technique patchbay FAQ

patching up

FREQUENTLY ASKED QUESTIONS: PATCHBAYS

Of the technical queries received at *Sound On Sound*, many fall into the 'hardy perennial' category. One common source of these enquiries is patchbays and their role in the project studio. **Hugh Robjohns** provides some answers...

Walk into any professional studio and you will find a patchbay (or jackfield, to use the original British term) lurking in a rack somewhere. This kind of facility might seem totally superfluous in a simple home studio, but once the number of outboard units and sound sources increases, a patchbay quickly becomes an essential facility rather than an expensive luxury. The different types available, their setup, and their exact function in a studio can be the source of considerable confusion. In an effort to set things straight, I have tried to answer many of the most common patchbay questions we receive at *Sound On Sound*.

Q
Should I install a patchbay in my home studio?

Small studio installations are usually 'hard-wired', each source being permanently connected to a mixer channel, with the mixer outputs directly connected to the multitrack recorder, and the outboard equipment always plugged into the same inserts or effects loops. This is how we all start, and is usually the best arrangement for a simple home studio -- the kind of thing involving, perhaps, a small mixer, an 8-track recorder, and a multi-effects unit.

It's a very reliable technique but not particularly flexible, as it is often awkward to re-patch the equipment, or accommodate a temporary device. Fortunately, with this level of technology, flexibility is often restricted just as much by the limitations of the equipment. However, as the amount and sophistication of the equipment increases, so too does the requirement for flexibility -- the need to connect up a borrowed synth, or a temporary second master recorder, to patch a compressor to channel 6 instead of channel 1, or key the noise gate from channel 10. Scrabbling around the back of a mixer and rummaging in the entrails of an outboard rack is no fun and doesn't impress!

So, once your equipment list starts to grow, and the mixer has more than about eight outputs, it is time to consider installing a patchbay -- you can start small and expand later.

The idea of a patchbay is to allow fast, convenient access to audio signals at all the strategic points in the signal paths. All the audio signals converge to a single, convenient location (no need to scrabble around in the dark behind a rack of equipment, or bang your head on the wall each time you try to replug the back of the mixer), and interfacing is via a unified connection format so anything can be patched to anything else with a standard lead.

Q

Which is best type of patchbay to install?

There are three main types of patchbay format, although several alternatives exist on the continent. In the UK most professional systems employ the PO316 connector (also known as B-gauge) which is an extremely rugged format originally designed for telephone switchboards (before they used switches!). It uses a three-pole plug (see photograph below), making it ideal for balanced audio circuits, and is constructed from brass. Although it has roughly the same dimensions as the more familiar A-gauge TRS jack plug there is a significant difference between the two: the tip of the PO316 is rounded and slightly smaller than the angular, enlarged tip of the A-gauge.

This might not sound particularly important, but it means that the contact springs in the PO316 socket don't bend very far when the plug is inserted, reducing the stress on the contacts and lowering the effort needing to insert the plug. The contacts are also arranged to wipe along the plug as it is inserted, helping to keep them clean and ensuring good contact. Inserting an A-gauge plug in a PO316 socket will cause irreparable damage, permanently bending or breaking the spring contacts. Plugging a PO316 (B-gauge) plug into a TRS socket will result in a very dodgy connection, as the contacts will barely reach the thinner-bodied plug.

B-gauge jackfields are expensive -- a Mosses & Mitchell 1U panel with two rows of 24 holes would cost in the region of £230, and a two-foot patch cord about £12. The rear of the jackfield usually contains solder points for hard-wiring -- no plug-and-play flexibility here!

The Bantam plug is really just a miniaturised version of the PO316, designed to allow a much higher density of connectors in a given rack space. Unfortunately, scaling the dimensions also reduces the contact area and the durability of the system, particularly the sockets. In my experience, Bantam jackfields are notoriously unreliable and should be avoided whenever possible! A 1U, two-row, 48-hole (ie. twice the PO316 density) Mosses & Mitchell patch panel costs roughly £345, and a two-foot patch cord around £15. Both are more expensive than the PO316, but the connector density is doubled.

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The third and most common format in semi-professional installations is the TRS (tip-ring-sleeve) or A-gauge jack. This is the standard quarter-inch chrome-plated connector we all know and love, with the angular tip. Designed for unbalanced (tip and sleeve) or stereo (tip, ring and sleeve) applications, the latter is often used for balanced audio circuits in jackfield applications.

Completing the financial comparison, Deltron or Rean A-gauge jackfields (1U panel with two rows of 24 than an expensive luxury."

holes, complete with rear-panel A-gauge sockets for easy installation) would cost around £60, while a two-foot patch cord would stretch the budget by £4.50.

In a professional installation, the jackfield is wired directly to a central frame, along with cables from all the other equipment in the studio. Link wires in the frame semi-permanently allocate sources and destinations to the relevant sockets, which is very reliable and provides flexibility if the jackfield has to be modified later, but it is also quite time-consuming and expensive.

In a semi-pro installation, most A-gauge jackfields employ sockets on both the front and rear panels. This makes installation and subsequent reallocation of sockets as easy as re-plugging the rear connections. However, the disadvantage is that there are twice as many connectors in the system, inherently reducing reliability, but if the amount of repatching is low, A-gauge jackfields are perfectly acceptable and very cost-effective.

The B-gauge patchbay is the first choice for professionals because of its proven reliability, with Bantam jackfields employed where space is at a premium. The A-gauge jackfield is by far the cheapest and most practical solution, though, and most jackfields of this type have provision for simple normalling options (see page 124).

Assuming a fairly typical 6 x 24 jackfield is required, with 40 two-foot patch cords, a typical PO316 system would cost about £1,170, with a Bantam field taking half the rack space but £1,208 of the budget. Both are horribly expensive compared to the modest A-gauge system, which would cost close to £345, all in! It may be a little less reliable and wear out more quickly than a B-gauge system, but you could afford to replace the A-gauge jackfield three times for the same cost!

For a semi-pro installation, the A-gauge patchbay offers the most cost-effective solution, but be prepared to replace panels every now and again as they wear and become unreliable. If you anticipate doing a lot of repatching (continually setting up and breaking down patches, or plugging lots of microphones several times a day, for example), or are involved in work which is not tolerant of jackfield failures (such as live recording or broadcasting) it would probably pay to invest in a B-gauge system. However, you should also think carefully about how to interface the patchbay, and budget for a suitable wiring frame as well as the jackfield itself.

Q

Can I plug my microphones through a patchbay?

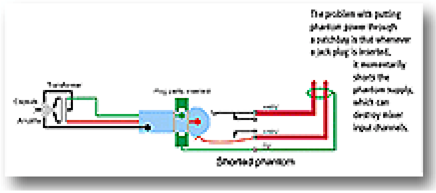
Patching microphone circuits from the studio floor to the desired mixer channel is one of the most useful aspects of a jackfield, although there are potential problems since, if phantom power is being supplied from the desk through the jackfield, patching a mic can damage the console.

As the jack plug is inserted into the jackfield its tip will momentarily connect with the ring contact in the socket, while the ring of the plug touches the sleeve contact. This short-circuits the phantom supply, bridging the +48V line straight to the earth return and, although the phantom supply should cope, the resulting voltage spike can cause irreparable damage to the input circuitry of the mixer channel. The mic input stage can be destroyed outright (particularly with older types of electronically balanced inputs) but it is more usual to find a gradual degradation in performance as various circuit components deteriorate.

Also, unless the patchbay labelling is extremely clear (see page 128), it is all too easy to plug a line source into a microphone input accidentally. If you are lucky the result will be a loud and horribly distorted signal, but it is possible for the phantom power on the mic sockets to destroy the output stage of the line source you are trying to connect!

There are a couple of solutions to these problems. Ideally the phantom power should be turned off while patching, although many mixers hide the phantom switches on the back of the mixer where you can't get at them easily. Many of the better budget mixers (such as the latest XDR Mackie consoles, for example) have mic inputs which have been specifically designed to withstand hot-patching of mics. However, this still doesn't protect against plugging line sources into mic sockets.

If you are concerned about this kind of accident, a reasonably practical alternative (and one I personally recommend) is to patch the mics on a dedicated XLR patchbay -- Canford Audio, for example, can supply suitable panels. XLR sockets are designed so that the earth connector (pin 1) contacts first, with the two signal pins connecting fractionally later, thus avoiding any chance of the phantom supply being shorted. The contacts are also much better suited to delicate microphone signals, and you cannot accidentally plug a line-source jack plug into an XLR socket! In most broadcast studios the usual practice is to supply phantom power direct to the studio wall points, which is an alternative method of avoiding having phantom power across the jackfield.



Q

Is it OK to mix balanced and unbalanced connections?

Depending on the abilities of the equipment being connected, mixing balanced and unbalanced signals on the same jackfield shouldn't cause any more problems than connecting the equipment together directly. In fact there are some advantages to wiring everything as if it was balanced, as this can help reduce ground-loop problems. However, never plug an unbalanced (tip-sleeve) plug into a balanced microphone socket if phantom power is present (see the previous question).

A related issue is to avoid mixing stereo and balanced connections on the same jackfield, even though the two formats employ the same plugs and sockets. It can often be very convenient to patch (unbalanced) stereo signals, such as headphone cue feeds, with a single cord, but you will inevitably need a 'stereo-to-dual-mono' bodge lead at some stage and there are likely to be all manner of confusions along the way. A balanced signal will appear as out-of-phase mono to a stereo destination, and a stereo source as a very thin and reverberant signal to a balanced input! Far better to run everything on the jackfield as (pseudo) balanced mono, and wire the studio headphone points to combine the two relevant signals onto a stereo jack as necessary. It takes more patch cords and fractionally longer to plug, but avoids any confusion, has better reliability, and is much more flexible.

Q

What is normalling?

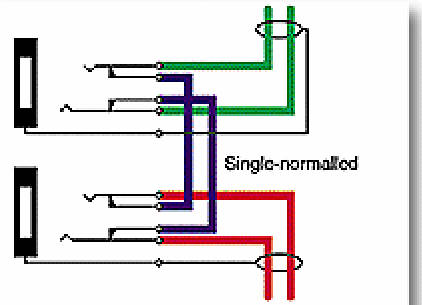
Normalling routes signals automatically between sockets on a jackfield, unless a plug is inserted to replace the 'normalled' signal with another. Patchbays are usually configured to allow a studio to operate with no plugs inserted on the jackfield at all -- sources would be routed automatically to their default console channels, desk outputs routed to the recorder inputs, and the relevant mixer monitoring outputs connected to the loudspeaker amplifiers. What the patchbay really provides is the flexibility to *alter* the normal signal path.

There are several varieties of normalling, but the most common arrangement is called 'half-normalling', also known as 'listen and break'. Of the two sockets involved in a normalled connection, the first (upper) carries the output of one piece of equipment, and the second (lower) the input to another device -- let's consider a keyboard output and a desk channel line input. The idea is that, under normal conditions, the keyboard will always be connected to the relevant channel line input. However, we might also want to route that keyboard output somewhere else, or we might want to connect an alternative signal to that particular mixer input.

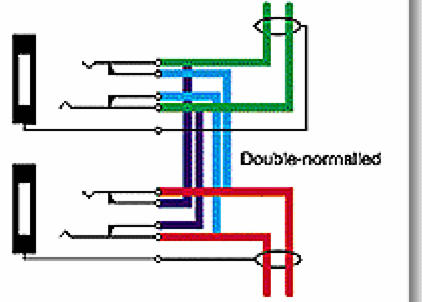
The arrangement shown at the top of this page allows precisely this. The keyboard signal is connected to the spring contacts in the top socket as well as the switching contacts on the bottom socket. The spring contacts of the bottom socket are connected to the mixer input. With nothing connected, the keyboard signal flows past the upper socket and through the switching contacts of the bottom socket, straight to the mixer. If a plug is inserted in the top socket, the keyboard signal can be distributed elsewhere -- this socket is often referred to as a 'Listen' or 'Sniff' socket because it permits the source signal to be listened to -- without changing the signal path to the mixer input.

However, if a plug is inserted into the bottom socket, the spring contacts are pushed away from the switching contacts by the body of the plug. The keyboard signal is therefore broken at these contacts -- hence this socket is referred to as a 'Break' socket. The inserted plug is now connected directly to the mixer input, allowing an alternative signal to be introduced.

On B-gauge and Bantam jack fields, normalling is either hardwired between the contacts of the jack sockets themselves, or performed at a central wiring frame -- each contact of every socket being wired back to this point. The former arrangement makes modification difficult, but the latter, although much more flexible, requires bigger cables and a lot more terminations in the wiring frame! On most A-gauge patchbays, each vertical pair of sockets is mounted on a separate circuit card -- patching sockets on one edge and rear-panel sockets on the other. The normalling facility is provided either by solder links or, more commonly, by reversing the circuit card.



In a single-normalled patchbay, plugging a jack into either socket breaks the signal path, while in a double-normalled patchbay the signal path is only broken if both sockets are filled.



The reversible circuit card enables normalling arrangements to be changed without needing any tools and works because the normalling link is in place all the time. When the normalled pair of connectors are positioned to the rear, the source and destination plugs from the equipment break the link anyway, but if the card is repositioned with the normalled connectors at the front, a half-normalled connection is established between the source and destination.

For the sake of completeness, other common types of normalling are called 'Single' and 'Double'. In single normalling, the switching contacts of both connectors are linked together so that plugging into *either* the source or the destination socket breaks the normalled signal path -- there is no 'listen' facility without breaking the normalled connection. Double normalling is used to provide better reliability since the switching contacts of both sockets are wired in parallel -- if one set becomes dirty, the second set maintains the signal path. With this arrangement, it is still possible to derive a 'listen' signal without breaking the signal path, but it is necessary to plug leads into *both* sockets to break the normalled signal path (see diagrams, right).

Q

What should or shouldn't be normalled on the patchbay?

The default connections for the studio should be normalled -- the idea is that the studio should operate without any patching (although it is usual to patch microphones). Line sources such as samplers, keyboards, CD players and so forth should be normalled to their usual input channels. Similarly, group outputs and tape inputs should be normalled, as should their returns. The same applies to the stereo mix output and the master stereo recorder, the monitoring outputs and the loudspeaker amplifiers.

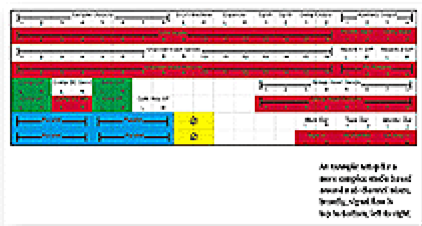
If the desk insert points are brought onto the patchbay, sends should be normalled to their corresponding returns, and if you always have a specific reverb connected to Aux 1, say, then normal those connections too.

Normalled connections should be planned carefully before you connect anything to the patchbay -- the classic cock-up is to accidentally normal the output of a signal processor to its own input, creating a permanent howl-round condition that is definitely not good for the processor!

Q

How should I allocate connections on a patchbay?

There are a few conventions in jackfield layouts. Most patchbays are designed with the overall signal flow working from top to bottom, left to right -- so you would expect sound sources and channel inputs at the top, main mixer stereo outputs and master stereo recorders towards the bottom. Jackfields are arranged with paired rows of sockets and these are always connected with outputs on the upper row and inputs on the lower row -- mainly to facilitate any normalling links.



In a very small patchbay, with just a couple of rows, you would expect the signal flow to zig-zag across the jackfield from left to right (see illustration at the top of this page). Although a larger installation follows the same basic rules, it is often necessary to make more compromises in the layout to accommodate everything economically. The best way to design a patchbay is to draw it on squared paper, working from a list of all the connections and normalling requirements. Start with the sources and console inputs and work down through the console connections until you reach the stereo mix output and master recorder.It is best if normalled inputs and their sources are grouped vertically together, but this is not always possible (for example, where a single group output is routed to several recorder track inputs), so aim to make the layout as logical as possible.

Many connections will not require normalling but are still closely related, such as channel or group inserts and the appropriate outboard equipment. Try to group these things reasonably close together and as logically as possible -- having four 12-foot patch cords strung between jackfields on opposite sides of the room to insert a compressor is not ideal!

This raises another point. Sometimes a couple of smaller patchbays work better than a single large one. If you do a lot of repatching of sources, for example, it may be a good idea to have a small 'Source' jackfield close to hand containing the console channel inputs and all the relevant sound sources. The rest of the patchbay connections -- inserts, outboard, group outs, recorder inputs, monitoring, mastering recorder and so on could be allocated to a remote patchbay.

If you adopt this kind of split-bay arrangement, you should include 'tie-lines' between the jackfields. These simply link sockets on one jackfield directly to corresponding sockets on another, allowing patches to be made without having to trail cables across the floor. I would recommend a minimium of four lines (stereo send and return), but it's always better to have a couple of spares.

If there are some spare sockets on the patchbay, it is useful to incorporate some parallel strips and phase reversers. A parallel strip is simply a row of (usually) four adjacent sockets connected together (tip-to-tip, ring-to-ring, sleeve-to-sleeve) which allows a mono source to be distributed to three simultaneous destinations. Never use a parallel strip for combining signals -- the output drivers of most modern equipment will expire if you try it! The phase reverser is useful if your mixing console doesn't have the facility on its input channels and is just a pair of adjacent sockets where the tip contact of one connects with the ring contact of the other, thereby reversing the polarity of a balanced signal.

Digital Patching

Standard patchbays cater for balanced and unbalanced analogue connections between pieces of studio equipment. Increasingly, however, equipment manufacturers are also providing digital connectivity, which offers obvious advantages. One frequently asked question, therefore, is whether you can use patchbays to simplify the digital routing in your studio.

The answer is yes, but with care. If you need to do a lot of digital repatching the best solution is to use a digital routing matrix such as the units from Akai, Fostex, Midiman, Sonorus and Z Systems, to name a few. A properly designed switcher will have the correct interfacing arrangements, format conversion (AES input to an S/PDIF output, for example), and routing memories for regularly used patches.

If you really do want to patch manually there are several options, but most are really more trouble than they're worth because digital signals are very fussy about cables and connectors. Poor-quality cables damage the critical timing components of digital signals, and inappropriate connectors cause impedance mismatches and reflections, corrupting the signal in all manner of ways -- some terminal!

Optical patch panels are available (Studiospares sell one, for example) and neatly avoid ground-loop problems, but I wouldn't recommend this approach, as the digital data can be degraded very quickly by the smallest imperfections in the fibres, or connector misalignment. Patching S/PDIF signals is a little more reliable, and can be performed very effectively using BNC connectors on a standard video patch panel. Normalling is not possible with this arrangement but, being designed for video circuits, these connectors and cables handle the high frequencies involved in digital audio well, exhibit the correct impedance (75(omega)), are affordable and remarkably robust. Good-quality, ready-made BNC-to-BNC and BNC-to-phono cables are also easy to find and not too expensive and, since most BNC patch panels have BNC connectors on both sides, no soldering is necessary. Don't go mad with the cable lengths, though. S/PDIF is not intended to travel great distances -- try to keep total cable runs (to the patchbay and back) under 5 metres, and the shorter the better.

AES-EBU signals are far more robust, so can travel much greater distances and, since they are balanced at an impedance of 110(omega), standard CAT-5 computer cable can be used very effectively and cheaply. There are pukka AES-EBU patchbays available (Ghielmetti produce one, for example) but these are hugely expensive, and a digital router would be more cost-effective in a typical digital home studio. However, I know of several installations employing standard B-gauge patchbays to route AES-EBU very effectively, complete with conventional normalling techniques. The AES and EBU don't recommend this, though, and it runs the risk of accidental cross-patching with analogue circuits. In my opinion, the better and most cost-effective solution is to construct an XLR patchbay using a 'Universal Connection Panel' from suppliers such as Canford Audio. Again, normalled circuits are not possible and the user ought to find some way of avoiding analogue (microphone) and digital circuits being cross-plugged, or inappropriate mic leads being used to patch digital signals.

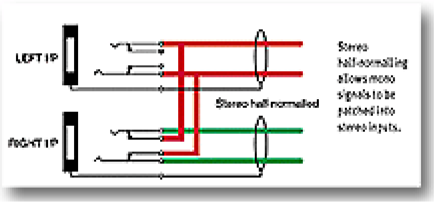
Q
Is there a standard patchbay colour-code?

There is no one standard for colouring patchbay labels, although there are a few common designations, but developing a colour-coding system can save a lot of time in locating a specific connection on the jackfield. There are several ways to colour the patchbay labels: professionals tend to use coloured film over printed labels, but you might find it easier to colour the label strips with highlighter pens, or make your own coloured labels on an inkjet printer.

The one standard which most jackfields adopt is to use red to indicate half-normalled sockets, warning that a normalled circuit will be broken if a plug is inserted. The rest of the colour scheme is up to you; green for line inputs, blue for outboard, or whatever you think will help you to find your way around.

Q
How can I connect a mono signal to a stereo input on a patchbay?

This is a common requirement with multi-effects processors which can accommodate a mono or stereo input, depending on the selected algorithm. Fortunately, it is easily solved with a special version of half-normalling called 'stereo half-normalling'! The answer is to connect the tip (and ring, in balanced interfaces) contact(s) of the left channel input socket to the *switching* contact(s) of the right channel's input socket. I know of no commercial patchbays with provision for this kind of facility, so it will require a couple of short lengths of wire and a bit of soldering (see diagram above).



With a single source plugged to the left channel's socket, the half-normalling will carry the signal over to the right input as well but, when a second input is plugged in, the normalling is broken and the two inputs are passed to their respective channels. The BBC use a specific colour-coding system to identify stereo half-normalling arrangements on the jackfield. The left (mono) input is coloured red, the same as any other break jack, but the right input is coloured with diagonal red stripes -- sufficient to suggest a break jack, but different enough to remind the user about the stereo half-normalling facility.

Q
How should I clean my patchbay?

Infrequently! A properly designed jackfield has self-cleaning wiping contacts so a single twist of the wrist, from one extent to the other and back, as the plug is inserted, is all that is required. On A-gauge sockets, t oo much wiping will wear the spring contacts and erode their chrome plating.

Mechanical jackfield cleaning tools (burnishers) are available, but their abrasive action will eventually destroy the contacts, especially with A-gauge sockets, which are not designed for a particularly long life anyway. A better solution for troublesome contacts is one of the spay cleaners such as 'Kontact' or 'Colclene TF', perhaps with a little gentle hand cleaning of the contacts with a lint-free cloth. These sprays evaporate leaving the contacts clean, dry and free of sticky residue -- never use spray lubricants or oils, such as WD40, because these do leave sticky residues, attracting dust and making dirty contact problems a thousand times worse!

"Depending on the abilities of the equipment being connected, mixing balanced and unbalanced signals on the same jackfield shouldn't cause any more problems than connecting the equipment together directly."

Prevention is better than cure, so avoid having dust and dirt enter the jackfield in the first place. Install jackfields vertically in a rack, rather than horizontally at the side of the desk where dust and dirt will fall into the sockets, and think about enclosing the rear of the rack to keep dust out. Avoid putting the jackfield in the same rack as machines with fans, or which generate a lot of heat, as the forced or convective air currents often end up entering or exiting the rack through the jack sockets, depositing a frightening amount of dust and grime along the way. SOS

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