Guitar Pickup Measurements 2

© *Malcolm Moore*
23-Jan-2003

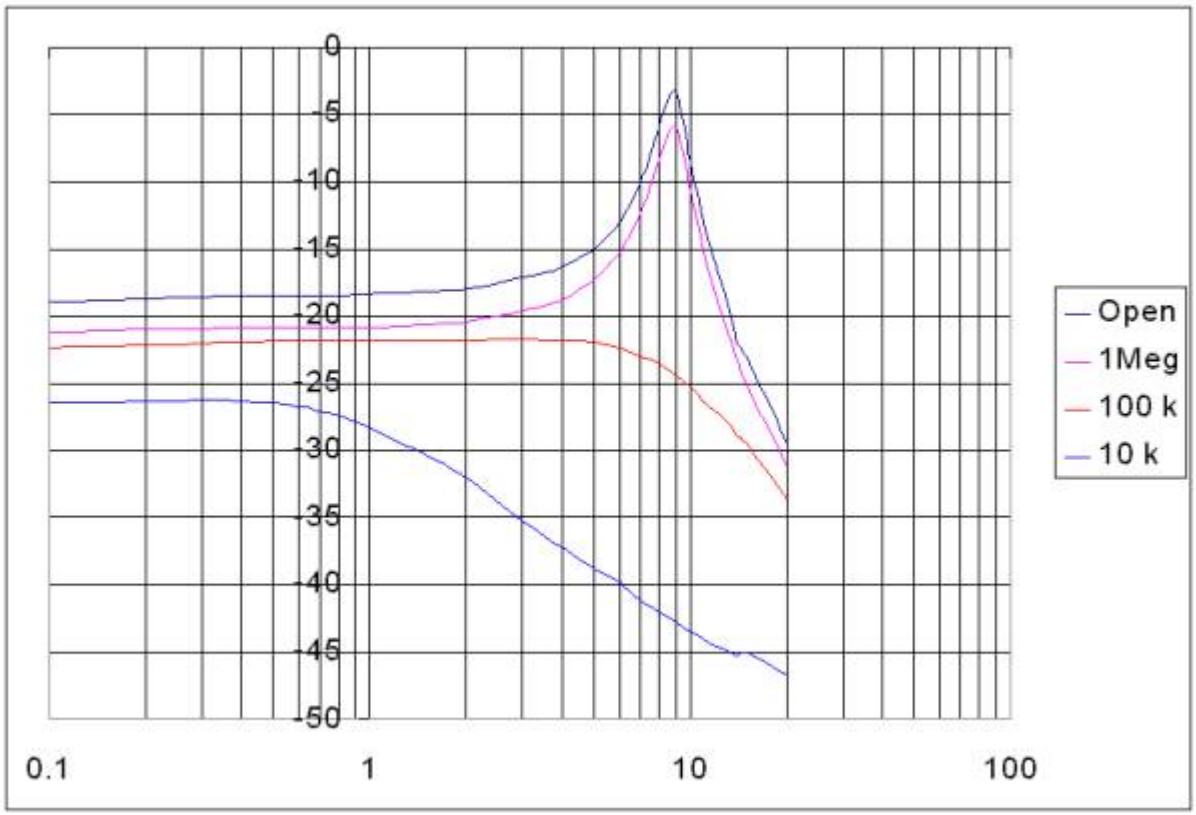
(2003, May 2007)

Frequency Response Tests

In this case, each pickup is placed nominally 20 mm from the exciter coil (and in the case of a Hum Bucker offset to give a maximum response), then the frequency responses measured with differing load resistors (50 M ohms, 1 M ohm, 100 k ohms and 10 k ohms).

These different loads give differing results, and these have been graphed because it is rather difficult for most people to visualise numbers.

The Test figures were put into an Excel Spreadsheet, then graphed, and changed to log axis, and then made into a picture.



The above graph is the practical results obtained using the Strat 02 pickup with different resistive loads. Referring back to the earlier analysis where predicted values gave almost identical results, it is now clear that all these pickups will follow the same general family of frequency responses, and that response can be predictably tuned by changing the load resistor (and the load capacitor).

There are three different scenarios going on here:

- In the first instance with the 10 k ohm load, the 3 dB point is about 1 kHz, and then the response falls off at –20 dB/decade, but the noise floor is about –48 dBV in this case so the response levels out above –50 dBV.

- In the second instance with the load being 1M ohm or greater, the ‘system is underdamped’ and it has a resonant peak at about 9 kHz about 14 dB above the stable level. This is a classic second order filter response with the roll-off above the peak at about -40 dB/decade. This resonant peak is caused by the resonance of the coil inductance with capacitance and in this case wiring and self-capacitances.
- In the third instance with a 100 k ohm load, the response is virtually flat till about 10 kHz where it then goes into a –40 dB/decade slope, is in this instance it is a ‘just overdamped’ second order system.

This graph is extremely powerful as it links the measured electronic values (resistance and inductance) of any electromagnetic pickup to a predictable frequency response – knowing the load resistance and load capacitance; which can be set as desired.

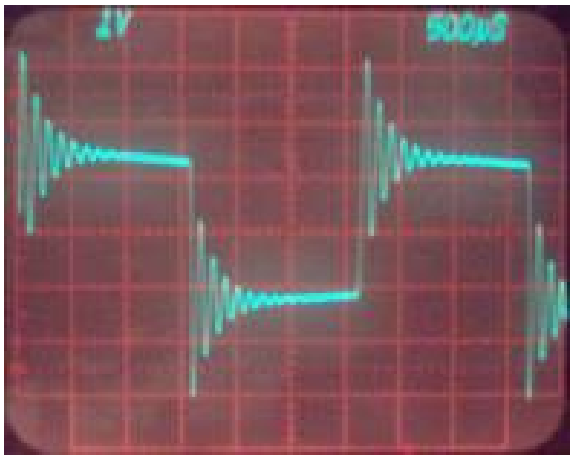
Now there is a lot more! Not only can we predict with reasonable confidence the size and shape of the pickup response (to get that special sound), but the transient response can also be estimated with reasonable accuracy too.

Underdamped frequency responses will have an overshoot in the transient like a knife blade being held over the edge of a table and flicked. The notes in that range ring on and can give a presence or ‘crisp/crunchy’ sound.

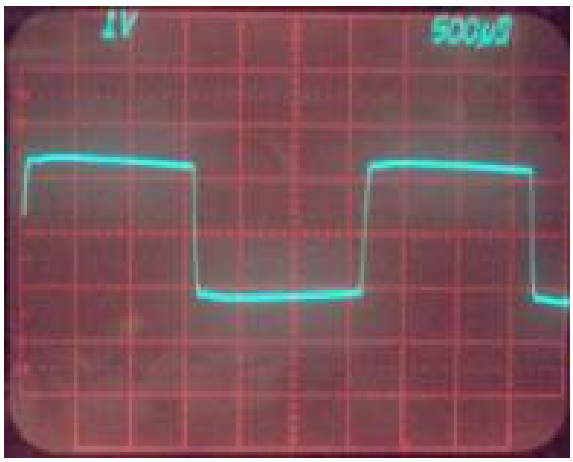
Transient Results

Just to get a picture if transients a ‘square wave’ was fed into the exciter coil and by looking with an oscilloscope to see the output, it is clear that when the frequency response has a ‘resonant peak’ then the transient response will also have a ‘ringing’ response.

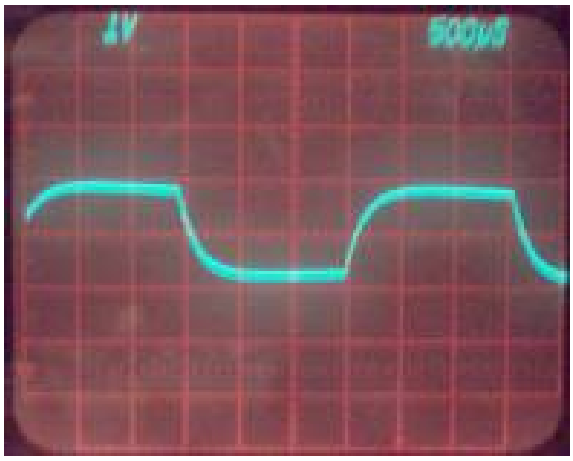
This is the Strat 01 pickup with a 1 Meg ohm load. See that it has a classic overshoot with heavy ringing before becoming stable. The peaks are more than double the step size, and this overshoots with the ringing should explain why amplifier “power ratings” are basically meaningless in overload situations.



The is the same Strat 01 pickup in the same setup as before but the load resistor is now 100 k ohms. This is a classical step and recovery, void of overshoot.



The is the same Strat 01 pickup in the same setup as before but the load resistor is now 10 k ohms. The leading signal edge is considerably smoothed and this is why this has a muffled sound.



So one pickup can give a wide range of predictable frequency responses – just be changing the load resistor and capacitor! All we need is the formulae!

Comments and Corrections are welcome