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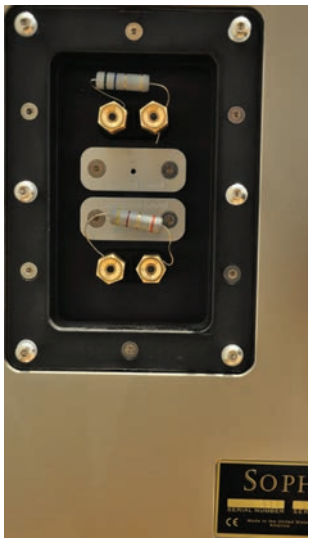
Crossover Resistor Sound

CROSSOVER RESISTORS ARE CONSIDERED THE MOST 'PASSIVE' OF CROSSOVER NETWORK COMPONENTS, BUT THEY CAN STILL AFFECT THE SOUND OF A LOUDSPEAKER, AS MARTIN COLLOMS DISCOVERS

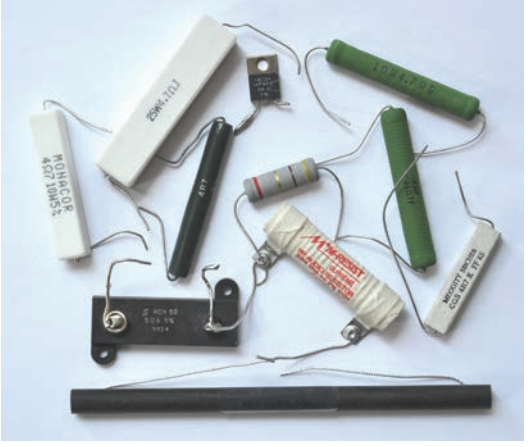


As electrical components go, from a simple technical viewpoint resistors are pretty well behaved. In factors like electron flow, specific resistance and tolerances (and with frequency response errors and distortions typically less than 0.0001%), they're much better behaved than capacitors or inductors.

Capacitors show self-resonance, frequency-dependent dielectric loss and microphony; inductors have magnetic hysteresis, saturation and self-capacitance, among several defects. Any of these may become audible under certain conditions in a revealing audio system. One might therefore suppose that resistors at least are audibly perfect, or at least very close to it.

Nevertheless the metallurgy and the materials used in the physical construction of a resistor, especially the resistive element (which is usually an intentionally poorly conducting film or alloy) have an effect on sound quality, as does the thermal behaviour. While the differences are not huge, we decided to try and find a way to audition them rationally and comparatively.

Issues to take into account include resistance changes with power and thus temperature. Resistance wires are usually alloys of nickel and chromium, with some magnetic interactivity. Film MOX resistors employ a thin layer of metal oxide on a thermally conductive substrate, and this still needs to be connected to external wires. Sometimes these lead out wires are steel or copper-coated steel, to reduce heat flow from the hot element to the rest of the assembly. Composition resistors (such as Duelunds) use a rod of partly conducting, pressed and/or baked material of graphite and other material, a bit like pencil lead, with wrapped or compressed wire terminations. Pure metal foil types may bonded to the thermally conductive substrate and laser trimmed, such as the ultra costly power Vishays which are built for high stability with temperature and power. A wound component may have a small inductive component, and designers are sometimes exhorted to use non-inductive types like the bifilar-wound Mills or Mundorfs; however, as seen in the test values, the inductance was essentially negligible.



The opportunity to carry out listening tests on industry crossover power resistors (*eg* 5 -10W) are limited. However, my own Wilson Audio *Sophia 3*s conveniently have an access cover to a pair of mid and treble driver protection resistors, and this provides an unofficial test bed. For this comparative test, 4.7ohm and 5.6ohm value resistors are perfectly acceptable standard substitution values. Although these are slightly removed from the Wilson calibration, they're close enough for critical auditioning after some degree of aural adjustment. (Our thanks to the suppliers for providing review samples.)

As standard, Wilson fits Caddock *MP821*, a good quality close tolerance oxide film type, rated such that a potentially damaging over-current to the mid or treble results in harmless fusing of the resistor (then to be easily replaced across gold plated binding posts). I could now substitute a variety of resistors of matched values and audition them in the knowledge that they were directly in series with Wilson's very high quality mid and treble drivers. The sonic signatures of these resistors, if any, would then be rendered accessible to listeners. The binding posts facilitated ready changeover and avoided the normally tricky process of getting into loudspeaker crossover networks.

Back in 1977, when PM was working on *Hi-Fi News*, he translated and published those famous articles by Jean Hiraga on musicality and the sound of various audio components, especially cables. These generated cries of outrage from industry traditionalists who (along with their extant successors) believed that measurements can fully describe the listening experience; that resistors are essentially perfect, and consequently must all sound the same. Hiraga inspired me to carry out numerous tests on passive components subsequently, on capacitors, resistors and cables.

THE RESULTS

Worst case resistance tolerance was -5% for the CGS Meggitt (auditioned only in the midrange location); most were less than 2% or better (representing an installed volume change of less than 0.15dB). The inductance for these various values and types ranged from negligible to zero: the worst case result of 1.5uH will not show a discernible effect until about 200kHz, so I consider that inductance is a negligible factor in these tests. The sound quality ratings are comparative for sound quality *per se*; there is no anchor for 'no resistor' in this test.

MARTIN COLLOMS

Caddock MP821: 53%
The MP821 delivered an above average sound with positive dynamic expression detail and transparency, but was held back by a degree of added brightness which emphasised any sibilance and treble distortion, if present. It sounded a little 'busy', leading to a divided opinion.

CGS Meggitt: 46%
This resistor had a characteristic ceramic wire-wound sound, with roughness, brightness and grit, but also showed better clarity and rhythm than is usual for the type (perhaps the consequence of a mild increase in loudness).

Duelund CAST: 79%
"Did not sound like a resistor", the *CAST* sounded neutral, transparent, free from audible distortion or emphasis, with excellent clarity and detail, good plus dynamics, and very good rhythm. The non-*CAST* construction Duelunds at half the price will clearly be also worth trying despite (or because of) their negative temperature coefficient, which is claimed to compensate to some degree for medium term compression due to voice coil heating. (For this to work properly, the two time constants would need to be matched, which seems unlikely.)

KNP (WW): 45%
The sound is reasonably well balanced, with some 'wiry' and boxy coloration, slower bass, and moderate sibilance excess. It's a typical industry result.

Monacor Ceramic (WW): 40%
The Monacor Ceramic had poorer depth, dynamics and detail than average plus some sibilant emphasis, and generally seemed less involving and musically interesting.

Mundorf MResist SUPREME (bi-filar WW): 64%
Mundorf's *MResist SUPREME* showed some extra brilliance and slight 'ringing', but dynamics and clarity were well preserved, nicely expressive and transparent, with low subjective distortion, and above average rhythmic integrity.

Mundorf MOX 10W: 51%
This resistor gave a well balanced performance: not objectionable, if a little bland musically, but with good neutrality and image depth.

Mundorf MOX 5W: 60%
This 5W MOX resistor sounded rather like the 10W version, but was clearly more interesting and involving musically, more open and transparent, and with better subjective rhythmic performance. Perversely, science would tend to predict the reverse in this comparison.

Mundorf WW ceramic 25W: 43 % (mid only test)
The sound here was not so relaxed with some added moderate sibilance, loss of clarity and focus, with rougher treble sounds.

Vishay Sfernice RCH25 series : 42%
This Vishay is a mysterious sounding design. It's quite neutral and accurate, but lacks dynamics and interest, so it's inexplicably rather bland and uninvolving, leading to poorer sense of rhythm and a loss of transparency.

Welwyn W24 : 36%
This well established vitreous coated 'oldie' seems to be betrayed by its copper-steel lead-outs, and has a dulled, uninvolving sound that masks detail and impact, resulting in a below average score.

CONCLUSIONS
While it's true to say that we were using a very high quality test platform, the differences we heard were greater than expected and led to clear preferences. Duelund's mythic reputation was upheld: its products really do seem to provide the required attenuation without significantly disturbing the music quality. (Close tolerance to order.) While slightly coloured, Mundorf's *MResist* also justified its reputation, this high specification component holding musical values essentially intact thanks to exceptional build quality.

One surprise was the higher ranking of the 5W Mundorf MOX over their 10W example, but it was also clear that these two were of different construction, and both are very good value. The Caddock MP series film sounded familiar, as it should, and certainly had hi-fi credentials, but was not the test favourite. Close tolerance values are available for this precision resistor. Industry generic ceramic wire-wounds do the job but are unremarkable, with some added subjective distortions, while the Welwyn *W24* warhorse no longer figures. Found to be rather self-effacing, Vishay's *Sfernice* oxide film type was quite neutral but musically rather bland.

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MAKE	TYPE	ERROR	POWER	TECHNOLOGY	SOUND	INDUCTANCE	APPROX PRICE £
Caddock	MP821	0.2%	25W	Metal oxide	53	<0.2uH	7
CGS Meggitt	SBCH	5% low	10W	ww/ceramic	46	<0.7uH	2
Duelund	CAST	4% high	10W	Carbon/silver	79	<0.2uH	25
KNP	WW	0.8%	10W	ww coated	45	1.5uH	2
Monacor	WW	4%	15W	ww/ceramic	40	0.8uH	3
Mundorf	MResist Supreme	0.8%	22w	ww coated	66	<0.3uH	12
Mundorf	MOX	0.7%	10W	Metal oxide	51	<0.2uH	4
Mundorf	MOX	0.7%	5W	Metal oxide	60	<0.2uH	2
Mundorf	WW	1.5%	25W	ww/ceramic	43	<1uH	4
Vishay Sfernice	RCH25	2%	25W	Thick film	42	<0.2uH	4
Welwyn	W24	1%	10W	ww vitreous	36	0.7uH	2