JOHN HECHTMAN • KEN BENSHISH

AUDIO WIRING GUIDE

How to wire the most popular audio and video connectors

Focal Press

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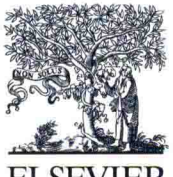
John Hechtman and **Ken Benshish**



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Audio Wiring Guide

Author Biographies

John Hechtman knew early in life that he wanted to record music – it seemed so magical to freeze time, and be able to replay a cherished event. And to be able to improve the event? Enhance it? Astounding!

With this in mind, John started work in audio studios at the tender age of 16. This unorthodox but highly effective approach gave him decades of hands-on experience, when other young people his age were still in school or just crossing over from school to the real-world workplace.

Learning by doing, and working with masters in the field, John became a proficient audio recordist. He has worked with such diverse artists as Joe Cocker, Lionel Hampton, Jim Carroll, Sy Oliver, The Mighty Sparrow, and many, many more. He says that his 'Andy Warhol' 15 minutes of fame occurred when he worked with The National Lampoon Radio Hour with great comedians like John Belushi, Gilda Radner, Billy Murray, and a slew of other stellar talents.

From working in studios, John branched out into working on studios, building them, wiring them, and managing them. Along the way he picked up a first-rate education in every possible problem an audio studio could have, and in finding ways to solve them.

In addition to his recording and tech talent, John is also a creative writer, songwriter, poet, and amateur inventor. He currently works as a freelance computer and audio consultant, with a strong tendency to prescribe Linux as a cure for the ills of both Microsoft and Apple.

Ken Benshish has a passion for life and celebrates this by sharing what he loves most, music and art, through education. He has played drums in the clubs on Bleeker Street in New York City to percussion with the Chicago Civic Orchestra in Symphony Hall. He has an appreciation for the flowing lines and customization that Harley Davidson offers, and has photographed many of his solo motorcycle adventures throughout the US. Ken is the co-founder and director of the iSchool of Music & Art in Port Washington and Syosset, New York, and is fortunate to be able to enjoy what he loves most in life on a daily basis. Ken lives in lovely Times Square, New York City.

Contents

Author Biographies vii

Section 1 Basic Information 1

Introduction 3
How we're going to do it 3
The tools you'll need 8
'I can't afford to buy all those tools!' 18
Tools you can build 19
Other necessary materials 20
Lighting your work 28
Organizing your work 28
Organizing your information 30
Job survey and information breakdown 32
Information needed for studio installation 34
'Aww gee, do I have to?' 35
Information for Iggy's imaginary installation 36
'Now are we ready to wire?' 39
Stripping wire 41
Dealing with multi-pair wire 51
Tinning wire 57
Time to practice tinning 59
Tinning (filling) solder cups 60
Inserting conductor strands 62
Now let's de-solder 63
A word about cleaning things 69
The end of the beginning 70

Section 2 Intermediate Information 71

Section 2.1 The good/bad/ugly and the 'bead game' 73

Some bad examples and a good one 73
The 'bead game' 77

Section 2.2 Using a DVOM or DMM, and what is it anyhow? 83

Section 2.3 Balanced and unbalanced audio and AC power 96

Unbalanced/balanced audio 96
Balanced AC (electrical) power 103
Introducing Equi=Tech 106
BACP theory and practice 107
Star grounding 111
Your choices 112

Section 2.4 Using spreadsheets 114

Section 2.5 Resources 129

Links from the AWG itself 129
Links for tools/supplies/gear 131
Reference links 132

Section 3 Connector Modules 133

Section 3.1 Guitar plug male connectors 135

Section 3.2 Guitar plug female connectors 157

Section 3.3 Mini-male guitar plug connectors 179

Section 3.4 RCA male connectors 202

Section 3.5 RCA female connectors 220

Section 3.6 XLR female and male connectors 241

Section 3.7 TT male connectors 263

Section 3.8 BNC male connectors 288

Section 3.9 F male connectors 307

Index 323

SECTION 1

Basic Information

1 Basic information

Introduction

I wrote this book out of an ongoing sense of frustration with bad workmanship in audio wiring. After 40 years in the recording studio business, the studios I've seen that were correctly wired could be counted on the fingers of one hand.

Often the people who had done the wiring were highly intelligent, motivated individuals. But craftsmanship is not synonymous with either intelligence or motivation. True craftsmanship also requires a thorough understanding of the materials you're working with, an understanding that can be gained *only* through experience. In this book I'll be sharing with you the experience I've gained during decades of audio/video wiring.

The *Audio Wiring Guide* (hereafter AWG) is designed for use by both the amateur and the professional. Whether you're wiring a home studio, a PA (public address system) or a commercial multi-track installation, this book will help you do it better, faster, cheaper, and with fewer mistakes. No matter what the size of your wiring project or installation, the AWG provides you with the essential information you need and the techniques to use it.

One of the biggest differences between the AWG and other books is that the steps you need to do for a particular sequence of work are *illustrated* – with photos that look exactly like the wires in your set-up. The instructions are written so you can understand them the first time you read them, no matter what your experience level.

How we're going to do it

Let's take a trial run now to see how it works.

Wiring nomenclature is often ambiguous and confusing. For example, the word 'wire' could refer to any of these:

- The individual copper strands inside a conductor.
- The strands and their insulating jacket.

- The cluster of conductors and the shield layer in a mic (microphone) or other cable.

All very confusing – and for no good reason! So listen up. In every part of this book, I'll use certain terms in specific ways. Here's an example (see Figure 1.1):

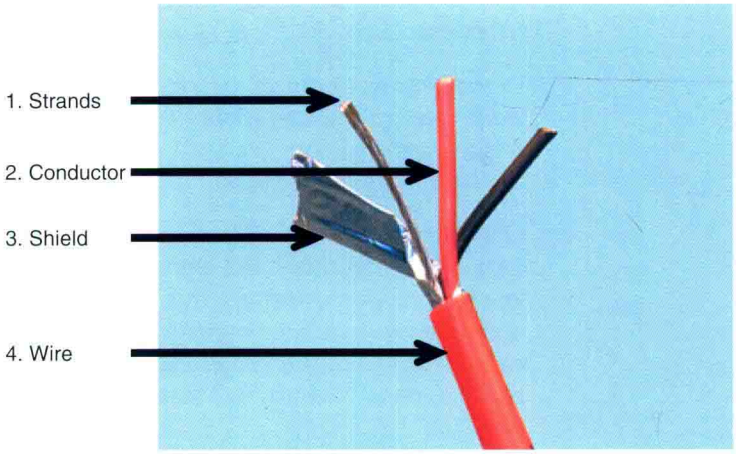

Figure 1.1 Components of a wire. (1) Copper strands. (2) Conductor (strands + jacket). (3) Shield – in this case a metalized mylar foil. (4) Wire.

- *Strands* are the individual copper strands of a wire.
- *Conductors* are made up of copper strands that are covered with an insulating jacket (different colors of pliable plastic).
- *Shield* is a metallic, conductive layer wrapped around the inner conductors to reduce noise. It may be a metalized mylar foil, an electrically conductive plastic or actual strands of copper wire that are commonly not insulated.
- *Wires* are made up of the conductors (strands and insulating jackets) in a shield, and commonly surrounded by an outer plastic or rubber jacket.
- A *harness* or *cable* is a collection of wires that are bundled together for a specific purpose.

With me so far? The copper *strands* go into an *insulating jacket* to become *conductors*. Conductors and their *shields* in an *outer jacket* are *wires*. Wires are bundled together to become *harnesses* or *cables* (Figure 1.2).

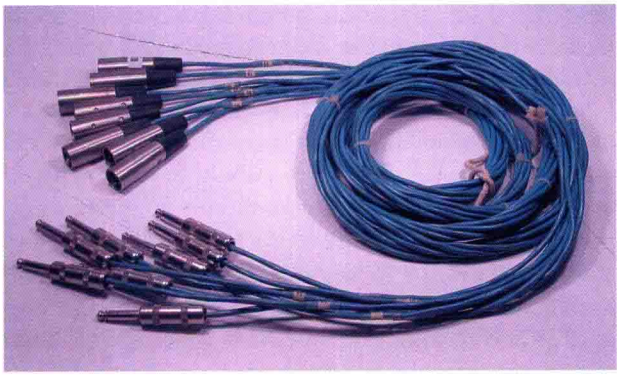

Figure 1.2 Wires in a harness.

The only exception to this rule (there's always something) is the drain (shield) conductor in shielded wire. The drain conductor has no insulation, permitting an electrically conductive contact with the foil or spiral wrap shield along its entire length. So that's why one of the conductors in Figure 1.1 has no insulation on it. In some types of wire, like those with a mylar or conductive plastic shield, the shield and the drain wire are separate. In spiral wrap, and braided shield wire, the drain and shield are sometimes combined in the outer wrapping of copper wire. This is shown in Figures 1.3 and 1.4.

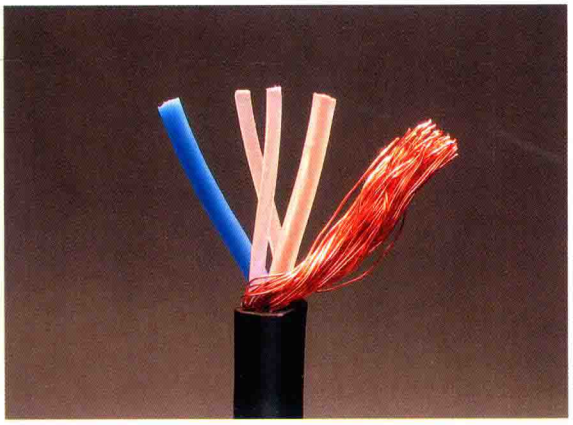

Figure 1.3 Spiral shield wire.

Figure 1.4 Braided shield wire.

Not so difficult, right? All the concepts in the AWG are explained like this – more than once, in fact, so you can follow along easily and understand every point. And the illustrations will show you exactly what I'm talking about.

There are two other common types of wire: these are spiral shield wire and braided shield wire. They do the exact same thing as the mylar foil shielded wire in Figure 1.1, but the shield construction is different.

In spiral shield wire (Figure 1.3), the shield layer is actual strands of copper, wound in a spiral around the inner conductors. The two inner conductors here are the blue and the translucent-over-copper colored items in the picture. The two thinner pale white strands have no electrical function, they are 'packing strands' that help keep the wire round when it's made.

This type of wire is stronger and more noise-resistant then the mylar shield type in Figure 1.1, but it's also larger and costs more. It's flexible and fast to work with, as opposed to the next type of wire I want to discuss.

Braided shield wire (Figure 1.4) offers top notch shielding, and it's very durable. But it's a real pain to work with, because you have to carefully unbraid the shield to connectorize it. Not recommended for the impatient.

Still with me? The three types of wire I've shown you all do the same thing, but they look different, require different techniques, and offer different pros and cons in terms of use. I'm showing all of them to you, because you're likely to encounter all of them in your wiring saga.

A lot of wiring work is like the examples above; the diversity of options available make it seem complicated and confusing. The trick is to see the underlying unity among the options. Three kinds of wire all do the same thing – cool!

If you ever do get confused, just stop, back up a page and read it over – which is a lot easier than hoping for the best, doing it wrong and *doing* it over. Take your time, and the AWG will soon have you soldering like a pro.

Other terms used in this section are explained the *first time* they are used in the text. If you skip a section where a definition is given, or if you forget it, you can look it up in the *online glossary* we've added to the AWG website. We (Focal Press and myself) chose to keep the glossary on the web in order to update it, and to allow more space in the book itself for vital information.

Some sections of the book (like the soldering instructions) are written with deliberate redundancy. If I tell you how to wire a connector, I have to give all the steps in the proper sequence. If you have to flip back and forth in the book to see how a connector is wired, it will only slow you down. So each connector section is designed to be read and followed as a piece of stand-alone text.

A caution, however: the illustrations show the ground wire always connected, since this is how an individual cable would be wired. A star-grounded system would have ground connected at only one end, not both (star grounding is thoroughly covered in a later chapter).

However, be sure you understand the concept of star grounding before doing work on previously installed wiring or starting construction of a new system. The difference in a star-grounded system is that the shield (ground) wire is connected at only one end, rather than both. Connecting shield at both ends of a wire can cause 'ground loops', which induce 'hum' and other types of noise in audio systems. Star-ground installations are always custom-wired and therefore costly – but they radically reduce system noise.

Disclaimer

The techniques explained in the AWG are those that I have used repeatedly in many studio installations with great success. I have made extensive efforts to verify them with other technicians.

But I cannot take responsibility for *your* application of them. Use them at your own risk. I don't mean to scare you (too much), but building and rebuilding studios is part of how I earn a living. I can't offer free tech support, and you may want or need to hire a professional if you can't make these techniques work for you.

However, I'm not asking you to be a guinea pig. Numerous other technicians and I have successfully used these techniques over and over. I've built over 20 functional multi-track studios ranging in size from four to 48 tracks. When it was possible to implement the techniques described in this book, they've always worked.

Finally, this book presents high-density instruction clearly and straightforwardly. You can study it as a textbook or use it as a reference manual during your work. If one picture is worth a thousand words, think of all the text you'd have to read just to get the information in the illustrations!

The tools you'll need

Wiring doesn't require many tools, but you do need some specific items. Let's list them now and talk about them. Necessary tools aren't too expensive, nor are they that hard to find and learn to use. But don't try to start working without them – you wouldn't try to dig a hole without a shovel, would you? Similarly, you need the right tools to wire correctly, rapidly and accurately. If you cut corners here, you'll wind up paying for it many times over – in slow, sloppy work that will need to be redone.

Get a temperature-controlled iron. I've seen more work ruined by people's attempts to use cheap irons than by any other cause. A good temperature-controlled iron will cost only about $60. Getting an iron that is also ESD (electrostatic discharge) safe is a very good investment. That way you're less likely to damage static-sensitive gear when working on it. The blue color of the iron handle in Figure 1.5 is a factory color code by the maker (Weller) that the iron is ESD safe.

Figure 1.5 Soldering iron and tips.

The best model to get is one with interchangeable tips for a variety of heat ranges and work sizes. That way you can use the iron with a micro-tip for miniature work, and switch to a large tip for heavy soldering jobs. The reason for doing this is that a small tip will be cooled down too much by using it on a large job, even if you have the heat range on the iron cranked all the way up.

Temperature-controlled (T-C) irons work with a magnetic sensor that keeps them at a constant heat. They'll burn out if you place them on a metal holder.

The magnet sees the metal of the holder and keeps the iron on all the time. So if you've made the investment in a T-C iron (and you should), protect it, and yourself, by getting it a proper holder. T-C is the way to go for an iron that stays at the right heat for the job you're doing; I recommend using only T-C irons!

You'll also get better results from your iron by keeping the tip clean with a *soldering iron sponge*. You can use any sponge in a pinch, but iron sponges are heat-resistant, and treated with special chemicals to prevent tip corrosion. You can also buy a tip cleaner that cleans the iron tip without cooling it down like a sponge does.

One possibility is the Radio Shack catalog no. 64-020 'Tip Tinner and Cleaner' (http://www.radioshack.com/product.asp?catalog%5Fname=CTLG&product%5Fid=64-020). Other manufacturers also market a basically identical product (e.g. Multicore TTC1 – http://www.computronics.com.au/multicore/ttc/). A slightly different approach is the Apogee VTSTC – which also works (http://www.apogeekits.com/solder_tip_cleaner.htm).

Sponge-type cleaners (like the one shown in Figure 1.6) are wetted with water before use. When the soldering iron hits the moist sponge, the tip temperature is lowered – which makes for bad (cold) solder joints. So while sponges are more common than the other types of tip cleaners, they're not really as good – but still totally usable. Just allow a few seconds after you clean the tip (with a sponge) for the iron to reheat.

Figure 1.6 Iron holder and sponge.

Finally, a dry or slightly dampened cloth or paper towel can be used to clean the tip – just be careful that you don't touch the hot iron tip to the towel/cloth for more than a few seconds. This is long enough to clean the iron tip, but not long enough to cause the cloth or paper towel to ignite.

Why all this fuss about keeping your iron's tip clean? A tip that's fouled by excess rosin or old solder won't carry the new molten solder properly to the elements being soldered. In addition, the excess rosin will eventually corrode the tip if left on it for a long period of time.

Buy two pairs of Miller wire strippers (Model 100) or their equivalent. They're available from several sources:

- http://www.kelvin.com/Merchant2/merchant.mv?Screen=PROD&Product_Code=520011&Category_Code=ELTOWS&Product_Count=5
- http://www.hmcelectronics.com/cgi-bin/scripts/product/5840-0004
- http://www.tecratools.com/pages/servise/wirestrippers.html

Get the kind that has a continuously variable slider to set the strip depth, or a non-preset wheel (Figure 1.7). Some wire strippers have tried to improve this design by providing a wheel with preset strip depth settings. These don't work, because the insulation and wire thickness often falls between the presets.

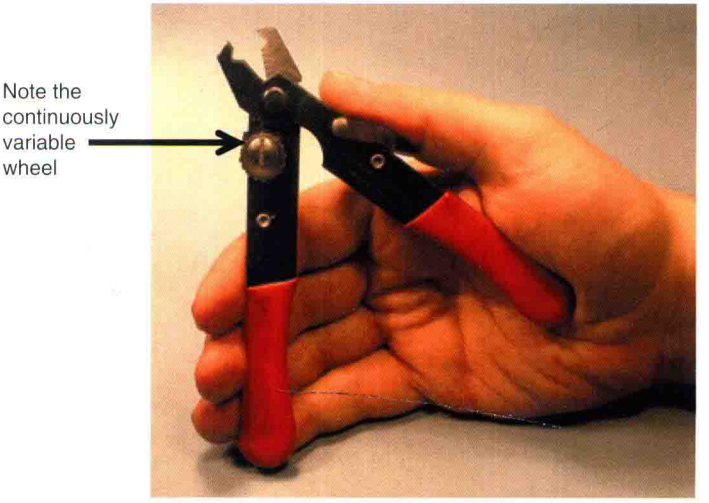

Figure 1.7 Wire strippers.