# The Ins and Outs of Patchbays

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## Introduction

Anyone with roots in the home studios of the 1970's and 80's has probably experienced a production environment without patchbays. In a simple setup this might mean crawling behind the equipment occasionally to reconfigure effects gear. But in a complex system constantly climbing under the desk becomes a nuisance, a time-waster and a drain on creative energy.

Patchbays help solve these problems by providing a convenient way to reconfigure the system signal flow without ever disconnecting equipment. This means faster access to devices to implement creative ideas and more efficient use of less equipment. It also means that multiple users do not have to wonder how things were left after the last session, and it can speed up fault troubleshooting considerably.

In a large, multi-room facility patchbays are a necessity unless one is willing to treat each room as an isolated system. Most sizable video facilities have a routing switcher to do electronically what a patchbay does manually, but patchbays are cheaper and, as passive devices, extremely reliable.

Patchbays come in a variety of types and styles, usually dictated by the kind of signals being routed. While this article will concentrate on audio, there are also specialized patchbays for video, optical, telephone, digital data and machine control. A complex facility may have many of each.

## Audio Patchbay Construction

Audio patchbays are usually found either built-in to a recording console or as stand-alone units mounted in an equipment rack. The built-in types are often provided by the console manufacturer, either as an option or a standard accessory. The great advantage of patchbays that come with a console is that the wiring between console circuit points and patch jacks is already done. In addition, most of these use multi-pin connectors to link the patchbay with studio wiring, so wiring harnesses can be constructed in advance of console arrival and simply plugged in. The disadvantage is that you may have to accept the manufacturer's view of where patchpoints should be in the signal path, and their layout preferences.

Standalone patchbays come in several forms. The most common "broadcast quality" units consist of individual jacks, made from heavy metal frames and springs with gold plated contacts, mounted together in a machined panel (the whole sometimes referred to as a jackfield or patch mat). These "long-frame" jacks may be 1/4" diameter or the more compact Bantam ("tiny telephone" or TT) type. The 1/4" jacks are about the same size as common 1/4" guitar cord plugs but have a more complex shape and contact arrangement. The shape and fit of both 1/4" long-frame and Bantam jacks, sometimes referred to as military or telephone style, is standardized throughout the industry. Generally these jacks require a mating plug with matching shape for the best connection, though guitar-type plugs may also work with the 1/4" size (although the converse is rarely true--military style plugs do not work well in standard 1/4" phone jacks). Long-frame jacks are designed for solder connections and may be used in this form or wired to an assortment of termination devices (discussed later).

The other common construction method is to build a patchbay around jacks that mount on printed circuit cards. These patchbays are usually set up so that both the front and rear have connectors (either 1/4" guitar-type or RCA) which allows the user to wire up a system with pre-made cables between the patchbay and equipment. This type of patchbay has the advantages of being easy to install and significantly cheaper than the long-frame type. The disadvantages are mostly in construction; PC mounted jacks tend to be less robust than long-frame, both in contact pressure and longevity (long-frame jacks are so unlikely to break that they all carry lifetime warranties), and are not usually gold-plated. Incidentally, console manufacturers may use either jack type in an inboard patchbay, and may also use anything from discrete shielded pair cables to ribbon cable for connection to the console.

As a rule, broadcast jackfields, whether 1/4" or Bantam, use 3-conductor (tip/ring/sleeve) jacks. This allows patching of balanced audio circuits. 2-conductor (tip/sleeve) jacks and plugs are available from some manufacturers but are not popular in professional installations. Printed circuit style patchbays may come in either form, though unbalanced (TS) is more common. In all cases the shield of each jack is generally isolated from the other jacks and the frame unless intentionally connected with a ground bus or other method.

Now comes the fun part: normalling. If patchbays required a patchcord for every connection they would be extremely tedious to use and very costly in patchcords. As might be guessed, normalling jacks means creating

a path through each jack circuit that exists without the need for a patch cord. This is the "normal" circuit path that is desired most of the time. Normalling is accomplished by using additional contacts on the jack besides the tip, ring and sleeve. Jacks with normal or "switching" contacts have springs that touch the main contacts when no plug is inserted. These contacts can be used to create a path to another jack. When a plug is inserted the main contacts are pushed away from the normal contacts, thus breaking the circuit (Fig. 1A).

By wiring the normal contacts of a pair of jacks together a circuit path is created between the jacks when no patchcord is present, and thus between the equipment that is connected to those jacks. When a plug is inserted, the signal flow is rearranged to follow the new path. Even more functionality can be achieved by using the normal contacts on the "input" jack, but the main contacts on the "output" jack, creating a bridging or "half-normal" configuration. Here, plugging into the output jack does not break the normal circuit, because it is wired to the main contacts, along with the equipment associated with that jack. The normal is only broken when a plug is inserted in the input jack. This creates an instant "Y" or mult of the equipment that feeds the output jack (Fig. 1B). With high impedance inputs, as are now common, the output signal can be split with no signal degradation.

One final note on normalling is the creation of "mult" jacks in a patchbay. These are simply jacks whose main contacts are wired in parallel, creating a multiple splitter. These can be handy, and are safe to use with high input impedance equipment, but they should **not** be used to combine equipment outputs together. Most device outputs are not designed to "see" another output and doing this can degrade the signals or possibly damage the equipment.

A large music console will have hundreds of patch points, and a complex mix can require dozens of patchcords. As previously mentioned, military style patch jacks require matching plugs. These are sold on patchcords of varying lengths, in both mono and stereo versions (two single plugs mated in one housing, which require specific jack spacing!). Military patchcords have traditionally used brass plugs, which can be either soldered or molded on. Even the type of wire varies from one manufacturer to another. For the most part, flexibility and resistance to breakage under hard use are the important issues; they will all get the signal across the patchbay. The other critical issue is contact resistance. While the jack contact surfaces may be gold, which does not tarnish, brass plugs do and can degrade or block the signal altogether. The new generation of nickel-plated plugs, available from most manufacturers, does not tarnish.

## Termination

Connections to long-frame jacks can be made several ways. The most obvious is soldering directly to the terminals. This is fine, and reasonable for a small patchbay, but is extremely labor intensive in a large setup. It is also difficult to change the configuration of the patchbay once it is installed.

The next step in terminating technology is the "christmas tree" block--a chunk of plastic with solder terminals mounted through it. Wires from the patch jacks are connected permanently to one side of the block, and wires from equipment are soldered to the other side of the terminal corresponding to the desired jack contact. Christmas trees are also laborious, but can be mounted at a distance from the patchbay so they at least make wire dress simpler. Patchbays can be purchased with christmas tree blocks pre-wired to the jacks.

The modern solution to professional patchbay termination is some type of "punch-down" block. These can range from the common "66" type used by the phone company to exotic brands. One of the most popular is the QCP system from ADC Telecommunications (also available on other manufacturers' bays). This system requires no soldering or stripping of individual wires and connections can be changed easily. All punch blocks require their own special tool--reliable connections cannot be made by jamming wires in with a screwdriver! It is also possible to purchase bays custom-wired to a variety of connectors including Molex, ELCO/EDAC, Cinch-Jones or whatever your system uses.

Terminating a patchbay requires attention to details beyond which wire goes where. Lead and cable dress should be neat enough so that contact points can be accessed, and there are no inadvertent shorts, but must allow wires to be moved out of the way for inspection or changes. Cables should have some type of strain relief to protect against being pulled out or broken, and possibly extra length for servicing. Consideration must be given to grounding schemes and buses. One side effect of having the ability to patch equipment is that devices with potentially incompatible types of input or output circuitry may be interconnected--such as electronically or transformer balanced mixed with unbalanced. Thought must be given to this issue to avoid signal degradation or equipment damage.

## PB Layout

For a patching system to be of any use patch points must be available where they are needed. A simple patchbay might allow for the most frequent changes, while a really comprehensive arrangement attempts to foresee, and include patch points for, unusual situations. Typically in a studio there are patchpoints between the

console line inputs and outputs and the tape machines (or other storage device), points in the channel signal path for inserting effects devices, zillions of patchpoints for effect gear ins and outs, and a variety of ancillary functions like mixdown machines, power amp and cue system inputs, tone generator outputs, mults, metering points and perhaps microphone patching. When setting up a system-wide patchbay thought must be given to potential patch use vs. cost; adding a whole panel to get that one additional jack may not be cost effective.

Standalone patchbays come in a few standardized sizes, though custom arrangements can be purchased from several manufacturers. Generally, 1/4" jacks come as two rows of 24 or 26 in a panel of either one rack unit (1-3/4") or two RUs in height. This amounts to 48 or 52 "points" in the panel. The vertical size difference affects rack space and labeling room. Bantam jacks are half the diameter of 1/4", so the same size panel can hold 96 or 104 jacks. Some console manufacturers stick with this basic scheme, or variations, while others use patch panels that are completely custom.

Referring to Fig. 2, there are some fairly well-accepted conventions for patchbay layout. First, referring to the two rows in a single patch panel, outputs are above inputs. This means signal flow is "down" the patchbay, like a waterfall. Since patchbays tend to end up needing more outputs than inputs there might be some extra input jacks that can be used for miscellaneous non-directional or non-affiliated signals such as tie lines, mults or tone generators.

Generally, two-channel or stereo devices are layed out with the channels next to each other, in pairs. Related signal paths or functions are grouped logically near each other, or in such a way as to imply the signal flow through the system.

While simply normalling all output jacks to input jacks will provide useful signal flow, normals can be used more cleverly. For example, they can be used to bring a desired "normal" signal to an input jack without actually connecting that signal to an output jack at all. This saves output jacks in some situations. Normalling should sometimes be avoided as well, particularly if feedback will be the result.

It is generally wise to locate outboard patchbays at a height and operator distance that allows ease of access for putting in patchcords and reading designation strips, as well as installation and maintenance (but also consider that patchcords will hang down in front of other equipment). In addition, there needs to be adequate space behind and beside the patchbay for the multitude of cables that will terminate there. Bays can be purchased with punchblocks wired to a cable harness which allows the external wiring to be located away from the actual jackfield if desired.

As for labeling, different manufacturers have different methods of attaching labels. Some provide precut strips which can be used, but its often easier to format and print label strips on a computer. Above all, the more information crammed in, the better.]

## Care of Patchbays

Modern long-frame patch jacks are gold plated at the contact points, and have "wiping" contacts which are self-cleaning when plugs are inserted and removed. If the patchbay has recently been exposed to construction dust, or has not been used in ages, it may need to be blown clean with compressed air and then exercised. Manufacturers I have spoken with recommend cleaning only by exercising noisy jacks with a patchcord. They claim that any sort of abrasive burnisher will remove the gold plating, and that spraying contact cleaner on the jacks will only attract dust.

I find this to be logical advice, particularly since my own experience with patchbays has shown that the most frequent culprit in problems with crackling, "thin" sound, or intermittent connections is dirty patchcords. Brass patch plugs will tarnish and become poorly conductive. They should be cleaned frequently with anything from steel wool to special cloths sold by some patchbay manufacturers. This simply act of prevention (or drudgery, if you have hundreds of cords) can work wonders. Nickel-plated plugs are a good solution for new purchases but its hard to justify replacing thousands of dollars worth of brass ones.

Printed circuit type patchbays are more likely to suffer from broken parts than oxidation, and the patch cords generally use guitar-type nickel plugs. These bays should be treated gently. Patchcords themselves are damaged mostly where the cable enters the plug, caused by failure to leave enough slack when making the patch, and by pulling them out with the cable instead of the plug body. Don't do this. A professional quality patchbay should pretty much last indefinitely, if treated nicely.

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