Oakley Sound Systems

Analogue Delay – ADR30

Main Board Issue 1

Builder's Guide

V1.7

Tony Allgood
Oakley Sound Systems
CARLISLE
United Kingdom

Introduction

This is the Builder's Guide for the Analogue Delay Module from Oakley Sound. This document contains a basic introduction to the three circuit boards used to make the ADR30 rack module and a full parts list for all the components needed to populate the board or boards.

For the User Manual, which contains an overview of the unit, the operation of the module and the calibration procedure, please visit the main project webpage at:

http://www.oakleysound.com/ADR30.htm

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 generic Construction Guide at the project webpage or http://www.oakleysound.com/construct.pdf.

The finished ADR30. A thin engraved metal overlay, made by Schaeffer, has been added to the front panel and is held in place by the pot nuts.

Constructing the ADR30

The prototype ADR30 built into a low cost Takachi YM-300 project case. The unit is powered from an external 500mA 15V AC wallwart keeping all high voltages out of the case.

The ADR30 project uses the ADR30 main board, the optional SREIO input/output board and the RPSU +/-15V power supply module.

The ADR30 main board requires a well regulated and quiet +/-15V to +/-16V supply. The current taken by the ADR30 varies slightly with modulation depth but the maximum current is around +80mA and -50mA. Power is admitted onto the main board via a 5-way Molex 0.156" KK or 5-way 0.156" MTA connector. Pin 1 is +15V, pin 2 and 3 are 0V, pin 4 is -15V and pin 5 is panel ground. Panel ground is typically connected to 0V at either the power supply or the input/output sockets. On the ADR30 main board Pin 5 connects only to the pot brackets and switches' metal supporting tangs.

The ADR30 is a large board at 198mm wide and 153mm deep. It is secured to the front panel by the pot brackets and to the lower panel of the case with two M3 screws and spacers. The board has four copper layers, the top and bottom copper layers carry signals, the lower middle layer carries power supplies and some signals, and the upper middle layer is solely designated to 0V. A four layer design, although expensive to produce, gives better performance than standard two layer board designs. It is, however, imperative that when soldering, and especially desoldering, that the through hole plating used to line all the solder pad holes is not damaged. If you do need to desolder a part then either use a proper vacuum desoldering tool or cut the component body out first and then desolder one component leg at a time.

The SREIO board is an input and output socket board designed for this project. It allows the simple interconnection between the ADR30 main board and the audio sockets via a single 16-way 0.05" IDC ribbon cable. The SREIO board also features a electromechanical relay to cut the connection between the main board's output circuitry and the output sockets at power on and power off. This reduces the likelihood of damaging thumps on the audio output when power is turned on and off. The anti-thump circuitry is powered from the main power supply module via a three way 0.156" Molex or MTA connector. Pin 1 is +15V and pin 3 is 0V. Pin 2 can be used to 'ground' the sockets' earth lug to the power supply's 0V if desired although this is not normally needed in most ADR30 builds.

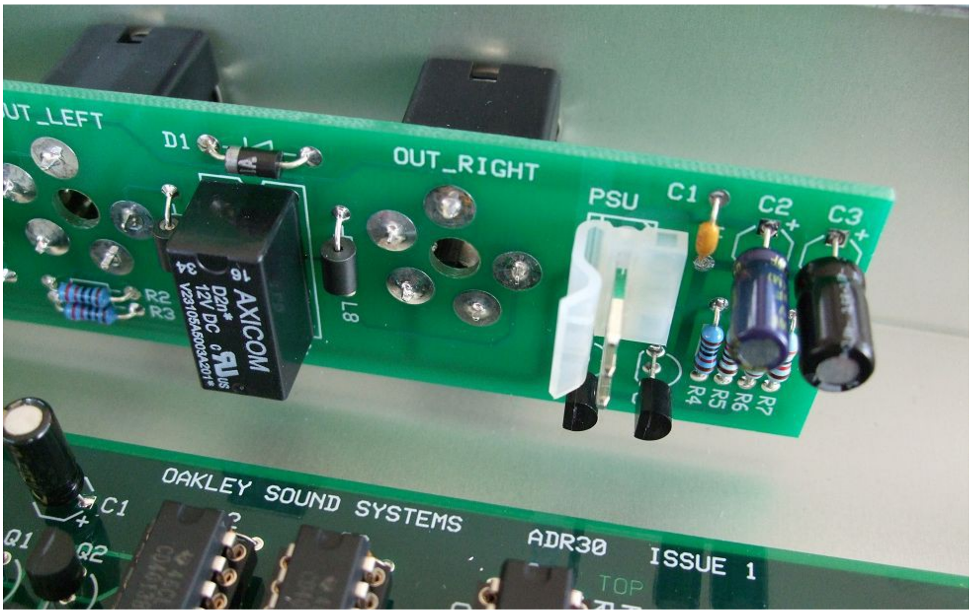
The SREIO board is 34mm high and 185mm wide. It is a two layer design. The sockets used are the industry standard 1/4" three pole TRS (Tip Ring Sleeve) socket, the Switchcraft 114BCPX. Various clones of this socket are available such as the Amphenol ACJS-MN-5. The CV input socket, fitted to position IN_B, doesn't have to be a TRS but can be a two pole type, such as the Switchcraft 112ACPX, which may save some money. For the prototype I used four Amphenol ACJS-MN-5 and have been happy with the results.

The RPSU is a power supply module designed for the ADR30 and other Oakley Sound rack projects. It generates +/-15V at up to around 1A given sufficient heatsinks and a suitable mains transformer. The ADR30 only needs less than 100mA but even so adequate heatsinking must be used for the two power devices. Since best performance for any electronic audio device comes from using a metal case it makes sense to use the case itself as a heatsink. Details on how to do this are given later in this document.

Although the RPSU can be used with an internal mains transformer, I recommend that builders use an external low voltage output line lump or wallwart type mains adapter. This keeps all the high voltages away from your project and ensures your safety. Later on in this document I will give details on how to build your RPSU module to suit your chosen method of supplying power.

The RPSU is 150mm by 51mm in size. It is a two layer board and made from double thickness copper to reduce unwanted voltage drops along the copper traces on the board. Unlike the issue 1 RPSU board there are no trimmers to set the voltages to exactly +/-15.00V. The ADR30 main board's circuitry is not bothered whether the voltage is exactly 15.00V but only that it doesn't change once the main board has been calibrated. The RPSU board thus needs no trimmers and produces a little over +/-15.1V when built as recommended.

The RPSU requires an AC supply of a minimum of 15V to work correctly. When used with a centre tapped AC supply, such as that from an internal mains transformer, the current taken is approximately 0.2A (RMS). With a single phase supply, such as that from a standard AC output wallwart supply, the current required will be in the order of 0.3A (RMS).



A close up of the anti-thump circuitry on the optional SREIO board. The PSU connector is a three way Molex KK 0.156" type which mates with a three way housing fitted with special crimps.

Parts Lists

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

The components are grouped into values, the order of the component names is of no particular consequence. Component values given in this list supersede those shown on the schematic.

A quick note on European part descriptions. R is shorthand for ohm. K is shorthand for kilo-ohm. So 22R is 22 ohm, 1K5 is 1,500 ohms or 1.5 kilohms. For capacitors: 1uF = one microfarad = 1000nF = one thousand nanofarad.

To prevent loss of the small '.' as the decimal point, a convention of inserting the unit in its place is used. eg. 4R7 is a 4.7 ohm, 4K7 is a 4,700 ohm resistor, 6n8 is a 6.8 nF capacitor.

ADR30 Main Board issue 1 Parts List

Resistors

All standard resistors should be 1% 0.25W metal film resistors except for R57 which can be 5% metal film or carbon.

R22 is a 1K positive temperature coefficient (PTC) resistor. Any temp co in the range of +3000ppm/K to +3900ppm/K can be used.

10R	R17, R24
22R	R1
220R	R18, R20, R19, R21, R122
680R	R2
1K PTC	R22
1K5	R84, R85
2K2	R32, R35, R26
2K7	R4
3K	R6
3K3	R3, R104
3K9	R59, R65, R66, R72, R71, R69, R70, R60, R63, R64, R58, R56, R105, R106
7K5	R40, R31
8K2	R45
10K	R25, R76, R55, R79, R57, R80, R54, R61, R8, R28, R68, R38, R62, R37, R53, R67, R73, R15, R16, R12, R11, R29, R77, R78
11K	R81, R82
12K	R7
15K	R87, R90
16K	R75, R74
22K	R125, R118, R10, R119, R97, R14, R9, R91, R96, R13, R107
33K	R103, R100, R88, R120, R115, R89, R83, R86, R116
47K	R102, R42, R95, R92, R113, R44, R43, R117
56K	R23
82K	R41
100K	R94, R30, R5, R108, R93, R39, R123, R111, R112, R36, R47, R98, R27, R99

330K	R46, R34, R33, R110, R124, R109, R101
470K	R50, R51, R114
680K	R121, R48
1M	R49, R52

Capacitors

100nF axial multilayer ceramic	C2, C30, C47, C15, C9, C97, C48, C3, C27, C95, C4, C90, C89, C88, C73, C96, C28, C85, C83, C98, C50, C49, C60
1nF 100V polyester	C71
2n2 100V polyester	C61, C67, C70
3n3 100V polyester	C68, C65, C16
6n8 100V polyester	C46
10nF 100V polyester	C66, C69
100nF 63V polyester	C7, C32, C33
220nF 63V polyester	C21, C26, C25, C24, C20, C45
470nF 63V polyester	C86, C79, C51, C92
1uF 63V polyester	C77, C99, C81, C80, C102
2u2 63V polyester	C94, C100
10pF 2.5mm ceramic C0G	C37
33pF 2.5mm ceramic C0G	C12, C91, C76, C74
47pF 2.5mm ceramic C0G	C54, C57
100pF 2.5mm ceramic C0G	C40, C63, C14, C87, C41, C93, C13, C6
150pF 2.5mm ceramic C0G	C52
220pF 2.5mm ceramic C0G	C53, C56
470pF 2.5mm ceramic C0G	C38, C35, C72
1nF 2.5mm ceramic C0G	C64, C58, C55, C59
1uF, 63V electrolytic	C84
4u7, 63V electrolytic	C22, C18, C31, C36, C44, C34, C29
10uF, 35V electrolytic	C10, C23, C78, C8, C75, C39, C42, C43, C101, C19, C62, C82, C11
22uF, 35V electrolytic	C17, C5
47uF, 35V electrolytic	C1

Discrete Semiconductors

1N4148 small signal diode	D1, D11, D8, D9, D5, D6, D10
1N5819 Schottky power diode	D3, D4
5V1 zener diode	D7, D12
BAT42 Schottky diode	D2
BC549C NPN transistor	Q19, Q9, Q21, Q22, Q1, Q2, Q20, Q12, Q11, Q18, Q3, Q7, Q13, Q17, Q16, Q15, Q14
BC559C PNP transistor	Q4, Q24, Q23, Q6, Q5
J112 N-channel JFET	Q10, Q8

3mm orange LED	ON
3mm green LED	OK
3mm red LED	PK

Integrated Circuits

CD4013BE dual flip-flop	U1, U2
CD4016BE quad analogue switch	U8, U9, U10
CD4069UBE hex inverter	U3
MN3005 4096 stage BBD	U6, U7
V571D or NE570 compander	U5
OPA2134PA dual op-amp	U16, U4, U12, U11
TL072CP dual op-amp	U13, U14, U15

Trimmers

All trimmers are 6mm types. For example, Bourns 3386F.

20K trimmer	FBK, OFF1, OFF2, BAL, WIDTH
100K trimmer	RANGE
50K trimmer	GAIN1, GAIN2

Potentiometers

All pots 16mm Alpha or Alps types.

50K linear	INPUT, WET/DRY, DELAY, FEEDBACK
50K linear (dual)	OUTPUT
50K log	RATE, DEPTH

Seven Alpha pot brackets. Seven knobs to suit.

Miscellaneous

SPDT PCB mounted toggle switch	MODE

Interconnects

5 way Molex 0.156" header	POWER
16 way 2 x 8 IDC box header*	IN1

* If choosing to hand wire the sockets rather than using the optional SREIO board then you do not need to fit this IDC header. Instead you will wire the sockets to the appropriate solder pads where the header would normally be fitted.

Hardware

Mounting hardware for the three mounting holes.

For the Holt Broadcast 1U aluminium or similar cases the following hardware can be used.

M3 hex threaded 6mm spacers (2 off)
M3 CSK 16mm screws (2 off)
M3 hex nut (2 off)
M3 shakeproof washers (4 off)
M3 flat washers (2 off)

For the Takachi YM-300 case the following hardware can be used.

M3 hex threaded 10mm male-female spacers (2 off)
M3 6mm black screws (2 off)
M3 hex nut (2 off)
M3 shakeproof washers (4 off)
M3 flat washers (2 off)

The shakeproof washers go between the bottom panel and the hex spacer, and between the flat washer and the top nut. The flat washer goes up against the top surface of the PCB.

SREIO Board issue 2 and 2.1 Parts List

Important Note

The four 1/4” sockets are fitted on the underside of the board. They should be fitted last and soldered from the top side of the board.

Resistors

All resistors 1% 0.25W metal film resistors.

220R	R2, R3
2K2	R5
3K9	R6
10K	R4
39K	R7

You need to fit two wire links to positions LK3 & LK4. The positions LK1 & LK2 must be left empty.

Capacitors

100nF axial multilayer ceramic	C1
2u2, 63V electrolytic	C2
220uF, 16V electrolytic	C3

Issue 2.1 SREIO boards feature additional locations for six low value ceramic capacitors. These are optional and act as radio frequency interference suppressors.

47pF C0G 2.5mm ceramic	C4, C5, C6, C7, C8, C9

Discrete Semiconductors

1N4004 diode	D1
BC549C NPN transistor	Q1, Q2

Interconnects

Switchcraft 114BPCX 1/4” socket	IN_A, OUT_LEFT, OUT_RIGHT
Switchcraft 112APCX 1/4” socket	IN_B
16 way 2 x 8 IDC box header	IN1
3 way Molex 0.156” header	PSU
16 way 2 x 8 IDC socket	2 off for SREIO to ADR30 interconnect.
16 way 0.05” IDC ribbon cable	Cut to length to fit between SREIO and ADR30 boards

Miscellaneous

Axial leaded ferrite bead	L1, L2, L4, L5, L6, L7, L8 (L3 is not fitted)
12V or 15V DPDT relay*	RELAY

* This relay is an industry standard type such as TE Connectivity part number 8-1393792-8.

RPSU issue 2 Parts List

Resistors

All resistors 1% 0.25W metal film resistors.

270R	R3, R4
3K	R1, R2

R5 and LK are not fitted.

Capacitors

100nF axial multilayer ceramic	C1, C4, C5, C6
10uF, 35V or 50V electrolytic	C2, C3, C7, C8
470uF, 35V or 50V electrolytic	C9, C10, C11, C12

C9 to C12 are radial types and have standard wire ended leads. Lead spacing is 7.5mm. Do not get 'push-fit' types as their pins would be too large to fit into the PCB. Ensure they have a ripple rating of at least 750mA and that their height doesn't exceed your chosen case once they are fitted into the board. One example is Nichicon UHE1H471MHD3TN.

C13 is not fitted.

Discrete Semiconductors

1N4002 or 1N4004	D1, D2, D3, D4, D5, D6
1N5401	D7, D8, D9, D10

D11 and AC LED are not fitted.

D9 and D10 do not need to be fitted if you are using a single phase wall wart or line lump, although they won't cause any problems if they are. For full wave rectification, that is, if you are using a split output line lump or an internal transformer with twin secondaries, then D9 and D10 are required.

Integrated Circuits

LM317T 1A variable regulator	U1
LM337T 1A variable regulator	U2

Ensure that both devices are TO-220 types and not any surface mounting or TO-3 packages. I much prefer the devices that have a thicker mounting (dual gauge) tab.

Do not fit solder U1 and U2 into the board just yet. They are only to be soldered once the board is fitted to the base panel of your case. See the section on mounting the RPSU board later in this document.

Miscellaneous

0.156” Molex KK 5-way header	PS1
0.156” Molex KK 3-way header	PS2 – if using the SRE I/O board.
0.156” Molex KK 5-way housing	2 off for power cable to main board
0.156” Molex KK 3-way housing	2 off for power cable to SREIO board
0.156” Molex crimps	16 off for power cables
Antisurge 20mm fuse*	F1, F2
20mm fuseholder PC mount*	F1, F2
4-way screw terminal 5mm**	POWER, SWITCH

* If you are using a single phase wall wart supply, then fuseholder F1 and its associating fuse does not need to be fitted. F2's fuse rating should then be a 500mA antisurge or time lag type. If you are using an internal transformer or split output line lump supply then both fuseholders are fitted and the fuses are both 500mA antisurge or time lag types.

** If you are using a single phase wall wart supply then you only need two 2-way screw terminals.

2 off TO-220 insulator	For mounting of U1 and U2 to panel
2 off TO-220 insulating bush	For mounting of U1 and U2 to panel
Heatsink paste	For mounting of U1 and U2 to panel if using mica plates

Suitable power switch
Suitable power socket

A suitable length of 24/0.2 insulated cable for all power connections.

Mounting hardware for the four mounting holes.

M3 hex threaded 6mm spacers (4 off)
M3 CSK 16mm screws (4 off) for Holt rack case
M3 16mm pan head black screws (4 off) for Takachi YM-300
M3 hex nut (4 off)
M3 shakeproof washers (8 off)
M3 flat washers (4 off)

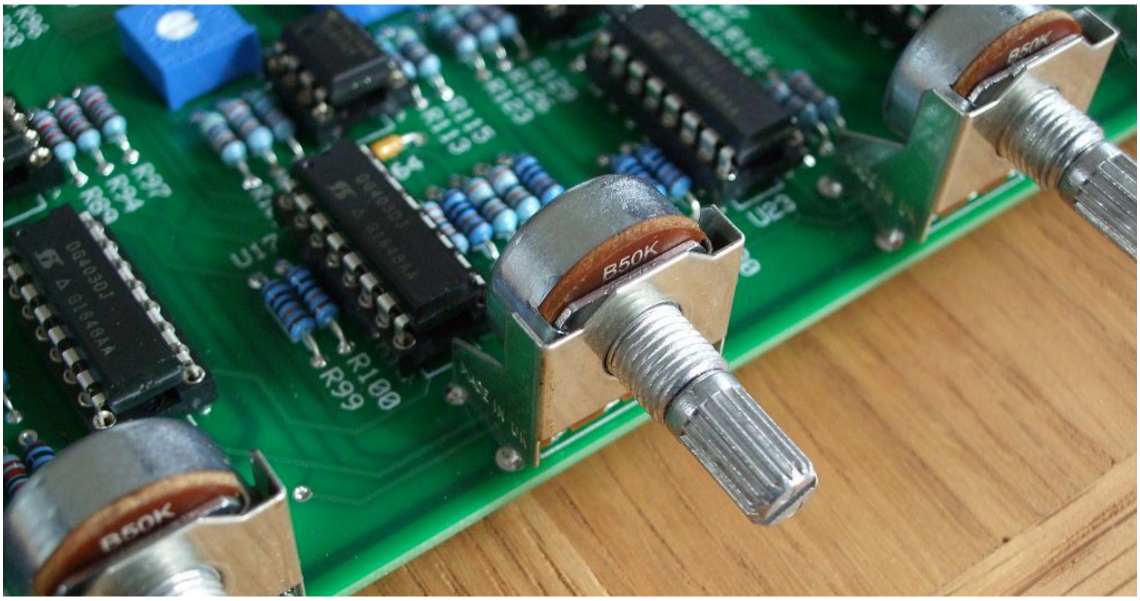
The shakeproof washers go between the bottom panel and the hex spacer, and between the flat washer and the top nut. The flat washer goes up against the top surface of the PCB.

For mounting the power devices, U1 and U2, you will also need the following parts.

M3 10mm screws (2 off)
M3 hex nut (2 off)
M3 shakeproof washers (2 off)

Please see later in this document for more details on how to mount the power devices.

Mounting the Pots and Switches



A close up of the single gang Triangle Modulation Depth pot with its solder bracket.

If you are using the recommended Alpha pots then they can help support the PCB with the addition of the specially manufactured pot brackets. However, given the large size of the ADR30 PCB it is also necessary to utilise the two additional mounting holes at the rear edge of the board. These holes are sized to take an M3 screw and can be used with suitable hex spacers to attach the PCB directly to the lower panel of your case.

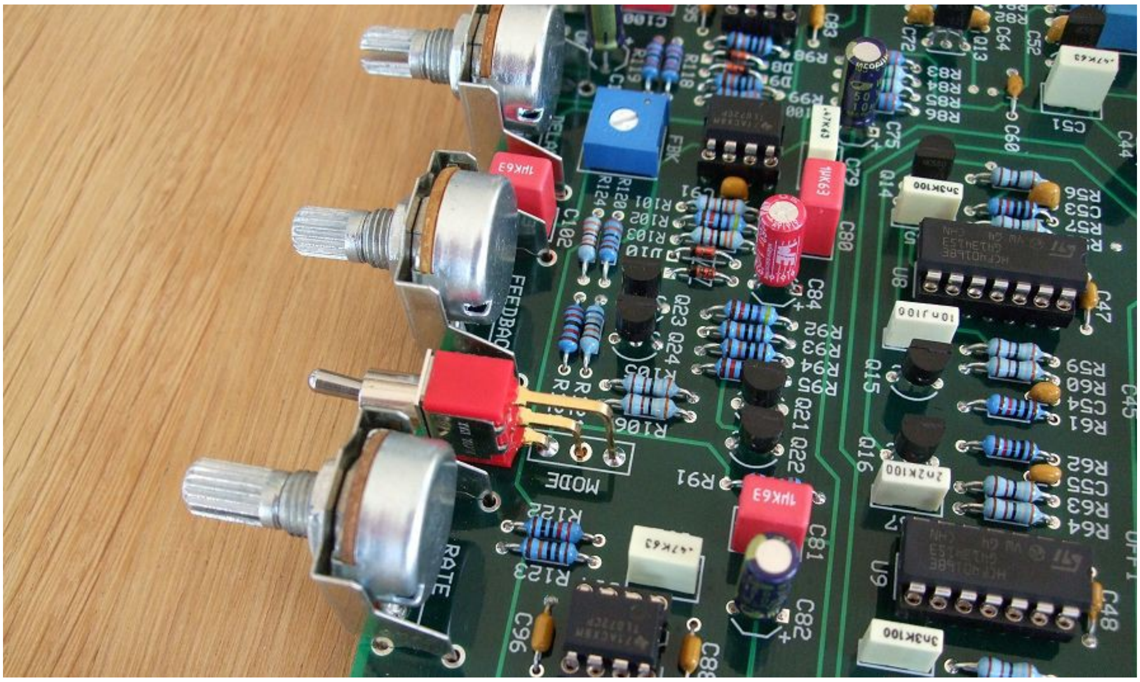
Alpha pots are labelled with an A, B or C prefix. For example: B50K or C10K. Alpha and ALPS use the key; A = logarithmic, B = linear and C = reverse logarithmic. So a B50K is a 50 kilohm linear pot. You can use 47K in place of a 50K pot.

When constructing the board, temporarily fit the pot brackets to their pots by the nuts and washers supplied with the pots. Now fit the pot and pot bracket assembly into the appropriate holes in the PCB. Solder only the three, or six for the dual gang pots, pins that connect to the pot. **Do not** solder the pot bracket at this stage. When you have soldered all the pot pins you can fit the board temporarily to the front panel. Ensure that the PCB is at right angles to the panel, the dual gang pot should hold it so, and then solder each of the brackets.

If you have used an enclosure, such as the Holt “Joggle” 19” cases, that does not allow you to access all the pot bracket pins once the board is fitted up to the front panel, then only solder the pins you can easily reach from the board's underside. Once these have been soldered remove the board from the front panel and solder the ones along the front edge.

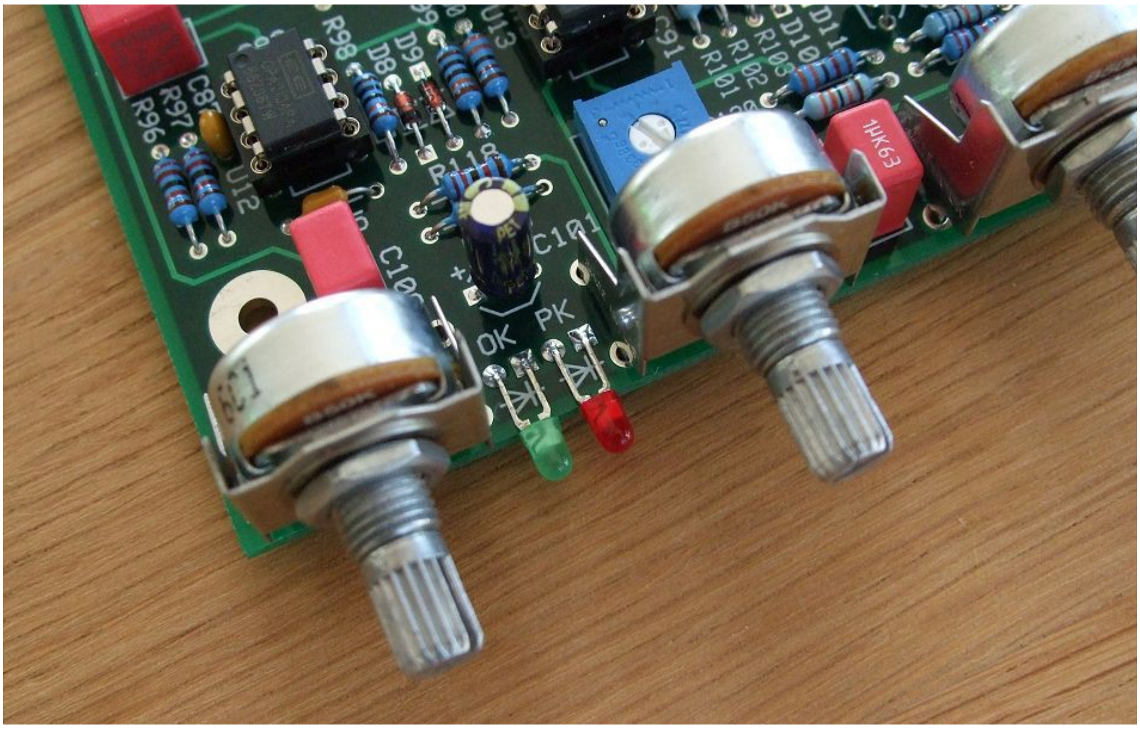
If you have used an enclosure, such as the Takachi YM-300, which doesn't allow access to any of the underside of the board once the pots are secured, then clearly the pot brackets need to be soldered before you place the board to the panel. You need to ensure, as much as you can, that the pot shafts are at right angles to the board surface before you solder the brackets. It may be prudent to solder one pin of each bracket and then check that the pot is correctly angled before soldering the remaining three pins.

Now remove the board from the front panel if you have not done so already. It's time to fit the switch. The PCB mountable switch should fit snugly into its holes on the board. Make sure the switch body is flat against the board. Now solder all the pins on each of the switches including the two securing pins to the front. You may need to trim the switch's pins if they stick out too far from the underside of the board.



The switch here is the Multicomp's two position 1MS1T2B4M7RE

Mounting the LEDs



The signal OK and Peak LEDs. The cathode is denoted by the square pad on the PCB and the larger triangular section within the LED's translucent plastic body.

Remove the front panel so that you just have the board again. Get one of the LEDs and find the cathode. Make sure the cathode of the LED will go into the square pad, pin 1, on the board. Carefully bend the LED’s legs at a point 6mm away from the plastic body of the LED. The legs should be bent by 90 degrees so that the legs are pointing straight down. Check to see if they fit into the board. The bottom of the LED’s body should fit just flush to the board edge. Fit the LED to the board but do not solder it in at this stage. Turn the board over and cut the protruding leads down to about 3mm in length. Now repeat the operation for the other two LEDs.

Fit the front panel again to the main board taking care to ensure that the three LEDs fit into their respective holes. Align any LED if it isn't quite straight and then solder them in place either from the top or the bottom of the board.

The Power Supply

The issue 2 RPSU board fitted to a Takachi YM-300 case. The RPSU has been built in the recommended half-wave option suitable for powering a single ADR30 main board.

Safety Warning

The RPSU supply module has been designed to work with isolated low voltage AC inputs only. Connection to any alternating current supply is done at your own risk. Low voltage is classified as being less than 25V with respect to the ground potential. Voltages above this level can, and often are, lethal to living creatures.

Oakley Sound Systems will not advise on building or modifying this board to allow for direct connection to the mains, or other high voltage sources, further to what is provided in this document. Please do not ask me for additional information pertaining to direct mains connections or using internally mounted transformers as I will not give it.

For safety and legal reasons I cannot recommend powering this board from any other supply than low voltage AC output mains adapters.

Oakley Sound Systems are not liable for any damages caused by the misuse of this product. It is your responsibility to use this product safely. If you have any doubt about installing a safe power supply, then please do not attempt to do so.

The recommended option: Use a single phase AC output wall wart supply.

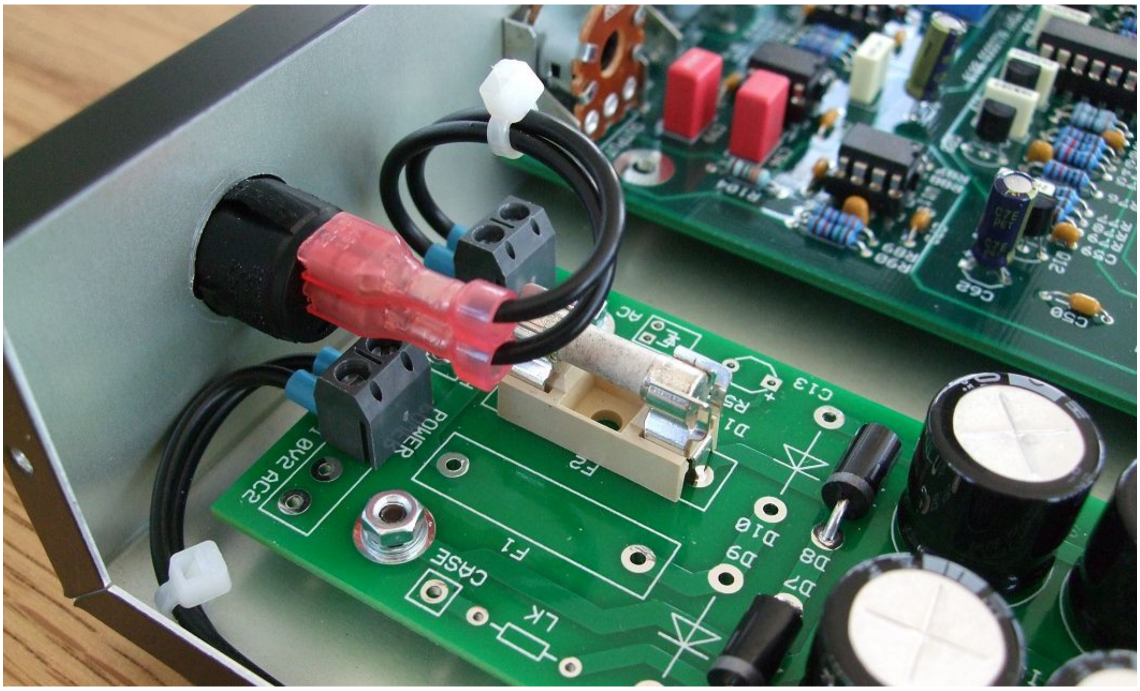
These wall warts are the most common AC output power adapters but increasingly they are getting harder to find particularly at higher output currents. Most wallwart supplies produce DC (direct current) voltages which means they are not suitable for use with the RPSU. Ensure that when you buy a wallwart type adapter it does actually output an AC (alternating current) voltage. Some DC output adapters are confusingly called AC adapters simply because they plug into your AC mains supply.

A single ADR30 main board requires around 300mA or 0.3A from a single phase 15V AC supply. That means you need to find one with **at least** this current capability. So a 15V 0.5A device would be perfect, but a 15V 0.2A would not. An 18V AC supply would also work but again at least 0.3A is required.

Quite often you will find power supplies not rated in amps but instead given an overall maximum power rating, or wattage. The maximum amount of current that can be taken is worked out by dividing the power rating in watts by the voltage output. The problem is that you don't often know the actual voltage the device is producing since it does vary a lot from what it says on the device. For example, a 15V supply may well be producing 18V even when at full load. So a 10W 15V AC device will almost certainly work well. However, a 5W 15V one which in theory should work, in practice it may not.

Ultimately, the proof of whether it works is twofold. It must firstly produce the correct voltage so the RPSU can actually create a stable +/-15V when driving the ADR30. And secondly, the adapter must not get overly warm in use. If you've bought what should be a good adapter but it gets hot or hums loudly when powering your project then it is not suitable. Another solution must then be sought.

In the UK and the Republic of Ireland you can use the Ideal Power 77DB-10-15M which is available from Farnell.



The wiring to the RPSU module. Here I have used boot lace ferrules for the cable ends that fit into the screw terminals, and 4.75mm 'faston' connectors for the switch. Neither type of termination are essential since you can solder the wires direct but this form of solder less connectivity is neat and effective.

Grounding Your Case

If you are powering your ADR30 project with an internal mains transformer then you will need to earth your case directly. This is covered in more detail in the section "Using a Mains Transformer" later in this document. If, however, you are powering your case from a wallwart or linelump power supply, the 0V reference point in the ADR30 will be floating with respect to the mains earth. The 0V will then only be 'tied' to mains earth or true ground when you connect your audio cables to your studio system.

It is a good idea to connect the metal casing of your project to 0V. This helps keep unwanted signal interference to a minimum. There are variety of ways that the case can be connected to 0V and I have found the best way is to use the sleeve connections of the input and output sockets. Linking LK4 on the SREIO board connects all the sleeve connections to the 0V that comes from the ADR30 main board. The sleeve connection on each socket is directly bonded to the threaded bush of the 114BPCX socket. Since these are securely fixed to the case, and assuming there is no paint getting in the way, this should mean that the case is also now connected to 0V. To ensure a good connection I use toothed shakeproof washers between the sockets and the inside surface of the rear panel. If you have used the Takachi YM-300 case then the whole lower section is one piece of metal and so should all now be connected to 0V.

With a case made from several parts the rear panel's mounting screws should then allow the rest of the case to also be connected to 0V. However, this does depend on the type of case, whether it is painted, how it is constructed and so on. It is worth therefore measuring the resistance between parts of the case. If you have no connection, ie. you have a resistance over 10K, between the front panel and the rear panel it will be worth fitting a wire link in the LK position on the RPSU board. This should tie the RPSU's 0V to the lower panel via the top right hand mounting screw on the RPSU and all the pot brackets on the ADR30 main board via pin 5 of the PS1 connector. How effective it is will depend on how well connected the top right mounting screw is to the bottom panel and how well the pots make contact with the front panel. You may need to scrape any paint from the relevant areas to allow the mounting screw or pot nuts to make good contact.

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.

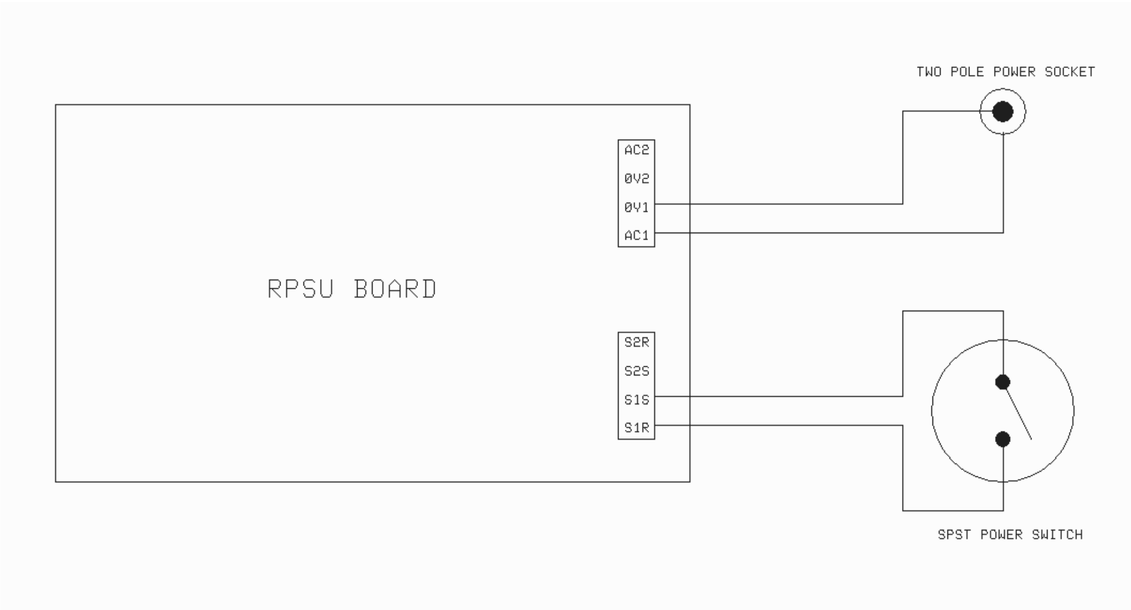
Linelumps and Wallwarts: Wiring Diagrams

The input power wiring will depend on the type of wallwart or linelump you will be using. A single ADR30 needs only +80mA and -50mA to work so the easiest option is to use a single phase wallwart with a current capability of at least 300mA. A centre tapped line lump like the Yamaha PA-20 could also be used but it would be considerably underused unless you were wanting to power two ADR30 main boards from one RPSU.

Standard AC output wallwart

Single phase, two wire, wallwarts or linelumps need to use half wave rectification so the Oakley PSU can generate both positive and negative supplies simultaneously. They only need the terminal's AC1 and 0V1 wired to the power socket. AC2 and 0V2 are left unused.

D9, D10 and F1 are not needed to be fitted to the RPSU although it will do no harm if they are fitted.



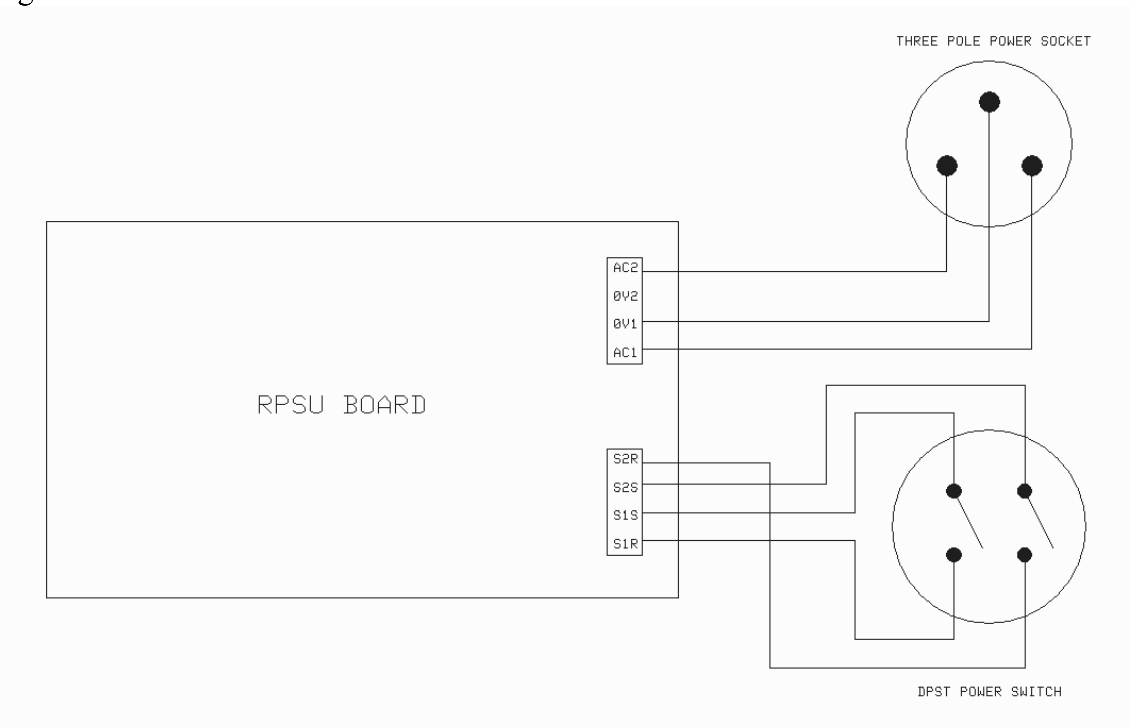
Connecting to a wallwart with single phase AC output.

The front panel switch is a single pole single throw (SPST) switch which simply connects S1R and S1S together when switched on.

Only F2 needs to be fitted and it should be rated at 500mAT, ie. a half amp anti-surge or time lag fuse.

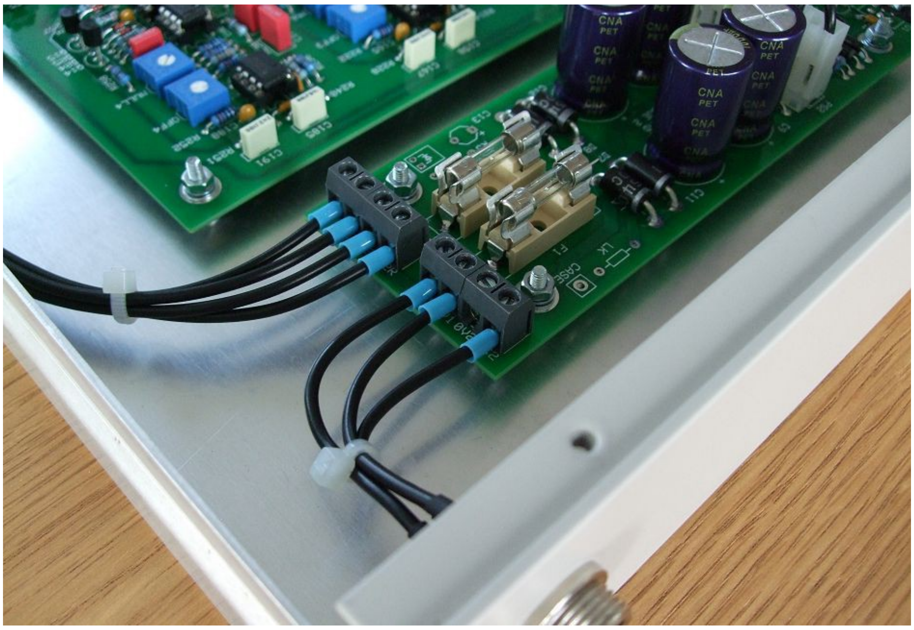
Centre tapped wallwarts and linelumps

Centre tapped linelumps like the Yamaha PA-20 will have three wires coming from their connector. It will have two AC outputs and one 0V. Take one of the AC outputs to terminal AC1 and the other AC output to terminal AC2. It should not matter which AC output goes to AC1 or AC2. The 0V should go to the 0V1 terminal. The 0V2 terminal is left unused.



Connecting to a linelump wiring with centre tapped output, eg. Yamaha PA-20

The front panel switch is a double pole single throw (DPST) switch which connects S2R and S2S together, and S1R and S1S together, when switched on. Both fuses are fitted and they are both 500mAT anti-surge or time lag types.



All power wiring, shown here on a SRE330 build, uses 24/0.2 insulated wire. I have also boot lace ferrules on the wire ends that go into the terminal blocks for neatness.

Using an Internal Mains transformer

Be afraid, be very afraid...

Some of you old hands will laugh about the level of hysteria that surrounds direct mains connection to DIY projects. However, this fear is more to do with our litigious society than the real danger to the builder. Even so, I have had more than my fair share of high voltage shocks over the years and it is not something I would want any builder to have to experience. It has been purely luck that has saved me in several of those cases.

So I will say again – do not attempt to build a mains transformer into your ADR30, or any other project, without realising that to do so carries a risk of death to either you, or to the person who may inadvertently put their fingers into your half built construction. Furthermore, it is up to you as the builder of such an item to make sure, that once built, the item is safe to use and meets all current safety legislation.

This is not a complete set of instructions on how to fit a transformer into a piece of electronic equipment. This information is offered only as a guide and should not be considered as your only source of information. No further information, other than that included here, will be provided by myself regarding the construction of mains powered items.

For powering either a single ADR30 board, or two ADR30 boards, then the mains transformer's secondaries should be rated:

Voltage: 18-0, 18-0 (dual secondary) or 18-0-18 (single tapped secondary)

Power: 15VA

This will give you a power supply that should be theoretically capable of providing just over 230mA to each rail assuming your heatsinking and smoothing capacitors are up to the job.

The transformer secondary voltage is suggested to be 18V. It may be possible to use a 15VA transformer rated at 15V. Most transformers produce more than their stated voltage when drawing less than their maximum current and I have found that 15V toroids tend to work well here in the UK. The benefit of using a lower secondary voltage is cooler power devices. However, the disadvantage is that you may be running your power supply very close to its lowest operating voltage – particularly if your country's line voltage is a lot less than the expected 230V (or 110V).

In the wiring diagram shown I have included a suggested wiring method for connecting up a mains transformer. Not all mains transformers are the same, some have additional windings, others have tapped windings. I have simply used a single primary, double secondary type for example only.

For the mains side fuse you should use a 500mA anti-surge type. All wiring at mains potential should be adequately insulated, secured well and protected from straying fingers.

There is no need to fit an AC standby switch since you will be fitting a proper mains switch in series with the transformer primary coil. So you should link S1A to S1R, and S2S to S2S, on the RPSU PCB.

Toroidal transformers are in theory much easier to mount than ordinary EI transformers, they simply need one large bolt to secure the various parts provided. However, there are two important considerations involved when mounting a toroidal in a 1U high rack or other height restricted case.

The first is that the transformer and the mounting bolt must fit inside the case without the metal mounting bolt or top mounting plate touching the metal case. The mounting bolt must only be in contact with the lower panel. If it touches the top this will short circuit the transformer and it will probably catch fire. Secondly, fitting a large bolt through the lower panel will mean the bolt head will stick out proud from the underside surface, and the case may not now fit into a rack without touching other rack equipment mounted below it. Commercial rack cases that use toroidal transformers often have a upward indented section on the underside panel on which the transformer sits. The hollowed out section can then easily hold the screw head without making the case exceed the 1U height format.

Earthing

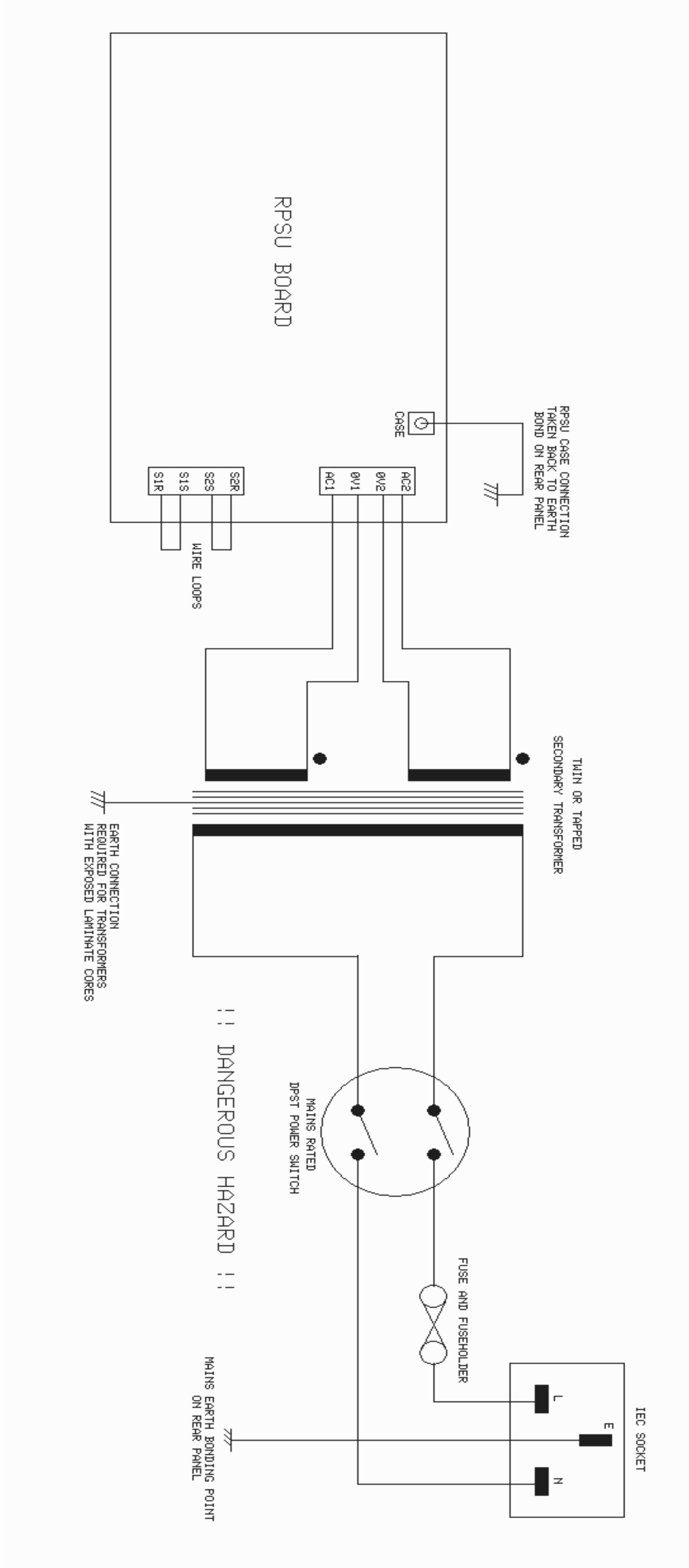
Remember it is up to you, the builder of the equipment, to make sure that your item is safe and is built to the required safety standard in your country. These notes are only a guidance and it is up to the reader to establish the exact obligations required in their own country.

It is essential that everything you build, that has both live mains inside and a metal case or panels, has a safety earth fitted. UK legislation requires that any metal panelling should be adequately insulated, ie. double insulated, or connected to earth. Since making a double insulated case is not practical you should ensure that any exposed external metal parts be properly earthed.

The case should be bonded to earth using an M4 screw, toothed washer, washer, solder tag and a securing nut (or two) bolted through the case and then via a thick piece of wire back to the earth tang of the IEC power inlet. It is useful to mount this earth bonding point on the rear panel of the unit. Remember that all other parts of the case must be earthed too. Painted metal parts of the case must be dealt with so that they too are earthed. This may involve using secondary bonding points or scraping back the paint at the appropriate point.

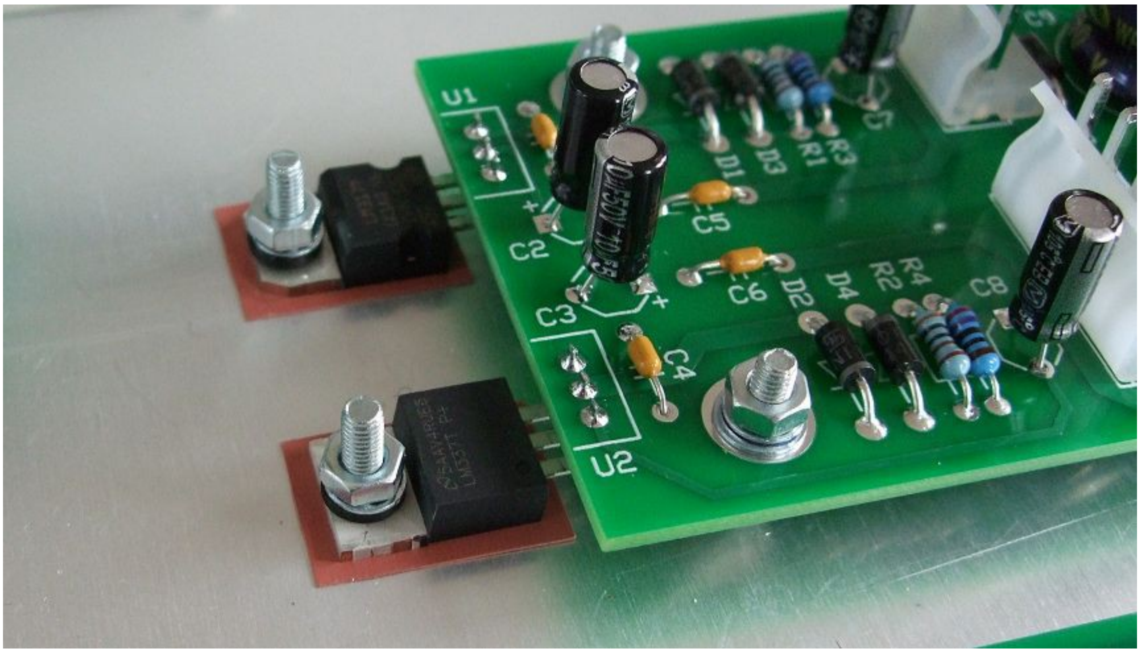
The RPSU board should be securely mounted (using all four mounting holes) onto the earthed casing using appropriate screws and toothed washers. You should also solder a thick wire from the solder pad marked 'CASE' on the RPSU to the earth bonding point on the rear panel.

You will also need to provide earthing to any exposed transformer core. This does not apply to toroidal types but EI types should have their metal frame earthed.



Mains wiring diagram. For experienced builders only!

Attaching the Power Devices



In this build the two regulators are insulated from the panel with soft red insulating pads. Standard pan head screws are used as the panel is too thin to support countersunk screws.

The RPSU PCB needs to be fitted to your case metalwork. Use the PCB as a template for the four holes needed for the mounting pillars. The board should be spaced high enough off the panel so as to not short out any of the components' leads should the board be flexed downward. However, they should also not be too long so that the leads from the two regulators can't reach through the board to be soldered. I find an 5 or 6mm spacer works very well.

Now you need to prepare the leads of the two power devices. The three legs need to be bent upwards so that the PCB can be fitted over them. Note that the top surface of the device is marked with the name of the component and it is the flat side on the bottom of the device that will be in contact with the panel. You should be able to see that the leads have a thicker section close to the body of the device. Make a 90 degree bend upwards at the point where the lead thickness changes. Do this for all three legs of the device.

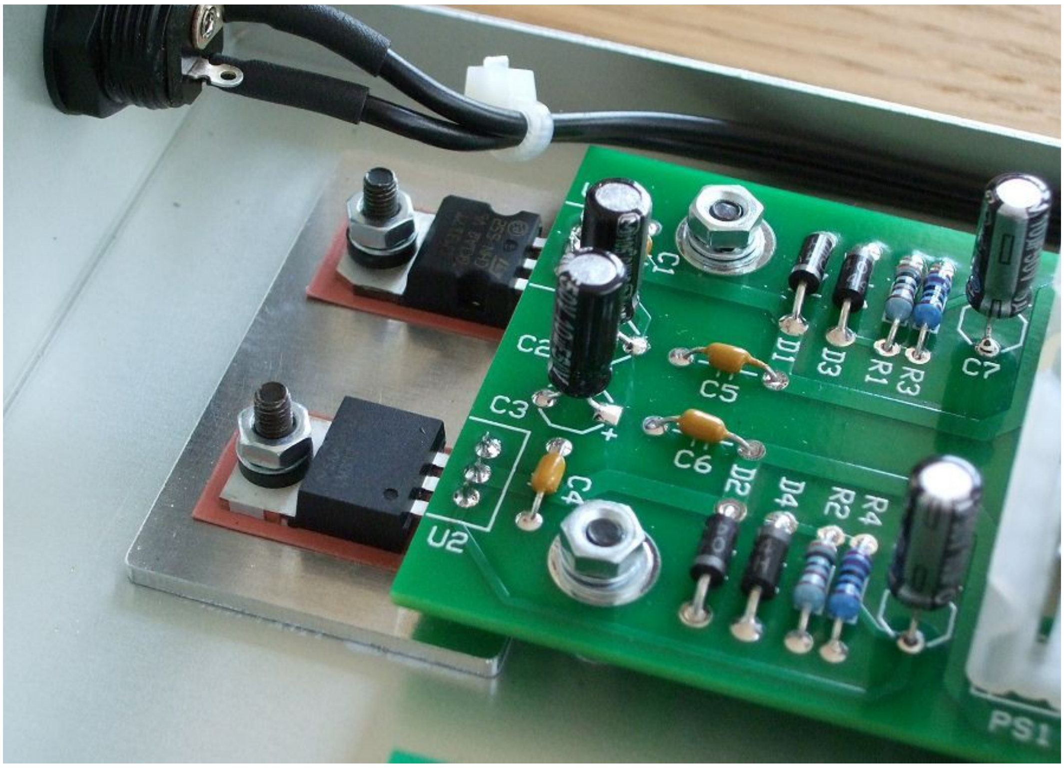
Remove the board from the panel and fit the power devices to the board by poking their legs up through the bottom of the board. Do not solder them but fit the board back into place. Use the hole in each regulator to mark out where you need to drill the mounting hole for the two devices. Now remove the board and regulators. Carefully drill a 3.8 or 4mm hole in the panel for each of the regulators. Clear off any swarf and, twisting with your hand only, use an 8mm drill bit to lightly deburr the edges of the holes. There should be no bumps around the holes.

The regulators are both TO-220 devices. They both need to be fitted to the panel mechanically and thermally but not electrically. That is the metal tab on each device that will be mounted to the panel should not make electrical contact with the metal panel. To achieve both thermal transfer and electrical insulation we use an insulator. These can be made of a 'soft' flexible material in the form of an insulating pad or a rigid thin glass like plate made from mica. If using the mica you will also need to use heat transfer paste. Since the paste is somewhat messy I recommend you use the insulating pads. Both types are normally available in 'mounting kits'. Also in the kit is a mounting bush. This top hat shaped piece of stiff plastic prevents the mounting screw from touching the regulator's metal tab.

Now place the mounting bush into the hole of the power device, with the flange of the bush lying on the top side of the device. Take one of the insulating pads and place it against the rear of the regulator. It should fit flat against the device and the bush should stick out a little allowing you to align the pad correctly.

Now place the power device, bush and pad, flat against the rear of the panel so that the bush fits into the panel hole. Make sure the pad does not slip out of place when you do this. Insert a 10mm M3 screw into the hole from the reverse side of the panel, and fit a spring washer and nut onto the screw but do not tighten. Do the same for the other regulator making sure, of course, that the correct device is in its proper location.

If you have drilled your holes correctly, you should find that the when the power supply PCB is lowered back its four mounting screws, you can coax the power devices' legs through the respective solder pads on the board. Now tighten the four nuts holding the RPSU board in place. You should have a flat washer and shakeproof washer under each nut. Gently tighten the screws holding the power devices. Do not tighten them too much as this will crush the insulating pad. Once secured you can solder the regulators' leads from the top side of the board and clip off any excess lead lengths.



Using an aluminium shim beneath the power devices so that the long part of the insulating bushes will not be damaged by the mounting screw.

If the bottom panel of your case, or the power device's mounting tab, is too thin, you may find that the insulating bushes stick out too far and will foul the mounting screw's head. This problem is more likely if one has used countersink screws as these sit inside the hole in the case. Countersink screws can be more appropriate since they sit flush with the underside of the case. However, if the insulating bush protrudes too far into the hole it may not allow a countersink screw, or even a pan head screw if the case metalwork is particularly thin, to seat properly. Tightening the screw will then inevitably crack the insulating bush and possibly allow the screw to make contact with the power device's metal tab. In this scenario it may be better to use standard pan head screws with no countersunk holes and accept that they stick out a little from the underside of the case.

Alternatively, you could use a 1.5mm or 2mm thick aluminium shim plate to go between the case and the power devices. The size of such a plate is not crucial but 30mm by 60mm would be sufficient. A Schaeffer fpd file can be found for a pre-drilled shim plate on the project webpage. Although not completely necessary, a thin smear of heat sink paste can be used between the shim and the case bottom to help with heat transfer.

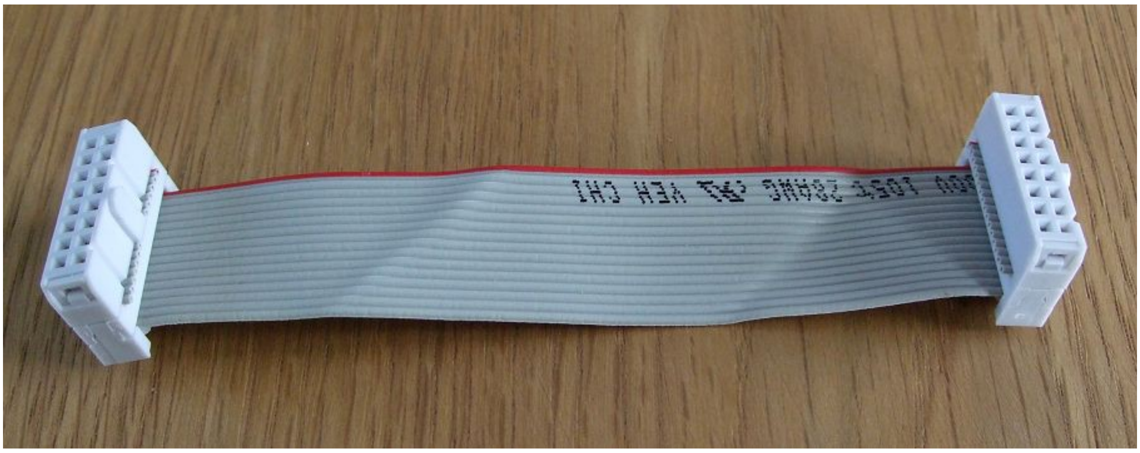
If you are using a YM-300 case for your project you will find that the metalwork is very thin and standard length insulating bushes will indeed push all the way through and sit proud of the underside. You should use either a shim plate as described above or use shorter insulating bushes. The YM-300's metal is too thin to use countersink screws so standard screws must be used.

It is possible to cut down the length of a standard insulating bush so that it matches the depth of the hole. The way I tend to do this is to slide the bush onto the round end of a 3.5mm drill bit which holds it steady and then use a sharp knife to cut back the excess length. Just make sure the bush is long enough to go through the tab of the power device, the insulating pad and enter the case hole by at least 0.5mm. This ensures that the tab will not make electrical contact with the case.

Interconnections

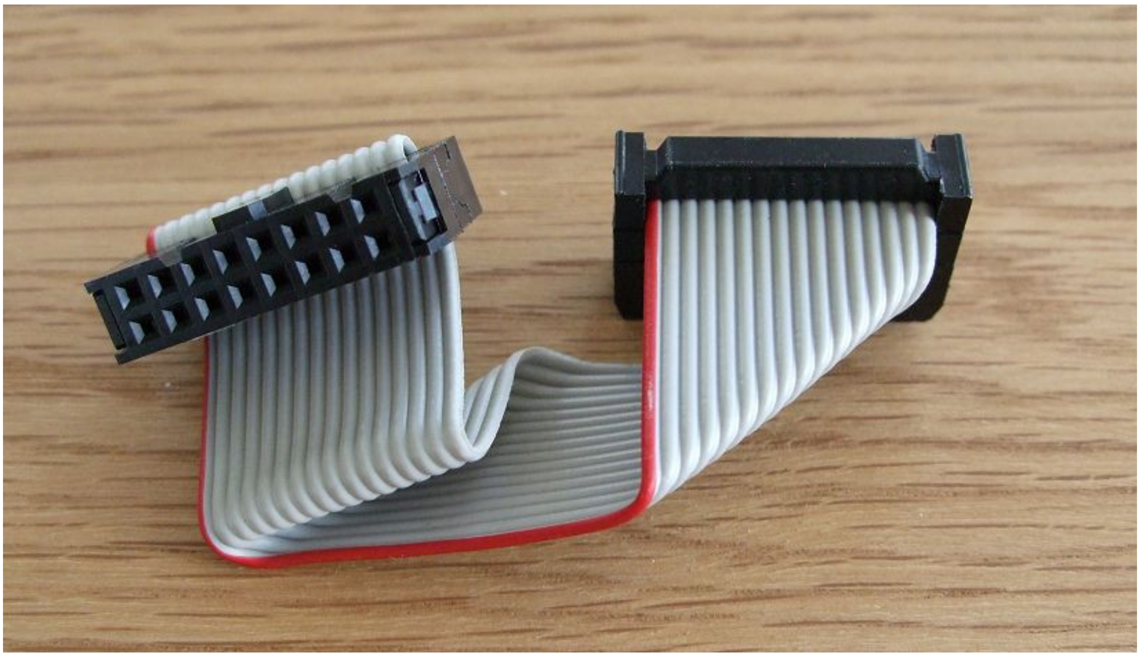
If you are building the ADR30 in the suggested way with all three Oakley PCBs you will need three sets of interconnects that link the boards together.

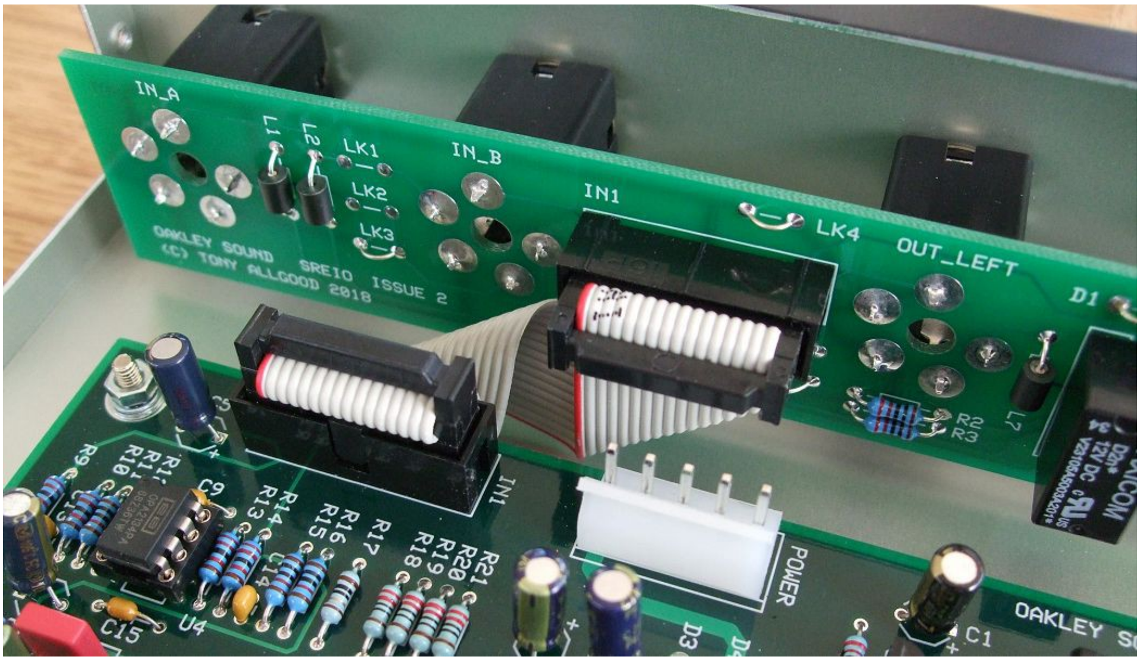
The 16-way IDC flat ribbon cable connects the SREIO and ADR30 main board together. It carries balanced audio signals and 0V.



The flat ribbon IDC (insulation displacement cable) should be made so that pin 1 goes to pin 1, pin 2 goes to pin 2, etc. Note the polarising lugs on each of the connectors in the photograph above – they both point right. The red edge denotes the pin one connection. Here I have used connectors that have a strain relief fitted which requires the cable to be folded back under the connector before the strain relief bar is clicked into place.

Fitting the cable into place usually involves some neat folding. You can see such fold lines on the cable above which was used in a full width rack case build. The one needed for the much less deep Takachi YM-300 case was more interesting. IDC ribbon cable will be tough enough to withstand some yoga but don't go stretching it.





The power connections are made with 24/0.2 cable fitted to Molex 0.156” KK crimp housings. You can use MTA type connections if you prefer but it can get a little tight if your case is not deep enough. For the YM-300 case I recommend sticking with Molex or other crimp equivalents. Again both cables are made so that pin 1 goes to pin 1. The three way connection only uses two of the connections. Pin 2, the middle pin, is NOT connected. With the five way connection, all five positions are used.

The above picture shows the RPSU in an SRE330 build and it shows the connections quite clearly. It's actually pretty straightforward using a YM-300 case too.

Final Comments

If you have any problems with the module, an excellent source of support is the Oakley Sound Forum at Muffwiggler.com. I am on this group, as well as many other users and builders of Oakley modules.

I'd love to hear about what you have done with your module. Please do post pictures of your finished module at the Oakley Sound forum on Muffwiggler.

If you are in the UK and can't get your project to work, then Oakley Sound Systems are able to offer a 'get you working' service. If you wish to take up this service please e-mail me at my contact e-mail address found on the website. I can service either fully populated PCBs or whole modules. You will be charged for all postage costs, any parts used and my time at 25GBP per hour. Most faults can be found and fixed within one hour, and I normally return modules within a week. The minimum charge is 25GBP plus return postage costs.

If you have a comment about this user guide, or have a found a mistake in it, then please do let me know. But please do not contact me directly with questions about sourcing components or general fault finding. Honestly, I would love to help but I do not have the time to help everyone individually by e-mail. The forum is the best place to ask these sorts of questions.

Last but not least, can I say a big thank you to all of you who helped and inspired me. Thanks especially to all those nice people on Muff's Forum and the SynthDIY and Analogue Heaven mailing lists.

Tony Allgood at Oakley Sound

Cumbria, UK