audio sleuth at work

fault finding in audio installations

The finding of a fault in an audio system would have been very much to Sir Arthur Conan Doyle's liking. Like Sherlock Holmes, you should sit down and calmly reason out what's wrong. Take the symptoms one by one, put them in logical order and then try to find the solution by deduction.

First of all, we are not going to suggest that you open up each item of your installation, heat your soldering iron, and prepare yourself for 'surgery'. On the contrary, the hints in this article deal with fault-finding without special tools and without expensive test equipment.

As a rule, start your fault-finding with a list of questions. How did the system behave before the fault? Was everything all right? Was there any noise, hum, or crackle? Has it ever worked satisfactorily? Such a list often points to the most likely area of the fault. You then carry out a quick check of whether this is indeed so. If so, all well and good; if not, a more systematic check has to be made.

One of the quickest methods is the so-called 'halving method'. Let us assume that the fault lies in an unknown part of a chain of units or circuits. Such a chain may consist of any number of items: figure 1 shows a typical 'audio chain'.

If a signal is applied to the input of the chain and something is wrong with the output of the pre-amplifier, you know that the fault lies somewhere in that unit. Then 'halve' the possibilities, and check the signal at the tape output: if this is all right, the fault lies between there and the final output. If, however, the signal at the tape 'OUT' is faulty, the fault lies in the pre-amplifier before the tape output.

Never start with the more complicated checks but rather with the simple ones; only when these give negative results, bring in the big guns. The possibilities vary from checking whether the mains plug is securely in the socket to 'open heart surgery' where

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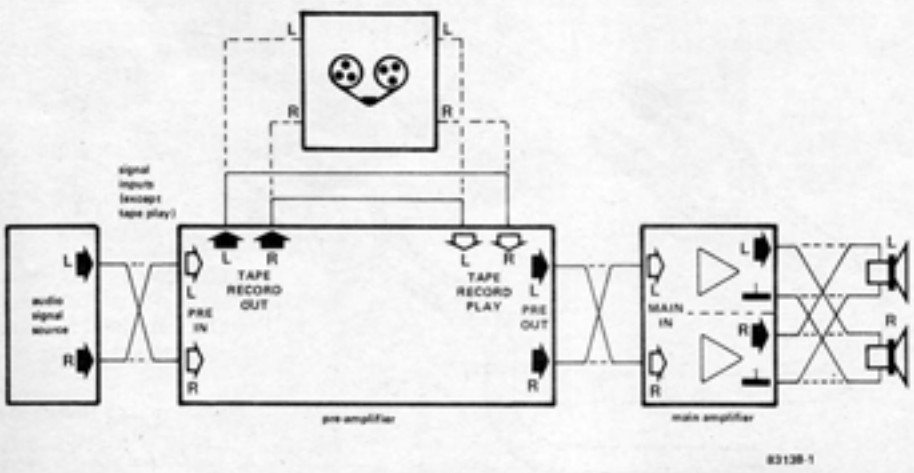

Figure 1. Possible cross-over points of the left and right-hand channels to enable the correct operation of either channel to be checked. Only one cross-over should be made at a time.

the main amplifier with the various printed-circuit boards temporarily removed is surrounded by an array of test instruments like a de luxe sine/square-wave generator, a double-beam oscilloscope, spectrum analyzer, and so on.
Checking the mains plug may sound ridiculous, but in practice many problems can be traced back to this sort of simple cause.
Check therefore whether somewhere in the chain there are no controls in the wrong position, and whether all fuses are OK.

The 'interchange trick'

A check which is very suitable as an indicator is the so-called 'interchange trick' in which the left and right-hand channels are crossed over somewhere in the chain. Figure 1 shows which inputs and outputs of an amplifier can be used in such a check. If we assume that the symptom is the non-satisfactory operation of one channel, change left to right and vice versa. If now the other channel shows the symptom, the fault lies before the point where the channels were interchanged. If the signs of disorder continue in the same channel, the fault exists after the cross-over point. Take care to make only one interchange at a time!
Restore the crossed-over point and make a similar check elsewhere in the chain. Such a check may also be combined with the 'halving' check. It is true that the number of possible interchange points in figure 1 is not great, but we felt it better not to show all the intermediate ones.
If the amplifier uses DIN connectors, an adapter as shown in figure 2 may have to be made up to enable cross-overs to be made.
If 'phono' connectors are used, making an interchange is, of course, simplicity itself.
If the checks described so far fail to give the right result, the time has come to bring in the big guns! Get the temporary use of a second, soundly functioning audio system and replace one or more of the units from the malfunctioning chain by the corre-

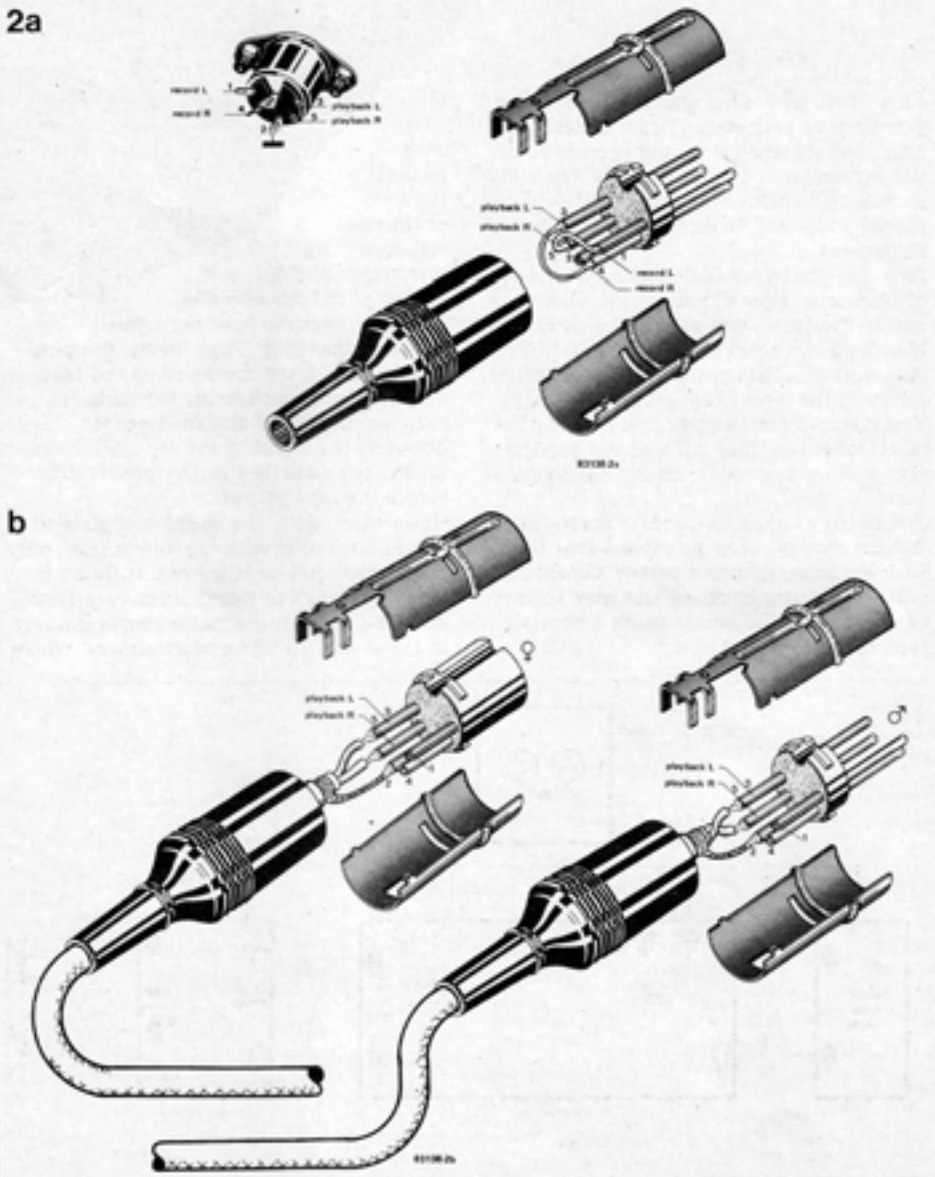

Figure 2. Test lead for the cross-over from left to right where DIN connectors are used. The connections for the left and right-hand channels are reversed in the plug with respect to those in the socket. The test lead is then connected between the amplifier and the relevant unit (record player, tuner, and so on).

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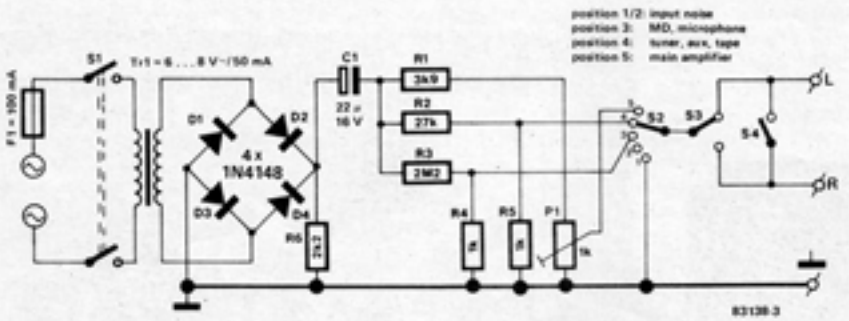

Figure 3. An inexpensive alternative to a 'real' signal generator. This simple 100 Hz generator produces a large number of harmonics, which enable the checking of even the high frequency end!

sponding ones from the auxiliary system. The interchange points indicated in figure 1 can be used for connecting the replacement units.

Balance check

If a loudspeaker is connected between the 'hot' terminals of a stereo amplifier (the two earth terminals thus remain 'open'), sound will come from the speaker even if only one channel is working properly. If no sound at all is audible, neither channel is operating. With the loudspeaker connected as above, apply a mono signal to both channels and set the mono/stereo selector to mono. With the balance control in its mid position, no sound will come from the loudspeaker, while increasing sound should be heard when the balance control is turned left or right. The sound-null will often coincide with the popular '12 o'clock' position of the balance control. Because only one loudspeaker is used, the coincidence is not the result of acoustical imbalance (that is, incorrect positioning of the loudspeakers), but rather of electronic imbalance of the two channels (it could also be faulty positioning of the knob of the balance control onto its spindle).

Signal generator

Before getting out the tone generator (if you have one), remember that you yourself are an excellent hum generator. Take a piece of bare wire between thumb and index finger and insert it into the relevant input. Before you do, turn down the volume control!

A better, but still inexpensive, alternative is the test circuit shown in figure 3 which, believe it or not, enables you to even check the high-frequency control! It uses a small transformer (for instance, a bell transformer) of which the secondary voltage is rectified and from which the d.c. component is removed by C1. The result is an *alternating voltage* with a fundamental frequency of 100 Hz and a large number of harmonics (primarily caused by the characteristic of diodes D1 ... D4). When S2 is switched from position 1 to 2, the unit to which the circuit is connected should produce more hum. If it does not, a fault is indicated.

Open circuits and dirty contacts

Is the sound weak and shrill, in other words, does the output consist mainly of high frequencies? That could indicate an open circuit, like a break in a cable (the high frequencies still come through, albeit attenuated, via the capacitance caused by the break).

Any crackling or loud clicks when a switch is turned? That may be caused by leaking coupling capacitors. Just behind each output coupling capacitor, and just before an input coupling capacitor, a resistor connected to earth is required to keep the d.c. across the capacitor constant. If d.c. appears across the resistor, the capacitor leaks and should be replaced. This sort of check requires the amplifier to be on: using a multimeter (lowest d.c. voltage range), measure the d.c. voltage across the relevant resistors. Often the cause for the crackling and clickling is far simpler and can be cured by the following 'shock therapy'. Switch off the amplifier and turn each switch a couple of times from one to the other extreme positions: this normally 'cleans' the switch contacts. This sort of remedy is also very useful for the connections at the back of the amplifier. Remove and re-insert each plug a couple of times. Phono connectors should be turned around their axis so that the contact areas are moved. Loudspeaker connections should be given a 'fresh' start by renewing the bare ends. Do NOT tin the new ends!

It does, of course, no harm to carry out this sort of 'shock' treatment once in a while even if there is no fault.

Phase check

If the sound is all rightish, but not really 'stereo', the betting is that the phasing of the loudspeaker connections is not right. The most reliable check for this is still the battery check. Take a 1.5 V battery and remove the cloth from the loudspeakers so that the cones become visible. Remove the speaker leads from the rear of the amplifier. Connect one of these leads to the + terminal of the battery and with the other touch the − terminal briefly. The cone of the loudspeaker will make a forward or a backward movement. Repeat this with the second loudspeaker. Both cones should move in the same direction if the speaker leads are connected to the battery with identical polarity. If not, the connections of one of the loudspeakers to the amplifier should be reversed. ⏮