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# Calculation of U-Shaped Absorbing Elements of Chip-Attenuators for Surface Mounting

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**Abstract**—A topology of absorbing elements of chip-attenuators of medium and large attenuations built on the basis of distributed resistive structures and intended for surface mounting is suggested and its calculation is performed. The results of calculations and experimental research on real samples of chip-attenuators and their large-scale models are provided.

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Wideband attenuators with film absorbing elements (AE) are widely used in television, radio-receiving and measuring systems for measuring and calibrated power attenuation of signals, mutual paths decoupling and decreasing of introduced by them reflection [1].

AE of such attenuators may be built on lumped (U and T shaped) and on the basis of distributed resistive structures. The latter being characterized by absence of sensitivity to point defects and heterogeneities, technological parameters scattering, precision and wideband response, greater stability towards pulse and temperature impacts, are the best to satisfy the constantly growing demands of the market for precise passive components [2, 3].

The known AE topologies on the basis of distributed resistive structures, designed earlier for coaxial and strip paths, appear to be inappropriate for building chip-attenuators for surface mounting, the contacts of which, according to technological considerations, should be located on the opposite sides of the substrate and enclose it. A topology suggested below (Fig. 1a) providing realization of the required medium and large attenuations (5–120 dB) under rather uniform current distribution between contacts.

Mirroring of polygon $M_0M_1M_2M_3M_4M_5M_6M_7M_8$ in $z$ plane (Fig. 1a) to the upper semi-plane $\xi$ with the specified in Fig. 1b correspondence of points is conducted using Christoffer–Shwarz integral [4]:

$$z = A\int_0^{\xi} \sqrt{(\xi^2 - a_1^2) / (\xi^2 - a_2^2)(\xi^2 - a_3^2)(\xi^2 - 1)} d\xi. \quad (1)$$

We determine constants $a_i$ from the equations system:

$$d/l = I_1/I_5, \quad b/l = I_2/I_5, \quad h/l = I_4/I_5, \quad I_1 + I_3 = I_5. \quad (2)$$

Hyper-elliptical integrals $I_1 - I_5$

$$I_1 = A\int_0^{a_1} \sqrt{(a_1^2 - \xi^2) / (a_2^2 - \xi^2) / (a_3^2 - \xi^2)(1 - \xi^2)} d\xi, \quad (3)$$

$$I_2 = A\int_{a_1}^{a_2} \sqrt{(\xi^2 - a_1^2) / (a_2^2 - \xi^2)(a_5^2 - \xi^2)(1 - \xi^2)} d\xi, \quad (4)$$