ISCE

The Institute of Sound and Communications Engineers

Engineering Note 3.2

Matched microphone attenuator

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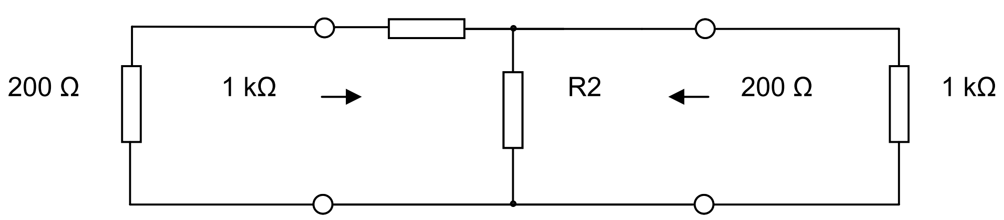
Professional low-impedance microphones are normally designed to present a source impedance of 200 Ω, and require a load of 1 kΩ, provided by the mixer input. An attenuator placed between the microphone and mixer should preserve these conditions, both proper termination of the microphone and low-noise conditions in the mixer. These are not the normal matching conditions for an attenuator, where the source and load impedances are equal.

We require the attenuator input resistance to be 1 kΩ when the output is terminated with 1 kΩ, and the output source resistance to be 200 Ω when the input is terminated in 200 Ω. The attenuator should be balanced, but we can analyse it as an unbalanced configuration.



It makes the calculations clearer if we work in kilohms, so that 1 kΩ appears as '1' and 200 Ω appears as '0.2'. Applying Ohm's Law at the output, we force the output source resistance to be 1 kΩ:

(R1 +0.2)/(R1 + 0.2 + R2) = 1....................................... (1)

and at the input, to force the input resistance to be 200 Ω:

R2/(1 + R2) + R1 = 0.2... (2)

Multiplying out, we get:

R1R2 + 0.2R2 = 0.2R1 + 0.04 + 0.2R2......................... (3)

in which the '0.2R2' terms cancel, and:

R2 + R1 + R1R2 = 1 + R2.. (4)

R2 kindly departs from (3) by itself, and we can get rid of R1R2 by subtracting (3) from (4), giving:

1.2R1 = 0.96

R1 = 0.8 (kilohms, remember!)

Substituting R1 = 0.8 back into (3), we get:

$$0.8R2 = 0.2 \times 0.8 + 0.04$$

$$R2 = 0.25 \text{ (kilohms)}$$

Since the impedance requirements have fixed the resistor values, we cannot independently choose the attenuation, so if it were 1 dB or 100 dB we will have wasted our time. We had better calculate it.

Just connecting the 1 kΩ load to the 200 ohm microphone attenuates its no-load output by 1/1.2 = 1.22 dB. That is the loss up to the left-hand pair of terminals. The attenuator then acts as a voltage divider, whose ratio is:

$$(0.25 \| 1)/(0.25 \| 1 + 0.8) = 0.2 \text{ , or 14 dB}$$

where the ‖ symbol means that we take the value of the two resistors in parallel. So, the *extra* attenuation introduced by the network is 14 dB, which fortunately is a very practical value.

To make the attenuator balanced, all we have to do is to split the 800 Ω resistor into two 400 Ω ones, and put one in each input lead. For practical purposes, 390 Ω and 220 Ω or 270 Ω resistors can be used.