JVB Electronics

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SA-16-AR THEORY OF OPERATION

Background

The SA-16-AR was designed as a direct replacement for the Aetna-Pollak potentiometer used in many loudspeakers designed by Acoustic Research. The Aetna-Pollak potentiometer was a very high quality 16-Ohm potentiometer that, among other features, included a nichrome resistance element embedded in ceramic. The pot is a "linear" type (the resistance tap changes linearly with rotation). The specified factory settings for the AR-3a were 1.75 Ohms for the tweeter and 3.25 Ohms for the midrange. This means, when the factory settings are used, that only 11% of the resistance wire is in series with the driver for the tweeter and 20% is in series with the mid-range driver resulting in 74% of the power dissipation for the tweeter control being dissipated in 11% of the winding. For the mid-range control, 80% of the power is dissipated in 20% of the winding. Only a small part of the resistance wire winding is dissipating most of the power in the pot, leading to higher temperatures in that section of the resistance wire. The sliding contact is resting at the edge of the hotter wire and thus is heated more than the entire potentiometer, leading to accelerated corrosion or oxidation both on the center contact and the windings themselves. This results in the infamous dead spots on the pots and, eventually, to a completely dead pot.

Design Goals

The SA-16-AR was designed to:

- Directly replace the Aetna-Pollak potentiometer

- Move the heat source (resistance) away from the switch contacts

- Have a balanced power dissipation allowing higher power in the series resistance (the equivalent of the small section of resistance wire in series with the driver)

- Allow operation with each resistor dissipating less than the rated value with 10 Volts Root Mean Square (RMS) voltage applied continuously in the frequency band of the driver at any setting of the switch. Under normal operation, 10 VRMS

is equivalent to 25 Watts at 4 Ohms continuous to the single driver. The total speaker power would be several times higher. Music peaks could easily be 10 dB higher (250 Watts) in the band for a short time without causing any problems with the attenuator. Power levels this high would probably only be seen in single-tone testing or severe clipping and would probably result in the destruction of the drivers. In short, the power handling design goal of the attenuator is to easily handle any power level the drivers can survive.

- Make the connection to the resistance elements reliable, repeatable, and unaffected by the power level of the music or vibrations caused by the music.

Design Details

The schematic diagram shows the design details. The SA-16-AR uses series and parallel 2-Watt metal oxide power resistors as needed to increase the power handling capability. For example, when switched to one click from the highest setting, three 1.5 Ohm resistors in parallel allow 6 Watts of power dissipation for the first 0.5 Ohms of series resistance. With 10 VRMS applied, each of these resistors would be dissipating 1.2 Watts, well under their 2-W rating. The following table shows the series resistance, the parallel resistance (16 Ohms minus the series resistance), the attenuation (assuming a 4 Ohm driver) and the maximum power dissipated in any single 2-Watt resistor with 10 VRMS applied in a 4 Ohm system (AR-3a, etc.). The dB (8 Ohm) column is included to show the attenuation if used in an 8 Ohm system (AR-2 etc.).

Step	R(series)	R(parallel)	dB (4-Ohm)	Pwr-Max	dB (8 Ohm)
12 (Full On)	0	16	0.0	1.4	0.0
11	0.5	15.5	-1.3	1.2	-0.8
10	1	15	-2.4	1.4	-1.5
9	1.75	14.25	-3.9	1.6	-2.6
8	2.5	13.5	-5.2	1.2	-3.5
7	3.25	12.75	-6.3	0.9	-4.4
6	4	12	-7.4	0.8	-5.3
5	5	11	-8.6	0.8	-6.4
4	7	9	-11.0	1.0	-8.5
3	9.4	6.6	-13.6	1.7	-11.1
2	12.4	3.6	-17.6	1.5	-15.6
1 (Off)	16	0	OFF	1.4	OFF

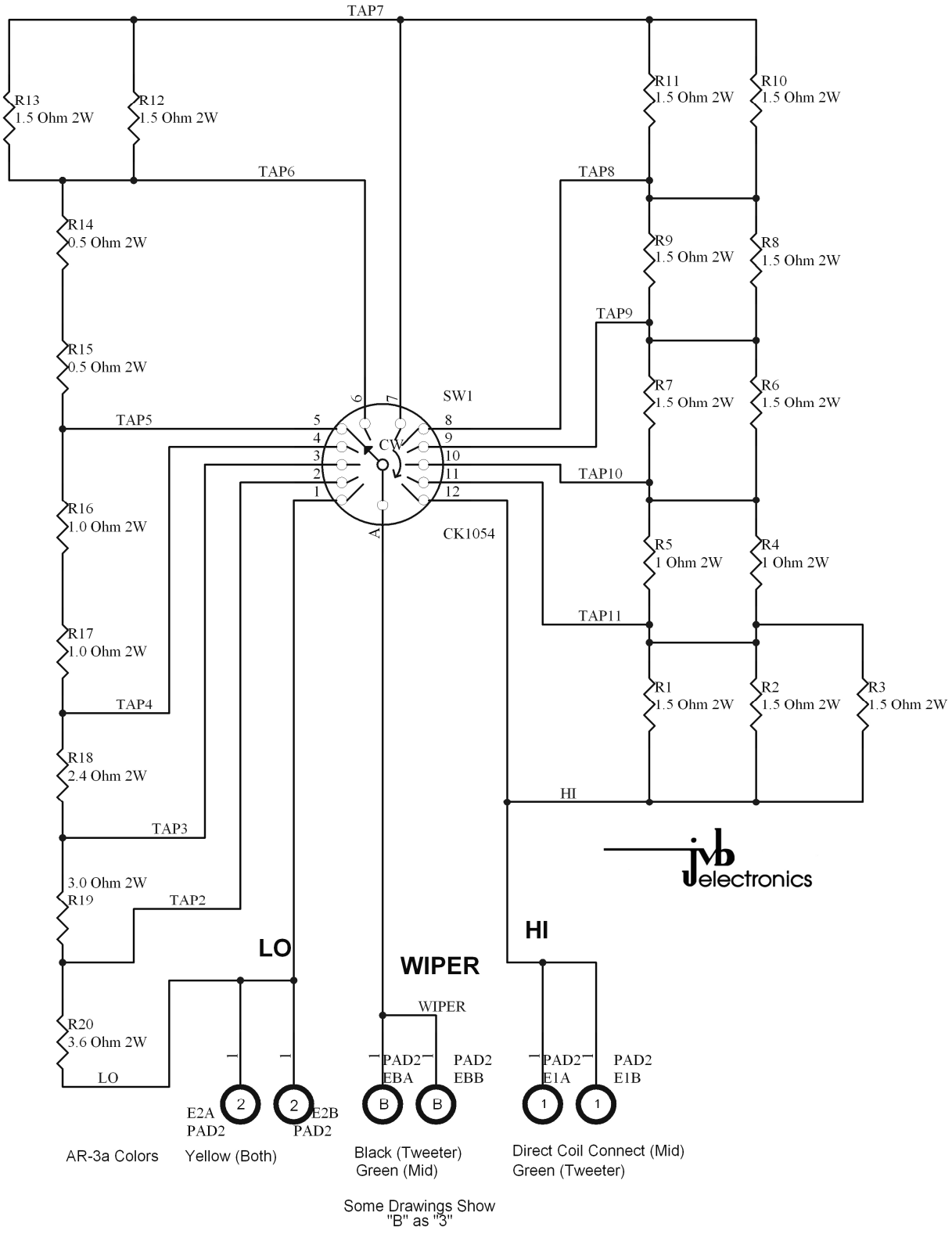

Figure 1. SA-16-AR Schematic Diagram.