Confage

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Date: October 17, 2022 REV 10
To: Kurt Denke, Bob Howard
From: Galen Gareis
Subject: ICONOCLAST Speaker Cable Technology.

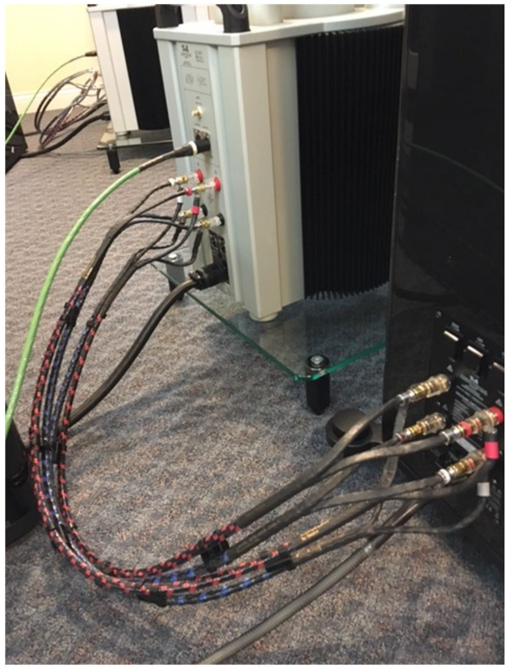
DUAL BI-WIRE and SINGLE WIRE

Blue Jeans constantly tries to drive down the cost of our hobby, and of course we do that with our wire products. The BAV, Belden Audio Video line is a stepping stone to more complex and expensive designs, called ICONOCLAST(TM). The BAV line uses larger production products that are "repurposed", based on test results and wiring configurations, to leverage volume costs.

Four separate and different cable examples demonstrate how parallel cable halves L and R but doubles C. The physics delivers that every time all the time. If this theory is TRUE, it impacts EVERY cable put in parallel. Usage is upon the user to evaluate the change in capacitance based on the root cable electrical and length.

We recently added 1310A speaker and sub cable to our BAV line of products based on excellent test results. This paper will cover exactly WHY we added 1310A and even better, we will show you how to improve speaker cabling, not just ours, to get meaningfully better measured electrical.

What exactly is dual cable bi-wire anyway? Here is the full Monty application pictured below.



In this application we see TWO cable sets parallel to the speaker bi-wire terminals. Each speaker terminal sees FOUR wires in parallel. Why would you want to do this? This report will investigate the double and single parallel cable arrangement and with a full set of measured results using four different speaker cables so we can assess the advantages. The copper draw science; TPC, OFE and SPTPC and other metallurgy have no impact on parallel wires L and C, just R and that is very small. L and C change a lot as we will see.

WHAT'S THE POINT OF THIS?

ICONOCLAST is a woven set of two BONDED PARALLEL wires in PARALLEL with several more: 24 or 48 total parallel wires per polarity. We already use parallel wires to reach electrical properties you can't approach with just two wires and aren't really doing anything new. Electrical circuits seeing different parallel current paths with ALL cable that use insulated multi-wire arrangements. Even though it looks like ONE wire on the outside, it is several in parallel on the inside.

The series II ICONOCLAST pushed the machines as far they can reach proper electrical with smaller 28 AWG wire. To get that last bit of DCR well below audible, TWO cables are used in parallel on the bass side. The series I ICONOCLAST already has low 9600 CMA DCR and is full range so to speak. BOTH design DCR improve paralleled, though. We shall see what this is all about as we work through the actual measurements in this study, so we can see for ourselves what is happening.

Some cables are high capacitance. One cable can load the amplifier far worse than low capacitance paralleled wires. The TOTAL capacitance needs to be calculated to understanding the circuit behavior. A single 1800 pF/foot cable is a higher reactive load on your amp than paralleled 1313A, 1310A or ICONCLAST series I or II cable. Yes, some cable design's are just long capacitors. A capacitor has low inductance and that's the single minded design goal. DCR is just the just CMA area of all your wires added up. What if we want to drive down ALL the variables such that the balance is better for us? Keeping capacitance low is important so the base design's are all low capacitance and inductance. We will see that capacitance ADDS in parallel. One cable, or more added in parallel, adds capacitance from all individual circuits (every single little wire is a R, L and C network).

"WHERE AM I GOING?" SAID THE ELECTRON

How does all this get the right signal to the right place? Electricity is lazy and is frequency dependent, both, and will ALWAYS reach the LOWEST energy state possible static or moving. This is how a cross-over divides up the signal based on the input impedance, or resistance, across a specific frequency range. The electricity will follow the easiest path.

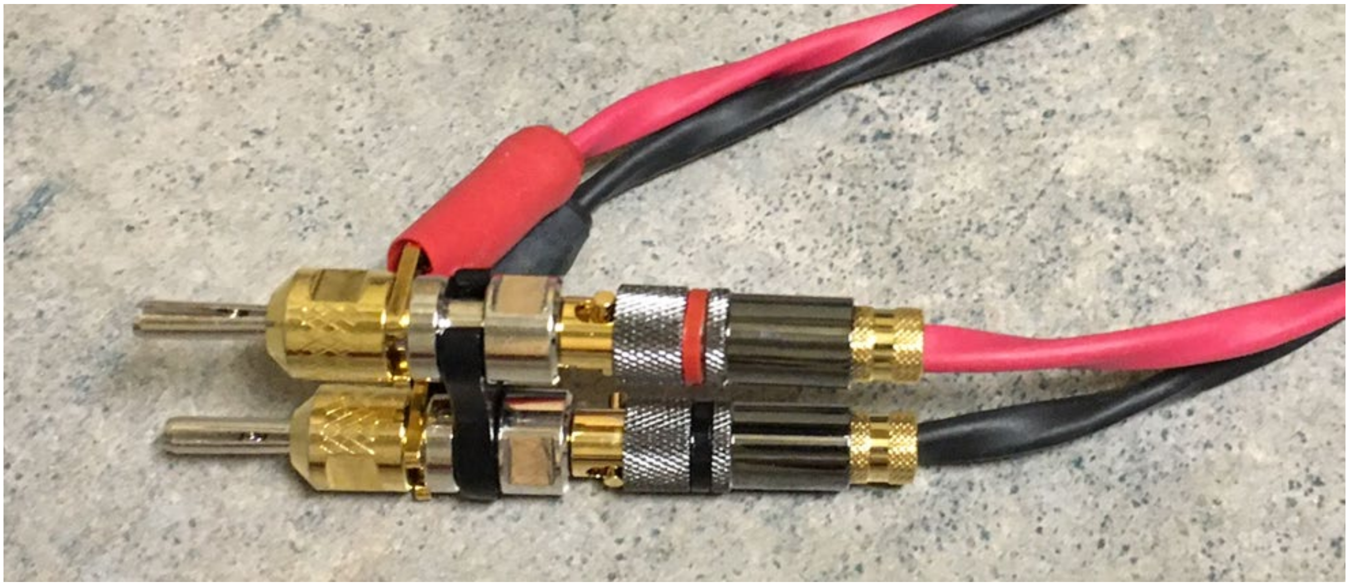
When a frequency leaves the amplifier terminals it, believe it or not, looks at the far end for the LOAD and at that specific frequency and takes the path of least resistance. Consider a speaker with a 200 Hz and a 2000 Hz cross-over inside. Signals that leaves the amplifier below 200 Hz go to the woofer, signals between 200 Hz and 2000 Hz go to the mid-range and signal above 2000 Hz go to the tweeter. The electrons all know the easiest path to the right load based on frequency. The speaker's internal cross-over is designed to tell the electrons where they need to go with frequency. We aren't doing anything different than with ONE wire. The speaker still divides it all up based on frequency. What we are doing is adding a better measuring cable to the circuit with external parallel wiring.

HOW THE TESTS WERE CONFIGURED

In the pictured case above there are TWO identical cables in parallel to each speaker section, woofer (200 Hz and down) and mid / tweeter (200 Hz and up). The cables are 4 feet long and this length has to be considered as we shall see. The cables are all in parallel at the amplifier even though we have TWO sets of terminals. They are still connected in parallel inside the amp...it just makes it easier to hook it all up.

What happens when we parallel cable? From a textbook viewpoint the resistance halves (twice the wire), the inductance halves (half the current in each wire) and the capacitance doubles (twice the plate area). If we add TWO parallel cable sets in parallel, we further keep halving R and L and doubling C. Does cable really behave like the parallel theory says?

To test the cables, high quality Cardas CABD banana were used to parallel the two cables. 10 AWG shorting wire plus spades were used for the "short" open-short impedance tests.



The test configuration allows a reliable and consistent termination. In-use would use the Cardas CABD banana and terminate the second cable spades onto the CABD as shown below. This removes a banana needed for the test set-up when we used locking banana on one cable end, versus the CABD, and spades on the opposite end.

The picture below shows the Cardas CABD banana terminated directly into the amp 5-way binding post with the second parallel cable spade terminated directly into the CABD body.

DATA

The following tables show the measured data for four sets of different cables both single and parallel. Each leg is measured for consistency, and then we parallel and re-measure to evaluate the theory to application. Four cables have been used to give a better idea how this potentially translates to other cable.

TEST EQUIPMENT
LCR METER AGILENT E4980A
DCR METER Valhalla 4176

1313A – 10 feet. 10 AWG dual wire ZIP CORD style.

	SINGLE 1	SINGLE 2	PARALLEL 1+2
Rloop - mOhm	0.0223	0.0227	0.0108
L - uH/ft	0.168	0.168	0.0782
C - pF/ft	15.4	15.7	31.7

1310A – 10 feet. 14 AWG x 4 legs STAR QUAD style.

	SINGLE 1	SINGLE 2	PARALLEL 1+2
Rloop - mOhm	0.028	0.028	0.014
L - uH/ft	0.082	0.078	0.042
C - pF/ft	44.000	44.060	89.200

SERIES I ICONOCLAST – 10 feet. 24 x 24 AWG weave style.

	SINGLE 1	SINGLE 2	PARALLEL 1+2
Rloop - mOhm	0.0237	0.0237	0.0123
L - uH/ft	0.084	0.085	0.0396
C - pF/ft	44.7	43.2	73.96

SERIES II ICONOCLAST – 10 feet. 48 x 28 AWG weave style.

	SINGLE 1	SINGLE 2	PARALLEL 1+2
Rloop - mOhm	0.0298	0.0298	0.0145

L - uH/ft	0.0788	0.080	0.0363
C - pF/ft	62.54	62.29	125.47

The data follows the theory pretty closely. We see that R and L roughly HALVE and the C roughly DOUBLE in parallel. What can we do with this information? It is often difficult to drive inductance low in a single cable. If we chose a cable with the capacitance in check (100 pF/ft or less) we can consider the possibility to DOUBLE bi-cable arrangements and enhance the electrical much more economically. This is a nice way to boost reasonably priced cable's electrical.

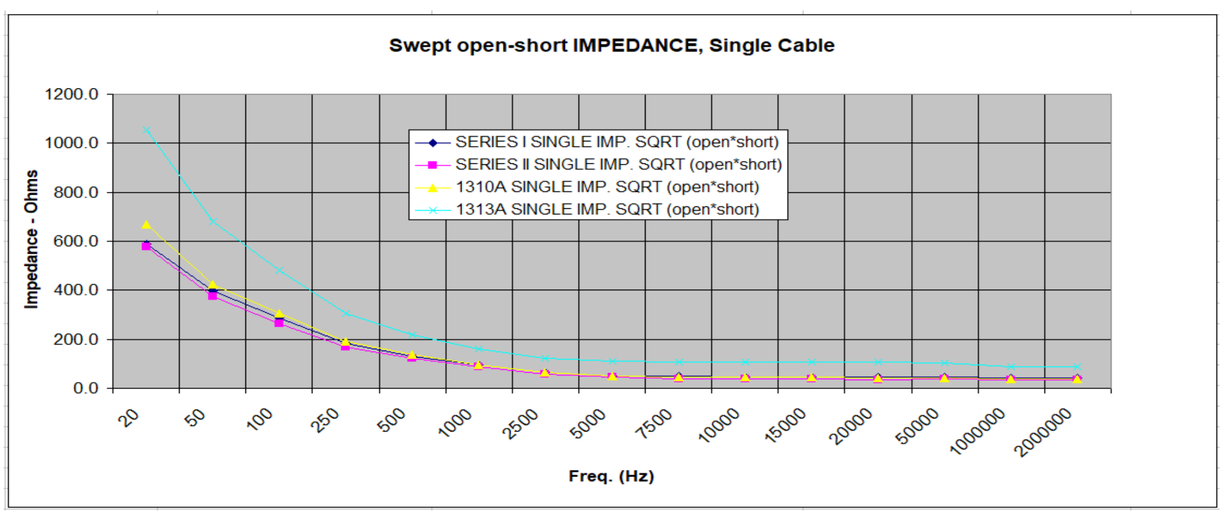
Two 1310A when attached to a single set of binding posts measures to very good electrical values in the table above. What if we want to bi-cable and bi-wire a double set to EACH set of speaker binding posts? The amplifier will see the total capacitive load for all four cables. This is why LENGTH and capacitance, both, need to be considered. Capacitance is per foot. For high quality cable parallel wire is a VERY good way to improve R and L electrical for speaker cable. It is extremely difficult to make a single aggregate cable that measures this well.

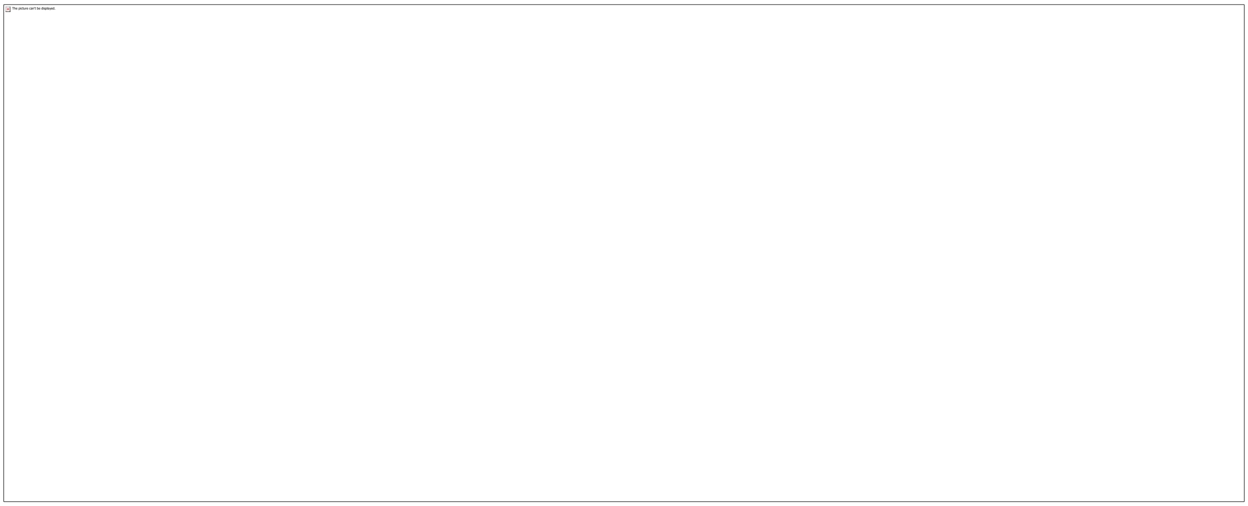
1310A when wired star quad, is two legs in parallel, and then for bi-wire (separating the woofer and mid/tweeter sections) two of those are in parallel to each amplifier's binding post like the initial pictured example using ICONOCLAST, that's four cables in parallel off each binding post to the speaker.

All the current Blue Jeans cable has low capacitance and tested in 10 foot real world assembly lengths and with connectivity. Why worry about capacitance when we all know that the first order filter roll-off is way above audible? Amplifier's that are too capacitive loaded can oscillate. Modern amplifier's are better stabilized than wide-band amplifier of the past but still, adding a cable load PROBLEM that we need to solve with the amplifier's design or a Zobel network isn't the best engineering. This is why I have limited the capacitance of the cable to proper values that even pretty picky amplifier's won't have issue with in 10 feet parallel, and even double parallel, lengths. ***Do check with your amplifier's capability to drive the TOTAL capacitance.***

Looking at the data charts above for each example the INDUCTANCE and RESISTANCE do drop to roughly HALF of what they were before. If capacitance isn't too high we can really give the cable assembly an electrical improvement with parallel cable. What does it do that we can see in the data? We have graphs for that.

All the data is real, and tested, with actual assemblies. Raw data is in the appendix support section. The first graph is the measured IMPEDANCE for ONE cables. Next graph is the IMPEDANCE after we wire two cable in parallel. The data shows that parallel cable reduce the impedance substantially.





The graphs above are the OPEN-SHORT impedance of the ten foot samples. Audio isn't RF, and we can't test short lengths accurately other than open-short for accurate results as the wavelengths are too LONG to fit enough into the cable to be a true transmission-line (typically 10 wavelengths for a stable RF situation). The LENGTH has to be typical of the use as well, so ten foot assemblies have been used to keep the data comparable. Different lengths WILL change the data but not the pecking order of what's low or higher impedance as the R, L and C are per unit length.

The IMPEDANCE is MUCH lower when we put two cables in parallel to the speaker terminals but passive cable cannot be eight ohm through low frequency audio as Vp, velocity of propagation, drops as frequency drops and RAISES the impedance. We can trick that rising impedance problem by doubling up cables and to better match the speaker load.

The frequency range that the most power transfer function is being applied is the WORST impedance match to the speaker. Many discussions about cable center on this issue, and how it helps or hurts the sound quality. Mitigate it as best we can seems to be the most appropriate answer, and we can budget the improvement for our needs.

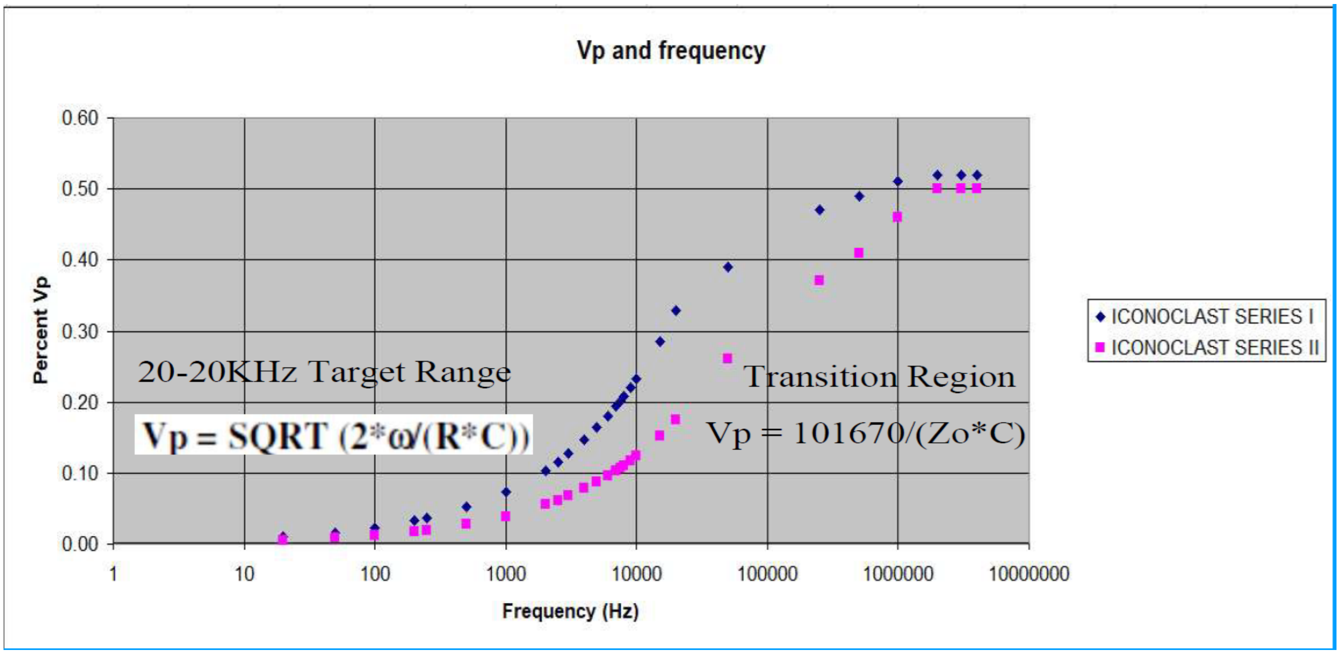
1310A using star quad wiring and ICONOCLAST lower the impedance even when used single wire over 1313A “zip cord”. Dual wire lowers impedance and resistance even more. Zip cord type 1313A isn't electrically ideal enough to mitigate the impedance issue when comparatively measured. 1310A, a reasonably priced cable, eclipses 1313A when it is wired star quad.

The next two chart traces on the next page are just the loop path SHORTED component of the IMPEDANCE data. The 20 Hz and DC loop DCR figures should nearly match if the two test instruments are calibrated properly. I use the Valhalla for DCR and the HP unit for swept points frequency data. We do indeed see proper DCR and 20 Hz loop resistive values at the low DC/20 Hz anchor point.

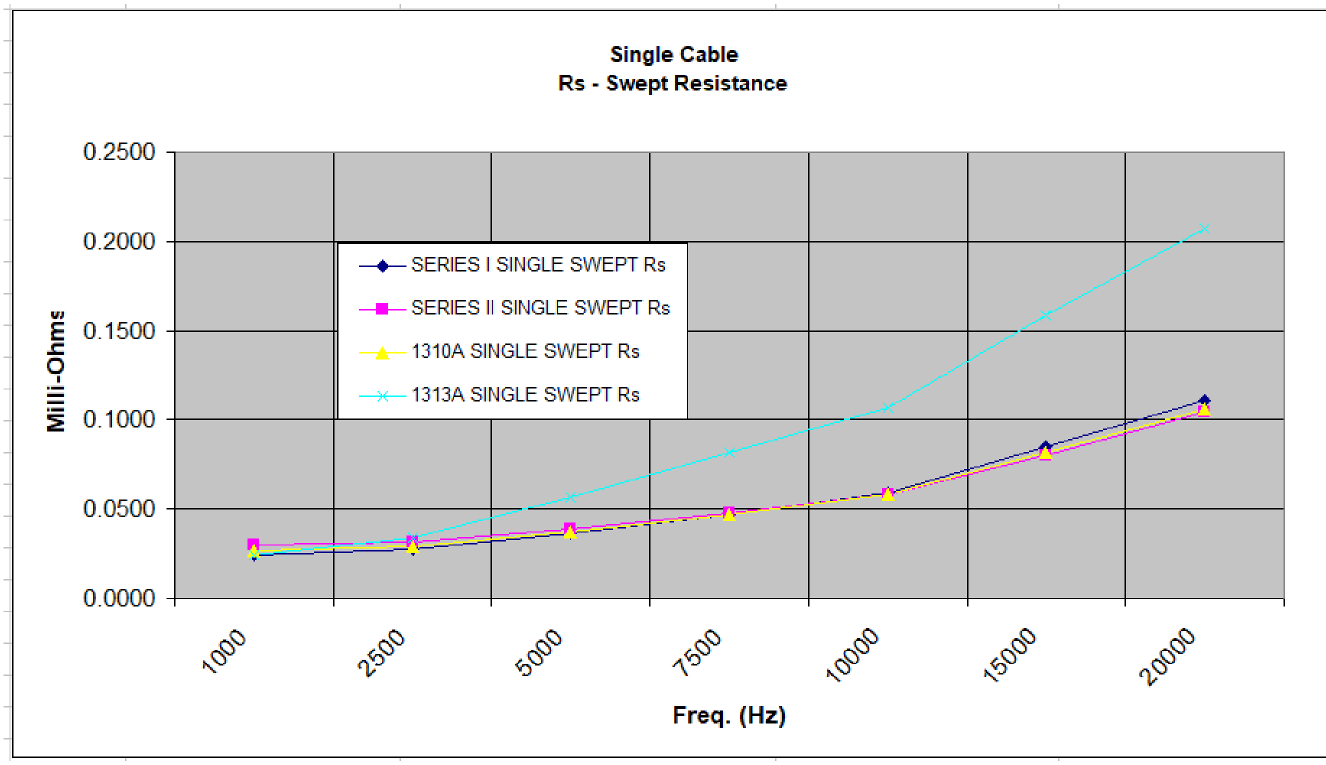
We'd like to see “zero” resistance across frequency and what we see is a composite effect across frequency that increases the resistance even in the audio pass band. Skin depth, proximity effect and attenuation effects to name a few are the culprits. Please look at the UNITS. It is in mill-ohms. That’s a SMALL measure but it is measurable through the analog audible range and below even 10 KHz. 1310A and ICONOCLAST are far flatter through audio. Not all cable can measure really well here.

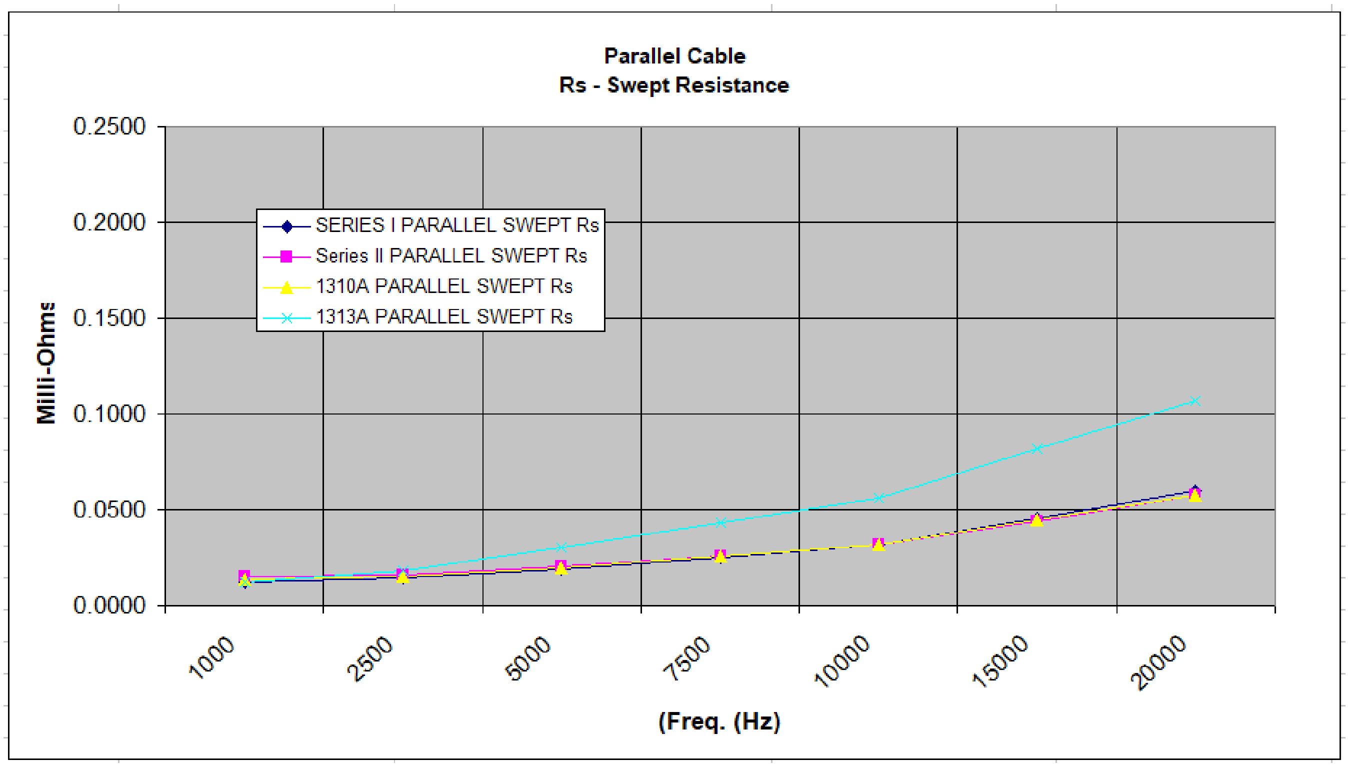
Series II ICONOCLAST does raise the capacitance on purpose to substantially reduce the Vp through audio, and this also keeps the impedance lower. Audio is a trade-off and you can't have both at the same time. One affects the other. Series II flattens the VP so it is more the same through audio but the equation required a higher DCR (28 AWG insulated wire) and higher capacitance to do that. The provided low frequency Vp equation tells you what needs to happen....not how to make it happen.

Simpler 1313A and 1310A cable designs cannot do this optimization with fewer fatter conductors. The BIG wire's DCR is too low. Series II does have the best Rs, lowest impedance and lowest Vp linearity but it is designed to be paralleled to REALLY shoot ahead in the bass region to where it is then the best of the best everywhere.



Comparing the following two charts below we can see that the resistive component of open-short impedance is cut theoretically in HALF when we parallel the cables. The data also shows that that's what we really see in the actual application. This is the BULK frequency resistance, not each individual insulated wire loop frequency resistance. All traces converge at the “DC” loop value at the left side of the charts.





Three designs have a lower impedance average and better resistive Rs uniformity than zip cord 1313A can offer...but the designs get more complex, especially ICONOCLAST that leverages multiple small wires for Vp properties that also optimally tune the capacitance limit at the low end to keep impedance low even with so many small wires used in the two ICONOCLAST designs. ICONOCLAST uses 24 and 48 wires in parallel in each polarity. Then we put those in parallel! Yes, it is a complex circuit best measured as those values are the facts in real world use.

See the ICONOCLAST Vp tech paper. It takes a lot of design work to eke out the Vp effects and not raise the L and C too much all the while keeping bulk DCR and swept resistance impedance low.

APPLICATION

Using this data, we see that paralleling a REASONABLE length cable can be beneficial electrically. All this complexity is still subject to audible evaluations as we just covered graphs and numbers to support the cable arrangement. BAV and ICONOCLAST are all about the numbers supporting what we do and why. If the supporting numbers aren't better what is?

APPLICATION ONE – for a VERY economical solution just parallel your existing single post speaker cable. This makes even 1313A look much better. If we are still wanting to better match speaker impedance at the low end (below 200 Hz or so) we can consider a more complex cable like 1310A or ICONOCLAST in parallel. Series II ICONOCLAST was designed to be used in parallel. Why? Because it eliminates the higher 24x28 AWG DCR. A more complex single cable to mitigate that higher CMA value would cost far more than using two series II ICONOCLAST in parallel. The 65 pF/foot capacitance was purposely used to hold the impedance low as well as the total capacitive load.

The series I or II in parallel double the CMA. CMA, Circular Mil Area, is just the wire diameter squared and added up. When we add the wire path length and connectors compared to the bulk CMA DCR, we measure 1.185 ohm/1000' and 1.49 ohm/1000' for the series 1 and II respectively. See the data charts above and raw data.

1313A will be closest to the calculated CMA DCR. There is one single wire path length, so we measured 1.12 ohm/1000 feet.

APPLICATION TWO – Use a star quad like 1310A. This is really a MULTIPLE parallel "quad" situation. We are already technically two legs parallel with ONE 1310A star quad. This is how we drive down the INDUCTANCE compared to 1313A or zip cord. Put TWO 1310A in parallel and we have another doubling of the paralleling property. This is how the 1310A gets to where ICONOCLAST is on low frequency impedance numbers. For a really nice cost center, use 1310A paralleled to the woofer and mid / tweeter in what I call parallel and bi-wire assemblies.

APPLICATION THREE – This is the most elaborate and expensive method with any cable. Optimally we use ICONOCLAST series I or II. The series I can be used parallel in the bass region at a lower cost, and the series II parallel in the upper mid/tweeter. This is what you see in the earlier picture. Or, you can use series I or II in both places. For the best performance keep the series II ICONOCLAST paralleled in the upper frequency range.

NOTE – DO NOT parallel different cable designs to the same driver(s) as the time based properties need to be crossed over between cable groups and through the frequency range each cable is used across.

SUMMARY

Proper design principles will transfer to other applications if it is a solid, and repeatable, process. We do have unique DESIGNS but the underlying physics is impartial, it works everywhere you use it. This is why 1313A and 1310A act the same as ICONOCLAST when paralleled.

If a cable gets too complex to improve, why not take advantage of measurable benefits of parallel cable? True, we need to add-up the capacitive effects but most cable with less than 100 pF/foot capacitance and shorter lengths will allow you to try this measurably improved solution. Not all cable will show the Rs improvements 1310A and ICONOCLAST do, so be aware that DESIGN influences that parameter. And, the use of multiple small wires to flatten Vp and tune the low frequency impedance, both, are not possible in simpler designs like 1313A and 1310A because the conductors are too low DCR. I covered the Vp issues in a separate paper with calculated and measured impacts of what R and C do with multiple small insulated wire and why it is a better, but VERY complex, solution.

1310A is a new BAV team member part number that with the proper testing and certification for our hobby that does great job of bringing even more value that everyone can afford. Blue Jeans is happy to push and push the lower priced products as close as we can to ICONOCLAST. The provided data demonstrates that 1310A wired in a star quad and parallel arrangement does exact that, it moves above and beyond 1313A but, it is a more expensive design. ICONOCLAST trickle down as much as we can.

SUPPORTING DOCUMENTS

The following are the actual test reports on each cable for those that want to see everything. One thing to note, that Rs impedance at 20 Hz has to near match the DCR tested with a Valhalla unit. The HP is a SWEPT frequency point set of data, and I always check that the DCR and the 20 Hz HP unit are in close correlation to verify the accuracy of the tests.

DATE		6/20/2022				
SAMPLE SERIES		SERIES 1				
SAMPLE LENGTH (inches)		10 FEET				
	SINGLE 1	**SINGLE 2**		**PARALLEL 2**		
Rloop - mOhm	0.0237	0.0237		0.0123		
L - uH/ft	0.084	0.085		0.0396		
C - pF/ft	44.7	43.2		73.96		
Freq.	**SINGLE OPEN (ohm)**	**SINGLE SHORT (ohm)**	**SERIES I SINGLE IMP. SQRT (open*short)**	**PARALLEL OPEN (ohm)**	**PARALLEL SHORT (ohm)**	**SERIES I PARALLEL Zo**
20	1.4750E+07	2.3560E-02	589.5	7.210E+06	1.20E-02	294.3
50	6.6700E+06	2.3560E-02	396.4	3.290E+06	1.20E-02	198.6
100	3.5200E+06	2.3570E-02	288.0	1.720E+06	1.20E-02	143.6
250	1.4500E+06	2.3620E-02	185.1	7.045E+05	1.20E-02	92.0
500	7.2990E+05	2.3740E-02	131.6	3.547E+05	1.21E-02	65.5
1000	3.6600E+05	2.4230E-02	94.2	1.779E+05	1.24E-02	46.9
2500	1.4670E+05	2.7320E-02	63.3	7.130E+04	1.41E-02	31.7
5000	7.3400E+04	3.6200E-02	51.5	3.570E+04	1.90E-02	26.1
7500	4.8900E+04	4.7330E-02	48.1	2.380E+04	2.51E-02	24.4
10000	3.6700E+04	5.9460E-02	46.7	1.790E+04	3.16E-02	23.8
15000	2.4500E+04	8.4960E-02	45.6	1.190E+04	4.54E-02	23.2
20000	1.8400E+04	1.1115E-01	45.2	8.940E+03	5.96E-02	23.1
50000	7.3500E+03	2.7022E-01	44.6	3.580E+03	1.46E-01	22.9
1000000	3.6470E+02	4.8100E+00	41.9	1.777E+02	2.63	21.6
2000000	1.8080E+02	9.6000E+00	41.7	8.780E+01	5.26	21.5

DATE		6/15/2022					
SAMPLE SERIES		SERIES II SPKR TPC					
SAMPLE LENGTH (inches)		10 FEET					
	SINGLE 1	**SINGLE 2**			**PARALLEL 2**		
Rloop - mOhm	0.0298	0.0298			0.0145		
L - uH/ft	0.0788	0.080			0.0363		
C - pF/ft	62.54	62.29			125.47		

Freq.	**SINGLE OPEN (ohm)**	**SINGLE SHORT (ohm)**	**SINGLE IMP. SQRT (open*short)**		**PARALLEL OPEN (ohm)**	**PARALLEL SHORT (ohm)**	**PARALLEL IMP. Zo**
20	1.1500E+07	2.9110E-02	578.6		5.580E+06	1.46E-02	285.3
50	4.8000E+06	2.9100E-02	373.7		2.400E+06	1.45E-02	186.8
100	2.4000E+06	2.9100E-02	264.3		1.230E+06	1.46E-02	133.8
250	9.9650E+05	2.9020E-02	170.1		4.974E+05	1.46E-02	85.2
500	4.9980E+05	2.9300E-02	121.0		2.496E+05	1.46E-02	60.3
1000	2.5040E+05	2.9600E-02	86.1		1.250E+05	1.49E-02	43.2
2500	1.0040E+05	3.1800E-02	56.5		5.000E+04	1.62E-02	28.5
5000	5.0200E+04	3.8600E-02	44.0		2.500E+04	2.02E-02	22.5
7500	3.3500E+04	4.7700E-02	40.0		1.670E+04	2.56E-02	20.7
10000	2.5100E+04	5.8100E-02	38.2		1.250E+04	3.15E-02	19.8
15000	1.6800E+04	8.0500E-02	36.8		8.360E+03	4.42E-02	19.2
20000	1.2600E+04	1.0400E-01	36.2		6.270E+03	5.74E-02	19.0
50000	5.0000E+03	2.7900E-01	37.3		2.500E+03	1.39E-01	18.6
1000000	2.4700E+02	4.5500E+00	33.5		1.235E+02	2.55	17.7
2000000	1.2140E+02	9.0600E+00	33.2		6.040E+01	5.11	17.6

DATE	6/15/2022
SAMPLE SERIES	1310A
SAMPLE LENGTH (inches)	10 FEET

	SINGLE 1	**SINGLE 2**	**PARALLEL 2**
Rloop - mOhm	0.028	0.028	0.014
L - uH/ft	0.082	0.078	0.042
C - pF/ft	44.000	44.060	89.200

Freq.	**SINGLE OPEN (ohm)**	**SINGLE SHORT (ohm)**	**SINGLE IMP. SQRT (open*short)**	**PARALLEL OPEN (ohm)**	**PARALLEL SHORT (ohm)**	**PARALLEL IMP. Zo**
20	1.7170E+07	2.6140E-02	669.9	8.420E+06	1.37E-02	339.1
50	6.9400E+06	2.6120E-02	425.8	3.440E+06	1.36E-02	216.3
100	3.5400E+06	2.6120E-02	304.1	1.730E+06	1.36E-02	153.4
250	1.4200E+06	2.6160E-02	192.7	6.970E+05	1.36E-02	97.4
500	7.1090E+05	2.6200E-02	136.5	3.490E+05	1.37E-02	69.1
1000	3.5650E+05	2.6400E-02	97.0	1.750E+05	1.39E-02	49.3
2500	1.4320E+05	2.9300E-02	64.8	7.040E+04	1.54E-02	32.9
5000	6.7700E+04	3.7080E-02	50.1	3.530E+04	1.98E-02	26.4
7500	4.8100E+04	4.7160E-02	47.6	2.360E+04	2.55E-02	24.5
10000	3.6200E+04	5.8300E-02	45.9	1.770E+04	3.16E-02	23.6
15000	2.4150E+04	8.1900E-02	44.5	1.180E+04	4.46E-02	22.9
20000	1.8110E+04	1.0590E-01	43.8	8.900E+03	5.78E-02	22.7
50000	7.2500E+03	2.4590E-01	42.2	3.560E+03	1.35E-01	21.9
1000000	3.5750E+02	4.1900E+00	38.7	1.766E+02	2.32	20.2
2000000	1.7690E+02	8.1900E+00	38.1	8.730E+01	4.55	19.9

DATE	6/15/2022
SAMPLE SERIES	1313A
SAMPLE LENGTH (inches)	10 FEET

	SINGLE 1	SINGLE 2	PARALLEL 2
Rloop - mOhm	0.0223	0.0227	0.0108
L - uH/ft	0.168	0.168	0.0782
C - pF/ft	15.4	15.7	31.7

Freq.	SINGLE OPEN (ohm)	SINGLE SHORT (ohm)	SINGLE IMP. SQRT (open*short)	PARALLEL OPEN (ohm)	PARALLEL SHORT (ohm)	PARALLEL IMP. Zo
20	5.1900E+07	2.1400E-02	1053.9	2.450E+07	1.10E-02	519.8
50	2.1300E+07	2.1800E-02	681.4	9.950E+06	1.10E-02	331.0
100	1.0700E+07	2.1800E-02	483.0	5.010E+06	1.11E-02	235.4
250	4.2200E+06	2.1900E-02	304.0	2.000E+06	1.11E-02	149.3
500	2.1200E+06	2.2400E-02	217.9	1.000E+06	1.14E-02	106.7
1000	1.0600E+06	2.4200E-02	160.2	5.011E+05	1.24E-02	78.7
2500	4.2500E+05	3.4200E-02	120.6	2.009E+05	1.79E-02	59.9
5000	2.1300E+05	5.6900E-02	110.1	1.007E+05	3.00E-02	55.0
7500	1.4220E+05	8.1400E-02	107.6	6.720E+04	4.31E-02	53.8
10000	1.0670E+05	1.0670E-01	106.7	5.041E+04	5.62E-02	53.2
15000	1.5570E+05	1.5870E-01	157.2	3.362E+04	8.20E-02	52.5
20000	5.3600E+04	2.0730E-01	105.4	2.520E+04	1.07E-01	51.9
50000	2.1700E+04	4.8020E-01	102.1	1.085E+04	2.47E-01	51.8
1000000	1.0000E+03	8.0000E+00	89.4	4.907E+02	4.16	45.2
2000000	4.9580E+02	1.5760E+01	88.4	2.439E+02	8.28	44.9