This is a slightly edited version of a technical paper that was originally published by SBE Electronics, the current manufacturer of Sprague brand capacitors (now deleted from their site).

DOES THE LOCATION OF THE "OUTSIDE FOIL" OF A FILM CAPACITOR MAKE ANY DIFFERENCE?"

Audio hobbyists often ask, "I am designing an audio amplifier and have a question about using PVC caps as tone and coupling capacitors. Articles in recent audio journals have recommended orienting the capacitor so that the outer foil connects to the "incoming signal" and the inner foil to the ‘output’ side of the circuit. The articles I'm referring to state that the outer foil is connected to the lead that's to left of the label and the inner foil to the right. Is there a way to tell, from the labeling or the ‘left’ or ‘right’ side of the PVC caps, which is the outer and which is the inner foil? Why is the outside foil no longer marked?"

These questions raise some interesting points, and the answers I have may be somewhat controversial in the world of "audiophiles," but I will back up my opinions with technical explanations.

Some background...

First of all, our manufacturing process for PVC capacitors cannot, and never could [even when Sprague manufactured these capacitors], differentiate which lead is connected to the outside foil.

Second, even though some of our products may have markings that could be construed as "outside foil," they are not.

RATIONALE FOR THE USE OF “OUTSIDE FOIL:”

To me the logic is clear, use the outside foil as a "shield." The CONCEPT works even if one terminal of the capacitor is not grounded. If I were to pay attention to which lead was the outside foil, my rule would be: "Connect the outside foil terminal of the capacitor to the lowest impedance side of the circuit." For coupling applications this means "orient the capacitor so that the outer foil connects to the "incoming signal" and the inner foil to the "output" side of the circuit." Signal sources are almost always lower impedance than signal loads.

For tone control circuits it is not as simple to define the signal in and signal out terminals of the capacitor. Tone control circuits operate with significant AC voltages across them. For the case where one end of the capacitor is grounded [such as in a simple treble cut circuit] the rule breaks down. In this case, the signal source should not be connected to the outside foil; the outside foil should be connected to ground. However, I do not believe use of the outside foil concept is meaningful for audio applications. There are so many more important issues.

For coupling applications, assume the use in a vacuum tube triode amplifier. Pentode analysis is similar, but will show that factors other than outside foil orientation are even more critical to performance.

For coupling to occur, the AC voltage across the capacitor must be near zero. That means that the AC impedance to ground at frequencies of interest is nearly the same at both ends of the capacitor.

The thing most folks forget when talking about the "value" of correct outside foil connection is the impedance of the capacitor itself. Lets say the plate load resistor of the source stage is 100K ohms, and the grid resistance of the load stage is 1 meg. For grins pick a coupling capacitance value of 47nf. At 60Hz, the capacitor impedance is 56K, a small fraction of the 1M grid resistance. Doing a simplistic analysis [and ignoring tube plate resistance], the total impedance looking back from the grid to the plate load is the square root of (100K squared + 56K squared) or about 115K. This means that if one got the coupling capacitor too close to the heater wiring the hum pickup would be nearly the same, regardless of which lead was the outside foil! The fix is to dress all high impedance signal carrying wire and components as far as possible from undesired sources. Keep all high impedance signal runs as short as possible, or run them in shielded cable. Better yet, remove undesired sources from the environment.... such as running the tube heaters with regulated DC.

From experience, that works very well. I have an old tube-type HP signal generator that had interference problems at lower harmonics of 60Hz. DC on all heaters completely eliminated the problem. For tone control applications I cannot be as specific without the circuit diagram at hand, but the analysis is the same. The wire dress and component placement are MUCH more important than outside foil orientation.

In my opinion the "outside foil orientation issue" has remained an active discussion topic in audiophile culture because it is perceived as a simple concept to implement. The best news about consideration of capacitor "outside foil" is that the correct implementation of its concepts [or even incorrectly implementation] can do no harm! The other good news is that discussion on this topic is a great springboard into a discussion of topics that really do influence the design, construction, and audio quality of the signal.

Should you decide that location of the outside foil remains important, the best way to determine the lead connected to the outside foil is to build a test oscillator that uses the capacitor in question as a resonating or frequency determining element.

One side of the capacitor must be at the circuit "common" or ground potential. Adjacent to the capacitor one would install a metal plate connected to a very high impedance [>10 megohm] amplifier. If the outside foil is connected to the circuit common, there will be little if any signal capacitively coupled to the test plate. If the inside foil is grounded, the voltage changes on the outside foil will be coupled to the high impedance amplifier.

Lastly, I have never had any application questions concerning location of outside foil except from those constructing or rebuilding vacuum tube audio equipment. There do remain some capacitor applications where I could be convinced that location of the outside foil connection *can* influence circuit behavior, so I remain with an open mind on the subject.

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