Oakley Sound Systems

DN-34 BBD Replacement Module

PCB: DN34 BBD Issue 1

Builder's Guide

V1.3

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Introduction

This is the Project Builder's Guide for the issue 1 DN34 BBD module from Oakley Sound. This document contains the full parts list for the components needed to populate the board, installation details and the calibration procedure.

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

The DN-34 Analogue Time Processor effect was made by Klark Teknik™ in the late 1970s. It features two channels of analogue delay each capable of creating a delay from around 1mS to around 27mS. The delay time could be controlled from a front panel pot, an internal LFO with sine, triangle and square waveforms, and an external control voltage (CV). The two delays could be operated in series to give one longer delay or in parallel to create interesting effects such as through zero flanging. What was particularly unique about the DN-34 was the very good sound quality available from the unit. Most BBD devices tend to be noisy and have limited bandwidth but the DN-34 excelled in both these areas.

Each delay channel within the DN-34 was made from eight SAD512D bucket brigade delay (BBD) chips. These devices are very difficult to source today and when you can get them they can be very expensive. This Oakley Sound module is designed to replace one channel of the DN-34 which replaces eight of these ultra rare SAD512D chips and their ancillary circuitry with near identical performance. It is, of course, possible to use two of these modules to replace both channels and saving the need for sixteen working SAD512D.

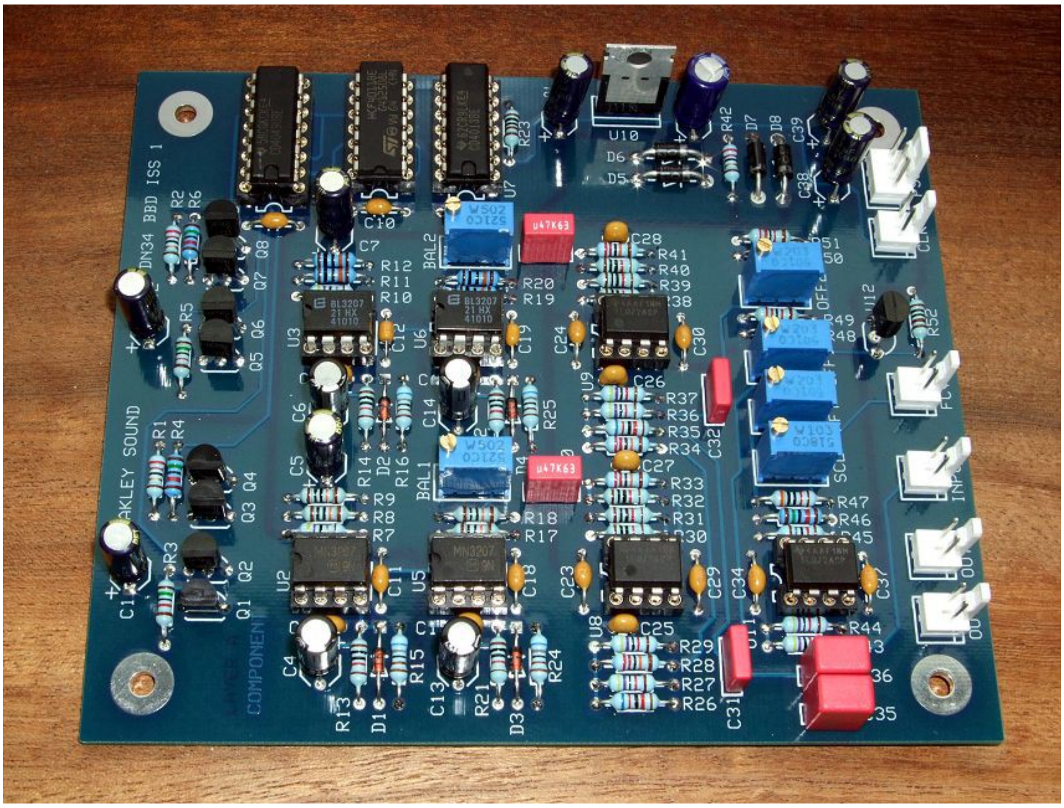
The Oakley Sound DN34 BBD module uses four Panasonic MN3207 BBDs - although you can also use V3207 and BL3207 devices with equal success. High speed, high current, non overlapping dual clock driver circuitry allows usage of the 3207 device up to clock frequencies of 1.3MHz.

The sound when using the replacement board is almost identical to the original circuitry - the only small difference is a slight loss of gain when the delay time is very small. In practice this makes little difference, if any, to the effect heard, even when using the device in self oscillating mode or very resonant flanging.

Klark Teknik™ is a registered trade mark and is the property of its owner.

Oakley Sound Systems are not affiliated with Klark Teknik™ and the use of their trade mark in this and other documents in no way means that they have endorsed this product.

The DN34 BBD Printed Circuit Board



The PCB is 103mm x 120mm in size and is connected to the DN-34's main PCB via a series of interconnects. A set of two way 0.1" (2.54mm) headers allow screened cable or just single core multistrand cable to make the three audio, one control voltage and one clock connections back to the DN34's main board. A single three way 0.1" header takes power to the module.

The PCB is constructed with four copper layers. The top and bottom side layers carry signals about the board and the tracks are a generous 20 thou wide. One of the internal layers carries only the power supply voltages, +/-15V and +9V. The other internal layer is a near solid plane of copper connected to 0V (ground). Although using four layers does the make the board more expensive to produce, it does reduce the level of unwanted interference and improves performance.

The PCB has four mounting holes for M3 screws one near each corner. The silver coloured metal rings around each mounting hole are electrically isolated.

Remember that one DN34 BBD board replaces the BBD array of one delay channel of the DN-34. To replace both delay channels you will need two DN34 BBD boards. It is expected that if only one board is being used then it will be Channel B that will be being replaced and Channel A would be left as it is.

DN34 BBD issue 1 Parts List

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

The components are grouped into values, the order of the component names is of no particular consequence.

A quick note on European part descriptions. R is shorthand for ohm. K is shorthand for kilo-ohm. R is shorthand for 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 4700 ohm resistor, 6n8 is a 6.8 nF capacitor.

Resistors

1% 0.25W or 0.4W metal film resistors are recommended.

22R	R1, R2
47R	R42, R7, R10
1K	R52, R23
1K5	To be fitted on DN-34 main board in place of R258
6K8	R15, R24, R25, R16
10K	R39, R22, R21, R40, R30, R31, R32, R38, R13, R14
15K	R3, R48, R50, R5, R46, R4, R6
18K	R45
22K	R49, R51
30K	R47
47K	R36, R37, R29, R44, R27, R43
62K	R26, R35
100K	R20, R11, R8, R17, R19, R9, R18, R12
220K	R41, R28, R33, R34

Capacitors

100nF, 50V axial multilayer ceramic	C23, C11, C34, C18, C17, C10, C3, C24, C37, C29, C12, C30, C19
47pF C0G ceramic 2.5mm	C25, C26
150pF C0G ceramic 2.5mm	C28, C27
330pF C0G ceramic 2.5mm	C8, C16, C9, C15
100nF, 63V polyester	C31, C32
470nF, 63V polyester	C21, C20
2u2, 50V polyester	C35, C36

2u2, 63V electrolytic	C39, C38
4u7, 63V electrolytic	C22
10uF, 35V electrolytic	C13, C4, C6, C14
47uF, 25V electrolytic	C5, C1, C2, C7
100uF, 25V electrolytic	C33

Discrete Semiconductors

1N4001 silicon diode	D5, D6, D7, D8
1N4148 small signal silicon diode	D1, D2, D3, D4
BC550 or BC549 NPN transistor	Q3, Q7, Q1, Q5
BC560 or BC559 PNP transistor	Q4, Q8, Q2, Q6

Integrated Circuits

MN3207 1024 stage BBD*	U2, U3, U5, U6
4011BE CMOS Quad NAND gate	U4
4013BE CMOS Dual Flip Flop	U7
4049UBE Hex invertor	U1
TL072ACP dual FET op-amp	U8, U9, U11
LM7809 9V regulator	U10
LM4040DIZ-10.0 10V reference**	U12

IC sockets are to be recommended. You need seven 8-pin, two 14-pin and one 16-pin DIL sockets.

* Panasonic's MN3207 may be replaced by either Coolaudio's V3207 or Belling's BL3207. It is worth noting that there does seem to be some differences in performance between the three makes. It may also be that vintage Panasonic devices perform differently to the current batch of parts bearing the Panasonic logo. Therefore, although the DN34 BBD board will work with all four types of devices I would advise against mixing between different types on one board. That is, use either vintage Panasonic, new Panasonic, Coolaudio or Belling, not a mixture of them. I have also found small, but not insignificant, differences between devices of the same manufacturer. Because of this I would recommend that you buy five or six devices just in case you get an odd one that can't be calibrated or is particularly noisy.

** The LM4040CIZ-10.0 is also suitable.

Trimmers (preset) resistors

Bourns 3296W or similar

5K multiturn	BAL1, BAL2
10K multiturn	SCL
20K multiturn	OFF1, OFF2, HFT

Interconnections

All interconnections can be connected to the board with Molex 0.1” (2.54mm) KK headers and housings. See my separate Construction Guide for details on how to use these.

2-way 0.1” (2.54mm) header	CLK, OUT1, OUT2, INPUT, FCV
3-way 0.1” (2.54mm) header	PSU
2-way 0.1” (2.54mm) housing	CLK, OUT1, OUT2, INPUT, FCV
3-way 0.1” (2.54mm) housing	PSU

Miscellaneous

Around 1m of standard multistrand hook up wire for the power supply interconnect.

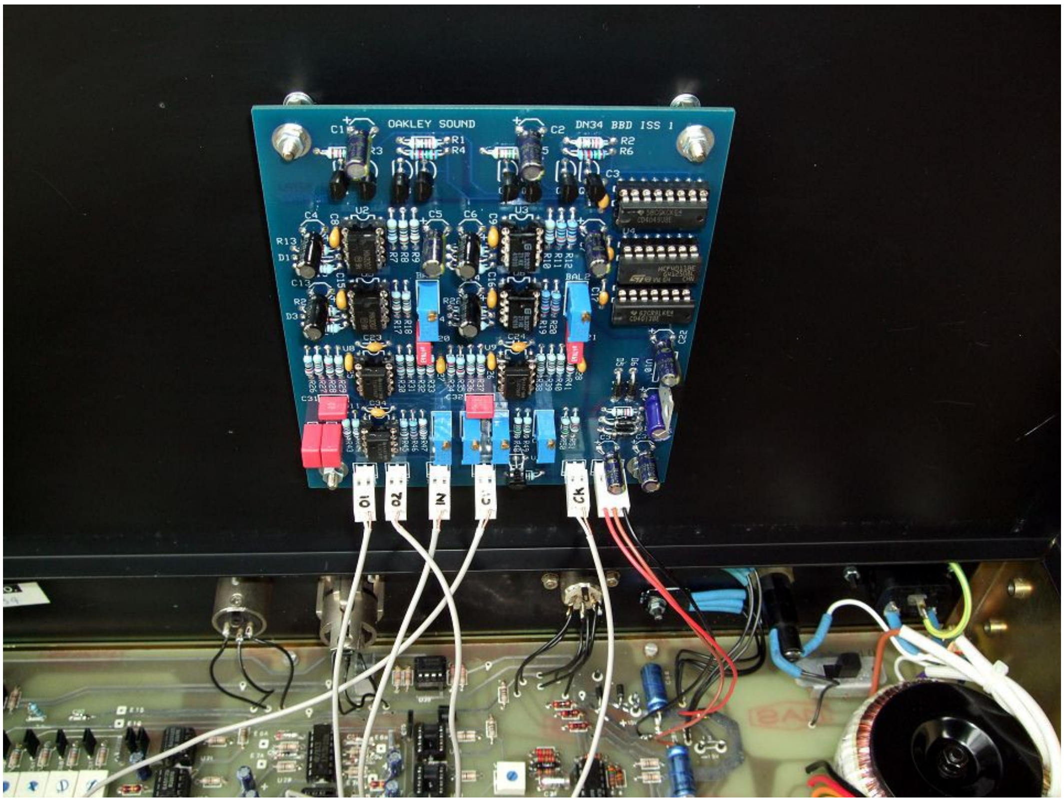
Around 2m of audio connecting screened cable.

Mounting hardware, eg. Four female-male hex 8mm spacers, four M3 nuts, eight M3 spring or star washers and four M3 6mm screws.

Daughter Board Placement

The DN34 BBD daughter board needs to be fitted so that the wiring to the DN-34's main board should be as short as possible and yet still allow servicing to both the main board and the daughter board. I found the best place to put the board was upside down mounted on the underside of the top cover. The unit can then be worked on with the top cover sitting at right angles on top of the rear part of the casing.

If you are fitting just one DN34 BBD then the BBD array to be replaced is channel B which is the right hand column of SAD512D ICs when looking at the main board from the front.



The DN34 BBD board in the above picture is mounted onto the top panel with four 8mm M3 threaded hex female to male spacers. Four 6mm M3 screws, along with star washers on the underside of the panel, secure the spacers to the panel. M3 nuts and washers then hold the board onto the spacers.

If you are fitting two DN34 BBD boards then it is best that you spend some time to find the best locations on the top panel for two boards before you drill any holes. It is not advisable to place either DN34 BBD board above the mains transformer. You can see the punch marks for the two right hand mounting holes in the above picture for a second DN34 BBD board which will be mounted to the left hand side of the already fitted board.

Please note that the DN-34 unit used for these photographs has been modified in other ways so certain features may be different to your own DN-34. For example, my unit had to have its mains transformer replaced as the original one hummed very badly.

Modifications to the DN-34 Main Board – For Channel B Only

If you are careful it is quite possible to modify your board without removing it from the base panel of the DN-34's case. However, if you are not that steady with a soldering iron, then I recommend you lift up the main board to get access to the underside of the PCB. This is not an easy task since both the front panel electronics and back panel components are soldered onto the main board with very short wires. It may be necessary to de-solder some of these wires.

Whichever way you do it several components will need to be removed. Thankfully, all the ICs are in sockets. You need to remove all eight SAD512D devices. You can keep any working ICs for maintaining channel A's BBD array or any other device you have that needs SAD512Ds.

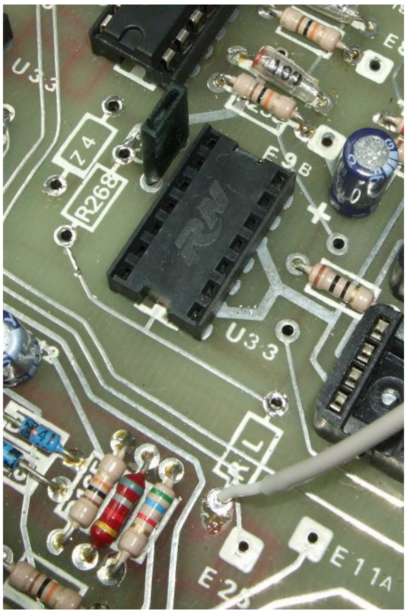
Remove U11 – this is an 8-pin IC that is situated below U29 and was a CA3140 in my DN-34 but might be any single op-amp. This op-amp would normally be used to invert the audio signal to the lower half of the BBD array

Remove also U33 – a 4013B. This is used as a divide by two circuit that creates the three phase clock signals the BBD array required.

Now we need to remove some soldered in components. You can snip these out from the top of the board but I managed to de-solder them from the topside of the board without too much difficulty. Remove the following components:

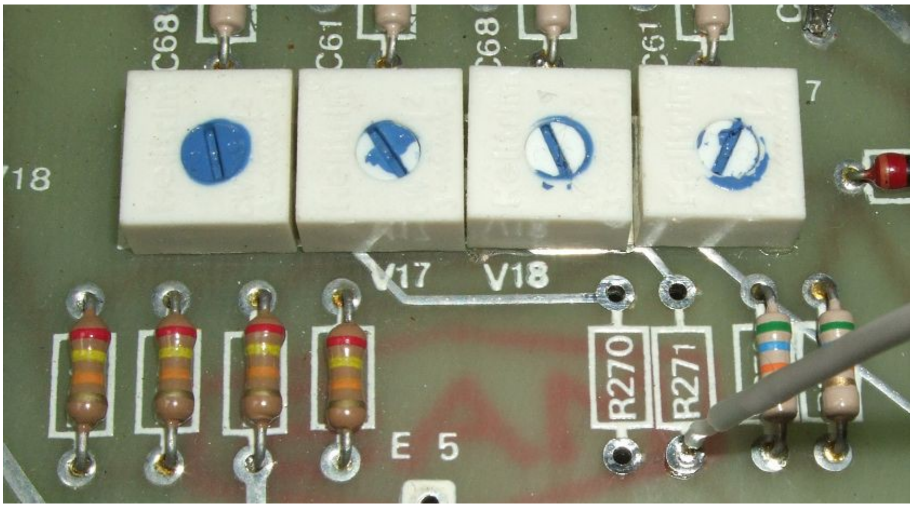
Z4 (an 8V2 zener diode) & R268 (a 1K resistor) to the left of U33.

RL (a 0R resistor) which is just to the left of test points E25 and U11a.

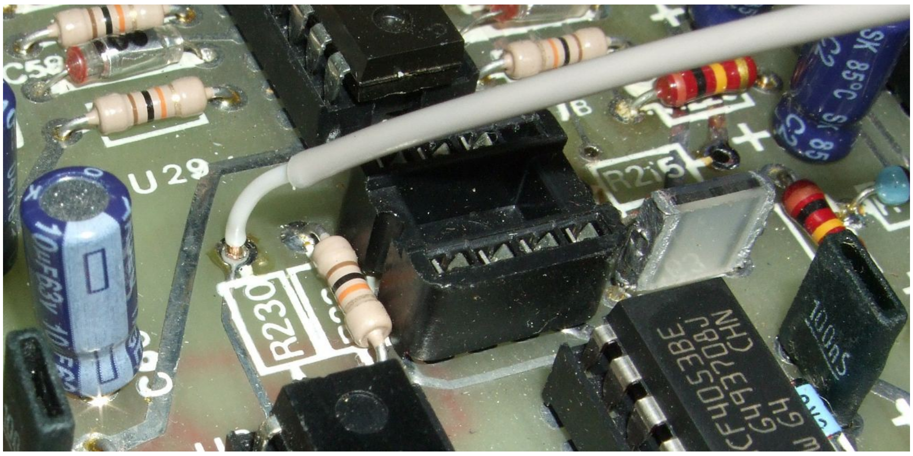


Ignore the grey and white wires in these photographs. They are used to connect the main board to the DN34 BBD board and I deal with this in the next section.

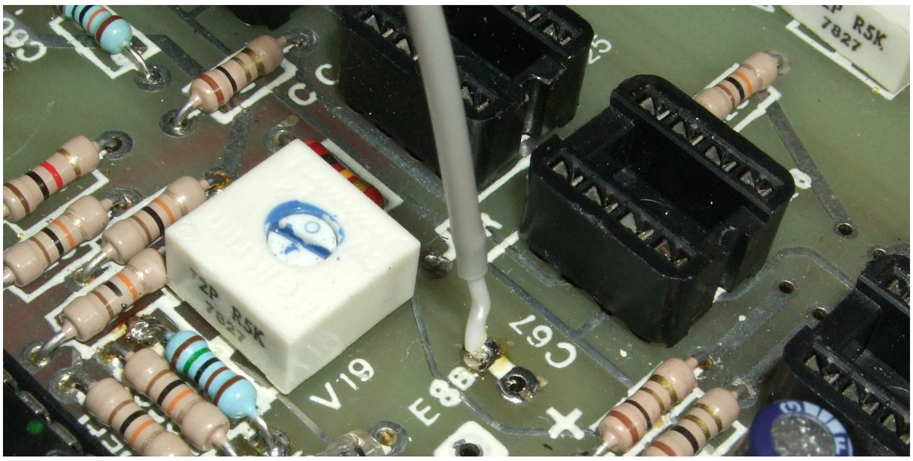
The next two components we need to remove are R270 and R271. Both 56K resistors.



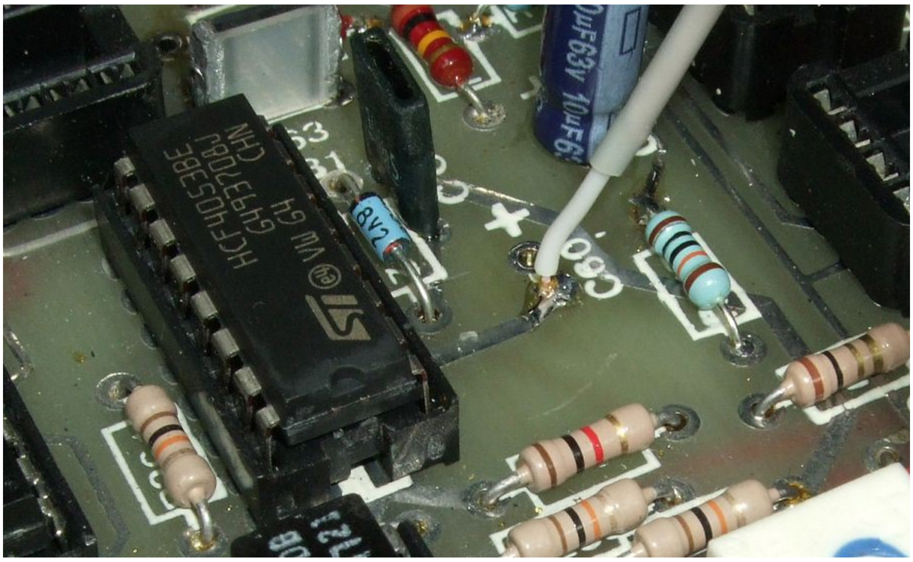
The next two components to remove are on either side of U11. That is R230 (a 100K resistor) and R215 (a 2K2 resistor).



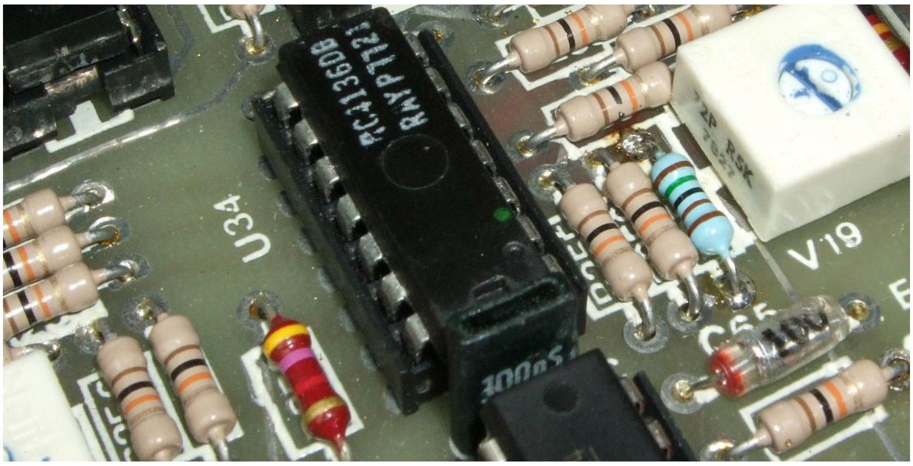
The next component is C67 (a radial electrolytic capacitor) just below the right hand V19 trimmer.



The penultimate component to remove is another radial electrolytic capacitor, C60.



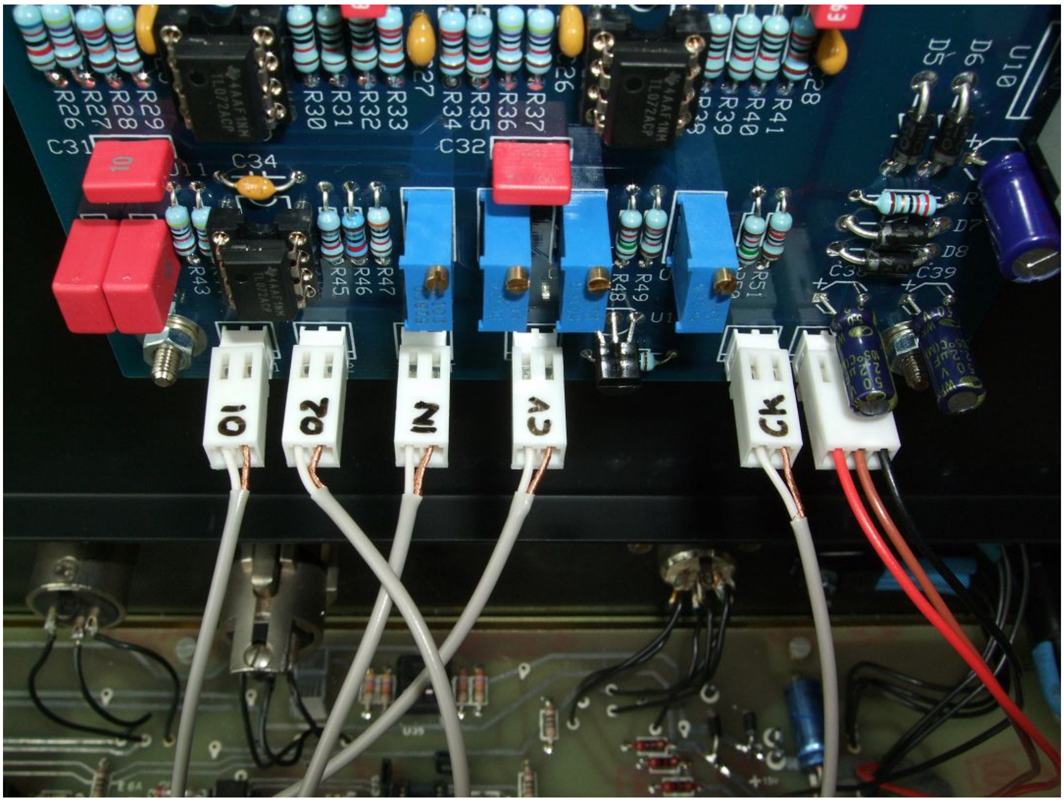
The final component we need to remove is R258 (a 4K7 resistor). Unlike the others, however, this one we will be replacing with a 1K5 resistor. You can see the new resistor in the photograph below as the light blue component to the left of V19.



The modifications to the main board are now complete if we are only replacing channel B's SAD512D array. If so we are now ready to connect the DN34 BBD board to the main board.

Note: Confusingly the makers of the DN-34 called the components in channel A the same name as channel B. So there are two V19s, two C60s, etc.

Interconnections – For Channel B Only



There are six interconnections to make between the DN34 BBD board and the main board. All interconnections, with the exception of the power supply, should be made with thin screened cable. This is essentially the same stuff as you would make patch leads and instrument cable from but made much thinner. You can use standard instrument cable if you wish but is often too thick and not very bendy. The power supply connection is made with standard 7/0.2mm multistrand hook up wire.

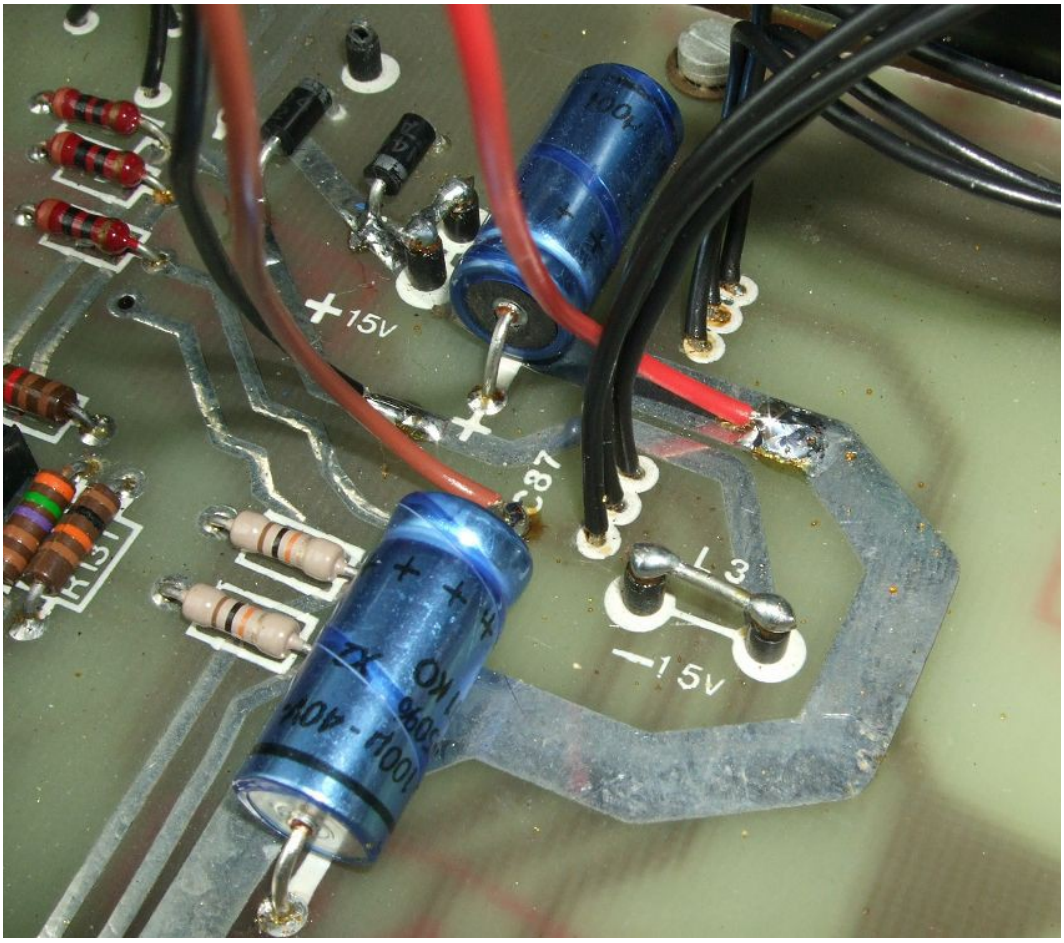
Each interconnect is attached to the DN34 BBD board via 0.1" (2.54mm) Molex KK headers and housings. You can, of course, solder your interconnection wires directly to the board but this can make future servicing and fault finding more problematic. Pin 1 on both types of connector is designated by the square solder pad on the PCB.

For the two way headers, pin 1 is the signal, and should be connected to the core conductor of the screened cable. Pin 2 is connected to 0V on the PCB and should be connected to the screen of the screened cable.

For the only three way header, the pin out of the connector is as follows:

Pin 1	+15V
Pin 2	0V (ground)
Pin 3	-15V

The DN34 BBD does feature some degree of power supply protection in the form of two diodes, D7 and D8. These will cause the DN-34's power supply to go into current limit should the power supply interconnect be reversed. However, they are not supposed to operate for any length of time like this, so all wiring should be checked thoroughly before powering up. If you are fitting two DN34 BBD boards then the power interconnects are done slightly differently and you should read the appropriate section later in this document.



In the picture above we can see the three wires that come from the PSU header on the DN34 BBD board. Red is +15V, brown is 0V and black is -15V.

The +15V (red wire) is soldered to the wide tinned copper trace that goes between the two bunches of wires that go to the regulator ICs mounted on the rear panel of the DN-34.

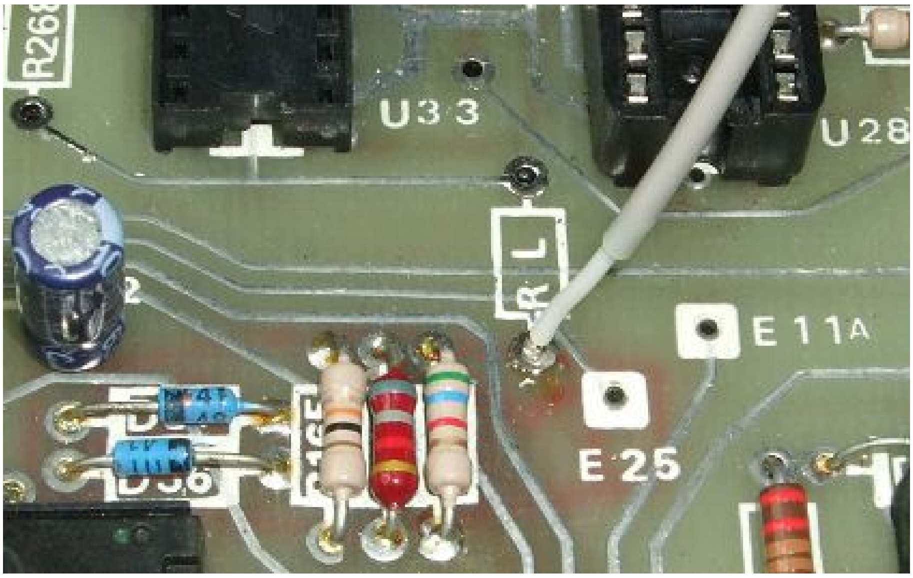
The 0V (brown wire) can't be easily soldered onto to a trace so it must soldered neatly onto the lead coming out of the positive end of C87 – the big 100uF axial capacitor.

The -15V (black wire) is soldered onto the medium width tinned copped trace near to the positive end of C88. Note that it must not actually connect to C88.

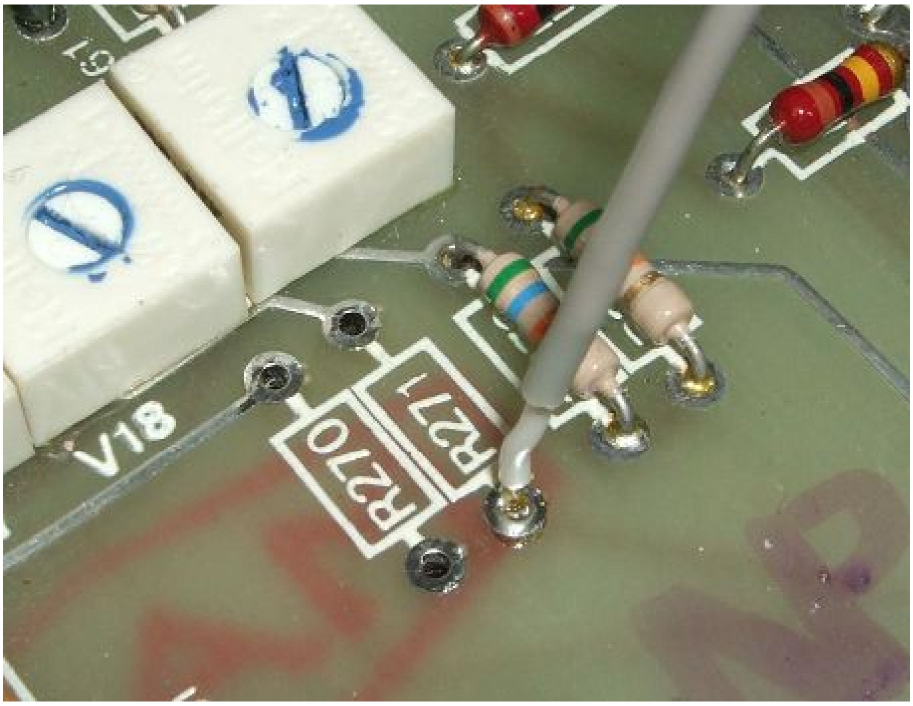
If your DN34 has not had its electrolytic capacitors replaced this may be a good time to do it. Both C87 and C88 have been replaced in this particular DN-34.

All the other interconnects are made in the same way. Once one end is correctly fitted into the two way Molex housing (or soldered into the DN34 BBD board) the cable can be cut to size. The screen of the cable is then cut back and secured and insulated with heatshrink. With the particular cable I use one can actually pull the outer casing of the cable over the loose end of the screen. You may have seen where the cables connect in the last section but we will deal with each of them in more detail here.

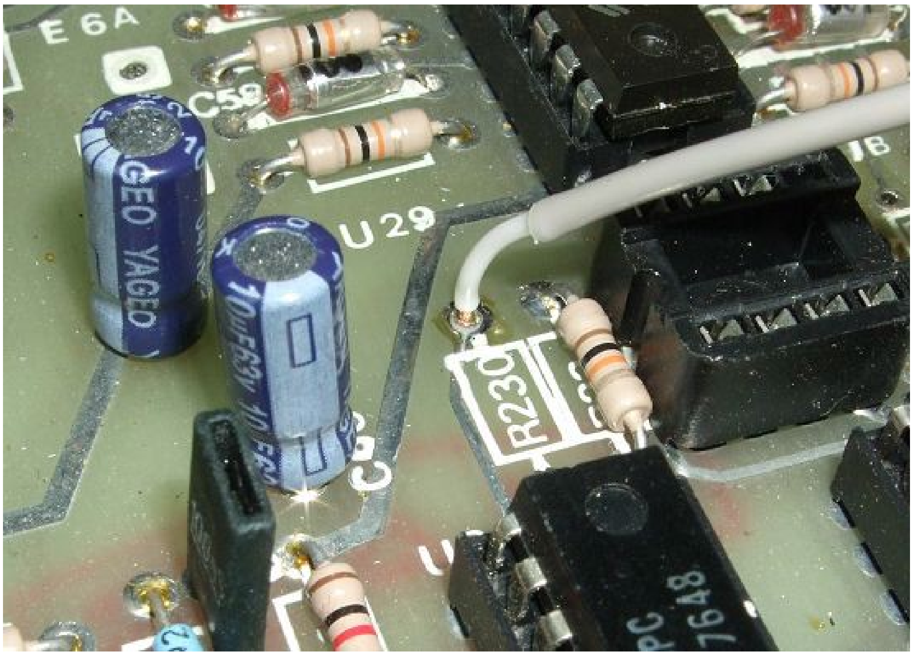
CLK: This carries the high frequency clock that controls the delay time. Pin 1 should connect to pin 7 of U32. The best place to access this is the lower solder pad of RL.



FCV: This carries the control voltage that controls the clock frequency. The DN34 BBD board uses this voltage to change the input offset voltage to the MN3207s to make them perform better at high frequencies. Connect pin 1 of FCV to the lower solder pad of R271.

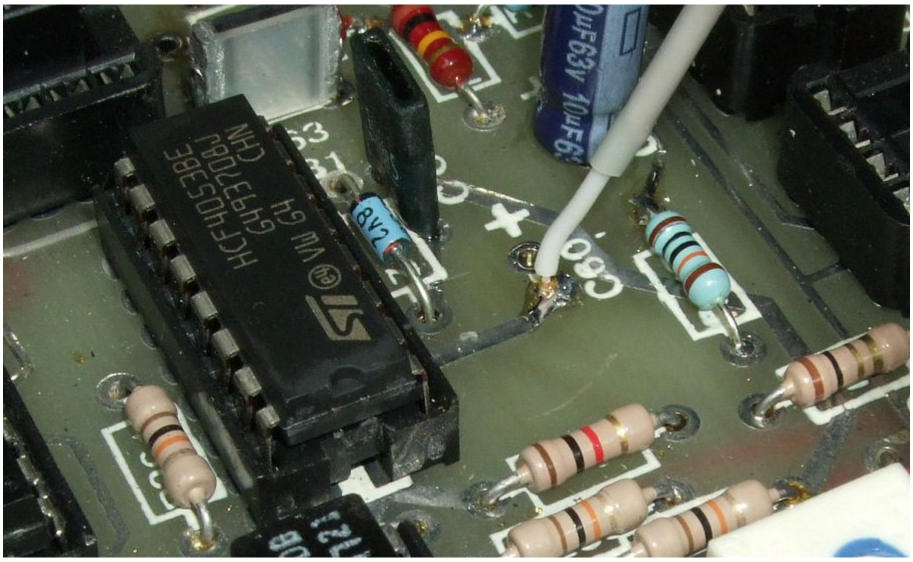


INPUT: This carries the input audio signal to the BBD array. Connect this to the top solder pad of R230.

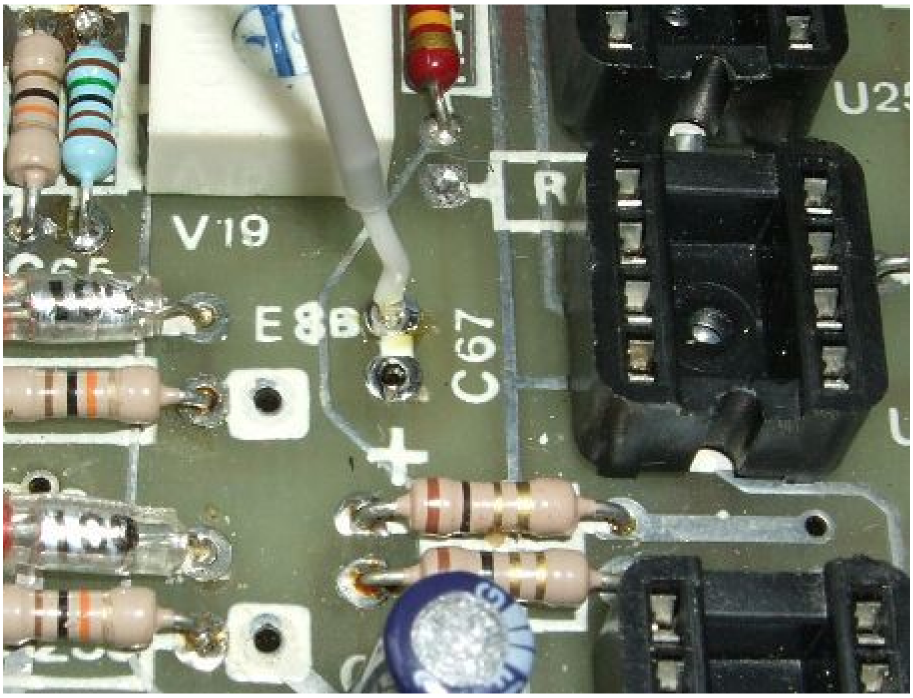


The DN34 BBD has two identical sets of BBD arrays. One, OUT2, carries a non inverted but delayed version of the input signal, the other, OUT1, carries an inverted and delayed version of the input signal. The two signals are added and processed together on the main board.

OUT2: This is connected to the lower solder pad of C60 – which is the negative terminal of C60.



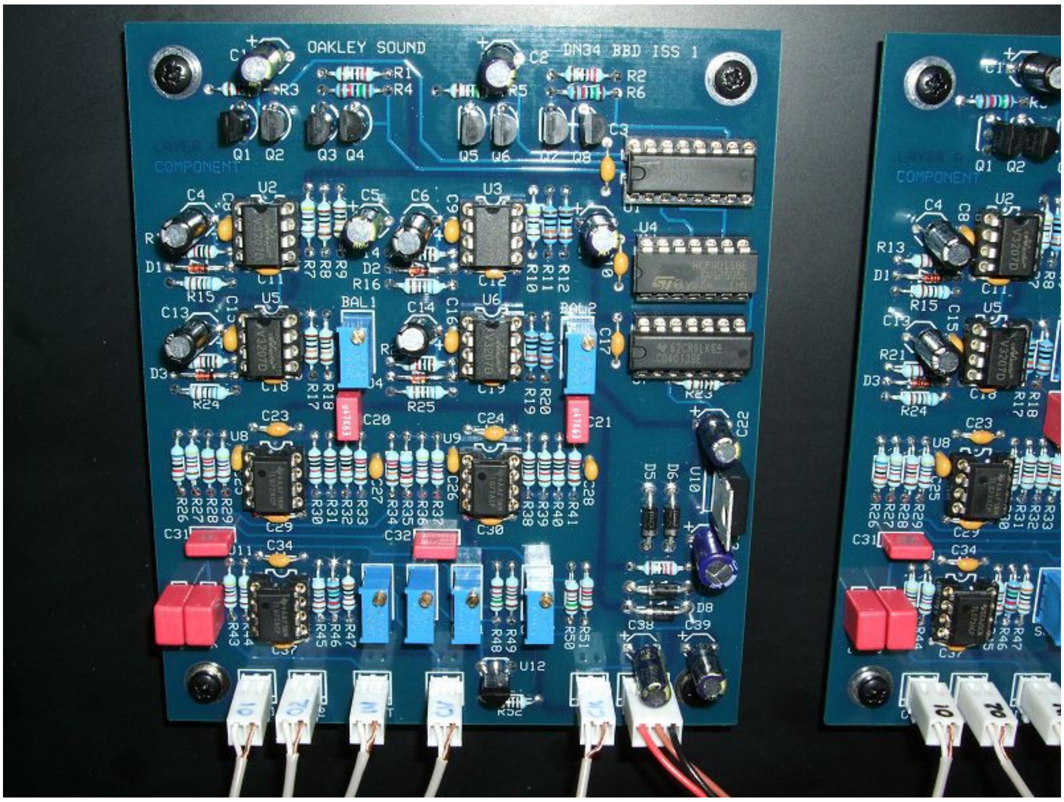
OUT1: This is connected to top solder pad of C67 – which again is the negative terminal of C67.



This then completes the interconnections for the DN34 BBD board for replacing channel B's SAD512D array.

Modifications to the DN-34 Main Board – For Channel A

This section assumes that you have already fitted and wired the DN34 BBD board that replaces the channel B BBD array.



The topological modifications required to make channel A suitable for use with the DN34 BBD board are the same as with channel B. However, because of the way the DN-34's main board is laid out, the positions of the modifications and interconnections are slightly different.

Firstly you need to remove the following ICs: Left hand U33 (4013), U29 (LM3900), U30 (LM3900) and all the remaining SAD512D BBDs (U21 to U28). Remember to keep any working SAD512D ICs as these are valuable devices.

Now we need to remove some soldered in devices. The following components need to be removed:

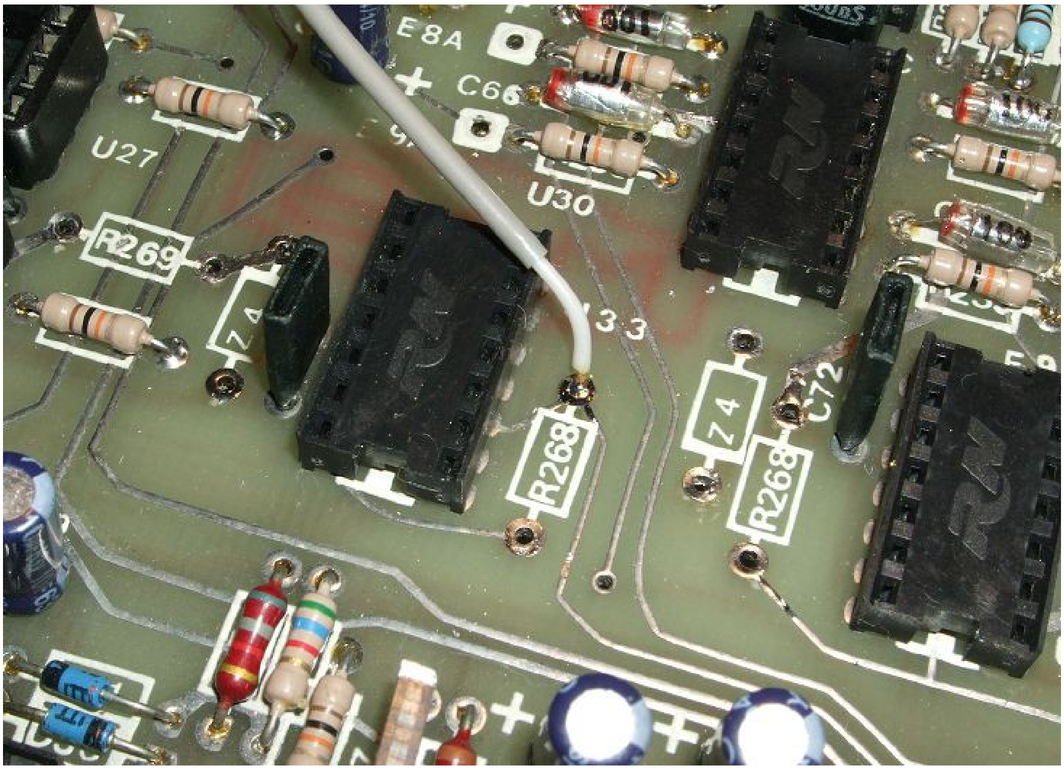
Z4 (an 8V2 diode) to the left of the left hand U33.

R268 (a 1K resistor) to the right of the left hand U33.

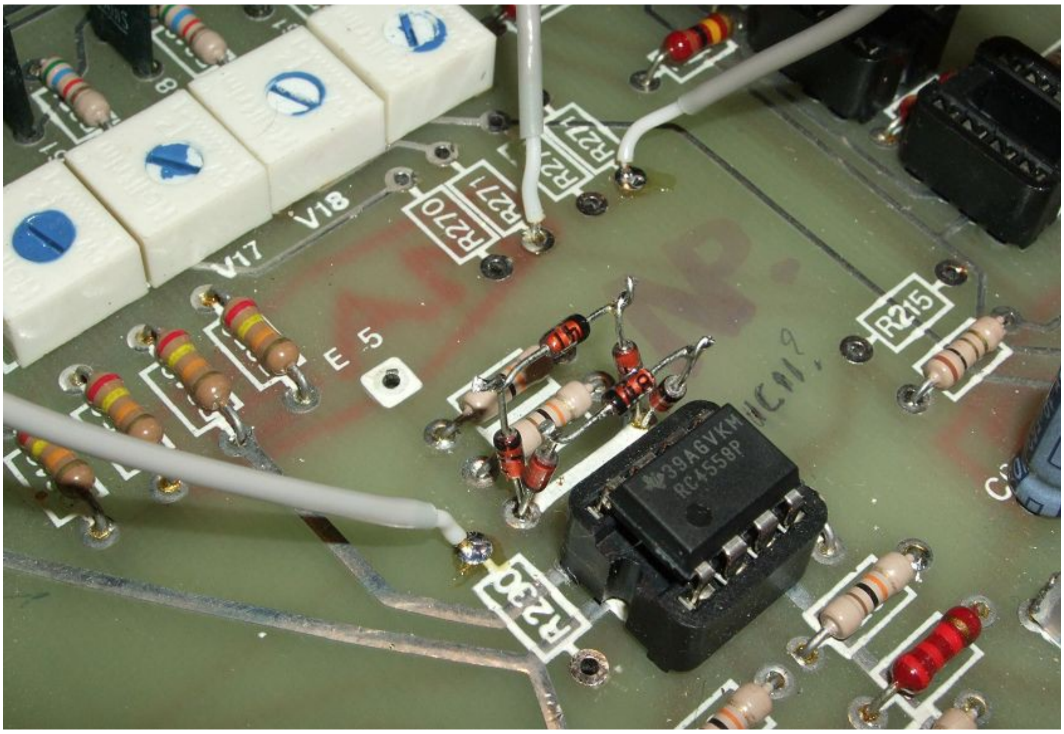
R270 and R271 (both 56K resistors) on the right hand side below the set of four trimmers at the top of the board.

R215 (a 2K2 resistor) next to an unmarked 8-pin IC (probably a MC1458) under the four trimmers. This IC is actually the left hand U11.

R230 (a 100K resistor) to the right of the unmarked 8-pin IC.



Remove Z4 and R268 around U33 on channel A. R269 does not need to be removed.

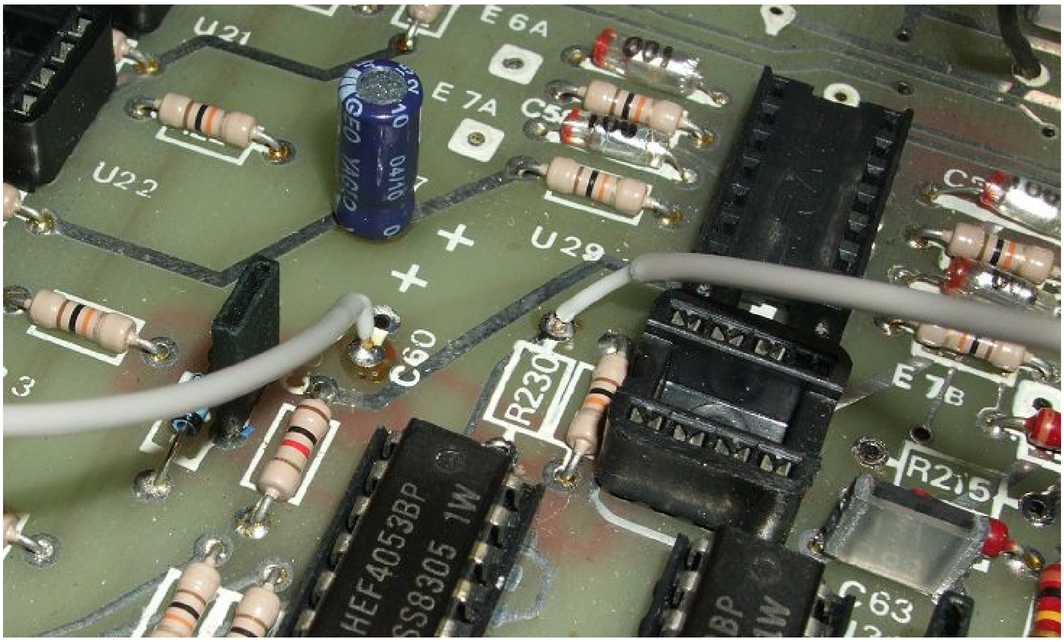


The unmarked 8-pin DIL IC which is actually IC11. Remove R215, R230, R270 and R271. You can ignore the diode network around IC11 – that is a modification that is not needed for the BBD replacement.

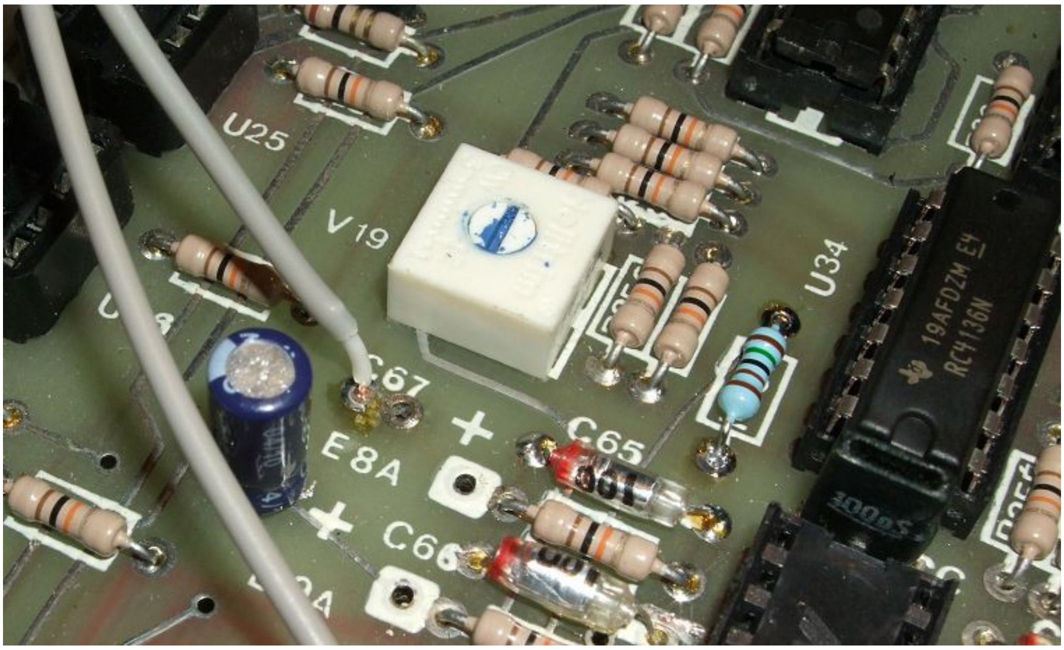
If the unmarked IC is actually a MC1458 or LM1458 then it would be wise to swap it for something better sounding. A TL072 or RC4558 work well enough in this application.

The next two components to be removed are C60 and C67. Both are radial electrolytic capacitors. C60 is to the left of channel B's R230. C67 is just under channel A's V19.

R258 (a 4K7 resistor) will need to be removed and replaced with a 1K5 resistor. R258 is immediately to the left of U34.



The right hand C60 needs to be removed.



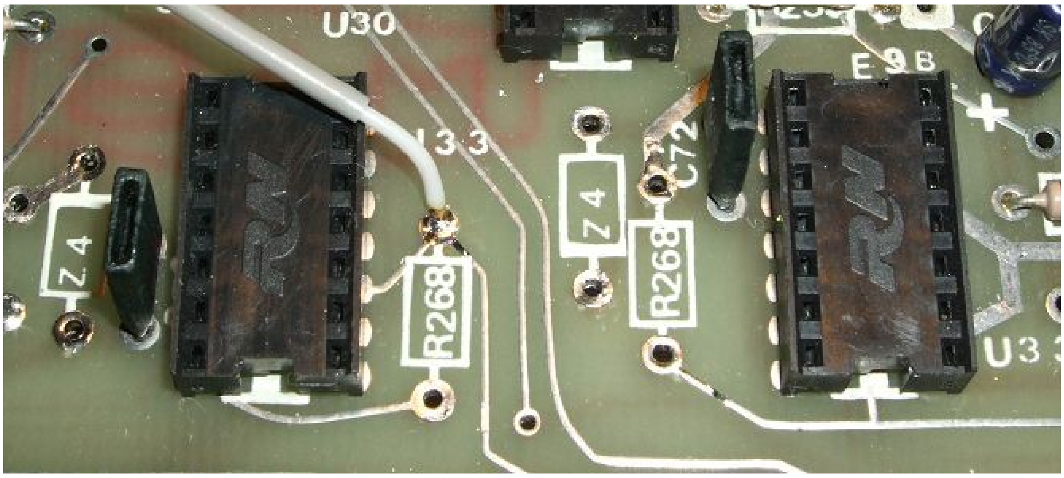
C67 is to be removed and R258 is now a 1K5 resistor (the light blue one).

Interconnections – For Channel A only

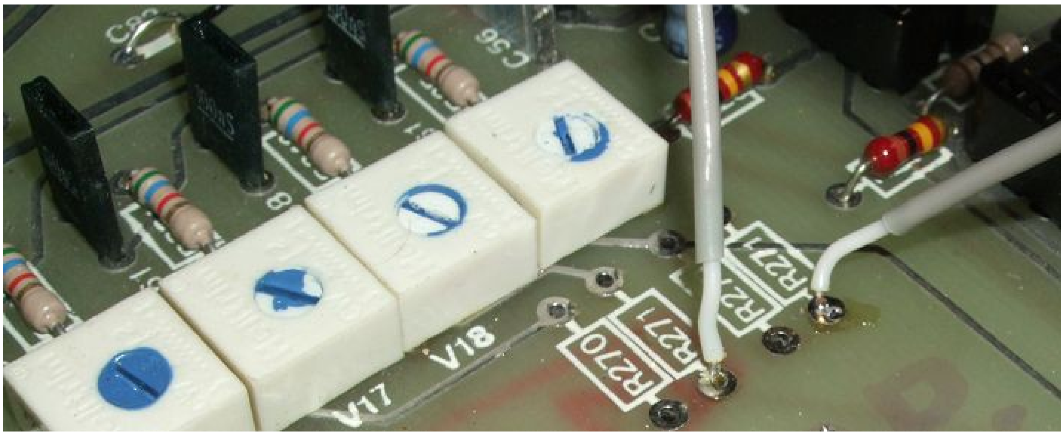
Like for Channel B there are six connections to be made and they should be made in much the same way as was done there. The three way power supply connector should be made up first and this has to connect to the very same parts as the wires done for Channel B.

Take special care with the 0V wires as both wires have to fit on the end of C87.

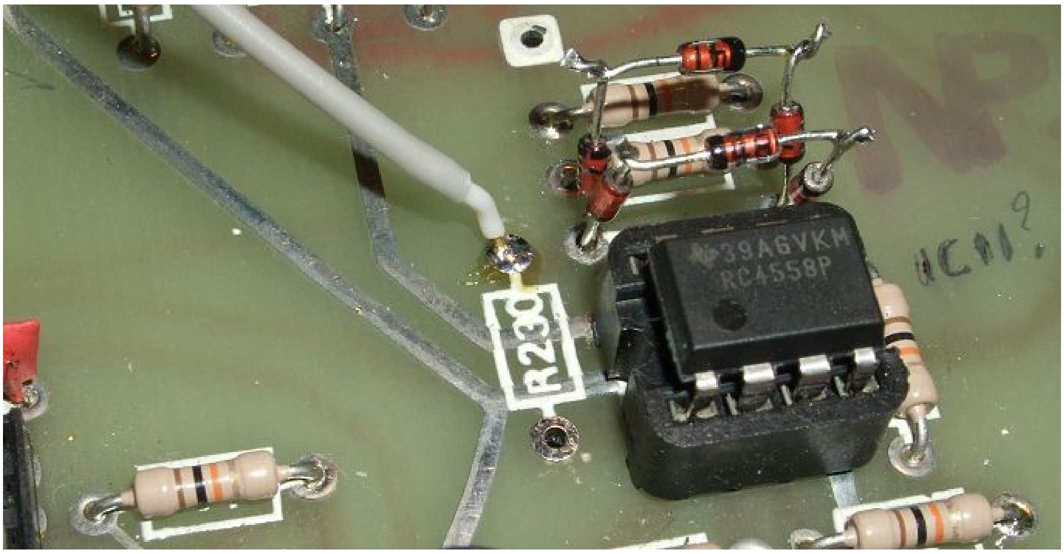
CLK: This carries the high frequency clock that controls the delay time of channel A. The core of the screened cable connects to the top pad of R268:



FCV: This connects to the bottom solder pad of the right hand R271:

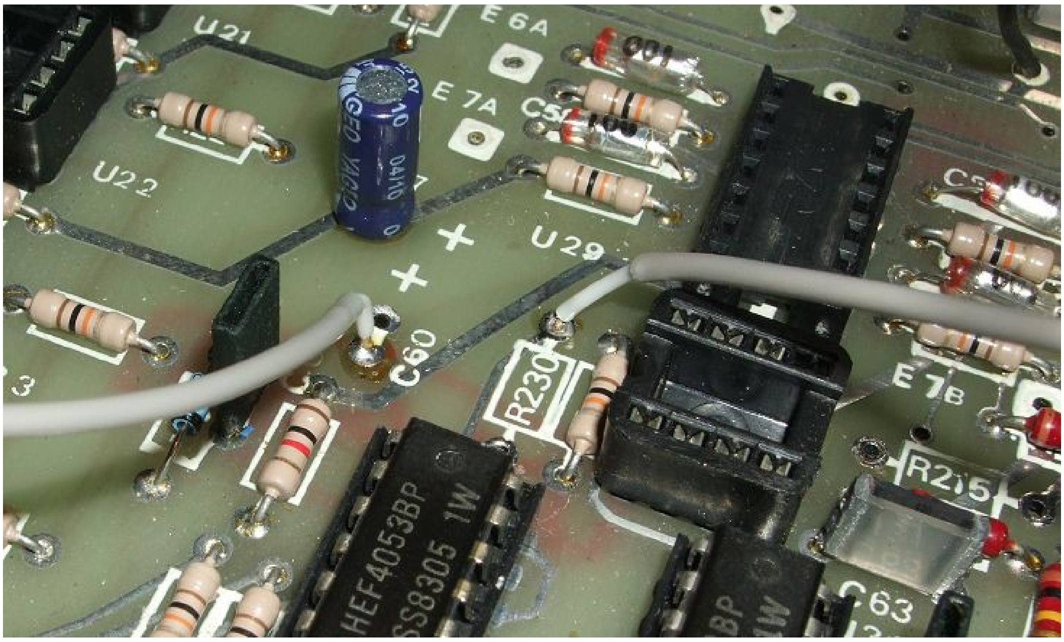


INPUT: This connects to the top solder pad of R230:

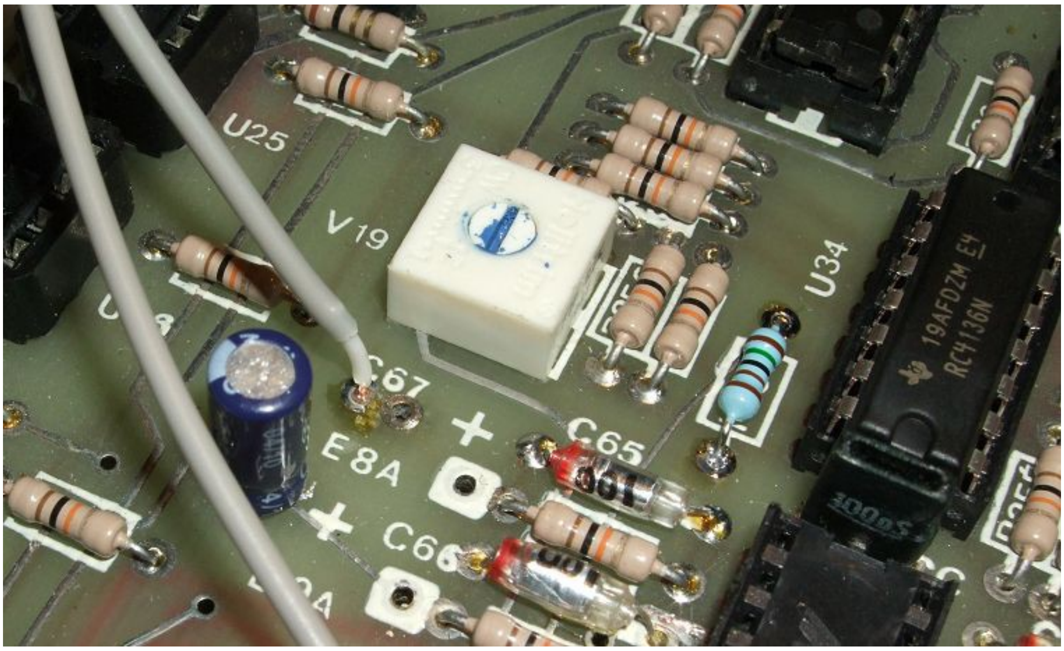


Ignore those six diodes in the picture above as they are part of my somewhat complicated 'noise reduction defeat' modification. They are not needed for the installation of the DN34 BBD boards. The diodes are there to capture any large peaks in the BBD's input signal when the DN-34's noise reduction is manually defeated.

OUT2: This connects to the lower solder pad of the left hand C60.

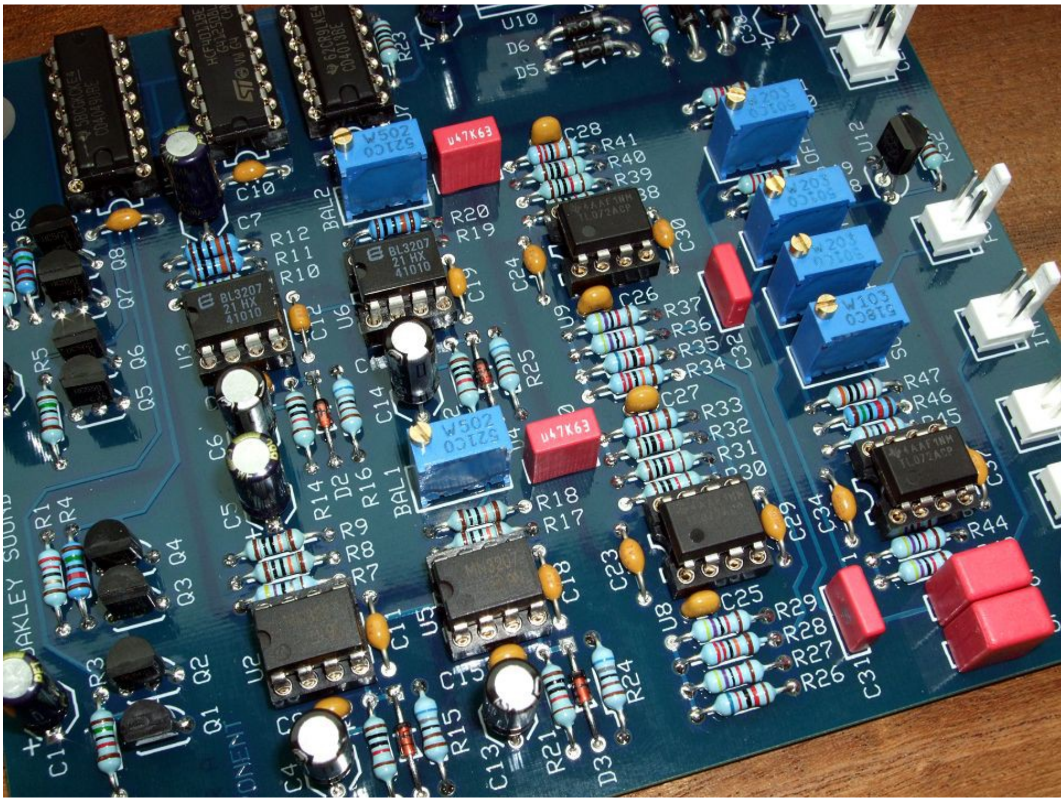


OUT1: This connects to the left hand solder pad of C67:



This then completes the interconnections for the DN34 BBD board for replacing channel A's SAD512D array.

Calibration



The DN34 BBD board has six trimmers to set correctly.

The unit should now be powered up and tested. Make sure that no components on the DN34 BBD board or boards are getting hot. If you have only fitted one DN34 BBD board then check the DN-34's channel A is still working as it should be. If you do try putting audio through channel B it may sound distorted or you may not hear audio at all. This does not necessarily indicate a fault but that the unit has not been calibrated yet.

To calibrate the DN34 BBD (and the DN-34 for that matter) you need to have access to an oscilloscope. All voltages and scope measurements should be done with respect to the DN-34's 0V (ground). The easiest way to access ground is the metal tab on U10 on the DN34 BBD board. Simply attach the scope probe's crocodile clip to the metal tab of U10.

Allow the DN-34 to warm up for about ten minutes or so. Set the input level and feedback level controls to their minimum value. Set the delay time on the channel we are calibrating to its maximum time. Using your scope or voltmeter measure the voltage on pin 7 of U11 on the DN34 BBD board. Adjust the SCL trimmer until the voltage is approximately 0.00V. Once done, you can then check that decreasing the delay time on the DN-34 increases this voltage. The response is not linear so expect the voltage to change in an interesting fashion with the movement of the control pot.

Now with a scope or voltmeter measure the voltage on the lower solder pad of R34 on the DN34 BBD board. This is the solder pad that is nearest to C32. Set the channel delay time to its minimum setting. Adjust HFT (high frequency tracking) until the voltage here is at 0V. What we are doing here is turning HFT completely off. We will adjust it again later.

Now increase the delay time to its maximum value. If your DN-34 is set up correctly the frequency of the clock signal available at pin 1 of U7 on the DN34 BBD board should be approximately 20kHz. If it is not, you can adjust this with the appropriate V21 on the DN-34's main board. Channel A's V21 is the left hand one, and channel B's V21 is the right hand side one just above test points E24 and E23. You may have to break the varnish seal on the trimmers to make this adjustment. Ultimately, you want the same frequencies being generated by both delay channel clocks when their front panel pots are in the same position. If you are only replacing channel B's BBD array then you can check the clock frequency of channel A by using your scope on pin 1 of the left hand U33 on the DN-34 main board.

With the clock frequency still at 20kHz, that is, the delay time is at its maximum, we can now check the balancing between the pairs of MN3207 devices. Using your scope monitor the signal at OUT1, you can use pin 7 of U8 on the daughter board. You should see a rather nasty looking signal of around several hundred millivolts that resembles a double edged sawtooth waveform. Each BBD is putting out a sawtooth style waveform and BAL1 will allow you to match, or balance, the levels of each sawtooth. Therefore adjust BAL1 until the waveform's amplitude is minimised. You will not be able to null the waveform – just get it to be as nice looking and small as you can.

Now do the same for OUT2, by scoping pin 7 of U9. If you find that you can't get an output nicely balanced then one of the BBD devices is probably out of specification. Try swapping one of the BBDs out for a different device. Note that BAL1 adjusts the balance between U2 and U5, and BAL2 adjusts the balance for U3 and U6.

Now it's time to put some audio through the DN-34 so we can set the two input offset trimmers and the high frequency tracking.

With both the DN-34's delay times set to their middle position connect an approximate 440Hz triangle wave to the DN-34. Adjust the input level so that the input level meter's green LEDs are all lit but the red is not.

With your scope look at the signal at OUT1, pin 7 of U8. It should be a triangle wave but you may see that the top or bottom parts of the waveform are clipped off. Adjust OFF1 and find the positions of OFF1 that the triangle wave becomes clipped at the bottom and then at the top. The ideal position for OFF1 will be exactly in the middle of these two extremes. You can may find turning up the input level on the DN-34 helps here, even if it means the red LED is lit.

Now do the same for OUT2, pin 7 of U9, but this time adjust BAL2.

Turn the delay time to its minimum time. We are now running the BBDs at their fastest and this causes the BBDs to behave in a non ideal way. To help us keep the signal integrity we have to lower the input offset voltage at these very high frequencies. This is the job of the high frequency tracking trimmer. Monitor again the signal at OUT1, pin 7 of U8. It will probably not look as good as it did before with the longer delay time. Adjust HFT until the triangle wave looks unclipped and clean again. You may notice that the triangle wave is a little smaller than at the longer delays. This is due to the inherent characteristics of the MN3207 and is nothing to worry about. There is only one HFT trimmer for both pairs of BBDs since input offset does not seem to vary too much from device to device if the same type of 3207 is used.

Check that lowering the delay time does not appreciably clip the signal. If it does you may need to change the two OFF trimmers again to find an workable compromise between the OFF trimmers and the HFT trimmer.

That completes the calibration of the DN34 BBD board but we have one more calibration to do on the main board. V19, which sets the gain of the audio signal in that particular channel, needs to be set so that the gains of both delay channels are identical and do not cause excessive feedback when the feedback level is turned up.

I find this adjustment is best done by ear. Set the delay on both channels to their middle positions and switch the DN-34 into parallel mode. Use the same 440Hz triangle wave as your input signal and listen the final output from the DN-34. By using the 'output pan' control, swiftly move between both channels are adjust the appropriate V19 until the signal level on both channels is the same. As usual there are two V19 trimmers, one controlling channel A on the left, and one controlling channel B on the right. If you have replaced just channel B then you need to be adjusting the right hand V19 trimmer next to the new 1K5 resistor.

I'm not sure whether the DN-34 is supposed to self oscillate when the feedback level is turned all the way up. However, I've set mine to do so and I quite like the effect. Adjusting the V19 trimmers to increase the signal level coming from each delay channel will allow for self oscillation.

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.

If you can't get your project to work and you are in the EU, 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, Tony Allgood, 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 builder's 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.

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 the Synth-DIY and Analogue Heaven mailing lists, and those at Muffwiggler.com.

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