How to Read your Test Report -
The upper text section of the report shows the basic information about the test conditions such as date and equipment used for the tests. For example, this pickup was measured on April 17, 2011, by sw. That's me. It will also list your model and serial number, and the kind of test equipment I used, and a little about how it was set up. That information helps to validate the results, and is nice to have if later someone wants to repeat the measurements for a rewind or copy.

Next is a chart for the electrical test data. This example is for a humbucker, so it has rows for the averages, each coil, and series or parallel connections as appropriate. There will usually not be data in all rows. For a single coil model, there would only be one row of data unless there is a coil split. The wire colors for the internal connections are shown. In this case the start of each coil is black and the ends are white. The hot and ground are connected to the coil starts, and the ends are joined. This example is connected in series, as is typical. Accordingly there is data in the series row and none for parallel. If there are any notes in parenthesis, they relate to the column heading not the row to save space, since one form is used for everything. The averages calculate automatically, in this case they are the same as the series values. To simplify things, I highlight in yellow the important values for comparison, i.e., all the data most other makers ever publish. For example this pickup has a measured DC resistance of 7.92 K ohms (DCR), and an inductance of 5.334 Henrys. The other data are AC resistance at 1kHz, Capacitance, and Q factor. See the primer for how to interpret these data. The DCR is corrected for temperature to 68°F. The other readings on this row are not temperature corrected and are captured directly from the LCR meter. For humbuckers, all of these measurements are made with the cover on if it has one, unless noted.

The next chart down has the winding data and the magnetic strength measurements. These I manually input for each pickup. The number of turns and winding direction are given for each coil. The winding direction is as viewed looking at the top of the bobbin from the direction of the strings. Next is the magnet alloy and the magnetic strength gauss readings taken in direct contact with each polepiece, with the cover off. The poles are identified by the open note in standard tuning, as a reference. The top row of this chart is a calculated average gauss for the two bobbins, and the overall average is highlighted. This data is not terribly important for comparisons, but highly useful for later rewinds or copies.

Guitar Pickup Test Report — **Sonny's Custom Shop**
Plano, Texas

Date Tested:	4/17/2011 5:23 PM	Tester:sw	
Description:	example	LCR Test Mode:	Serial 1KHz
Model Number:		LCR Meter:	Extech 380193
Serial Number:		Scope/ DMM:	Tektronix 2236

Signal Generator:	Tektronix CFG253
Spectrum Analyzer:	HP 3580A

	Pickup Style		Intended Position	Wire Color Code: Beginning	End	Measured Specifications: Magnetic Polarity	Resistance K ohms DC	Inductance Henrys	ACR k@1khz	Capacitance nano farads	Q @1khz
Averages	HB		neck				7.92	5.334	8.228	3.160	2.120
Adj Coil 1	(PAF		either	blk	wh	S					
Stud Coil 2	style)			blk	wh	N					
Series				shield / blk	join		7.92	5.334	8.228	3.16	2.12
Parallel											

	Number of Turns	Winding Direction	Magnet Type	AvgStrength Gauss	Low E	A	D	G	B	High E	Wire Type
					Magnetic Strength Gauss / Magnet lengths						
Averages			Alnico II	311	327	311	312	307	298	312	42 PE
Adj Coil 1	5000	CCW		303	322	292	307	283	290	326	
Stud Coil 2	5100	CCW		319	332	330	316	331	305	297	
Series											
Parallel											

The next section of the report has the output data and the audio spectrum measurements. To the upper left, the resonant peak frequency is highlighted, along with the average output measurement. Below that, if you have a comparison pickup specified, are listed the principal measured values of the comparison pickup you have selected. Of course, this assumes that I have an example of the comparison pickup available to measure. I can't get this type of detail from published data. If you have not selected a comparison pickup, the lower row of spectrum plots and the comparison values will be from an example I have picked from my library. By the way all the data shown here is just for illustration, it is from different pickups in each major section. To the right are a number of spectrum analyzer plots. The upper pictures are for the pickup under test. The same spectrum for the comparison pickup is shown below it. The spectrums for the resonant peak and C7 are taken for the 0-20 kHz range. Remember lower notes to the left, and higher to the right. This gives an overall picture of the frequency response. There is more technical information about how to interpret these spectrums below, but here is a short interpretation for this specific example. First, notice the frequency of the main peak in the first plot. It is shifted to the right versus the comparison. Looking at the numbers for peak kHz in the chart, you can see this example has a slightly higher self resonance frequency so it should be a little brighter overall than the comparison pickup. In the second plot, compare the heights of the odd and even numbered harmonics to each other and to the main peak to get an idea of richness and smoothness versus an edgier tone. In this case they are very similar, both have a nice difference between the heights of the odd and even peaks, indicating a rich tone. The remaining spectrums are taken in the 0-5 kHz range to zoom in on the response at various frequencies you might have more particular interest in. These aren't as informative but can give some idea of how much response your pickup will have at those notes compared to the reference. In this case, we were trying to nail it, so the graphs should look very similar, although on close inspection there are still some slight differences for example at C6. By the way, the notation C6 indicates the note C in the 6th octave. Notice how the peak in the C6 plot is a little broader. This indicates fatter mids. The example overall is very similar to the comparison pickup but a bit brighter with a little more midrange response. The spectrum capture shots in the test report are standardized and small sized, otherwise there would be room for nothing else on the page. But in the actual testing I may zoom in on areas of interest with the analyzer. Capturing the waveforms takes a lot of time, so for most production pickups, the waveforms shown are generic shots from previous testing of the same model, but guaranteed to be representative of your pickup. I do all the tests on every pickup, but for repeat production it would be too costly to capture the photos of the waveforms every time. If the waveform I see in the test looks just like the generic one I have on file for that pickup model I don't make a new photo. If that is the case, it will be noted on the charts by an asterisk.

All of this testing, numbers, and graphs needs to be taken with a grain of salt. I also put every custom pickup into a test guitar and play it through a good amp, because as Duke Ellington would say, "It don't mean a thing if it ain't got that swing". I measure everything as well as I can, and probably measure more than most other makers do, but there are still plenty of factors and sounds that just won't show up in these charts. Because I have to restring the test guitar each time that procedure takes a lot of time, which probably the majority of makers don't bother with. I can't afford to do that either for every production stock model, but I still do it for every production run.

If you have several comparison pickups in mind, and if I have examples of them in my library, I can also make additional test reports comparing your custom pickup to the others on request. If you are really into the nitty gritty details of comparisons it might be good data to have.

	Resonant Peak KHz	Output mv @ 1046 Hz
Averages	8.338	180
Adj Coil 1	cover on	165
Stud Coil 2	8.322	195
Series	cover off	
Parallel		

Audio Spectrum Capture

0 - 20 kHz | 0 - 5 kHz

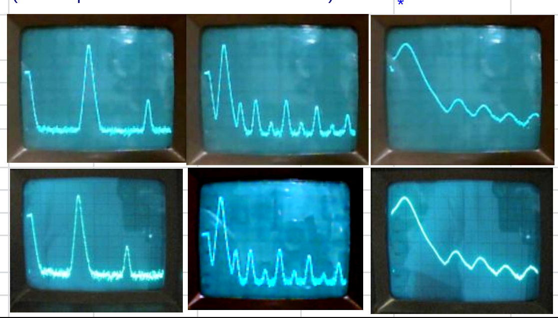
| At Self Resonance | C7 2093 Hz | A 440 Hz

(* = Representative Waveforms See Note1)

*

Pickup Under Test

Reference Comparison Pickup



Comparison Pickup: Gibson Patent Sticker '63 — This Pickup

Comparison Values

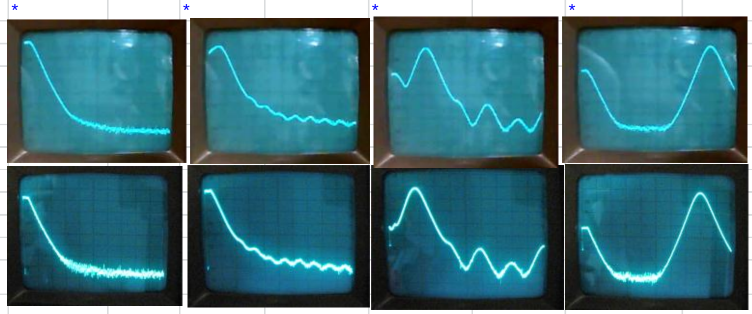
	Gibson Patent Sticker '63	This Pickup
DCR (K ohms)	7.23	8.18
Inductance (H)	4.073	4.544
ACR (K ohms)	11.06	13.068
Capacitance (nF)	6.177	5.412
Q	2.34	2.144
Avg Gauss	316	319
Peak KHz cov off	7.22	8.338
Output mv avg	168.5	180

Audio Spectrums 0 - 5 khz

Lowest Cello Note	Middle C	Highest FemaleVoice	Piano High C
C2 65.4 hz	C4 261.6	C6 1046.5	C8 4186
*	*	*	*

Pickup Under Test

Reference Comparison Pickup



Notes:

Meas.Temperature 80.4 ° F DCR Values Temperature Corrected to 68 F

Short Leg 49.2 mm Nickel Silver Frame - Butyrate Bobbins (Cream), 4 Conductor Leads w/Braid Shield, Bare Nickel Cover

Long Bar M55 Alnico V-U Magnet, Plain Enamel Wire, Maple Spacer, Wax Potted

Technical details on reading the spectrum analyzer plots.

In these plots, the spectrum analyzer instrument is taking hundreds of individual measurements - one for each frequency - and plotting them on the screen. This plot has the amount of electrical response (output from the pickup) as the vertical scale, compared to the frequency which is the horizontal scale. The pickup is being excited by a pure tone coming from the signal generator at the frequency shown for each plot. The pickup is loaded with a commonly accepted test circuit load that simulates a guitar's controls and cable.

The first two plots are by far the most important. Looking at the first plot which is made at the pickup's resonant frequency, and on the 0-20 kHz scale, the first thing to notice is the main central peak. This is the fundamental, which is also numbered as the first harmonic. The higher this peak, the stronger the response at the resonant frequency. I determine the resonant frequency in a separate test with the oscilloscope, and it is noted in the report. This will often or even usually be a different resonant frequency than the comparison pickup. The shape of the peak also gives something of an idea about tone. A pickup with a wide fat resonant peak will have somewhat more of a fatter tone than one with a sharper peak. The further to the right the center of the peak is, the brighter the tone. The further to the left, the darker the overall tone will be. With a little practice reading them, this plot and the next one alone can be a very good indication of the overall tone a pickup will have. The pickup will produce its' best output at its own resonant frequency and at all of the resonant frequency's harmonics. The resonant frequency is characteristic of that particular pickup's construction details. Don't be too concerned if there are more or less smaller peaks in this plot relative to the comparison. Those are the partials or harmonics, which represent overtones, and if your pickup has a higher frequency peak, its' higher harmonics will still be there but possibly located further to the right or off the scale. The important thing is the location of the main peak, its' shape, and the strength of the harmonics relative to it. If your pickup has a higher resonant peak, there may be fewer harmonics showing in the 0-20 kHz range than the comparison. Be sure to take into account that the comparison plot is taken at its' own resonant frequency, which will usually be different than the pickup under test. The human ear can hear about 0-20 kHz, so that is the range of this plot.

The next most informative plot is the one taken at the C7 note, or the high note for a flute, also shown for 0-20 kHz. The important thing here is to look carefully at the relationship of the partial peaks, which are the smaller peaks to the right of the main peak. Their frequencies are at integer multiples of the fundamental (i.e., harmonics). You want to compare the strength of the even numbered harmonic peaks to the odd numbered ones. Count them off one by one starting with the highest peak (the fundamental).* That peak is number one. The closest peak to the right is the second harmonic, which will be one octave higher. It should be strong. The next one which is the third harmonic and all of the odd numbered ones after that should usually be higher in amplitude than their even numbered neighbors. The fourth peak is two octaves higher. After that, the next octave is at the eighth peak, and everything past that is usually too high to hear. The stronger the harmonic peaks are relative to the fundamental, the richer and fuller the tone. For one thing, this is just a characteristic of the natural electrical response of the pickup, and of electrical harmonics in general. And usually for music we want some of both even and odd. Without any harmonics at all, the tone would sound synthetic, like a dial tone which by the way is most often an A. But also, when the odd order harmonics are stronger relative to the even ones, the grittier, edgier, and more appealing the tone will be, up to a point, like putting salt in food. Also a characteristic of the design of AB class amplifiers is to emphasize the odd harmonics, another reason they should be well represented. Almost all tube amps are class AB. The push-pull design of those amplifiers causes even numbered harmonics to partially cancel. Even numbered harmonics sound "nicer" and cleaner, but it is the character of all the harmonics together that our ears associate with guitar sounds and miss hearing when listening to a pickup or an amplifier that is too dull or sterile sounding. I could pick any frequency for this test, but the C7 note is a good place to start, and that is what I picked to standardize for the report. Before getting too carried away overanalyzing all of this, remember that also we are comparing these tests to the same tests done on a pickup that we already know the sound of. The more similar the pattern is, the more similar the sound will be, regardless of any interpretations given to the waveform.

The rest of the plots are zoomed in at a different frequency range, the 0-5kHz range, which is basically the fundamental frequency range of the guitar. These plots are much less important for evaluation, but will show the relative response of the pickup under test to the response of the comparison pickup for the given notes indicated. These plots show how strong the output will be for those notes, and should look very similar to the comparison pickup (assuming that the goal is to get a similar sound to the comparison). These are good to look at when trying to match up a custom pickup under test to a specific comparison example. All together the spectrum plots indicate how similar the overall tone of the pickup will be to the comparison pickup selected.

*(Note, it is easy to get confused about the numbering of harmonics and overtones. Remember the fundamental is also the first harmonic. Overtones are numbered differently, the fundamental is not counted - which can cause confusion. I have had to revise this discussion after reading up on music theory, because in earlier versions I was counting overtones like they were harmonics, which reversed the meaning of the odd and even terms.)

Revised April, 2013.