## What is the minimum size allowed for R1 that will not damage the speaker in the circuit in Fig 1?

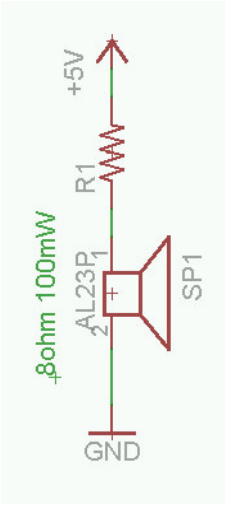

Fig. 1

Let Is equal the current flowing through the speaker
Let Vs equal the voltage drop across the speaker

Using Ohm's law ($V = I \times R$ or $I = \frac{V}{R}$)

**Eq 1**: $Is = \frac{Vtotal}{Rtotal} = \frac{5}{R1 + 8}$

Using Ohm's law again
**Eq 2**: $Vs = Is \times Rs = Is \times 8$

Substituting Is from Equation 1 into Is in Equation 2 yields
**Eq 3**: $Vs = \frac{5}{R1 + 8} \times 8 = \frac{40}{R1 + 8}$

Using the formula for Watts ($W = V \times I$) the wattage consumed by the speaker is
**Eq 4**: $Ws = Vs \times Is$

Using 100mW for Ws and sSubstituting Vs from Equation 3 and Is from Equation 1 into Equation 4 yields
**Eq 5**: $100mW = \frac{40}{R1 + 8} \times \frac{5}{R1 + 8} = \frac{200}{R1^2 + 16R1 + 64}$

Multiplying both sides by $R1^2 + 16R1 + 64$ and dividing both sides by 100mW yields

$R1^2 + 16R1 + 64 = \frac{200}{100mW} = 2000$ or $R1^2 + 16R1 - 1936 = 0$

This quadratic equation has two solutions 36.72 and –52.72

Negative value resistors are extremely hard to come by which leaves

**36.72Ω as the minimum resistance value for R1**