Step By Step Procedure For Measurement of Loudspeaker Voice Coil Operating Temperature in Real-Time

The following describes a method by which the temperature of a loudspeaker voice coil may be continuously monitored as the coil is heated by an applied signal. This signal may be in the form of steady state or swept sine waves, filtered or unfiltered noise, or music.

Referring to the attached circuit diagram, the voltage (V) across capacitor C3 is proportional at all times to the voice coil resistance (R), and is governed by the relationship:

$$(1) \qquad V = \frac{R}{R_1 + R} \times V_s$$

so that

$$(2) \qquad R = \frac{R_1}{\left(\frac{V_s}{V-1}\right)}$$

where V_s is the applied DC voltage across C_2 (supplied by means of a precision DC power source), and R_1 represents the value of a precision resistor, expressed in ohms.

The DC resistance of the voice coil wire is a linear function of temperature as follows:

$$(3) \qquad R(T_1) = R(T_0) \times [1 + a(T_1 - T_0)]$$

where: T_0 = the initial temperature of the voice coil (usually ambient) in °C

T_1 = the elevated temperature of the voice coil during operation, in °C

$R(T_0)$ = the voice coil DC resistance at T_0 , in ohms.

$R(T_1)$ = the voice coil DC resistance at T_1 , in ohms.

and a is the thermal coefficient of resistance of the voice coil wire, given by the formula:

$$(4) \qquad a = \frac{1}{\left(\frac{1}{c}\right) + (T_0 - 25)}$$

where c = 0.00385 per °C for copper wire or 0.00401 per °C for aluminum wire. At T_0 = 25° C, this equation becomes simply $a = c$.

Since from equation (3):

$$(5) \quad R(T_1) - R(T_0) = Ra(T_0)[T_1 - T_0]$$

then

$$(6) \quad T_1 = \frac{1}{a}\left(\frac{R(T_1)}{R(T_0)} - 1\right) + T_0$$

and substituting equation (1):

$$(7) \quad T_1 = \frac{1}{a}\left[\frac{V_s - V(T_0)}{V_s - V(T_1)} \times \frac{V(T_1)}{V(T_0)} - 1\right] + T_0$$

where:

$V(T_0)$ = voltage across capacitor C_3 at T_0

$V(T_1)$ = voltage across capacitor C_3 at T_1

Thus, we see that voice coil temperature may be calculated from (7) knowing four factors:

1. a, which is given above for the two most common voice coil materials.
2. $V(T_0)$ and **3.** T_0, measured at the start of the experiment using the suggested circuit.
4. $V(T_1)$, measured during the experiment.

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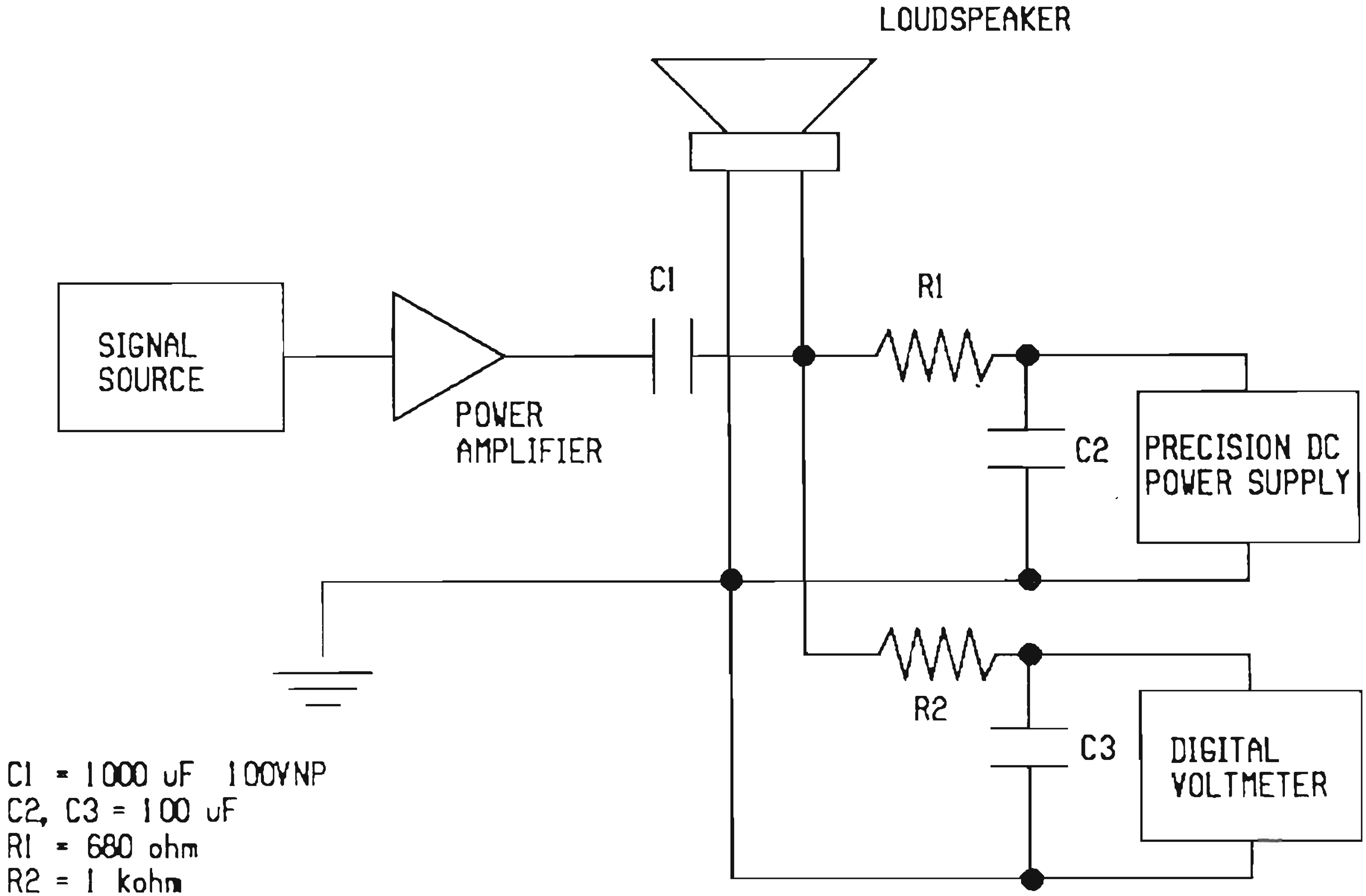

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