

Howdy!

I often am asked which value of tone capacitor works best for a given pickup. This month's tech tip will provide you with a method for installing two different tone capacitors (aka "caps") in an instrument and changing between the two "on the fly".

But first, what are tone capacitors and what are they used for?

Tone capacitors are paired with a variable potentiometer ("pot") in an electric guitar or bass to allow the player to remove a portion of the treble frequencies from the output signal of one or more pickups. Electrical engineers refer to this simple frequency filter as an "RC circuit". The frequencies removed are a function of the value of the resistance, R [units: Ohms] and capacitance, C [units: micro-Farads]. The range of average human hearing is from a low frequency of 20 Hertz [Hz or cycles per second] and a high frequency of approximately 20,000 Hz. Useful tone controls would operate within this range.

As one changes the value of R in the tone control circuit by rotating the shaft of the tone pot the "cutoff" frequency is changed.

I used the RC circuit calculator on <http://www.pronine.ca/rccir.htm> to calculate the cutoff frequencies in the following tables:

Table 1, Cutoff frequency, Fc calculated as a function of R for a fixed value of C= 0.047 micro-Farads

Capacitance, C [micro-Farads]	Resistance, R [Ohms]	Cutoff frequency, Fc [Hz]
0.047	0.169	20,000
0.047	1.69	2,000
0.047	16.9	200
0.047	169	20

Table 2, Cutoff frequency, Fc calculated as a function of R for a fixed value of C= 0.022 micro-Farads

Capacitance, C [micro-Farads]	Resistance, R [Ohms]	Cutoff frequency, Fc [Hz]
0.022	0.361	20,000
0.022	3.61	2,000
0.022	36.1	200
0.022	361	20

From these tables you may start to recognize why guitar circuits which use tone capacitors with a value of 0.047 micro-Farads often employ tone pots which have a range of 0.1 to 250 k-Ohms and instruments which have 0.022 micro-Farad tone capacitors use tone pots which have a range of 0.1 to 500 k-Ohms (modern standard) or 0.1 to 300 k-Ohm (vintage standard).

Another way to gauge the effect of the value of a tone cap is to calculate the cutoff frequency

Table 3, Cutoff frequency, Fc calculated as a function of C for selected values of R

Resistance, R [Ohms]	Capacitance, C [micro-Farads]	Cutoff frequency, Fc [Hz]
0.36	0.022	20,000
0.36	0.047	9361
3.6	0.022	2,000
3.6	0.047	936
36	0.022	200
36	0.047	93.6
360	0.022	20
360	0.047	9.36

The data in Table 3 suggests that the larger value capacitor (0.047 micro-Farads) has a lower cutoff frequency (F_c) for a given resistance, R . The effect we experience with the 0.047 micro-Farad tone capacitor as compared with the 0.022 micro-Farad tone capacitor is a more pronounced elimination of treble frequencies as the tone control is engaged.

I hope this information is helpful to you.

Best Wishes.