

**EFFECT OF ELBOW SMA CONNECTORS AT THE
INPUT PORT OF CRYOGENIC 4-8 GHz
AMPLIFIERS**

Juan Daniel Gallego
Carmen Diez González
Isaac López Fernández

June 2000

TECHNICAL REPORT C.A.Y. 2000-3

ABSTRACT

Sometimes is very convenient to use elbow SMA connectors to save some space and to facilitate cable routing. However, elbows have worse reflection coefficient than straight SMA connectors do. The aim of this Technical Report is to make an estimation of the effect of elbow SMA plugs used in the cable connected to the input of the 4-8 GHz cryogenic amplifiers used in HIFI receivers. This estimation is based on models of the SMA connectors obtained with S parameter measurements and on the model used for the design of the amplifier.

1 MODELS OF STRAIGHT AND ELBOW CONNECTORS

Two different semi rigid cables were specially built to measure the effect of SMA connectors. In both cases the cable used was semi rigid .141" cooper conductors with solid Teflon dielectric. The length of the two cables was ~30 mm. The elbow connectors were Radiall R125 154, with a specified maximum usable frequency of 12.4 GHz and a VSWR of $1.10 + 0.01 F$ (GHz) (catalog data). The straight connectors were Radiall R125 055, with a specified maximum usable frequency of 18 GHz and a VSWR of $1.05 + 0.004 F$ (GHz) (catalog data). The two cables were measured with a Vector Network Analyzer HP 8510 C calibrated with a 3.5 mm Cal. Kit. The frequency range of the measurements (0.131-26.5 GHz) was adequate for the time domain low pass mode, very useful in finding the nature of the discontinuities. A picture of the two cables measured is shown in figure 1, and the equivalent circuits obtained and used in this work are presented in figure 2.

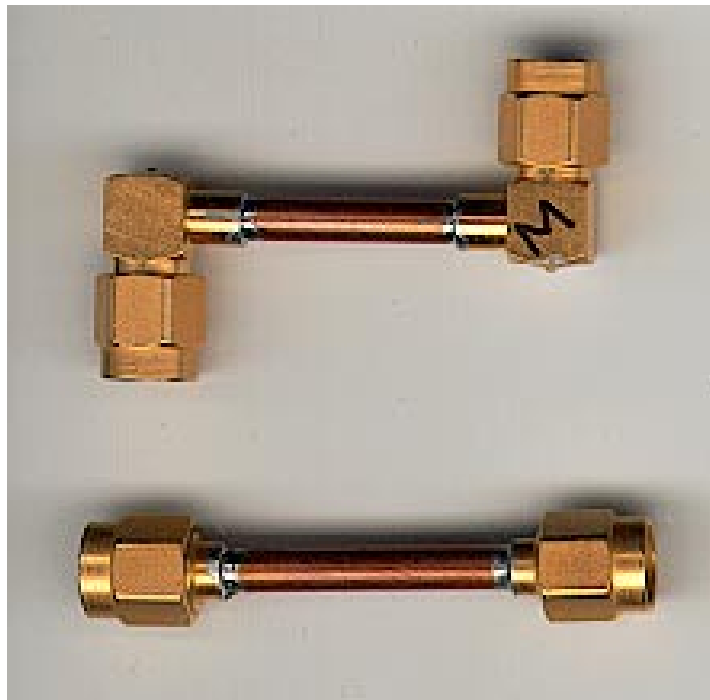


Figure 1: The two semi rigid cables measured

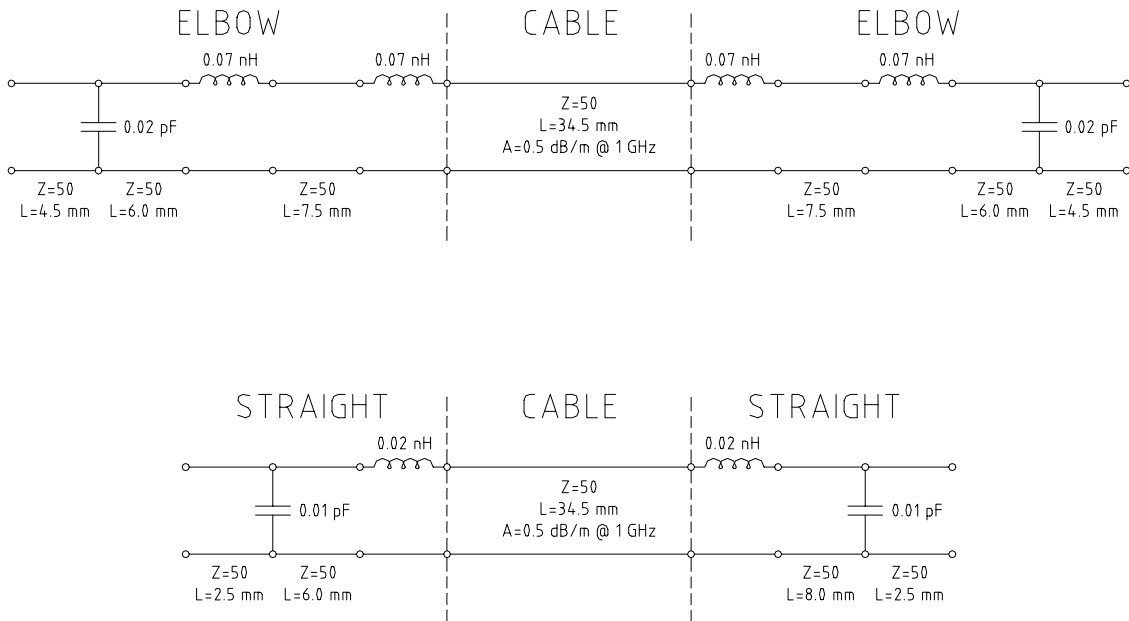


Figure 2: Equivalent circuits obtained for the two cables. Losses are for room temperature and are scaled by the square root of the frequency.

The data obtained from the model, compared with the specification for each connector is presented in figure 3. It is important to note that special care is required to assemble elbow connectors to the cable correctly. In our first attempt the two elbows were soldered wrong, and very poor performance was obtained. It is imperative to follow the instructions for assembly carefully and to use the right tools. Probably most elbow cables assembled in our lab in the past are wrong!

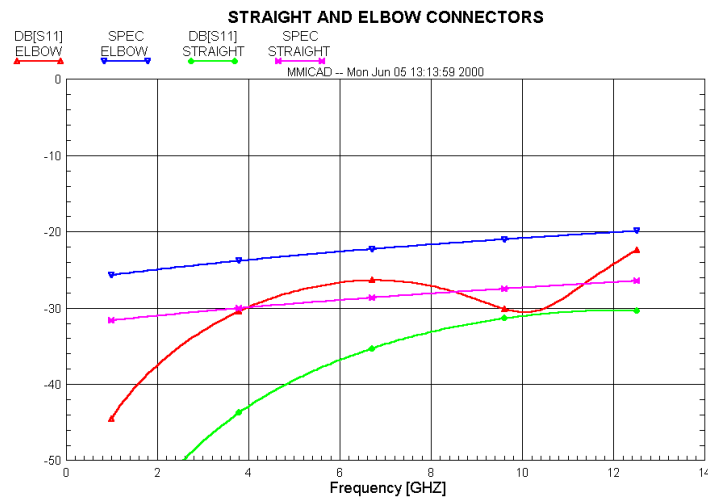


Figure 3: Comparison of reflection of the elbow and straight connectors (for a single connector). The specification value from Radiall catalog is shown in the same plot for reference.

2 EFFECTS WITH A CRYOGENIC AMPLIFIER

For the evaluation of the effects of the elbow connectors in the performance of a cryogenic amplifier, the model used for the design of the 4-8 GHz IF amplifier for HIFI was used. A cable of 60 mm with connectors was assumed at the input. The losses determined for the cable at room temperature (0.5 dB/m @ 1 GHz) were assumed to decrease in the usual factor at 15 K (to 0.1 dB/m @ 1 GHz). These losses were scaled according to the measurements with the square root of the frequency. The results of the simulation for the amplifier without input cable, and with the two different cables (with elbows and straight connectors) are shown in figure 4.

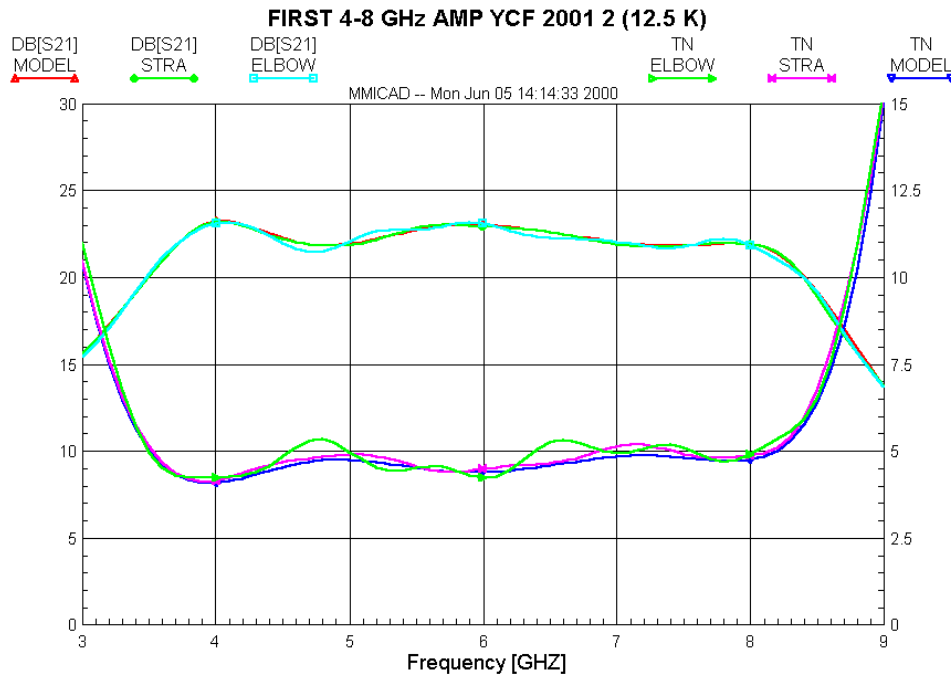


Figure 4: Comparison of the results of the model for three different situations: a) no input cable, b) 60 mm cable with straight SMA connectors and c) 60 mm cable with elbow SMA connectors.

3 CONCLUSIONS

From the results of the simulation, the cable with two elbow connectors clearly adds a ripple to the amplifier noise of about 0.8 K peak to peak. The cable with straight connectors adds a ripple of less than 0.2 K peak to peak. The effect on gain is less important, with an additional ripple of 0.4 dBpp for the two elbow connectors and negligible for the two straight connectors. It is interesting to note that the reflection coefficient of the connectors is relatively good in the band (better than -25 dB for elbows), but still has a measurable effect in the noise. In a real receiver other effects, like the output impedance of the isolator, may dominate, and the effect of elbows may be acceptable.

4 ADNOWLEDGMENTS

This work has been founded in part with the CICYT and European Commission project 1FD1197-1442.