

## Crosstalk constraints in interconnects design

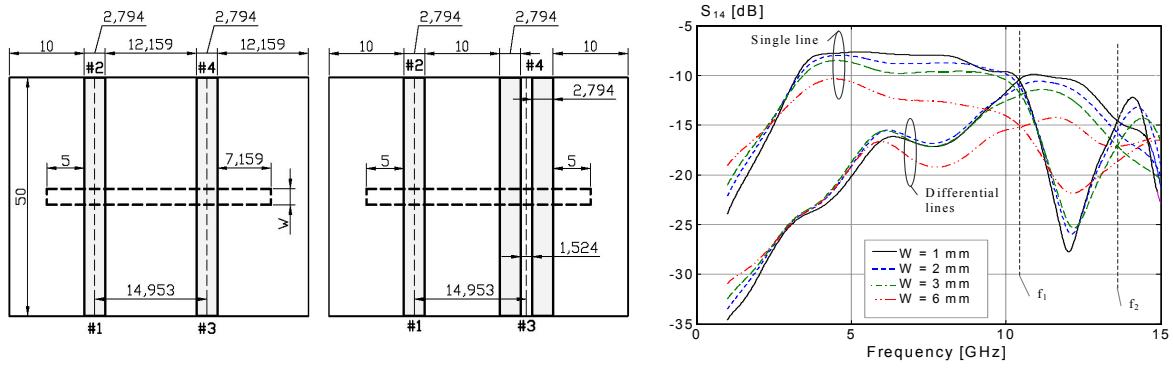
R. Araneo, S. Celozzi

*Department of Electrical Engineering, University of Rome "La Sapienza", Rome, Italy  
e-mail: rodolfo.araneo@uniroma1.it, salvatore.celozzi@uniroma1.it*

Differential signalling is frequently chosen for the distribution of high-speed signals on printed circuit boards (PCBs) since it is commonly superior to conventional single line configurations in terms of electromagnetic interference (EMI) and signal integrity (SI) performance, especially when it is necessary to cross discontinuities placed on the ground plane, such as slits which are often used to isolate noisy or susceptible analog circuits. In the past much work has focused on several effects which slits introduce on classical single line configurations: degradation of the propagation of digital signal with high frequency content [1,2], radiation emission in the neighbourhood of the slits [3], crosstalk between different lines crossing the same slits [2]. Anyway few works investigate the behaviour of differential signalling: only the excitement of common mode radiation has been studied in [4].

In this paper a comprehensive study of the behaviour of differential lines crossing slits as concerns the crosstalk is afforded. The effect of the geometrical dimensions of the slit, i.e. length and width, is investigated as well as the effect of the relative position of the strips with respect to the slit, in order to carry out some guidelines useful in the preliminary design stage. Furthermore a lumped equivalent circuit in terms of propagation of strip-line and slot-line modes is proposed for the differential configuration [1,2,5].

As a preliminary study, the models shown in Figure 1a,b have been investigated. A classical single line fed at port #1 and closed at port #2 on the characteristic impedance of  $50 \Omega$ , shares a slit with another equal single line in case (a) and with a differential line in case (b), both closed on a load of  $50 \Omega$  at both ends. The substrate is a FR-4 laminate with permittivity  $\epsilon = 3.38$  @ 10 GHz, with an height  $h = 60$  mils. Figure 1c shows the crosstalk between the lines, by means of the amplitude of the scattering parameter  $S_{14}$ , for different widths of the slit, whose length is maintained fixed. As it is possible to note, in the low frequency range, below  $f_1 = 10.4$  GHz, the differential line shows better performance compared with the single trace, confirming the general design rule that differential lines are potentially less affected by discontinuities. Nevertheless the magnitude of the scattering parameter increases constantly with frequency and between  $f_1$  and  $f_2 = 13.8$  GHz the differential line performance deteriorates with respect to the single line which shows a lower crosstalk. The width of the strip affects the magnitude of the coupling, since the radiation losses increase with the width, but it does not affect the frequencies  $f_1$  and  $f_2$ , since the same resonance frequencies of the slit are excited.



**Figure 1 – Geometry of the configurations under analysis: single line (a) and differential line (b) (units in mm). Magnitude of the  $S_{14}$  parameter (c) for the two configurations under analysis.**

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