel in the ith time interval, x_r, x_q — generalized coordinates of calibrating source with respect to DAA normal, λ — wavelength of calibrating source carrier, d_r, d_q — the distance between array's elements in a row and in a column correspondingly, R, Q — number of array's elements in a row and in a column, β, ε — angle coordinates of the calibrating source with respect to DAA normal,

$$a_i^{c} = \frac{1}{RQ} \sum_{r=1}^{R} \sum_{q=1}^{Q} \left(U_{rq_i}^{c} \cos(x_r + x_q) + U_{rq_i}^{s} \sin(x_r + x_q) \right),$$

$$a_i^{s} = \frac{1}{RQ} \sum_{r=1}^{R} \sum_{q=1}^{Q} \left(U_{rq_i}^{s} \cos(x_r + x_q) - U_{rq_i}^{c} \sin(x_r + x_q) \right).$$

In the considered case the expressions for the correction coefficients can essentially become simpler if the calibrating source (heterodyne) is placed in the array plane.

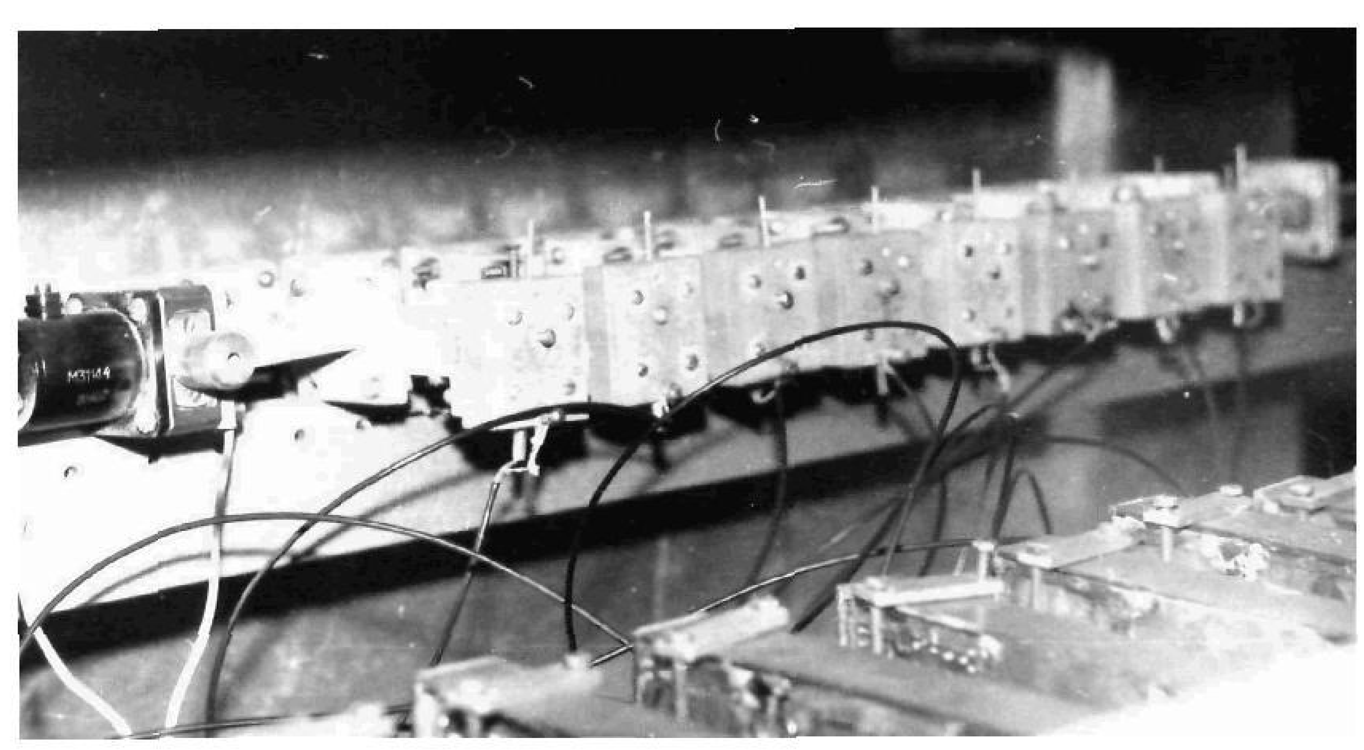

Fig. 1

The proposed approach has been tested on a working model of the 8-element digital antenna array made in 1989 by a team of scientists of the former Academy of Anti-aircraft Defence of Ground Forces (Kiev) headed by Dr. Sci. Prof. V.A.Varjukhin. An appearance of model's elements is shown in Fig. 1-4. Fig. 1 shows a microwave part of the array with a heterodyne block (to the left). A set of the digital receiving modules is shown in Fig. 2 (to the left). Fig. 3 shows the outputs of digital filters of quadratures diversing, from which signals are applied to a buffer storage and adapter of the central computer (Fig. 4).

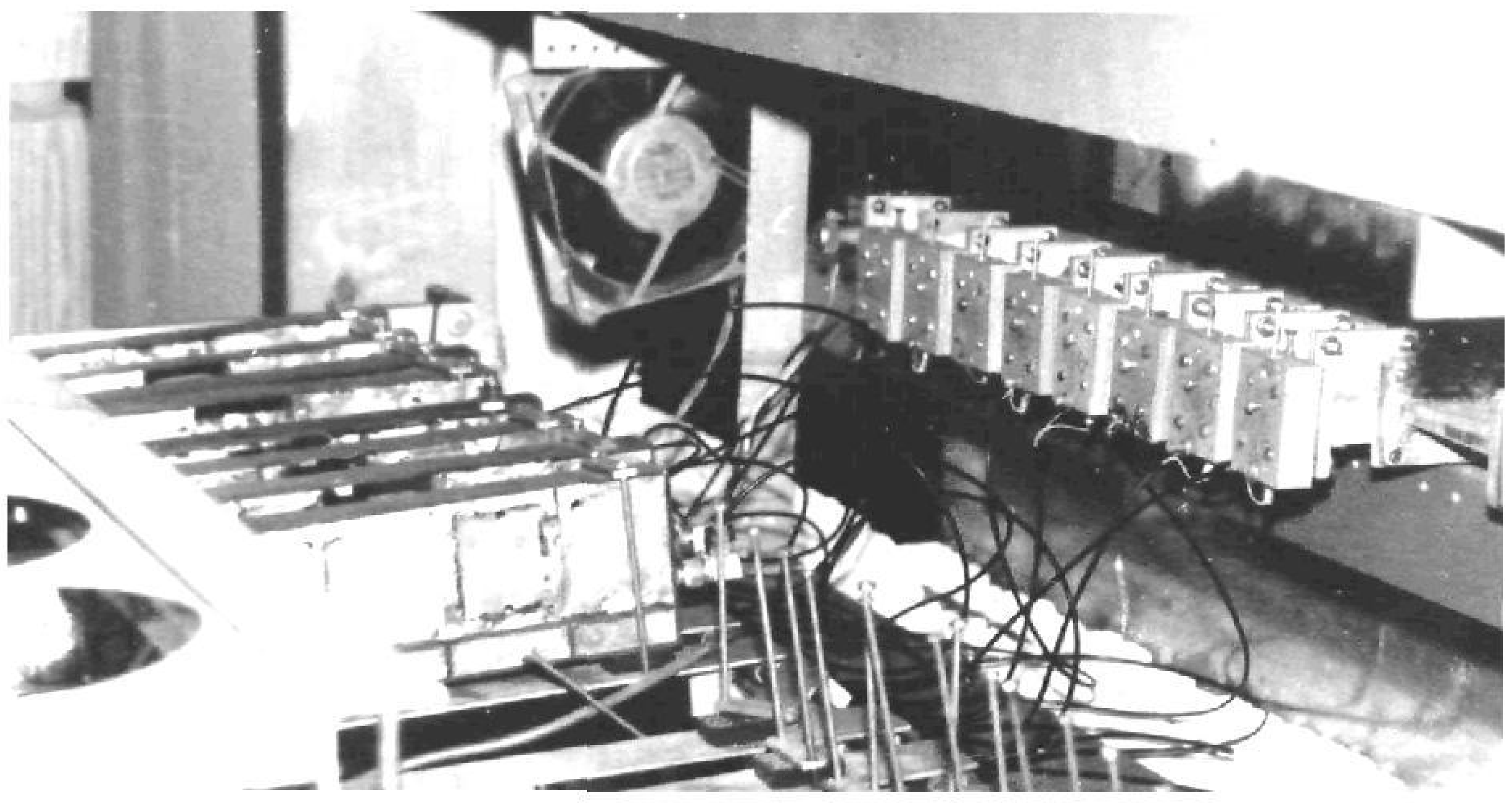

Fig. 2

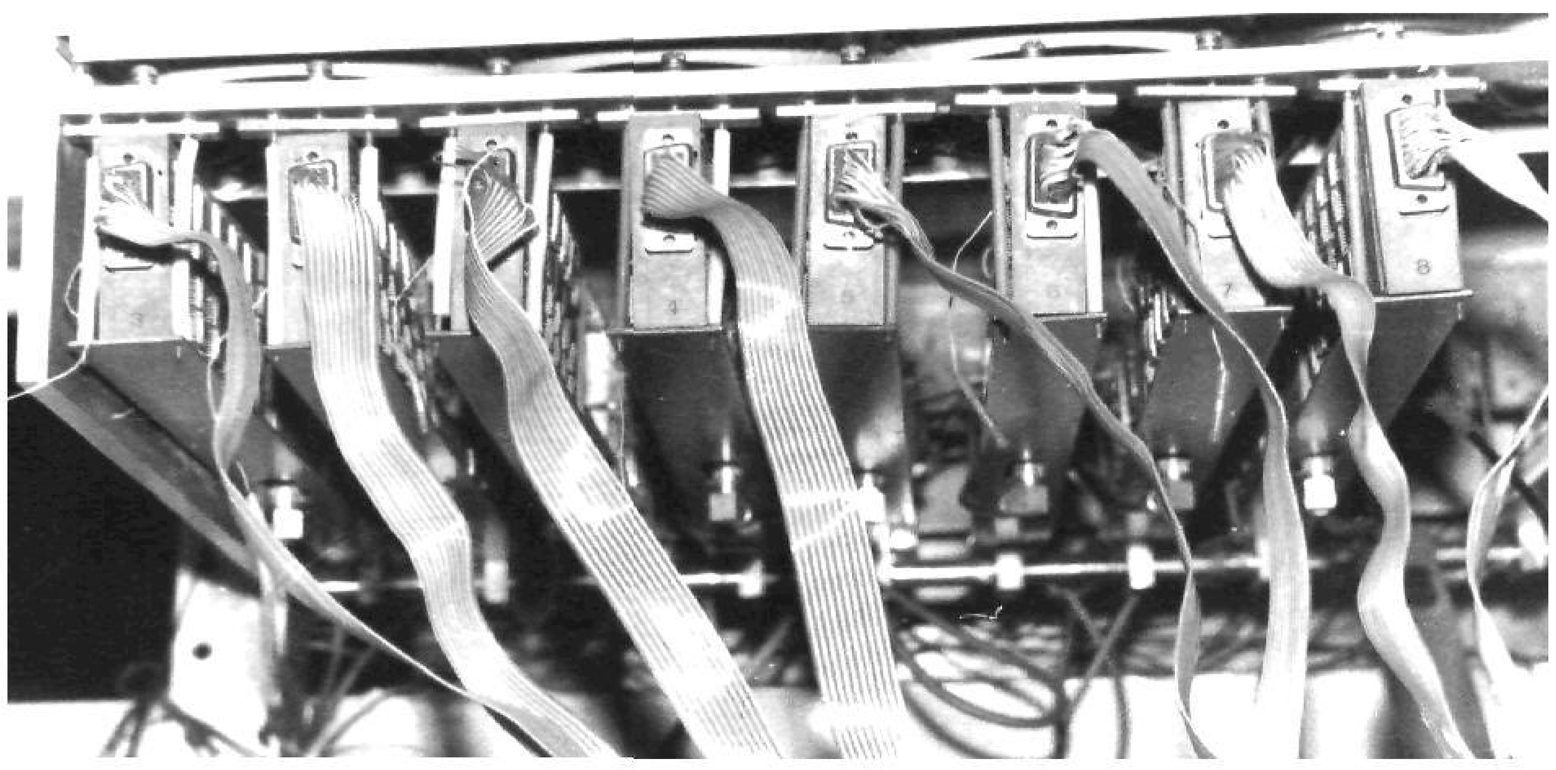

Fig. 3

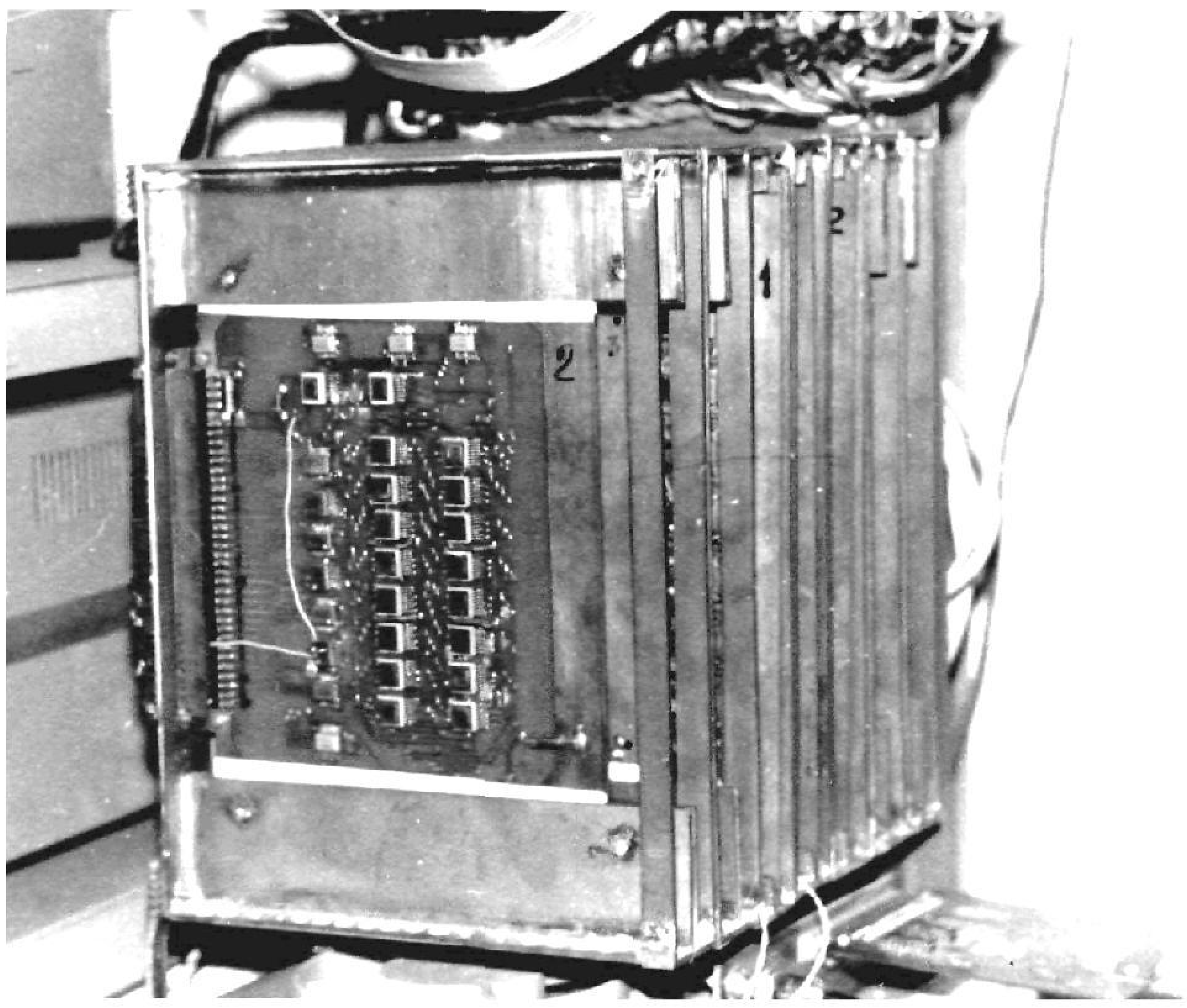

Fig. 4

The experimental results have confirmed the effectiveness of the proposed method of promt correction. But however, the problem of technological optimization of reliable heterodyne changing over into unnominal operational mode and its reset requires further investigations.

REFERENCES

1. Patent of Russ. Fed. N 2103768 H 01 Q3/36, G 01 R 29/10. A way of amplitude-phase characteristics correction of primary channels of plane digital antenna array. Slyusar V.I., Pokrovskij V.I., Sakhno V.F., priority 16.10.92, publ. 27.01.98.