

Oakley Sound Systems

Dizzy

The Power Distribution Board

PCB Issue 4

User Manual and Builder's Guide

V4.3

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Introduction

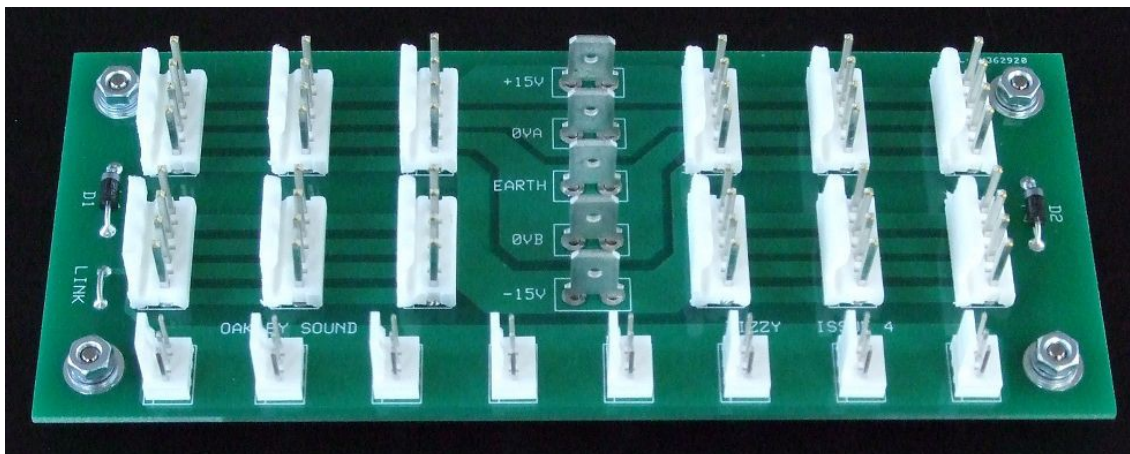
This is the User Manual and Project Builder's Guide for the issue 4 Dizzy module from Oakley Sound.

This document contains a basic summary of its operation and some information about how to connect it to your power supply and modules.

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or <http://www.oakleysound.com/parts.pdf>.

For general information on how to build our modules, including circuit board population, mounting front panel components and making up board interconnects please see our Construction Guide at the project webpage or <http://www.oakleysound.com/construct.pdf>.

The Dizzy – A Power Distribution Board for the MOTM system



A completed Dizzy module. 1/4" (6.35mm) Faston blade terminals provide for easy and reliable connections to the master power supply.

This is a power distribution board supporting twelve 4-way 0.156" MTA/Molex headers and five 1/4" (6.35mm) Faston blade terminals for power entry.

Also included in the design are eight 0.1" headers that can be fitted to connect to the Oakley Bus. The Oakley Bus can carry Key CV and gate signals to suitably equipped modules, like the Oakley VCO, VRG, ADSR, etc.

The double sided circuit board is 5.6" (142mm) long by 2.35" (60mm) wide. It is designed to go at the rear of 19" rack units or built into the bottom panel of wooden modular cases. Each row of three headers is 'star wired' back to the blade terminals to ensure to lowest possible resistance and unwanted interaction between connected modules.

It is fully compatible with Oakley and MOTM power busses. The Oakley power system is identical to MOTM power systems except that the pin 3 position on the power header is used for solely connecting to the module's socket's ground lugs and panel metalwork. This can help in alleviating unwanted inter-module crosstalk.

The Oakley Power Bus

In an ideal world I wanted the Oakley power bus to be based on a five way 0.156" MTA or Molex connector. This would contain +15V, -15V and three 0V or grounds. One ground would be the safety ground; this would be connected to the power supply's 0V, the modules' front panels and to the mains earth. The second would be a clean ground for all the analogue modules to take their supply reference, the true zero volt line, ie. 0V. The third would be a dirty ground. This would be the ground reference for things like the noisy digital circuitry and LED switching. All three would be connected together but only at the power supply. However, this system would be incompatible with the popular MOTM modular system which only has a four way connector for its analogue modules. So the question now remained, how could I make my system work with MOTM, yet still retain some of the features I needed.

The chosen Oakley power bus comprises of +15V and -15V lines with two separate 0V connections. These 0V are not connected together in each module as they are in MOTM modules. They are joined only at the power supply in a wholly Oakley Modular.

In an Oakley modular one of the grounds, pin 2, is solely used for the electronics in the module. I call this module ground or module 0V, it's the reference point for all the circuitry used in a module. Unfortunately, it is also the dumping point for some hefty current but I try to reduce this to a minimum by certain design choices in the modules.

The second ground is on pin 3. This is also connected to the power supply's 0V output. This ground is connected only to the metal lugs of the sockets on each module, and therefore the panel itself, and nothing else on the module. This way it is impossible for any signal return currents to travel down the inserted patch cords since the panel is isolated from the system ground except at one point, the PSU.

MOTM modules can be modified to allow full Oakley compatibility although this should be done as you are building the module. Modifying a completed MOTM module is possible, but the reverse side of the PCB must be accessed so that you can cut the required tracks.

However, note that the MOTM and Oakley power systems are still compatible. Any Oakley module will work in a MOTM system. And MOTM modules will work in an Oakley system – the only downside being that some of the benefits of a two ground system are increasingly lost as you add more MOTM modules to the mix.

Personal Note...

One has to a little careful when using the word 'ground'. I sometimes talk about local ground and 0V as being the same thing. This is technically incorrect but it is used a lot. I worked at Marconi in the 80s and Soundcraft in the early 90s, and ground and 0V were used interchangeably even by seasoned engineers. We'd talk about chassis ground, dirty ground, signal ground and clean ground. They'd all be connected to 0V somewhere in the system but the term ground was in common usage.

Ground, when used in this way, is then a local common reference connection tied to the 0V of

the unit's power supply. It is not the same as mains earth. Indeed, it may not even be tied to mains earth in the unit in question.

Strictly speaking, electrical ground is mains earth and historically it was solely referred to as that, but usage, incorrect or not, has meant a shift in the meaning. Ideally, we should call our common reference connection within our unit as 0V and not use the term ground.

Parts List for issue 4 Dizzy

For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or <http://www.oakleysound.com/parts.pdf>.

Diodes

1N5819 Schottky power diode	D1, D2
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Link

A wire link should be fitted across the two pads labelled LINK. You can use one of the lead clippings from the diodes to do this.

Connectors

'Faston' 6.35mm single blade terminal	+15V, 0VA, 0VB, -15V, Earth (Optional)
4-way MTA156 (3.96mm) headers	12 off
3-way 2.54mm KK or MTA header	8 off Oakley Bus headers (Optional)

Building your Dizzy

The Dizzy printed circuit board (PCB) is double sided which means it has copper tracks on both sides to carry the electrical current around the board. The copper layer is 2oz grade which means it is twice as thick as most ordinary circuit boards. This keeps the electrical resistance of the tracks low which reduces the chances of the connected modules interacting with each other.

Thick tracks and lots of copper mean that not only does the board carry electricity well, it also means that the tracks conduct heat well. So when you solder your board you will find you will require more heat than normal to melt the solder effectively. A good well powered soldering iron is essential for getting a good solder joint.

If you find that when soldering you are not getting your solder to wet both parts of the joint then you may need a hotter iron or a more powerful iron. The smaller components should be no problem but the bigger ones like the blade terminals will require some time to heat up to the correct temperature to allow the solder to melt. With the blade terminals I apply the soldering iron to the solder tang for a second and then apply solder to the tip of the tang only. Allow the tang to heat up and then start to apply a small bit of solder to the PCB pad. Keep applying the heat and a nice neat solder joint should form. A small amount of solder will wick through to the other side of the board but not a great deal as the blade terminal itself will steal away the heat and prevent the solder from going all the way through. Each blade terminal has two tangs and it is best to solder the second immediately after the first as the heat already built up will speed things along with the second.

The PCB hole size for the 1/4" (6.35mm) faston single blade terminals is around 1.5mm in diameter. This may not be tight enough for some types of faston terminals to held in place when the board is upside down and ready to be soldered. I recommend fitting all four, or five, at the same time while the board is held upright. Then with something flat and stiff, a small bit of MDF sheet will do, placed on top of them to hold them in place, the board can be inverted and placed onto your work surface. The blades can then be soldered while you hold the board steady and in a position where the blades are mostly perpendicular to the board's surface. Once cool you can gently bend them if they are a little wonky.

The Oakley Bus and Module Normalisation

The Oakley Bus, previously known as the Oakley Buss, is a three way connector found on various Oakley modules. Pin 1, the square solder pad on the PCB, carries the keyboard control voltage (KCV) input for note pitch control, and pin 3 carries gate input for note on and note off. Pin 2 is connected to 0V via the wire link, LINK, on the Dizzy boards and acts only as a 'fire break' between the gate and CV lines preventing any crosstalk between the two. It is possible not to fit LINK and utilise the pin 2 connection for your own purposes.

The word bus is perhaps a little grand for something that has just two control lines and a single ground. However, it still adheres to the principle of a common set of conductors that is available to all modules.

Normalising is the process by which some signal paths are already made for you. In other words no patch leads are needed to make those connections; they are connected internally either within the module or between different modules but behind the faceplates. However, normalising can always be overridden by the user. The name itself comes from the use of normalised connections on sockets. When a socket does not have a jack inserted it is in its normal position. There is often a connection between the signal lug of the socket and an extra contact called the NC (normally closed) lug. It is this third lug on the socket that is used for the normalisation. Inserting a jack plug will break the connection between the NC and the signal lug.

To help us understand where normalisation is useful consider a VCO with a 1V/octave, or Key CV, socket on its front panel. To connect KCV to this socket one would ordinarily need a patch lead. But imagine a system where you have four VCOs and two VCFs that all need the same KCV signal. It can take many patch leads to do this; seven if you have a large multiple panel. Now suppose that the NC lug of every 1V/octave socket is connected to a common KCV bus. All six modules can now be driven without the need for those seven patch leads. This saves you leads, time, and also gives you a better working environment because you don't have to fight your way through a tangle of leads to get to the module's knobs. Inserting a jack into any one of those sockets would disconnect it from the KCV bus, so you still have complete modularity.

The Oakley VCO, VCO Controller, midiDAC, ADSR, VRG and ASV have the three pin headers on the main or socket boards ready for easy direct connection to the Dizzy or MU Dizzy. However, you should note that, although the Oakley Bus header is a three way connector, the actual interconnect does not require all three wires connected. The actual wires you do need is determined by the module type. For example:

The Oakley VCO is connected only to pin 1 of the Oakley Bus. This is the connection carrying KCV. This means you need to use only a single wire that is terminated in a 3 way housing at either end. The first location of the housing, pin 1, is the only one used, with the other two locations being left empty and no other wires needed.

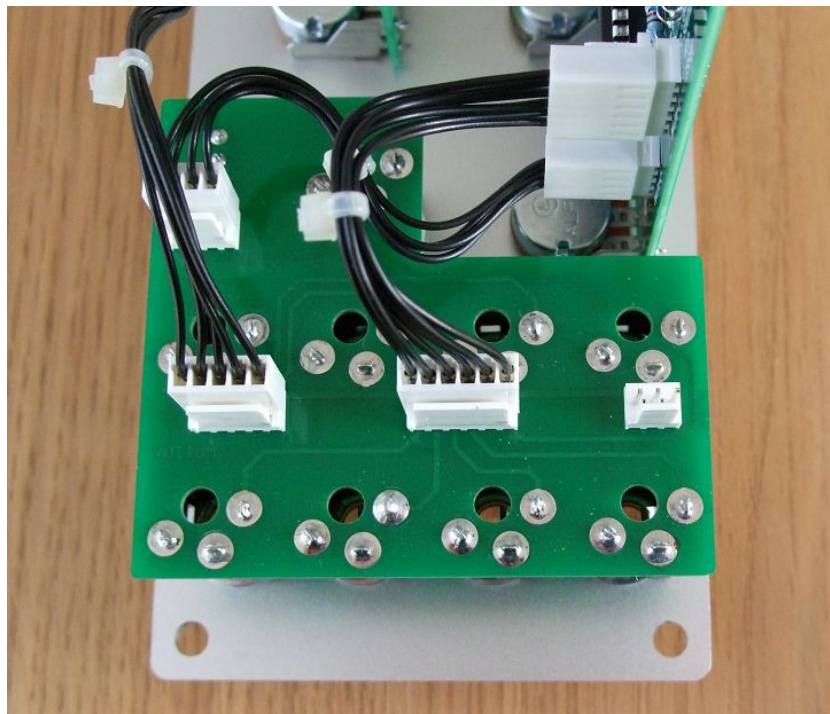
Likewise the Oakley ADSR and VRG modules need only to be connected to pin 3 of the Oakley Bus. This is the connection carrying the gate. So this time you only need to wire up pin 3 and positions 1 and 2 are left blank.

The midiDAC, however, generates the CV and gate lines for your modular so this should have two wires connected on its bus connector. Both pins 1 and 3 are used on this module.

The ASV also requires the bus connector to have two wires. The ASV has both gate and KCV inputs that can be connected to the Oakley Bus.

You could make a generic Oakley Bus connector that would be suitable for all modules using the bus. This would comprise of two wires terminated at each end in three way housings but with the middle location left unused.

On no account should an interconnect with three wires fitted be used to connect the Oakley Bus together. The middle location, pin 2, is 0V on the modules and the Dizzy. Connecting the two 0V in this way could, but probably won't, induce introduce unwanted crosstalk in your system.



The rear of the VCO module. The Oakley Bus header is the empty three way header on the right of the socket board.

Note: I have previously used the term 'buss' instead of 'bus'. A bus to me was a form of public transport, and buss was an distributed electrical connection. It seems I was not alone, you'll find various audio sites talking about the 'mix buss'. But from where the extra 's' came nobody seems to know. Perhaps it was a confusion between Bussman the fuse manufacturers. Whatever the history, the use of the word 'buss' is probably wrong. So for now I'll try to stick with bus. Although the plural, buses, looks wrong to me...

The Earth Terminal

The issue 4 Dizzy features a fifth blade terminal connector labelled earth. This is connected to the 0VB terminal on the Dizzy PCB. Whether you use the earth terminal or not depends on how you have built your system.

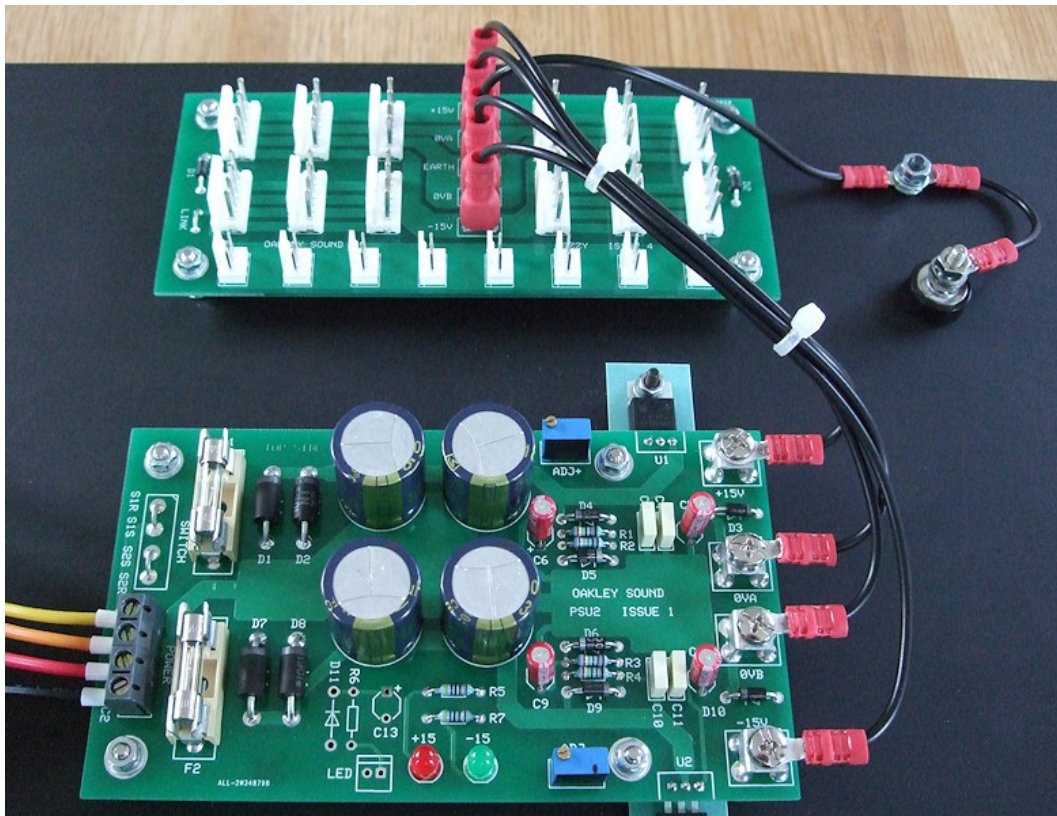
The power supply's 0V output and any metal panels should be connected to mains earth if you are powering your system with an internally fitted mains transformer. The metal panel is typically earthed using a solid earth bond near the mains power inlet socket. While the power supply's 0V terminal is usually connected to earth either with a separate bond to the panel, or wired directly back to the earth bonding point. If you have built a PSU2 then some details for doing this are given in the PSU2 Builder's Guide. However, it may be beneficial in some situations, perhaps when you have multiple Dizzies connected to a single PSU, to earth each Dizzy individually instead of a single earth connection to the PSU's 0V terminal. This may be useful if you have the Dizzies mounted onto the same metal panel, as you can use the metalwork as a low resistance pathway for earthing. In this particular case each Dizzy would have its own local earth bond, from the earth terminal on the Dizzy to the earthed metal panel, and the power supply's 0V would be connected to earth by the Dizzies' 0VB connections.



An earth or grounding bond using an M4 screw and crimped ring terminal. Any surface coating, eg. paint or anodising, should be scraped off around the hole to provide a low resistance connection.

Using an external linelump to power the system's power supply is the most safe option as it keeps all the dangerous high voltages out of your modular. However, there is no earth in such a system as the linelump's 'double insulated' transformer has no mains earth connection. Even so, it is a good idea to ground any metal work to the power supply's 0V. This can be done either via the power supply's own 0V connections or via the Dizzy's earth terminal. The latter may be more suitable if you have the Dizzy board mounted on a metal panel that is some distance away from the power supply. The Dizzy's earth terminal then provides a simple way of bonding that panel to 0VB.

Connecting the Dizzy to the Power Supply



Using black 24/0.2 wire and crimped terminations to connect the Oakley PSU2 module to the Oakley Dizzy. Although I haven't done it here, colour coding your wires, or labelling the Faston sockets with a marker pen, is a good idea.

The cables connecting the power supply with the Dizzy board should be as thick and as short as possible. I recommend using wire that has a cross sectional surface area of at least 0.75mm^2 (18AWG) and be no longer than 30cm. Wire that is defined as 24/0.2 is particularly suitable, its cross sectional surface area being 0.75mm^2 .

The Dizzy therefore should be mounted as close to the power supply as possible. It is far better to keep the four interconnecting wires short and the module power leads long rather than the other way around.

Make sure that the leads are connected correctly before powering up for the first time. The blade terminals on the Dizzy are appropriately named, so the +15V terminal should go to the +15V output on your power supply, the -15V to -15V, and so on. Two 0V connections are provided on the Dizzy, so if your power supply has two 0V outputs then these should both be used, each one going to its own 0V terminal on the Dizzy. If you only have one 0V connection on your power supply then both 0VA and 0VB on the Dizzy must go back separately to that point.

One of the problems encountered by people when building up large modular systems is unwanted interaction between modules. For example, an LFO module may be modulating the pitch of a VCO even though there is no cable connecting the two. Or perhaps you can always

faintly hear a VCO from your main output even though it's not patched up. These are examples of crosstalk. There are two main causes of this. Firstly, signals can be radiated through the air, much like a radio transmitter. Simply moving the offending module from more sensitive ones can help here. Secondly, crosstalk can occur via the power supply, and although there are different types of power supply crosstalk the main one will be due to the resistance of the power supply cables.

Unless we have access to superconducting materials we cannot have electrical cables without resistance. The thinner and longer the cable, the more resistance. When electric current travels through a cable with resistance a voltage is developed across it. The bigger the resistance, the bigger the voltage drop. That voltage drop along the whole system of wires and circuit boards in the modular means that the voltage any module sees at the end of its own power cable will not be what it was designed to deal with. But worse still, this voltage drop will not be constant. Each module in the modular system will be taking varying amounts of current and this unsynchronised battle for current will see the voltage across the power supply pins of every module be different and be continuously changing. Even the best designed modules cannot be expected to work flawlessly with that amount of noise on the power supply.

So if we cannot rid ourselves of crosstalk completely we must try to reduce it as much as possible. However, do bear in mind what is an acceptable amount of crosstalk inevitably depends on the user of the system. After all, the VCS3, a modular synthesiser of a sort, has problems with crosstalk for a multitude of reasons, but is still very much regarded as a classic instrument. That said if the problems are slight with a small modular system then they will almost certainly get worse as the system grows unless steps are taken to prevent it.

We must do three things to reduce crosstalk when using separate power distribution boards:

- a) Minimise the resistance of the cable feeding the distribution boards. That is, the cable from the power supply to the distribution board must be as thick and short as possible.
- b) Reduce the current travelling along the cables that connect to each distribution board. This means that each distribution board should not have too many modules attached to it. A single large distribution board feeding over twenty power hungry modules is going to develop an excessive voltage drop along its feeder cables and within the distribution board itself.
- c) Reduce the resistance of all connections on the distribution board. This means that the distribution board must be as physically small as possible, use thick copper traces and be arranged so that each header has the shortest distance back to the power entry points as possible.

The first point's objectives are clear and the third point should be achieved by using the Oakley Dizzy. The second point though requires a little more thought even if you are using the Dizzy. It may, in some circumstances, be preferential to put all your heavy current modules on one Dizzy even though this seems to go against point two. If one Dizzy was to power, say, a single digital sequencer (complete with flashing lights) and then a bunch of low current analogue modules, you may find that the varying clock and LED current pulses from the sequencer would be picked up by the more sensitive of the analogue modules. So even though the current draw from that particular Dizzy was average, the fact that the power lines had to supply that one noisy module was detrimental to a sensitive analogue module.

Sometimes the current guzzling modules, even though they may be the source of the problem, are the least sensitive to crosstalk from other modules. In this case it may be better put them together rather than shared across your system. Ultimately it pays to swap things around in your modular so you can achieve the quietest operation without sacrificing usability.

The Power Supply

My own recommendation for very large modular systems is always to use several smaller power supplies with a small number of distribution boards rather than one big power supply driving multiple arrays of distribution boards. I think a good system would have no more than two Dizzy boards per power supply. This could allow for up to 24 modules to be powered from each power supply. Even though this is potentially more expensive than using one big power supply there are several reasons for doing this. Firstly, it keeps the wires between your distribution boards and the power supply as short as possible. And secondly if the power supply breaks in such a way that, say, puts the unregulated 25V on your +15V line you don't smoke your whole modular.

If you do chose to use multiple smaller power supplies then a good solid connection must be made between each power supply's 0V. Not a huge amount of current needs to travel down this cable or cables but if you can use a thick cable connection then any problems of hum and crosstalk will be minimised.

Using the Oakley Power Supply (PSU2) to drive the Dizzy is easy. Simply connect four wires from the PSU to the Dizzy board using the screw terminals on the PSU2 and the Faston connectors on the Dizzy. Several ring terminals can be fitted to each of the PSU2's screw terminals.

One final point about using multiple Dizzy boards; watch your maximum current draw. Just because you can have up to 24 power headers does not mean you can actually power 24 modules. Each module takes current, the actual amount should be given in the documentation that came with your module, and your power supply can only supply a certain amount of current.

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