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SHORT COMMUNICATION

The Influence of Air-Abrasive Trimming on the Current Noise of Thick Film Resistors

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In the work cited[1] the authors investigated the influence of trimming on current noise, if the resistors differ by the same scaling factor before and after trimming. These are the cases in which the aspect ratio is one, the size of the square is 0.3, 0.5, 0.7, and 0.9 cm and the cut length is half or one third of the resistors width. Summarizing their results the authors conclude, that (i) the increase in current noise is larger for small resistors and (ii) that this is due to a more inhomogeneous current density in small resistors. This Comment is to show, that (ii) is not correct and that (i) is due to the fact that the relative increase has been considered:

According to Butterweek[2] the current noise voltage $\overline{u_\omega^2}$ for an arbitrary geometry is given by

$$\overline{u_\omega^2} = \frac{\Delta f}{f} C^* \cdot \frac{1}{I_0^2} \cdot \int d\tau\, E_0^4 \cdot \sigma_0^2 \tag{1}$$

(C^* – material constant, describing noise behaviour; I_0 – applied dc-current; E_0 – electric field within TFR, not a constant; σ_0 – conductivity of TFR material). Scaling an arbitrary two-dimensional configuration and assuming I_0 = const., for the scaled case one has to replace:

$$d\tau' = \alpha^2 d\tau, \quad E_0'(\alpha r) = \frac{1}{\alpha} E_0(r), \quad U_0 = \text{const. if } I_0 = \text{const.} \tag{2}$$

(where α is the scaling factor).

From (2) the relation (3)

$$\left.\frac{\overline{u_\omega^2}}{U_0^2}\right|_\alpha = \frac{1}{\alpha^2} \cdot \left.\frac{\overline{u_\omega^2}}{U_0^2}\right|_{\alpha=1} \tag{3}$$

follows immediately. If after trimming the current noise voltage for the unscaled case is increased by a factor K, relation (3) shows that the noise index NI increases by $\Delta NI = NI_{trimmed} - Ni_{untrimmed} = 10\, \ln K$. Thus ΔNI is independent of α, i.e. the absolute size of the TFR. This result is verified by the result given[1], as shown in Table I (cf. also Table III and IV[1]).

Hence the "small increase" of current noise for large resistors discussed in (1) results from the circumstance that there the quantity $\Delta NI/|NI|$ has been considered and for large

TABLE I
ΔNI (mean values) for different sizes of geometry from data (1)

square size	0.3 cm	0.5 cm	0.7 cm	0.9 cm
ΔNI/dB for w/2-cut	4.2	4.4	4.2	3.8
ΔNI/dB for w/3 cut	3.2	3.2	3.1	3.4

TABLE II
(NI(α) - NI(α = 1))/dB from data (1) [α = 1 corresponds to 0.9 cm TFR's]

square size	0.3 cm	0.5 cm	0.7 cm	0.9 cm
untrimmed	9.43	4.79	2.13	
w/2-cut	9.45	4.8	2.25	0[+]
w/3-cut	9.58	5.18	2.08	
theory	9.5	5.1	2.2	0

[+]zero due to the comparison of all values to 0.9 cm $\sim$ squares.

resistors |NI| is larger than for small resistors (in the cases considered, for other $R_\square$ values this may be wrong!). Also the effects of current density in small and large trimmed TFRs are the same because the cut is scaled by the same factor α. Table II presents the values NI(α) – NI(α = 1) derived from the data (1) and compares the results with theory according to (3) (last line):

The mean values and the detailed evaluation of the values for each sample (not presented here) show, that the trimming procedure led to very clean cuts.

REFERENCES

1. Ying-Nam Lai, Juinn-Jey Chang; "The influence of air-abrasive trimming on the current noise of thick film resistors", *Electrocomp. Sci. and Techn.* **9**, 15 (1981).
2. H.J. Butterweck, "Noise voltage of bulk resistors due to random fluctuations of conductivity", *Phil. Res. Rept.* **30**, 316 (1975).