Oakley Sound Systems

Dizzy

The Power Distribution Board

PCB Issue 3

User Manual and Builder's Guide

V3.5

Tony Allgood
Oakley Sound Systems
CARLISLE
United Kingdom

Introduction

This is the User Manual and Project Builder's Guide for the issue 3 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.

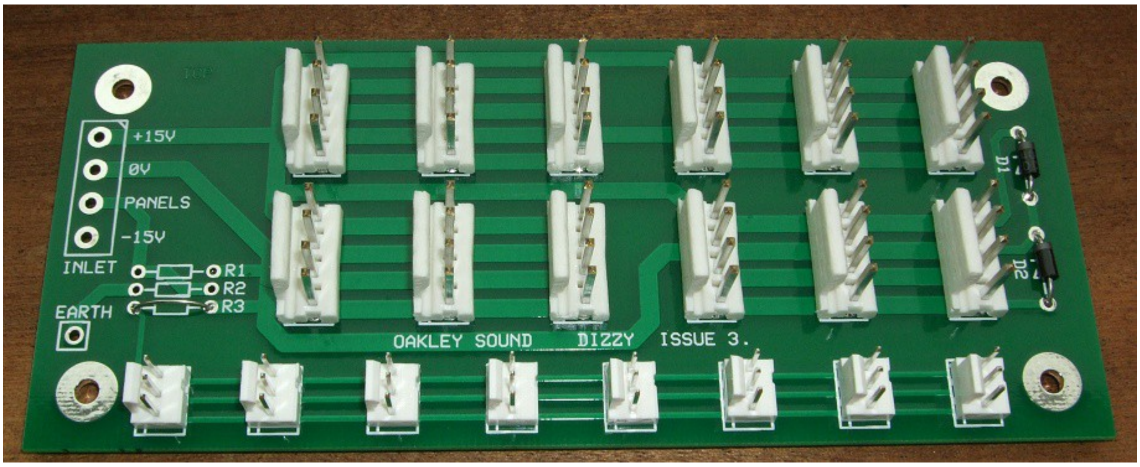
For general information regarding where to get parts and suggested part numbers please see our useful Parts Guide at the project webpage or http://www.oakleysound.com/parts.pdf.

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 Modular Distribution Board for the MOTM system

This is a simple distribution board that enables you connect up to twelve Oakley, Blacet or MOTM modules together. It also features eight 0.1” headers to allow for normalisation paths for keyboard CV and gate.

The larger headers are arranged in three blocks of four. The one master supply inlet uses a 0.2” (5mm) screw terminal connector. An optional earthing point is provided to tie the panels connection to earth potential.



The issue 3 Dizzy board fitted with MTA156 power headers and Molex KK 0.1” headers for the Oakley Bus. The four way power inlet has not been fitted since this particular board will be hard wired to an Oakley PSU.

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 grounds. One ground would be the safety ground; this would be connected to the front panels and then directly onto the main’s supply earth. The second would be a clean ground for all the analogue modules to take their supply reference, the 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. However, this system would be incompatible with the MOTM modular which 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 grounds. These grounds are not connected together as in the MOTM. They are joined only at the power supply in a wholly Oakley Modular.

In an Oakley modular one of the grounds, pin 2, goes straight to the power supply’s star point. This is the analogue reference point and is correctly called 0V or module ground. This is the same as the MOTM ground. The second ground is on pin 3. This is also connected to the power supply’s star ground. But this ground is connected only to the metal lugs of the sockets on each module and nothing else on the module. It is this connection that sets the potential of the patch lead’s screening and the metal case of the modular. This way it is impossible for ground currents to travel down the inserted patch cords, since the panel is isolated from the system ground except at one point.

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.

But I said earlier that the MOTM and Oakley power systems were compatible. And indeed they are. Any Oakley module will work in a MOTM system. And vice versa. But you will not get the full inherent advantages of a two ground system if you mix and match systems.

Building the Dizzy board for your needs

The Dizzy board can be utilised very easily. Simply solder twelve 0.156” headers to your board, making sure that pin 1 goes towards the top of the board. You can use either Molex or Amp MTA headers. The latter is the standard fixing on all Oakley and MOTM ready made modules. These are IDC (insulation displacement cable) systems and require a special tool to jam the wire into the specially made connectors. Molex is a ‘strip and crimp’ system, that requires you to strip each wire and then crimp (or solder) the wire into individual terminals. The terminals are then pushed into the housing and held in place by a little spring loaded clip.

The MTA system is good if you have a lot of cables to make, but that IDC tool is very expensive for what it is. The Molex system is cheap and works just as well, but does take longer to prepare the assemblies.

Connect your power supply to the header marked INLET with four wires. The Dizzy board uses a 5mm screw terminal connector. For example, Rapid part number: 21-0116. One four way type is soldered into the Dizzy board, and the connecting wire is fed into the appropriate hole and screwed into place.

Additional board space has been given up to fit two diodes. Use 1N5819 Schottky power diodes. They don’t have to be fitted, but they may help if there ever is a problem with your power supply and/or wiring. These two diodes prevent the positive rail from becoming negative, and vice versa.

Please make sure you fit them in the right way. The white band on the diode should match up with the horizontal band on the PCB legend.

There are spaces for three 'resistors' on the Dizzy board. These are actually spaces for some optional wire links. They allow different earthing arrangements to be set up within your modular. R1 connects between the PANELS and 0V lines, R2 connects between the EARTH pad and PANELS. R3 connects between the 0V and pin 2 of the normalising bus.

Using the Oakley PSU with the recommended AC power adapters you would only need to fit a wire link in position R3. R1 and R2 links are not fitted and are left empty. R3 simply ties the copper trace between the CV and gate lines of the Oakley Bus to ground. If you are not using the Oakley Bus or want to use the middle pin for another job you should omit R3.

The board is arranged in three sets of four headers. It is best to keep more ‘delicate’ modules, like MOTM VCOs, to the two left hand sections. These headers have the shortest path back to the power supply and are the most stable. Each set of four is star wired back to the INLET header, and this should reduce any likelihood of supply line interference between the sets. The connections between each header in the sets are done with tracks on both sides of the boards. This is to try and keep the potential drops between the modules as low as possible.

The Oakley Bus and Normalisation.

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. However, normalising can always be overridden. 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 socket on its front panel. It is most likely to be used to for a keyboard control voltage (KCV). 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 one of those sockets would disconnect it from the KCV bus, so you still have complete modularity.

Normalising is frowned upon by some people, and loved by others. Most modulars do have some form of normalising. The Roland System 100 probably has the highest degree of normalising. You don't even need a patch lead to get that one to sing. The MOTM has no form of external normalising, although there are normalising routes within each module.

When I first started building my own modular system, I thought that normalisation was a bad thing. Like preset memory patches it would stifle creativity by making things a little too easy. However, in practice I noticed that I was routing CV and gate to the same locations in the modular for almost all my patches. So I decided to provide some form of limited normalising. I chose to normalise just KCV and gate. No audio normalisation was allowed. It was easy to do, and proved very effective.

The issue 3 Dizzy PCB includes a three way normalising bus which we call the Oakley Bus. This Oakley standard, originally created with the Dizzy issue 1 PCB, gave us just two lines; the KCV and Gate busses. These are accessed by the three way 0.1" headers. Pin 1 of each header is KCV and pin 3 is Gate. Pin 2 was connected to ground on the first board, but some customers modified the board to give a third CV bus. This issue of the Dizzy board leaves it floating so you can now use it to normalise a third CV line without cutting any PCB tracks. However, it is usually connected to 0V ground via R3. If you do not intend to use pin 2 for anything, make R3 a wire link to provide some isolation between the other two lines.

The Oakley VCOs, ADSR, midiDAC and VCO Controller already have the three pin headers on the main or socket boards ready for direct connection to the 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 module needs 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 2 are used on this module.

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 to any module. The middle location, pin 2, is ground on the module and this should not be connected to the Dizzy or midiDAC modules. Connecting the two grounds in this way could induce earth loops and introduce hum or crosstalk in your system.

Any module not fitted with a suitable three way header that you wish to connect to the Oakley Bus will need to have a suitable length of wire terminating in a 3-way 0.1" header. Again, you'll probably only need to use one pin for each module, since very few synthesiser modules actually use KCV and gate together. The wire end of the interconnect needs to be connected to the NC lug on the relevant socket, ie. 1V/octave or gate. Be sure that you remove any existing normalising on the socket that you want to use. Note that some MOTM and older Oakley modules have the NC lug connected to ground.

The furthest left hand header can be joined to the midi-CV convertor, or an interface panel.

You may feel that adding little single, or double, wire tails to your MOTM modules is not a good idea. It is a little untidy. But I certainly would recommend to try it out if you use your modular for straightforward musical applications.

Connecting the Dizzy to the Power Supply

Cables

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 $0.75mm^2$.

Name	***Pin number***	***Source***
+15V	1	Power supply positive
Module GND (0V)	2	Power supply 0V
Panels	3	Power supply 0V
-15V	4	Power supply negative

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 mains 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.

Tony Allgood